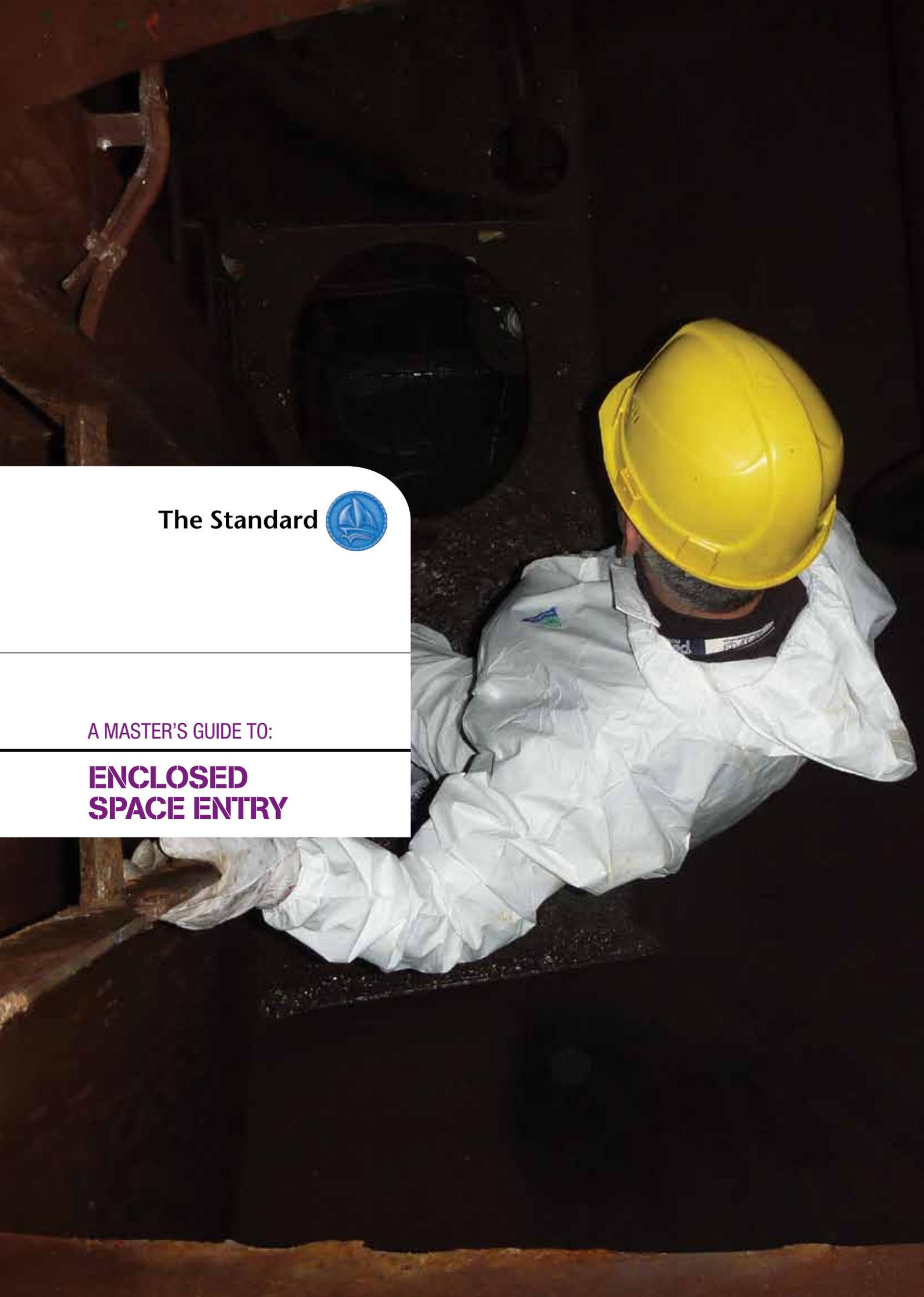


The Standard



A MASTER'S GUIDE TO:

**ENCLOSED  
SPACE ENTRY**



## The Standard P&I Club

The Standard P&I Club's loss prevention programme focuses on best practice to avert those claims that are avoidable and that often result from crew error or equipment failure. In its continuing commitment to safety at sea and the prevention of accidents, casualties and pollution, the club issues a variety of publications on safety-related subjects, of which this is one.

For more information about these publications, please contact the Standard Club or visit [www.standard-club.com](http://www.standard-club.com)

The Standard



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# 01 INTRODUCTION

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The challenge of entering enclosed spaces safely is a subject that has tragically been with the industry for many decades. It is not known exactly how many seafarers, shoreside workers, surveyors and stevedores have died in enclosed spaces on ships and offshore units, but it is estimated that there are dozens of fatalities every year.

It is imperative that those who join the industry learn at an early stage of the dangers of entering into enclosed spaces. Seafarers must realise how unsafe it can be to go ill-prepared into an enclosed space to assist a colleague or carry out some task. **No enclosed space should be entered without proper precautions.** Doing so puts lives at risk, and this means that training is essential.

This guide is intended to assist seafarers to enter enclosed spaces safely. Its contents may highlight shortfalls in individual company procedures in equipment and training and in onboard practices.

**Investigations into many casualties have shown that accidents onboard ship are in most cases caused by an insufficient knowledge of, or disregard for, the right precautions rather than a lack of guidance.**

Capt Chris Spencer  
Director of Loss Prevention  
Standard Club

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## Example incidents

### Three experienced seamen died inside a chain locker

The first two were overcome while tying off an anchor chain to prevent it from rattling in the spurling pipe. The third to die was the first rescuer who entered the chain locker wearing an Emergency Escape Breathing Device (EEBD). Constrained by the device, he removed its hood. All three men died from lack of oxygen inside the chain locker caused by the on-going corrosion of its steel structure and anchor chain.

### Two seamen collapsed in a store room

The chief officer entered the store to try to rescue the men but was soon forced to leave when he became short of breath and his vision was affected. The two seamen had been asphyxiated. The store was next to the ship's forward cargo hold containing steel turnings. To allow for the drainage of sea water and the removal of cargo residue, a section of the cargo vent trunk on either side of the cargo ventilation fan motor, located in the store, had been cut. This allowed a path for air from the self-heating cargo to enter the store. When tested later, the air in the cargo hold was found to contain only 6% oxygen.

### An experienced seaman died on a cruise ship after he entered an almost empty ballast tank.

The tank's manhole cover, which was inside a small cofferdam accessed from the engine room, had been removed and the seaman was instructed to confirm the amount of water in the tank. As it was not intended that the seaman enter the tank, no permit to work was issued. When the seaman was found to be missing, an experienced motorman was sent into the cofferdam to check on him. He found the seaman lying at the bottom of the empty tank and raised the alarm. The motorman entered the tank but collapsed as he tried to recover his colleague. When the ship's emergency response team provided air to the stricken duo with in-line breathing apparatus, the motorman recovered and was able to leave the tank. The seaman, however, never regained consciousness. He had been asphyxiated in the oxygen depleted atmosphere of the tank, which had not been inspected for several years and was heavily corroded.

### A junior officer and a bosun died on a tanker.

A junior officer was asked to check whether there was any oil cargo remaining in a cargo tank. The officer took the task literally and went into the tank through its access lid to check how empty it was. When the officer did not return, the chief officer asked the bosun to check where he was. The bosun saw the tank lid open and the officer lying at the bottom of the tank near the access ladder. The bosun went into the tank to try to assist the officer, but both men died from asphyxiation in the oxygen depleted atmosphere.

Enclosed spaces are present shoreside and fatalities also occur there.

In dry dock, where the enclosed space may appear to be safe, good practice and caution should always be exercised. **Contractors activities should be closely monitored.**

**More than 50% of workers who die in enclosed spaces do so in the course of attempting to rescue other workers.**

Common factors:

- failure to recognise an enclosed space
- failure to recognise the hazards involved in enclosed space entry
- tendency to trust to physical senses
- tendency to underestimate the danger
- complacent attitude
- attempt to save a co-worker

### What is an enclosed space?

This is defined as any space of an enclosed nature where there is a risk of death or serious injury from hazardous substances or dangerous conditions such as lack of oxygen. Some enclosed spaces are easy to identify, for example enclosures with limited openings such as ballast tanks. Others may be less obvious, but can be equally dangerous, for instance unventilated or poorly ventilated rooms.

Examples:

Boilers	Pressure vessels	Cargo holds
Cargo tanks	Ballast tanks	Double bottoms
Double hull spaces	Fuel oil tanks	Lube oil tanks
Sewage tanks	Pump-rooms	Compressor rooms
Cofferdams	Void spaces	Duct keels
Inter-barrier spaces	Engine crankcases	Main engine crank cases
CO <sub>2</sub> rooms	Thruster spaces	Chain lockers
Paint lockers	Battery lockers	Hollow spaces – e.g. masts
Fresh water tanks	Gas bottle storage lockers	
Spaces affected by chemical spill	Spaces affected by fire	

An enclosed space has one or more of the following characteristics:

- limited openings for entry and exit
- restricted natural ventilation
- not designed for continuous presence of workers

#### Limited openings for entry and exit

Enclosed space openings are limited primarily by size or location. Openings are often small, perhaps only 450mm (18 inches) in diameter, and are difficult to move through easily. Small openings make it difficult to get equipment in or out of the spaces, especially life-saving equipment when rescue is needed. Conversely, openings which are large, for example open-topped spaces such as ships' holds, or pump room access, create other problems. Access to open-topped spaces may require the use of ladders, hoists, or other devices, and escape from such areas may be very difficult in emergency situations.

#### Restricted ventilation

Because air may not move freely in and out of enclosed spaces because of their design, the atmosphere inside can be quite different from the atmosphere outside.

- Deadly gases may be trapped, particularly if the space is used to store or process chemicals or organic substances which may decompose.
- There may not be enough oxygen inside the enclosed space to support life.
- The air could be oxygen-rich to the extent that it increases the chance of fire or explosion if a source of ignition is present.

#### Not designed for continuous presence of workers

Most enclosed spaces are not designed for people to work inside on a routine basis. They are designed to store a product, to enclose materials and processes, or transport products or substances. This means that occasional entry by workers for survey, inspection, maintenance, repair, clean-up, or similar tasks is often difficult and dangerous because of lack of air, presence of chemicals or physical hazards.



^ Be safe inside an enclosed space. Always use a tank entry permit and wear PPE

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# 02 SAFETY MANAGEMENT SYSTEM

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The International Safety Management (ISM) Code is Chapter IX of the International Convention for the Safety of Life at Sea (SOLAS). It places obligations concerning safety on both the ship and the owner or operator of the ship.

It requires that there is a safety management system (SMS) in place, which is a structured and documented system enabling company personnel to implement effectively the company safety and environmental protection policy.

The SMS should provide instructions and procedures to ensure the safe operation of the ship and protection of the environment. Companies are required to establish procedures, plans, and instructions, including check-lists as appropriate, for key shipboard operations concerning the safety of the personnel, ship, and protection of the environment.

