

Construction Hazards and Risks Control

Lecture Title: – Confined space Entry

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Undergraduate Diploma in
Occupational Health and Safety

Confined Spaces

- The risks associated with confined space work have been documented since Roman times (AD 80 – 180), notably when Emperor Trajan condemned criminals to clean sewers, an occupation regarded as one of the most hazardous.
- While working conditions have significantly improved since then, the same dangers continue to cause injuries and fatalities in the workplace each year.
- According to the Bureau of Labor Statistics, showing over 1000 fatalities between 2011 – 2018 (100+ fatalities per year within the same period) in permit-required confined spaces. (Link below)
- <https://www.bls.gov/iif/factsheets/fatal-occupational-injuries-confined-spaces-2011-19.htm>



How to identify a confined space?

- "confined space" means an enclosed space which has limited openings for entry or egress, and, or which may contain insufficient levels of oxygen or contain or produce dangerous air contaminants liable to cause a risk to the health and safety of workers who enter such a space, and includes any room, chamber, booth, tunnel, tank, silo, pit, pipe, drain, sewer or flue and any other enclosed space.
- Provided that for the purposes of these regulations, any enclosed space which is liable to be flooded or filled by the inflow of any liquid or solid material shall also be considered a confined space.
- <https://legislation.mt/eli/sl/646.19/eng>
- S.L. 646.19 - WORK PLACE (MINIMUM REQUIREMENTS FOR WORK) (CONFINED SPACES AND SPACES HAVING EXPLOSIVE ATMOSPHERES) REGULATIONS –
LN 41/2004

