

Confined Space Safety Guidebook

for Supervisors and Workers



WSHCOUNCIL

1. Introduction

Confined spaces can be deadly.

Many people are killed or seriously injured while working in confined spaces each year in Singapore. According to the Workplace Safety and Health Council¹, 10 per cent of workplace fatalities were due to work-related accidents in confined spaces.

These fatal accidents happened across a wide range of industries: from complex plants to simple storage vessels. Those killed were not only people who worked in confined spaces but also others who tried to rescue them.

Therefore good safety practices should be implemented to ensure a safe working environment for everyone.

Investigation of past cases surfaced the following as contributing factors to fatalities from confined space accidents:

- Absence of risk assessment prior to work commencement;
- Inadequate safe work procedures and emergency response plans;
- Absence of atmospheric testing prior to entry;
- Inadequate or absence of mechanical ventilation;
- Lack of proper supervision;
- Inadequate training;
- Lack of control of contractors and sub-contractors;
- Co-workers performing rescue without proper personal protective equipment and emergency response measures.

¹ Workplace Safety and Health Council. 2008. *Workplace Safety & Health, 2008: National Statistics*. Singapore: Workplace Safety and Health Council.

2. Roles and Responsibilities of Supervisors, Entrants and Confined Space Attendants

The main role of the supervisor is to provide direct and close supervision of the entry operations performed by the entrants and confined space attendants.

Supervisors are responsible for:

- a. ensuring that entrants and confined space attendants are briefed on the safety and health precautions to take prior to confined space entry and work;
- b. authorising entry into confined spaces;
- c. ensuring that entrants and confined space attendants adhere to entry procedures;
- d. rescue equipment and appointed rescue personnel are available when confined space work is to be carried out;
- e. implementing control and preventive measures to manage all identified hazards are implemented;
- f. applying the entry permit and have it endorsed by the Authorised Manager before commencement of confined space work;
- g. terminating the entry permit after completion of work.

The main role of the entrants is to do work in confined spaces. Entrants are responsible for:

- a. following entry and work procedures when carrying out work in confined spaces;
- b. carrying a portable gas/vapour measuring instrument for continuous monitoring of the atmosphere in the confined space for the full duration of their work;
- c. inform the confined space attendant of any unsafe atmospheric conditions or when any emergency situation arise; and
- d. inform co-workers to evacuate from the confined space should the portable gas/vapour instruments' alarm be activated due to unsafe atmospheric conditions.

The main role of the confined space attendant is to:

- a. monitor entrants entering and working in a confined space;
- b. maintain regular visual and or verbal contact with the entrants in the confined space;
- c. inform entrants to evacuate the space should the need arise; and
- d. alert the rescue personnel to activate the rescue operation in the event of an emergency.

3. Why is Working in Confined Spaces More Hazardous?

Working in confined spaces is more hazardous than in other workspaces because:

- a. the entrance to or exit of a confined space might not allow workers to evacuate effectively should there be a flood or collapse of free-flowing material;
- b. self-rescue by workers is more difficult;
- c. rescue of victims is more difficult; the interior configuration of a confined space often restricts the movement of people or equipment within it;
- d. natural ventilation alone is often not sufficient to maintain breathable air quality. The interior configuration of the confined space does not allow easy movement of air within;
- e. conditions in a confined space can change very quickly;
- f. the space outside the confined space can impact on the conditions inside the confined space and vice versa;
- g. work activities may introduce hazards not present initially.

4. Identification of Confined Spaces and Hazards

Characteristics of Confined Spaces

A confined space is any enclosed or partially enclosed area that:

- is not primarily designed or intended for human occupancy where supply of air is inadequate for sustaining life;
- has a restricted entrance or exit by the way of location, size or means;
- may contain a hazardous atmosphere which involve the risks of fire or explosions;
- contains materials that could trap or bury an entrant;
- is configured so that an entrant could become trapped or asphyxiated; or
- can present a risk for the health and safety of anyone who enters, due to one or more of the following factors:
 - its design, construction, location or atmosphere;
 - the materials or substances in it;
 - work activities being carried out in it; or
 - the presence of mechanical, process and safety hazards.