The safety management system should provide clear instructions on procedures for entry into enclosed spaces. It should provide the ship's crew with the following:

- a training schedule which should include training and drills on the dangers of enclosed space entry, entry procedures, and rescue of personnel from enclosed spaces
- guidance on how to determine whether a space may be hazardous
- procedures to be followed during all stages of entry into an enclosed space
- guidance on standards and duties of personnel involved in enclosed space entry
- guidance on safety equipment to be used in enclosed space entry
- emergency procedures including the evacuation of a casualty in an enclosed space

## Shoreside personnel

The safety management system should address managing subcontracted workers, technicians, welders, and shore cleaning staff engaged to work on the ship. Such staff must always be managed to work safely and comply with the enclosed entry and working procedures laid down by the company. At times this may be challenging, and during occasions such as drydocking, agreements have to be made as to who is responsible for the safety procedures of the shore personnel

This Master's Guide covers in detail the elements of enclosed space entry with which crew members should be familiar. The SMS should take into account the information provided here.

As a part of the audit process of the safety management system it should be confirmed that all personnel are:

- trained in and aware of the enclosed space entry procedure (ESP)
- aware of the dangers that an enclosed space can present
- aware of the precautions necessary to enter an enclosed space

# 03 ENCLOSED SPACE HAZARDS



^ Enclosed spaces are hazardous spaces.

## There are four main types of hazards:

- hazardous atmosphere
- configuration hazard
- changing and hazardous conditions
- engulfment hazard

## Hazardous atmosphere

There are seven types of hazardous atmospheres:

- oxygen depleted or oxygen enriched
- presence of toxic gases or liquids
- flammable atmosphere
- temperature extremes
- presence of dust
- absence of free flow of air

## Oxygen enriched or depleted atmosphere

Man can live:

- three weeks without food
- three days without water
- **only three minutes without oxygen!**

**The acceptable range of oxygen inside an enclosed space is between 19.5% and 23.5%. Normal air contains 21% oxygen.**

## ENCLOSED SPACE HAZARDS

The health effects and consequences of lack of oxygen in an enclosed space are listed in the table below. These effects will happen without warning!

% oxygen content	Effect
23.5%	Oxygen enriched atmosphere. Disorientation, breathing problems, vision
<b>19.5%</b>	<b>Absolute minimum acceptable oxygen level</b>
15–19%	Impaired coordination. Decreased ability to work strenuously
12–14%	Respiration increases. Poor judgement
10–12%	Respiration increases. Lips blue
8–10%	Mental failure. Fainting. Nausea, unconsciousness, vomiting
6–8%	8 min: fatal. 6 min: 50% fatal. 4–5 min: possible recovery
4–6%	Coma in 40 seconds. Death in 3 minutes



^ Check your oxygen. Use an oxygen content meter.

Lack of oxygen is the most dangerous factor in an enclosed space. The oxygen level in an enclosed space can decrease because of work being carried out, such as welding, cutting, or brazing or it can be decreased by chemical reactions like rusting, paint drying or through bacterial action (fermentation).

Normal air is made up of 78% nitrogen (N<sub>2</sub>); 21% oxygen (O<sub>2</sub>); and 1% other trace gases. An enriched oxygen atmosphere (> 23.5% O<sub>2</sub>) can cause flammable and combustible materials to burn quickly and violently when ignited.

CAUTION: never use pure O<sub>2</sub> for ventilation.

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### **Oxygen deficiency can be caused by CONSUMPTION**

- fire
- 'hot work' (welding/cutting)
- breathing
- chemical reactions (oxidation of chemicals or metal)
  - rusting
  - paint drying
- biological action (decomposing organic matter – sewage tanks)

### **Oxygen deficiency can be caused by DISPLACEMENT**

Gases produced or emitted in the space may displace the oxygen content:

- gases may be emitted into the space by cleaning agents, adhesives, or other chemicals
- carbon monoxide and other gases in exhausts spread from combustion: the use of generators nearby, or burning work inside the space
- people in the space breathe out carbon dioxide
- bio-decomposition can lead to hydrogen sulphide and methane in sewage systems
- displacement by inert gases (fire fighting CO<sub>2</sub> and nitrogen)

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## **The presence of toxic and flammable gases and liquids**

### **Toxic atmosphere**

A toxic atmosphere may stem from:

- product stored in an enclosed space
- work performed in an enclosed space:
  - welding, cutting, brazing, soldering
  - painting, scraping, sanding, degreasing
  - sealing, bonding, melting
- the use of a motor or generator in the space
- areas next to an enclosed space
- corroded pipelines running through the space

Toxic atmospheres are generated in various processes. For example, the vapours from cleaning solvents may be poisonous in an enclosed space. It is important to be aware that hot work consumes oxygen.

### **Hydrogen emission accumulators (and lead acid batteries)**

Hydrogen gas (H<sub>2</sub>) is produced from an electrolytic reaction from zinc/carbon and alkaline accumulators (batteries). A mix of hydrogen gas and oxygen may form a highly explosive atmosphere. Hydrogen gas is a light gas which displaces oxygen. The use of oxygen measuring equipment is recommended when entering accumulator rooms and other enclosures where accumulators are kept.

**Welding** – Hot work on all surfaces with coatings creates several gases which can be toxic. The gas may even enter from hot work being carried out in an adjacent tank.

### **Inert gas (IG) – nitrogen/exhaust gas**

Inert gas is a non-reactive gas used to prevent the build-up of an explosive atmosphere from cargo vapours. On oil tankers, the most common inert gas is the exhaust from oil fired boilers or main or auxiliary engines. On gas and chemical tankers, nitrogen can be used as the inert gas. Pure nitrogen is not poisonous in itself, but it causes displacement of the natural environment for breathing. Exhaust gasses contain hundreds of chemical compounds.

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## ENCLOSED SPACE HAZARDS

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The main components are: carbon monoxide, oxygen, nitrogen, water vapour, sulphur dioxide, nitrogen oxides and hydrocarbons. It may reduce lung capacity and increase respiration in addition to causing irritation to the mucous membranes in the eyes, nose, and throat. Dilution of oxygen by another gas, such as carbon dioxide, will result in unconsciousness, followed by death.

Great care should be taken when entering void spaces or adjacent spaces which are inerted with IG, or can be connected to the IG system. Careful monitoring of IG systems and isolation of IG systems is required.

### Tankers

This guide is not able to go into detail of all the specific hazards that relate to cargo tank or void space entry on oil, chemical, vegetable oil and gas tankers. The variation of cargoes carried are considerable and the hazards may be particular. It is the ship owner and the master's responsibility to ensure that the hazard details (safety data sheets etc) are available and suitable precautions taken. In general terms the procedures for any tank entry are similar, however there may be specific hazards, such as hazardous gasses from the cargo. These hazards may be difficult to identify and testing by a professional shore chemist may be necessary to warrant that the space is safe to enter or work in.

Company safety management systems (SMS) should clearly identify these issues on these types of ships and give guidance, particularly with reference to certain cargo types. This may include dangers from:

- inherent dangers of hydrocarbon gasses and/or Hydrogen Sulphide gas
- chemical gasses
- inert gasses

Some tankers require regular cargo tank inspections after tank cleaning or before loading and these occasions should always be entered with the proper enclosed space procedure.

**Do not take short cuts.** Hydrogen Sulphide (H<sub>2</sub>S) is a particular danger with many oil cargoes and hydrogen sulphide poisoning has been the cause of many fatalities when proper tank entry procedures have not been followed. 10ppm H<sub>2</sub>S can cause nausea and eye irritation and extended exposure to 50ppm and over of H<sub>2</sub>S concentration can cause death.

### Bulk cargoes

Many bulk cargoes may cause the level of oxygen in the hold to drop. This occurs mainly with vegetables, grain, timber, forestry products including wood chips, iron metals, scrap metals, metal sulphide concentrates and coal. Some bulk cargoes may oxidise to give a reduced level of oxygen, emit poisonous gases or may self-ignite. Other bulk cargoes may produce poisonous gases without oxidation, especially when wet. Closed holds should be considered as enclosed spaces.

### Container ships

There is evidence that containers in the holds of container ships can occasionally present a hazard when personnel enter the hold. This stems from the fact that the cargo inside the container may:

- be poorly stowed, and therefore allow the packaging to become damaged and the contents to be spilled
- have had its contents misdeclared, with the cargo less benign than described on the manifest
- contain poor quality drums leaking chemicals or other hazardous material into the hold, or reacting with other products inside the container

All of these scenarios indicate that entering a hold at sea even with fans running should be treated as an enclosed space procedure. They underline the importance of carrying out a risk assessment, particularly when doing inspection rounds and following the proper entry procedures of using an oxygen meter. Always advise the responsible officer of the intended entry.

**Example incident: general cargo ship carrying logs in the hold**

This accident occurred when the stevedores began to enter the fully laden hold, just after the hatches were opened. One of the stevedores slipped and fell into a gap between the logs. Seeing the fall, three other stevedores attempted to rescue him but also became trapped in the log cargo. All four stevedores were brought out from the narrow spaces within the stow, which were 4 to 5m deep, only with great difficulty and with the assistance of shore fire-fighters. All suffered a lack of oxygen and were brought up unconscious almost one hour after the fall and tragically declared dead on arrival at the local hospital.

**Example incident: general cargo ship in port**

In another incident, after a ship arrived at a discharge port, two stevedores went into a closed hold and did not return. A search party in breathing apparatus entered the hold and found the two men dead. Initial suspicions were that the men had died from inhalation of the chemicals used to fumigate the hold at the loading port but it was eventually found that the men were killed by asphyxiation in the hold's oxygen depleted atmosphere.

**Table showing Gas Monitor Alarm concentrations for common gases.**

Contaminant	Alarm concentrations
<b>O<sub>2</sub></b> (oxygen)	Less than 19.5%
<b>O<sub>2</sub></b> (oxygen)	Greater than 23%
<b>CO</b> (carbon monoxide)	35 ppm
<b>CO<sub>2</sub></b> (carbon dioxide)	5,000 ppm
<b>H<sub>2</sub>S</b> (hydrogen sulphide)	10 ppm
<b>Cl<sub>2</sub></b> (chlorine)	0.5 ppm
<b>NO<sub>2</sub></b> (nitrogen dioxide)	3.0 ppm
<b>NO<sub>x</sub></b> (oxides of nitrogen)	3.0 ppm
<b>CH<sub>4</sub></b> (methane)	Greater than 10% of lower explosive limit
<b>NH<sub>3</sub></b> (ammonium)	25 ppm concentration
<b>O<sub>3</sub></b> (ozone)	0.1 ppm
<b>Flammable or combustible gas</b>	10% of lower explosive limit <sup>1</sup>
<b>Particulate</b>	10% of lower explosive limit <sup>1</sup>

<sup>1</sup> Where a flammable/combustible gas or particulate is present, the lower explosive limit of the gas/particulate should be known.

