FREEPORT-
McMoRan

STUDENT GUIDE

CONFINED SPACE
SFT FCX1003C

October / 2018
VERSION 2.1

"We start with looking after our workers' welfare."

Richard C. Adkerson
President and CEO, Freeport-McMoRan[1]

1. Richard C. Adkerson, "Richard Adkerson CEO Freeport-McMoRan Copper & Gold." *Youtube.com*, May 4 2011, Accessed July 2, 2015. https://www.youtube.com/watch?v=j61aFypdvgE

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FREEPORT-McMoRan

Freeport-McMoRan Inc.
Safety and Health Policy

The safety and health of all Freeport-McMoRan Inc. ("FCX") employees is of the highest priority and a core value of the company. Our objective is zero workplace injuries and occupational illnesses. Production and costs are critical to the well-being of the company, but these considerations must never take precedence over safety, employee health or protection of the environment.

We believe that all injuries and occupational illnesses are preventable. We further believe that safety and health considerations are integral to, and compatible with, all other management functions in the organization and that proper safety and health management will enhance rather than adversely affect production or costs.

A fundamental tenet of our policy is that there will be compliance with applicable internal and external safety and health standards. Safety and health is a line management responsibility and all safety and health policies and practices must be adhered to and actively supported by all levels of management. Each employee must take individual responsibility for his/her safety and that of their co-workers. It is the job of each employee to create a work environment that eliminates occupational health and safety hazards whenever possible. If a hazard cannot be eliminated, then employees must work together to ensure that it is effectively reduced or controlled. Assigning responsibility and determining accountability measures for safety and health performance are established at all levels of management. The Board of Directors will monitor and receive regular reports on outcomes and results.

We will measure progress to attaining our objectives against regularly established benchmarks. We will provide the training and resources necessary to achieve our safety and health benchmarks, and everyone will be held accountable for the results.

We will ensure that employees and contractors are properly trained and held accountable for following all prescribed safety procedures and practices. Safety and health issues will not be compromised. Each employee and contractor is responsible for their personal safety, the safety of others and the environment in which they work. No job will be considered so important, and no schedule so urgent, that time cannot be taken to perform work in a safe manner. Working safely is a condition of employment.

As a matter of philosophy and practice, we will hold all contractors operating at our facilities accountable for the same level of safety that we expect of ourselves. All contracts will include specific safety provisions designed to achieve this result. Regular audits of our contractor's safety compliance will be performed to ensure adherence with our policies and core values.

We will conduct comprehensive safety audits and industrial health audits on a regular basis at our operations to evaluate the status of compliance with our safety and health programs and will communicate that information to all levels of management.

The safety professionals working in our operating units are charged with assisting those units in achieving their safety and health objectives. They will assist management in developing and implementing effective safety programs, and will design the methods to effectively measure safety performance. They will also analyze compliance results and trends in order to make recommendations to improve performance.

We are committed to providing a safe and healthy workplace and to providing adequate resources through training programs, safety incentive programs, and occupational health programs to attain recognized leadership in matters of safety and health. We consider safety and health programs, both on and off the job, to be an investment in our most valuable resource - our employees.

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As amended by the Board of Directors through February 3, 2015

LEARNING OBJECTIVES

Learning objectives have been provided to establish guidance and focus throughout the course.

MODULE 1: EVALUATING A CONFINED SPACE

Upon completion of this module, students will be able to:

- Classify confined spaces, based on the three criteria.
- Discuss the characteristics of a permit-required confined space.

MODULE 2: PERMIT-REQUIRED CONFINED SPACE HAZARDS

Upon completion of this module, students will be able to:

- Discuss hazards associated with permit-required confined spaces.

MODULE 3: CONTROLLING CONFINED SPACE HAZARDS

Upon completion of this module, students will be able to:

- Analyze a scenario, evaluate the hazards, and recommend controls.

MODULE 4: ENTERING A CONFINED SPACE

Upon completion of this module, students will be able to:

- Demonstrate the process for entering a confined space.

COURSE INTRODUCTION

Every year hundreds of workers are needlessly injured or killed when confined space guidelines are not properly followed. According to the Department of Labor, there has been an average of 92 fatalities per year over ten years (1990-2000) involving confined space entries.[2]

Many workplaces contain areas which are defined as "confined" due to the constraints that limit the employee's ability to enter, exit, or perform their job. In addition, confined spaces are more difficult to evacuate in an emergency, or they make access to life-saving equipment more difficult. The words "confined space" should trigger a concern for added caution whenever any activity or task is performed.

We should all have the necessary knowledge and skills to recognize the hazards and select the safe work practices necessary to deal with these hazards. This course has been developed to explain the hazards of confined space work and the procedures required to control them.

If at any time you have a question, either in this class or while you are working in the field, it is your responsibility to stop and seek the answers you need. Do not proceed with any job if you have not been properly trained and are not sure of the correct steps to ensure you and your co-worker's safety.

This course is intended to satisfy the requirements of training for the roles of Entrant, Attendant, and Entry Supervisor.

2. "NIOSH Program Portfolio: Work Organization and ..," *CDC*, accessed April 14, 2016, http://www.cdc.gov/niosh/topics/confinedspace/.

FATAL RISKS AND CRITICAL CONTROLS

Fatal Risk Management is a continuation of the Fatality Prevention Program. Focus is placed on identifying Fatal Risks and Critical Controls in an attempt to safeguard all employees within the Company. The Fatal Risk Management Program standardizes Fatal Risk communication by implementing icons, definitions, and Critical Controls for twenty-three Fatal Risks.

Fatal Risks are based on safety issues that have resulted in catastrophic events such as severe injury or death. While all risks have a degree of danger, Fatal Risks are those risks that, when left uncontrolled, will kill you. After identifying a Fatal Risk, Critical Control(s) are implemented to prevent death or mitigate the consequences of the Fatal Risk. The absence or failure of a Critical Control significantly increases the risk of severe injury or death despite the existence of other controls. In short, Critical Controls help keep you from being killed. The Fatal Risk(s) and Critical Controls relevant to this course are provided below.

ENTANGLEMENT AND CRUSHING

The Entanglement and Crushing Fatal Risk is defined as contact with machinery/moving parts (entanglement, crushing, pinching, penetrating, and cutting forces)

Critical Controls

- Blocking for Maintenance Work
- Energy Isolation/LOTOTO
- Guards, Barriers and Barricades

EXPOSURE TO HAZARDOUS SUBSTANCES - ACUTE

The Exposure to Hazardous Substances Acute Fatal Risk is defined as workplace exposure to substances that are immediately toxic, asphyxiating, or corrosive (e.g. H_2S gas, NO_2 gas, CO gas, concentrated acids, caustics, etc.).

Critical Controls

- Access Control
- Alarm Systems
- Engineered Controls
- Handling Requirements
- Loading and Unloading Protection
- Mechanical Integrity of Storage and Distribution
- PPE

UNCONTROLLED RELEASE OF ENERGY

The Uncontrolled Release of Energy Fatal Risk is defined as exposure to stored energy from pressure (e.g., pneumatic systems, hydraulic systems, steam, tires, etc.); Items under tension or compression (e.g., mooring lines, springs, counterweights, etc.).

Critical Controls

- Energy Isolation/LOTOTO
- Guards, Barriers, and Barricades
- HDPE Management
- Hose Coupling Lock System
- Piping Hoses and Equipment Mechanical Integrity
- Relief Valves
- Tensioned Lines Management
- Tire Management

Evaluating a Confined Space

MODULE 1

MODULE 1: EVALUATING A CONFINED SPACE

MODULE 1 LEARNING OBJECTIVE

Upon completion of this module, students will be able to:

- Classify confined spaces, based on the three criteria.
- Discuss the characteristics of a permit required confined space.

INTRODUCTION

Confined spaces exist on all of our properties. They can be easily identifiable or more obscure, so it is important that you are able to recognize a confined space and take appropriate action. Whether the action is notifying management, classifying the space, or avoiding it, you need to be familiar with Freeport-McMoRan's Confined Space Policy (FCX-HS05) and Technical Supplement.

This module explains the criteria that defines a confined space, the types of confined spaces, and the roles of the people involved with entry. Familiarize yourself with these points, so that you are well-informed should you find yourself questioning the specifics of an area.

CONFINED SPACE CRITERIA

The term "confined space" refers to a space which by design has specific characteristics that may create additional hazards to workers.

Listed below are the specific characteristics of a confined space.

1. Space is large enough and so configured that an employee can bodily enter and perform assigned work.
2. Space has limited or restricted means of entry or exit.
3. Space is not designed for continuous employee occupancy.

To be considered a confined space, all three of the above criteria must be met.

Fig. 1 Rebricking in a confined space

Fig. 2 A ball mill is a confined space

LARGE ENOUGH TO ENTER

A confined space must be large enough for you to be able to enter with your whole body. This is only one of the three criteria for defining a confined space. Be aware once any portion of your body crosses into the space, the confined space has been entered.

Fig. 3 A crusher chute is large enough to enter

LIMITED OR RESTRICTED MEANS OF ENTRY OR EXIT

A space is considered to have limited or restricted means of entry or exit whenever the entrant's ability to escape or be rescued in an emergency situation is hindered. This includes any time the entrant cannot walk through the access standing upright and unimpeded, or must bend, stoop, crawl or climb (i.e. ladders) in order to access the space. This can also apply to areas with two exits if both of them are hard to get through, or if one is blocked by construction or debris.

Fig. 4 Tail launders have limited entry and exit locations

NOT DESIGNED FOR CONTINUOUS OCCUPANCY

Confined spaces are not designed for you to work inside them for long periods of time; while a tank may have an access door, the presence of a door does not necessarily mean that the space is not a confined space. For example, an office building is designed for human occupancy, and has ventilation, illumination, fire protection, and other life safety features. Meanwhile, a storage bin is designed to contain material, and does not provide any worker protection in its design. Spaces designed for continuous employee occupancy include offices, rooms, work areas, buildings, walkways, etc. Tanks, silos, bins, etc. are not specifically designed for you to work inside them for long periods of time.

Fig. 5 SX filters are not designed for continuous occupancy

Confined spaces are found in a wide range of work areas which you could encounter throughout your site. Each site keeps inventory of all recognized confined spaces. These confined spaces are labeled and easy to identify. Due to the complexity, age, and size of our sites, there is a chance that not all confined spaces have been formally recognized. Therefore, it is important for you to be able to recognize a confined space that has not been previously identified or properly labeled.

CONFINED SPACE EXAMPLES

The following are examples of confined spaces. This is not an all-inclusive list.

- Storage tanks
- Pits
- Vats
- Storage hoppers
- Boilers
- Ducts
-
- Sewers
- Manholes
- Furnaces
- Vaults
- Bins

NON-PERMIT REQUIRED CONFINED SPACES (NPRCS)

The vast majority of confined spaces at our different sites have already been identified and labeled. While signs are a good way to inform us of the presence and locations of confined spaces, it is important to note signs and labels can fade or become damaged over time and some spaces may get overlooked.

Anytime you have doubts whether an area should be classified as a confined space, contact your supervisor or health and safety professional.

Now that you have the ability to recognize a confined space, it is important to know they can be classified as either a Non-Permit Required Confined Space (NPRCS) or a Permit Required Confined Space (PRCS). This classification is extremely important as there are additional steps that must be followed to ensure your safety, if it is determined you are working within a PRCS.

"Non-Permit Required Confined Space" means a confined space:

- Does not contain any physical hazard capable of causing death or serious injury, and
- Does not have the potential to contain any atmospheric hazard capable of causing death or serious injury.

Notify management if signage is missing from a suspected confined space.

PERMIT-REQUIRED CONFINED SPACES (PRCS)

To be considered a PRCS, the confined space must:

- Contain or have the *potential* of containing a hazardous atmosphere.
- Contain a material that has the *potential* for engulfing an entrant.
- Have 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.
- Contain other recognized serious safety or health hazards.

If a confined space contains or has the potential to contain any one of the above hazards, it is by definition a Permit-Required Confined Space. The illustration below summarizes the criteria that defines a confined space, and how to classify these confined spaces as PRCS vs NPRCS.

Confined Space (Must contain all three of the following)

Large enough to bodily enter	Not designed for continuous occupancy	Limited or restricted means of entry or exit

Non-Permit Required Confined Space (NPRCS)	Permit-Required Confined Space (PRCS)
Contains no potential or existing hazard There is no such thing as NPRCS with a hazard; if any danger exists, the space is permit required.	Must contain one or more of the following hazards: • Atmospheric • Engulfment • Configuration • Any other serious hazard

HAZARDOUS ATMOSPHERE

"A PRCS contains or has a potential to contain a hazardous atmosphere."[3]

While hazardous atmospheres are covered in more detail in the following modules, it is important to understand what a hazardous atmosphere is.

Fig. 6 Acid tank is a hazardous atmosphere

A hazardous atmosphere is defined as an 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:

- Atmospheric oxygen concentration below 19.5% or above 23.5%.
- Flammable gas, vapor, or mist greater than 10% of the lower flammable or explosive limit (LFL or LEL).
- "Airborne combustible dust at a concentration that meets or exceeds its LFL"[4]
    - **Note:** This concentration may be approximated as a condition in which the combustible dust obscures vision at a distance of 5 feet (1.5 meters) or less.
- Atmospheric concentration in excess of the occupational exposure limit for any substance "capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects"[5] and which could result in employee exposure in excess of its dose or permissible exposure limit.
- "Any other atmospheric condition that is immediately dangerous to life or health"[6] (e.g. heat).

3. "Permit Required Confined Spaces," *OSHA*, accessed April 18, 2016, https://www.osha.gov/Publications/osha3138.html.

4. See comment 1

5. Subpart AA Confined Spaces in Construction, https://www.osha.gov/confinedspaces/1926_subpart_aa.pdf (accessed April 05, 2016).

6. See comment 1

ENGULFMENT

A PRCS contains material that has the potential for engulfing an entrant.

Engulfment is "the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing."[7]

Engulfment refers to situations where a confined space entrant is trapped or enveloped. The engulfed entrant is in danger of asphyxiation, either through suffocation when material is inhaled, or through the compression of their chest by the weight of the surrounding material. Grain, sand, dust, and water are examples of materials that may pose an engulfment hazard to employees.

Fig. 7 Tank has the potential for engulfment

INWARDLY CONVERGING WALLS

"A PRCS 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."[8]

Fig. 8 Dust collector has inwardly converging walls

Employees could fall into and may become trapped in a space containing inwardly converging walls or floors and suffocate due to pressure on the upper torso making rescue difficult.

Most entrapment hazards fall into one of three categories:

1. The "cone trap" – found in the bottom of cyclones and precipitators.
2. The "cylinder trap" – a pipe or similar opening in the bottom of a confined space big enough for someone to fall into. For example, the pipe leading up to an elevated water tower.
3. The "wedge trap" – converging walls that entrap someone who has fallen into them. They are commonly found in bins, larger boilers, and sand hoppers.

7. Definitions. - 1926.1202, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_i (accessed March 28, 2016).

8. See comment 6.

ANY OTHER SERIOUS HAZARD

A PRCS contains any other recognized serious safety or health hazard.

Any “serious safety or health hazard” is defined as any condition that poses a threat to life, which could cause irreversible health effects, or would interfere with the ability to escape unaided from the space.

Examples of serious health hazards can include, but are not limited to:

- Temperature
  - Steam
- Moving parts
  - Agitators
  - Pumps
  - Conveyors
- Fall hazards
- Chemical
- Biological
- Wildlife
  - Rodents
  - Snakes
  - Spiders
- Electrical

Fig. 9 Chemical hazards at SX settlers

Note: The work you are performing within a confined space may be what causes the serious safety or health hazard (e.g. welding, high noise, PPE).

This is not an all-inclusive list of the hazards that classify a space as a PRCS. It is important to determine whether exposure to a hazard in a confined space will impair the ability to self-rescue. Remember to follow your site’s LOTOTO policy and procedure to isolate all rotating, moving mechanical, moving equipment, or energy sources that could create a hazard within a confined space.

ROLES

Confined space entry cannot be performed alone. With the risks involved, it is important that multiple people are included. This group of individuals is called the entry team. A typical entry team consists of an entrant, an attendant, and an entry supervisor.

For any PRCS entry, a minimum of two individuals is necessary. These individuals will be classified as either the entrant or the attendant.

The responsibilities for the roles are described below.

Entrant	• Communicate with the Attendant • Inspect for hazards within the space • Wear designated PPE

Attendant	• Control access to the PRCS:
	  o Maintain an accurate count of entrants
	  o Do not allow unauthorized entry
	• Communicate with the authorized entrants
	• Monitor entrant(s) activities and conditions
	• Maintain retrieval lines/system
	• Manage emergencies
	• Attendant may not perform any other duties

Entry Supervisor	• Define all Risks and Controls • Establish in writing all acceptable entry conditions • Conduct a pre-entry meeting with all confined space team members • Ensure that the atmospheric tests is conducted and recorded • Ensure all members have been trained in Confined Space entry • Ensure that rescue services are notified and available, and that the means for summoning them are operable • Ensure acceptable entry conditions are in place before anyone enters the space and that conditions remain safe throughout the entry • Maintain the confined space permit • If hazardous conditions arise that are Immediately Dangerous to Life and Health (IDLH), immediately evacuate the space

MODULE 1 QUIZ

Complete the following quiz.

1. What are the four conditions that make up a Permit Required Confined Space (PRCS)?
    a. No hazards, large enough to bodily enter, limited or restricted entry and exit, and not designed for continuous occupancy
    b. Atmospheric hazards, inwardly converging walls, engulfment hazards, or any other serious hazard
    c. Unrestricted air flow, no hazardous conditions, no entry required, and open to the outside air
    d. Clean, dry, odorless, and colorless

2. What conditions define a space as a Non Permit Required Confined Space (NPRCS)?
    a. No potential for atmospheric hazards and no hazard capable of causing death or serious harm
    b. All potential hazards controlled and normal air
    c. Normal air and all hazards controlled
    d. NPRCSs do not exist

3. A confined space must be large enough to bodily enter, not be designed for continuous occupancy, and have limited entrances and exits.
    a. True
    b. False

Permit-Required Confined Space Hazards

MODULE 2

MODULE 2: PERMIT-REQUIRED CONFINED SPACE HAZARDS

MODULE 2 LEARNING OBJECTIVE

Upon completion of this module, students will be able to:

- Discuss hazards associated with permit-required confined spaces.