Examples of Confined Spaces



Manhole



Silo



Reactor



Bore Hole



Barge Tank



ISO Tank

Common Atmospheric Hazards

Hazard	How it can happen	What the danger is
Oxygen deficiency (less than 19.5% vol oxygen)	<ul style="list-style-type: none"> • Oxidation from rotting of organic materials • Rusting • Bacterial growth • Oxygen depleting work such as welding and cutting • Displacement by other gases • Poor ventilation 	Oxygen-deficient atmospheres can cause difficulty in breathing, headaches, nausea, unconsciousness and eventually death at low oxygen levels
Oxygen enrichment	<ul style="list-style-type: none"> • Leaking oxygen from gas cutting equipment, e.g. welding torch • Leaking pneumatic tools 	Flammable materials catch fire more easily
Fire/Explosion	<ul style="list-style-type: none"> • Fuel, oxygen, and a source of ignition 	Burns and deaths
Toxic atmospheres	<ul style="list-style-type: none"> • Accumulates through some manufacturing, biological, or chemical reactions • Released during tasks such as welding and cleaning 	Exposure to these toxic substances can cause irritation, chemical asphyxiation, headache, dizziness, nausea, cancer and chemical poisoning

Common Non-atmospheric Hazards

Hazard	How it can happen	What the danger is
Heat	<ul style="list-style-type: none"> • Poor mechanical ventilation • Crowded space • Hot work • Heat generating machinery • Thick/heavy protective clothing/ equipment • Strenuous activities 	Heat cramps, heat exhaustion, heatstroke
Noise	<ul style="list-style-type: none"> • Jack hammering • Cutting • Ventilation fans • Physical activity, e.g. erecting scaffolds 	Short term or long term hearing loss (noise-induced-deafness) Poor communication between entrants, leading to accidents
Ergonomic hazards	<ul style="list-style-type: none"> • Limited space • Awkward working position, e.g. overhead • Manual carrying/lifting of equipment, e.g. PPE, tools 	Musculoskeletal effects, e.g. backache, muscle cramps/strain
Poor lighting	<ul style="list-style-type: none"> • Insufficient artificial lighting 	Slips, trips, falls
Mechanical hazards	<ul style="list-style-type: none"> • Moving or rotating parts, e.g. belts, gears • Improper or lack of log out and tag out procedures 	Injury, death
Electrical hazards	<ul style="list-style-type: none"> • Improper electrical wiring • Poor housekeeping of electrical cables • No provision of grounding • Improper or lack of lock out and tag out procedures • Wet spaces • Humid environment which leads to decreased electrical resistance 	Electrocution which leads to burns, death
Skin contact with chemicals/ absorption	<ul style="list-style-type: none"> • Painting, cleaning using solvents or acid • Inadequate skin protection 	Skin irritation, dryness, swelling Skin burns Systemic effects, e.g. liver poisoning, blood disorders, if absorbed through skin into the bloodstream