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## ENCLOSED SPACE HAZARDS

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**Carbon monoxide is a colourless, odourless and tasteless gas which is slightly lighter than air. The table below illustrates the effect on humans based on various concentrations:**

CO ppm	Exposure	Effect on humans
50	8 hours	Normal permissible exposure limit
200	3 hours	Slight headache, discomfort
600	1 hour	Headache, discomfort
1,000–2,000	½ hour	Slight heart palpitation
1,000–2,000	1 hour	Tendency to stagger
1,000–2,000	2 hours	Confusion, nausea, headache
2,000–2,500	½ hour	Unconsciousness

### Flammable atmosphere

Two things make an atmosphere flammable:

- the oxygen in the air; and
- a flammable gas, vapour, chemical reaction, or dust in a particular mixture

If a source of ignition, say a sparking or electrical tool, static electricity, or sand blasting, is introduced into a space containing a flammable atmosphere, an explosion will result. An oxygen-enriched atmosphere will cause flammable materials, such as clothing and hair, to burn violently when ignited. Some bulk cargos may produce toxic dust which also will represent an explosive hazard, especially during cargo handling and cleaning.

Typical ignition sources:

- sparking or electric tools
- welding and cutting operations
- smoking
- electrical lighting
- equipment in poor condition

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## Temperature extremes



^ Monitor personnel's condition when working in extreme hot or cold enclosed spaces.

Extremely hot or cold temperatures may present another problem for anyone working in the enclosed space:

The temperature of the working environment, and length of time personnel will be in the space, should be taken into consideration when conducting a risk assessment in advance of entry. Extreme hot or cold can reduce a person's safety and situational awareness.

**Heat** – A person working in a very hot environment loses body water and salt through sweat. This loss should be compensated by water and salt intake. Fluid intake should equal fluid loss. On average, about one litre of water each hour may be required to replace the fluid loss. Plenty of drinking water should be available on the job site and workers should be encouraged to drink water every 15 to 20 minutes, even if they do not feel thirsty. Drinks specially designed to replace body fluids and electrolytes may be taken. Alcoholic drinks should NEVER be consumed, as alcohol dehydrates the body.

**Cold temperature** – At very cold temperatures, the most serious concern is the risk of hypothermia or dangerously low body temperature. Warning signs of hypothermia include nausea, fatigue, dizziness, irritability and euphoria. Sufferers may experience pain in their extremities (for example hands, feet, and ears) and severe shivering.

### Presence of dust

A high concentration of dust in an enclosed space is hazardous to health and can cause breathing difficulties. It can also hamper visibility and work. Toxic dust can be harmful even in small concentrations.

The use of machinery and powered tools may require special precautions, such as the provision of dust extraction for a portable grinder.

## ENCLOSED SPACE HAZARDS

### Configuration hazard

Configuration hazards are determined by the structure of the enclosed space and devices and equipment connected to it. Personnel should understand the layout of the space before entering. Check the ship's plans if uncertain. No risk assessment (and therefore no permit to work) can be completed unless the layout of the space is known. Pipework running through a tank, for example, may present a danger of trip and falling from height.



^ Always be aware of the layout of an enclosed space before entry.

Examples of configuration hazards include:

- slicks, wet surfaces and ladders
- very narrow openings that inhibit emergency evacuation
- risk of fall from unguarded heights
- complex arrangement of structure making illumination difficult
- surface configuration such that cleaning ahead of entry is difficult
- objects falling from deckhead openings

### Engulfment hazard

Engulfment is when the person entering is drowned, suffocated, or trapped by falling material. Loose, granular material stored in holds or tanks, such as grain, can overcome and suffocate a person. The loose material can crust or bridge over and break loose under the weight of a person.

Measures must be taken ahead of entering tanks to secure relevant pipelines to prevent fluids, such as cargo, fuel oil, or ballast water, being inadvertently pumped into the tank while people are inside. Use Safety tags or signs to ensure pumps and valves are not used.

# 04 RISK ASSESSMENT



^ Plan your enclosed space entry, start with a risk assessment.

There are many ways of conducting a risk assessment. The company should provide guidance on how to carry out risk assessments and any hazard identification (HAZID) techniques that must be used. One of the outcomes of a risk assessment should be a hazard register.

The hazard register records all the hazards that have been identified by the various HAZID techniques, showing representative causes, consequences and safeguards for each. It is sensible to maintain a portfolio of hazard registers specific to tasks or operations on your ship, including entry into enclosed spaces. When a non-routine or particularly hazardous activity is to be conducted, the register can be referred to in order to see which hazards apply and the safety measures to be put in place. Whilst not all of the hazards may be present on each occasion, there may be additional hazards that have not previously been identified. The register is therefore a guidance document to be consulted, and should not replace an assessment of the risks on each occasion.

There is a move with some authorities requiring a register of safeguards to be produced rather than hazards, since these have more specific management requirements. HAZID techniques are well suited to identifying safeguards, especially safety-critical ones, as well as hazards.

## RISK ASSESSMENT

Such registers should be 'living documents' – continually reviewed and updated. The following table is an example of a list of typical enclosed space entry hazards, methods for controlling the hazards and mitigating measures – steps that can be taken that should reduce the impact of any incident:

Incident	Cause	Preventative measures	Mitigating measures
Person entering collapses in the space	<ul style="list-style-type: none"> <li>• poor atmosphere</li> </ul>	<ul style="list-style-type: none"> <li>• all lines leading into the space secured</li> <li>• space emptied</li> <li>• space remotely cleaned prior to entry if possible, i.e. COW washing of oil tanks or filling tanks with water then pumping out</li> <li>• atmosphere tested and found safe prior to entry</li> <li>• atmosphere tested at regular intervals</li> <li>• continuous ventilation of the space</li> </ul>	<ul style="list-style-type: none"> <li>• personnel entering the space trained in enclosed space entry procedures</li> <li>• attendant at entrance – contact with bridge</li> <li>• regular communication between attendant and entry personnel</li> <li>• emergency signal established</li> <li>• entrants wearing personal monitors</li> <li>• rescue equipment on stand-by including breathing apparatus, harness, and lifeline</li> </ul>
Fire/explosion in the space	<ul style="list-style-type: none"> <li>• dust cloud</li> <li>• flammable atmosphere</li> <li>• hot work</li> <li>• equipment failure</li> <li>• oxygen-rich atmosphere</li> <li>• hydrogen rich</li> </ul>	<ul style="list-style-type: none"> <li>• monitor atmosphere</li> <li>• use only intrinsically safe equipment in potentially flammable atmospheres i.e. fuel oil tanks</li> <li>• follow hot work procedures</li> <li>• do not use defective equipment</li> <li>• do not ventilate with pure oxygen</li> </ul>	<ul style="list-style-type: none"> <li>• sufficient personnel on board to form a fire party</li> <li>• training and drills in fire-fighting</li> <li>• first aid equipment available</li> </ul>
Slip/trip	<ul style="list-style-type: none"> <li>• poor lighting</li> <li>• poor housekeeping</li> <li>• inadequate PPE</li> <li>• hazardous structural arrangement</li> <li>• worker fatigue</li> <li>• slippery surfaces</li> <li>• poor visibility from dust/ smoke/mist, etc.</li> </ul>	<ul style="list-style-type: none"> <li>• good lighting arrangements</li> <li>• monitor and maintain good housekeeping</li> <li>• relevant PPE worn as appropriate</li> <li>• briefing/awareness of space arrangement before entry</li> <li>• assessment of personnel before entry and throughout. Proper rest periods and rehydration</li> <li>• good ventilation and dust prevention measures</li> </ul>	<ul style="list-style-type: none"> <li>• stretcher and first aid kit available</li> <li>• drills in first aid incidents, including procedures for communication to shore-side assistance</li> </ul>

<b>Incident</b>	<b>Cause</b>	<b>Preventative measures</b>	<b>Mitigating measures</b>
Fall from height	<ul style="list-style-type: none"> <li>• unguarded edges</li> <li>• structural failure of ladders and platforms</li> <li>• unsafe use of ladders/staging</li> </ul>	<ul style="list-style-type: none"> <li>• wear fall prevention devices where appropriate</li> <li>• guards/rails on platforms</li> <li>• inspection of ladders and platforms</li> <li>• training in the use of portable ladders and staging</li> <li>• personnel assisting where portable ladders are used and where equipment is to be moved</li> <li>• proper securing of portable ladders and staging</li> </ul>	<ul style="list-style-type: none"> <li>• stretcher and first aid kit available</li> <li>• drills in first aid incidents, including procedures for communication to shore-side assistance</li> </ul>
Illness of person entering	<ul style="list-style-type: none"> <li>• dust</li> <li>• smoke</li> <li>• fumes</li> <li>• noise</li> <li>• humidity/heat/cold</li> <li>• phobias, fatigue, mental and physical condition</li> <li>• heat fatigue</li> </ul>	<ul style="list-style-type: none"> <li>• monitor and ventilate atmosphere</li> <li>• ear protection, personal protective equipment (PPE)</li> <li>• rehydration (drinks)/rest periods/adequate clothing/PPE</li> <li>• suitability of crew according to risk assessment before entry</li> <li>• pre-employment medical examinations</li> </ul>	
Rescue equipment not usable	<ul style="list-style-type: none"> <li>• falling objects</li> <li>• electrical/mechanical equipment in the space</li> </ul>	<ul style="list-style-type: none"> <li>• harnesses for tools and equipment at height</li> <li>• hard hats (PPE)</li> <li>• pumps and mechanical equipment in the space isolated</li> <li>• analysis of the job hazards and equipment before entry</li> <li>• protection of electrical equipment from fluids</li> </ul>	
Rescue equipment not usable	<ul style="list-style-type: none"> <li>• equipment does not fit through access</li> </ul>	<ul style="list-style-type: none"> <li>• drills on board confirm suitability of rescue equipment</li> <li>• discussion before entry about available rescue equipment for the space</li> </ul>	

# 05 ENTRY PROCEDURES



^ Always use an enclosed space entry permit.

