Safety in Confined Spaces

Safe Working in a Confined Space

TOGETHER to ZERO eliminating workplace deaths

OCCUPATIONAL SAFETY & HEALTH SERVICE
TE RATONGA ORANGA

DEPARTMENT OF LABOUR
TE TARI MAHI

Safety in Confined Spaces

Introduction

to confined space safety

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Information Sheet No. 1

Working in a confined space is potentially one of the most dangerous of all workplace hazards. It's been calculated that working in a confined space is 150 times more dangerous than doing the same job outside.

Over the years, many workers, in a range of occupations, have lost their lives or suffered serious harm while working in tanks, vats, sumps, sewers, pits, traps and other types of confined space. All of these deaths and injuries could be averted by following the established procedures for such work and using proper personal protective equipment.

AUSTRALIAN STANDARD

The key document is AS 2865: 1995 *Safe working in a confined space*. This Standard was prepared to meet the need for requirements and procedures for the prevention of occupational illness, injuries and fatalities associated with persons entering and working in a confined space. It is designed not only to ensure that confined spaces are made safe for those entering them, but also to highlight the likely hazards associated with such work areas and the relevant safe work processes necessary to deal with those hazards.

The Standard emphasises the responsibilities for safety before entry and during the entire operation. Such responsibilities cover conditions of work for an organisation's own employees, as well as for any contractors or other persons on the premises. This Standard requires that adequate steps be taken to eliminate or control hazards. It also requires that all persons involved in the entry of a confined space be trained and instructed on the nature of the hazards and the precautions to be followed.

This Standard conforms with the hierarchy of controls set out in the Health and Safety in Employment Act 1992 and its use is endorsed by the Occupational Safety and Health Service. It is recommended that this Standard form the basis of procedures adopted in all industries where work is performed in confined spaces.

WHO NEEDS THIS INFORMATION?

Industries where work has to be undertaken in a confined space include:

- Chemical industries
- Telecommunications
- Underground services
- Food and beverage industries
- Construction,
- Energy industries,
- Railways.
- Shipbuilding and repair

This set of information sheets provides general, non-technical information on safe working in a confined space, and includes examples of accidents. It is intended to supplement the Standard. As well as assisting employers, some of these sheets may be useful as employee information and for training purposes.

OTHER INFORMATION

There is a large literature on the subject of work in confined spaces. AS 2865 lists various key documents that were consulted in the development of the Standard, and articles on aspects of the subject are published in health and safety journals, in New Zealand and overseas. Manufacturers and suppliers of safety equipment also provide relevant information.

Every industry and place of work needs to have all the technical information relevant to the work carried out in confined spaces, and to document its procedures fully. If expertise is not available to do this within the organisation, it is recommended that assistance be sought from a suitably qualified consultant.

Safety in Confined Spaces

Essential facts
on confined space safety

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Information Sheet No. 2

Serious accidents have occurred and continue to occur to people working in confined spaces. A significant number of such accidents are fatal, and multiple fatalities are not uncommon. If you must work in a confined space, you must observe special precautions.

WHAT IS A CONFINED SPACE?

A confined space is any area that is not intended for human occupancy and that also has the potential for containing a dangerous atmosphere. A confined space:

- is large enough for a worker to enter and perform assigned work;
- has limited entries and exits;
- may contain a hazardous atmosphere, arising from chemicals, sludge or sewage;
- is constructed so that anyone who enters could be asphyxiated or trapped by walls or floor that converge to a small cross-section, such as a hopper;
- contains a material, such as sawdust or grain, that could engulf anyone who enters.

Examples of a confined space include a tank, vessel, vat, silo, bin and vault. Others which are less obvious can be equally dangerous, e.g. open- top tanks and vats (particularly where heavier than air gases or vapours may be present), closed and unventilated rooms, or furnaces and ovens in which dangerous accumulation of gases can build up because of restricted air circulation even though the door is left open.

This information sheet is not a substitute for special training on confined space entry, but gives an overview of the common hazards and suggests where specialist information and standards may be found.

AUSTRALIAN STANDARD

The recommended document for establishing good systems and practices is the Australian Standard AS 2865 :1995 *Safe working in a confined space*. The Standard was prepared for the prevention of occupational illness, injuries and fatalities associated with persons entering and working in confined spaces. It is designed not only to ensure that confined spaces are made safe for those entering them, but also to highlight the likely hazards associated with such work. Besides covering the conditions of work for an organisations own employees it also covers contractors or others on the premises.

Additionally, by complying with the Standard, the principles for eliminating or controlling hazards will be compatible with obligations under the Health and Safety in Employment (HSE) Act 1992.

LEGAL RESPONSIBILITIES

The Health and Safety in Employment Act 1992 places responsibilities on employers, employees, people who hire contractors, and others.