5. Safe Work Practices for Working in Confined Spaces

General Control and Preventive Measures

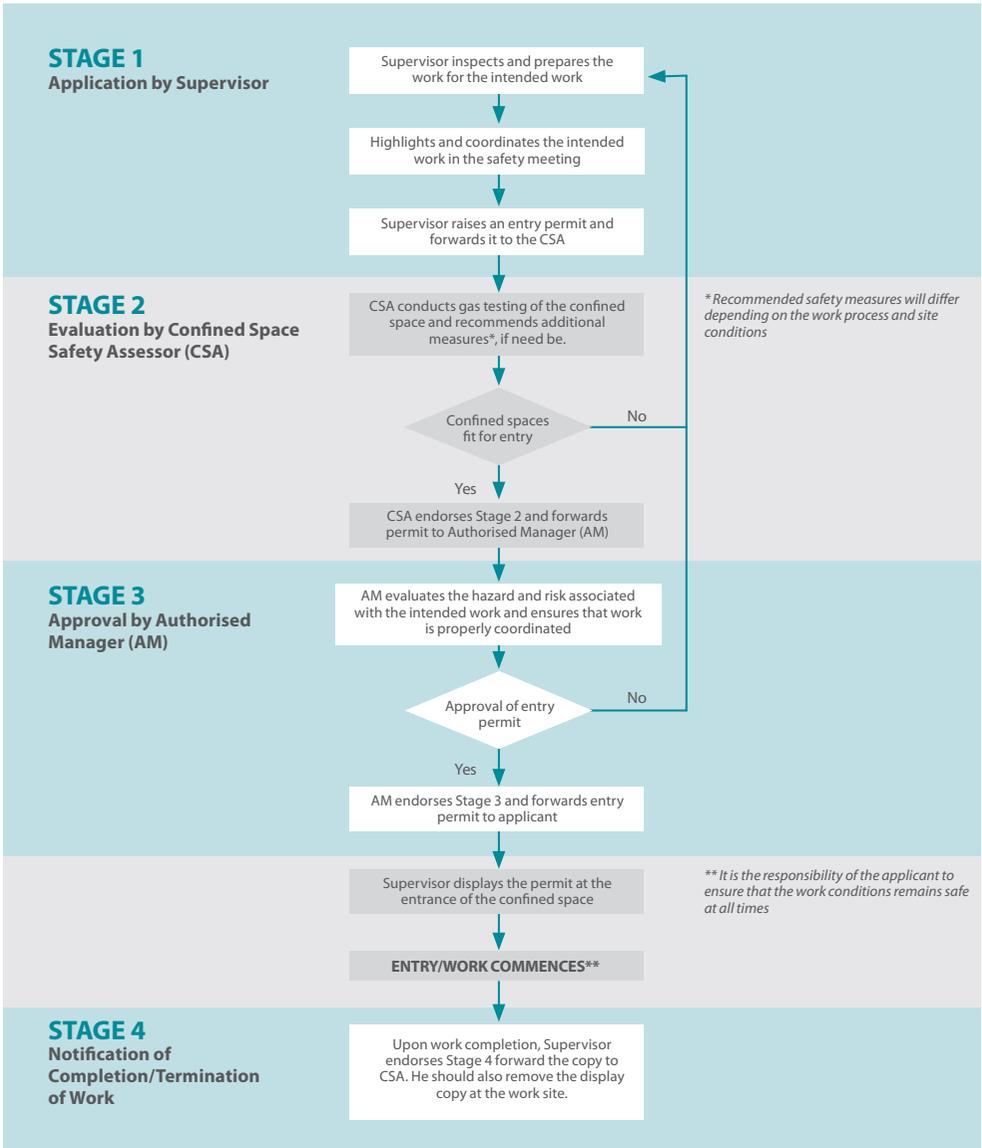
The following should be taken where appropriate, to prevent deaths and injuries from confined space work.

- a. Conduct risk assessments to identify all hazards, evaluate risks and planned mitigating measures;
- b. Implementation of a confined space entry permit system;
- c. Provide safe means of access to and egress from confined space;
- d. Implement safe practices for opening of the entrance/cover of a confined space;
- e. Conduct gas testing of the confined space prior to entry;
- f. Display of identification tags or badges for all entrants;
- g. Provide sufficient and suitable lighting for entry into or work in a confined space;
- h. Provide adequate ventilation to the space before entry and during work in a confined space;
- i. Provide appropriate personal protective equipment to reduce exposure to any residual risks;
- j. Maintain clear and proper communication between entrants, attendants and rescue personnel;
- k. Provide adequate safety and health training on working in confined spaces to all entrants and confined space attendants;
- l. Provide adequate training on rescue operations in confined spaces to rescue personnel;
- m. Appointment of a confined space attendant for every confined space entry or work;
- n. Establish a rescue plan and provision of rescue equipment for the confined space.

Confined Space Entry Permit System

A formal check is necessary to ensure all the elements of a safe system of work are in place before persons are allowed to enter or work in confined spaces. No person should enter or work in a confined space without a valid entry permit.

