 هيئة مياه وكهرباء أبوظبي Abu Dhabi Water & Electricity Authority	<b>ABU DHABI WATER AND ELECTRICITY AUTHORITY (ADWEA)</b>	Effective Date : 18.06.2009		
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## CONFINED SPACES GUIDELINES



# ADWEA HSE PROCEDURE MANUAL

## CONFINED SPACES GUIDELINES

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#### 1. Introduction

A confined space is any enclosed or partially enclosed space where entry is required and where there is a risk of encountering hazardous substances or conditions that could lead to anyone entering the space being overcome due to:

- fire or explosion
- gas, fumes, vapour, lack of oxygen
- drowning
- being buried under a free flowing solid (e.g. sand)
- high temperature

Examples of spaces considered as confined spaces include the following:

- Process vessels and associated equipment, including vessel skirts
- Blend tanks and vats
- Cargo, ballast and void spaces on board ships
- Support columns/legs/pontoons of structures
- Cellars, vaults, unventilated rooms and other similar spaces which may be considered confined spaces under specific circumstances
- Pits, culverts, pipes, drains, sewers, sewage pits, tunnels, wells, well cellars, trenches, ducts, shafts, etc.
- Boilers, furnaces and flues
- Entry on to the floating roof of a tank, where the roof is greater than 2 metres below the tank rim
- Storage tanks for water, oil or any other substance, and any other similar space without natural ventilation, or where there is a danger of ingress of harmful vapour or shortage of oxygen.

It is worth noting that a space in which a person may become trapped is also regarded as a confined space. Although there may be no hazardous substances involved and conditions may not appear to be hazardous, the consequential effect of being trapped could lead to the person(s) being overcome.

Confined spaces can be dangerous places and entry into them must be strictly controlled to prevent injury to the people whose work requires them to enter these spaces. These guidelines together with Permit to Work Procedures provide the basis for control.



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### 2. Responsibilities

#### 2.1 General

In view of the hazards associated with working in confined spaces, all personnel who work in or support confined space work must demonstrate a responsible attitude at all times during the work and in particular, ensure that:

- Entry into a confined space is not permitted unless a work permit has been obtained.
- The precautions stated on the work permit and associated certificates are understood and observed.
- The potential need for personal protective equipment whilst working in the confined space is understood and users are familiar in its use.
- No person shall enter a confined space unless all directly connected sources of process and utilities fluids have been positively isolated from the confined space.

#### 2.2 Site Managers/Team Leaders or Heads

Site Managers/Team Leaders or Heads with responsibility for an operating site that includes confined spaces must ensure that:

- A review and control procedure is established to ensure that the safety requirements of confined spaces are reviewed on a regular basis.
- A formal evaluation procedure is undertaken to identify all work locations within each area of operations which are, or may be, classified as confined spaces.
- Personnel are familiar with the hazards that may be present in confined spaces.
- Suitable personnel are trained and competent in the use of appropriate safeguards and test equipment for controlling those hazards.
- Gas Testers are trained, competent and appointed.
- Work in confined spaces is adequately supervised to ensure that work is conducted safely by all personnel.
- The requirements of the Permit to Work system are applied.

#### 2.3 Supervisors

Supervisors are responsible for ensuring that:

- An assessment is made of the site where work is to be carried out to determine if it constitutes a confined space.
- The confined space is properly isolated before entry is permitted.

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- The atmosphere in the confined space has been fully tested for oxygen, toxic and flammable materials, by an authorised gas tester.
- All personnel working within their area of supervision are properly instructed in the requirements of confined space entry, and work to these requirements.
- A record of all personnel, tools and materials entering and leaving the confined space is kept.
- A set of emergency procedures relevant to the confined space entry task has been developed, and that all the work crew are familiar with those procedures.

### **2.4 Attendants**

Attendants are responsible for ensuring that:

- The safety of personnel inside the enclosed space is closely and constantly monitored.
- The record of all personnel, tools and materials entering and leaving the confined space is maintained.
- Emergency and rescue services and equipment are available.
- All personnel entering the confined space are aware of the relevant safety procedures.
- Communication is established and maintained with personnel entering the space.