INTRODUCTION

Confined spaces present a unique safety challenge because their hazards are deceiving and may not be readily apparent. Also, confined spaces may have been previously entered with no apparent signs of danger. However, conditions within a confined space can change very rapidly; with hazards that are not visible, you can never assume the space is safe for entry each time.

Confined spaces typically have poor ventilation and may be of limited size and restricted access; this combination can quickly increase the potential for toxic gases, vapors, fumes and other hazardous atmospheres to develop. Work in confined spaces can also increase the risk of injury or death by making employees work closer to hazards than they otherwise would, or by creating additional hazards such as engulfment. When emergencies do occur, limited access can prohibit a timely rescue by emergency personnel.

These conditions can result in hazardous situations which do not arise in an open workplace. First and foremost, it is important to recognize what a confined space entry is and some of the reasons for entering them.

Confined space incidents have occurred when the workers did not realize or were unaware of the dangers or potential dangers existing in or around the space, or did not consider any new hazards that were created as a result of the work. When planning a confined space entry, you must take into account any existing hazards and any hazardous conditions that could be generated or introduced by the work you will be performing. Therefore, it is important to plan for any current or potential hazards in a confined space before entering a space.[9]

To effectively understand all of the hazards associated with a confined space, we must also understand the hazards associated with entry into a confined space. By initially treating all confined spaces as permit required, we eliminate the potential for serious injury at the expense of a little extra time.

Fig. 10 Railcar as a PRCS

9. Atmospheric Hazards Confined Space free online training, https://www.oshatrain.org/courses/mods/713m4.html (accessed March 24, 2016).

ATMOSPHERIC HAZARDS

By their very nature, confined spaces have poor ventilation, and "the atmosphere inside of a confined space can be very different from the atmosphere outside. There may not be enough oxygen inside the space to support life, or the air could be so oxygen-rich that it is likely to increase the chance of fire or explosion if a source of ignition is present. Deadly gases may be trapped inside, particularly if the space is used to store or process chemicals."[10] A hazardous atmosphere may result from the work being done in the space such as welding, application of coatings, removal of sludge, etc.

Fig. 11 Acid plant has atmospheric hazards

According to OSHA, most deaths and injuries in confined spaces are related to atmospheric hazards.[11] Atmospheric hazards are controlled in several ways and the most important tool at your disposal is your monitor.

NORMAL AIR

The air we breathe is 99% comprised of two gases: oxygen (21%) and nitrogen (78%). The remaining 1% is made up of an assortment of other gases, such as argon, carbon dioxide, and methane. Our bodies are designed to survive within small variations to these amounts. Oxygen levels must always be between 19.5% and 23.5% in order to maintain a safe atmosphere.

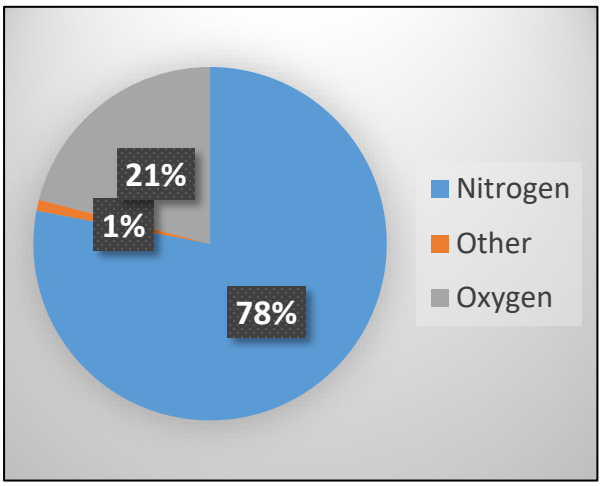

Fig. 12 Example of normal air breakdown

10. A Guide to Safety in Confined Spaces - CDC, http://www.cdc.gov/niosh/docs/87-113/default.html (accessed March 24, 2016).

11. Section 2 – II. Hazards – Occupational Safety & Health Administration, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=PREAMBLES&p_id=839 (accessed April 7, 2016)

OXYGEN-ENRICHED AIR

When the oxygen content of the air is greater than 23.5%, it is considered an oxygen-enriched atmosphere. An atmosphere rich in oxygen does not, by itself, pose a hazard to people. That being said, oxygen-enriched environments can be more prone to accelerated and explosive combustion. If an ignition source is present, materials not normally considered a fuel source can become one. Due to this fact, if you find yourself in an oxygen-enriched atmosphere, calmly evacuate while taking care not to risk ignition, such as dropping metal tools onto a surface or using electrical equipment not already in operation.

Avoid hazards within an oxygen-enriched environment by following the guidelines below.

- Never bring any compressed gas tanks/cylinders inside of a confined space except supplied breathing air.
- Always remove welding lines/hoses, if exiting the confined space for a break.
- Never ventilate with pure oxygen.

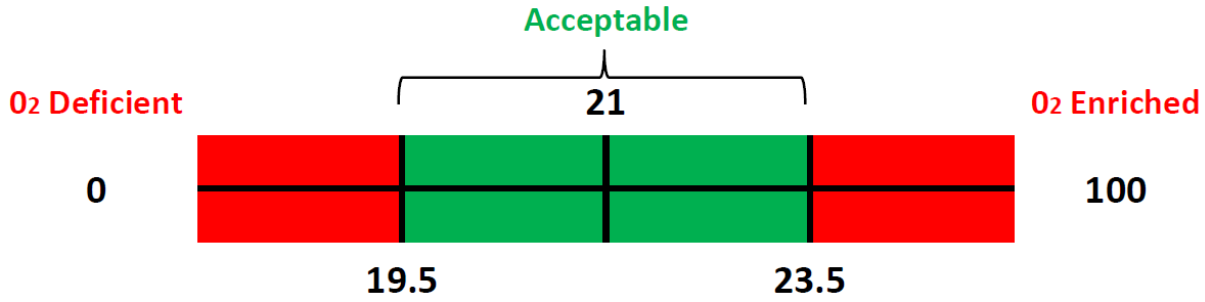

Fig. 13 Range for acceptable and unacceptable oxygen levels

OXYGEN DEFICIENT (LESS THAN 19.5%)

Oxygen levels under 19.5% are inadequate for a person to be able to breathe, causing suffocation, even if the space contains no toxic materials.

CAUSES OF OXYGEN DEFICIENCY

Oxygen deficient atmospheres in a confined space may be the result of either consumption or displacement.

Consumption

Consumption is the process of removing oxygen from the air through usage. Additional information about consumption is listed below.

- Combustion of Flammable Substances: welding, heating, cutting, and brazing consumes oxygen
- Bacteria: consume oxygen as they grow
- Chemical Reactions: Oxygen may also be consumed during chemical reactions as in the formation of rust (iron oxide) on the exposed surface of the confined space, or even consumed by materials like activated charcoal. While this process is very slow, any vessel that has been in service for a long period of time may have an oxygen deficient atmosphere.
- People: working inside of a confined space deplete the oxygen as they breathe. The more physical the activity, the faster the oxygen is consumed within the confined space.

Displacement

Displacement is the movement of oxygen by another gas to a different location. Additional information about displacement is listed below.

- Gases: such as helium, argon, and excess nitrogen are capable of displacing oxygen, and, therefore, reducing the oxygen levels in a space.
- Carbon dioxide may also displace air and can occur naturally in sewers, storage bins, wells, tunnels[12] or as a result of vehicle exhaust.
- Vapors: Released during the application of coatings.

12. Permit Required Confined Space (OSHA 1910.146), https://www.osha.gov/dte/grant_materials/fy11/sh-22230-11/ConfinedSpaceManual.pdf (accessed March 24, 2016).

EFFECTS OF OXYGEN DEFICIENCY

If the levels of oxygen in your work area are changing, there is a reason. Something is consuming or displacing the oxygen. Leave the space immediately and notify supervision so that everyone understands the reasons for the changes.

- Can cause an accelerated heartbeat, impaired attention, impaired thinking, impaired coordination, convulsive movements and even death.
- Most combustible gas monitors (LEL) are oxygen dependent and do not provide reliable readings below 19.5%.
- Victims of an oxygen deficient atmosphere are often unaware of their predicament until it is too late.

Learn from Others

In February 2010, two welders made an unauthorized entry into a confined space. The welders connected a pipe to a nozzle on a heat exchanger vessel then requested the pipefitters shut off the argon source which supplied the weld purge. Due to complexity of the bottle set-up, one bottle was inadvertently left open.

As one welder re-entered the vessel head to inspect the weld, he inadvertently drew the still-flowing argon hose inside, increasing the argon concentration of the atmosphere. He was overcome by a low oxygen atmosphere due to displacement of argon gas.

When the second welder saw his co-worker in physical distress, he called for help and entered the space to rescue him. He, too, was overcome by the lack of oxygen. A pipe-fitter responded to the cries for help and alerted the supervisor who took charge and initiated the rescue. Tragically, both welders were pronounced dead after recovery.

Fig. 14 Workplace where incident occurred

"Learn from Others" Incident[13]

13."Incident Review – Confined Space Double Fatality," *Methanex*, (accessed May 19, 2016), http://miningquiz.com/pdf/Confined_Space/Egypt_Double_Fatality.pdf.

FLAMMABLE GASES AND VAPORS

This category of hazardous atmospheres includes atmospheres containing gases such as methane or acetylene, or vapors of solvents or fuel such as gasoline, kerosene, or toluene. Flammable gases or vapors can be dangerous because of the threat of fire and explosion.

Note: Always follow your area's Hot Work procedures and guidelines.

Ensure tanks or cylinders of compressed gases, (acetylene, oxygen, etc.) other than breathing air, are prohibited in confined spaces. All welding leads, cutting torch hoses, hose extensions, etc. should only be used within the space when welding or cutting is required and must be removed from the space when not in use.

FIRE TRIANGLE

There are three ingredients are necessary for an atmosphere to become flammable or explosive.

- Heat (ignition source)
- Fuel (combustible gas or vapor)
- Oxygen

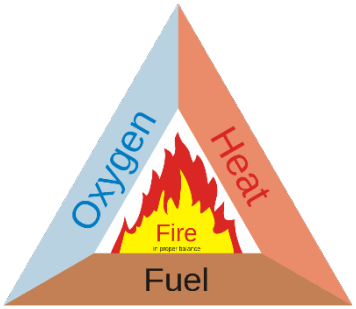

Fig. 15 Fire Triangle

EXAMPLES OF FLAMMABLE GASES/PRODUCTS

Listed below are some examples of flammable gases and products. This list is not meant to be all-inclusive. Check with your supervisor or health and safety professional for a list of flammable gases or products in your workplace.

- Propane
- Methane
- Leaking oxygen/acetylene hoses
- Hydrogen
- Hydrogen sulfide
- Evaporated flammable liquids (gasoline & toluene)
- Epoxy coatings
- Paints
- Surface prepping solvents
- Oils/fuel oils
- Dust

LOWER EXPLOSIVE LIMIT (LEL)

The lowest concentration (air-fuel mixture) at which a gas can ignite. Concentrations below this limit are too lean to burn and as a precautionary standard need to remain below 10% for entry into a confined space.

UPPER EXPLOSIVE LIMIT (UEL)

The highest concentration at which a gas ignites is called the upper explosive limit. When the concentration exceeds the UEL, then the mixture is too rich to burn.

Fig. 16 Illustration of explosive limits

POTENTIALLY TOXIC AIR CONTAMINANTS

The term "toxic atmospheres" refers to atmospheres containing gases, vapors or fumes known to have poisonous effects. These could be present if a chemical is in use or residue remains inside the space from a previous process.

Some toxic atmospheres can produce delayed harmful effects which may not manifest until hours or days later, while others may be immediate and kill quickly. Some toxins have both effects.

For example, carbon disulfide at low concentrations may exhibit no immediate sign of exposure, yet it can cause permanent and cumulative brain damage as a result of repeated exposures. At higher concentrations, it can kill quickly.

Toxic atmospheres in confined spaces can be caused by the following scenarios listed below.

- Products stored in the space: The product may contain a toxic component, which is then absorbed into the walls of the vessel. It can also have the potential for release depending on the use of the space or location, such as beneath sludge or crust being removed.
- Areas adjacent to the confined space: Toxins produced by nearby work can enter and accumulate in confined spaces. Example: nearby engines can produce carbon monoxide (CO).
- Type of work being performed: welding, cutting, brazing, painting, scraping, sanding, and the use of cleaning solvents can generate toxic atmospheres. The vapors from these solvents can build up to toxic or even explosive levels.

Fig. 17 Potential for vapors, gases, and fumes at sulfuric acid plants

EXAMPLES OF TOXIC CONTAMINANTS

Many toxic gases can be found in a confined space. Methane, carbon monoxide, and hydrogen sulfide are three examples. It is important to be aware that the type of gas can have a drastic impact on how it mixes with normal air inside the confined space.

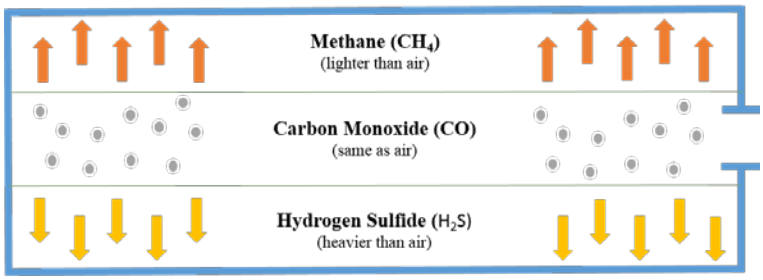

Fig. 18 Layering gases within a space

Methane

Methane (CH_4) is a naturally occurring compound and is a component of natural gas. "It is a flammable, explosive, colorless, and odorless gas. It can displace oxygen to the point of oxygen deficiency in a confined space, causing dizziness, unconsciousness, and asphyxiation."[14] Methane is lighter than air and, barring any air movement, will tend to accumulate in the upper portion of the confined space. Methane is considered a simple asphyxiant and will displace oxygen. This can result in an oxygen deficient atmosphere.

Carbone Monoxide

Carbon monoxide (CO) is a colorless and odorless gas that will mix evenly with normal air in a confined space. It can cause headaches, dizziness, unconsciousness, asphyxiation, and death. Unlike methane, carbon monoxide is a chemical asphyxiant that will prevent oxygen absorption in the bloodstream. Since it is a chemical asphyxiant, carbon monoxide will also accumulate in your system regardless of the amount of oxygen present. Sources include incomplete combustion from equipment, such as an engine or in smoke from a fire.

Hydrogen Sulfide

Hydrogen sulfide (H_2S) is similar to carbon monoxide in that it is a chemical asphyxiant, but different in that it will tend to settle at the bottom of a confined space. H_2S is found at many of our sites as it is a byproduct from some Molybdenum and Mill processes.

It is a flammable and poisonous gas. H_2S has a distinct odor of rotten eggs at low concentrations and will cause olfactory fatigue (the nose stops perceiving its smell). H_2S can block respiration so quickly, that it is commonly referred to as a "knockdown gas." It can cause a rapid loss of consciousness, and even death, with only a few breaths.

While you may not be exposed to these specific gases at your site, it is important to understand how certain gases will layer themselves within a confined space. Therefore, it is necessary to test all areas (top, middle, and bottom) of a confined space with properly calibrated instruments.[15]

14. Atmospheric Hazards Confined Space free online training, https://www.oshatrain.org/courses/mods/713m4.html (accessed March 24, 2016).

15. A Guide to Safety in Confined Spaces - stacks.cdc.gov, http://stacks.cdc.gov/view/cdc/5830/cdc_5830_DS1.pdf (accessed March 24, 2016).

HOW TO PROTECT YOURSELF

Read product labels and utilize the SDSs, which refer to the manufacturers' specifications.

- Determine appropriate type of PPE.
- Know and understand the exposure symptoms of the chemicals you are working with.
  Note: Cleaning solvents, epoxies, paints, etc. can emit dangerous fumes.

Be aware of any chemicals used or generated in your specific area, such as:

- Carbon monoxide.
- Sulfur dioxide.
- Hydrogen sulfide.
- Any residues remaining in vessels.

Note: Ask questions about the materials you use. Contact a Health and Safety Professional or an Industrial Hygienist to help clarify what equipment to use and the correct way to deal with specific hazards.

Fig. 19 Understanding the job and materials can make your task safer

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH)

An IDLH atmosphere is any condition that poses an immediate or delayed threat to life; one that could cause irreversible adverse health effects; or one that interferes with an individual's ability to escape unaided from a confined space. Confined spaces with an IDLH atmosphere must not be entered unless entry is a rescue performed by a properly trained and equipped emergency rescue team or is specifically required and detailed procedures are followed. If a hazardous atmosphere is detected, the space shall be immediately evacuated and evaluated to determine how the hazardous atmosphere developed. Re-entry can only occur once the source of the hazardous atmosphere has been identified and is appropriately controlled to a safe level.

IDLH is any condition that can:

- Cause death (immediate or delayed).
- Permanent health effects.
- Prevent escape.

Entrants must evacuate the space immediately if any of these three atmospheric IDLH conditions exist:

- Oxygen-rich/deficient.
- >10% of LEL/LFL.
- Toxic gases have reached their IDLH limits.

IDLH values can be found at the locations listed below.

- SDS and H&S
- Regulatory agencies
- The US National Institutes of Occupational Safety & Health (NIOSH) publishes guidance on IDLH values in NIOSH's online Pocket Guide to Chemical Hazards (refer to www.cdc.gov/NIOSH).