Flowchart Of Confined Space Entry Permit Application



6. Emergency Response Planning and Rescue Procedures

All workers should be trained on rescue plans before any confined space entry or work.

The rescue operation plan should:

- have names of the designated rescue personnel that are available;
- indicate the methods of rescue to retrieve persons inside a confined space;
- prescribe the types and availability of equipment necessary for rescue; and
- provide an effective recall means to summon the designated rescue personnel in a timely manner.

Rescues should be well planned and specific for each type of confined space. A rescue drill in a confined space should be held at least once in every 12 months to familiarise all workers with the use of rescue methods and equipment.

Workers who are not trained in proper rescue procedures should not undertake or be permitted to undertake rescue operations.

Rescue and emergency equipment need to be suitable and allow emergency arrangements to be carried out in a timely and safe manner. The equipment provided should be appropriate for the likely type of emergency identified in the risk assessment, and should be properly maintained. It should be readily available, whenever and wherever confined space work is undertaken.



Enter the confined space only when you know it is safe. (Picture courtesy of WorkSafeBC)

Rescue equipment may include:

- Self-contained Breathing Apparatus (SCBA);
- full body harness with retrieval line attached;
- hand-cranked mechanical winch and tripod (required when entrant is five feet or more below the entrance);
- ladder;
- explosion-proof lighting;
- stretcher;
- approved head protection;
- reviving apparatus;
- first aid equipment.

Ropes, harnesses, fall arrest gear, lifelines, lifting equipment, first aid equipment, protective clothing and other special equipment should be provided for use in case of an emergency. The equipment should only be used for the purposes for which they are intended, and appropriate and recognised standards should be taken into account, where they exist.

7. Training

All supervisors, entrants and confined space attendants must be trained prior to being appointed to work in confined spaces.

Training should be conducted in the following situations:

- a. the risk assessment or entry procedures have been reviewed and changed;
- b. change in duties or appointment of new duties;
- c. work involving a new type of confined space or new hazards which were never encountered before; or
- d. the entrant or confined space attendant involved has demonstrated a lack of understanding of his duties or any safe work procedures.

Training Courses Available

Supervisors Course

Safety Instruction Course (manhole)

Workers Course

Safety Orientation Course (manhole)

For more information on Ministry of Manpower's (MOM) accredited training providers for occupation and health personnel:

http://www.mom.gov.sg/occupational_safety_health_personnel

8. Dos and Don'ts when Working in Confined Spaces

The following pages illustrate safety practices for confined space work such as:

- identification of confined spaces
- control measures - pre-entry
- control measures - during work
- emergency response and rescue

Identification of Confined Spaces

Identify and label all confined spaces



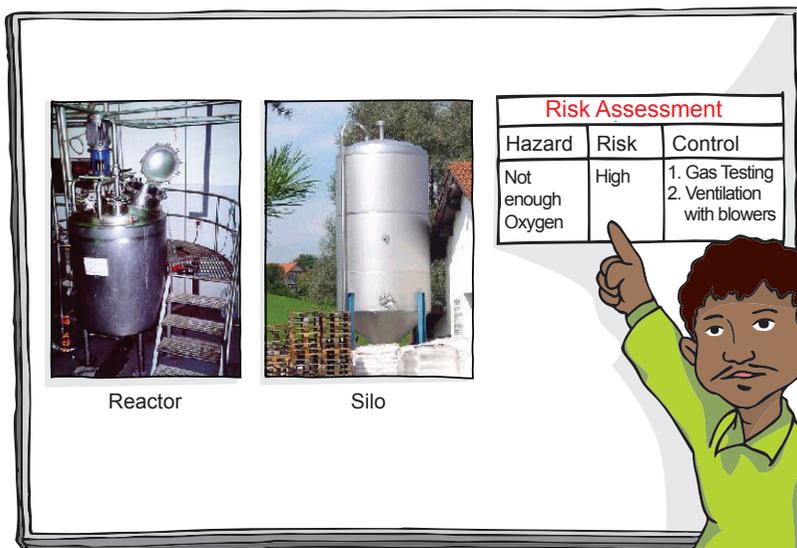
Maintain a register of all identified confined spaces at your workplace and label them with prominent signs to prevent unauthorised access.

