



▶ **LOSS PREVENTION**

Enclosed Space Entry



SHIPOWNERS

SECURITY FOR SMALL & SPECIALIST VESSELS



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Chapter 1

Introduction

In 2007 we published a booklet highlighting the correct procedures for Enclosed Space Entry. At the time the Club was experiencing a number of claims where people had sadly lost their lives by not following procedures properly. However, today similar incidents are still taking place. At Shipowners' we want to ensure our Members are protected from any eventuality. With this in mind and the fact that the 'International Maritime Organisation' has recently rolled out a number of initiatives around enclosed space entry, we have revised and updated our Enclosed Space Entry booklet.

In most cases enclosed space incidents on board ships are caused by an insufficient knowledge of, or disregard for taking precautions. Studies have shown that those involved in the majority of these incidents were not suitably trained, experienced in making enclosed space entries or aware of the associated dangers. There have even been instances where suitably trained and experienced personnel have been involved in such incidents, as highlighted in Chapter 6 (Case Studies).

When seeing a colleague collapsed within an enclosed space it is a natural and impulsive reaction to rush in and help. Unfortunately, this is one of the main causes of fatalities. Over 50% of workers who die in confined spaces are attempting to rescue colleagues who have found themselves in difficulty. It is essential to remember that when faced with such a serious dilemma, it is hard to think rationally. This is why it is important to prepare correctly. It cannot be overemphasised how important performing thorough risk assessments, evaluations, training and drills are in preparation for enclosed space entry.

Prevention is better than cure. To reduce the possibility of an incident, notwithstanding the type of vessel or the relevance to the ISM Code, written procedures for entry into enclosed spaces should be established, giving all persons making an enclosed space entry instructions to adhere to. Once these procedures have been implemented, no entries are to be undertaken without compliance.



Figure 1: Warning notice displayed on the entrance to an enclosed space

Chapter 2

▶ Enclosed Spaces and Associated Hazards

Enclosed space, as defined by IMO Resolution A.1050(27), means a space which has any of the following characteristics:

- limited openings for entry and exit;
- inadequate ventilation; and
- is not designed for continuous worker occupancy,

and includes, but is not limited to: cargo spaces, double bottoms, fuel tanks, ballast tanks, cargo pump-rooms, cargo compressor rooms, cofferdams, chain lockers, void spaces, duct keels, inter-barrier spaces, boilers, engine crankcases, engine scavenge air receivers, sewage tanks, and adjacent connected spaces.

With reference to the above, an '*adjacent connected space*' means 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.

To identify enclosed spaces a list should be produced bespoke to each vessel. This should be produced by using risk assessment and continuous review. It should also be noted that while some enclosed spaces may be easy to identify, others may be less obvious, though equally dangerous. To complicate matters, some spaces may be dangerous only temporarily – perhaps due to the type of cargo being carried or work to be undertaken, such as a compartment during spray painting.

On ships where entry into enclosed spaces is uncommon, the dangers may be less apparent and therefore these may need increased vigilance and crew training.

The possible hazards associated with an enclosed space include:

1. Oxygen deficiency

An empty tank or confined space may become deficient in oxygen if kept closed for a long time due to corrosion. Other factors that contribute to oxygen depletion are activities such as welding, gas cutting, painting, the presence of oxygen absorbing chemicals or cargoes, displacement of oxygen by other gases such as hydrogen, inert gases, carbon dioxide or other fire extinguishing media and gases released from volatile cargoes.

2. Oxygen-enriched atmosphere

Since oxygen aids combustion, an oxygen enriched compartment greatly increases the risk of fire, spontaneous combustion and/or explosion. Oxygen is colourless, odourless and has no taste. Hence an oxygen enriched atmosphere cannot be detected by normal human senses. Oxygen also does not give any physiological effects which could alert personnel to the presence of oxygen enrichment. Some of the factors that could lead to oxygen enrichment are leaking or damaged hoses, pipes, valves, excess use of oxygen in welding, flame cutting or similar processes.