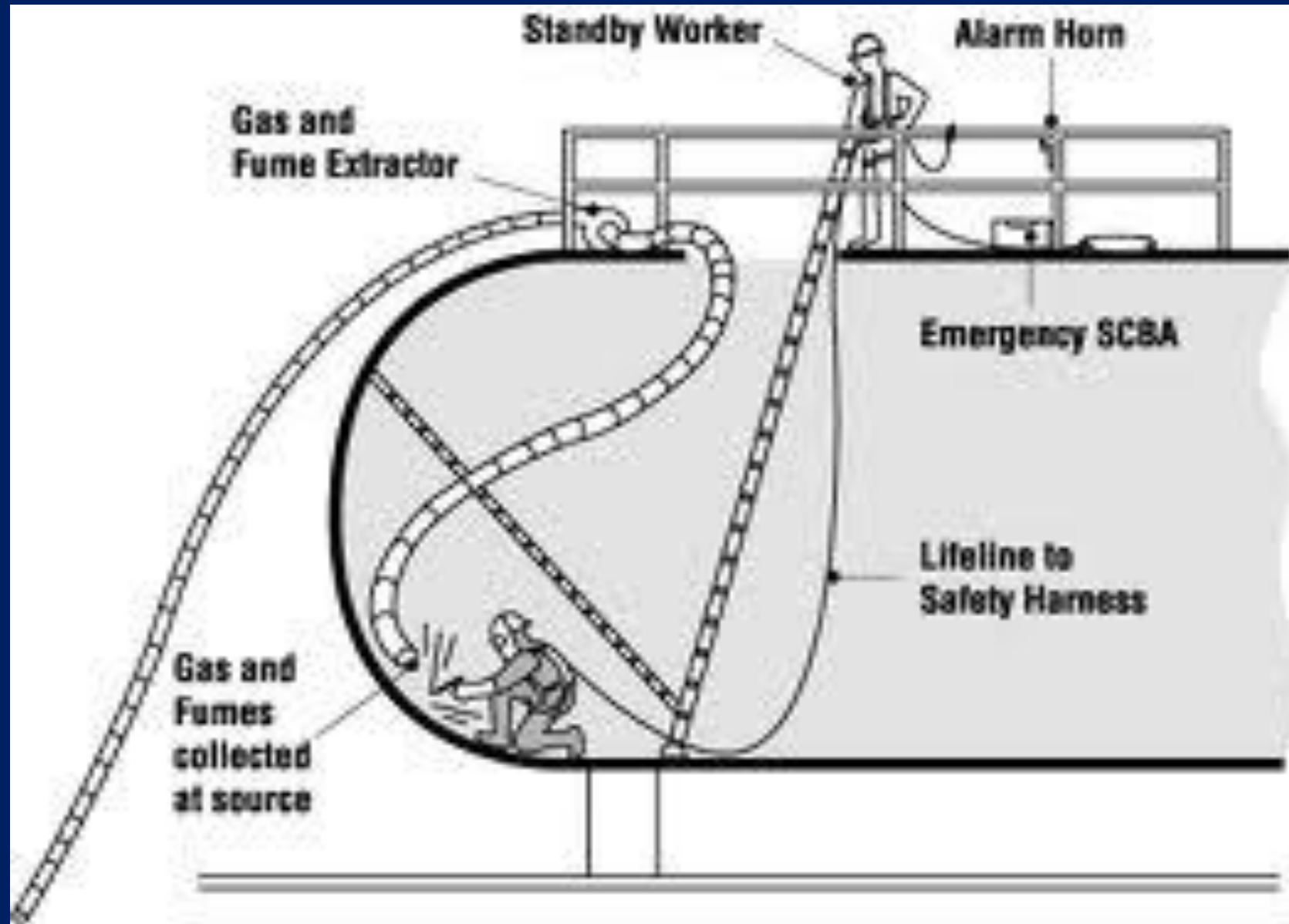
Definition as per S.L. 646.19

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Requirements of a CS

- Limited openings for entry and exit (24inch or less) in diameter
- Unfavorable natural ventilation
- Not designed for continuous worker occupancy.
- Where there arises a reasonably foreseeable specified risk
- Oxygen-deficient atmosphere – oxygen can decrease because of welding (source of ignition), fermentation



Employer Responsibilities for CS

An employer shall :

- Ensure that all Confined Spaces at the Workplace are identified.
- Avoid work in Confined Spaces otherwise alterations in CS. This includes to consider alterations to CS including structural alterations / modifications to existing work practices to enable work outside CS
- Ingress to and egress from the space are taken into the system of work which minimises risks to health and safety
- If deemed necessary to work in CS, take all necessary measures
- Equipment is suitable to be used in confined space
- Maintain all equipment used for CS under preventive maintenance



Employer Responsibilities for CS (2) Reg 6

- Prior allowing entry or work in a CS, ensure that ...
- PTW system is set up and maintained to regulate entry in each CS, depending the nature and risks
- A CP has carried out an assessment of the hazards which are present in the CS, which may arise during the course of work **INSIDE** the CS and which are present **OUTSIDE** which may create an additional hazard for workers inside the CS, and for all hazards the CP shall assess the resultant risks to H&S
- The valid PTW is placed at a position outside and adjacent the CS where it can be viewed and read and measures shall be taken as reasonably practicable to prevent the tampering of this document.
- The workers shall be informed of such hazards and risks also the contents of the PTW
- All requirements set out by the CP shall be complied at all times



Authorized Entries in CS

- Reg 5 (1) states that no person shall enter a CS and no work shall be carried out for any purpose UNLESS it is not reasonably practicable to achieve that purpose without such entry.
- (2) states that it shall be the duty of the employer to ensure that no person enters and that no work is carried out in a CS UNLESS a valid, written permit to work has been issued by a competent person authorizing such entry and work under appropriate conditions, except in exceptional circumstances, for rescue or evacuation purposes and such entry and work is carried out by persons wearing SUITABLE breathing apparatus and all other possible measures required to protect H&S are taken

Self-Contained Breathing Apparatus

Open-Circuit (OC-SCBA): The most common type, delivering compressed air from a tank and releasing exhaled breath into the atmosphere, simple and reliable but limited by cylinder size.

Closed-Circuit (CC-SCBA/Rebreather): Recycles exhaled air by removing CO₂ and adding oxygen, allowing for much longer duration, used for extended operations but more complex.



Key Components of SCBA

- Air Cylinder & Valve: Holds high-pressure compressed air.
- Harness & Carrier: Carries the cylinder comfortably on the back.
- Regulator (First & Second Stage): Reduces high cylinder pressure to a breathable level.
- Facepiece & Demand Valve: Provides a seal and delivers air to the user.
- Control Module/PASS Device: Includes low-air warnings, motion sensors (Personal Alert Safety System) to signal distress.

