Confined Space Entry Training Pack

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Based on the requirment of Toll Blender Safety Guidelines C3: Method to identify, evaluate, communicate and correct safety hazards in the facilities. Confined Space Entry & Clearnace is part of the Work Permit System

Confined Space Entry

Definition : any enclosed or partially enclosed space, either above or below ground, where there is risk of :

- Reduced oxygen level or
- Accumulation of toxic, flammable or explosive materials or
- Engulfment

It is not intended as a regular work place and may have:

- Restricted entry or exit.
- Inadequate ventilation.
- Oxygen deficiency.
- Contaminated atmosphere

Confined Space (CS) Entry is a dangerous activity and you need to be aware of the following:

- It is 100 times more dangerous than any other industrial operation.
- > 50% of CS) victims are would-be rescuers.
- There is high chance of an accident from entering a CS without evaluating the hazards and risks.
- It is a common problem for both workers & management to fail to recognise they are entering a CS.
- CS Entry victims complacently enter a CS.

CS Entry conditions can change within minutes. WHY?

- Entry of Product into CS
- Entry of Fumes in the CS
- Generation of fumes due to the type of work being done in the CS
- Loss of ventilation

Entering a CSE at a PLI location is an extremely high risk activity. Before you enter, DO a RISK ASSESSMENT and complete a Work Permit

What Confined Spaces are you likely to find at PLI?

1. Storage Tanks & Blend Vessels
2. Boiler
3. Sewers & Tunnels
4. Pits more than 1.5m deep have poor ventilation
5. Excavation and trenches deeper than 1.5 m
6. Road Tank Compartments
7. Others

The main hazards are:

- Atmospheric
- Physical
- Biological

The atmosphere has Nitrogen 78%; Oxygen 20%; 11 other gases 2%.

In a CSE, the atmosphere can be

a. oxygen deficient or enriched, and

b. contain dangerous levels of flammable or toxic gases.

Oxygen Deficiency

When O_2 oxygen level falls **<19.5%**, the CS atmosphere is unsafe to enter without wearing approved breathing apparatus & having emergency procedures & equipment in place….

The effect on a person entering a CS with oxygen levels lower than 19.5% are :

- 6 to 10% O_2 - Loss of consciousness.
- < 6% O_2 - Death may occur within a minute.
- < 2% O_2 - Unconsciousness immediate followed by death.

The CSEs likely to be oxygen deficient are:

- Poorly ventilated tanks – usually with one manhole; Small tanks
- Small tanks with steel surfaces which may have been covered with water or other corrosive liquids (corrosion and rust removes oxygen from the air).
- Deep trenches & pits if poorly ventilated, and/or contain stagnant water.

It is important to be aware of the sorts of activities and conditions within, or adjacent to, the CS which can change the safe level of oxygen within the CS. These are

- Welding and oxy cutting will reduce oxygen level and generate toxic fumes.
- Ingress of CO2 and CO.
- Use of cleaning solvent for spot cleaning will displace oxygen and create a possible flammable toxic atmosphere.
- Chemical Reaction such as oxidisation, fire and growth of organic matter.

Oxygen Sufficient

The CSEs generally considered to have a satisfactory oxygen content for personnel entry, providing these have been thoroughly gas freed are

- Steel tanks greater than 100m3, providing there is more than one manhole
- Fully lined steel tanks/vessels,
- Aluminium & Steel tanks/vessels and

However, **for the first entry test for oxygen**. Ensure CS has not contained toxic liquid such as leaded product. These CSs can only be considered safe if

- There is no possibility of liberating flammable fumes when climatic conditions change.
- There is no possibility that ingress of fumes or toxic vapours could occur from any adjacent activity.
- Adequate ventilation.

List examples of situations and circumstances where you must test for Oxygen?

- Where poor ventilation is believed to exist.
- In unlined steel tanks <100 m3; In trenches and pits > 1.5m
- In tanks with one manhole; Before taking explosimeter reading in a CS .

Note: A trench or excavation which is deeper than 1.5m, besides possibly being a CS, it may also require the approval of a competent person regarding the safety associated with shoring or battering of the excavation.