1



Identification of Confined Spaces

Inform and train employees



Risk Assessment		
Hazard	Risk	Control
Not enough Oxygen	High	1. Gas Testing 2. Ventilation with blowers

Reactor

Silo

2

Inform employees of all confined spaces in the workplace and ensure they are trained on the hazards and conduct risk assessments prior to working in confined spaces.



Control Measures – Pre-entry

Do not enter confined spaces



DO NOT enter or put your head into a confined space unless authorised.

3



Control Measures – Pre-entry

Prevent unauthorised entry



4

Prevent unauthorised workers from entering confined spaces by placing barriers and warning signs and post endorsed entry permits at the entrances of confined spaces.



Control Measures – Pre-entry

Log out and tag out



Lock out and tag out hazardous equipment in a confined space.

5



Control Measures – Pre-entry

Test for hazards



6

Test for atmospheric hazards in the following order: oxygen, flammable gases and toxic or corrosive gases and permit employees to observe testing.



Control Measures – Pre-entry

Identify proper equipment



Supervisors have to identify proper equipment and tools and train workers on the proper usage before starting confined space work..

7



Control measures – During work

Carry a personal gas detector



8

At least one worker must carry a personal gas detector when working in confined spaces.



Control measures – During work

Communication



Communication between workers and confined space attendants must be maintained at all times.

9



Control measures – During work

Prevent unauthorised entry



10



Prevent unauthorised workers from entering or working in confined spaces.

Control measures – During work

Ensure adequate ventilation



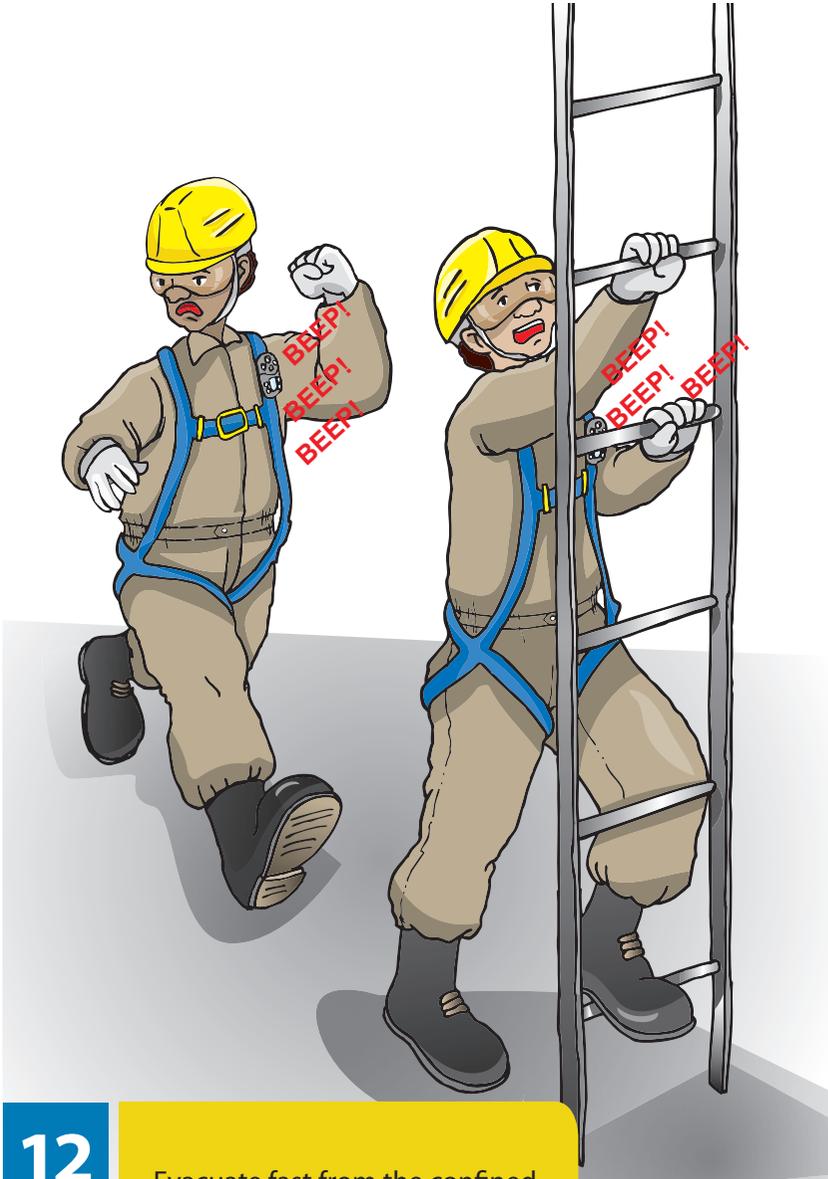
Ensure that there is adequate ventilation during work in confined spaces.