Competent Person

- Suitable training
- Sufficient knowledge,
- Expertise and skill for the safe performance of the specific task

"competent person" means a person having suitable training and sufficient knowledge, expertise and skill for the safe performance of the specific task or work required;

Duties and responsibilities of Competent Person

- To carry out a proper assessment of the risks and take into consideration of the below:
 1. Hazards which are present in the confined space
 2. Hazards which may arise during the course of work inside the confined space
 3. Hazards which are present outside but which may create an additional hazard for workers inside the confined space



The Competent Person shall Keep in Mind

- The general conditions and the dimensions of the space;
- The ease of access and egress;
- The risk of fire and explosion;
- Levels of any gas or fumes, the lack of oxygen;
- Temperatures present and to be generated;
- The level of lighting;



- What work activity is going to be carried out;
- The level of noise,
- The use of electrical equipment
- Oxygen depletion caused by burning, welding or grinding;
- The introduction of exhaust fumes from outside the confined space

Permit to Work

- The competent person examining a confined space shall issue two copies of a permit to work and shall state in writing (issue 2 copies):
 1. The level of the oxygen concentration and that of any explosive gas or vapour or of any other hazardous gases present in the confined space,
 2. The presence of any other substance which may cause a risk to health or safety,
 3. Whether work can be allowed, and the type of work activity to be allowed.
 4. The safety precautions required by any person entering the confined space, and any protective measures which are required to be taken by the employer or by the workers entering the confined space;
 5. The number of persons allowed at any one time in the confined space;
 6. The duration of the validity of the permit to work, and the time at which a further assessment is required.



PTW Sample

CONFINED SPACES			PERMIT TO WORK No.		
JOB DETAILS					
SPECIAL TOOLS TO BE USED					
JOB LOCATION/ PLANT IDENTIFICATION					
IS ANY OTHER WORK CURRENTLY BEING UNDERTAKEN THAT MAY INTERACT OR AFFECT THIS PERMIT? (QUOTE PERMIT NUMBERS WHERE APPLICABLE)					
<p>This permit is only valid when all sections are complete. If you are in doubt or don't understand, then please ask. Remember, all accidents are preventable and it is people who get hurt and suffer pain. Please use this permit in the spirit intended to protect yourself and others. Please ensure that you sign this permit-to-work.</p> <p>Do not proceed with your work until your permit has been authorised by the relevant member of staff.</p>					
HAZARDS AND PRECAUTIONS TO BE TAKEN					
PRIMARY HAZARDS - fumes, electrics, gases, liquids, sludge, radiation, moving parts					
PLEASE ANSWER THE FOLLOWING QUESTIONS TRUTHFULLY					YES NO PLEASE TICK ✓
Are you qualified/trained to undertake this work?					
Has the confined space been isolated from all connected pipework?					
Has the confined space been purged with steam/water/air?					
Has the confined space been electrically isolated and locked out?					
Is the confined space below 30°C on full cooling?					
Is a supply of respirable air assured/ventilation required?					
Is there an acceptable means of access to and escape from the confined space?					
Is breathing apparatus at hand and in good working order?					
Is a safety line/tripod/harness and any other back-up equipment to hand?					
Are there adequate emergency arrangements in place?					
Are you likely to come into contact with asbestos? If yes, please refer to Asbestos Present Permit-to-Work					
TIME OF TEST 1			TIME OF TEST 2		
OXYGEN	%	PASS/FAIL	OXYGEN	%	PASS/FAIL
CARBON MONOXIDE	PPM	PASS/FAIL	CARBON MONOXIDE	PPM	PASS/FAIL
CARBON DIOXIDE	%	PASS/FAIL	CARBON DIOXIDE	%	PASS/FAIL
OTHER (SPECIFY)	%	PASS/FAIL	OTHER (SPECIFY)	%	PASS/FAIL
Other precautions required					
Other safety equipment required					

PTW Sample

AUTHORISATION AND ACCEPTANCE			
I confirm that I have verified the above information and ensured that the necessary precautions have been taken. It is safe to carry out the work as defined above and the permit information has been explained to all workers involved. I accept responsibility for this work.			
PERSON IN CHARGE	<input type="text"/>		
COMPANY	<input type="text"/>		
SIGNATURE	<input type="text"/>	DATE	TIME
AUTHORISING PERSON	<input type="text"/>		
<div>EXPIRY DETAILS</div> <div>DATE</div> <div><input type="text"/></div> <div><input type="text"/></div> <div>TIME</div> <div><input type="text"/></div>			
HAND BACK AND CANCELLATION			
I confirm that the work has been completed/partially completed*, checked by myself and the area left in a safe and tidy condition. (*delete as appropriate)			
PERSON IN CHARGE	<input type="text"/>	<input type="text"/>	
I have inspected the completed/partially completed* work and hereby cancel this permit. (*delete as appropriate)			
AUTHORISING SIGNATURE	<input type="text"/>	DATE	TIME

Who is the supervisor in a confined space entry scenario?