If you are an employer

Under the HSE Act, if you are an employer then you must take all practical steps to:

- Ensure your employees are safe while at work;
- Identify all hazards in a place of work; and
- Where the hazards identified are significant- eliminate, isolate or minimise your employees exposure to the hazard.

You must involve your employees in the development of procedures for identifying and managing hazards in your business, including emergency plans.

If your employees are still exposed to significant hazards, you must provide protective clothing and equipment for them and monitor their exposure to the hazard.

In addition, you must inform your employees about the hazards in your business and the results of any monitoring of their health or the work environment. You must take all practicable steps to train your employees to work safely, or have them supervised by someone with adequate qualifications and/or experience.

You must also take all practical steps to ensure that while your employees are at work, they do not harm other people.

If you are an employee

You must not do anything at work that will harm yourself or other people.

If you engage a contractor

You must ensure that the contractor, the contractor's employees and any subcontractors are not harmed while doing any work (other than residential work) that the contractor was engaged to do.

RISK ASSESSMENT

The Standard emphasises that the employer must ensure that a risk assessment is undertaken by a competent person before work begins. As far as practicable, the assessment should be in writing and take into account at least the following:

- the work required to be done;
- the range of methods by which the work can be safely done;
- the hazards involved and the associated risks;
- the actual method selected and plant proposed; and
- emergency and rescue procedures.

The assessment should be revised whenever there is evidence to indicate that it is no longer valid. It does not, in itself, make the job safe, but is dependent for its effectiveness on the persons concerned carrying it out. (For a sample risk assessment, see Appendix C of the Standard.)

SECURING A SAFE ATMOSPHERE

Employers should ensure that a competent person assesses the atmospheric contaminants before entry.

The initial assessment should include, where appropriate, an analysis of the atmosphere for contaminants and oxygen. Forced ventilation with a blower fan is the preferred method of displacing contaminated air.

After withdrawing the plant from service, precautions should be taken to prevent potentially dangerous materials from entering it while workers are inside. The safest course is to completely disconnect the space from every other item of plant and to seal off every inlet pipe. If isolation is not possible, and the space is likely to be seriously re-contaminated during occupancy, continuous ventilation and continuous monitoring is called for.

All materials— solids, liquids or gases — which are liable to present a hazard inside the space must be removed. Potentially dangerous materials may be trapped in sludge, scale or behind loose linings or brickwork.

Special care should therefore be exercised and cleaning processes adopted to meet each set of circumstances. Where it is necessary to enter the space to remove sludge etc. which is liable to give off dangerous fumes, suitable breathing apparatus and, where practicable, a safety line should be worn, and rescue equipment and personnel should be available.

With steam-volatile substances, steam cleaning will be found to be effective to remove residues. Solvents and neutralising agents may be employed before steam cleaning to remove non-volatile materials. Areas containing flammable vapour may be purged with an inert gas (e.g., nitrogen, carbon dioxide) to prevent formation of explosive mixtures with air. The inert gas should then, in turn, be purged with air and the area thoroughly tested for oxygen deficiency.

Atmospheric testing should always be considered before entering a confined space. All spaces where flammable gases, toxic vapours and abnormal oxygen content are suspected should be tested before an entry permit is issued. Contractors, who may be unaware of any special risks, should be included in the permit to work system.

Atmospheric testing using an explosiometer is not normally satisfactory for assessing possible toxic risks. In most cases, the safe explosive limits (LELs) are many times higher than the toxic limits. Testing is a highly technical skill and it is particularly important that the competent person with this responsibility is thoroughly trained.

Gas detection instruments should be recalibrated at regular intervals, e.g. weekly, or in certain circumstances, each time the instrument is used. This is to check for sensor poisoning and sensor response.

RESPIRATOR CHOICE

The responsible person controlling the operation should aim to achieve a safe atmosphere where respirators are not necessary. If this is not practicable, an appropriate respirator should be considered. The decision of what constitutes an appropriate respirator depends on the likely concentration of contaminant and/or oxygen in the confined atmosphere.

- Air-purifying respirators offer no protection against oxygen deficiency or oxygen enrichment. However, they can remove contaminants from the air you breathe. To safeguard against dusts, fumes and mists, respirators must be fitted with particulate filters. To protect against chemical vapours and gases, respirators must be fitted with the appropriate chemical filter. Some atmospheres require respirators fitted with a combination of both.
- Negative-pressure air purifying respirators should *not* be used when the concentration of contaminant exceeds ten times the maximum recommended level for unprotected breathing. Atmospheric monitoring is requirement for this decision.
- Air-supplied respirators help protect against temperature extremes and heavy concentrations of dust fumes and chemical vapours.
- Airline respirators can protect against oxygen deficiency when used with a small self-contained compressed air supply (sometimes called an escape bottle or a self-rescue bottle).
- A self-contained breathing apparatus is useful in atmospheres that can't be tested or where the suspected contaminant has not been identified. This form of protection is the only acceptable type for emergency rescue personnel.