11



Emergency Response and Rescue

Evacuate fast



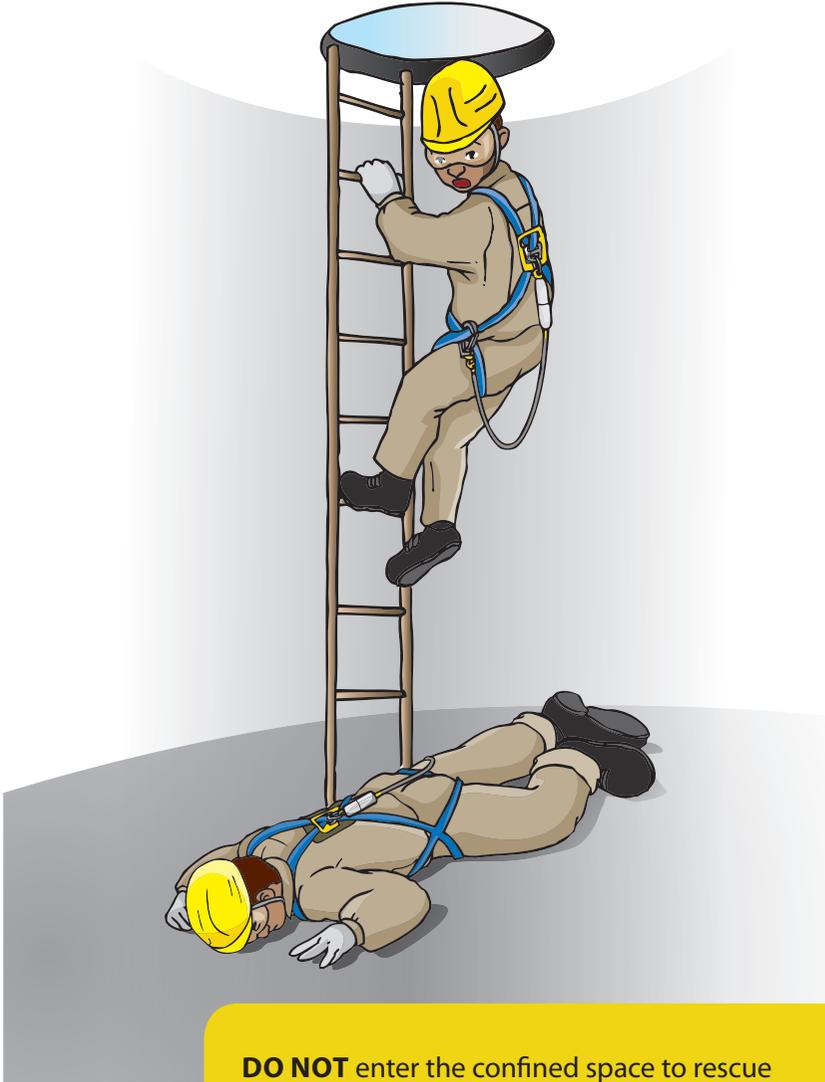
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Evacuate fast from the confined space if the portable gas detector alarm goes off.