- A person appointed or employed by an employer having overall direction on site and, or having the task of supervising entry and work in a confined space, and who has received appropriate training for such a task.
- An employer shall appoint a sufficient number of supervisors to ensure adequate supervision on all matters relating to the entry and work in a confined space.
- Shall be the duty of the supervisor to manage and implement the permit to work system, and to ensure that the terms, conditions or recommendations laid out in the permit to work are followed.
- At the end of a working shift, a supervisor should ensure that new workers, including replacements, are informed of the permit to work and its contents, including any terms, recommendations or conditions made by the competent person.

Health Surveillance

- Only workers who have undergone health surveillance and certified medically fit to enter and work in a Confined Space.
- Medical conditions for which a person may not be certified fit to enter and work in a confined space.
- A history of fainting, black-outs or bouts of loss of consciousness, including a history of epilepsy or uncontrolled diabetes mellitus
- A history of shortness of breath
- Disabilities related to limited dexterity or mobility, whether temporary or permanent
- A history of mental disease or of any other relevant mental condition
- A history of heart disease or high blood pressure
- Severe disabilities related to hearing or vision
- A history of drug or alcohol abuse, or when a worker is taking medication liable to cause drowsiness, lack of co-ordination, slowing of reflexes or response times or disorientation
- Any other serious medical condition which in the opinion of the medical practitioner carrying out the examination should preclude a worker from being certified fit to enter or to work in a confined space.



Workers who may not be certified as being fit for entry or to work in a confined space.

- Young workers
- Pregnant workers, or workers who have recently given birth or are breastfeeding
- History of Blackouts, fainting, epilepsy, diabetes, shortness of breath, mental disease, lack of hearing and vision



Training of Workers and Supervisor

- Employer to ensure that all workers entering the CS are trained on:
 - the work to be undertaken,
 - the possible hazards and the resultant risks to H&S,
 - the necessary precautions to be taken,
 - how to minimise risks arising during works performed and
 - how to make proper use of any PPE required to be worn.



Information to Workers

- a) the need to avoid entry into a confined space unless the purpose to be achieved could not be reasonably attained without such entry;
- (b) testing and, or monitoring of the atmosphere, including training to carry out such testing and, or monitoring;
- (c) isolation procedures;
- (d) correct selection and use of safety equipment;
- (e) selection, use and maintenance of personal protective equipment, including respiratory protective equipment;
- (f) the indications for, and the procedures to be followed whenever the need arises for shutdown of plant or equipment;
- (g) communication between workers inside and outside the confined space;
- (h) procedures to be followed when the need arises to raise the alarm;
- (i) recording systems in use, including maintenance logs, accidents and near misses



Information / Training to Supervisors

- Supervisors shall be informed / trained on:
- (a) the provisions of these regulations;
- (b) the principles of risk assessment;
- (c) the work activities and processes involved;
- (d) the necessary control measures and procedures;
- (e) permit to work systems;
- (f) the identification and control of hazards and risks;
- (g) recognizing and dealing with an emergency situation and following emergency procedures;
- (h) the keeping of records required by these regulations.



Oxygen Deficient Atmospheres

19.5 %	Minimum acceptable oxygen level.
15 - 19%	Decreased ability to work strenuously. Impair coordination.
12-14%	Respiration increases. Poor judgment.
10-12%	Respiration increases. Lips blue.
8-10%	Mental failure. Fainting. Nausea Unconsciousness.
Vomiting.	
6-8%	8 minutes - fatal, 6 minutes - 50% fatal
	4-5 minutes - possible recovery.
4-6%	Coma in 40 seconds. Death

Oxygen Enriched Atmospheres

- Oxygen level above 21%.
- Causes flammable and combustible materials to burn violently when ignited.
- Never use pure oxygen to ventilate.
- Never store or place compressed tanks in a confined space.