PERMIT TO WORK

A permit is essentially a document which sets out the work to be done and the precautions to be taken. Having completed the assessment above, the permit specifies work methods. It predetermines a safe procedure and a clear record that all foreseeable hazards have been considered in advance. An example of a typical permit is shown in Appendix G of the Standard. This permit is to be signed by a person with the authority to represent the employer.

A common error is to omit contractors from the permit system. Contractor's employees may be completely unaware of the risks in an unfamiliar workplace. The responsibility in law is with the principal management to ensure a safe workplace. No person should enter a confined space without a permit from the employer.

ATMOSPHERIC TESTING

The standard emphasises that before a person enters a confined space, testing is carried out to ensure that:

(a) the confined space contains a safe level of oxygen;

(b) atmospheric contaminants in the confined space are reduced to a safe level;

(c) the confined space is free from extremes of temperature;

(d) the concentration of flammable contaminant in the atmosphere is 0% of the Lower Explosive Limit (LEL) if hot work is to be carried out, or 10% if cold work is to be carried out.

The employer should ensure that the atmospheric testing is carried out consistent with the risk assessment. If it is not practicable to provide a safe oxygen level, or safe level of air contaminant, suitable protective equipment, including air-supplied respirators are to be worn, as specified on the entry permit.

STAND-BY PERSON AND RESCUE CONSIDERATIONS

A stand-by person should be stationed at the entrance to the confined space to ensure that communication is constantly maintained when the risk assessment indicates that:

(a) there may not be a safe level of oxygen;

(b) atmospheric contaminants are present or may be present in concentrations above the safety exposure standards;

(c) there is a risk of fire or explosion;

(d) there is a risk of entrapment or engulfment;

(e) conditions outside the confined space threaten the safety of people inside, e.g. respiratory air supply, vehicles and weather.

RETRIEVAL EQUIPMENT

To facilitate entry into and exit from a confined space, it is essential to have a proper retrieval system for both workers and equipment. Proprietary systems are available consisting of a heavy-duty lifeline, tripod and personnel winch. Typically, a winch has a mechanical advantage of between 2:1 and 6:1, which makes it possible for a worker to be quickly extracted from the confined space should the need arise.

All equipment must be carefully checked before use. Harnesses or retrieval lines showing any signs of wear should not be used.

Employers should ensure that the appropriate rescue and first aid procedures and provisions are planned, established and rehearsed.

COMMUNICATION

It is essential to have an appropriate means of communication between the person working inside a confined space and the person stationed outside, whether by voice, rope tugging, tapping or by a battery-operated communication system specially designed for confined space use.

Note that radio frequency/wireless devices do not work effectively in confined spaces such as tanks or sewers, where there is metal or concrete shielding between the interior of the space and the outside.

Body alarm devices may be useful in a confined space where communication between workers and attendants is difficult. These are designed to sound if the wearer does not move during a specified period of time.

EDUCATION AND TRAINING

Training is necessary for supervisors, stand-by person, workers entering confined spaces and rescue personnel. In practice, some of these functions will be fulfilled by the same person, but it is important that everyone involved must be properly trained by a competent trainer. The training programme should include at least the following:

(a) the hazards of confined spaces;

(b) assessment procedures;

(c) control measures;

(d) emergency procedures; and

(e) the selection, use, fit and maintenance of safety equipment.

The employer should record the topics covered in the training and the names of trained employees.