Everyone has the right to refuse to enter a space they consider unsafe. Do not enter an enclosed space if in doubt, and only do so when the correct procedures have been followed, even in an emergency. Always use an enclosed space entry permit or a tank entry permit

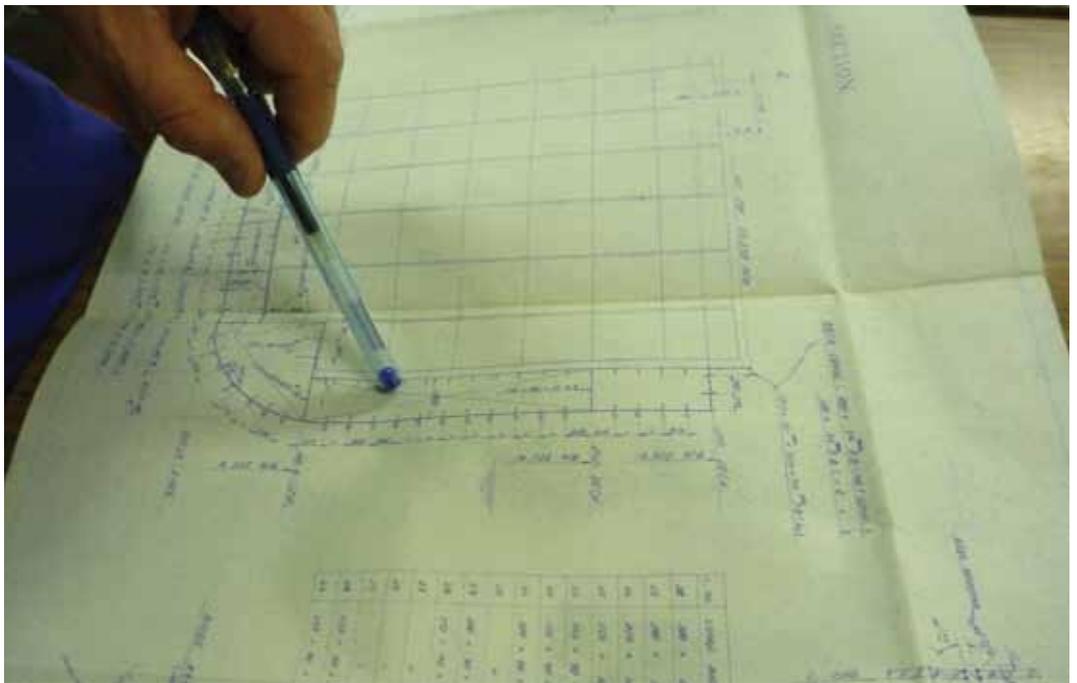
- when possible, avoid entry to enclosed spaces, for example by performing the work from the outside
- if entry to an enclosed space is unavoidable, in cases such as tank inspections, follow a safe system of work; and put in place adequate emergency arrangements before the work starts
- do not enter an enclosed space alone – enter in pairs and monitor each other

## Getting it right

Proper planning for entry into an enclosed space should cover:

- the task
- the working environment
- materials and tools
- the knowledge and experience of those carrying out the task
- arrangements for emergency rescue

Given the usual confined and darkened nature of an enclosed space, this activity should not be carried out by personnel suffering from phobias such as claustrophobia, or who are susceptible to panic or anxiety attacks. All new, inexperienced crew must be advised on the dangers of enclosed space entry.



^ Check the ship plans before entering the space for the first time.



^ Check all pipelines into the space are safe and isolated.

## ENTRY PROCEDURES

The table below provides an overview of entry procedures:

Before entry	<p><b>All parties to discuss the job to be done in the space</b></p> <ul style="list-style-type: none"> <li>• what are the hazards of the space and how can they be controlled?</li> <li>• what are the hazards of the job and how can they be controlled?</li> </ul> <p><b>Risk assessment</b></p> <ul style="list-style-type: none"> <li>• document the hazards and necessary safety measures and controls</li> </ul> <p><b>Secure the space</b></p> <ul style="list-style-type: none"> <li>• empty the space if necessary and take steps to prevent the space filling up:             <ul style="list-style-type: none"> <li>– lock out valves and pumps; and</li> <li>– place notices forbidding their operation.</li> <li>– is the space adjacent to other tanks, holds, or pipelines which if not secure could present a danger?</li> </ul> </li> </ul> <p><b>Ventilate</b></p> <ul style="list-style-type: none"> <li>• allow sufficient time for the space to be thoroughly ventilated naturally or mechanically</li> <li>• guard any openings against accidental and unauthorised entry</li> </ul> <p><b>Test</b></p> <ul style="list-style-type: none"> <li>• test the atmosphere in the space for oxygen content and the presence of flammable and toxic gases or vapours</li> <li>• do not enter until the atmosphere has been determined to be safe</li> </ul> <p><b>Permit</b> – complete an enclosed space entry permit to work, confirming that:</p> <ul style="list-style-type: none"> <li>• the hazards of the job and of the space have been dealt with</li> <li>• the atmosphere in the space is safe and ventilated</li> <li>• the space will be adequately illuminated</li> <li>• an attendant at the entrance has been appointed</li> <li>• communications have been established between bridge and entry point, and entry point and entry party</li> <li>• emergency rescue equipment is available at the entrance and there are sufficient personnel on board to form a rescue party</li> <li>• all personnel involved are aware of the task and the hazards, and are competent in their role</li> </ul>
During entry	<ul style="list-style-type: none"> <li>• ensure the space is suitably illuminated</li> <li>• wear the right PPE</li> <li>• continue to ventilate the space</li> <li>• test the atmosphere at regular intervals</li> <li>• communicate regularly</li> <li>• be alert, and leave the space when requested or if you feel ill</li> </ul>
After entry	<ul style="list-style-type: none"> <li>• ensure all equipment and personnel are removed from the space</li> <li>• close the access of the space to prevent unauthorised entry</li> <li>• close the entry permit</li> <li>• reinstate any systems as appropriate</li> </ul>

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### **Danger – some enclosed spaces are difficult to ventilate**

Entry into enclosed spaces with a compartmental structure, such as double hull and double bottom tanks, which are more difficult to ventilate than conventional tanks, require particular care when monitoring the tank atmosphere. Entry into these spaces should be undertaken in two stages:

#### **First stage**

The first stage should be for the purpose of atmosphere verification and a general safety review. The personnel making the entry should be equipped with:

- an emergency escape breathing set
- personal gas detector capable of monitoring hydrocarbon and oxygen levels
- portable radio
- emergency light source (torch)
- a retrieval harness
- an alternative means of attracting attention, such as a whistle

#### **Second stage**

Only after the first stage has verified that the atmosphere throughout the tanks is safe for the intended task should entry for other purposes be permitted.

### **Procedures before entry**



^ Always use an enclosed space entry permit.

Access to and within the space should be adequate and well illuminated.

No source of ignition should be taken into the space unless the master or responsible officer is satisfied that it is safe to do so. Use only equipment that is certified intrinsically safe in potentially flammable atmospheres, especially in fuel oil tanks.

In all cases, rescue and available resuscitation equipment should be positioned ready for use at the entrance to the space. Rescue equipment means breathing apparatus together with fully charged spare cylinders of air, life lines and rescue harnesses, and torches or

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## ENTRY PROCEDURES

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lamps, approved for use in a flammable atmosphere. A means of hoisting an incapacitated person from the confined space may be required.

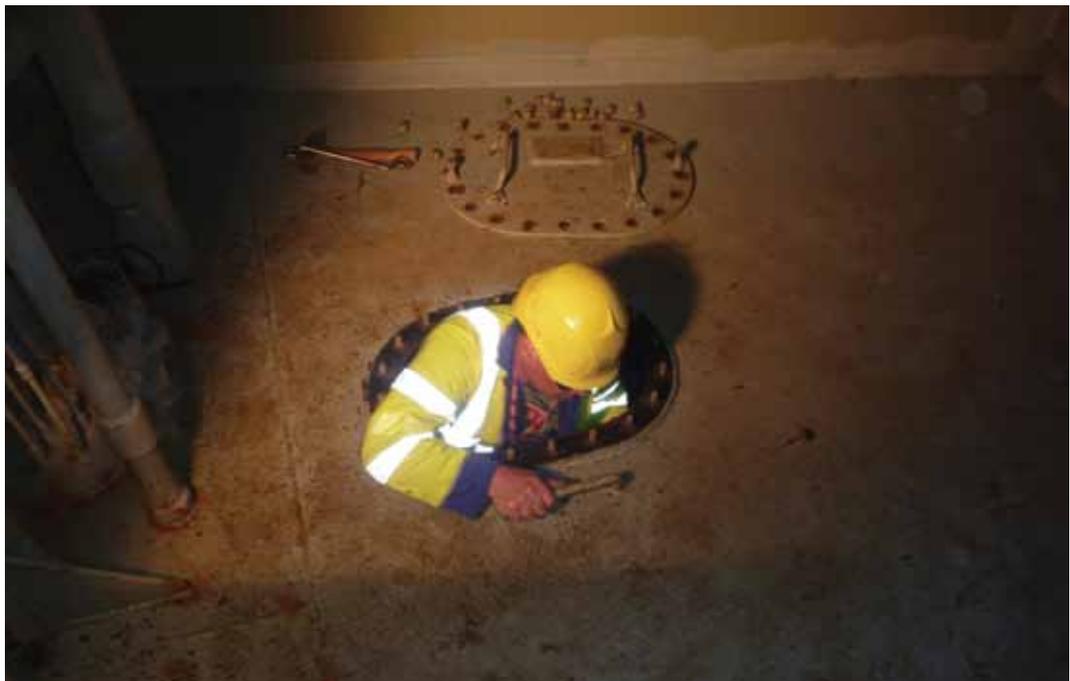
The number of personnel entering the space should be limited to those who need to work in the space. When necessary, a rescue harness should be worn to facilitate recovery in the event of an accident.

At least one attendant should be detailed to remain at the entrance to the space while it is occupied. An agreed and tested system of communication should be established between any person entering the space and the attendant at the entrance, and between the attendant at the entrance to the space and the officer on watch.

Before entry is permitted it should be established that entry with breathing apparatus is possible. Any potential difficulty of movement in any part of the space as a result of breathing apparatus or lifelines or rescue harnesses being used or any other problems that would arise if an incapacitated person had to be removed from the space should be carefully considered and the risks minimised.

Lifelines should be long enough for the purpose and capable of being firmly attached to the harness, but the wearer should be able to detach them easily should they become tangled.

### Procedures during entry



^ Always use an enclosed space entry permit. Do not enter a tank without one.

Ventilation should continue while the space is occupied and during temporary breaks. In the event of a failure of the ventilation system, any personnel in the space should leave immediately.

Good natural ventilation is acceptable if for example two accesses are open so there is a through draft of fresh air. Care needs to be taken in large enclosed spaces without forced ventilation as there may be pockets of poor quality air that have not been replaced by good air.

The atmosphere should be tested periodically while the space is occupied and personnel should be instructed to leave the space should there be any deterioration of conditions.

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If unforeseen difficulties or hazards develop, the work should be stopped and the space evacuated so that the situation can be reassessed. Permits should be withdrawn and only reissued, with any appropriate revisions, after the situation has been reassessed.

If any worker in a space feels in any way adversely affected they should give the prearranged signal to the attendant standing by the entrance and immediately leave the space.

Should an emergency occur, the alarm should be sounded so that back-up is immediately available to the rescue team. Under no circumstances should the attendant enter the space before help has arrived and the situation has been evaluated to ensure the safety of rescuers who may have to enter the space.

If air is being supplied through an air line to a person who is unwell, a check should be made immediately that the air supply is being maintained at the correct pressure.

Once the casualty is reached, checking of the air supply must be the first priority. Unless he is gravely injured and in imminent danger, the casualty's condition should be properly assessed before being removed.

#### **Noise**

Noise in an enclosed space can be amplified by the design and acoustic properties of the space. Excessive noise can affect communication, such as a shouted warning going unheard or misinterpreted.

