WEST

Enclosed Space Entry

Loss Prevention Bulletin

Entering an enclosed space is a potentially hazardous activity on board a vessel.

A vessel's Safety Management System (SMS) is required to contain "procedures, plans and instructions, including checklists as appropriate, for key shipboard operations concerning the safety of the personnel, ship and protection of the environment. The various tasks should be defined and assigned to qualified personnel". The SMS will therefore include procedures for entering enclosed spaces. However, in spite of such procedures, incidents resulting in injuries or fatalities continue to occur.

This Loss Prevention Bulletin contains guidance for anyone who may be required to enter an enclosed space. However, it is important to note that the information is intended to supplement, but not replace, SMS procedures.

Further advice on enclosed space entry may be found in IMO Resolution A.1050(27) "Revised Recommendations for Entering Enclosed Spaces Aboard Ships".

What is an Enclosed Space?

Personnel are sometime unsure about the conditions which turn a compartment into an enclosed space, requiring the necessary procedures for safe entry to be followed. In order to assist in the identification of such compartments, IMO has defined an enclosed space as being one which has any of the following characteristics:

- Limited openings for entry and exit;
- Inadequate ventilation; and
- Is not designed for continuous worker occupancy.

Examples of enclosed spaces may include:

- Ballast tanks
- Boilers

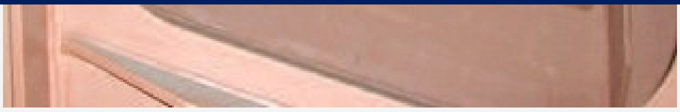
- Cargo compressor rooms
- Cargo holds[1]
- Cargo pumprooms
- Cargo tanks
- Chain lockers
- CO2 Rooms
- Cofferdams
- Dry bulk tanks
- Duct keels
- Engine crankcases
- Engine scavenge air receivers
- Foam tanks
- Fuel tanks
- Inter barrier spaces
- Oil spill dispersant tanks
- Potable water tanks
- Sewage tanks
- Stool spaces
- Void spaces
- Waste oil tanks

[1] Particularly when carrying oxygen-depleting or noxious cargoes

It is recommended that a responsible and experienced officer carries out a risk assessment exercise to identify and record the enclosed spaces on board. The exercise should be repeated periodically as conditions may change over time. If there is any doubt as to whether or not a particular compartment should be listed, it should be treated as an enclosed space until determined otherwise.

Compartments next to enclosed spaces should also be considered. IMO defines an “adjacent connected space” as being “a normally unventilated space which is not used for cargo but which may share the same atmospheric characteristics with the enclosed space such as, but not limited to, a cargo space accessway”. An example of an adjacent connected space may be a deck house containing a booby hatch leading to a cargo hold. The characteristics of the atmosphere in the deck house may be similar to that of the cargo hold if, for example, the booby hatch lid sealing arrangements are in poor condition and leak, resulting in similar atmospheric conditions within both compartments.

It should also be borne in mind that vent pipes from an enclosed space may pass through compartments which are not necessarily adjacent. If the pipes are not in good condition, these compartments may also be affected. In a recent case, a cargo hold vent pipe ran through a forecastle store some distance away. The oxygen deficient atmosphere



If you are unsure whether or not a compartment is safe to enter you should assume that it is an enclosed space

Photo: MAIB Report on the death by asphyxiation of two crewmen on board Sava Lake. © Crown Copyright from the cargo hold leaked into the forecastle store via a hole in the vent pipe, causing a serious incident.

Similarly, tankers constructed with heavy external deck frames may find that pockets of gas build up outside the access ports if the frames hinder natural surface ventilation.

These, and all other possibilities, should be considered when the risk assessment is carried out.

Atmospheric Hazards

By far the biggest cause of incidents within enclosed spaces is a hazardous atmosphere due to:

- Insufficient oxygen to support human life.
- Flammable (hydrocarbon) gas which may also increase the risk of explosion.
- Toxic gas which may be fatal in certain concentrations.

Before entering an enclosed space, the amount of oxygen in the atmosphere must be checked. However, the presence of flammable or toxic gas will usually depend on the type of compartment and the properties of the cargoes previously carried. The Material Safety Data Sheets for such cargoes should be consulted to assist in determining the atmospheric hazards that may exist. If there is any doubt regarding the gases or vapours that may be encountered a risk assessment should be carried out.

Prior to entry the atmosphere must be tested to check that oxygen levels are satisfactory and that flammable and/or toxic gases, where present, are within acceptable safe limits.

When testing for gases it is important that all levels of the space are checked. Some gases are heavier than air (eg hydrogen sulphide) and some are lighter (eg methane).