Flammable & Toxic Gases

A number of flammable and toxic gases can be found in Confined Spaces. They have potential to cause illness, death or injury to the unwary entering a CS. The types of gases that can be found (detected) in a CS are:

- Carbon monoxide (CO) which is colourless, odourless, lighter than air and in sufficient quantities will kill a person in minutes.
- Carbon dioxide (CO2) which is colourless, odourless, heavier than air and will displace oxygen rendering a person unconscious, ultimately leading to death after sustained exposure.
- Methane is a combustible gas that is lighter than air and dilutes oxygen.
- Hydrogen Sulphide (H2S) which is colourless, flammable, heavier than air, pungent gas (smells like rotten eggs) that quickly deadens the sense of smell and causes dizziness, nausea, headache and vomiting, ultimately leading to death after sustained exposure.
- Ammonia, sulphur dioxide, toluene, benzene, xylene, etc., have variously similar adverse effects on people exposed to these in CSs.

Anyone entering a CS must be properly equipped and trained to enter and work in such areas. Nitrogen is lighter than air and will dilute Oxygen.

Common physical, atmospheric and biological hazards in CS

- Contaminated atmosphere, leaded sludge
- Restricted Entry/ exit
- No natural lighting
- Work at elevated heights
- Noise amplification
- Oxygen deficiency from inadequate ventilation and type of work being done e.g. welding
- Awkward and uncomfortable working condition
- Potential for engulfment
- Inadequate illumination
- Manual Handling
- Noise, slip, trip, fall
- Temperature

BIOLOGICAL

Some of the biological hazards that maybe found in a CS are :

- Fungal or bacterial growth that depletes the atmosphere of sufficient oxygen and can affect the respiratory system
- Plant growth with the same effect as above.
- Rotting plant and waste material giving-off methane with the same effect as above or creating a flammable atmosphere.

Where might you find biological hazards resulting in insufficient oxygen ?

- Deep drains
- Tunnels
- Interceptors
- Sewers
- Pits - Organic decomposition & bacteria can occur in stagnant water

ISOLATION

What would be some typical CSE isolation controls implemented at a location?

- Isolation of pipelines and pumping equipment
- Plugging of drains
- Locking and tagging of supply line valves, etc.
- Signs and barricades
- Restricted access
- Isolate any mechanical equipment
- Isolate all service pipelines
- Isolate CS outside normal working hours to prevent entry

For mechanical equipment such as stirrers, mixers

- Positively disconnect.
- Electrically lock-off.

For drains entering underground pits

- Plug at a point upstream from the pit.
- Plug outlet to prevent vapour from returning into the pit.

EQUIPMENT

The type of equipment required for CSE depends on the condition and type of CS. The equipment typically required are:

- Breathing apparatus (Two spare sets of BA outside the CS)
- Safety harnesses and lines, if practical.
- Ventilation trunking; Forced air supply; Back-up emergency air supply
- Atmospheric monitoring equipment
- Two radio equipment
- Protective clothing
- Lighting
- Mechanical lifting device
- Adequate tools to carry the task
- Entry and exit equipment (ladders)

EXIT & ENTRY CONDITIONS – Specific Conditions

Regardless of the whether entry is with or without BA there are specific conditions which must be covered, documented and complied with for all CSE activity. These are

- Work to be done.
- Isolation requirements.
- Personal protection equipment.
- Atmospheric tests for LEL, O_2, H_2S.
- Ventilation.
- Peripheral restriction.

Important Notes:

Any non-compliance work must stop and exit the CS.

Never take compressed gas cylinders, such as oxygen, LPG, acetylene into a CS. However, compressed air cylinders for self-contained breathing apparatus are allowed.

Any gun and hoses must be inspected for leaks before taking them into a CS. These must be removed during any break from work, as any leakage from these can result in flammable atmosphere and oxygen enriched atmosphere which can result in spontaneous combustion of some materials.

EXIT & ENTRY CONDITIONS – Entry with Breathing Apparatus (BA) - 1

Before allowing anyone into a CS with BA :

- Disconnect all product pipelines and blank.
- Blank or spade all steam, hot oil, foam, or water pipelines.

The recommended method of isolation is removal of a section of pipeline, as close as possible to the CS, and blanking it.

- Inserting spades is not satisfactory, unless you can prove a 100% seal.
- Two valve isolation is not acceptable. However, if this method has to be used for some remote reason, the two valves as close to the CS as possible would be locked closed and a drain valve between the two valves locked open and all valves would be tagged.
- Percentage LEL at the manhole < 20%
- Adequate ventilation, preferably mechanical, must be operating before anyone enters. The ventilation must continue during the total period of occupancy. The fan must be locked on or tagged.