3. Toxicity

- A. **Due to liquid bulk** – This includes liquid petroleum and chemicals carried in bulk. Hydrocarbon gases are toxic and may be present in fuel or cargo tanks that have contained petroleum or its products. Similarly the vapours of some chemical cargoes, such as hydrogen sulphide, are highly toxic too. These gases may also be present in the pump rooms, cofferdams, duct keels or other spaces adjacent to cargo tanks if the cargo has leaked. Due to the enormity of the cargoes carried in liquid bulk form and the inherent dangers posed by each, particular care should be taken and cases should be dealt with on an individual basis.
- B. **Due to solid bulk** – A toxic atmosphere may develop in cargo spaces of ships carrying solid bulk cargoes due to the nature of the cargoes. Care should be taken when entering such spaces and suitable references to the shipper's declaration and the International Maritime Solid Bulk Cargoes (IMSBC) Code are to be made.
- C. **Due to dangerous goods in packaged form** – Cargo spaces carrying dangerous goods in packaged form may be subject to a toxic atmosphere due to the nature of the cargo carried. In such a scenario, reference to the relevant sections of the International Maritime Dangerous Goods (IMDG) Code and the Emergency Procedures for Ships Carrying Dangerous Goods (EMS) should be made.
- D. **Others** – Ship board activities such as painting, chemical cleaning and fumigation, may also create a toxic atmosphere.

4. Flammability

Flammable liquids, gases or combustible dusts can create an explosive/flammable atmosphere within an enclosed space. If ignited, these could lead to fire or explosion. Some of the contributing factors to this could be an oxygen enriched space, a space carrying cargoes that emit volatile vapours or introduction of chemicals such as paints in an enclosed space which would effectively complete the fire triangle.

Chapter 3

▶ Enclosed Space Entry Procedures

The Club has published the following guidelines to complement procedures established by our Members for enclosed space entries and to assist Members, who do not have their own procedures, to create their own. All Members, even if entries into enclosed spaces are infrequent on board their vessels, should have a checklist for entering into enclosed spaces forming part of their laid down procedures. These recommendations may not be applicable to all vessels and circumstances but are intended to be used as a general guide to demonstrate good practice from which specific guidelines/procedures can be drawn up.

When drafting and developing enclosed space entry procedures reference should also be made to:

- The United Kingdom's MCA (or home countries equivalent authority) 'Code of Safe Working Practices', Chapter 15 (of the 2015 edition).
- United Kingdom's Merchant Shipping (Entry into Enclosed Spaces) Regulation 1988 (SI. 1988–1638).
- IMO Resolution A.1050(27), Revised Recommendations For Entering Enclosed Spaces Aboard Ships.
- Flag Administration/local regulations as may be applicable.



Figure 2: Entry tag displayed on entrance to enclosed space. This summarises that the space has been passed for entry by a competent/responsible person.

Risk Assessment

In addition to the risk assessment undertaken while compiling a list of enclosed spaces on board a ship (as highlighted in Chapter 2), before any entry into an enclosed space, another risk assessment should be carried out of the space by a competent person¹. Such an assessment should take into account various factors such as last cargo carried, ventilation of the space and should be undertaken with an aim of establishing whether there are any potential hazards in the space. The assessment should be carried out with the assumption that the space to be entered is hazardous until established otherwise.

On smaller vessels such as barges and vessels operating specifically in and around harbours, a competent person and/or the relevant equipments may not be available on board. In such cases, no attempt should be made to enter into enclosed spaces until an appropriate assessment has been carried out and proper procedures established.

Assessment of the space and identification of the hazards should be undertaken even when the entry is being carried out by a third party such as a surveyor. To ensure safe entry the risk assessment should be undertaken by the competent person who should be fully aware of the vessel's characteristics or special circumstances that may effect safe entry.

Procedures for entering into an enclosed space need to be adopted once the risk assessment has been carried out and hazards and their severity have been identified.

Authorisation of entry

It should always be remembered that anyone has the right to refuse to enter any compartment that they question the safety of.

No entry into an enclosed space should be made without being authorised by the Master or the nominated responsible person².