### **2.5 Gas Testers**

Gas Testers are responsible for ensuring that:

- The equipment they use is:
  - Suitable for the atmosphere to be tested
  - Properly calibrated and maintained
  - Within its validation period
- They are sufficiently knowledgeable to interpret the results correctly.
- They are aware of the likely contaminants and the appropriate testing regime.
- Gas testing is done immediately and the results recorded.

**NOTE:** Paint solvents have characteristics that differ from methane gas, the reference for test meters, and appropriate conversion factors must be used by Gas Testers to give an accurate Lower Explosion Limit (LEL) percentage. Conversion factors for different vapours/gases are given in Appendix 1.



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#### **3. Work Permits**

No person may enter a confined space without an authorised work permit.

Appendix 2 contains a planning guide which should be used by work site supervisors to ensure that the required pre-conditions for safe entry into a confined space have been identified and are in place.

#### **4. Risk Assessment**

Before issuing a work permit, risk assessment should take place and all information regarding the confined space should be considered during the Risk Assessment, such as engineering drawings, working plans, and data on relevant soil or geological conditions.

Consider what might be present or not present that could affect work in the confined space such as:

- Previous contents.
- Residues.
- Contamination.
- Oxygen deficiency.
- Oxygen enrichment.
- Physical dimensions.

Where residues are present, the Safe System of Work must assume that any disturbance of residue will release gas, fume or vapour.

When considering the impact of physical dimensions, consider whether air quality can vary in different parts of the confined space.

Consider the hazards that may arise from the work itself including:

- Exterior welding or other application of heat.
- Cleaning chemicals.
- Sources of ignition.

Consider the need to isolate the confined space to prevent dangers arising from elsewhere especially the ingress of substances.

Consider the requirements for emergency rescue arrangements for foreseeable incidents. Possible emergencies must be anticipated and appropriate rescue arrangements made.



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#### 4.1 Oxygen Deficiency/Enrichment

Confined spaces which are found to have atmospheres containing less than 19.5% of oxygen by volume are considered to be oxygen deficient. Personnel are not permitted to enter into or remain in oxygen deficient atmospheres unless:

- positive pressure breathing apparatus is worn
- the cause of the oxygen deficiency is identified
- the work permit and associated certification specifically identify and allow entry to the oxygen deficient space.

Entry into confined spaces where the atmosphere is deficient in oxygen to such an extent that it presents an immediate danger to life or health is not permitted under normal working conditions.

Atmospheres containing more than 21% of oxygen by volume are considered to be oxygen enriched.

**Entry into oxygen enriched atmospheres is prohibited at all times and under all circumstances.**

#### 4.2 Chemical/Toxic Substances

Chemical/toxic substances inside confined spaces may cause injury, acute or long-latency illness, or death, depending on the concentration and duration of exposure, and the characteristics of the substance.

Chemical/toxic contaminants may exist in the form of vapours, dust, mists or contact hazards. Information for all substances is contained on the Material Safety Data Sheets (MSDS). In the event that data is not available, the supervisor may contact the HSE Unit for information and guidance.

Exposure limits in excess of 50% of the Occupational Exposure Limit (OEL) must not normally be exceeded, other than where clear justification exists, suitable plans and precautions have been established, appropriate protective equipment is available and worn, and the degree of contamination of the space clearly and accurately established.

Entry to spaces where the atmosphere contains contaminants above the Occupational Exposure Limit is not permitted under normal working conditions, irrespective of the type of respiratory protection used. Atmospheres that are so toxic as to present an immediate danger to life or health, should the respiratory protection fail, must not be entered.

#### 4.3 Flammability, Fire and Explosion

Where entry to a confined space is required without breathing apparatus, the maximum concentration of flammable gases must **never** exceed 1% LEL. Personnel are prohibited from entering or working in confined spaces without breathing apparatus where concentration of flammable gases exceeds 1% LEL.

Where flammable vapours are present at concentrations greater than 1% LEL but less than 10% LEL, then entry is only permitted when breathing apparatus is worn, and the full rules for wearing of breathing apparatus within confined spaces are followed.

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Note: **On no account should entry into a confined space be made, whether or not breathing apparatus is worn, where any flammable vapours present exceed 10% LEL.**

Hot work is not permitted where flammable vapours greater than 1% LEL are detectable anywhere inside the confined space.