Concentrations of gas towards the lower parts of an enclosed space will displace air and force it towards the top of the compartment, and vice versa. In addition to testing at different levels within the space, as far as practicable tests should also be carried out at different locations within the space as pockets of gas may still be present even after thorough ventilation. A particular effort should be made if the space contains complex framing arrangements which may restrict the movement of air.

In the event that adequate testing of the atmosphere cannot be undertaken from outside the space, it will be necessary to enter the compartment to do so. In such a situation suitable breathing apparatus should be worn and the guidance in the section in this bulletin on “Entry into a Space with an Unsafe Atmosphere” should be followed.

Gas Detectors

There are numerous makes and models of gas detection equipment available. Some may only detect one type of gas, others may detect several. There are also limited life disposable detectors with a sealed battery, and reusable units which require periodic recharging, calibration and servicing. Due to the wide variety of gas detectors that are available, personnel responsible for using such equipment should make sure they are thoroughly familiar with the type of gas detectors on board and how they operate. In addition to understanding the settings, users should be able to distinguish between the various alarms (eg audible, visual, vibrating) so that they are instantly recognisable, allowing appropriate action to be taken without delay.

Gas detectors should not be placed in an atmosphere containing gases for which they were not designed as they may not operate correctly thereafter.

The requirements for testing, calibration, servicing and sensor replacement will vary depending on the manufacturer of the equipment and the model. Manufacturers’ recommendations regarding maintenance should always be followed and, where necessary, a suitable stock of gas for testing/calibration should be retained on board. Only competent personnel should be involved with the testing of such equipment, and details of all testing, calibration, servicing and the replacement of sensors should be recorded in the Planned Maintenance System (PMS).

Rechargeable batteries should always be fully charged prior to use. If possible, fully charged spare batteries should also be readily to hand. Detectors should always be tested in accordance with manufacturers’ instructions prior to each use.

The person in charge of the operations within the space should carry a gas detector capable of measuring all gases which may be encountered. Depending on availability it is also recommended that everyone required to enter the space is provided with a personal gas monitoring device designed to measure oxygen content, and preferably flammable and/or toxic gases as well when necessary.

If painting or cleaning is to be conducted within an enclosed space, it should be remembered that the paint or cleaning agents may produce solvent gas or other vapours that may be flammable and/or toxic.

If gas cutting equipment is to be used inside an enclosed space, the possibility that oxygen and/or acetylene may leak from the hoses or gas torch fittings should be considered. Acetylene gas is lighter than air and will therefore rise to the top of a space. It is also toxic and extremely combustible.

When taking remote samples, care should be taken to acquire samples which provide an accurate representation of the atmosphere inside the space. The sampling pipeline should be long enough to reach all levels within the compartment and should be free of kinks, knots and blockages. When using a hand pump to obtain samples manually, close attention should be paid to pumping a sufficient quantity of the atmosphere through the gas detector to ensure that the readings are reliable. Similarly, units fitted with electric pumps should be run for sufficient time beforehand to allow a fully representative sample to pass through the gas detector. The manufacturer's instructions should be consulted to determine how many times the hand pump should be squeezed or for how long the electric pump should be run, taking into account the length of sampling hose in use.

Oxygen

The presence of oxygen in the air we breathe is vital to life, therefore verifying that there is sufficient oxygen in an enclosed space prior to entry is crucial. The normal level of oxygen in air is 20.9%.

Three crewmembers died after entering this chain locker where heavy rusting had reduced the oxygen content to less than 10%

Photo: MAIB Report on the death of three crewmen on board ERRV Viking Islay. © Crown Copyright

If testing indicates that the amount of oxygen in a compartment is insufficient to sustain life, oxygen displacement or oxygen depletion may have occurred due to

A person inside a space where the oxygen level has fallen to below 19% will begin to suffer drowsiness and nausea, and will start to breathe faster in order to draw the necessary oxygen into their lungs. If the oxygen content falls below 17%, these symptoms will become progressively more pronounced. A level of below 12% will result in unconsciousness and anyone exposed to concentrations of 6% or less may not survive. The effects may be sudden and rapid, explaining why personnel in an oxygen deficient compartment often succumb before they realise what is happening and are unable to exit the space.

As a general rule an enclosed space should not be entered unless consistent oxygen readings above 20.0% are obtained. However, more stringent national, flag state or SMS requirements should be followed if applicable.

Most gas detectors have two oxygen alarms. The first will sound at around 19% and a second at around 17%. If either of these alarms is heard after entering an enclosed space, the compartment should be evacuated immediately.

Excess oxygen in an enclosed space may also impair a person's ability. In addition, an oxygen-rich atmosphere may present a fire hazard; flammable items such as clothing will burn more readily when ignited and may even spontaneously combust. For this reason pure oxygen should never be used to ventilate a space.