Note: Always consult with your area health and safety representatives before dealing with any conditions associated with IDLH.

Fig. 20 Attending an IDLH confined space

IDLH ENTRY REQUIREMENTS

A situation may develop where personnel believe it is necessary to enter an IDLH space for a reason other than a rescue, such as the prevention of a severe production interruption. In this case, all feasible efforts must be made to eliminate the IDLH atmosphere through means such as purging the space with air, an inert gas

Note: This method creates another type of IDLH or by ventilating the space.

If these efforts are not successful, and an IDLH space must still be entered to prevent a severe event, a health and safety representative with expertise in confined space entry and a manager-level or higher department leader shall discuss the need for entering into the space. If entry is necessary, then a plan of action is developed and documented with a new permit, meeting the requirements defined below.

- Use of any electrical equipment in areas where a flammable atmosphere exists must be intrinsically safe. This determination is made during the pre-entry atmosphere survey. An atmosphere reading 10% of the lower explosive limit (LEL) shall be considered a flammable atmosphere for these purposes.
- Entrants use respiratory protection ("pressure demand or other positive pressure SCBAs, or a pressure demand or other positive pressure supplied-air respirator with auxiliary SCBA"[16]) and skin protection that is appropriate for the IDLH atmosphere.
- One trained attendant or, when needed, more than one trained attendant is located outside the IDLH atmosphere.
- "Visual, voice, or signal line communication is maintained between the entrants and the attendants located outside the IDLH atmosphere."[17]
- A backup rescue team is located immediately outside the IDLH atmosphere, and is trained and equipped with the following to provide prompt and effective emergency rescue:
  - Pressure demand or other positive pressure SCBAs, or a pressure demand or other positive pressure supplied-air respirator with auxiliary SCBA
  - Appropriate skin protection for the IDLH atmosphere
  - "Appropriate retrieval equipment for removing the employee(s) who enter(s) these hazardous atmospheres where retrieval equipment would contribute to the rescue of the employee(s) and would not increase the overall risk resulting from entry"[18]

16. Respiratory Protection. - 1910.134, https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=12716&p_table=ST (accessed March 29, 2016).
17. See comment 13
18. See comment 13

ENGULFMENT HAZARDS

"Engulfment is the surrounding and effective capture of a person by a liquid or flowable solid." [19] This means there is a potential for material to fall/flood around an employee effectively trapping him. This is one of the leading causes of death from physical hazards in confined spaces.

The releasing of material through lines into a confined space can pose an engulfment hazard. "All lines should be physically disconnected, blanked off, or a double block and bleed system should be used."[20]

"In some cases, material being drawn from the bottom of storage bins can cause the surface to act like quicksand. When a storage bin is emptied from the bottom, the flow of material forms a funnel-shaped path over the outlet. The rate of material flow increases toward the center of the funnel. During a typical unloading operation, the flow rate can become so great that once a worker is drawn into the flow path, escape is virtually impossible."[21]

The behavior of such material is unpredictable, and entrapment and burial can occur in a matter of seconds. If the confined space is a trench or excavation, ensure the retaining walls are sufficient and meet all applicable Trenching/Excavating standards.

Note: Engulfment hazards are associated with storage bins, silos, and hoppers where sand, gravel, or other loose material are stored, handled, or transferred. Retrieval lines are required anytime you enter these areas.

Fig. 21 Potential for engulfment in this tank

19. See comment 6

20. OSHA Compliance Manual: November 2010, http://osha-compliance-manual.blogspot.com/2010_11_01_archive.html (accessed March 24, 2016).

21. Preventing Entrapment and Suffocation Caused by the .., http://www.cdc.gov/niosh/docs/88-102/default.html (accessed March 24, 2016).

INWARDLY CONVERGING WALLS

Inwardly converging walls are walls that slope or taper down to a small area, such as tanks, hoppers, and chutes. The hazards inwardly converging wall can create in a confined space are slipping or falling hazards. These allow employees to enter into a smaller space. The employee then may become trapped or asphyxiated by loose materials that have fallen from the vertical walls.

Gases or toxins that are heavier than air migrate to the smaller area creating a hazardous atmosphere by displacing oxygen causing an oxygen deficient atmosphere. Also, the smaller volume of space may increase the vapor concentration creating an explosive atmosphere. If hot work is performed, it could provide the ignition source to cause an explosion or fire.

Below are some common locations where inwardly converging walls can be found.

- Dust collectors
- Thickeners
- Flotation cells/tanks
- Feed chutes
- Ball bins
- Sumps (large enough to enter)

Fig 22 Silos have inwardly converging walls

OTHER SERIOUS HAZARDS

While atmospheric hazards, engulfment hazards, and inwardly converging walls are three of the most predominant causes of fatalities when working within a confined space, it is important to take into account other serious hazards. Physical hazard accidents are on the rise. It is important not to overlook or become complacent with normal workplace risks. This includes risks related to being caught within a machine, struck by material, slips/trips/falls, and even heat-related illnesses.

ELECTRICAL

Electrical vaults and structures can result in confined space hazards, due to the fact that these areas may not be commonly entered. This is especially true for areas below ground level. The air inside may degrade and become oxygen deficient, or some other gas may have entered the space undetected. These electrical installations should be treated as PRCS until air monitoring has been completed.

The most common electrical hazard found in confined spaces is a result of electric power tools and equipment brought into the confined space. The electrical hazard results because there was not an approved grounding system or the protection afforded by ground-fault circuit interrupters or low-voltage systems.

While not specifically an electrical hazard, a hazard typically found on our operating sites are magnetic fields. These fields, generated by large magnets, can affect pacemakers or other medical devices, as well as instrumentation that may be needed to perform the work. Ensure you perform proper LOTOTO procedures when working with or around electricity.

Fig. 23 Electrical conductors under a concentrator

MECHANICAL

Mechanical energy can be identified as either stored energy or energy of motion, and is the second most common form of energy, behind electricity, found in our workplace.

Mechanical hazards typically exist where electrical and mechanical equipment are inside the confined space, such as mixers, agitators, and float valves. Ensure you perform proper LOTOTO procedures.

Fig. 24 Mechanical hazards exist inside tanks

FLUID PRESSURE

Liquids flowing into confined spaces create the potential for drowning and chemical exposures. If you find yourself entering a confined space that could potentially be under fluid pressure, ensure you perform proper LOTOTO procedures.

Fig. 25 Fluids under pressure at an acid plant

CHEMICAL

Chemical hazards in confined spaces are typical for storage containment. Residual material may not be compatible with cleaning solutions or methods may create potential hazards by causing a reaction or volatilization of chemicals.

Fig. 26 Chemicals are stored in tanks

BRIDGING

"Bridging occurs when loose material clings to the sides of a container or vessel that is emptied from below, allowing a hollow space to be created. The bridge of material over the space may collapse without warning, entrapping workers who are standing below or on top of the bridge and who are unaware that the surface is unstable."[22] The storage vessel size and the amount of moisture in the stored materials are factors that contribute to bridging.

If you are ever working in an area where engulfment or bridging could be a possible hazard, safety lines must be utilized. If chutes/feed lines become clogged, do not enter the bin unless necessary and attempt to resolve the situation remotely. If an entry is essential, ensure you have looked at the potential hazards and have removed them before continuing.

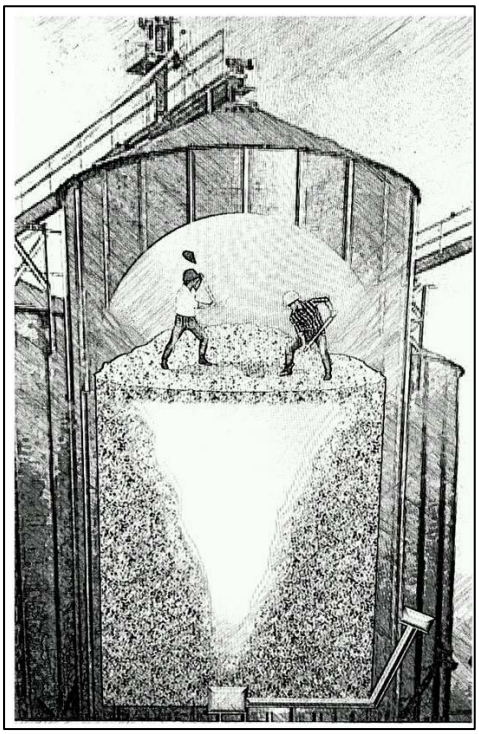

Fig. 27 Example of bridging

22. See comment 6

SLIPS, TRIPS, AND FALLS

Many confined space entries can involve cleaning. Workers can also be exposed to slippery working surfaces, tripping hazards and falls which could cause injury and even death. The internal configuration of a confined space can greatly increase the hazards of slipping and falling within a confined space. Inwardly converging walls, or a floor that slopes downward and tapers to a smaller cross-section, can trap and even suffocate an individual if they fall into a space and cannot move.

Fig. 28 Be Aware of Tripping Hazards

Always follow Freeport-McMoRan's Working at Heights Policy (FCX-HS02) and Technical Supplement for working at heights when dealing with any potential fall hazards within and around a confined space. Sites may have specific procedures surrounding these types of hazards, which are put in place for your safety and must be followed.

Be aware of:

- Wet, oily and greasy ladders or surfaces.
- Equipment, hoses, and internal structures.

Below are some solutions to implement when mitigating hazards:

- All spills are cleaned up immediately.
- Visual inspection is conducted.
- Adequate illumination is provided.
- Housekeeping is maintained.

Note*:* **"**Falling objects can pose a hazard in confined spaces as well, particularly in areas that have topside openings for entry through which tools and other objects may fall and strike a worker."[23] Follow the Flagging and Barricading Policy as well as the Working at Heights Policy and Technical Supplement.

23. See comment 6

TEMPERATURE EXTREMES

Temperature extremes are environmental factors that can greatly alter a confined space and, in turn, the associated hazards while performing the assigned task.

While you may be familiar with the hazards associated with heat, it is important to realize that extreme cold can present equally dangerous hazards. In situations of extreme cold, your ability to use your hands effectively is substantially reduced. In circumstance like this, using tools may become more difficult and in turn, can result in injury.

Fig. 29 Molten copper in a concentrator reaches high temperatures

HEAT-RELATED ILLNESS

As hot conditions intensify in the summer, and we continue to perform our regular job duties, the potential for heat-related illnesses rises dramatically. These illnesses are serious and can even cause death in some cases. It is important to understand the symptoms of heat-related illnesses or heat stress, what to do if you or a co-worker starts to experience them, and what precautions to take to avoid problems when working in hot environments.

Our bodies naturally maintain a constant body temperature around 98.6°F (37°C). When your body temperature begins to increase, your body will circulate more blood to the surface of your skin which allows you to cool. As this happens, your skin may appear flushed or red. If the increased blood flow alone cannot cool the body, you begin to sweat.

As perspiration evaporates from the skin, heat is removed, cooling the body and maintaining its temperature. If our sweat is unable to evaporate, there is minimal cooling effect on the body. High humidity and most confined space designs, as well as PPE, can hinder the evaporation process and contribute to the hazard.

Your body will continue to function normally until your temperature reaches approximately 102°F (39°C). When this occurs, the body responds by further increasing the amount of blood flowing toward the skin's surface in an attempt to cool down its core temperature. This leaves the brain, muscles and other body parts with a depleted blood supply. At this point if our temperature is not effectively controlled, then symptoms of heat stress will appear.

Below is a table addressing different types of heat-related illnesses and the factors that can affect the likelihood of experiencing those illnesses.

This table describes ways of preventing these illnesses.

Heat-related Illness	Factors that increase the likelihood
Dehydration	• Failure to drink enough water
Loss of electrolytes	• Salts, potassium, calcium, etc. • Lost when you sweat • Needed for your body to function normally
Acclimatization	• Adjustment to the heat
Personal fitness	• Age, weight, etc.
Past heat-related illness	• Previous occurrences lower your resistance
Medical conditions	• Heart conditions • Diabetes • Illness/fever • Medications • Allergies • Epilepsy

DIFFERENT FORMS OF HEAT STRESS

Heat stress disorders are serious, can manifest in different ways, and become progressively worse if they are not addressed. If you or a co-worker experience signs of heat stress, initiate your site emergency response protocol.

Heat cramps are the earliest sign of heat stress. If precautions to cool off and rehydrate at this point are not made, the more severe stages of heat-related illness (heat exhaustion leading to heat stroke) can occur in a rapid progression. The progression from heat exhaustion, and subsequently to heat stroke, can be very quick and can result in a potentially life-threatening situation.

Heat-related illnesses include:

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat stroke

CAUSES, SYMPTOMS, AND TREATMENT OF HEAT-RELATED ILLNESSES[24]

Heat-related Illness	Cause(s)	Symptoms	First Aid
Heat rash	• Sweat that does not evaporate and irritates skin	• Clusters of red bumps on skin • Often appear on neck, upper chest, folds of skin	• Try to work in a cooler, less humid environment if possible • Keep the affected area dry
Heat cramps	• Loss of body salts and fluid during sweating	• Muscle spasms • Pain • Usually in abdomen, arms, or legs	• Have worker rest in a cool, shady area • Provide water or other cool beverage • Wait a few hours before allowing worker to return to strenuous work • Have worker seek medical attention if cramps don't go away
Heat exhaustion	• Loss of water and salt from heavy sweating	• Cool, moist skin • Heavy sweating • Headache • Nausea or vomiting • Dizziness • Light headedness • Weakness • Thirst • Irritability • Fast heart beat	• Have worker sit or lie down in a cool, shady area • Provide water or other cool beverage • Cool worker with cold compresses/ice packs • Take to clinic or emergency room for medical evaluation or treatment if signs or symptoms worsen or do not improve within 60 minutes • Do not return to work that day
Heat stroke	• Body is unable to regulate its core temperature • Sweating stops and body can no longer rid itself of excess heat	• Confusion • Fainting • Seizures • Excessive sweating or red, hot, dry skin • Very high body temperature	• Follow your site's emergency response notification protocol While waiting for help • Place worker in cool, shady area • Loosen clothing, remove outer clothing • Fan air on worker; cold packs in armpits • Wet worker with cool water; apply ice packs, cool compresses, or ice if available • Provide fluids (preferably water) asap • Stay with worker until help arrives

[24] US Dept. of Labor, "Heat-related Illnesses and First Aid", *Osha.gov*, Accessed June 10, 2016. https://www.osha.gov/SLTC/heatstress/heat_illnesses.html

PREVENTING HEAT-RELATED ILLNESS

Ultimately the best way to prevent a heat-related illness is to avoid one in the first place. Listed below are a few preventative measures for heat related emergencies.

Acclimatization

"Adjust yourself to the heat through short exposure periods followed by longer exposure until your body is accustomed to the heat. It may take 5-7 days of hot weather exposure before the body undergoes changes that make heat more bearable."[25]

Drink lots of water/liquids

Replenish the fluid your body is losing through sweating. Even if you are not thirsty, you still need to drink about eight ounces of water for every 20 minutes of activity.

Monitor

Know the signs and symptoms of heat stress disorders, and monitor yourself and co-workers.

Act quickly

If you feel hot, dizzy, and nauseous or if your muscles cramp, stop and cool off.

Steady pace

Do not overwork yourself. By working at a steady pace, you can stay busy without making yourself ill. Take plenty of breaks in the shade for at least 5 minutes at a time. Plan work around the cooler parts of the day.

Note: If the body is dehydrated by only 1%, then performance is decreased by up to 10%. By ensuring we are following the above precautions, we can avoid heat-related illnesses and potentially life-threatening situations.

Immediately contact your supervisor if you or a co-worker is experiencing any heat-related symptoms.

25. Warning - Extreme Heat is Coming - TOOLBOXTOPICS.COM, http://www.toolboxtopics.com/Gen%20Industry/Warning%20Extreme%20Heat%20Is%20Comi (accessed March 21, 2016).

MODULE 2 QUIZ

Complete the following quiz.

1. The three ingredients needed to create a flammable atmosphere are oxygen, fuel, and a hazardous atmosphere.
    a. True
    b. False

2. Some of the hazards associated with inwardly converging walls in a confined space are slips, trips, or falls.
    a. True
    b. False

3. Heat-related illnesses include heat rash, heat cramps, fainting, heat exhaustion, and heat stroke.
    a. True
    b. False

Controlling Confined Space Hazards

MODULE 3

MODULE 3: CONTROLLING CONFINED SPACE HAZARDS

MODULE 4 LEARNING OBJECTIVES

Upon completion of this module, students will be able to:

- Analyze a scenario, evaluate the hazards, and recommend controls.

INTRODUCTION

Once you have identified a hazard, you must determine the best way to control it by either eliminating or reducing it to an acceptable level. Remember, acceptable entry conditions must be attained before entry and maintained throughout the duration. There are five levels of hazard control strategies used to mitigate hazards. They are listed below in the order of their effectiveness and are called the Hierarchy of Controls.

HIERARCHY OF CONTROLS

The five levels of hazard control strategies for reducing an identified risk range from the most effective (elimination) to the least effective (personal protective equipment).

- Elimination
- Substitution
- Engineering
- Administrative
- Personal Protective Equipment (PPE)

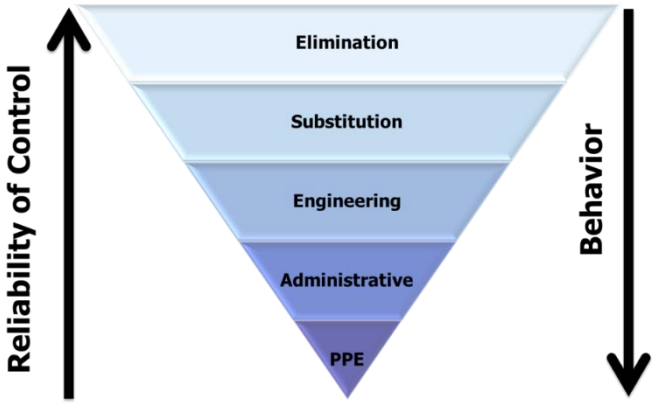

Fig. 30 Hierarchy of Controls

Most of the hazards in our work areas come from some form of energy. Whether it is stored energy (suspended loads, pressurized lines, etc.); energy in motion (moving machine parts, vehicles, etc.); thermal energy (furnaces, boilers, roasters, etc.); electrical energy or others, all of them have one thing in common. They can be predicted. If a hazard can be predicted, it can be prevented.