Before entering an enclosed space a '*Permit to Work*' system should be in place.

The Master or the nominated responsible person authorising the entry should be satisfied that all aspects of the '*Permit to Work*' are complied with and that regular checks are in place to continuously monitor the space prior to authorising entry.

¹ Competent person means a person with sufficient theoretical knowledge and practical experience to make an informed assessment of the likelihood of a dangerous atmosphere being present or subsequently arising in the space.

² Responsible person means a person authorised to permit entry into an enclosed space and having sufficient knowledge of the procedures to be established and complied with on board, in order to ensure that the space is safe for entry.

Definition provided by IMO Resolution A.1050(27).

Securing the space

It is imperative to ensure that the entrance to an enclosed space is secured against accidental entry. This is especially important when a door or an access is left open to provide for natural ventilation. An open door or access could be mistaken for an indication that the space is safe to enter and therefore the entrance needs to be suitably cordoned off by use of a mechanical barrier and/or warning signs displayed at the entrance, as well as other prominent locations on the vessel. If possible, an attendant is to be stationed at the entrance.

When preparing a space for entry, it needs to be isolated by means of lock out/tag out procedure to ensure that the space is taken out of service. This can be attained by isolating electrical sources, hydraulic systems, valves, piping systems and placing adequate warning signs at locations where controls of the above mentioned may be present. Reference should be made to vessel systems drawings to ensure that the isolation is absolute.



Figures 3 and 4: Warning signs displayed on a valve and at the control station

Ventilation

Before entering any enclosed space it should be sufficiently ventilated. Ventilation should be carried out by releasing as many openings as possible, preferably with at least one opening at each end of the relevant space.

Ventilation should ideally be carried out for a minimum of 24 hours prior to entry; however this may not always be the case, especially when the entry into an enclosed space is not scheduled. In such cases, efforts must be made to ventilate the space for the maximum period possible to ensure the space is safe for entry. It is important that the ventilation is continuous as a hazardous atmosphere may form again once the air flow is stopped. If the ventilation system fails, all persons in the enclosed space must immediately evacuate the space.

It is preferable to use forced ventilation as opposed to natural ventilation if the vessel is provided with mechanical blowers or fans. Natural ventilation can be assisted by using sails or cowls to direct the air flow into the space. Natural ventilation is most efficient only when at least two accesses are open (preferably at each end) to allow a through draft of air. It is important to note that, whether mechanical or natural ventilation is used, the air intake should be placed in an area that will draw in fresh air only. Any vented gases should be discharged away from the area, so as not to contaminate the vicinity.

Testing the atmosphere

Before entry and at regular intervals thereafter until all work is completed, the atmosphere of the space must be tested using properly calibrated instruments. These should only be used by persons trained specifically in the use of the equipment. Forced ventilation must be stopped during testing (preferably 10 minutes before testing). Where appropriate, the testing of the space should be carried out at as many different levels as is necessary to obtain a representative sample of the atmosphere in the space. In some cases it may be difficult to test the atmosphere throughout the enclosed space without entering the space (e.g. the bottom landing of a stairway). The use of flexible hoses or fixed sampling lines, which reach remote areas within the enclosed space, may allow for safe testing without having to enter the space.

It should be emphasised that the enclosed space may also have pockets where atmosphere may be unsuitable. This can be caused by various factors such as cargo residue or tank structure and therefore, although the atmosphere may have been tested and deemed as being suitable for entry, due caution must be exercised.

It is important to note that the IMO Resolution A.1050(27) – '*Revised Recommendations For Entering Enclosed Spaces Aboard Ships*' states various steady readings for entry purposes,

which if not met, would require additional ventilation and re-testing of the atmosphere after a suitable interval.

It is often assumed that by de-ballasting a tank, a full air change is consequently introduced but this procedure does not guarantee a safe atmosphere and testing is still required. An empty ballast tank could be oxygen deficient due to internal corrosion.

SOLAS regulation (XI-1/7) makes it mandatory, on applicable vessels, to carry an appropriate portable atmosphere testing instrument or instruments. This regulation comes into force in July 2016.