#### **Falling objects**

Workers in enclosed spaces should be mindful of the possibility of objects falling, particularly in spaces which have a topside opening, and where work is being carried out above the worker.

#### **Slick/wet surfaces**

Slips and falls can occur on a wet surface causing injury or death. Corroded and unstable platforms and ladders are a risk.



^ Enclosed spaces are potentially dangerous.

# 06 DUTIES AND RESPONSIBILITIES



^ Always use an enclosed spaces entry permit.

## Senior officer

Before entry to any enclosed space, authorisation should be given by a senior officer. A senior officer, in this context, means the master, chief officer, or chief engineer.

## Supervisor and permitting officer responsibilities

- ensure good communications exist between all parties
- ensure a risk assessment and enclosed space entry permit have been properly completed
- determine whether acceptable entry conditions are present
- authorise and oversee entry operations
- ensure adequate protection is provided to people entering by verifying adequate lockout and tagout and that all hazards are securely isolated
- support the attendant's authority in controlling access to an enclosed space
- ensure that all personnel involved are briefed and aware of the hazards associated with the space
- ensure that rescue personnel are available before entry takes place
- the duties of entry supervisor may be passed from one individual to another during an entry operation
- verify that all personnel have exited before closing the space
- the supervisor or permitting officer may also serve as an attendant or authorised entrant

The officer completing the enclosed space entry permit-to-work should have visited the access point to the space and satisfied himself that the hazards have been identified and the necessary safety precautions taken, particularly ventilation and atmosphere testing.



^ Permitting officer making checks before issuing an enclosed space entry permit.

### Personal responsibility

If you are entering an enclosed space, it is your responsibility to:

- not enter alone
- not enter without a valid tank or enclosed space entry permit
- ensure that the space has been adequately ventilated, isolated, emptied, or otherwise made safe for entry
- immediately exit a space, without question, upon word from the attendant, no matter what the reason
- follow all safety rules and procedures that apply to the job
- be familiar with the work to be performed and the procedures that apply to the job
- use the appropriate PPE

### Attendant's responsibilities

- maintain communications with those who have entered the space
- maintain communications with a responsible officer on the bridge
- summon assistance in an emergency
- monitor those who have entered during the job, and on entry and exit to help ensure their safety
- monitor conditions in the space before and during entry
- control access to the enclosed space and guard against unauthorised access
- summon emergency assistance as needed
- keep records of enclosed space work, such as air test results, and a log of personnel entry and exit times
- monitor factors that could affect the space and warn those entering of any changes to conditions

The attendant should not abandon his post for any reason while personnel are in the space, unless relieved by another qualified attendant.

### Example incident

#### Fatality in engine scavenging air receiver

A containership reported on leaving port that the second engineer was missing. After an extensive search by the crew, the individual was presumed to have gone ashore and missed the sailing. When the ship arrived at the following port the engineer was found dead behind an access door to the main propulsion engine's scavenging air receiver. The engine's scavenging air space can normally be accessed by two manholes located on both ends of the scavenging air receiver.



^ Scavenge space inspection door.

These circular manholes are secured by three L-shaped dogs, having an outer edge that is tightened against an inner circumferential lip on the edge of the access hole. Tightening is achieved by a handled fastener.

Investigators determined that the engineer entered the scavenging air receiver alone. Although his reason for entering the receiver was not known, engine maintenance was performed in that space while at the first port and he may have returned to reinspect the area or check for left-behind tools and materials. It appears that after his entry, the door accidentally closed. Investigators believe that at that time, the upper left dog, because of its weight and perhaps the vibration of the door as it closed, caused it to move; allowing its edge to catch the lip at the opening. Once caught, the door could no longer be opened from inside the receiver.

The second engineer was a mariner experienced in following company procedures and safe working practices. Unfortunately, on this occasion, he entered without informing anyone or having an assistant stationed outside. Searches by the crew in the machinery spaces and the main engine while the ship was preparing to sail, failed to uncover what had gone wrong.

In this casualty, there were initially sufficient quantities of oxygen for the second engineer to breath, until the engine started, which caused the ambient conditions inside the receiver to change dramatically and kill him.

Mariners may not associate certain work areas with the concept of confined spaces and therefore may fail to take the precautionary steps needed. In the engine room, the following should be considered examples of enclosed spaces:

- main engine crankcases
- scavenging air spaces
- exhaust ducting
- boiler drums
- furnaces
- stack casings
- condensers
- sewage plant tanks
- fuel oil and lube oil tanks
- waste oil tanks

# 07 SECURING THE SPACE FOR ENTRY



^ Ensure hazards are isolated before entry.

## Isolating the space

Isolation of an enclosed space is a process whereby the space is removed from service by one or more of the following:

- **Locking out** electrical sources, preferably at disconnect switches remote from the equipment.
- **Blanking and bleeding, securing valves** – cargo, steam, ballast, inert gas system, pneumatic, hydraulic and fuel oil lines, etc. The inert gas branch should be blanked off if workers are to enter a tank or space with an inert gas arrangement. The appropriate blanking is to be checked at each tank if entry is required while inerting, or if gas freeing of other tanks is taking place, or if any other tanks are inerted or contain hydrocarbons. An alternative to pipe blanking is to remove a section of the branch line.
- **Disconnecting** mechanical linkages on shaft-driven equipment where possible.
- **Securing** mechanical moving parts in enclosed spaces with latches, chains, chocks, blocks, or other devices.

## SECURING THE SPACE FOR ENTRY



^ Ensure appropriate lockouts have been used.

**Notice boards** which clearly identify which spaces and prevailing requirements are agreed for enclosed space entry should be displayed in prominent locations such as the bridge, cargo control room, and engine control room.

Notices should be clearly posted at control panels to prevent inadvertent activation.



^ Communicate to personnel not to use or start equipment.

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Nobody should enter or remain in a ballast or cargo tank if ballast is being transferred – a mistake in the transfer could lead to ballast water being pumped into an occupied space.

### Signage

There is no internationally recognised marine signage that depicts – ENCLOSED or CONFINED SPACES. Different signs have been promulgated and many ships denote the danger by the use of painting warning notices or stencils. This guide suggests one design, but there are many that could be used. The important point is that the crew are warned that the space is enclosed and that entry requires an entry permit and authorisation to enter.

Companies and ships officers should identify enclosed spaces on-board their ships and ensure that appropriate warning signage is used.



^ Enclosed spaces should be treated as potentially hazardous spaces.

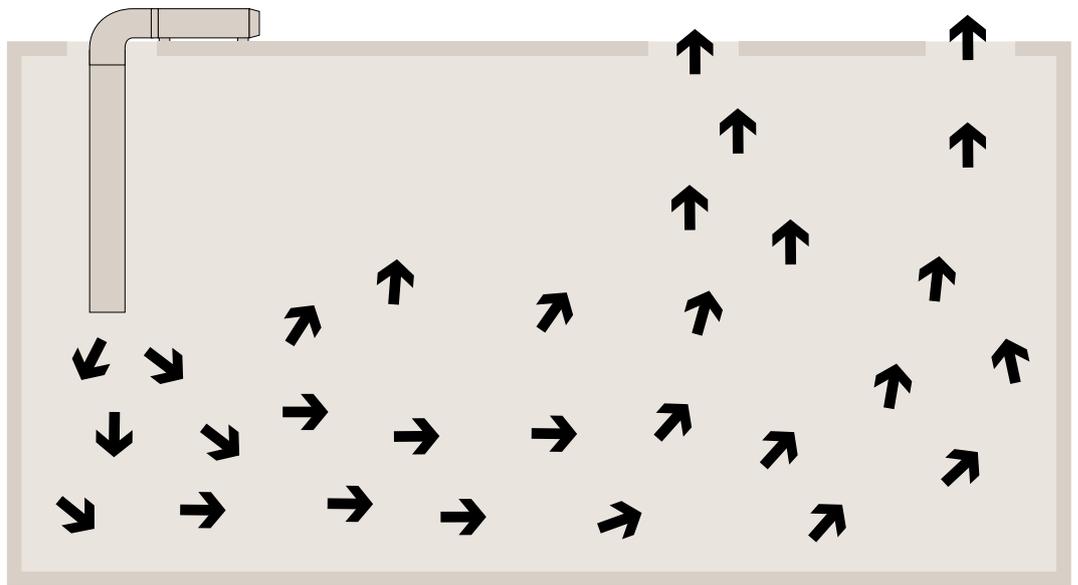
# 08 VENTILATION



^ Always have good ventilation when working in a space.

Before any enclosed space is entered, it should be ventilated by releasing as many openings as possible. Ventilation should be continuous where possible because in many enclosed spaces the hazardous atmosphere forms again when the flow of air is stopped.

A common method of ventilation requires a large-diameter ventilation hose in good condition: one end attached to a fan and the other lowered into a manhole or opening. For example, a manhole would have the ventilating hose run to the bottom (see above) to dilute or displace all harmful gases and vapours. The air intake should be placed in an area that will draw in fresh air only.



#### WARNING

- never use pure oxygen to ventilate
- never store or place compressed oxygen tanks in an enclosed space
- de-ballasting a tank does not guarantee a safe atmosphere in the tank
- ventilation and testing of its atmosphere is still required
- inert gas fans should not be used to provide fresh air ventilation to tanks with inert gas arrangements because contaminants from the inert gas lines could be introduced into the space

Natural ventilation may be acceptable if, for example, two accesses are open to allow a through draft of good air. Caution should be taken in large enclosed spaces without forced ventilation as there may be pockets of poor quality air that have not been displaced with good air. Oxygen monitors must always be used to check the atmosphere in naturally ventilated enclosed spaces.

# 09 TESTING THE ATMOSPHERE



^ Do not enter an enclosed space without completing an entry permit.

No enclosed space is to be entered until the atmosphere in the space has been found safe following thorough testing with approved and calibrated instruments. Tests should confirm that all areas of the space (bottom in particular) are safe for entry, that is, testing for:

- oxygen deficiency
- flammable gases and vapours
- toxic gases and vapours

At any time an atmosphere-related limit is exceeded, no matter what the reason, all personnel should immediately exit the space, and no-one should enter until atmospheric conditions are returned to safe levels. The entry permit should be revoked and re-entry suspended until authorised by a senior officer.

## Flammable atmosphere

A combustible gas meter indicates flammability in percentage terms, within a safety range of 0–10% of the Lower Explosive Limit (LEL). It should ideally read 0%. A space with an atmosphere with more than 1% of the Lower Flammable Limit (LFL) or Lower Explosive Limit (LEL), on a combustible gas indicator should not be entered.

## Toxic atmosphere

Toxins are measured in parts per million (ppm). An enclosed space shall be considered not fit for entry if the alarm concentrations are exceeded. If it is suspected the space contains toxins then a competent shore chemist should determine whether it is safe for entry.