Toxic Atmospheres

- Product stored in a confined space:
 - Gases released when cleaning.
 - Materials absorbed into walls of confined space.
 - Decomposition of materials in the confined space.
- Work performed in a confined space:
 - Welding, cutting, brazing, soldering.
 - Painting, scraping, sanding, degreasing.
 - Sealing, bonding, melting.
- Areas adjacent to a confined space



Hydrogen Sulfide (H₂S)

- Decomposition of materials. Human waste.
- Rotten egg odor at low concentrations.
- Possibly no warning at high concentrations.

<u>PPM</u>	<u>Effect</u>	<u>Time</u>	
10	Permissible	Exposure Level	8 Hours
50 - 100	Mild Irritation - eyes, throat	1 Hour	
200 - 300	Significant Irritation	1 Hour	
500 - 700	Unconsciousness, Death	1/2 - 1 Hour	
>1000	Unconsciousness, Death	Minutes	



Carbon Monoxide (CO)

- Odourless, Colourless Gas
- Combustion by-product
- Quickly collapse at high concentrations

<u>PPM</u>	<u>Effect</u>	<u>Time</u>
• 50	Permissible Exposure Level	8 Hours
• 200	Slight headache, discomfort	3 Hours
• 600	Headache, discomfort	1 Hour
• 1000-2000	Confusion, nausea, headache	2 Hours
• 1000-2000	Tendency to stagger	1.5 Hours
• 1000-2000	Slight heart palpitation	30 Min.



Temperature Extremes

- Extremely hot or cold temperatures.
- Steam cleaning of confined spaces.
- Humidity factors.
- Extremely cold liquids.
- Work processes inside the confined space can increase temperature extremes.
- Personal protective equipment.



Engulfment Hazards

- Loose, granular materials stored in bins and hoppers – grain, sand, coal, etc.
- Crusting and bridging below a worker.
- Flooding of confined space.
- Water or sewage flow.

Other Hazards

- Noise
 - Amplified due to acoustics within the space.
 - Damaged hearing, affect communication.
- Slick / Wet Surfaces
 - Slips and falls.
 - Increased chance of electric shock.
- Falling Objects
 - Topside openings expose workers inside confined space to falling objects.

Isolation

- Locking and tagging out electrical sources.
- Blanking and bleeding pneumatic and hydraulic lines.
- Disconnecting mechanical drives and shafts.
- Securing mechanical parts.
- Blanking sewer and water flow.
- Locking and tagging out shutoff valves.



Emergency Response

- Employer shall
- Appoint and ensure that are trained an adequate amount of emergency responders
- Make necessary arrangements with services outside the workplace
- Name and phone numbers of rescue and emergency services.
- Communication procedures such as the ERP, the use of VHF (ATEX) etc.
- Special equipment and procedures.
 - Personal protective equipment. (harness, lifeline, gloves, proper footwear, overall, etc.)
 - Alarm procedures.
 - Rescue equipment.
 - Respirators.



Standby / Buddy System

- Worker assigned to remain outside the confined space and be in constant contact with the workers inside via radio comms.
- Emergency rescue procedures, understood, trained and retrained.
- 50% of workers who die in confined spaces are would-be rescuers.
- Trained in use of emergency rescue equipment and PPE such as but not limited to setting up a tripod, the use of manual winch, harness, etc.)



Training and Education

- All workers who must enter confined spaces
- All attendants and rescue team members.
- Prior to initial work assignment.
- Employees are subject to retraining:
 - Job duties change.
 - Change in permit system.
 - New hazards are present.



Additional Reading re CS, PTW, Case Studies, ATEX EU Directive, Etc.

- https://www.osha.gov/sites/default/files/2018-12/fy15_sh-27664-sh5_Confined_Space_Entry_Permit_Example.pdf
- <https://www.osha.gov/confined-spaces-construction/case-studies>
- <https://cpdonline.co.uk/knowledge-base/health-and-safety/lessons-from-confined-space-rescue-operations/>
- <https://www.imca-int.com/resources/safety/safety-flashes/2723-case-study-confined-space-fatalities-due-to-hydrogen-sulphide/>
- <https://www.iml.org/file.cfm?key=8911>
- <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0034>
- <https://tvmnews.mt/en/news/20-years-since-cirkewwa-tragedy-worker-died-trying-to-rescue-colleagues/> - Water services
- <https://www.youtube.com/watch?v=pCUcCKiXh1E> – Um El Farud