When selecting a portable atmosphere testing instrument for enclosed spaces, reference should be made to MSC.1/Circ. 1477 (*Guidelines to facilitate the selection of portable atmosphere testing instruments for enclosed spaces as required by SOLAS regulation XI-1/7*). The resolution states, amongst other requirements, that the instrument should be capable of measuring and displaying concentrations of:

- Oxygen;
- Flammable gases or vapours (% of Lower Explosive Limit);
- Carbon monoxide; and
- Hydrogen sulphide.



Figure 5: Testing the atmosphere of the enclosed space

Checks prior to entry

In addition to securing and isolating the space, carrying out ventilation and testing the atmosphere, the following are to be determined prior to entering an enclosed space:

1) Is there sufficient rescue and resuscitation equipment available at the enclosed space entrance?

If a person in an enclosed space encounters difficulties and has to be rescued, this has to be carried out as quickly as possible since survival time in such circumstances is very limited.

In particular, on tankers and other vessels carrying flammable products, all equipment should be of an approved type and also be Intrinsically Safe. To speed up a rescue it is imperative that the safety equipment is readily available at the entrance to the space. This should include, but not be limited to:

- SCBA (Self Contained Breathing Apparatus) with a fully charged spare cylinder.
- Lifeline and rescue harness. The lifeline should be of an adequate length and strength and be detachable in case of entanglement.
- Torches.
- Means of hoisting up an incapacitated person, e.g. stretcher (Figure 6).
- Portable atmosphere testing instruments
- Resuscitation equipment (Figure 6).



Figure 6: Emergency equipment placed at the entrance to enclosed space

2) Is there a suitably experienced person in attendance at the entrance?

Both before and during the entry into an enclosed space it is crucial to ensure that an attendant¹ remains at the entrance. In no circumstances should the attendant move from his/her station until all persons have exited the space and the space has been secured against entry.



Figure 7: Attendant at location (regular atmosphere tests are taken to monitor the environment in the enclosed space)

¹ Attendant means a person who is suitably trained within the safety management system, maintains a watch over those entering the enclosed space, maintains communications with those inside the space and initiates the emergency procedures in the event of an incident occurring. Definition provided by IMO Resolution A.1050(27).

3) Have communication arrangements been agreed between the attendant and those entering?

The means of communication between the person(s) entering the tank, the nominated attendant, competent person, responsible person, Master and any relevant persons in the engine room/bridge should be established and tested prior to entry into the tank. A pre-arranged schedule of how often communications need to be made should be agreed between parties to ensure regular communications are maintained.

Communication should be made using the appropriate means, such as physical communication using a pre-arranged number of tugs on a lifeline or audible communication using handheld radios of an approved type (intrinsically safe on tankers). In the event that lifelines are rigged, they 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.

4) Is there safe access and sufficient lighting?

Sufficient and suitable lighting should be rigged as far as possible and where practicable. Whenever possible, natural lighting should be provided in the tank during inspection by opening all tank hatches. If lighting in the space is not adequate it is advised to carry a fully charged, approved torchlight into the space.

5) What personal protective equipment (PPE) is to be used?

The protective equipment required will differ from case to case. This is because it depends on the risk assessment which will be different for each enclosed space entry.

Basic equipment (all to be of approved type) may include:

- Hard hat, with chin strap.
- Gloves.
- Goggles/protective eyewear.
- Ear defenders.
- Intrinsically safe torch.
- Protective footwear.
- Overalls (protective clothing).
- An ELSA (Emergency Life Support Apparatus), EEBD (Emergency Escape Breathing Device) or other emergency escape breathing device - The EEBD and other similar

emergency escape sets such as an ELSA (see Scott Health & Safety Ltd, www.scottsafety.com) should not be considered as a SCBA. They are designed to enable escape from a hazardous environment by providing a limited supply of air delivered via a plastic hood or mask. It should be borne in mind that these devices must not be used as a means to enable the entry into the enclosed space as its intended purpose is to enable the user to exit a space safely, should the atmosphere become oxygen deficient or if hazardous gases are released.