Nitrogen is normally used as an inert gas on tankers and may also be employed to inert the cargo holds of bulk carriers. Nitrogen itself is not poisonous and accounts for approximately 78% of fresh air. However, nitrogen used as an inerting agent will displace the oxygen in the atmosphere, making the space hazardous in the process. One deep breath one or more reasons. For example:

- The rusting or “oxidation” of bare steel. Spaces where bare steel surfaces may be heavily rusted include chain lockers, void spaces and ballast tanks.
- If hot work, such as welding or cutting with oxy-acetylene, has been carried out inside a compartment.
- The decomposition of organic material within the space, such as a cargo of timber.
- Fumes released by drying paint.
- The breathing of personnel, particularly if the space is small and/or poorly ventilated.
- The use of inert gas such as Nitrogen (N) or fixed fire extinguishing gas such as Carbon Dioxide (CO2).
- The development of hydrogen inside ballast tanks generated by the electrolytic reaction between the steel and the sacrificial anodes.

of 100% nitrogen may be fatal.

Flammable gas

If a tank has contained a hydrocarbon product such as oil or fuel and hydrocarbon gas or vapour is present along with oxygen in quantities sufficient to create a flammable atmosphere, a source of ignition such as a spark will create an explosion. In order to ensure that the atmosphere within the space is safe, the proportion of flammable gas must be measured to verify that it is below the lower limit at which a flammable atmosphere will form. This threshold is termed the Lower Explosive Limit (LEL).

A flammable gas detector will measure for the presence of hydrocarbon gases and vapours and provide the reading as a percentage of the LEL. In order to provide an adequate margin of safety, an enclosed space should not be entered if the atmosphere contains flammable gas at a level above 1% of the LEL.

It should be borne in mind that some flammable gas detectors may not provide an accurate reading if the level of oxygen in the compartment is low. Reference should be made to the manufacturer's manual in this respect.

Flammable gas detector alarms are normally triggered by a number of predetermined LEL concentrations. These will depend on the purpose of equipment, the manufacturer and the particular hydrocarbon gas concerned. Typically, flammable gas detector alarms will sound at 10% or 20% of LEL, then at 40% of LEL, and finally at 100% of LEL.

It should be remembered that a tank may continue to produce hydrocarbon vapours if cargo or bunker residues are present, particularly if sludge is disturbed or if rust scale is removed.

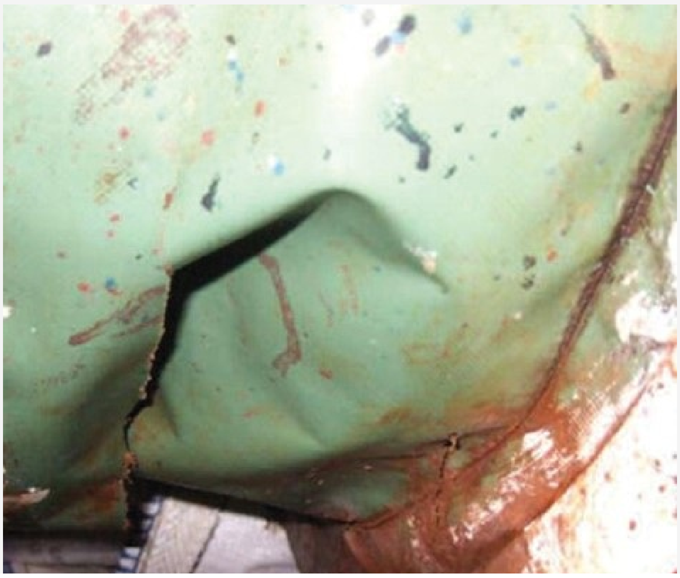
Workplace Exposure Limit (WEL)				
Substance	Long Term Exposure Limit (8 hour TWA)		Short Term Exposure Limit (15 minute TWA)	
	ppm	mg/m3	ppm	mg/m3
Benzene	1	3.25	-	-
Carbon Dioxide	5000	9150	15000	27400
Carbon Monoxide	30	35	200	232
Hydrogen Sulphide	5	7	10	14
Phosphine	0.1	0.14	0.2	0.28
Toluene	50	191	100	384

Workplace Exposure Limits (WELs) for some of the more commonly encountered toxic gases on ships

Toxic gas

Toxic gas may be found in several different types of enclosed space:

- In cargo tanks and associated spaces due to residues from a previous cargo. The applicable Material Safety Data Sheet (MSDS) should be consulted to determine which gases may be present.
- In cargo tanks due to the presence of an inert gas which contains various toxic trace components such as carbon monoxide or nitrogen dioxide.
- In cargo holds due to the decomposition of an organic product (eg carbon monoxide produced by wood pellets) or a chemical reaction (eg carbon dioxide if a



grain cargo starts to ferment).