In this section, we will explain some of the procedures and precautions in place to safeguard entrants, and we will review examples of how to utilize these controls before beginning work within a confined space.

STEP 4: Pre-Entry Air Sampling (Immediately Prior to Entry)			STEP 5: Pre-Entry Meeting and Review	
GAS	ACCEPTABLE	READING	MEETING/REVIEW	INITIALS
Oxygen	19.5 – 23.5%		Pre Entry Meeting and Review Conducted	
LEL*	< 10%		Acceptable Entry Conditions Have Been Met	
Toxics	< PEL* / TLV* /OEL*			
Other:				
Time of testing		Initials of Tester		

* LEL = Lower Explosive Limit, PEL = Permissible Exposure Limit, TLV = Threshold Limit Value

According to Freeport-McMoRan's Confined Space Entry Permit, utilize the confined space permit to ensure you are properly completing and documenting all hazard control procedures.

ELIMINATION/SUBSTITUTION

Elimination and substitution are the most effective ways to reduce a hazard.

Elimination is the process of removing the hazard from the workplace. Eliminate all hazards in the space, perform the task without ever entering the space, or control the hazards so the entrants can accomplish their tasks and exit the space safely. This control is applied through Lockout-Tagout-Tryout (LOTOTO). For example, disconnect, and LOTOTO all electrical energy sources of equipment in the confined space to eliminate the hazards; remove remnants of sludge and remove any potential trapped products or gases through continual cleaning.

Substitution uses a less hazardous chemical, substance or practice in place of a highly hazardous one. Instead of entering a confined space to carry out an activity, consider the possibility of using alternative methods to do the job without entering. For example, use a vacuum truck and an extended hose to suck out the sludge, rather than entering the confined space to manually remove it.

Unfortunately, changing a process can be difficult, and sometimes there are no other options available for substitution. Practically speaking, eliminating the hazards through LOTOTO is the most viable option when dealing with confined space hazards.

ENGINEERING

Engineering controls focus on eliminating or reducing employees' exposure to the hazard. The basic concept behind this control is to block access to the hazard through a barrier.

"These controls do not have to be expensive or complicated. These include using continuous forced ventilation with continuous monitoring of the atmosphere to ensure the ventilation is adequate in the confined space. These will help to maintain a safe atmospheric and comfortable work environment."[26]

26. Working safely in a confined spaces pdf - SlideShare, http://www.slideshare.net/cloudyyagami/working-safely-in-a-confined-spaces-pdf (accessed March 24, 2016).

ADMINISTRATIVE

Administrative controls involve changing how or when employees do their jobs and help control exposure to a hazard by implementing guidelines. The confined space procedures and permits are considered administrative controls. Always follow your site's confined space procedures as they will either meet or exceed the Freeport-McMoRan's Confined Space Policy (FCX-HS05).

Below are two examples of administrative controls with entry procedures and entry permits.

"Before any worker enters a confined space, it is necessary to establish safe work procedures covering all phases of the entry process. It is crucial that the entry permit is completed,"[27] and the confined space is safe for workers to enter. Remember, "Entry" occurs when any part of a person's body passes through an opening into the confined space.

"It is necessary for the entry permit documents to reflect acceptable entry conditions and indicate that the confined space is safe for workers to enter."[28] Remember, to display the entry permit at the confined space entrance.

Fig. 31 Signage on a chute entrance is an administrative control

27. See comment 23
28. See comment 23

PERSONAL PROTECTIVE EQUIPMENT (PPE)

"If other control measures are not available or practical to diminish the risks of working in a confined space, the use of personal protective equipment (PPE) may be considered,"[29] but only as the last line of defense. For example, when welding inside a ball mill, the atmospheric hazards may not be eliminated by ventilation alone. If the entry is deemed essential, supply fresh air, respiratory protection and other control measures.

Fig. 32 Employees wearing PPE

While PPE seems like a simple solution to a hazard, it is important to note any system that relies on behavior is inherently unreliable. Both administrative controls (rules) and PPE methods have proven to be less effective than other measures, requiring significant effort by everyone involved.

MONITORING THE ATMOSPHERE

One of the primary questions to ask as you begin to evaluate your confined space is, "does an atmospheric hazard exist, and how can you be sure?" There are many unseen and odorless contaminants or oxygen-deficient atmospheres that can kill or incapacitate workers almost immediately. Of those contaminants that have an odor, some can be detected by our senses only at higher than allowed concentrations. Due to this, an employee "might assume that a confined space is safe when it is not. There is no substitute for testing the air in a confined space with an air monitor."[30]

A confined space air monitor is a device used to detect the levels of gases in the air. Each device is designed differently and has different sensitivities. While some are designed to detect only one type of gas, others can recognize three or more gases. When working in small areas, it does not take much gas at all to poison an individual, so confined space monitors are designed to detect even the smallest amount. If the air monitor sensors detect a harmful atmospheric condition, the device sounds an alarm as a warning to alert the entry team.

Fig. 33 Example of an air monitor

29. See comment 23
30. See comment 7

DETERMINING THE RIGHT TYPE OF AIR MONITOR AND SENSORS

Understanding your work area and tasks is essential not only for the purpose of identifying the hazards, but in choosing the right type of air monitor to use. Careful thought and planning must be given to the required atmospheric testing for each confined space. If an air monitor system is not already established for your department, speak with your area's Industrial Hygienist or Safety Professional. It is important that the monitor is designed to recognize the gases most likely to occur in your working area.

The most common configuration for a multiple-sensor air monitor can read oxygen levels, flammable gases (LEL), hydrogen sulfide and carbon monoxide, and may be appropriate for a routine confined space entry in a Mill. Other areas nearby, processes, substances in the space, and materials used in the space can create other dangerous atmospheres which could require additional testing as sensors are chemical specific.

Monitors are gas specific. You must verify the monitor you are using is appropriate for the gases/chemicals you are concerned about and how to understand the readings. For instance, painting, using solvents, welding and burning in confined spaces can create dangerous atmospheres that cannot be detected by common air monitors and sensors. Again, always speak with your area's Health and Safety representative when determining what type of air monitor to use and the acceptable entry conditions.

Note: Before allowing any solvent use, paints or welding/burning equipment in a confined space, review the labels, SDSs and consult an Industrial Hygienist. Numerous fatalities have occurred when products safe to use in a well-ventilated area have been used in confined spaces.

The vast majority of the gas monitors you will be using at our different sites provide simultaneous readings of multiple gases, but this does not diminish the importance of the order of testing. These monitors vary from site to site and you must be specifically trained on each monitor before using. Before operating an air monitor, it is important you inspect it just like any other piece of equipment.

Inspect your monitor:

- Calibration - Look for a sticker indicating the monitor is calibrated for the time frame specified by the manufacturer.
- Battery - Turn monitor on and check the battery charge.
- Zero - Confirm all sensors are operating and at normal levels. When zeroing your instrument, verify you are in non-polluted fresh air.
- Clearing the Peaks – Erases the history from the previous use. This clears the monitor's peaks (exposure) so any new detection is a true value for the environment. Not clearing out the history will result in false readings.
- Bump Test - Before you use your instrument, it is important you know the sensor and alarms will function properly. The only way you can be sure of this is to expose your instrument to a gas and verify it responds correctly.

Note: Some air monitors have docking stations which will automatically bump test your instrument. Do not assume this is being done. Ask questions and verify, for your own safety. Most departments have different air monitoring equipment; your department will train you in their use. If you are not trained or signed off on the specific monitor given to you, do not use it and do not proceed with the entry. If a monitor is malfunctioning in any way, stop work until another operating monitor is obtained.

Learn from Others

In October 2011, a 21 year-old contract tire repair technician with 37 weeks of experience was killed at a surface gold operation. The victim was working in a shop repairing a haul truck tire. He was applying adhesive inside the tire and was completely out of view. He was not wearing respiratory protection.

Fig. 34 Employee was working inside the tire

"Learn from Others"[31]

31. "Mine Safety and Health Administration – Metal/Nonmetal Mine Fatality," *United States Department of Labor*, accessed May 19, 2016, http://arlweb.msha.gov/FATALS/1999/FAB99M52.HTM

PRE-ENTRY MONITORING

All confined space atmospheres must be pre-tested, in the following order:

1. Oxygen- is tested first because most air monitors are oxygen-dependent and will not work correctly when used in oxygen-deficient atmospheres. In addition, both oxygen-deficient and oxygen- enriched atmospheres are extremely hazardous.
2. Flammable gases and vapors- "are tested next because the threat of fire and explosion is both more immediate and more life-threatening, in most cases than exposure to toxic gases and vapors."[32]
3. Potential toxic air contaminants- ensure you are knowledgeable about the materials you are using. Familiarize yourself with all SDSs, if chemicals are involved. Even if you are aware of the chemicals being used, you must also exercise caution in the environment. Due to the jobs being performed, some work areas can have airborne combustible dust, such as in the crusher, mill, etc.

Once you have defined what atmospheric hazards you are monitoring for and determined your instrument is correctly set-up and functioning properly, it is time to begin monitoring the space before entering.

If a potentially hazardous atmosphere exists in a space, test the atmosphere around the opening, and then gradually release/open the access-way while testing. If conditions indicate an immediate danger, back away to a safe point and then resume testing once levels have reached safe values. If your monitor alarms for any reason, immediately evacuate the space.

Monitors are equipped with a probe that enables you to test the space several feet in front of you. This probe allows you to monitor a confined space without actually entering and lets you detect a hazard without being exposed. Pre-testing of the atmosphere is conducted through small cover openings or by cracking open the cover while utilizing a probe.

Without entering, use the probe to reach farther into the confined space testing the top, middle and bottom. Remember, different gases have different properties and may be found in layers throughout your confined space. Record these readings on your Confined Space Permit. If ventilation is being used to purge the confined space or control the hazards, it is shut down before testing, to show "worst case" conditions.

Fig. 35 Taking pre-entry monitor readings

Note: It is important to remember an air monitor takes a few moments to analyze the atmosphere; this response time is increased even more when using a probe.

32. Office of environmental health and safety, http://ehs.osu.edu/FileStore/Occ%20Health%20&%20Safety/SOP%20-%20Confined%20 (accessed March 24, 2016).

MONITORING THE SPACE

For permit required confined spaces that are deep or have areas leading away from the entry point, hazardous atmospheres may be layered or "pocketed" in remote or low-lying areas and behind obstructions. Once all acceptable entry conditions are defined, all the controls and necessary steps are in place and your entry begins, utilize your monitor as you enter the space.

Testing must occur in the areas surrounding the entrant, four feet in the direction of travel and to each side. As you move into the confined space, you must move slowly enough so the monitor has time to complete the testing, keep this "response time" in mind before moving onto a new area.

If you notice an air monitor is detecting changes in the atmosphere, even before an alarm has sounded, ensure you and the entry team understand why.

- Before entering a space:
  - Test the area outside.
    - If a potential hazardous atmosphere exists, conduct the test prior to opening the cover
  - Slowly open space and continue monitoring.
  - Only continue, if no hazard is present.
- Test the top, middle, and bottom of your confined space.

Air monitoring does not end with the pre-entry test; atmospheric conditions within a confined space are capable of changing rapidly. If work has been interrupted for any amount of time, all air monitoring procedures must be repeated before work is resumed. Record your readings on the confined space permit.

Remember, test the space:

- Before entry.
- During entry.
- After ventilating/purging the space.
- Before re-entry.
- At shift change.
- If conditions change.

Fig. 36 Confined space signage

For all practical purposes, re-entry testing and pre-entry testing are performed in the same manner and are considered equally important. Use this table to determine actions when using an air monitoring device.

If…	Then…
The gas detector alarm goes off before I go into the space	Do not enter the space.
The gas detector registers an oxygen deficient flammable, or toxic potential, but it does not alarm	
The monitor alarm sounds while I am in the space	Evacuate the confined space immediately.

CONTINUOUS MONITORING

Continuous monitoring is necessary if:

- The atmospheric hazards are not completely eliminated.
- New or additional atmospheric hazards result from the tasks performed in the space.
- Unacceptable atmospheric conditions could occur within the space, for example, due to activities or nearby processes.

If any of these hazardous atmospheric conditions are present, you must continuously monitor.

- Oxygen-rich/deficient
- >10% of LEL/LFL
- Toxic

For larger or more complex situations, an alternative is to utilize individual monitors the entrant wears into the space; however, "wearing a gas monitor into a confined space is not enough to protect from many hazardous conditions that are immediately harmful to the entrant."[33]

ADDITIONAL MONITORING RECORD

GAS	ACCEPTABLE	TIME	READING	INITIALS	TIME	READING	INITIALS	TIME	READING	INITIALS
Oxygen	19.5 – 23.5%									
LEL*	< 10%									
Toxics	< PEL* / TLV*/OEL*									
Other										

As your work continues, periodically record your atmospheric monitoring results on the confined space permit. Whenever hazardous atmospheres are identified or experienced, such information must be recorded on the entry permit, and communicated to other departments who may have occasion to enter such space. If there is a potential for a hazardous atmosphere, then continuous monitoring is always required.

33. Common Mistakes in Confined Space Monitoring - EHS Today, http://ehstoday.com/safety/confined-spaces/ehs_imp_37605 (accessed March 24, 2016).

VENTILATING

One primary reason confined spaces are so hazardous is the lack of adequate ventilation, which allows contaminants to reach concentrations not normally experienced in open work areas. Once it is determined a confined space contains a harmful atmosphere, the next step is to clear it. In some cases, confined space atmospheric hazards can be controlled or removed through mechanical ventilation, which is considered an Engineering Control.

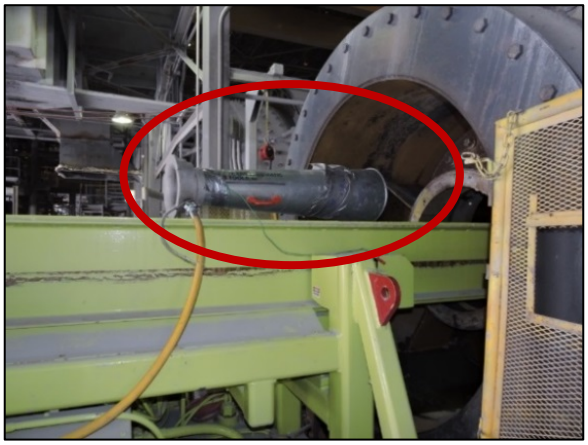

Fig. 37 Ventilation in use in a ball mill

"When a confined space is known to contain hazardous contaminants, it is crucial to purge (flush)"[34] the space adequately before any entry. Even when the confined space is cleared for entry, new contaminants may be introduced from a change in conditions, or by work performed in the space such as welding. Continuous ventilation must be provided to maintain a safe work environment in these instances, for example, when sandblasting, painting, and solvent cleaning, etc. It is also important to note that purging and ventilation do not exclude the need for air monitoring.

Purging (flushing) is ventilating a confined space by blowing out oxygen-deficient, flammable or contaminated atmospheres and harmful vapors and replacing them with clean, fresh air. This is conducted before any entry into a confined space where a hazardous atmosphere is detected.

The amount of time required to remove a hazardous atmosphere is dependent upon the size of the area, the concentrations of gases and the amount of air being ventilated. Always speak with your area's Health and Safety Professional or Industrial Hygienist when determining acceptable entry conditions.

For effective ventilation to occur, the following needs to be accounted for:

- Chemicals/residues.
- Type of work performed.
- Amount of air being supplied by the ventilation equipment.
- Size and the dimensions (openings, blocks to air flow) of the confined space.

Ventilation supplies clean air to the area and makes it safe to breathe. Always be sure there is an adequate supply of blowers and flexible ducts for the operations performed.

34 See comment 7

VENTILATION TYPES

When controlling for hazards in a confined space, there are two main ventilation types to consider: forced air and local exhaust. The work being performed, along with the configuration of the space will dictate which form of ventilation is best. Be sure to contact your health and safety representative or site Industrial Hygienist, if you are at all unsure of which option is best for you.

FORCED AIR (DILUTION) VENTILATION

Dilution ventilation works by moving (pushing) large quantities of fresh air into the space using blowers and flexible ducts. A constant supply of fresh air in enough quantity will maintain the oxygen level within the space and dilute the contaminant levels released to acceptable levels.

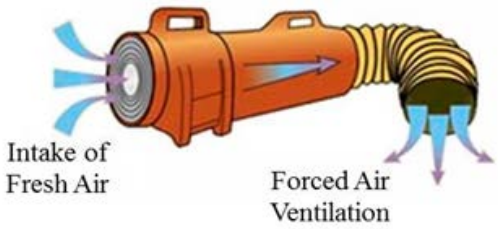

Fig. 38 Example of forced air ventilation

Some forced air ventilation examples are listed below.:

- Blowing air into a confined space causes turbulence which tends to dislodge pockets of "bad" air.
- Applying positive pressure to the confined space eliminates the chance of gas seepage through crevices or ducts back into the work area.
- Blowing air into the confined space reduces the chance of flammable gases drawn across the ventilator motor.
    - Ensure the source of the air is not contaminated (such as from adjacent process, exhaust from vehicles/compressors, etc.)

LOCAL EXHAUST VENTILATION

Local exhaust ventilation involves pulling air out of the confined space and in the process, removing the contaminants from inside the space. It draws air adjacent to the work, such as painting, and exhausts it to a safe area away from any access points. "It is important that the exhausted air is discharged outside the confined space to avoid re-introduction into the space."[35] For local exhaust ventilation to be effective, it is crucial to place the intake port close to the contaminant source. For example, in some operations, such as welding, the intake port must be very close-within 12".