Cold work, e.g. tank cleaning and inspection, is permitted up to a maximum permitted level of 10% LEL under strictly controlled conditions that must include the wearing of air supplied breathing apparatus. At this level of flammability, however, other contaminants may be present and Gas Testers need to satisfy themselves that any relevant Occupational Exposure Limit (OEL) is not exceeded. Limits for oxygen, flammable vapours and toxic contaminants are shown in Table 1.

#### 4.4 Physical Hazards

Personnel do not normally enter or work in confined spaces where there is a risk of physical danger, e.g. the integrity of the isolation not assured, or the physical condition of the confined space unknown, or where emergency escape or rescue is not possible. A number of physical hazards may be present, and identification of these forms part of the pre-entry planning process. Physical hazards likely to be encountered include:

- Structural failure, e.g. failure of an internal floating roof
- Falling tools and materials
- Improper shoring in excavations or trenches leading to cave-ins
- Failure to positively isolate confined spaces, e.g. drop out or blank off pipe connections
- Failure to disconnect or make inoperative electrical, hydraulic or mechanical equipment
- Restricted working spaces or conditions
- Slippery surfaces
- Inadequate lighting
- Inadequate or faulty personal protective equipment
- Excessive noise or heat levels
- Radioactive substances, used for level gauges, or present in small quantities in some crude oils or condensates.
- Electric shock

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**Table 1 – Limits of Oxygen, Flammable Vapours and Contaminants**

Type of Work	Flammable Vapours	Oxygen	Oxygen	Toxic Contaminants
	Maximum	Maximum	Minimum	Maximum
Hot Work, general (See Note 1)	1% LEL	21%	19.5%	50% OEL
Cold work, general	10% LEL	21%	19.5%	50% OEL
Entry into confined space without breathing apparatus	1% LEL	21%	19.5%	50% OEL Organic lead - Nil
Entry into confined space with breathing apparatus, for cold work and inspection only	10% LEL	21%	19.5%	100% OEL unless respiratory protection specifically certified suitable
Entry into confined space with breathing apparatus, for hot work (See Note 1)	1% LEL	21%	19.5%	100% OEL unless respiratory protection specifically certified suitable
Entry into an inert confined space with positive breathing apparatus(See Note 2)	Normal flammability rules not relevant	8%	0%	Special precautions apply.
Entry into an inert confined space without breathing apparatus	Not permitted			

LEL Lower Explosive Limit

OEL Occupational Exposure Limit

Note 1: The permitted 1% LEL of flammable vapours allows for possible instrument inaccuracies. All possible steps must be taken to ensure that the hot work area/confined space is totally gas free.

Note 2: Entry into a confined space with an inert atmosphere is only permitted in exceptional circumstances.

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#### 5. Isolation

##### 5.1 Process Isolation

Confined spaces such as vessels, pipelines and other items of process equipment must be mechanically isolated from other process or control equipment. Isolation is normally by positive segregation; single valve isolation of confined spaces where entry is required is not permitted other than in exceptional circumstances

##### 5.2 Electrical Isolation

All permanently installed electrical equipment associated with the confined space must be electrically isolated.

##### 5.3 Physical Prevention of Entry

Confined spaces that are 'open' but not currently certified as safe for entry, e.g. a storage tank under maintenance with man lids removed for ventilation prior to entry, must be physically barred off to prevent unauthorised or inadvertent entry. Care is needed to ensure barriers do not prevent natural venting.


#### 6. Gas Purging

Where flammable or toxic gases or vapours are present, or possibly present, it may be necessary to purge the gas or vapour from the confined space. This can be done with air or inert gas when the contaminants are non-flammable, but should be done first with inert gas only when there are flammable contaminants. Following purging, the atmosphere must be tested to check that purging has been effective and that it is safe to breathe, before allowing people to enter.

In circumstances where the safest method of removing a flammable or explosive hazard is by purging with inert gas and the work cannot be carried out from a safe position outside the confined space, then a Risk Assessment must identify the standard of protection of all exposed persons. This may include the use of full breathing apparatus.

Account must be taken of the possibility of personnel exposure to vented purge gases. Consider the possibility of exposure of all people, including contractors, personnel working on other adjacent facilities and members of the public. All necessary precautions must be taken to protect them from toxic, flammable or irritating gases and vapours.