- In cargo holds which have been fumigated but not ventilated. Phosphine, one of the most common types of fumigant, is extremely toxic.
- In cargo holds containing packaged dangerous goods if damaged due to improper handling, stowage or securing.
- In fuel tanks, especially residual oil tanks, as traces of hydrogen sulphide may be present.
- In sewage tanks as traces of methane, carbon dioxide, hydrogen sulphide and other toxic gases may exist.

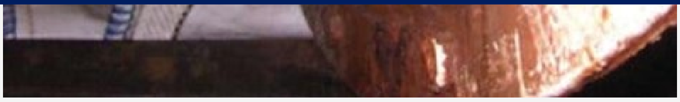
In addition, carbon monoxide, a colourless and odourless toxic gas, is produced when portable generators and other engine driven plant is operated. Such equipment should not be used within an enclosed space.

Many other toxic gases and vapours are also colourless and odourless. Deciding whether or not a toxic gas is present or if a space is safe for entry should never be determined by smell alone.

Toxic gases and vapours are normally measured in parts per million (ppm). However, figures expressed in milligrams per cubic metre (mg/m3) may also be encountered.

It may be possible to work in a space containing toxic gas provided the amount does not exceed safe limits. Several different terms are in use for expressing the maximum safe exposure limit including:

- Threshold Limit Value (TLV)
- Occupational Exposure Limit (OEL)
- Indicative Occupational Exposure Limit Value (IOELV)
- Workplace Exposure Limit (WEL)
- Maximum Accepted Concentration (MAC)
- Permissible Exposure Limit (PEL)



This hold vent bellows in a forecastle store had been cut to drain water. However, it also permitted the oxygen deficient atmosphere of the hold to enter the store, leading to two fatalities

Photo: MAIB Report on the death by asphyxiation of two crewmen on board Sava Lake. © Crown Copyright

The maximum safe exposure limit is defined by the Time Weighted Average (TWA) for both short term exposure (15 minutes) and long term exposure (8 hours). Gas detectors may normally be set to trigger an alarm for either the short term or long term TWA. If the long term TWA is selected, some detector units may also sound an alarm if the level of toxic gas exceeds the short term TWA, thereby providing an early indication of deteriorating atmospheric conditions. It is important to be familiar with the alarm settings for each toxic gas detector on board as the functions may vary. Manufacturers' manuals should be referred to as necessary.

A European Commission Directive on Indicative Occupational Exposure Limit Values specifies the WELs for a large number of toxic gases. The WELs for some of the more common ones are reproduced in a table on the previous page. In addition, there may be flag state or national regulations governing maximum safe exposure limits. If so, such limits should be observed. However, entering an enclosed space is not recommended if the toxic gas readings exceed 50% of the WEL or equivalent.

If it is necessary to enter an enclosed space which adjoins a compartment containing inert gas, the possibility of leakage (eg via a defective inert gas line valve) should be taken into account. In such cases it may be prudent to insert blanks into the inert gas line or remove a section of pipework to ensure that the enclosed space is isolated from the inert gas system.

The risks associated with hydrogen sulphide also need to be considered as this highly toxic gas may be present in cargo tanks, pumprooms or pipelines following the carriage of sour crude oil. It may also be present in bunker tanks; for further information please refer to the Club's Loss Prevention Bulletin "The Dangers of Hydrogen Sulphide in Marine Bunkers".

Sewage tanks may also produce hydrogen sulphide.

If traces of hydrogen sulphide are detected when the atmosphere is tested, the space should not be entered.

It is important to remember that the distinctive smell of rotten eggs associated with hydrogen sulphide is associated with low concentrations of the gas. However, concentrations of hydrogen sulphide exceeding 100 ppm paralyse the olfactory nerves in the nose at which point it is no longer possible to smell it.

This non-intrinsically safe halogen lamp was placed just inside the door of a boiler steam drum shortly after it was opened for inspection following a chemical clean. The tank atmosphere exploded causing fatal injuries to one of the personnel outside the steam drum door.

Photo: MAIB Safety Digest 2/2008. © Crown Copyright

General Safety

In addition to the atmospheric hazards associated with enclosed spaces, such compartments are often unlit, cramped, have limited access and may have slippery surfaces due to the presence of water, mud, cargo residues or rust scale.

Often the edges of frames, decks and stringers are exposed, and there may be unguarded lightening holes within the space requiring additional vigilance. If due to work at a height, additional precautionary measures including a Permit to Work may be necessary.

The following Personal Protective Equipment (PPE) is recommended as a minimum for enclosed space entry. However, the requirements of the SMS should also be followed in this regard:

- Overalls, with high visibility reflective markings.
- Safety boots.
- Hard hat with chin strap.
- Eye protection; either safety glasses or goggles.
- Gloves, unless deemed to be a hindrance on slippery ladders.
- Torch with a suitable strap so that it may be slung around the body to prevent it from being dropped or lost. If due to be used in an atmosphere that may be flammable, the torch should also be intrinsically safe (ie equipment that has been designed and approved for use in flammable atmospheres).
- Where available, a personal gas detector for each person entering the space.
- Depending on the risk assessment:
    - ear protectors, particularly if due to work in a high noise environment.
    - protective filter mask if, for example, the atmosphere contains particles. However, filter masks should never be used as a life support device in atmospheres which are deficient in oxygen or contain toxic and/or flammable gas.
    - more suitable protective clothing and eyewear if personnel are to enter a cargo tank which contains chemical residues where there may be a risk of skin absorption.