## Oxygen in the atmosphere

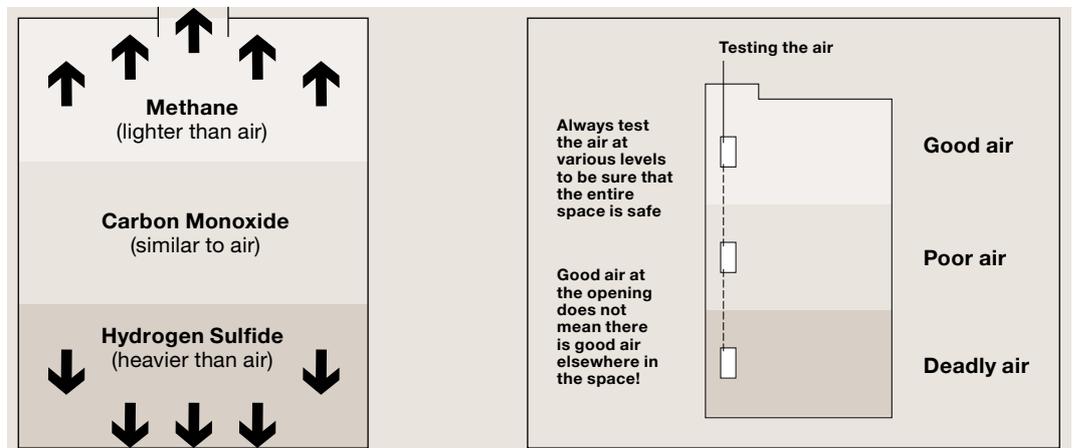
The oxygen meter should indicate around 20.8% oxygen in the space being tested.



^ Always make sure your oxygen meter is properly calibrated.

Never trust your own senses to determine whether the air in an enclosed space is safe. Many toxic gases and vapours can be neither seen nor smelled, nor can the level of oxygen be determined.

It is important to understand that some gases and vapours are heavier than air and will settle to the bottom of an enclosed space. Some gases are lighter than air and will be found around the top of the enclosed space. Therefore, it is necessary to check all areas (top, middle and bottom) of an enclosed space with properly calibrated testing instruments to determine which gases are present.



^ Atmospheres may be different in individual bays of the same tank.

## TESTING THE ATMOSPHERE

If testing reveals oxygen deficiency, or the presence of toxic gases or vapours, the space must be ventilated and retested before entry. If in doubt, do not enter and consider seeking shore-side advice.

### Testing instruments

When a Draeger tube or equivalent is used for detecting toxic gases, the sampling gas should have sufficient time to pass through the sampling hose.

As a rule, if a manual hand rubber pump is used, approximately four squeezes are needed for each metre of the sampling hose. If battery driven pumps are used, approximately 10 seconds for each metre of sampling hose should be sufficient. Refer to manufacturer's instructions.

### Atmosphere testing shall be performed:

- before every entry when the space is vacant
- after ventilation period
- at least hourly
- more frequently if conditions or suspicions warrant

### Guidelines for the use of personal gas detectors

In spaces of complicated geometry with a high possibility of pockets of atmosphere with low O<sub>2</sub> content, and where rescue operations may be difficult, such as tanks and voids, **the use of a portable oxygen meter with audible alarm is strongly recommended.**

A multi-gas meter, capable of simultaneous monitoring of oxygen, combustible gases, hydrogen sulphide and carbon monoxide, should preferably be used.

Note that carbon monoxide (CO) sensors may also be sensitive to low concentrations of hydrogen (H<sub>2</sub>). Therefore it is important to evaluate whether there is CO/hydrogen in the space. Anodes may generate hydrogen when in use.

The personal instrument should be turned on before tank entry.

If those entering are not wearing personal monitors, the person in attendance at the entrance should conduct regular tests of the atmosphere in the space.



### Calibration of monitoring equipment

Ships should be equipped only with monitors that can be calibrated. Some types of monitors come with manufacturer-approved calibration devices – others should be sent ashore for calibration. Calibration on board must be carried out only by a competent officer.

Monitoring equipment should always be marked with the due date of the next calibration. The equipment should not be used if calibration of the device is overdue.

# 10 ENTRY AND RESCUE EQUIPMENT



^ Have the emergency equipment prepared at the space entrance.

Entry and work in an enclosed space can only take place when it is safe to do so. Study the following list of equipment, and ensure you have everything on board to do the job safely.

## Entry equipment check list

<input type="checkbox"/>	<b>Signage &amp; barriers</b> Ensure you have adequate signs and barriers against all openings to prevent accidental or unauthorised entry.
<input type="checkbox"/>	<b>Ventilation</b> Natural ventilation, over a number of hours, may be sufficient to ventilate a space sufficiently. Often, however, it will be necessary to ventilate the space mechanically. Do you have the equipment to do this?
<input type="checkbox"/>	<b>Atmosphere testing</b> It will be necessary to test the atmosphere. The safety management system should require the atmosphere to be tested and found safe before entry – this can only be conducted if equipment is available onboard. Equipment should be of a type that allows the user to test the atmosphere at various heights in the space and not just at the entrance point, that is, with the use of Draeger tubes (or similar). Additionally, it is recommended that there are personal monitors available which personnel can wear when inside the space.
<input type="checkbox"/>	<b>Lighting</b> Natural lighting should be provided if this can be achieved, by opening all accesses to the tank. A pocket backup light should always be carried when working in enclosed spaces in case of loss of light. Lighting in enclosed spaces may not be good and will require temporary arrangements to be cabled into the space, or torchlight. Intrinsically safe lamps should be used in spaces where there is a risk of an explosive atmosphere. Low voltage lighting should always be used.
<input type="checkbox"/>	<b>Staging</b> Consider how you will reach the work site. It may be necessary to rig a scaffold stage to reach upper parts in the space. Additionally, consider rigging safety barriers to prevent falls from height.

## ENTRY AND RESCUE EQUIPMENT

<input type="checkbox"/>	<b>Personal protective equipment (PPE)</b> <ul style="list-style-type: none"><li>• boiler suit (other types of coveralls may be necessary)</li><li>• safety helmets</li><li>• boots or other safety footwear</li><li>• goggles or other eye protection</li><li>• gloves (suitable for the work)</li><li>• harness (to aid in emergency recovery)</li><li>• the work may require dust masks or other respiratory protection</li><li>• welding and other types of work may require specialist equipment such as aprons, full face masks, etc.</li></ul>
<input type="checkbox"/>	<b>Documentation</b> <ul style="list-style-type: none"><li>• risk assessment</li><li>• entry permit</li><li>• entry log (recording personnel entering and leaving the space)</li><li>• warning signage</li><li>• material safety data sheets for any chemicals used</li></ul>
<input type="checkbox"/>	<b>Communications</b> <ul style="list-style-type: none"><li>• between the bridge and the attendant at the entrance to the space</li><li>• between the attendant at the entrance of the space and those inside it</li></ul>
<input type="checkbox"/>	<b>Emergency escape breathing device (EEBD)</b> <p>Should the atmosphere in the space become unsuitable, and especially if someone is feeling unwell/or it is a particularly large space – for instance a double bottom ballast tank – EEBDs may significantly help those trying to evacuate.</p> <p><b>Warning</b> EEBD sets are designed for escape and are not to be used for entering a space to conduct a rescue.</p>

### Procedures

Do your company procedures cover the following?

- risk assessment
- permit to work system
- enclosed space entry
- enclosed space rescue
- training on enclosed space entry
- training on enclosed space rescue
- managing shoreside contractors



^ Always have adequate safe lighting in the space.

### Rescue equipment check list

#### Rescue equipment should be readily available at the entrance to the space

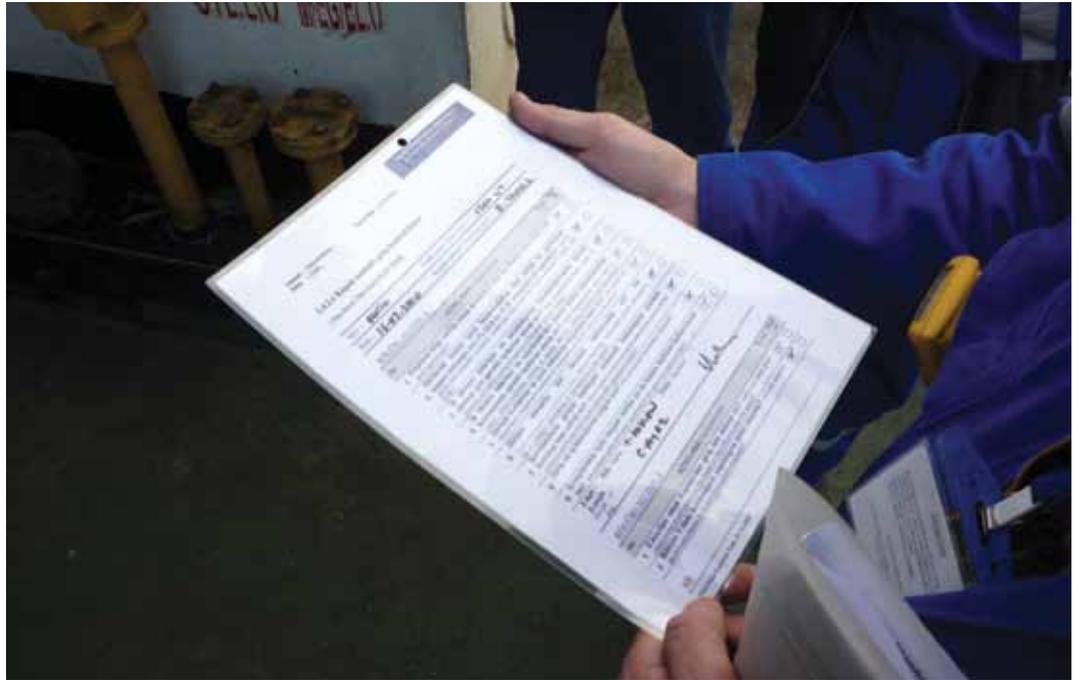
<input type="checkbox"/>	<b>Breathing apparatus</b> Two sets of breathing apparatus should be brought to the entrance to the space and tested before anybody enters the space. The test should confirm that the apparatus is in working order, with fully charged air cylinders.
<input type="checkbox"/>	<b>Stretcher</b> A stretcher is needed to lift anyone collapsed or injured. Tanks usually have lightening holes and many standard stretchers will not go through them. Do check the stretchers you have onboard. Flexible stretchers that have been designed for use in confined spaces are available from manufacturers.
<input type="checkbox"/>	<b>Rescue tripod</b> How will you lift a casualty out of an enclosed space? Crew may not be physically capable of lifting a large person by rope, particularly where this has to be done over a great height. Conditions can also be very dangerous for the person being lifted. Ships should consider installing a rescue tripod or similar system that can be erected over an access hatch for the purpose of rigging a block for lifting a casualty to deck level. Consider welding lifting pad eyes to enclosed spaces to facilitate rescue, and carrying out regular inspection.

#### Rescue party – additional equipment

Breathing apparatus should be ready at the entrance to the space for use by a casualty brought out of the space. A safety harness and lifeline should also be available for the casualty. Any other equipment that may assist in the recovery of a casualty should be placed at the entrance to the space.