- Personal Gas Monitoring Equipment - This equipment is designed for personal use only; to provide a warning against oxygen deficiency, toxic gases and explosive atmospheres whilst the wearer is in the space. Personal gas monitoring equipment should not be used as a means of determining whether a space is safe to enter.



Figure 8: ELSA sets in use



Figure 9: EEBD positioned in the engine room

If the atmosphere in the enclosed space is classed as unsafe or suspect, following risk assessment, the space should only be entered when no practical alternatives exist. This should only be for further testing, essential operation, safety of life, or safety of the ship. Breathing apparatus should always be worn during such an entry and the number of persons entering the space should be kept to the minimum needed to perform the work.

Breathing equipment may be bulky and limit movement in the space. Before entry is permitted, checks should be made to make sure entry with breathing apparatus is possible and there is no difficulty in moving within the space or in rescuing an incapacitated person from the space.

All crew members should be trained in the use of the breathing apparatus. This can be ensured by performing regular safety drills and including it in the on board training procedures. When the responsible person is allocating personnel for the entry, the proficiency of using breathing apparatus should be taken into account. The competent/responsible person and the person wearing the breathing apparatus should undertake the full pre-donning checks as recommended in the manufacturer's instructions.

It should be borne in mind that when using breathing apparatus in stressful emergency situations the air consumption is greatly increased and thus the duration of the air available is decreased.

6) Is a 'Permit to Work' in place?

A 'Permit to Work' (enclosed space entry permit) should be completed for each and every enclosed space entry as it serves as both a check and a record that all necessary measures have been properly carried out and are in place for the intended entry. A copy of the permit must be placed outside the entry point. The permit should be as relevant and accurate as possible. On expiry of the permit all persons should leave the space and re-entry should not be made until another permit has been issued. The permit should be completed and signed by all appropriate parties concerned.

The points below detail broader items that a 'Permit to Work' should cover. Additional points may be added specific to the space being entered as required:

- Location, type of work, details of participating crew, responsible person, attendant and validity period of the permit (this should never exceed 24 hours).
- Nature and results of the preliminary tests carried out and the measures undertaken to minimise the risks and make the job safe.
- Details of ventilation and confirmation that continuous ventilation would be maintained.
- Results of the testing of the atmosphere.
- Details of the rescue and resuscitation equipment positioned.
- Confirmation that all personnel are wearing correct personal safety equipment of approved types including confirmation of testing of the equipments and that relevant personnel are competent in their use (e.g. breathing apparatus). It should be remembered that when using breathing apparatus in stressful emergency situations the air consumption is greatly increased and thus the duration of the air available is decreased.
- Space and access illuminated as far as possible.
- Suitable communication system set up between all parties involved.

Precautions during entry

1. Ensure the space is suitably illuminated.
2. Always wear the right PPE. At no point in time whilst inside the enclosed space should any of the PPE be removed.
3. Ventilation should continue during the period that the space is occupied and during temporary breaks. The atmosphere should be re-tested before re-entry after a break. In the event of failure of the ventilation system, any persons in the space should leave immediately.
4. The atmosphere should be tested periodically whilst the space is occupied and persons should be instructed to leave the space should there be deterioration in the conditions or if an alarm sounds on the personal gas detector.
5. Communicate regularly as agreed.
6. If a hazard develops or any personnel in the space feels adversely affected, the work in the space should be stopped and a fresh assessment be carried out including issuance of a fresh '*Permit to Work*'.
7. In the event of an emergency, the relevant alarm should be raised. Under no circumstances should the attendant enter the space.

Checks upon completion of job

1. Upon completion of the job, either in entirety or upon expiry of the permit for the day, the responsible person should ensure that all personnel and equipments are out of the space.
2. The access to the space should be secured against entry.
3. The permit should be closed out and signed off.
4. All systems that had been locked/tagged out, blanked off, etc. to be restored, if applicable.

Chapter 4

▶ Drills, Training and Emergency Procedures

SOLAS Regulation III/19 makes it mandatory¹ that crew members with enclosed space entry or rescue responsibilities shall participate in an enclosed space entry and rescue drill to be held on board the ship at least once every two months.