Safety in Confined Spaces

Summary of confined space Entry procedures

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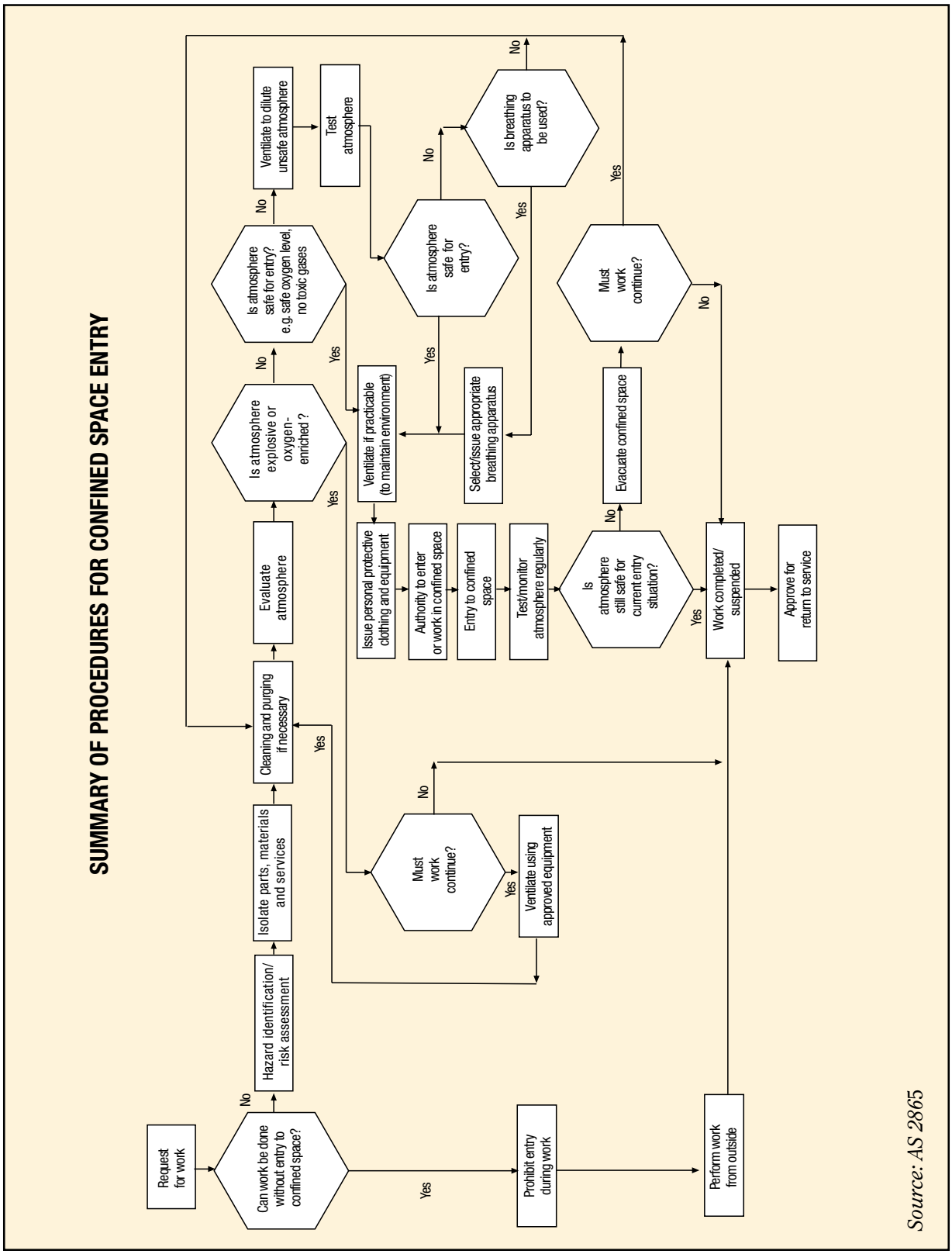
Information Sheet No. 3

SUMMARY OF PROCEDURES FOR CONFINED SPACE ENTRY



Source: AS 2865

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ISSUED BY THE OCCUPATIONAL SAFETY AND HEALTH SERVICE, DEPARTMENT OF LABOUR, WELLINGTON, NEW ZEALAND

Confined space safety in Construction work

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Information Sheet No. 4

The following information is reproduced from the OSH publication *Guidelines for the Provision of Facilities and General Safety in the Construction Industry* (pp. 52-53).

Legislation: HSE Act 1992

6. Employers to ensure safety of employees—Every employer shall take all practicable steps to ensure the safety of employees while at work; and in particular shall take all practicable steps to—
(a) Provide and maintain for employees a safe working environment;

(d) Ensure that while at work employees are not exposed to hazards arising out of the arrangement, disposal, manipulation, organisation, processing, storage, transport, working, or use of things—
(i) In their place of work; or
(ii) Near their place of work and under the employer's control;

"Confined spaces" are not limited to closed tanks with restricted means of entry and exit. Also included are open manholes, trenches, pipes, flues, ducts, ceiling voids, enclosed rooms such as basements and other places where there is inadequate ventilation and/or the air is either contaminated or oxygen deficient.

Before entry to any confined space it shall be tested to determine that there are adequate levels of oxygen present, and that dangerous amounts of flammable and or poisonous gases are not present. (Proprietary meters are available.)

No one is to enter any space if testing shows that the air is dangerous inside. Forced ventilation should be used to remove or dilute the gases and supply fresh air. The air shall be tested again prior to entering, and monitoring continued while work is being conducted inside the space.

TYPES OF CONFINED SPACE

Confined spaces may be inherently unsafe. Alternatively, different types of work being completed in the confined space may also make the atmosphere dangerous.