Ventilation

Mechanical ventilation is crucial to making safe the atmosphere within a space. The more air changes that can be carried out prior to entry the better.

So far as is safe and practicable, all accesses to the space should be opened to maximise air flow and aid the evacuation of the space in an emergency. Suitable signs and barriers should be placed near each access prohibiting entry, and any openings in the deck should be fenced off to prevent injury.

Before entering cargo holds the fixed ventilation fans should be turned on (where fitted). Ventilation may be further improved by partially opening the hatch covers if it is safe to do so.

If portable fans are used, the suction arrangements should be placed in the open, well clear of all accesses to ensure that the space is provided with a clean supply of fresh air. Ducting to transfer fresh air to the worksite should be rigged where possible. Intrinsically safe fans should be used where necessary.

Inert gas fans should not be used to ventilate cargo tanks as they may introduce traces of inert gas into the compartment.

If access to ballast tanks is required, entering the tanks soon after they have been emptied is preferable as the action of removing the ballast will draw fresh air into the space. However, it will still be necessary to follow the applicable SMS enclosed space entry procedures including ventilating the tanks and testing the atmosphere beforehand.

Ventilation should be stopped sufficiently in advance of testing to allow the atmosphere within the space to stabilise. Ten minutes or more should suffice. If the readings are satisfactory, ventilation should be resumed. Ventilation should continue until work inside the enclosed space has been completed and the compartment has been vacated.

Should the ventilation arrangements fail while personnel are inside an enclosed space, everyone should leave the compartment immediately. Such a situation invalidates the applicable Permit to Work.

Enclosed Space Entry

SMS procedures should always be followed when entering an enclosed space. A risk assessment should also be carried out where deemed necessary or if required by the SMS, and a Permit to Work must be obtained prior to entry. Ideally, and before anyone enters the space, the Permit to Work provisions should be checked carefully by the person in charge of the task due to be carried out inside the compartment and verified by the responsible person in overall charge of the operation who should remain outside throughout. This will minimise the possibility of key safeguards being overlooked.

A Permit to Work for an enclosed space should be issued for a defined period. Open ended permits are unacceptable. It is recommended that Permits to Work are issued for a period not exceeding 24 hours, or less if required by the SMS or as determined by a risk assessment.

When entering an enclosed space a suitably experienced crew member should be stationed at the entrance to the space. The IMO term for this person is an “attendant”, described as being “a person who is suitably trained within the safety management system, maintains a watch over those entering the enclosed space, maintains communications with

The restricted manhole opening into this chain locker made it difficult to access the space whilst wearing SCBA and to recover the persons who had collapsed inside

Photo: MAIB Report on the death of three crewmen on board ERRV Viking Islay. © Crown Copyright those inside the space and initiates the emergency procedures in the event of an incident occurring". The attendant should remain by the entrance until all personnel have left the space.

There should be an agreed means of communication between those in the space and the attendant, for example by using visual signals or two-way handheld radios. The reporting interval should be understood by all personnel involved. There should also be a means of communication between the attendant and whoever is on watch on the bridge, in the cargo control room or in the engine room so that immediate assistance can be summoned in an emergency.

Ensure that all tools, equipment and materials are removed from the space upon completion of work

If the attendant is changed, a thorough handover should take place. The new attendant should be provided with all relevant information including the number of people in the space, the method of communication with those inside, the reporting interval and the means of summoning assistance in case a rescue team is required.

Should there be a change in conditions, particularly if the atmosphere in the space deteriorates, a gas monitoring device alarm is heard or the ventilation arrangements fail, the Permit to Work is rendered invalid and everyone must leave the space immediately. Personnel may only re-enter the compartment once the situation has been rectified, the atmosphere has been made safe and a new Permit to Work has been issued.

Upon completion of the work, all personnel should leave the space promptly taking with them all tools, equipment and materials. The attendant should perform a head count thereafter. All accesses to the space should then be closed.

Manhole sealing arrangements should be cleared of debris and new gaskets fitted where possible. The lids should be re-secured and opposite bolts tightened sequentially. In the case of ballast tanks manholes it is recommended that the tanks are tested hydrostatically at the earliest opportunity to ensure that there are no leaks. If an adjacent space contains cargo, such a test may be postponed until it is empty.