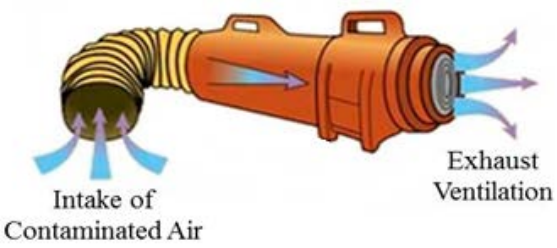

Fig. 39 Example of local exhaust

35. See comment 23

FORCED AIR VS. LOCAL EXHAUST VENTILATION

The difference between a forced air supply "push" system and a local exhaust "pull" system is that fans can "push" or blow air much farther than they can capture or "pull" it in. In general, the ratio of push to pull is 30:1. This means that a fan capable of blowing air a distance of thirty (30) feet will only be able to capture (pull) in contaminants that were within a one (1) foot distance.

While local exhaust systems effectively remove hazardous fumes and dust generated from operations such as welding, cutting, burning, and continuous brazing at or near the generation point, forced air (dilution) systems are much more effective. Forced air ventilation is used as a primary source of air circulation or in conjunction with a local exhaust system called a Push-Pull system whenever possible.

When purging or ventilating a confined space, it has been proven to be much more effective to "push" fresh air into a confined space rather than "pull" out contaminated air.

PUSH-PULL SYSTEMS

A push-pull system uses a combination of both forced air ventilation and local exhaust ventilation and is more efficient than using any using one ventilation system alone. The push-pull system introduces fresh air into the space while removing contaminants by exhausting them.

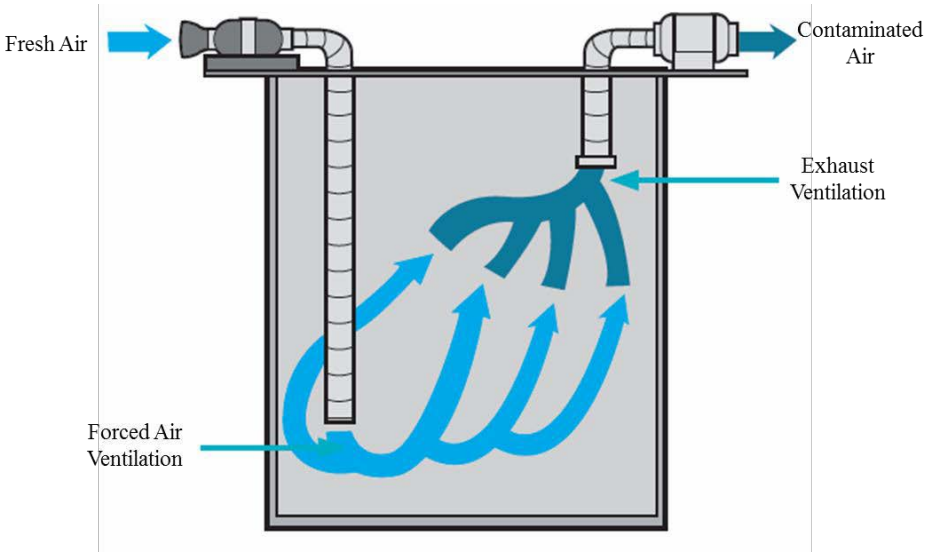

Fig. 40 Example of a push-pull system

VENTILATION AND SIZE/CONFIGURATIONS

When ventilating a confined space, always take into consideration the number of openings, size and configuration. For long or deep confined spaces, blow fresh air into one end (top, bottom, sides) and allow the contaminated air to exhaust from the other.

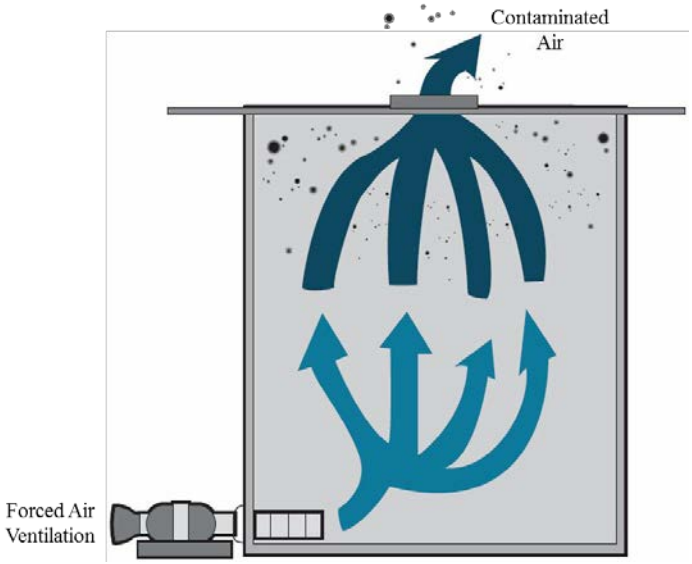

Fig. 41 Ventilating a confined space

PREVENT POCKETING AND SHORT-CIRCUITING

Be aware of walls, low-lying areas, secondary pits, etc. within the space as these areas may not become ventilated due to the obstructions. "Make sure to ventilate the space thoroughly so that there are no contaminated pockets left, and then test the atmosphere"[36] routinely until levels stabilize at acceptable entry conditions. "Prevent short-circuiting in a confined space that has only one opening by using a powerful blower to blow clean air into the entire space or a long ducting to reach the bottom of the space."[37]

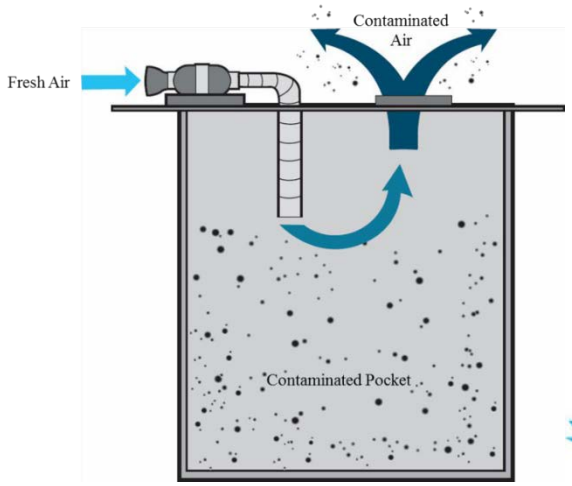

Fig. 42 Pocket remains in this space

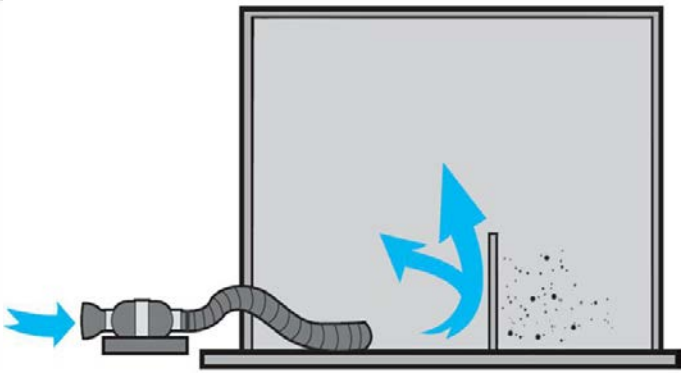

Fig. 43 Clean air is not reaching the contaminants

36. See comment 7
37. See comment 23

VENTILATE WITH UNCONTAMINATED SOURCES

It is important to confirm the air moving device, placed where the air is drawn into the confined space, is from an uncontaminated source. For example, it is not appropriate to set the air moving device next to a diesel generator vehicle, or compressor exhaust system where you can draw in one hazardous gas while exhausting another.

Additionally, prevent exhaust air re-circulation in a confined space by positioning the air intake away from the opening of a confined space. Always ventilate confined spaces with clean breathing air.

General guidelines for ventilation systems:

- Do not locate air inlets close to outlets or contaminated air may be drawn in.
- Do not draw contaminated air past workers inside the space.
- Do not impede access.
- Use explosion-proof fans, where flammable atmospheres could be present.
- Verify contaminated air discharged from the confined space is not a hazard to workers outside the space. Redirect such air a sufficient distance away from the space, the standby person, and any other workers. If this is not possible, ensure any exposed workers use the appropriate respirator.

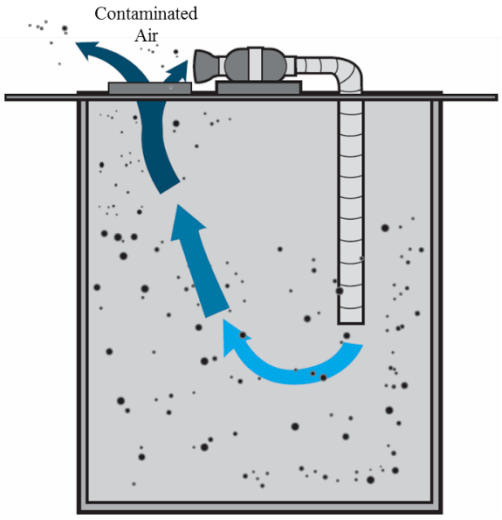

Fig 44. Air inlet is drawing in contaminated air

- Verify hatchways or entranceways to the space cannot be accidentally closed if they are being relied on to maximize the air circulation.
- Never use oxygen for ventilation. Remember a high level of oxygen in the air increases the risk of an explosion or fire.

LOCKOUT/TAGOUT/TRYOUT (LOTOTO)

It is important that all confined space hazards are identified in advance. Before anyone enters a confined space, isolate or eliminate all energy sources that can enter the space according to the Freeport-McMoRan's Lockout/Tagout/Tryout (LOTOTO) Policy (FCX-04). LOTOTO means the disconnection, blocking or bleeding of all energy sources that may create a motion or action by any machine part and its auxiliary equipment.

"It is important to remember that just turning off a switch is not the same as lockout because there is still energy in the circuit. If there is a short at the switch or the machine is accidentally turned on, it will energize and cause it to run."[38]

This is to prevent materials from coming through pipelines or vents and to protect personnel from injury due to the unexpected energization, start-up or release of stored energy from the machines, equipment, or processes while the entrant is inside. In all cases, a check is required to confirm isolation is effective.

Accidents have occurred even when workers did take the necessary steps of disconnecting the main power source, but did not perform a crucial step for a complete lockout procedure. They failed to test the equipment to make sure the machinery was, in fact, de-energized.

"It is necessary to isolate all mechanical, electrical equipment and all other energy sources connected to a confined space to prevent them from unintentional activation."[39] Remember, energy sources are not limited to electrical hazards and can include fluids, chemical, mechanical, stored energy, thermal, etc. All pipes entering the space must be blanked/blinded, broken or double blocked and bled.

38. Lockout/Tagout for Employees, https://www.dir.ca.gov/dosh/etools/08-003/P08-00302.pdf (accessed March 22, 2016).

39. See comment 23

Learn from Others

In December 1999, a 22- year-old Laborer with 2 weeks of mining experience was fatally injured when his clothes became entangled in a self-cleaning pulley and he was subsequently pulled into the moving machine parts. The victim had entered into a confined space area containing an unguarded self-cleaning pulley that was in operation. Guards had been provided to protect persons from the moving machine parts, however, the guards had been removed and were laying on the ground.

Fig. 45 Location where incident occurred

BLANKED/BLINDED

The blank or blind is the block you put into the line or pipe at a joint. This is to stop whatever material is in the line from entering the confined space. The pipeline is first bled to relieve any pressure. Flange bolts are removed to separate the pipes. The blank or slip blind, which is sometimes referred to as a pancake, is inserted between the two pipes and bolted. Blanks need to fit tightly with all bolts in place. They must be strong enough to withstand four times the pressure in the line.

You want to be sure even if the valve is opened, nothing will get through. Inserting blanks into chemical lines can be hazardous. It is important to know if the chemical in the line reacts with any metals. For example, carbon tetrachloride may react with a blank made of aluminum.

When the valve is locked-out, make sure it does not move more than a one-quarter turn (tryout). Once a line is blanked, lock-out the blank to show it must not be removed. Piping that has been blanked or blinded must be clearly marked to indicate the presence of the blank or blind.

DOUBLE BLOCK AND BLEED

"Double block and bleed" involves the use of a three-valve system when closing a line, duct, or pipe leading to the confined space being isolated. Two in-line valves are locked closed and then a drain valve, in between the two closed valves, is opened and locked so that material is prevented from flowing and drains in case of a valve leak.

“When used, a double block-and-bleed must be situated directly upstream of the work area. This means that if flow in the pipe can come from more than one direction, a double block-and-bleed setup is required on each upstream side.” [40] Valves, whether opened or closed, are locked out. Each entrant has a lock on the valve. If the only lock on a valve belongs to the person who isolated the line, it is possible the line can be opened before the confined space is vacated. If each entrant has a lock on the line, this cannot happen.

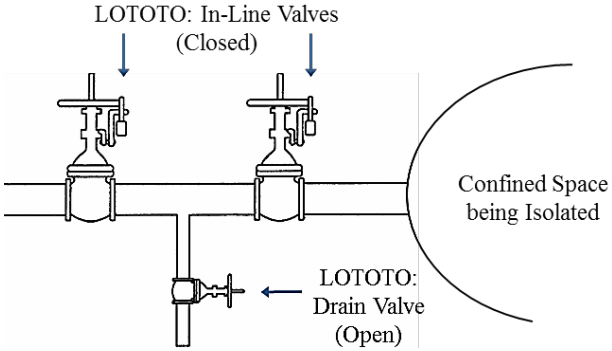

Fig. 46 Example of double block and bleed

LINE BREAKING

Line breaking is a way of removing a spool section (an expansion joint) of a pipe/duct. Similar to a double block and bleed, all upstream valves need to be closed and locked in accordance with LOTOTO Policy (FCX-04). Removing the spool section serves the same purpose as the drain valve in a double block and bleed. If the valve were to fail, removal of the joint ensures material does not flow to the confined space. To ensure that this control functions properly, place a lock through a bolt hole to prevent accidental re-sectioning.

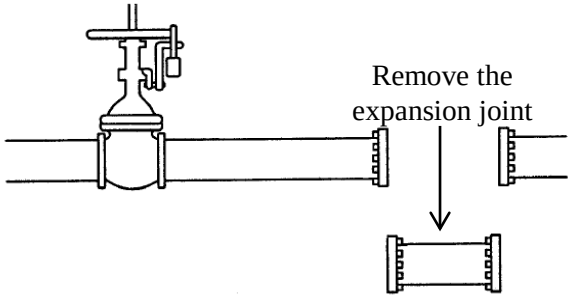

Fig. 47 Example of line breaking

40. Section 215.4 Isolating piping - Alberta Labour, http://work.alberta.ca/SearchAARC/639.html (accessed March 24, 2016).

INTRINSICALLY SAFE DEVICES

If you are working in areas with flammable chemicals, you must ensure the work you are performing does not produce an ignition source. Any electrical equipment can produce a spark that could potentially ignite vapors. If working with these products, electrical equipment must be rated as intrinsically safe.

Intrinsically Safe (IS): An intrinsically safe device is designed to not introduce an ignition source (spark). Electrical equipment must be IS rated if used in any areas where a flammable atmosphere could exist. Read instruction manuals on equipment you are taking into confined space.

Fig. 48 Back of a head lamp shows IS rating

PERSONAL PROTECTIVE EQUIPMENT (PPE)

One criteria for acceptable entry conditions into a confined space includes the equipment needed to assist in a safe and incident free entry. All required equipment must be listed on the confined space entry permit. Remember, PPE is only used as a last resort when controlling or reducing a hazard.

PPE requirements vary greatly between entries but at a minimum include proper head, and eye protection and safety footwear. It may also include rubber boots, chemical protective clothing, fall protection, hearing protection, distress alarms, and respirators (either for specific hazards present or for escape.)

STEP 1: HAZARD IDENTIFICATION AND RECOGNITION			
EXISTING HAZARDS WITHIN, CONNECTED TO, OR NEAR THE SPACE (hazardous energy, radiation, etc)	**CONTROLS**	**HAZARDS TO BE INTRODUCED TO THE SPACE FROM THE WORK BEING PERFORMED** (welding fumes, noise, dust, hot work, other tasks that require specialized PPE)	**CONTROLS**

Freeport-McMoRan's Confined Space Entry Permit - Ensure you are recording all PPE required for use within the Confined Space on your entry permit. If this space requires use of a respirator, contact your site's Industrial Hygienist for medical evaluation and fit testing.

CHEMICAL PROTECTIVE CLOTHING

The PPE you wear while working within a confined space is determined by the hazards of the space. Any PPE needed to complete the entry safely must be recorded on the entry permit. PPE used for confined space entry can range from ordinary work clothes to a fully encapsulated chemical protective suit. Always read chemical labels and SDS sheets. Speak with your area's health and safety representative when deciding what chemical protective clothing may be required.

RETRIEVAL SYSTEMS

In order to conduct a non-entry rescue in a PRCS, a full body harness and rescue line must be worn by the entrant at all times. If the entry supervisor determines the use of the full body harness and rescue line is infeasible or creates a greater hazard, an exemption to the policy must be requested and approved in a task review. The exemption must identify alternative control measures such as wristlets, man-basket, etc.

Retrieval lines must also be attached to the safety harness when its use could assist with a possible rescue, and it does not create an additional hazard during the entry. Powered hoists and cranes must never be used as retrieval devices.

For horizontal access, this may be nothing more elaborate than a harness on the entrant with an attached rope, tied off to a fixed object outside the space. For vertical entries, like manholes, an approved retrieval device, such as a tripod, stanchion, or davit is required.