Enclosed space entry and rescue drills should be planned and conducted in a safe manner, taking into account, as appropriate, the guidance provided in the recommendations developed by the Organization as adopted by Resolution A.1050(27).

Each enclosed space entry and rescue drill shall include:

1. checking and use of personal protective equipment required for entry;
2. checking and use of communication equipment and procedures;
3. checking and use of instruments for measuring the atmosphere in enclosed spaces;
4. checking and use of rescue equipment and procedures; and
5. instructions in first aid and resuscitation techniques.

These drills will assist in assessing whether pre-defined contingency plans are suitable and ascertain how effectively they fare with different scenarios. They should be made as realistic as possible by using appropriate spaces where such incidents are likely to occur. It is important to remember that each vessel may have its unique problems or characteristics which may affect the rescue operation and therefore all procedures must be vessel specific. To add to the realism, a dummy of estimated weight and size should be used as a victim. All drills must be recorded appropriately. If a full muster, drill or training session is not held at the scheduled time, an entry shall be made in the log-book stating the circumstances and the extent of the muster, drill or training session held.

Every crew member shall be given instructions on risks associated with enclosed spaces and on board procedures for safe entry into such spaces. Such instructions should assist the crew members in identifying the applicable spaces and their associated problems, including the nature of activities, which may cause an unsafe atmosphere to be present.

¹ For vessels entered with the Club to which SOLAS does not apply, please refer to our bulletin titled "Advice for vessels below 500GT on the benefits of adopting ship-specific procedural systems" at www.shipownersclub.com/advice-for-vessels-below-500gt-on-the-benefits-of-adopting-ship-specific-procedural-systems



Figure 10: Enclosed space drill and training in progress to familiarize crew members with procedures and associated equipment

In the event of an emergency

In the event of an emergency the vessel's crew must follow the emergency procedures detailed on how to respond to the situation. No one should enter any space where the atmosphere is suspect to attempt a rescue without taking suitable precautions for their own safety. Failure to do so will put the would-be rescuer's life at risk along with the casualty's chances of survival. Many fatalities have occurred as a result of individuals attempting a rescue in enclosed spaces without taking adequate precautions.

Under **no** circumstances should the attendant enter the space. Once help has arrived, the situation should be evaluated and the rescue plan put into effect. If the casualty is unconscious it must be assumed that the atmosphere in the space is unsafe and the rescue team must not enter unless wearing adequate safety equipment including a breathing apparatus. The attendant should remain outside the space at all times to ensure the safety of those entering the space to undertake the rescue.

The following illustrates some areas to be covered by the vessel's emergency plans, but it should be noted that this is not exhaustive:

- The composition and duties of the persons acting within the emergency plan including assignment of duties to individual emergency teams.
- Procedures for communication including emergency signals between all parties concerned.
- The availability of the equipment required including the vessel's plans.
- Checklists to ensure that all relevant aspects have been attended to without leaving it to memory.
- The manner in which the vessel liaises with external parties including shore management, shore authorities and the media.

Chapter 5

▶ Safety Management Systems¹

Following a comprehensive risk assessment, it is recommended that the company develop procedures and a safety strategy in order to prevent accidents related to entry into enclosed spaces. Such procedures should be included among the key shipboard operations to ensure the safety of the personnel and the ship.

The procedures developed by the company should, as a minimum, include the following:

1. Plans and procedures for training in the use of atmospheric testing equipment in such spaces.
2. A schedule of regular on board drills for crews.
3. Plans and procedures for training of the competent and responsible persons in enclosed space hazard recognition, evaluation, measurement control and elimination, using standards acceptable to the Administration.
4. Training plans for the crew members, as appropriate, on enclosed space safety, including familiarisation with on board procedures for recognising, evaluating, and controlling hazards associated with entry into enclosed spaces along with procedures to be followed during all stages of entry into an enclosed space.

Internal audits by the company and external audits by the Administration of the ship's safety management system¹ should verify that the established procedures are complied with and are consistent with the safety strategy as stated above.