Good ventilation and a supply of breathable air are essential. Inhaling an atmosphere that contains no oxygen can cause loss of consciousness in a matter of seconds. Inhaling an atmosphere with reduced oxygen content will result in personnel feeling fatigued and they may become irrational. Prolonged exposure can result in loss of consciousness.

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## 7. Ventilation

Some confined spaces are enclosed to the extent that they require mechanical ventilation to provide sufficient fresh air, both to replace the oxygen that is used by people working in the space and to remove or dilute fume or vapour produced by the work. Fresh air should be drawn from a point where it is not contaminated either by used air or by other pollutants. Never introduce additional oxygen into a confined space as this can lead to oxygen enrichment, rendering certain substances, such as grease, liable to spontaneous combustion. It will also greatly increase the combustibility of other materials. Oxygen above normal air concentrations may also have a toxic effect if inhaled.

When considering the ventilation method, account must be taken of the layout of the space, the position of the openings and the properties of the pollutants, especially their density, so that ventilation air circulates throughout the space. Natural ventilation may suffice where there are sufficient top and bottom openings, but forced ventilation is normally preferable.

When using forced ventilation, ensure that an airline or trunking is introduced at, or extends to, the bottom of the space to ensure removal of heavy gas or vapour.

It is essential to ensure that extract ventilation is routed away from all possible sources of re-entry.

**Note: Oxygen is a promoter of combustion, and must NOT be used in an attempt to correct oxygen deficiency in a confined space.**

Where there is a life-threatening situation, or after all reasonably practicable steps have failed to gas-free the confined space, the decision to allow personnel to enter a non gas-free space shall be made **ONLY** by the Site Manager/Team Leader or Head and countersigned on the permit.

## 8. Inert Atmospheres

Entry into inert atmospheres is normally prohibited, and is only permitted where specific written procedures have been prepared and authorised in writing by the Site Manager/Team Leader or Head.

Only contractors who are specialised in working in inert atmospheres are employed for this work. They must provide the following information, approved in writing by the Group Company, before commencement of work.

- Comprehensive written safety and operating procedures and instructions for inert atmosphere handling that define:
  - maximum allowable oxygen content
  - minimum inert gas flow rate
  - total daily consumption of inert gas
  - number and position of inert gas injection points
  - persons responsible for monitoring inert gas pressure gauges

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- number and location of oxygen measuring elements and responsibility for monitoring and calibration
- restricting access to the immediate vicinity of the inert space to persons involved in the work
- arrangements for securing the work site in the event of work interruption
- Training certificates for entry into inert atmospheres showing dates of refresher training and experience of the persons selected for the job.
- Confirmation that all named personnel undergo regular medical checks and are allowed to perform such work.
- Details of the gas testing equipment to be used. Note that normal gas detectors (explosimeters) with catalytic sensors are not suitable.

To safeguard against all identified hazards and foreseeable difficulties, close co-operation between the Group Company and contractor staff must be established and maintained from the pre-planning stage onwards.

Areas of responsibilities in the execution of work must be clearly defined, easily understood and strictly followed.

**Note: Entry into inert confined spaces may only be made using air-supplied positive pressure breathing apparatus with a self-contained cylinder or other independent back-up supply. Entry using only conventional self-contained breathing apparatus is limited to emergency life-saving intervention.**

#### 9. Testing and Monitoring

Entry into a confined space is not authorised unless an authorised Gas Tester has tested the atmosphere. The results of the tests must be satisfactory with regard to the proposed task and method of entry and the type of equipment used to carry out the test, and documented accordingly on the work permit.

Gas tests carried out to obtain results representative of the entire space and the test equipment must be:

- suitable for the atmosphere to be tested
- of an approved type
- properly calibrated and maintained
- within its validation period

As a general rule, tests are carried out in the following sequence:

- oxygen content
- flammable gas
- toxic gas

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Monitoring must be repeated and the results recorded at regular intervals whilst personnel are in the confined spaces, and in any event the maximum 'interval' between tests must not exceed 2 hours.

Where the potential exists for an oxygen deficient atmosphere or an unexpected release of flammable or toxic gases, continuous monitoring must be carried out.