Fig. 49 Employee wearing a full body harness

BARRICADING AND PREVENTING UNAUTHORIZED ENTRY

"It is essential to use safety barriers to separate workers from hazards that cannot be reasonably eliminated by other engineering controls."[41] Whether you are working in a PRCS or a NPRCS, it is imperative you adequately secure each entrance to the confined space against unauthorized or accidental entry. These measures and procedures are done in accordance with the Freeport-McMoRan's Flagging and Barricading Policy (FCX-HS19) and may include, but are not limited to, adequate barricades, appropriate warning signs, temporary railing, cones or other devices or any combination around the space.

Fig. 50 Temporary guarding protecting an opening

"Selection of suitable barriers will depend on the nature of the hazard and the size of the area or equipment to be cordoned off."[42] The entry supervisor must determine if safety barriers or guarding will be needed for the confined space entry before any workers enter the confined space.

Additionally, unauthorized entry into a confined space, especially when there are many employees and contractors involved in an operation, must be controlled. Only authorized personnel are allowed entry to the confined space, in accordance with the procedures laid out in the confined space entry plan. The attendant must control access to the space, especially if an emergency situation arises.

"Even if properly trained, workers may forget their training and/or disregard proper entry procedures and enter a confined space without PPE because they are overcome by the natural emotion to rescue a co-worker."[43]

41. See comment 23
42. See comment 23
43. Confined Space Entry Training - MCA Detroit, http://www.mcadetroit.org/documents/ConfinedSpace2014.pdf (accessed March 24, 2016).

LIGHT AND ELECTRICAL EQUIPMENT

One drawback of a confined space is the lack of natural lighting. Entrants must be provided with enough light to properly perform their jobs. Low voltage lighting is preferred when performing a confined space entry. Lighting equipment must be rated for explosive atmospheres if the potential for explosive atmospheres exists.

A wet surface will increase the likelihood and effect of electric shock in areas where electrical circuits, equipment and tools are used. If wet or damp conditions exist inside the confined space, all electrical equipment must be GFCI protected and tested before each entry. If the potential for flammable or explosive atmospheres are possible, lighting and all other electrical equipment must be classified as intrinsically safe (IS) and rated for use in that type of hazardous atmosphere.

Fig. 51 Lighting is used to illuminate this confined space

ACTIVITY 5: TEST THE SPACE

You are expected to perform a task in a confined space that could potentially expose you to a certain gas. Based on the specific properties of the chemical, answer the questions provided.

EXPOSURE TO ARGON GAS

Scenario: You have been asked to enter a confined space to perform repair work that will require TIG welding using Argon Gas as the inert shielding.

PROPERTIES OF ARGON GAS

- Used as an inert gas shield in arc welding
- 38% more dense than air
- This gas is inert and is classified as a simple asphyxiate
- "Death may result from errors in judgement, confusion, or loss of consciousness which prevents self-rescue"[44]
- Colorless, odorless, non-flammable, and non-toxic
- Evaporates very quickly causing super saturation of the air with serious risk of suffocation when in confined areas
- Inhalation in excessive concentrations can result in dizziness, nausea, vomiting, rapid breathing, muscular incoordination, diminished mental alertness, loss of consciousness, and death
- At low oxygen concentrations, unconsciousness and death may occur in seconds without warning

DIRECTIONS: Answer the following questions with the information provided.

1. What are the potential hazards that will be introduced when the task is performed?
2. What part of the confined space would you test to detect presence of Argon?
3. How would you monitor test for this hazard?
4. How would you control the hazard?

44. Material safety data sheet (MSDS) Page 1 2 liquid argon .., http://www.afrox-zambia.com/internet.global.corp.zmb/en/images/Liquid_Argon379_2 (accessed March 24, 2016).

EXPOSURE TO HYDROGEN SULFIDE

Scenario: You have been asked to enter and clean a digestion tank that is used to treat organic waste.

PROPERTIES OF HYDROGEN SULFIDE

- Hydrogen sulfide often results from the bacterial breakdown of organic matter in the absence of oxygen. H_2S also arises from virtually any place where elemental sulfur comes in contact with organic material, especially at high temperatures.
- Slightly heavier than air
- A highly flammable gas. A mixture of H_2S and air can create an explosive atmosphere. Hydrogen sulfide is also highly toxic.
- Considered a broad-spectrum poison, meaning that it can poison several different systems in the body
- Exposure to lower concentrations can result in eye irritation, a sore throat and cough, nausea, shortness of breath, and fluid in the lungs.
- Short-term, high-level exposure can induce immediate collapse, with loss of breathing and a high probability of death.

DIRECTIONS: Answer the following questions with the information provided.

1. What are the potential atmospheric hazards you might encounter?
2. What part of the confined space would you test to detect presence of H_2S?
3. How would you monitor test for this hazard?
4. How would you control the hazard?

EXPOSURE TO ACETYLENE

Scenario: You have been asked to enter a confined space to remove obsolete equipment. This will require cutting out material using an oxy/acetylene torch.

PROPERTIES OF ACETYLENE

- A hydrocarbon gas commonly used for torch cutting.
- Packaged and transported within a compressed gas cylinder. It must be dissolved in acetone inside this cylinder, because pure acetylene is explosive above 30 psi.
- A colorless gas that generally has a garlic-like odor.
- Mixed with air is highly explosive and easily ignited.
- Highly flammable and unstable under pressure.
- Lighter than air and is considered a simple asphyxiant.

DIRECTIONS: Answer the following questions with the information provided.

1. What are the potential atmospheric hazards you might encounter or introduce to the confined space?

2. What part of the confined space would you test to detect presence of Acetylene?

3. How would you monitor test for this hazard?

4. How would you control the hazard?

MODULE 3 QUIZ

Complete the following quiz.

1. What are the five levels of hazard control strategies (Hierarchy of Controls) from the most effective to the least effective?
    a. Substitution, PPE, Engineering, Training, Compliance
    b. Policies, Procedures, Training, Audits, Critical Controls
    c. Elimination, Substitution, Engineering, Administrative, PPE
    d. PPE, Administrative, Engineering, Substitution, Elimination

2. What type of control uses forced air ventilation in a confined space to remove hazardous contaminants?
    a. PPE
    b. Engineering
    c. Elimination
    d. Administrative

3. Prior to entering a confined space, pre-entry monitoring must be performed. What should you do to ensure correct functioning of your device?
    a. Zero and battery test
    b. Calibration and battery test
    c. Bump test, calibration, and zero
    d. Calibration, battery check, zero, clearing the peaks, and bump test

Entering a Confined Space

MODULE 4

MODULE 4: ENTERING A CONFINED SPACE

MODULE 4 LEARNING OBJECTIVES

Upon completion of this module, students will be able to:

- Demonstrate the process for entering a confined space.

INTRODUCTION

"A confined space entry is considered to have occurred when any part of a person's body crosses the plane of an opening into the space."[45] Before an "entry" can occur, make sure you have followed all applicable procedures.

Entries into a confined space may be for a variety of reasons. They are usually completed to perform a necessary function, such as an inspection, repair, maintenance (cleaning or painting), or similar operation which may be scheduled on a routine or non-routine basis, depending upon which site and department you are working for.

As you begin a confined space project, ask yourself two questions:

1. Is it necessary to enter the confined space?
   *If possible, **avoid** entering a confined space.*

2. Is it possible to complete the task from the outside?
   Before attempting to enter or work in a confined space, every consideration should be given to completing the task from the outside the space. It is important to consider the possibility of using alternatives and other methods to do the job without entering, and entry into or work in a confined space is only as a last resort.

Fig. 52 Employees gather for a pre-job meeting

45. "Definitions," *Confined Space OSHAcademy free online training*, http://www.oshatrain.org/courses/mods/713m1.html (accessed March 24, 2016).

REQUIRED TRAINING

As the space you are entering has been classified as a PRCS, you must now designate the authorized entrants, attendants, and an entry supervisor. Any employee assigned to your confined space entry team must be trained in confined space entry, including training on their role on the entry team (supervisor, attendant, or entrant). At least two people are assigned to the confined space work, with one person acting as the attendant outside the confined space, one person working within, and with one of them assuming the duties of entry supervisor.

Fig. 53 A training class in session

PERMIT PROCESS

When entrance into a confined space is required, follow the procedures. Always adhere to any existing safe operating procedures (SOPs) for the space being entered. Verify everyone who is part of the confined space entry team has been appropriately trained and signed off. Treat all confined spaces as permit required until it has been determined otherwise.

DETERMINATION OF CONFINED SPACE

The first step in entering a confined space will always be the evaluation. As you evaluate the space, you are outlining and defining all of the acceptable entry conditions. This includes determining whether the space will be classified as a NPRCS or a PRCS, if it has not already been completed. Utilize the top portion of the confined space permit, "Step-1 Hazard Identification and Recognition." Review your area SOPs, HIRADC (Risk Register), and go over the tasks that will be performed within the space. For example: if welding, torch cutting, burning, painting, applying solvents, or similar activities will take place in the space.

STEP 1: HAZARD IDENTIFICATION AND RECOGNITION			
EXISTING HAZARDS WITHIN, CONNECTED TO, OR NEAR THE SPACE (hazardous energy, radiation, etc)	**CONTROLS**	**HAZARDS TO BE INTRODUCED TO THE SPACE FROM THE WORK BEING PERFORMED** (welding fumes, noise, dust, hot work, other tasks that require specialized PPE)	**CONTROLS**

HAZARD IDENTIFICATION/EVALUATION

It is important to be able to define and plan how to directly address identified hazards, suitable procedures, and specific steps that must be followed to adequately control the hazards. This will ensure you can safely enter and work within the space. The plan and the controls you put in place which keep you safe are called acceptable entry conditions.

Acceptable entry conditions include a plan to determine what hazards exist within the confined space and document that they have all been:

- Eliminated - (NPRCS)
- Controlled to a suitable level - (PRCS)

The Confined Space Policy (FCX-HS05), Technical Supplement and Permit are documents that will help you develop and verify acceptable entry conditions. These documents will help you determine whether to classify your space as NPRCS or PRCS.

Step 2 of the Confined Space Entry Permit will help you determine if the space is NPRCS or PRCS. In the case of a PRCS, the confined space entry permit must then be completed and posted at the entrance.

STEP 2: ASSESSING THE SPACE

SECTION A: CONFINED SPACE HAZARDS	YES	NO
Hazardous / Potentially Hazardous Atmosphere		
Sloping or Converging Walls or Floors		
Engulfment / Entrapment		
Any Other Recognized Hazards: (noise, heat, uncontrolled energy source, fall hazards inside the space, radiation, thermal exposure etc) List these hazards and controls in section 2		
If the answer to ALL question above is NO, or can be eliminated: The space may be classified as NON-PERMIT REQUIRED.		
Name:		
Signature:		

SECTION B: INITIAL AIR SAMPLING (around the opening of the space, and at multiple levels within the space)		
GAS	**ACCEPTABLE**	**READING**
Oxygen	19.5 – 23.5%	
LEL*	< 10%	
Toxics	< PEL* / TLV* /OEL*	
Other:		
Time of testing		
Date of calibration		
Initials of person taking the sample		
Test instrument and #		

STEP 3: PRE ENTRY PREPARATION AND CONTROLS

EQUIPMENT	REQUIRED / N/A	COMMUNICATION	TESTED
Ventilation Required: YES / NO		Entrant and Attendant Communication Method:	
Type: Duration:			
Retrieval System (Emergency Escape Apparatus)		Supervisor Communication Method:	
Fire Extinguisher			
Intrinsically Safe Equipment		Emergency Response Communication Method:	
LOTOTO			
Flagging and Barricading			

STEP 4: Pre-Entry Air Sampling (Immediately Prior to Entry)				STEP 5: Pre-Entry Meeting and Review	
GAS	**ACCEPTABLE**	**READING**		**MEETING/REVIEW**	**INITIALS**
Oxygen	19.5 – 23.5%			Pre Entry Meeting and Review Conducted	
LEL*	< 10%			Acceptable Entry Conditions Have Been Met	
Toxics	< PEL* / TLV* /OEL*				
Other:					
Time of testing		Initials of Tester			

If you are ever in doubt regarding the classification of your space as NPRCS or PRCS, always use the confined space entry permit and procedures. Additionally, follow any other existing safe operating procedures for the space being entered and ensure all employees who are part of your confined space entry team are trained in confined space entry.

When completing a confined space entry permit, ensure you are reviewing your site's Hazard Identification Risk Assessment and Determination of Controls (HIRADC), sometimes referred to as a Risk Register, as the confined space may have previously been identified by your department. This register will help you by providing a list of hazards which are identified, as well as the controls necessary to remove them.

Never enter a space or continue working within a confined space without ensuring that acceptable entry conditions are constantly in place. Remember; always utilize your consequence thinking by continually assessing hazards as conditions can quickly change.

DEFINE HAZARD CONTROLS

While evaluating your space, confirm all potential hazards and energy sources are identified. This may require reviewing your work and ensuring that all risks have been recognized. Once you are sure this is complete, follow existing policies such as Freeport-McMoRan's Lockout/Tagout (LOTOTO) Control of Hazardous Energy Sources Policy (FCX-04), and any other applicable site policies, SOPs or equipment manuals. Then, proceed in isolating/eliminating all energy sources that could enter the space before your entry begins.

Document the basis for determining all hazards in the space have been eliminated by using the Confined Space Entry Permit or through a similarly approved form. This document will be made available to each employee entering the space.

Note: Energy sources are not limited to electrical hazards and can include fluids, mechanical hazards, stored energy, etc. Additionally, verify all pipes entering the space are blinded, broken or double blocked and bled.

Once you have completed the above steps and determined your space is non-permit required, you can begin the confined space entry. Always follow any safe operating procedure for the space being entered (where applicable). If conditions inside or outside the space change, evacuate and re-evaluate the space to ensure you and your co-worker's safety.

Regardless if your confined space is classified as a NPRCS or PRCS, you need to ensure that unauthorized personnel do not enter the space by placing temporary railing, cones or other devices around the space opening in accordance with the Freeport-McMoRan's Flagging and Barricading Policy (FCX-HS19). Conditions can change rapidly within a confined space and only the people designated for entry are allowed to enter.

ASSIGNMENT OF RESPONSIBILITIES

The entry team is the group of employees assigned to complete a task within a confined space.

A typical entry team consists of an entrant, an attendant, and the entry supervisor. For any PRCS entry, a minimum of two individuals are necessary.

These individuals are classified as either the:

- Entrant (the individual entering the confined space).
- Attendant (the individual staying outside of the confined space).

Fig. 54 Attendant observing entrant

The Entry Supervisor may or may not have the formal title of supervisor and may also serve as an attendant, but NOT as an entrant. Also, the entry supervisor duties may pass from one individual to another during the entry operation.

ENTRANT

The entrant is the individual entering the space and performing work. Entrants, those who "will actually have direct exposure to the hazards identified in the permit-required space, must have additional training and knowledge to perform work in that space."[46] They must be aware of the hazards, what type of controls are in place to reduce the risk to an acceptable level, the necessary PPE; the proper use of all safety equipment used, and will have participated in any required LOTOTO procedures to ensure the controls stay in place during their entry.

Entrants must also have the knowledge and be appropriately trained and signed off on any applicable tasks performed within the space.

Questions to ask yourself:

- Does the space require purging or ventilating prior to entry?
- Is lockout required for electrical, pneumatic, hydraulic, chemical or other forms of energy?
- Are there physical hazards to address, such as high heat, high-level noise or unguarded moving machinery?
- Once these special precautions are taken, can the permit-required space be reclassified?
    - In other words, by performing the special precautions, has the entrant eliminated the life-threatening hazard that made it a permit-required space in the first place?

46. Confined spaces - National Precast Concrete Association, http://precast.org/wp-content/uploads/2011/05/Confined-Space-article.pdf (accessed March 22, 2016).

Additionally, the Entrant:

- Is familiar with the controlled or potential hazards of the confined space during the entry, including the exposure route for chemical hazards, e.g., inhalation, skin absorption, etc.; and signs, symptoms, and consequences of overexposure.
- Is familiar with the currently defined "acceptable entry conditions" for the confined space.

Each authorized entrant into a permit required confined space must use a full body harness at all times. A retrieval line must be attached to the safety harness when its use could assist with a possible rescue and it does not create an additional hazard during the entry. Wristlets may be used in place of full body harness, if the entry supervisor determines the use of the full body harness is infeasible or creates a greater hazard and the use of wristlets is the safer alternative.

Entrant Responsibilities	Description
Communicate with Attendant	• Maintain communication with the attendant throughout the entry, alert the attendant, and exit the space where there are warning signs or symptoms of exposure to a hazardous situation, or any "red flags" are detected
Inspect for Hazards	• Inspect for hazards not previously identified during initial entry and if any arise, call for the entry team to evacuate the space until they are communicated and controlled
Stop Work and Evacuate the Space	• Immediately exit the confined space whenever o Air monitor alarms o Air monitor stops functioning normally o Uncontrolled hazard is suspected or observed o Any entrant experiences signs or symptoms of exposure to hazards o Communication link between the entrant and attendant is broken o Conditions outside the space threaten the entrant or attendant o Attendant calls for an evacuation
Wear Designated PPE	• Each authorized entrant into a PRCS must o Properly use designated equipment o Use a full body harness at all times o Use a retrieval line attached to the safety harness o Wear all required PPE

Entrants must don and utilize a lifeline and a harness (or other means of affixing a lifeline) when entering bins, hoppers, silos, tanks, and surge piles where unconsolidated material is stored, handled or transferred. Self-retracting lifelines that rely upon fall speed to lock must not be used. Anchor points must be selected to ensure the user's torso remains above the original level of the material.

ATTENDANT

The attendant is stationed outside of the confined space and is responsible for the safety of all individuals who enter. They are the entrant's communication link to the outside world and ensure all individuals are accounted for. They may also be responsible for recording periodic air monitor readings and must be knowledgeable of the hazards within and around the space, know the emergency procedures for getting help, and call for help if an emergency situation arises.