¹ For vessels entered with the Club to which ISM does not apply, please refer to our bulletin titled "Advice for vessels below 500GT on the benefits of adopting ship-specific procedural systems" at www.shipownersclub.com/advice-for-vessels-below-500gt-on-the-benefits-of-adopting-ship-specific-procedural-systems

Chapter 6: Case Studies

▶ Case Study 1

The following case study has been issued by the MAIB.

A 12,000 gross registered tonnage foreign flagged Ro-Ro cargo vessel, operated by British Officers, was on passage to the UK. The vessel's fuel oil was found to contain water and during the search to find the cause, tanks were opened and inspected. The Chief Engineer carrying out the inspection was found by a watchkeeper with his legs protruding out of a tank manhole. He was removed from the tank and First Aid was carried out immediately, but without success. The pathologist who carried out the post mortem, confirmed the cause of death was due to lack of oxygen and exposure to oil fumes.

Observations

1. No forced ventilation of the tanks was used.
2. No test on the tank atmosphere was made, as the oxygen meter's battery was flat.
3. No other person was in attendance at the tank entrance.
4. Breathing apparatus was not made available.

Comment

1. There have been many similar accidents, one was reported in the MAIB Summary of Investigations 3/93 publication, page 2. For those who have not seen the guidance regarding safe entry into spaces it is contained in the following:
 - The "Code of Safe Working Practices for Merchant Seamen" (2015 Edition), Chapter 15 – Entering Enclosed (Dangerous) Spaces;
2. It is disturbing that officers who should be aware of the requirements for safe entry to spaces do not carry out basic checks and take the necessary precautions.
3. For UK vessels the legislation contained in the Merchant Shipping (Entry into Dangerous Spaces) Regulations 1988 as amended, would apply.

▶ Case Study 2

The following case study has been issued by the MAIB.

A single-hold general cargo vessel of 996 gross registered tonnage was alongside in port and had commenced discharging her cargo of timber. The timber consisted of approximately 3 metre length cut hard wood logs of up to 30cm in diameter with bark attached. The logs were loaded inside the cargo hold up to the level of the hatch coaming and also as deck cargo on top of the closed hatch covers.

Prior to opening the hatch covers, it was normal practice for the crew to sweep up any remaining debris on top of the hatch covers upon completion of the deck cargo discharge. In preparation for this task, the Mate instructed one of his crew to fetch some brooms, which were stored both in the forward storerooms and also at the bottom of the cargo hold aft access trunkway.

A few minutes later, the attention of the Mate was drawn to the crew member, who was now lying at the bottom of the aft access trunkway. While assistance was being summoned, the Mate entered the trunkway and was subsequently found lying on top of the first crew member. Another crew member entered the trunkway but, after experiencing difficulty in breathing, climbed back out. A shore worker then attempted to enter the trunkway but was prevented from doing so by another member of the crew.

After being alerted to the emergency, the Master started the cargo hold fan and then entered the trunkway wearing a self-contained breathing apparatus set. Both men were removed from the trunkway using a block and tackle but subsequent attempts to revive them failed.

Observations

1. The cargo hold and access trunkways had not been ventilated since the logs were loaded approximately 6 days before the accident.
2. Although the vessel carried gas detection equipment, no means were provided for remote detection.
3. Brooms were stored at the bottom of the trunkway for the purpose of sweeping the cargo hold upon completion of discharge
4. In order to confirm the probable condition of the atmosphere inside the trunkway at the time of the accident, atmospheric tests were conducted under similar conditions upon the vessel's next arrival at the port. The test results included a minimum oxygen reading of 1.9% and a maximum carbon dioxide reading of 10.5%.

Comments

1. The two men died when they entered a dangerous enclosed space, which was deficient in oxygen and contained gas products of the timber cargo.
2. The Merchant Shipping (Entry into Dangerous Spaces) Regulations 1988 (as amended) apply to UK vessels and to non-UK vessels when in a UK port. They require that entrances to unattended dangerous spaces should be secured against entry and that procedures for safe entry should be laid down and enforced. A conscientious regard for the training of crew and for the strict enforcement of clearly understood procedures would probably have prevented this accident.
3. Although it is generally known that a depletion of oxygen may occur in cargo spaces filled with certain types of wood cargoes, the danger associated with the carriage of logs requires increased attention.