Some examples of confined spaces in which the work being done can make the space dangerous, are given below:

- Some painting work, and the application of certain adhesives, and liquids such as paint thinners. These can produce dangerous amounts of solvent vapour, which can cause dizziness and impair judgement. Such solvents are often flammable, so there is an accompanying risk of fire.
- The use of LPG appliances and petrol or diesel engines can lead to the build-up of poisonous carbon monoxide gas. There is also a risk of fire resulting from leaks.

Among the confined spaces that may be inherently hazardous are:

- Manholes, tunnels, trenches set in chalk soil, which can partly fill with carbon dioxide gas, displacing breathable air.
- Poisonous or flammable gases can collect in manholes in contaminated ground (e.g. near underground petrol tanks or refuse tips).
- In manholes, pits or trenches connected to sewers, there can be a build-up of flammable and/or poisonous gases and/or insufficient oxygen in the air.
- Sludges and other residues in tanks or pits, if disturbed may partially fill the confined space with dangerous gases.
- Rotting vegetation, rusting metal work, and similar natural oxidation processes may lead to an oxygen-deficient atmosphere inside the space.

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PRECAUTIONS

If work in a confined space could be potentially dangerous, entry shall be strictly controlled and detailed precautions taken.

Preferably employers should adopt an entry permit system, so as to ensure that employees and others are aware of the location of anyone required to enter confined spaces. As mentioned above, tests may be required to identify any dangerous amounts of flammable or poisonous gases.

Where the work being carried out could cause danger:

- The hazard should be kept out of the confined space. For example, petrol or diesel engines should not be used inside the space, but sited outside in a well ventilated area; and
- Paints and adhesives should be avoided which give off dangerous solvent vapours. (Use water-based adhesives where possible.)

  If these steps cannot be taken, then provide adequate ventilation (forced ventilation may be required), or mechanical extraction to ensure that fumes are expelled in a safe area free from potential sources of ignition.

Where the confined space itself may be dangerous (regardless of the work carried out):

- People who are required to work in or enter the space should receive training and instruction in the precautions to be taken inside the area.
- At least one person should be stationed outside the space to keep watch and communicate with anyone inside.
- Rescue harnesses should be worn by all those inside the confined space, with a lifeline attached to the harness and a suitable winching mechanism at or near the point of entry.
- Rescue procedures should be included in the training of workers. Reliance should never be placed on one person alone to lift injured or unconscious people out of a confined space during rescue, unless they are equipped with special lifting appliances. Rescue equipment, including emergency breathing apparatus, should be available near the entrance at all times.
- No attempt should ever be made to clear fumes or gases with pure oxygen.
- Appropriate respiratory protection shall be provided where the results of monitoring assessment indicates that a safe atmosphere cannot be established.

FURTHER INFORMATION

AS 2865-1995 *Safe working in a confined space*

Occupational Safety and Health Service, *Approved Code of Practice for Safety in Excavation and Shafts for Foundations*

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Confined space safety in Ship building and repair

Information Sheet No. 5

This information sheet provides additional information to employers and employees involved in ship building, repair and breaking. The term shipbuilding means any work on any size vessel, including cargo ships, tankers, pleasure boats (especially fibreglass and aluminium), barges, tug boats, ferries and military vessels. This information sheet should be read in conjunction with Australian Standard AS2865:1995 *Safe working in a confined space*.

EXAMPLES OF CONFINED SPACES

There are many shipboard spaces that obviously fall into the category of a confined space, and others which are not so obvious. Some shipboard confined spaces are:

- Spaces which must be entered through small hatchways or access points;
- Cargo tanks and holds;
- Cellular double-bottom tanks;
- Duct keels;
- Ballast and oil tanks;
- Void spaces.

Because of their nature, other spaces such as cabins and walkways may also become a confined space when other work restricts access, or work is being carried out that may give rise to fumes.

HAZARDS OF MARITIME CONFINED SPACES

The hazards of enclosed and confined spaces are a daily rather than an occasional concern in the marine industry.

- Shipbuilding is an intensive, high-skilled industry. It involves the simultaneous application of dozens of industrial processes to the vessel, including solvent-based spray painting, welding, gas-freeing, product tank cleaning, fuel loading, ship fitting, burning, abrasive blasting, etc.
- The sizes and types of vessels may vary with every repair or construction job. The products carried as cargo may vary.
- Since tanks on vessels generally directly adjoin each other (as opposed to being separated by significant spaces as in land-based petroleum terminals), the attention to adjacent spaces is important to the repair activities. Poorly planned hot work applied to one side of a bulkhead might initiate a fire or explosion on its other side.
- Despite differences between the risks of confined spaces and enclosed spaces, many enclosed spaces are treated with the same respect as confined spaces on ships. Large petroleum product tanks and vessel pump rooms may be very easily entered and exited. The enclosed space may even be designed for extended occupancy. However, they are always treated with extreme caution as potential sources of fire, explosion, or places that can quickly incapacitate and kill.
- The turnover of vessels in shipyards involves severe time limitations. Unlike a land-based facility, no matter how limited the repair, the entire vessel is out of service and no part of it earns money for its owner.
- Ship repair, causing most of the serious accidents, involves a one-way transfer of an active vessel to an inactive state. In eliminating the hazards delivered with the vessel, the shipyard's responsibility changes to monitoring the hazards introduced during the repair process.