If you do not have the appropriate procedures or equipment onboard, raise the issue during an onboard safety meeting and with the ship managers.

# 11 ENTRY PERMIT



^ Always use an enclosed space entry permit.

The ISM code requires the company to establish safe practices in ship operation, and a safe working environment. This is commonly provided for by a permit-to-work system, which consists of an organised and predefined safety procedure.

A permit-to-work does not in itself make the job safe, but contributes to measures for safe working. The enclosed space entry permit relates to allowing people into the space – the work to be conducted in the space requires a separate evaluation.

- the permit should be relevant and as accurate as possible. It should state the location and details of the work to be done, the nature and results of any preliminary tests carried out, the measures undertaken to make the job safe and the safeguards that need to be taken during the operation
- the permit should specify the period of its validity (which should not exceed 24 hours) and any time limits applicable to the work which it authorises
- only the work specified on the permit should be undertaken
- before signing the permit, the authorising officer should ensure that all measures specified as necessary have been taken
- the authorising officer retains responsibility for the work until he has either cancelled the permit or formally transferred it to another authorised person who should be made fully conversant with the situation. Anyone who takes over, either as a matter of routine or in an emergency, from the authorising officer, should sign the permit to indicate transfer of full responsibility
- the person responsible for carrying out the specified work should countersign the permit to indicate his understanding of the safety precautions to be observed
- on completion of the work, that person should notify the responsible officer and get the permit cancelled
- the person carrying out the specified work should not be the same person as the authorising officer

# PERMIT-TO-WORK FOR ENTRY INTO ENCLOSED/CONFINED SPACE

## Section A – Scope of Work

Location (designation of space)

Plant apparatus/identification (designation of machinery/equipment)

Work to be done (description)

Permit issued to (name of person carrying out work or in charge of the work party)

## Section B – Checklist/Isolation data

Has a risk assessment of the proposed work been carried out?

### Checklist

### Checked

1	Space thoroughly ventilated	<input type="checkbox"/>
2	Atmosphere tested and found safe	<input type="checkbox"/>
3	Space secured for entry	<input type="checkbox"/>
4	Rescue and resuscitation entrance	<input type="checkbox"/>
5	Testing equipment available for regular checks	<input type="checkbox"/>
6	Responsible person in attendance at entrance	<input type="checkbox"/>
7	Communication arrangements made between person at entrance and those entering	<input type="checkbox"/>
8	Access and illumination adequate	<input type="checkbox"/>
9	All equipment to be used is of appropriate type	<input type="checkbox"/>
10	Personal protective equipment to be used: Hard hat, safety harness as necessary	<input type="checkbox"/> <input type="checkbox"/>
11	When breathing apparatus is being used	<input type="checkbox"/>
	(i) Familiarity of user with apparatus is confirmed	<input type="checkbox"/>
	(ii) Apparatus has been tested and found to be satisfactory	<input type="checkbox"/>

## Section C – Certificate of checks:

I am satisfied that all precautions have been taken and that safety arrangements will be maintained for the duration of the work.

Authorising person in charge

Name

Signature

Time

Date

## Section D – Cancellation of certificate:

The work has been completed/cancelled and all persons under my supervision, materials and equipment have been withdrawn.

Authorising person in charge

Name

Signature

Time

Date

Delete words not applicable and where appropriate state:

The work is complete/incomplete as follows: (description)



# 12 COMPLETION AND PERMIT CLOSURE



^ Certain checks need to be done after tank entry.

**On expiry of the permit-to-work, everyone should leave the space, and openings should be closed or otherwise secured against entry.**

At the end of the work, the permit must be closed and signed off. Where work is ongoing but the permit period expires, an extension can be provided in the form of a new permit. Where an extension is required, the safety measures originally taken must be reconfirmed and entry must be reapproved.

Before closing the space, the responsible officer should check to confirm that all people and equipment have been removed.

The entrance to the space should never be left unattended while open, without measures having been taken to prevent unauthorised access. This is particularly important where the access is on the deck, as there is a risk that somebody may fall in to the space.

## Example incident

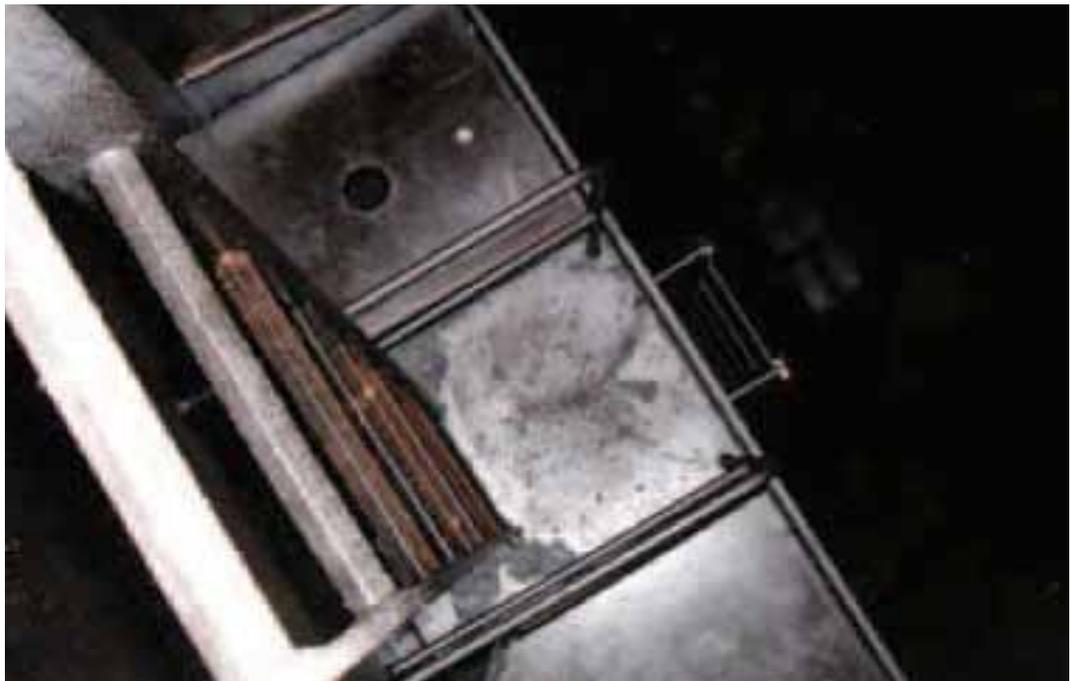
A stevedore onboard a container ship in a UK port fell through the manhole of a ballast tank that had been left open and unguarded. Fortunately, the ballast tank was full and the stevedore fell into the water. He managed to swim to the surface and escape unharmed through the manhole.

### Example incident

#### Fatality in fuel tank

An ordinary seaman lost his life while working in a fuel oil tank. After an inspection of the fuel tank, the ship's bosun was instructed to secure the tank lid. The chief officer also instructed him to renew the gaskets of the manhole cover. To facilitate proper tightening of the tank lid with the renewed gasket, the bosun cleaned the contact surfaces of the manhole and lid. As a result, some debris collected on the upper access ladder platform immediately underneath the manhole, some two metres below the deck. The bosun sent the seaman to collect the debris; the rating went down to the platform and requested a brush and dustpan be lowered so that he could sweep it clean.

While an able seaman was sent to fetch the cleaning gear, the bosun observed that the man inside the tank appeared to be kneeling, but assumed that this was to help clean the platform. A few minutes later, the bosun called out to the man and lowered the cleaning gear on a rope. The man rose from the kneeling position, with his hands raised above his head to collect the equipment being lowered. At this point he either suffered a blackout or lost balance, and he fell backwards 12m down to the tank bottom. The platform had guard rails on only two of its sides, and the unprotected side happened to be the one behind the victim.



^ View of the platform from the main deck before accident. Two tiers of chain fencing were later fitted on the unprotected side.

# 13 RESCUE FROM AN ENCLOSED SPACE



^ Enclosed spaces should be considered as potentially hazardous areas.

Should a rescue be necessary, the attendant at the entrance to the space is usually the person who will notify the officer on watch of the emergency. The general alarm should be sounded in order that the crew muster and a rescue party can be formed. The rescue party will don PPE and prepare breathing apparatus. Ideally, all the equipment required to rescue the casualty should already be at the entrance to the space, prepared for use by the rescue team.

No one must enter the enclosed space until the atmosphere in the space has been checked and is safe.

For a rescue to be efficient the right equipment must be onboard and the crew well trained in its use. Regular drills should be held to avoid unwelcome surprises during a real emergency.

If the unconscious casualty is in an enclosed space:

- it must be assumed that the atmosphere in the space is unsafe and the rescue team must not enter unless wearing breathing apparatus
- personnel **MUST NOT** enter the enclosed space unless they are a trained member of a rescue team acting upon instruction
- help should be summoned and the master informed
- separate breathing apparatus or resuscitation equipment should be fitted on the casualty as soon as possible
- the casualty should be moved quickly to the nearest safe area outside the enclosed space, unless his injuries and the likely time of evacuation make treatment essential before he is moved

## Rescue response time goal

The following table provides a guide to response time. This is based on a scenario where the ship is properly equipped and the crew are well drilled in enclosed space rescue. Even so, almost an hour elapses before the casualty reaches the ship's hospital. An ill-equipped and unprepared team will take substantially longer in recovering the casualty.

## RESCUE FROM AN ENCLOSED SPACE

Time lapse	Activity	Duration
0–03 minutes	Enclosed space incident occurs and rescue team is called	03 minutes
03–13 minutes	Rescue team arrives at the scene	10 minutes
13–23 minutes	Rescue team sizes up and prepares to initiate rescue	10 minutes
23–38 minutes	Rescue team reaches and rescues the casualty	15 minutes
38–53 minutes	Casualty is transported and arrives at the ship's hospital	15 minutes

### Rescue action plan

#### Safety precautions

- do not rush in
- do not try to act alone – do not enter until help arrives
- call back-up
- standby team to assist
- ventilate the atmosphere

#### Emergency response

- follow correct procedures
- stay alert and be ready to get out quickly if there are any worrying signs

#### Casualty assessment and care

- approach with care – don't become a casualty too
- if the atmosphere is safe, begin primary assessment
- if the atmosphere is unsafe, remove the casualty immediately

#### Methods of casualty evacuation from an enclosed space

Evacuation of casualties from enclosed spaces can be difficult and risky for both casualty and rescuers. The following methods may be adopted in an emergency evacuation.



^ Practice your emergency rescue procedures.

---

### How effective is your stretcher in confined spaces?

Stretchers are available that are specifically designed for use in confined spaces where rigid stretchers would not be suitable or might not even reach.

Stretchers are available that roll up and can be stowed away in a backpack. Flexible stretchers and spine boards like these are ideal for use where a casualty may have to be transported through lightening holes or around other structures in tank and void space arrangements.