Fig. 55 Attendant reading air monitor

Additionally, the attendant:

- Is familiar with the controlled or potential hazards of the confined space during the entry, including route of exposure for chemical hazards, e.g., inhalation, skin absorption, etc.; and signs, symptoms, and consequences of over exposure.
- Is familiar with the currently defined "acceptable entry conditions" for the confined space.
- Is capable of speaking and communicating effectively with the employees working in the confined space and with potential rescuers.
- Remains outside the permit space until relieved by another attendant, and/or job activities are completed.
    - Most people killed in confined spaces are would-be rescuers.
    - Do not enter the space for any reason
    - There must ALWAYS be an attendant outside of any PRCS where there are entrants
- If an entry team suspects an alarm is due to a malfunctioning monitor, the team must respond as if the monitor is accurate until it can demonstrate otherwise
    - **Note:** Alarms on monitors are adjusted to match the acceptable entry conditions. For example, if half-face respirators are in use for sulfur dioxide, and the acceptable entry condition is defined as 10X the exposure limit for sulfur dioxide, the alarm point should be set accordingly. Otherwise, the alarm may sound continuously. Alarms must never be ignored.
- Performs no duties that might interfere with the attendant's primary duties (monitoring and protecting authorized entrants).

Attendant Responsibilities	Description
Control PRCS Access	• Continuously maintain an accurate count of authorized entrants by name in the PRCS • Do not allow unauthorized persons to enter the area
Communicate with Entrants	• Communicate with the authorized entrants at all times to monitor entrant status and to alert the entrants of the need to evacuate the space
Monitor Entrant Activities	• Monitor entrant and working area to ensure acceptable entry conditions are maintained • Watch for o Any hazards inside or outside of the confined space o Entrants showing any signs or symptoms of exposure to hazards
Maintain Retrieval Lines	• Tend any retrieval lines used in entry • Ensure lifelines remain taut when entrants enter spaces where unconsolidated material is stored, handled, or transferred
Stop Work and Evacuate the Space	• Immediately stop work and evacuate the space when any one of the following takes place o The attendant detects • a non-acceptable entry condition • behavior changes in entrants • outside conditions arise that may endanger the entry team o The air monitor alarms o Any new or uncontrolled hazards are introduced
Manage Emergency Situations	• If an emergency arises o Immediately call for the entrants to evacuate the space o Call for emergency assistance, if necessary o Initiate non-entry rescue o Prevent unauthorized rescuers from entering the space

ENTRY SUPERVISOR

The Entry Supervisor holds a key position with important responsibilities and oversees all aspects of the confined space entry, work and exit procedures.

The individual is “responsible for:

- Determining if acceptable entry conditions are present at a permit space where entry is planned”[47].
- Authorizing entry.
- Overseeing entry operations.
- Terminating entry.

The entry supervisor may or may not have the formal title of supervisor. Additionally, the Entry Supervisor:

- Ensures an effective Hazard Identification / Risk Assessment / Determination of controls (HIRADC) assessment has been conducted on the entry, and that acceptable entry conditions are defined. This includes hazards which may result from work activities within the space.
- Refers and follows Freeport-McMoRan’s Confined Space Policy (FCX-HS05) in the event an IDLH condition is encountered.

47. See comment 6

Entry Supervisor Responsibilities	Description
Define All Risks and Controls	• Establish in writing all acceptable entry conditions listing all the hazards and the procedures, actions, controls, and equipment needed to ensure a safe entry on the permit (Include any hazards that may result from the work being performed).
Conduct Pre-Entry Meeting	• Conduct a pre-entry meeting to confirm all hazards and associated controls have been established and that they have been communicated with all individuals involved or impacted.
Ensure Complete Atmospheric Testing	• Ensure the required atmospheric tests are: o Conducted and recorded in alignment with the monitoring procedures in the policy to classify the space. o Conducted immediately prior to the entry to accurately reflect conditions at time of entry. o Conducted throughout the entry, if required.
Verify Entry Team Training	• Ensure all members have been trained in Confined Space entries.
Ensure Rescue Team Training	• Ensure rescue services have been notified and are available, and the means for summoning them are operable.
Verify Safe Entry Conditions	• Ensure acceptable entry conditions (procedures, equipment, and resources) are in place before anyone enters the space and conditions remain safe throughout the entry.
Maintain Confined Space Permit	• Maintain the confined space permit by: o Authorizing entry by signing the entry permit after all conditions for space entry have been met. o Posting the completed, signed permit at the entrance to the space. o Terminating the entry and cancel the permit when entry operations are complete or when uncontrolled hazards arise in or near the permit space. o Filing the original cancelled permit with the appropriate department.
Evacuate Space, if IDLH Conditions Exist	• If hazardous conditions arise that are IDLH, immediately evacuate the space and cancel the permit.

NOTIFICATION OF RESCUE SERVICES

Rescue services must be notified of any planned entry into a PRCS, which ensures their availability and informs them of the location and hazards involved. Some sites may rely on main gates, dispatch, control rooms, or security to act as a connection between the entry team and rescue services. Ensure any group who acts in this manner has made contact and verified rescue services are available and on standby. Ensure you know your site specific requirements.

PRE-TASK MEETING

Once your entry team has been designated, the entry supervisor will perform a pre-task meeting for all entrants, attendants, and any other employees who may affect conditions of the confined space to explain the hazards, acceptable entry conditions, required PPE, testing and all communication procedures.

After determining who will play what role, a tail gate will be held explaining:

- Hazards and Controls.
- PPE.
- Communication procedures.

All individuals involved must be familiar with all of the hazards of the confined space entry including:

- Routes of exposure:
  - Inhalation.
  - Absorption.
  - Digestion.
- Signs/Symptoms/Consequences of an exposure.

ISSUE EQUIPMENT

Provide the following equipment as necessary for safe work:

- Personal Protective Equipment (skin, hearing, respiratory, eye protection).
- Full body harness must be worn at all times. If the entry supervisor determines the use of the full body harness is infeasible or creates a greater hazard, wristlets may be used if they offer a safer alternative.
- Retrieval line must be attached to the safety harness when its use will assist with a possible rescue and it does not create an additional hazard during the entry.
- Lighting equipment rated for explosive atmospheres if the potential for explosive atmospheres exist.
- Ladders, ramps or other effective means for proper egress.
- Testing and monitoring equipment (rated for explosive atmospheres, if applicable).
- Ventilation equipment (rated for explosive atmospheres, if applicable).

- Communication equipment (rated for explosive atmospheres, if applicable).
- Rescue and emergency equipment (rated for explosive atmospheres, if applicable).
- Any other equipment necessary for safe entry into permit spaces.

Note: Ensure the communication system/equipment between attendant and entrant, attendant and emergency providers and rescue equipment is fully functional prior to entry.

COMPLETE THE PERMIT

Complete the permit and keep a copy posted at the space. A new permit must be completed at the start of each shift and/or when the entry crew changes. The permit will be updated anytime safety or health conditions inside the space change during entry. Safe entry into a confined space is dependent upon effectively controlling all aspects of the job. This permit is a safety checklist to make sure nothing is overlooked.

Fig. 56 Filling out a permit

Throughout the following steps, ensure you are filling out the confined space permit.

The confined space permit:

- Lasts one shift only - cannot be extended or transferred.
- Is posted at the entrance until the entry has been completed.
- Is updated, if conditions change within the space.

Once the confined space entry has been completed, notify the appropriate departments (first responders, etc.). Review your entry and determine if all safeguards are adequate.

EVACUATING THE SPACE

If a rescue becomes necessary, the attendant will activate the emergency response process and may attempt non-entry rescue using the retrieval system. All personnel must remain outside the space; responders will attempt non-entry retrieval if possible. If entry is necessary, only properly trained and equipped responders may enter the confined space.

This table lists scenarios that require immediate evacuation.

If...	Then...
• Atmospheric monitor detects an atmosphere that falls outside of the acceptable entry conditions • The monitor stops functioning normally • The monitor alarm sounds while I am in the space • An uncontrolled hazard is suspected or observed • An entrant experiences signs or symptoms of exposure to hazards • The communication link between the entrant and attendant is broken • When conditions outside the space threaten the entrants or attendant • The attendant calls for an evacuation	All entrants **must** immediately evacuate the confined space and cancel the permit

CLOSEOUT AND NOTIFY DEPARTMENTS

Notify the appropriate departments and rescue services after entry operations are complete. Contact the main gate, control room, etc. so that rescue services are now able to stand-down.

REVIEW

Review the entry operations to determine if measures taken were adequate to protect employees. If evacuations were necessary, or additional hazards identified during the entry, ensure these issues are communicated with management and your health and safety representative. In this way, these items can be included in future hazard assessments and communicated to other co-workers who may enter the space.

If a PRCS "poses no actual or potential atmospheric hazards and if all hazards within the space are eliminated without entry into the space, the permit space may be reclassified as a non-permit required confined space for as long as the hazards remain eliminated."[48] Control of atmospheric hazards through forced air ventilation does not constitute elimination of hazards. Ventilation only controls the atmospheric hazard and does not eliminate it. If the atmospheric hazard could return once ventilation ceases or is removed, then the space may not be reclassified.

48. See comment 6

Based on the evaluation of the hazards, a qualified person will classify the confined space as either a permit-required confined space (PRCS) or non-permit required confined space (NPRCS). All confined spaces are treated as permit spaces until determined to be otherwise.

EMERGENCY RESPONSE TEAM/RESCUER(S)

In an emergency, non-entry rescue is the preferred method of retrieving an entrant. The attendant or Emergency Response Team (ERT)/Rescuers use retrieval systems previously identified in the confined space entry permit. Retrieval devices for non-entry rescue are used whenever feasible. These devices include tripods, davit arms, rope and pulley systems, rescue harnesses and wristlets.

Fig. 57 ERT Training

RESCUE CONSIDERATIONS

If an emergency occurs within a confined space, it is imperative that everyone on the confined space entry team knows what to do. A confined space emergency is any occurrence inside or outside the space, including failure of hazard control or monitoring equipment, which may endanger the authorized entrants.

The period of time for successful rescue is very limited. While the attendant's job during a confined space entry may seem unimportant, when an emergency situation arises how you react may be the deciding factor on whether a rescue attempt is successful or becomes body retrieval. "The job of the attendant, in an emergency, is not to personally rescue the victims, but to implement the rescue plan."[49]

1. Summoning Emergency Services - As soon as you determine that entrants may need assistance to escape from any confined space, follow your plan and call for help.
2. Preventing Unauthorized Entry - Do not enter the space. Keep others from entering if they have not been trained as a Confined Space Rescuer.
3. Initiating Non-Entry Rescue - Utilize retrieval lines, to remotely rescue the attendants within the space. For horizontal, level entry, this may be a harness and lifeline tied to a fixed object outside the space. For vertical entry, an approved rescue hoist device is required.

   Non-entry retrieval is not initiated if:
   - There is no visual or verbal confirmation that the entrant can be moved safely
   - The employee cannot be seen or communicated with
   - There are physical hazards in the retrieval path that will injure the entrant or inhibit the retrieval process; for example life lines have become entangled.

49. Common Mistakes in Confined Space Monitoring, http://ehstoday.com/safety/confined-spaces/ehs_imp_37605 (accessed March 22, 2016).

4. Maintaining Contact with Entrants - If possible, maintain contact with entrants. Assure them help is on the way and keep them calm.
5. Gathering Information - When rescue services arrive, it is imperative they are provided with up to date information regarding:
    - The hazards within the space
    - The number and condition of the entrants
    - Any related mechanical or system information that may prove useful to the rescue

Believe it or not, during emergencies, rescuers end up as confined space fatalities more often than those being rescued. According to the CDC, over 60% of all confined space fatalities occur among would-be rescuers.

Fatalities can occur when the rescuers:

- Are overcome by their emotions.
- Take unnecessary chances.
- Do not know the hazards involved.
- Do not have a plan of action.
- Lack confined space rescue training.

"To prevent deaths, it is critical to use good confined space entry practices so that there is no need for rescue operations. Remember, even a well-planned rescue can end up as a tragedy if not performed properly."[50]

In certain situations, there may be instances when an external or third party Emergency Response Teams/Rescuers must be utilized. However, there are certain criteria that must be followed. Responsibilities of external or third party Emergency Response Teams:

- Familiar with the various types of confined spaces at your facility and their potential hazards.
- Knowledgeable on how to eliminate or control the hazards of the confined space.
- Knowledgeable on the various types of equipment that will be necessary to safely enter each confined space.
- Available at the time of entry to provide confined space rescue services.

50. Rescue in Confined Spaces OSHAcademy free online training, http://www.oshatrain.org/courses/mods/713m8.html (accessed March 22, 2016).

PROCEDURE FOR RECLASSIFICATION OF A PRCS TO NPRCS

A PRCS may be "reclassified" as a NPRCS, by an entry supervisor, if all hazards, atmospheric and non-atmospheric, are eliminated prior to entry. NPRCSs must be periodically re-evaluated to verify proper classification. Always assume a confined space is Permit-Required. When reclassifying the space to Non-Permit Required, document that all hazards in the space have been eliminated.

Use the first step of the Confined Space Entry Permit, the site's Risk Assessment, HIRADC or another form that contains:

- The date.
- The location of the space.
- The reasons for the determination.
- The signature of the person making the determination.

This document will be made available to each employee who enters the space.

This table provides actions for reclassifying a PRCS to a NPRCS.

If…	Then…
The permit space poses no actual or potential atmospheric hazards	The permit space may be reclassified as an NPRCS for as long as the hazards remain eliminated. (Control of atmospheric hazards through forced air ventilation does not constitute elimination of hazards.)
All hazards within the space are eliminated without entry into the space	
All hazards, atmospheric and non-atmospheric are eliminated prior to entry	A PRCS listed in the inventory may be "reclassified" as a PRCS, by entry supervisor.
Any conditions change in the space which introduces new hazards to the space	An immediate re-evaluation of the space before entry is required

Note: Based on the evaluation of the hazards, a qualified person will classify the confined space as either a permit-required confined space (PRCS) or non-permit-required confined space (NPRCS). All confined spaces are treated as permit spaces until determined to be otherwise. Any NPRCSs are periodically re-evaluated to verify proper classification.

ACTIVITY 6: COMPLETING THE PERMIT

Break into groups and decide who will be the entrant, attendant, and entry supervisor. Record the names below. Using the provided scenario, complete the permit form on pages 97-98. The Confined Space Policy and Technical supplement are shown as a reference.

Entrant	
Attendant	
Entry Supervisor	

SCENARIO

The pressure on an 8 inch steam line for the milk of lime tank heater is set incorrectly. The steam line is located in a concrete vault measuring 10 feet deep by 9 feet wide by 15 feet long. The top of the vault is covered with removable sections of steel grating. At one end of the vault, a 200 foot passageway leads to the low level of the mill. A louvered door used for ventilation is located approximately 75 feet into this passageway. Part of the doorway can be opened from the opposite side. The task is to open a hand operated valve on the 8 inch steam line. The temperature of the steam is 366 degree F.

FREEPORT-McMoRan

Confined Space Policy

Health and Safety FCX-HS05 | Version 1 | Release 03/2018

POTENTIAL FATAL RISKS

Exposure to Hazardous Substances
Entanglement and Crushing
Uncontrolled Release of Energy

CRITICAL CONTROLS

Atmospheric Monitoring
Ventilation
Energy Isolation
Entry Permit Execution

A Confined Space is a space that meets all three of the below conditions:

1. Is large enough and so configured that a person can enter with their whole body and perform their assigned work
2. Has a limited or restricted means of entering and exiting (a configuration that would impede a person ability to self-rescue)
3. Is not designed for continuous occupancy (i.e. an individual could not occupy the space during normal operating conditions)

TRAINING REQUIREMENTS

Awareness Training for all employees
Initial Training
Annual Refresher Training
Remedial Training as required

POLICY

OVERVIEW

The Confined Space Policy establishes the requirements and performance standards needed to protect employees and contractors from hazards associated with confined space and to safely enter to perform work in confined spaces.

Permit Required Confined Spaces (PRCS) are confined spaces that have one or more of the following characteristics:

1. Contains or has the potential of containing 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

NOTE: Permits are valid only for as long as it takes to complete the task, but not more than one shift.

ACTIONS TO STAY SAFE

The following requirements must be met when FCX employees or contractors are entering confined spaces on FCX properties:

- Evaluate confined space using the permit to determine if the space is a permit required confined space, retain documentation
- Verify, understand and abide by Confined Space Permit requirements
- Monitor atmospheric condition periodically throughout the entry
- Entrant(s) have the right to observe pre-entry atmospheric test
- Identify and control the hazards within the confined space
- Use proper ventilation
- Understand and abide by assigned roles and responsibilities of confined space entry team
- Establish a communication process with entrant(s)
- Evacuate space immediately at established alarm condition, atmospheric monitor failure, or any uncontrolled/unanticipated change in condition

A confined space entry team is the group of individuals assigned to complete a task within a confined space. A typical entry team consists of three roles: entrant, attendant, and entry supervisor. For any Permit Required Confined Space (PRCS) entry, a minimum of two individuals are necessary. These individuals will be classified as either the:

- Entrant (individual entering the confined space)
- Attendant (the individual staying outside and monitoring the confined space)

A person will also be designated as the entry supervisor (the attendant may serve as the entry supervisor, but the supervisor may never serve as the entrant) and will be responsible for the confined space entry and ensuring that all safety precautions have been met.