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SAFETY GUIDELINES

Shipyards need to have suitably trained people who have access to appropriate testing equipment to inspect, test and certify confined spaces as safe for the work planned. Only after such inspection and testing can a permit for entry and work be issued.

With permit-required spaces, work at making physical changes that can eliminate the permit-required criteria. These changes may include:

- Installation of permanent ladders, forced ventilation systems and permanent internal barriers;
- Additional or better barriers;
- Valves that can eliminate potential atmospheric, energy or uncontrolled material problems from being introduced to the space;
- Better lockout and isolation equipment.

In short, work to eliminate the possible conditions associated with the space that might quickly incapacitate and kill the entrants.

Acknowledgement: Abridged from: E.J. Willwerth, Maritime Confined Spaces, *Occupational Health & Safety*, January 1994.

Accidents
in confined spaces

OCCUPATIONAL SAFETY & HEALTH SERVICE
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Information Sheet No. 6

The following cases from the investigation files of the Occupational Safety and Health Service illustrate the varying nature of some fatal and near-fatal accidents involving entry of workers into confined spaces.

- A worker was overcome by fumes and died when he climbed into a degreasing bath containing the solvent 1,1,1-trichloroethane, in order to remove articles which had fallen out of a wire mesh basket into the bottom of the bath. He had ignored instructions not to enter the bath, was unsupervised and did not use any respiratory protective equipment.
- The preparation of a large steel tank for use in electroplating required it to he lined with acid-resistant ceramic tiles which were to be stuck to the bottom and sides of the tank using a solvent-based adhesive. Prolonged breathing of the solvent vapour caused the unsupervised worker to slump unconscious into the bottom of the tank. He was working late and alone after normal working hours in order to finish the job, and he was not using respiratory protection. His body was discovered the next morning.
- A worker was cleaning out a paint vat in a hurried job, where the vessel was urgently needed for a different paint batch. Safety precautions regarding entry into the vat were completely ignored. The worker was overcome after prolonged inhalation of the paint solvent and was not noticed for some time, even though activity continued in the vicinity. Attempts at resuscitation were unsuccessful.
- An unsupervised worker died while cleaning out sludge from a freezing works holding tank which was used to store bulk blood. No tests were carried out on the atmosphere within the tank and no precautions of any sort were taken during the work. In fact, cleaning could easily have been done from outside the vessel either through the top hatch or a side manhole, using high-pressure hoses.
- A worker dropped his pen into a small mixing vessel at a paint manufacturing factory and entered the vessel in order to retrieve it. The action was a spontaneous unsupervised entry into an area which was never entered in the normal course of events. The worker was rendered unconscious on inhalation of the paint solvent vapour, and although he was discovered and was helped out and revived, he suffered serious and apparently permanent damage to his brain and central nervous system.

Safety in Confined Spaces

Farmer collapsed and died after entering offal pit

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A self-employed farmer collapsed and died after descending into an offal pit to retrieve a grubber. Subsequent tests by the Occupational Safety and Health Service (OSH) found that the atmosphere in the offal pit was severely deficient in oxygen.

SUMMARY OF ACCIDENT

The offal pit was drilled nearly five weeks before the accident, but remained unused for three weeks.

The day before, the farmer had dropped two lamb carcasses into the offal pit, and by accident a grubber was also dropped into the pit.

The farmer and his adult son discussed how to retrieve the grubber. After considering a lasso method, they decided to use a ladder to descend into the pit. The ladder was lowered through the central opening and secured in place.

The farmer climbed down the ladder and recovered the grubber. He had climbed most of the way up, when he fell back down. The son realised the seriousness of the situation and called for help with a cellphone.

The volunteer fire brigade arrived and rescued the farmer from the pit. Ambulance officers and a doctor attempted to resuscitate him, but were unable to do so.

FURTHER TRAGEDY NARROWLY AVERTED

The volunteer firefighter who rescued the farmer from the pit had a narrow escape. He was lowered down on a rope and at about 2.5 metres down, he couldn't breathe and called out to be raised. Wearing a self-contained breathing apparatus set, he was then able to effect the rescue.
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OSH INVESTIGATION

As part of their investigation, OSH Health and Safety Inspectors carried out tests to establish the likely atmospheric conditions in the pit at the time of the accident.