EXIT & ENTRY CONDITIONS – Entry with Breathing Apparatus (BA) - 2

Other essentials to be fully accounted for and used are

- Back-up BA supply.
- Communications two-way and agreed hand signals.
- Safety harness and line (if required).
- Barricades and signs in place.
- Checklist used before, during and after entry.
- Emergency plan agreed to and understood.

Users must :

- Be thoroughly trained in its use.
- Be clean shaven to avoid ingress of vapours under the mask.
- Not be suffering from any respiratory condition, or be claustrophobic, and be reasonably fit.

EXIT & ENTRY CONDITIONS – Entry with out Breathing Apparatus

Entry without breathing apparatus is only permitted when all of the following requirements are satisfied :

- Vessel is completely isolated.
- Vessel never contained leaded product.
- Nil explosimeter reading is obtained.
- Oxygen content, by volume at least 20% and not greater than 21%.
- Adequate ventilation usually mechanical, ventilation maintained while person is in CS.
- Fumes or dust generated are removed from the work area.

Entering and working in a CS is hazardous and imposes extra physiological demands on the worker.

- Emergency procedure must be agreed on and where possible practiced. It is not easy to extract an unconscious person from a CS, especially where there is a restricted means of access.
- Therefore, their aptitude and physical competence must be taken into account before entry. It is also preferable that the workers and observer are trained in emergency rescue, first aid and CPR.

Safety Equipment for considerations

1. **Safety Harness & Life Line** – for additional safety, the personnel in the CS can be connected via life line to the observer stationed outside.
2. **Mechanical Lifting Device** - If entry to the CS is vertical and an operator could fall more than 1.8m, an approved lifting device for lowering and lifting operators must be positioned at the CS entry/exit point.
3. **Communications** –
   - Communication b/w the people inside the CS & the observer is mandatory
   - This may be achieved by radio, sight or signals
   - When signals are used these must be simple and clearly understood by all those people involved
4. **Barricades & Signs**

   The area surrounding a CS must be:

   - Marked & protected by barricades & signs outside normal working hours.
   - During operating hours warning signs should be in position and where appropriate the work area will also be barricaded.
   - Out-of-hours the CS must be secure against unauthorised entry. This is done by bolting mesh screens over any openings to a CS.

Observer's Role

An observer must be present all the time people are working in a CS. The observer must be:

- Outside & maintain continuous visual contact with the person working in a CS.
- Have an effective means of communication in the event of an emergency.
- Trained and understand emergency procedures.
- Understand normal and emergency communication signals and systems
- Two spare sets of breathing apparatus available for immediate emergency use.

Checklist: Pre-Entry, Occupation, Post-Entry & Completion

A means of maintaining safe work procedures is to develop a checklist-cum-questions that covers:

1. Pre-entry
2. Occupation
3. Post-exit and
4. Completion phases of CSE work.

Checklist: Pre-Entry

Helps to ensure those entering a CS are:

- Fit, apt and trained in procedures of CSE.
- Trained, drilled in and familiar with emergency procedures.
- Know how to use breathing equipment.
- Trained in first-aid and CPR methods.
- Familiar with the ‘whys’ and ‘wherefores’ of lockout methods and procedures.
- Have tested and know how to use the communications equipment.
- Know how to use the safety and rescue equipment.
- Endorsed and checked the conditions of the Work Permit.

The following conditions of CS & work procedures must be checked & in place:

- CS isolated; All lock-outs and blanks recorded; Environment evaluated (No physical and chemical hazards are present)
- Someone is on-hand to continuously or frequently monitor the space. Sufficient and competent staff are on stand-by.
- Work area is adequately sign-posted and protected.
- Ventilation of the space started and satisfactorily maintained.
- Rescue equipment is readily available and in working order.
- Oxygen level is safe.
- Work will not produce further hazards.

Checklist: Occupation

During occupation, the procedures to be followed and safety levels maintained are:

Permit conditions are regularly checked and followed by all those involved.

- Atmosphere is constantly or frequently monitored.
- Work practices are safe.
- Working conditions are safe.
- Suspend the work if there is non-compliance with the conditions.

Checklist: Post Exit

The items to be checked to ensure all personnel are accounted for and the space rendered safe are

- All personnel and equipment are accounted for
- Openings are sealed
- Lockouts and blanks have been removed

Checklist: Completion

After the work is completed and the area cleared the following points need to be covered:

- Check if any equipment need servicing and, if required, ensure it is done.
- All reports are written-up. (Be sure any unsatisfactory elements of the work are covered in the report)