Regardless of the role, all entry team members, attendants, entrants and entry supervisors, must:

Responsibilities and Duties of the Entry Supervisor:

- Define all Risks and Controls
- Establish in writing all acceptable entry conditions
- Conduct a pre-entry meeting with all confined space team members
- Ensure that the atmospheric tests is conducted and recorded
  - To classify the space
  - Conducted immediately prior to entry
  - Continued throughout the entry if required
- Ensure all members have been trained in Confined Space entry
- Ensure that rescue services are notified and available, and that the means for summoning them are operable
- Ensure acceptable entry conditions are in place before anyone enters the space and that conditions remain safe throughout the entry
- Maintain the confined space permit:
  - Authorize entry by signing the entry permit after all conditions for safe entry have been met
  - Post the completed, signed permit at the entrance to the space
  - Terminate the entry and cancel the permit when entry operations are complete or when uncontrolled hazards arise in or near the permit space
  - File the original canceled permit with the appropriate department
- If hazardous conditions arise that are Immediately Dangerous to Life and Health (IDLH), immediately evacuate the space

Responsibilities and Duties of the Attendant:

- Control access to the PRCS:
  - Maintain an accurate count of entrants
  - Do not allow unauthorized entry
- Communicate with the authorized entrants
- Monitor entrant(s) activities and conditions
- Maintain retrieval lines/system
- Stop work and evacuate the space if:
  - A non-acceptable entry condition occurs
  - Behavior changes in the entrant(s)
  - Outside conditions arise that may endanger the entry team
  - The air monitor alarms
  - Any new or uncontrolled hazards are introduced
- Manage emergencies
- Attendant may not perform any other duties

Responsibilities and Duties of the Entrant(s):

- Communicate with the Attendant
- Inspect for hazards within the space
- Stop work and evacuate the space if:
  - Air monitor alarms
  - Air monitor stops functioning normally
  - Uncontrolled hazard is suspected or observed
  - Any entrant experiences signs or symptoms of exposure to hazards
  - Communication link between the entrant and attendant is broken
  - Conditions outside the space threaten the entrants or attendant
  - Attendant calls for an evacuation
- Wear designated PPE

Technical Supplement

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ATMOSPHERIC TESTING & MONITORING

Atmospheric testing is required for two distinct purposes:

1. Evaluation of the hazards of the permit space; and
2. Verification that acceptable entry conditions for entry into that space exist.

Air monitoring equipment will be selected by a qualified individual based on the hazards of the entry. As the monitor's sensors are gas specific, these determinations must be documented with area SOPs/Risk Registers/HIRADC/JSA. Calibration will be performed per the manufacturer's specifications and records will be kept according to the Records Retention Program.

Acceptable Monitoring Levels and Entry Conditions:

- **Oxygen levels**: O_2 levels between 19.5% - 23.5%
  - **Oxygen Deficient** (< 19.5%) is considered hazardous
  - **Oxygen Enriched** (> 23.5%) is considered hazardous
- **Flammable Gases**: Flammable gas concentration less than 10% of the Lower Explosive Limit (LEL) of the flammable gas.
- **Toxicity:** Atmospheric concentration in excess of the occupational exposure limit for any substance that is capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects and which could result in employee exposure in excess of its dose or permissible exposure limit.

Refer to the **FCX IH Field Guide** for more information on exposure limits.

REFERENCES

- 29 CFR 1910.146; Permit-required Confined Spaces
- 29 CFR 1910.146 Appendix B; Procedures for Atmospheric Testing
- 29 CFR 1910.146 Appendix F; Rescue Team or Rescue Service Evaluation Criteria
- 30 CFR 56.16002; Bins, hoppers, silos, tanks, and surge piles
- NSI/ASSE Z117.1-2009; Safety Requirements for Confined Spaces

ADDITIONAL REQUIREMENTS

(1) Evaluation testing. The atmosphere of a confined space should be analyzed using equipment of sufficient sensitivity and specificity to identify and evaluate any hazardous atmospheres that may exist or arise, so that appropriate permit entry procedures can be developed and acceptable entry conditions stipulated for that space. Evaluation and interpretation of these results, and development of the entry procedure, should be performed by, or reviewed by, a technically qualified person based on evaluation of all serious hazards.

(2) Verification testing. The atmosphere of a permit space which may contain a hazardous atmosphere should be tested for residues of all contaminants identified by evaluation testing using permit specified equipment to determine that residual concentrations at the time of testing and entry are within the range of acceptable entry conditions. Results of testing (i.e., actual concentration, etc.) should be recorded on the permit in the space provided adjacent to the stipulated acceptable entry condition.

(3) Duration of testing. Follow manufacturer's recommendations for the duration of time the monitor should remain in place for a complete response, analysis times may vary depending on probe length and flow rate.

(4) Testing stratified atmospheres. When monitoring for entries involving a descent into atmospheres that may be stratified (layered), testing should proceed from the top to the bottom of the space and tested a distance of approximately 4 feet (1.22 m) in the direction of travel and to each side. If a sampling probe is used, the entrant's rate of progress should be reduced to accommodate the sampling speed and detector response.

(5) Order of testing. Test for oxygen first because most combustible gas meters are oxygen dependent and will not provide reliable readings in an oxygen deficient atmosphere. Test for combustible gases next because the threat of fire or explosion is both more immediate and more life threatening, in most cases, than exposure to toxic gases and vapors. If tests for toxic gases and vapors are necessary, they are performed last.

CONFINED SPACE Entry Permit

FREEPORT-McMoRan

DIVISION	DEPARTMENT
DATE TIME	SHIFT
CONFINED SPACE LOCATION	CONFINED SPACE ID #
PURPOSE OF ENTRY	AUTHORIZED DURATION
ENTRY SUPERVISOR NAME	SUPERVISOR APPROVAL SIGNATURE
ENTRY ATTENDANT(S) NAME(S)	
AUTHORIZED ENTRANT(S) NAME(S)	(continue over if necessary)
ROUTINE ☐ NON-ROUTINE ☐	WORKPLACE EXAM COMPLETED ☐ SOP/JHS COMPLETE AND REVIEWED ☐

STEP 1: HAZARD IDENTIFICATION AND RECOGNITION

EXISTING HAZARDS WITHIN, CONNECTED TO, OR NEAR THE SPACE (hazardous energy, radiation, etc)	CONTROLS	HAZARDS TO BE INTRODUCED TO THE SPACE FROM THE WORK BEING PERFORMED (welding fumes, noise, dust, hot work, other tasks that require specialized PPE)	CONTROLS

STEP 2: ASSESSING THE SPACE

SECTION A: CONFINED SPACE HAZARDS	YES	NO
Hazardous / Potentially Hazardous Atmosphere		
Sloping or Converging Walls or Floors		
Engulfment / Entrapment		
Any Other Recognized Hazards: (noise, heat, uncontrolled energy source, fall hazards inside the space, radiation, thermal exposure etc) List these hazards and controls in section 2		
If the answer to ALL question above is NO, or can be eliminated: The space may be classified as NON-PERMIT REQUIRED.		
Name:		
Signature:		

SECTION B: INITIAL AIR SAMPLING (around the opening of the space, and at multiple levels within the space)		
GAS	ACCEPTABLE	READING
Oxygen	19.5 – 23.5%	
LEL*	< 10%	
Toxics	< PEL* / TLV* /OEL*	
Other:		
Time of testing		
Date of calibration		
Initials of person taking the sample		
Test instrument and #		

STEP 3: PRE ENTRY PREPARATION AND CONTROLS

EQUIPMENT	REQUIRED / N/A
Ventilation Required: YES / NO	
Type: Duration:	
Retrieval System (Emergency Escape Apparatus)	
Fire Extinguisher	
Intrinsically Safe Equipment	
LOTOTO	
Flagging and Barricading	

COMMUNICATION	TESTED
Entrant and Attendant Communication Method:	
Supervisor Communication Method:	
Emergency Response Communication Method:	

STEP 4: Pre-Entry Air Sampling (Immediately Prior to Entry)			
GAS	ACCEPTABLE	READING	
Oxygen	19.5 – 23.5%		
LEL*	< 10%		
Toxics	< PEL* / TLV* /OEL*		
Other:			
Time of testing		Initials of Tester	

STEP 5: Pre-Entry Meeting and Review	
MEETING/REVIEW	INITIALS
Pre Entry Meeting and Review Conducted	
Acceptable Entry Conditions Have Been Met	

* LEL = Lower Explosive Limit, PEL = Permissible Exposure Limit, TLV = Threshold Limit Value

NOTE: Post completed permit, and any other relevant forms at the entrance to the Confined Space

Post Entry Cancellation of Permit by Confined Space Entry Supervisor: NAME.....SIGN.....

ADDITIONAL MONITORING RECORD										
GAS	**ACCEPTABLE**	**TIME**	**READING**	**INITIALS**	**TIME**	**READING**	**INITIALS**	**TIME**	**READING**	**INITIALS**
Oxygen	19.5 – 23.5%									
LEL*	< 10%									
Toxics	< PEL* / TLV*/OEL*									
Other										

AUTHORIZED ENTRANT(S) NAME(S) (continued from front page)	Time

AUTHORIZED ATTENDANTS (S) NAME(S) (continued from front page)	Time

MODULE 4 QUIZ

Complete the following quiz.

1. When have you entered a confined space?
    a. When you are performing pre-entry monitoring
    b. When any part of your body enters the space
    c. When you open the entry door
    d. When you pass the flagging and barricading

2. Prior to entering a confined space with an atmospheric hazard, a confined space entry permit must be completed.
    a. True
    b. False

3. A permit-required confined space entry team consists of an Entrant, Attendant, and Entry Supervisor.
    a. True
    b. False

COURSE CONCLUSION

Ultimately every confined space entry is different. Recognize the hazards before entering your confined spaces, and remember "Predictable = Preventable." If you have the proper procedures in place and you follow them, even if something goes wrong, the situation can be controlled. By developing a well thought-out plan defining the acceptable entry conditions and communicating the steps needed to ensure you and your co-workers safety, lives can be saved. Ask tough questions that might reveal problem areas, and then ensure corrections are made.

By making sure that no production need is ever more important than you and your co-worker's safety, we can ensure everyone makes it home safely. Working safely is more than a condition of employment, it is our livelihood.

After the successful completion of this course, you will have satisfied the training requirements for the roles of Entrant, Attendant, and Entry Supervisor.

Resources

RESOURCES

GLOSSARY

Acceptable Entry Conditions - The conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space. This includes a risk management plan that incorporates all safety-related aspects of the entry (e.g. ventilation equipment, LOTOTO requirements, allowable concentrations of air contaminants, remote rescue plan, etc.)

Note: Care must be taken to identify and evaluate the potential for conditions to change within the space as a result of the work being done (e.g. application of coatings, welding, removal of sludge, etc.)

Attendant - An individual stationed outside a permit required confined space who monitors the authorized entrants and who performs all the attendant duties assigned in the confined space program. An attendant will watch only one space at a time. This responsibility can be rotated. The attendant must not break the plane of the entrance into the confined space or leave their post (unless relieved by another attendant or the entrants exit the space).

Authorized Entrant - An employee who will be entering the confined space and is aware of the hazards, PPE requirements, acceptable entry conditions, and communication procedures prior to entry.

Blanking or Blinding - 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.

Confined Space - A Confined Space is a space that meets all three of the below conditions:

1. It is large enough and so configured that a person can enter with their whole body and perform their assigned work
2. It has a limited or restricted means of entering and exiting (i.e. tanks, vessels, silos, storage bins, hoppers, vaults, etc.)
3. It is not designed for continuous occupancy (i.e. an individual does not occupy the space during normal operating conditions)

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.

Emergency - Any occurrence (including any failure of hazard control or monitoring equipment) or event internal or external to the permit space that endangers entrants or attendant(s).

Engulfment - The surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing

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

Entry Permit - The written document provided by the entry supervisor to allow and control entry into a permit required space. Valid for one shift only; must be posted at the entrance of the space. A copy of the permit is retained for one year for audit verification purposes.

Entry Supervisor - The person responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry, overseeing entry operations, and for terminating entry. The entry supervisor may or may not have the formal title of supervisor.

Note: An entry supervisor may also serve as an attendant but may NOT serve an entrant. In addition, the duties of the entry supervisor may pass from one individual to another during the course of the entry operation. The entry supervisor will not enter the space at any time.

Hazardous Atmosphere - An 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:

1. Flammable gas, vapor, or mist greater than 10% of the lower flammable or explosive limit (LFL or LEL)
2. Airborne combustible dust at a concentration that meets or exceeds its LFL
   Note: This concentration may be approximated as a condition in which the combustible dust obscures vision at a distance of 5 feet (1.5 meters) or less
3. Atmospheric oxygen concentration below 19.5% or above 23.5%
4. Atmospheric concentration in excess of the occupational exposure limit for any substance that is capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects and which could result in employee exposure in excess of its dose or permissible exposure limit
5. Any other atmospheric condition that is immediately dangerous to life or health (e.g. heat).

Hazard Identification-Risk-Assessment-Determination of Controls (HIRADC) - A systematic risk management process in which a team reviews a task to identify potential hazards, assesses the risk based on likelihood and potential severity, and defines control measures to reduce risk to a tolerable level. Each FCX operation has defined a HIRADC process consistent with OHSAS 18001 and the FCX policy titled Hazard Identification and Risk Assessment- FCX-09.

Hot Work Permit - A written authorization to perform operations (e.g. riveting, welding, cutting, burning, and heating) capable of providing a source of ignition. (See FCX Hot Work & Permit Policy FCX-HS06.)

Immediately Dangerous to Life or Health (IDLH) - Any condition that poses an immediate or delayed threat to life or that causes irreversible adverse health effects or that interferes with an individual's ability to escape unaided from a confined space. Guidance on IDLH values is available from Material Safety Data Sheets and H&S regulatory agencies. The US National Institutes of Occupational Safety & Health (NIOSH) publishes guidance on IDLH values in NIOSH's online Pocket Guide to Chemical Hazards (refer to www.cdc.gov/NIOSH). Always consult with area Health and Safety representatives before dealing with any conditions associated with IDLH.

Isolation - The control of all energy sources such that the potential for exposure does not exist. Examples of isolation may include: blanking of supply lines, a double block and bleed system, lockout/tagout/tryout of all sources of energy, breaking or disconnecting a line to stop flow, and blocking or disconnecting all mechanical linkages.

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

Lifeline - In contrast to retrieval lines, the purpose of a lifeline is to prevent the user from being engulfed due to voids in loose, unconsolidated material. Self-retracting lifelines that rely upon fall speed in order to lock may not be used in this application. Anchor points must be selected to ensure that the user's torso remains above the original level of the material.

Non-Permit Required Confined Space - "Non-permit required confined space" means a confined space that does not contain any hazard capable of causing death or serious harm, and does not have the potential to contain any atmospheric hazard capable of causing death or serious harm.

Permit Required Confined Space - Permit Required Confined Spaces (PRCS) are confined spaces that have one or more of the following characteristics:

1. Contains or has the Potential of containing 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

Qualified Person - An individual who, through combined education, training, experience, and process knowledge, has demonstrated that he/she is capable of recognizing, evaluating, and effectively identifying controls.

Reclassification - A space classified as a permit-required confined space may be reclassified as a non-permit required confined space under certain procedures where permit required definition hazards have been eliminated before work begins. Reclassification can be temporary or permanent.

Retrieval System - Equipment (including a retrieval line, full-body harness, wristlets if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

Serious Health or Safety Hazard - Any condition that poses an immediate or delayed threat to life, or that causes irreversible health effects or that interferes with an individual's ability to escape unaided from a permit space. Examples include but are not limited to heat, electricity, and falls.

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INDEX

STUDENT END OF COURSE QUESTIONNAIRE

Course Date		Site	
Facilitator Name		Course	

Survey Questions

1. How could the course be improved?

2. What did you enjoy most about the course?

3. What did the facilitator do well?

4. What could the facilitator improve?

Continued on next page

Directions: For each item identified below, circle the number to the right that best fits your judgment of its quality. Use the rating scale to select the quality number.

1 = Strongly Disagree **2 = Disagree** **3 = Neutral** **4 = Agree** **5 = Strongly Agree**

About the Course					
5. Course schedule was well planned (restroom breaks, lunch, etc.)	1	2	3	4	5
6. Course content matched the learning objectives.	1	2	3	4	5
7. Materials were applicable to the learning objectives.	1	2	3	4	5
8. Activities corresponded to the learning objectives.	1	2	3	4	5
9. Group discussions were helpful in exchanging ideas with each other.	1	2	3	4	5
10. Course content was easy to understand.	1	2	3	4	5
11. Presentation tools used in the course were effective.	1	2	3	4	5
12. Length of the course was appropriate for the learning objectives.	1	2	3	4	5
13. There was enough time to practice the learning objectives.	1	2	3	4	5
14. Course content was relevant to your job.	1	2	3	4	5
15. Your department will support your use of skills learned in this course.	1	2	3	4	5
16. There was enough time to cover the course content.	1	2	3	4	5
17. The course met your needs.	1	2	3	4	5
18. You would recommend this training program to others.	1	2	3	4	5
About the Facilitator					
19. The facilitator was prepared and organized	1	2	3	4	5
20. They used class time efficiently	1	2	3	4	5
21. The facilitator was knowledgeable	1	2	3	4	5
22. They presented the material clearly	1	2	3	4	5
23. The facilitator logically communicated ideas and was thought provoking.	1	2	3	4	5
24. The facilitator inspired interest/excitement in the material	1	2	3	4	5
25. They motivated the students.	1	2	3	4	5
26. The facilitator was an effective as an instructor.	1	2	3	4	5
27. There was enough workspace for class activities.	1	2	3	4	5
28. Overall instructional environment was conducive to learning.	1	2	3	4	5

Continued on next page

Course Training / Learning Objectives	Yes	No	If yes, confidence in doing so (1-100%)
29. Of the following training /learning objectives that were presented in this course, I will be capable of applying...			
Module 1: Definition of a Confined Space			
Module 2: Types of Confined Spaces			
Module 3: Confined Space Hazards			
Module 4: Controlling Confined Space Hazards			
Module 5: Entering a Confined Space			
30. What might prevent you from applying what you learned?			
31. What will encourage you to apply what you learned in your job?			
Additional Comments:			

Thank you for taking the time to complete the survey.

Please mail to: Mine Training Institute, Attention: Suzanne Anderson, 18550 S. La Canada Drive, Sahuarita, AZ 85629
Or scan and email to: sanderso2@fmi.com