The tests found that the oxygen concentration at the bottom of the pit was only 3%. This level of oxygen would not sustain life, with death occurring in a matter of minutes. The normal concentration of oxygen in the atmosphere is 21%.

HAZARD MANAGEMENT

Both the farmer and his son were aware of the hazards of offal pits. They thought it would be safe to enter because the pit was relatively new.

Farmers need to identify the hazards associated with entering confined spaces such as offal pits, water tanks, septic tanks, grain silos, milk vats and other similar enclosed spaces. The likelihood of an oxygen-deficient or toxic atmosphere in such areas may not be realised.

Safety in Confined Spaces

Paint fumes ignite in Fishing vessel maintenance

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Information Sheet No. 7

Two serious accidents involving workers spray painting in fishing vessels highlight the need for owners of vessels, contractors and employees to be aware of the dangers of working in confined spaces such as the holds of vessels.

WORKER BURNED TO DEATH

Two employees were spray painting in the hold of a fishing vessel. Because of the fumes, they took breaks at five-minute intervals.

A portable light being used kept falling off its attachment. The skipper of the vessel decided to hold the light, at a spot where the worker had spray painted. An explosion occurred. The worker was enveloped by the ensuing fire and burned to death.

The investigating inspector's report concluded that the accident was caused by the confined space being filled with solvent vapours, with no mechanical ventilation or extraction provided to vent the space.

When the vapours mixed with oxygen and the mixture was at the lower explosive limits, it is most likely that a spark from the short-circuiting light lead raised the mixture to local ignition temperature and ignited the vapours and an explosion/fire occurred.

SERIOUS BURNS TO HEAD AND ARMS

Two employees were spray painting in the fore peak chain locker on a fishing vessel. One of the employees left the vessel, while the other started to pack up the gear. As he stepped over a hatch to switch off the power, a light he was using fell and broke, igniting the paint fumes and causing serious burns to the worker's head and arms.

The accident occurred because the worker had been spray painting in a confined area with no means of mechanical ventilation to extract paint solvent fumes or introduce fresh air.

The paint was a 31% solvent mix, consisting of four solvents with a flash point range of less than 0°C to 36°C, with 64% of the solvent mix at less than 0°C flash point. With no air being extracted from the chain locker, there would have been no dilution of the solvent in the atmosphere.

The average solvent concentration in the chain locker was calculated at about 0.2% volume. As the solvent vapour density was higher than air, it would have tended to settle nearer to the floor, and the concentration would have varied with the distance from the floor.

A 75-100 watt light bulb breaking after an hour's use would have been hot enough to ignite the fumes.

PREVENTATIVE MEASURES

To prevent such accidents, these precautions should be followed:

1. Staff painting in enclosed spaces need to know the hazards of solvents from paints:

   (a) The hazard to health, i.e. asphyxia, skin damage, neurological damage.

   (b) The danger of a flammable mix occurring when adequate ventilation is not provided.

2. Electrical equipment such as light leads and cables need to be intrinsically safe. All other sources of ignition must be eliminated.

3. Mechanical ventilation must be provided to ensure fumes are diluted to a level well below the flammable limit. In the case of solvents that are heavier than air, the extraction system needs to remove vapours from floor level, allowing fresh air to be treated from above.

4. A confined space entry permit system should be adopted. It should take into account all the possible hazards likely to arise with work done in chain lockers or other confined spaces.

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5. An entry permit system should be used for all work to be performed in confined spaces, i.e. welding.
6. Vapour levels should be monitored while the work proceeds to determine the effectiveness of the venting and extracting procedures.
7. Suitable protective equipment should be provided and worn.
8. Suitable equipment must be on hand in the event of an emergency, i.e. fire extinguisher, rescue equipment.

Safety in Confined Spaces

Entry into Septic and sewage holding tanks

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Information Sheet No. 8

While working in a sewage holding tank, two workers were overcome by toxic gas and drowned in the sewage. There have been other fatalities following entry into such tanks and also in situations where improperly equipped individuals have attempted to rescue workers in distress.

Oxygen is depleted when sewage decomposes. Toxic and flammable gases such as hydrogen sulphide and methane are produced and can be trapped in the sludge at the bottom of the tank. When this sludge is disturbed, the trapped gases are often released into the atmosphere. High concentrations of hydrogen sulphide or lack of oxygen can cause unconsciousness and death.

Entry into septic and sewage holding tanks is extremely hazardous and suitable precautions must be taken. AS2865 *Safe working in a confined space* details the precautions to be taken during entry into confined spaces.

These precautions include, among other things:

- Test the air for oxygen as well as toxic and flammable gases.
- Use suitable breathing equipment in spaces that cannot be purged and ventilated.
- Provide safety harnesses and ropes.
- Have a second worker stationed outside the confined space.
- Have a person trained in artificial respiration.