Once the space has been closed, any valves that were locked shut should be put back into service. Warning notices and blanks inserted into lines should be removed, and any disconnected sections of pipe should be refitted.

Gas detection equipment should be retested and calibrated in line with manufacturers' instructions before being stowed away ready for the next occasion, and assigned for servicing if required. Similarly, all emergency tank rescue equipment should be returned to its storage location.

Copies of the Permits to Work issued for the enclosed space entry should be filed in accordance with SMS requirements.

Enclosed Space Rescue

It is natural for humans to try and rescue someone believed to be in danger. However many seafarers and stevedores have lost their lives by following their instincts and entering an enclosed space without thinking in order to rescue a collapsed colleague. More than half of all personnel who have died in enclosed spaces were would-be rescuers.

In many instances the rescuer had acted alone after mistakenly thinking that the person lying at the bottom of the compartment had slipped and fallen while using the ladder or tripped and knocked themselves out, not realising that they had collapsed due to the deficient atmosphere inside the space. Although assumptions of this kind may sometimes be correct, chances must never be taken and enclosed space rescue procedures should always be followed regardless of the actual cause of the incident.

Similarly, the attendant stationed outside the enclosed space should never enter the compartment if those inside appear to be getting in to difficulty. Every rescue attempt should be safely managed so that the rescuers do not become additional victims, compounding the size and complexity of the rescue operation.

Rescue equipment should be placed by the entrance to the enclosed space before personnel start work, ready for immediate use. Such equipment may include:

- Oxygen/flammable gas/toxic gas detectors.
- Full rescue harnesses.
- Lifelines of sufficient length.
- Additional communication equipment.
- Self-Contained Breathing Apparatus (SCBA) - ideally positive pressure with spare bottles, or airline breathing apparatus.
- Protective clothing, particularly where contact with hazardous substances is possible.
- Torches, intrinsically safe where necessary.
- Tripod and man-riding winch gear - where available, and if vertical rescue is possible.
- Neil Robertson stretcher or equivalent.
- Resuscitator.
- First aid kit.

Members of the enclosed space rescue team should not be tasked with working inside the compartment and should be available to provide rapid assistance without delay. They should also be properly drilled in enclosed space rescue and be familiar with the use of the SCBA and airline breathing apparatus available on board.

The person in charge of the enclosed space rescue team should direct the rescue efforts from the entrance to the compartment and should not enter the space itself. Sufficient personnel should be available outside the compartment to assist, particularly if casualties in Neil Robertson stretchers need to be lifted out.

Under no circumstances should Emergency Life Support Apparatus (ELSA) be worn by anyone rescuing a casualty from an enclosed space. There have been many deaths and near- fatalities involving personnel who have attempted to rescue a colleague while wearing an ELSA.

During a rescue attempt, personnel wearing SCBA may not be able to enter the compartment easily if the access arrangements are restricted. It may be necessary for the SCBA to be passed through the access separately to the mask wearer inside. Some manufacturers now produce smaller SCBA sets that are designed to be donned rapidly and enable easier access to spaces with limited openings. Entering an enclosed space with a confined entrance should be practiced during rescue drills.

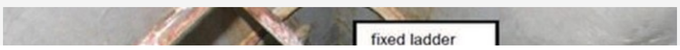
In the event of an enclosed space incident in port or at anchor, additional assistance from the emergency services ashore should be requested at the earliest opportunity.

Enclosed space rescue training is not, at present, a statutory requirement under SOLAS, and very few countries require enclosed space rescue drills to be conducted in order to comply with national or flag state requirements. Consequently Members are encouraged to require their vessels to carry out regular enclosed space entry training during shipboard emergency drills, perhaps once every two months, if they are not doing so already.

Amendments to SOLAS Chapter III to mandate the conduct of periodic enclosed space rescue training are being discussed by the IMO and are expected to come into force in the not too distant future.

Entering an Enclosed Space with an Unsafe Atmosphere

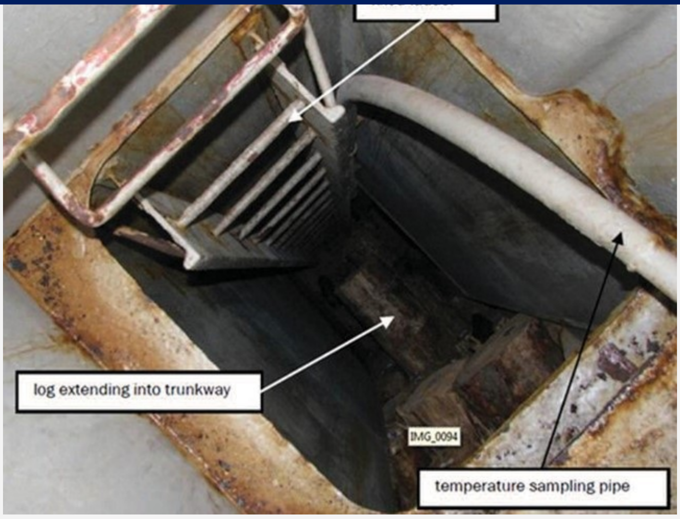
It may sometimes be necessary to enter an enclosed



space where the atmosphere cannot be made safe beforehand, or it is not possible to test the space due to the unavailability of gas detectors.