Where oxygen enrichment is possible, e.g. when oxy/propane burning equipment is used in confined spaces, the atmosphere must be continuously monitored.

If oxygen deficiency or enrichment occurs while work is in progress, the confined space must be evacuated, flushed with air and re-entry permitted only after further tests produce satisfactory results.

Note: the positioning of oxygen and flammable gas cylinders in a confined space is permitted only in exceptional circumstances.

#### 10. Entry into Confined Spaces without Breathing Apparatus

Prior to authorisation of confined space entry without breathing apparatus, the Area Authority must consider:

- The method and period of ventilation of the space.
- The results of the tests carried out by the Gas Tester and declared on the Confined Space Entry Certificate.
- The nature of any contaminants likely to be found, e.g. mercury or lead, or likely to enter, e.g. weld fumes or hydrocarbon vapours.
- Vessel configuration and the possibility of dead legs that may not be gas free.
- The means of escape from the confined space and how a rescue would be carried out.

#### 11. Personal Protective Equipment (PPE)

PPE relevant to the confined space (e.g. lifelines, harnesses, SCBA, etc.) and appropriate to the task (e.g. safety helmet, welders' masks, gloves etc.) shall be worn.



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#### 12. Attendants

An Attendant who has been trained and instructed in his responsibilities controls access to confined spaces. Note that in the case of entry into a confined space not certified gas free, two Attendants are required. Where there is multiple access points in use, there must be an Attendant at each access.

Attendants are provided with:

- a confined space standby man pocket card
- radio or other special means of continuous communication with the persons within the confined
- emergency and rescue equipment and personnel readily available
- emergency medical aid readily available

When air line breathing equipment is being used by the persons carrying out the work in a confined space, Attendants must ensure that:

- air quality has been tested and found acceptable prior to the start of work and at weekly intervals thereafter air receiver pressure is adequate and being maintained
- the integrity and availability of back-up supplies is acceptable
- air lines are laid such that they cannot be damaged nor impede the movements of the equipment users


Attendants must be supplied with and be trained and competent in the use of self-contained breathing apparatus (SCBA) and a lifeline, together with any other equipment necessary to effect the rescue of personnel from inside the confined space.

When SCBA equipment is in use by the persons carrying out the work in a confined space, Attendants must ensure that:

- regular checks are maintained on the status of the SCBA sets
- low pressure audible alarms are tested before each entry
- exposure times are calculated and monitored

Attendants must NOT carry out other tasks whilst they are carrying out their duties as Attendants and must not leave the access point unattended while persons are inside the space.

When work is suspended, Attendants ensure that all personnel have vacated the confined space and erect barriers and signs to prevent unauthorized access to it.

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### 13. Emergency Procedures

Entry into a confined space must not be made unless emergency procedures for rescue have been formulated for that entry, they are readily available on site and equipment and personnel are provided. The emergency procedures must take into account:

- The identified hazards at the work site and the work to be performed.
- The worst case situation.
- The equipment normally kept on site.
- Circumstances which could necessitate the use of special equipment such as harness, line and winch or pulley for personnel recovery from spheres or columns.
- Available manpower, especially those trained in first aid techniques.
- The availability of back-up air supplies.

Emergency procedures must be tested before first entry into a confined space and at regular intervals thereafter.

In the case of confined spaces not certified gas-free, at least two attendants must be fully prepared to undertake IMMEDIATE rescue.

On no account must an Attendant attempt to enter the space before help has arrived or without breathing apparatus, harness and lifeline.

### 14. Closure of Confined Spaces

The Area Authority must ensure that the work is complete and that all personnel, tools and materials have been removed from the confined space before authorising the space to be closed. The confined space may then be closed before the work permit is signed off as complete.

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**Appendix 1 - Correction Factors for Pellistors in Gas Test Meters**

To obtain an approximate LEL value for the gases/vapours below, multiply the meter reading on a methane calibrated detector by the value shown.