Sewage and holding tanks should be designed so that cleaning, maintenance and repairs can normally be done from the outside. This will reduce the need for workers to enter these tanks.

Safety in Confined Spaces

Fire hazard in Enriched oxygen atmospheres

OCCUPATIONAL SAFETY & HEALTH SERVICE
TE RATONGA ORANGA

DEPARTMENT OF LABOUR
TE TARI MAHI

Information Sheet No. 9

Three men working in a confined space were burned to death when hot welding slag ignited a worker's clothing.

Investigation showed that an enriched oxygen atmosphere had developed in the confined space because of a leaking rubber hose in an oxy-acetylene cutting torch.

When working with gas welding or cutting equipment in a confined space, all fuel and oxygen hoses should be inspected prior to work being started.

Oxygen and fuel hoses fed from a manifold system shall be disconnected when work is completed, either during a shift or after a shift. This will eliminate the possibility of a build-up of dangerous gas concentrations due to leaking hoses.

There are several things to remember prior to entry into a confined space:

- Test for oxygen content and the accumulation of hazardous gases;
- Provide adequate ventilation when welding or cutting is done; and
- Comply with the provisions for confined space entry set out AS2865.

It's important to know that clothing can be easily ignited and will burnt fiercely if it is saturated with oxygen. Oil and grease can ignite spontaneously in an enriched oxygen atmosphere.

Safety in Confined Spaces

Worker in confined space
Overcome by toxic fumes

OCCUPATIONAL SAFETY & HEALTH SERVICE
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TE TARI MAHI

Information Sheet No. 10

A 42-year-old maintenance fitter was overcome by toxic fumes while working in a confined space. He was in the process of painting the inside of an air receiver with a zinc-based paint.

Investigation of the accident revealed the following contributing factors:

- The injured worker had not been provided with appropriate training, instruction and information for entry into a confined space.
- The worker was not adequately supervised.
- A safe system of work was not provided.

Preventative measures in this case are as follows:

- Workers should be provided with suitable instruction, information and appropriate training.
- Workers should be adequately supervised.
- A safe system of work in accordance with AS 2865: 1988 *Safe working in a confined space* should be adopted.

Test yourself
on confined space safety

OCCUPATIONAL SAFETY & HEALTH SERVICE
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TE TARI MAHI

Information Sheet No. 11

How much do you remember about working safely in confined spaces? Take the following 5-minute quiz. If you get more than one answer wrong, go back and read the material again. This will help you learn all you can about how to protect yourself in confined spaces.

1. It's not necessary to lock out/tag out mechanical equipment before entering a confined space.
   True ☐ False ☐

2. Using a radio is the ideal way for an entrant to stay in touch with an attendant while working in a confined space.
   True ☐ False ☐

3. Entry permits are necessary only when a confined space is known to be dangerous.
   True ☐ False ☐

4. Air purifying respirators are the ideal choice for use against unknown hazards, oxygen deficiency, or toxic atmosphere in confined spaces.
   True ☐ False ☐

5. In an emergency, it's okay to enter a confined space without respiratory protection, a safety harness or a lifeline, as long as you'll be inside for only a few minutes.
   True ☐ False ☐

6. A self-contained breathing apparatus is the only form of protection acceptable for emergency rescue personnel.
   True ☐ False ☐

1. (False) Be sure to lock out/tag out mechanical equipment before entering a confined space. This can help prevent injuries from motors and other moving parts. 2. (False) A radio is only one communication option when voice or visual contact is impractical. Other options include hand or rope signals and a sound-powered telephone. 3. (False) An entry permit from a trained and authorised person is necessary to enter any confined space 4. (False) Air-purifying respirators offer no protection against unknown hazards, oxygen deficiency or enrichment, or highly toxic atmospheres in confined spaces. A better choice is a self-contained breathing apparatus (SCBA) or a supplied-air respirator combined with an SCBA. 5. (False) Even in an emergency, it's never permissible to enter a confined space without respiratory protection and a safety harness or a lifeline. 6. True. It's also useful in atmospheres that can't be tested or where the suspected contaminant has not been identified

RECOMMENDED STANDARD

We recommend you purchase your own copy of AS 2865: 1995 *Safe working in a confined space* and keep it in this folder, together with any other relevant documentation.

The Standard is available from:

Freepost 1573

Standards New Zealand

Private Bag 2439

Wellington 6020

Phone: (04) 498-5991

Fax: (04) 498-5994

Price: $69.75 (Retail)

$55.80 (Members)

"Working in a confined space is potentially one of the most dangerous of all workplace hazards. It's been calculated that working in a confined space is 150 times more dangerous than doing the same job outside."

The information in this folder could save someone's life.