Entering a space in these conditions should only be undertaken if it involves the safety of life or the safety of the ship, or due to essential operational requirements. If such a situation arises, in addition to the usual enclosed space entry precautions, further safety measures should be taken to reduce the risk of an incident. For example:

- Only the minimum number of persons required to complete the work safely should enter the space.
- As far as possible the space should be ventilated.
- Each person should wear breathing apparatus, ideally positive pressure, of the self-contained or airline type. If the latter, airline systems with two separate air supplies (main and backup bottle) are preferable. Emergency Life Support Apparatus (ELSA) should not be used.
- Personnel entering the space must be thoroughly familiar with the use of the breathing apparatus being worn.
- Airline breathing apparatus should be fed with a continuous supply of air, and hoses should be laid out on deck to stop them becoming crushed or kinked. If necessary, notices should be posted instructing personnel to stand clear of the airlines. If a compressor is being used to supply the air, the duty engineer should be informed to ensure that it is not shut down inadvertently.
- Should breathing difficulties be experienced or if an airline system with two separate supplies is being worn and the primary supply fails, the integrity of the air supply and airline should be checked immediately and the user should leave the space.
- Each person should wear a full body rescue harness and, where practicable, be connected to a lifeline of sufficient length. The attendant situated outside the space should ensure that the lifelines run freely, paying them out and taking up the slack as necessary.
- Everyone entering the compartment should be provided with a personal gas detector for measuring oxygen and, depending on the atmosphere inside the tank, flammable and toxic gas.
- If residues inside the space might pose an absorption hazard to personnel, suitable protective overalls and eye protection should be worn.
- If SCBA is being worn, bottle pressure readings should be taken prior to entry. Air bottle duration, whistle times and a deadline for leaving the compartment calculated in accordance with the bottle pressure readings should also be discussed and agreed.



A Chief Officer collapsed when entering this hold full of logs. A seamen who attempted to rescue him also collapsed. An engineer who tried to rescue both men was lucky to escape with his life after entering the access wearing an ELSA. The Chief Officer and the seaman both lost their lives

Photo: Transport Accident Investigation Commission, New Zealand; Double fatality onboard the TPC Wellington

Never enter an enclosed space alone or attempt to rescue somebody who has collapsed without following the vessel's enclosed space rescue procedures

- A rescue team should stand by outside the space wearing full body rescue harnesses, breathing apparatus and lifelines, ready to enter the space immediately in case of an emergency.

Further Considerations

Suitable notices may be displayed outside all enclosed spaces designating each compartment as one where enclosed space procedures must be followed prior to entry. This may overcome the possibility of personnel regarding an enclosed space fitted with a weathertight door as being safe, as opposed to a compartment where the only means of access is a bolted manhole. Consideration may also be given to locking the doors of spaces where access is not normally required, such as chain lockers and cofferdams.

If the cargo is to be fumigated, all access doors to the cargo holds should be locked and warning notices posted prohibiting entry. These arrangements should remain in place until such time as the spaces have been fully ventilated in keeping with the fumigator's instructions.

In addition to crewmembers, shore contractors should also be required to follow a vessel's Permit to Work procedures where applicable. No distinction should be made in this respect, and shore contractors should be fully briefed and instructed by a responsible officer in accordance with the vessel's Permit to Work procedures before they begin. If concerns arise regarding the capabilities of the shore contractors or if it appears that they are not fulfilling the appropriate Permit to Work conditions, work should be stopped until such time as the responsible officer is satisfied that the shore contractors will work safely in compliance with the vessel's procedures.

If significant work is to be carried out concurrently in multiple enclosed spaces, for example in a shipyard or dry-dock, it may not be possible to implement the vessel's Permit to Work system effectively and cover all work activities. Shipyards and dry-dock facilities will normally have their own procedures covering such situations and often employ their own Safety Officers or chemists to test the atmosphere of enclosed spaces, particularly if they need to comply with local regulatory requirements. However, it may be prudent to check that the procedures are satisfactory before work begins. Similarly, work should be halted if any unsafe practices are observed thereafter.

In all cases it is recommended that nobody enters an enclosed space alone.

Contact us

Members requiring further guidance should contact the Loss Prevention department.