Gas/Vapour	Detector Calibration Methane	Gas/Vapour	Detector Calibration Methane
Acetaldehyde	1.6	Ethyl Ether	2.1
Acetic Acid	1.6	Ethylene	1.2
Acetic Anhydride	2.0	Ethylene Dichloride	1.4
Acetone	1.6	Ethylene Oxide	1.8
Acetylene	1.7	N-Heptane	2.3
Acrylonitrile	2.0	N-Hexane	2.0
Alkyl Alcohol	1.9	Hydrogen	1.2
Ammonia	0.6	Kerosene	2.8
N-Amyl Alcohol	2.8	LPG	2.1
Aniline	2.5	Methane (LNG)	1.0
Benzene	1.9	Methanol	1.2
1.3 Butadiene	1.3	Methyl Chloride	1.0
N-Butane	1.6	Methyl Cyclohexane	2.0
Iso-Butane	1.8	Methylene Dichloride	1.0
Butene-1	2.0	Dimethyl Ether	1.4
N-Butanol	2.9	Methyl Ethyl Ether	2.0
I-Butanol	1.9	Methyl Ethyl Ketone	2.2
Tert-Butanol	1.3	Methyl-N-Propyl-Ketone	3.2
Butyl Acetate	3.0	Naphthalene	2.8
N-Butyl Benzene	3.0	N-Nonane	2.8
Iso-Butyl Benzene	3.0	N-Octane	2.6
Carbon Monoxide	1.2	N-Pentane	1.9
Carbon Disulphide	8.0	Iso-Pentane	1.9
Carbon Oxysulphide	1.0	Petrol	1.9
Cyclohexane	2.0	Propane	1.3
Cyclopropane	1.6	N-Propanol	2.0
N-Decane	2.8	I-Propanol	1.8
Diethylamine	1.8	Propylene	1.8
Dimethylamine	1.5	Propylene Oxide	2.0
2.3 Dimethylpentane	2.2	Iso-Propyl Ether	2.0
2.2 Dimethylpropane	2.2	Propyne	2.2
Dimethyl Sulphide	2.2	Styrene Monomer	8.0
Dioxane	2.0	Tetra Hydra Furane	2.1
Ethane	1.4	Toluene	1.9
Ether Acetate	1.8	Trimethylbenzene	3.0
Ethanol	1.85	White Spirit	3.0
Ethyl Benzene	2.6	o-Xylene	2.8
Ethyl Bromide	1.0	m-Xylene	2.2
Ethyl Chloride	1.6	p-Xylene	2.2
Ethyl Cyclopentane	2.2		

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Planning & Development Director:

**Appendix 2 - Confined Space Entry Planning Guide**

This guide should be used by Work-site Supervisors as a checklist of points to be considered and actions required during the planning and preparation stages before work in a confined space commences.

<b>Hazard Identification</b>	Check for:	<ul style="list-style-type: none"> <li>- General hazards</li> <li>- Bad/poor visibility and lighting</li> <li>- Oxygen deficiency</li> <li>- Flammable/toxic gases/liquids</li> </ul>
<b>Permit Controls</b>	Specify on permit:	<ul style="list-style-type: none"> <li>- Tests for oxygen levels and harmful gases (specify types of gas)</li> <li>- Position of barriers and warning signs</li> <li>- Systems to be isolated (mechanical and/or electrical)</li> <li>- Identity of isolation certificates</li> <li>- Identity of confined space entry certificate</li> <li>- Continuous monitoring of oxygen content (stop work if oxygen level falls below 19.5% or monitoring instrument fails)</li> <li>- Personal protective equipment to be used</li> </ul>
<b>Other Hazards</b>	Check for:	<ul style="list-style-type: none"> <li>- Exposure to falls from height</li> <li>- Special hazards identified in Safety Case</li> <li>- Hazardous substances (radioactive sources, inert gas, nitrogen fibrous material)</li> <li>- Manual handling of heavy, awkward objects</li> <li>- Any other hazard not listed above</li> </ul>
<b>Communication</b>	Ensure:	<ul style="list-style-type: none"> <li>- All members of workforce are briefed</li> <li>- Briefing covers permit contents, hazards, controls</li> </ul>
<b>Control Checks</b> space	Confirm:	<ul style="list-style-type: none"> <li>- Gas cylinders not to be taken into the confined</li> <li>- Torches removed when not in use</li> <li>- Emergency procedures explained and understood</li> <li>- Access and escape routes are clear</li> <li>- Ventilation and/or breathing equipment arrangements made</li> <li>- Work-site and surrounds checked for unsecured objects</li> <li>- Illumination adequate</li> </ul>

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