A stretcher is the ideal means of transporting a casualty. Where the stretcher is too large, or not available, the following methods can be used:

- forward drag (rescue crawl or neck drag)
- cross chest method
- collar pull
- leg pull
- blanket

If the atmosphere and environment are safe, and the casualty has suffered a physical injury, it is advisable to seek professional medical advice before moving him/her, particularly where it is suspected that the casualty has a spinal injury.

#### **Forward drag/rescue crawl/neck drag (casualty without hand injury)**

1. tie casualty's arms securely at both wrists with triangular bandages
2. kneel astride the casualty
3. pass your head between the casualty's arms
4. straighten your arms to lift casualty
5. drag out the casualty by crawling and pushing your feet

#### **Forward drag/rescue crawl/neck drag (casualty with hand injuries)**

1. pass belt, rope or triangular bandage under casualty near armpits
2. kneel astride the casualty
3. pass the loop over your head
4. straighten your arms
5. drag the casualty forward by crawling and pushing your feet

#### **Cross-chest method (unconscious casualty with minor injuries)**

1. lift the casualty to a sitting position
2. sit behind the casualty with both legs apart
3. cross the casualty's hands and place them across his chest, with fingers on shoulders
4. insert your arm under the casualty's armpit and hold the outer arm of casualty
5. drag out the casualty backwards

#### **Rescue using a blanket**

The casualty may be conscious or unconscious, with or without fracture.

### Collar pull method

- employed when methods described earlier cannot be used
- casualty's head is positioned in direction of exit

### Leg pull method

- last resort in very enclosed spaces under life threatening situation
- if casualty's legs are in direction of exit and casualty cannot be repositioned

### Example incident

#### Fatal fall in cargo tank

A three-man team of shore workers entered No.2 cargo tank to sweep the remains of a cargo of stearin (a derivative of crude palm oil) into the cargo pump suction well, to maximise the cargo discharge. On leaving the tank, one of the workers was fatally injured when he fell 18m onto the tank top.

Although a risk assessment for the sweeping had been carried out by the ship, no consideration had been given to using a safety harness or fall arrestor despite the extreme waxy nature of the cargo and the advice in the ship's safety management system regarding their use in large spaces. The supervisor, whose role was to advise the crew on optimal cargo operations, gave two of the shore workers a short brief on the sweeping task, but no safety briefing or other information came from the ship's officers.

The atmosphere of the cargo tank was tested correctly for oxygen levels but the equipment used to test for other gases only reached half way down the tank. The supercargo noticed that one of the sweepers, who was the subsequent casualty, needed help to descend the angled ladders.

Following the accident, the casualty was lifted from the tank by the local emergency services, which declined the use of the ship's recovery equipment because of its weight and lack of portability.



^ Cargo tank.



^ Access ladder.

The post mortem toxicology report identified that the casualty had prescription and illegal drugs in his blood which would have caused severe impairment. All the evidence suggests that the casualty fell from the vertical ladder. His cargo-contaminated gloves could easily have caused him to lose his hand grip on the slippery surface and his risk of falling would have been exacerbated by his physical condition. The investigation also found that the mandatory two-monthly dangerous space casualty recovery drills had not been practised for a considerable time.

### Safety lessons

- While a worker has the responsibility to take reasonable care of his own health and safety, there should be clear guidance in the ship's safety management system on the responsibilities of ship staff for effectively controlling and managing contractors.
- If there is any doubt about the physical or professional ability of persons designated to carry out work, regardless of whether they are crew or a contractor, they should be confronted and, if necessary, the task should be aborted.
- Risk assessments need to be thorough if they are to identify the appropriate control measures. When the task includes working at height, including entering or exiting cargo tanks, consideration should be given to the use of safety harnesses or fall arrestors.
- Crew should be equipped with correct atmosphere sampling equipment and be fully trained in its use and interpretation of results. Equipment needs to reach to the bottom of a tank.
- The crew in the case above had not been properly trained in rescue techniques and the ship's casualty recovery equipment was unsuitable for the task. Lightweight rapid-deployment tripods and quadpods which are commercially available would have been helpful.

# 14 TRAINING



^ Training always saves lives.

There is a statutory requirement for drills to be carried out, usually every two months (depending upon flag requirements) simulating the rescue of an incapacitated person from a dangerous space. Each drill should be recorded in the official log book. A drill should normally be held soon after significant changes of crew members.

All personnel should be aware of enclosed space entry hazards and procedures.

## Drills

- Drills carried out onboard should be as realistic as possible. It is useful to have a human-sized training dummy available so that crew can practice moving a pretend-casualty on a stretcher through a ballast tank, while wearing breathing apparatus.
- Briefings should take place to ensure crew members understand the correct procedures to be followed for enclosed space entry, and the purpose of the equipment used or kept on stand-by.

Any attempt to rescue a person who has collapsed within a space should be based on a prearranged plan, which should take account of the design of the ship in question. Allocation of personnel to relieve or back-up those first into the space should be part of the plan.

Regular drills should test the feasibility of the ship's rescue plan under different and difficult circumstances. In the drill, an enclosed space should be made safe or, for operational convenience, a non-dangerous space may be used, so long as it provides equivalent, realistic conditions for actual real-life rescue.

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Training should include:

- enclosed space entry procedures
- responsibilities of workers entering an enclosed space,
- the hazards associated with entry into dangerous spaces, and the precautions to be taken
- the use and maintenance of equipment and clothing required for entry into dangerous spaces
- hazard assessment, particularly for permit issuers
- recognition of the circumstances and activities likely to lead to the presence of a dangerous atmosphere
- use of the atmosphere testing equipment
- calibration procedures of the atmosphere testing equipment
- management of shoreside contractors

#### **Maintenance of equipment for entry into dangerous spaces**

All breathing apparatus, rescue harnesses, lifelines, resuscitation equipment and any other equipment for use in, or in connection with, entry into dangerous spaces, or for use in emergencies, should be properly maintained, inspected periodically and checked for correct operation by a competent person, and a record of the inspections and checks kept. All items of breathing apparatus should be inspected for correct operation before and after use.

Equipment for testing the atmosphere of dangerous spaces, including oxygen meters, should be kept in perfect working order and, where applicable, regularly serviced and calibrated. Careful heed should be given to manufacturers' recommendations, the details of which should always be kept with the equipment.



^ Always have good lighting when in an enclosed space.

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# 15 APPENDICES

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- Appendix 1 – Checklist
- Appendix 2 – Enclosed space access log
- Appendix 3 – Safety signage

# 1. CHECKLIST

PHOTOCOPY FOR FURTHER USE

## Entry procedures/activities

- master/duty deck officer/engine control room advised as necessary
- risk assessment
- toolbox talk/job safety analysis
- secure space (valves isolated, etc.)
- ventilate space
- guard all openings
- attendant at entrance to the space
- test atmosphere in the space
- atmosphere in the space confirmed safe
- emergency rescue equipment on stand-by
- communications established and tested
- access confirmed safe
- lighting satisfactory (intrinsically safe equipment if necessary)
- staging/access/fall prevention equipment readied
- work equipment prepared for the job
- personnel available for rescue party
- entry permit issued
- all relevant parties notified of intended entry
- entry made to the space
- continuous ventilation
- regular monitoring of atmosphere
- staging/access/fall prevention equipment checked

## On completion of the work

- all personnel accounted for as having exited the space
- all equipment confirmed removed
- all openings closed and secured
- permit closed

## Equipment

- |  |  |
|--|--|
| <input type="checkbox"/> breathing apparatus | <input type="checkbox"/> rescue line           |
| <input type="checkbox"/> torch <sup>1</sup>  | <input type="checkbox"/> communications        |
| <input type="checkbox"/> stretcher           | <input type="checkbox"/> hoisting equipment    |
| <input type="checkbox"/> staging             | <input type="checkbox"/> lighting <sup>1</sup> |
| <input type="checkbox"/> ventilation         | <input type="checkbox"/> atmosphere monitoring |
| <input type="checkbox"/> EEBD                | <input type="checkbox"/> PPE                   |
| <input type="checkbox"/> safety signage      | <input type="checkbox"/> guards and barriers   |

<sup>1</sup> Only use intrinsically safe equipment where there is a risk of a flammable atmosphere.

# 2. ENCLOSED SPACE ACCESS LOG

PHOTOCOPY FOR FURTHER USE

Date:		Entry permit done Y/N
Enclosed space name:		Responsible Officer:
Enclosed space access point:		
Purpose of entry:		

	Name	Time in	Time out
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

### 3. SAFETY SIGNAGE

- Ensure you have adequate signage onboard to warn crew members and visitors of any hazard, and unauthorised access.
- When planning access to an enclosed space, establish how many access points will be opened, and the number of signs required to warn of all openings.
- Identify locations that should always be categorised as enclosed space, and affix appropriate signs at all access points

**Copy, print, and laminate the example signage on the following page.**



^ Display clear safety warnings to enclosed spaces

Use lock-out tags to prevent other people from activating equipment or valves. Print and laminate the tag-out cards below:



The Standard



**DANGER**

**VALVE  
CLOSED**

**DO NOT OPEN**



The Standard



**DANGER**

**DO NOT  
ENERGISE**

**EQUIPMENT  
LOCKED OUT**



The Standard



**DANGER**

**DO NOT  
START**

**EQUIPMENT  
LOCKED OUT**



The Standard



**DANGER**

**DO NOT  
OPERATE**

**EQUIPMENT  
LOCKED OUT**

Sign:

Rank:

Date:

Sign:

Rank:

Date:

Sign:

Rank:

Date:

Sign:

Rank:

Date:

Use lock-out tags to prevent other people from activating equipment or valves. Print and laminate the tag-out cards below:



The Standard



The Standard



The Standard



The Standard

**DANGER**

**DANGER**

**DANGER**

**DANGER**

**DO NOT  
OPERATE**

**DO NOT  
START**

**DO NOT  
ENERGISE**

**VALVE  
CLOSED**

**EQUIPMENT  
LOCKED OUT**

**EQUIPMENT  
LOCKED OUT**

**EQUIPMENT  
LOCKED OUT**

**DO NOT OPEN**

Sign:

Rank:

Date:

Sign:

Rank:

Date:

Sign:

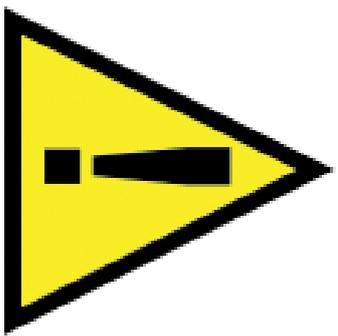
Rank:

Date:

Sign:

Rank:

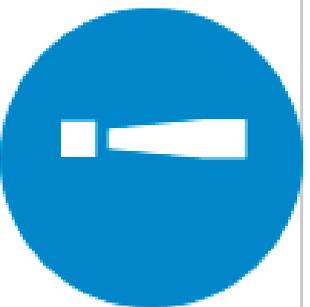
Date:



**Warning**  
**Confined space**



**No unauthorised  
entry**



**Entry Permit must be  
obtained**

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