Contact here →

WEST

Example - Enclosed Space Entry - Permit to Work

Vessel Name	**Date**
Space to be entered	
Work description	
Permit Issue Time/Date	
Permit Expiry Time/Date	
Responsible person in overall charge of operation	
Person in charge of the work inside the space	
Persons permitted to enter space	

Item No.	Action	Yes	No
All of the following items are to be checked by the person in charge of the work before entering the space and verified by the responsible person in overall charge of the operation thereafter.			
Prior to entry into the enclosed space			
1.	Has a risk assessment been carried out?		
2.	Have all pumping systems, pipelines and electrical systems been isolated and/or locked with warning signs posted, as applicable?		

3.	Have all open accesses to the space been guarded to prevent inadvertent entry and have suitable warning signs been posted?		
4.	If manhole covers have been removed to aid ventilation, have the open manholes been guarded to prevent injury to personnel?		
5.	Has the space been thoroughly ventilated by fans?		
6.	Have arrangements been made to ventilate the space continuously throughout the period that personnel are inside?		
7.	Have suitable lights been positioned outside the entrance and inside the space?		
8.	Has enclosed space entry rescue equipment been placed by the entrance ready for immediate use?		
9.	Does the enclosed space entry rescue equipment include the following recommended items?		
	Oxygen/flammable gas/toxic gas detectors?		
	Full body rescue harnesses?		
	Lifelines of sufficient length?		
	Self-contained Breathing Apparatus (SCBA), ideally positive pressure with spare bottles, or airline breathing apparatus?		

	PPE including protective clothing and eye protection, particularly if there is a chemical absorption hazard?		
	Torches, intrinsically safe where necessary?		
	Where available and where vertical rescue is possible, a tripod and man-riding winch gear?		
	Neil Robertson stretcher or other suitable rescue stretcher?		

	Resuscitator?		
	First aid kit?		
10.	Has a competent attendant been instructed to remain by the entrance throughout and are they familiar with their duties?		
11.	Have communications between the persons in the space and the attendant at the entrance been agreed and tested, and has a reporting interval been established?		
12.	Have all interested parties (eg Bridge/Cargo Control Room/Engine Control Room) been notified that the work is to take place?		
13.	Have communications between the attendant at the entrance and the Bridge/Cargo Control Room/Engine Control Room (as applicable) been agreed and tested?		
14.	If there is a chemical absorption hazard, are all personnel wearing appropriate PPE including protective clothing and eye protection?		
15.	Are all personnel equipped with a torch (intrinsically safe where necessary)?		
16.	Has the atmosphere in the space been tested? (Nb ventilation is to be stopped at least 10 minutes prior to testing and resumed prior to any person entering the space).		
	Are the readings within acceptable safe limits as follows?		

Gas	Reading	Unit	Requirement
Oxygen		%	Constantly above 20%
Flammable Gas (hydrocarbon)		% LEL	Less than 1% LEL

	Toxic Gas 1 Name:		ppm	According to national or flag requirements		
	Toxic Gas 2 Name:		ppm	According to national or flag requirements		
	Toxic Gas 3 Name:		ppm	According to national or flag requirements		
17.	Are all personnel equipped with devices to check the atmosphere while they are inside the space?					
18.	Are all personnel familiar with the hazards associated with entering an enclosed space and are they willing to proceed with the entry?					
19.	Are all personnel familiar with their tasks within the space, and have they been fully briefed regarding safety and emergencies?					
20.	Have any other permits necessary for the work been issued (eg hot work, working aloft)?					

Item No.	Action	Yes	No
If breathing apparatus is to be used			
21.	Are all personnel familiar with the operation of the breathing apparatus to be used?		
22.	Have the breathing apparatus sets been checked, and have such checks confirmed that they are ready for use?		
23.	Has positive pressure been selected on the breathing apparatus?		
24.	Are all personnel wearing a full rescue harness?		
25.	Are all personnel attached to lifelines, where practicable?		
26.	Have air bottle readings been taken, and are personnel familiar with air bottle duration, whistle times and the deadline for exiting the space?		
27.	Is a fully briefed and equipped rescue team standing-by, ready to enter the space immediately if necessary?		

	Person in charge of work and entering the space	Responsible person in overall charge of the operation
	All necessary protective measures have been taken prior to entry and will continue to be applied until work has finished and the space has been vacated.	
Name		
Signature		
Position		

After work in the space has been completed or on expiry of the permit			
28.	Have all personnel, equipment and materials been accounted for?		
29.	Have all accesses been closed and properly sealed/tightened?		

30.	Have all pumping systems, pipeline and electrical system isolations including warning notices been removed?		
31.	Have all interested parties (eg Bridge/Cargo Control Room/Engine Control Room) been notified that work is complete?		

Time		**Date**
	Person in charge of work and entering the space	**Responsible person in overall charge of the operation**
Name		
Signature		
Position		

The details contained in this Loss Prevention Bulletin are of a general nature only and are intended to supplement but not replace a company's existing enclosed space entry procedures.