Emergency Response and Rescue

Do not attempt rescues on your own

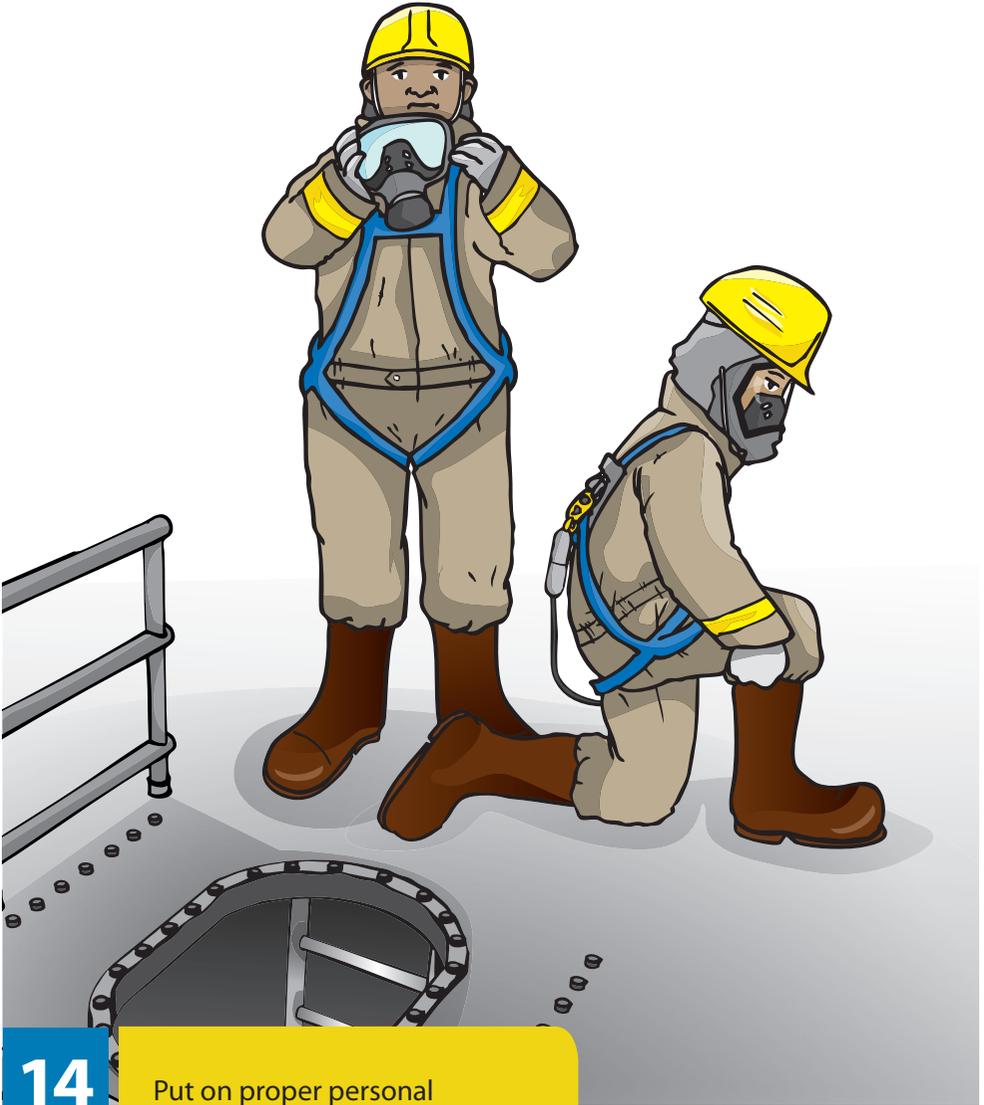


DO NOT enter the confined space to rescue coworkers on your own. Instead inform the emergency response team immediately and wait for help.

13



Wear personal protective equipment



14

Put on proper personal protective equipment before conducting any rescue in confined spaces.



9. Acknowledgement

The picture featured on page 11 is for illustrations purposes and is from the Hazard Alert *Confined Spaces -- Deadly Spaces* and reproduced with permission from WorkSafeBC. For additional confined space resources, visit <http://www2.worksafebc.com/Topics/ConfinedSpaces/Home.asp>

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