▶ Case Study 3

The vessel involved in this case was a 97 foot fishing vessel which had left her home waters in Alaska to fish for Albacore Tuna in the South Pacific. The vessel experienced problems with her refrigeration system which culminated in a full catch of approximately 15 tons of tuna being rejected as unfit for human consumption.

The skipper decided to cut his losses and return to Alaska, hoping to sell the catch as bait. It appears however that problems with the refrigeration system worsened and six days into the voyage the refrigeration system was shut down altogether. The three man crew started to dump the fish over the side. Nine tons were disposed of before the smell of decomposing fish became overwhelming. The Captain decided to partially flood the fish hold in the hope that the fish would rapidly break down into a soup which could be pumped overboard.

After leaving the fish to decompose for a few days they commenced pumping the mixture but after a short period the strum box clogged with fish remains. The skipper descended the ladder into the fish hold to try to clear the pump. Within seconds he was overcome by hydrogen sulphide gas given off by the rotting fish. The engineer attempted to rescue him and also succumbed. The one remaining crew member was unable to operate the radio to summon assistance and steamed in the general direction of Honolulu until the boat's generator ran out of fuel and the electrical supplies to the steering gear failed. At that point he abandoned ship and set off the EPIRB. He was rescued by the US Coastguard.



Observations

This unusual incident highlights the dangers of entering enclosed spaces. The atmosphere of any enclosed or confined space which is not continuously and adequately ventilated may be deficient in oxygen or contain flammable/toxic fumes, gases or vapours.

Crews should be made aware of the dangers and instructed not to enter enclosed spaces if there is any reason to suspect that the atmosphere may be hazardous. On no account should rescue attempts be made without wearing breathing apparatus, a rescue harness and lifeline. In this case the crew were aware that the fish were rotting but were ignorant of the effects of the gas being given off. The vessel carried no breathing apparatus, gas testing equipment or oxygen analysing equipment. This accident could have been avoided if the crew had been aware of the risks of enclosed spaces and not attempted to deal with the problem without proper equipment.

Chapter 7

▶ **Appendix**

SECTION 2 – PRE-ENTRY CHECKS
(To be checked by each person entering the space)

	Yes	No
I have received instructions or permission from the master or nominated responsible person to enter the enclosed space	_____	_____
Section 1 of this permit has been satisfactorily completed by the master or nominated responsible person	_____	_____
I have agreed and understand the communication procedures	_____	_____
I have agreed upon a reporting interval of ----- minutes	_____	_____
Emergency and evacuation procedures have been agreed and are understood	_____	_____
I am aware that the space must be vacated immediately in the event of ventilation failure or if atmosphere tests show a change from agreed safe criteria	_____	_____

SECTION 3 – BREATHING APPARATUS AND OTHER EQUIPMENT
(To be checked jointly by the master or nominated responsible person and the person who is to enter the space)

	Yes	No
Those entering the space are familiar with any breathing apparatus to be used	_____	_____
The breathing apparatus has been tested as follows:	_____	_____
Gauge and capacity of air supply	_____	_____
Low pressure audible alarm if fitted	_____	_____
Face mask – under positive pressure and not leaking	_____	_____
This means of communication has been tested and emergency signals agreed	_____	_____
All personnel entering the space have been provided with rescue harnesses, where practicable, lifelines	_____	_____

Signed upon completion of sections 1, 2 and 3 by:

Master or nominated responsible person _____ Date _____ Time _____

Attendant _____ Date _____ Time _____

Person entering the space _____ Date _____ Time _____

SECTION 4 – PERSONNEL ENTRY
(To be completed by the responsible person supervising entry)

Names _____

Time in _____ Time out _____

SECTION 5 – COMPLETION OF JOB
(To be completed by the responsible person supervising entry)

Job completed Date _____ Time _____

Space secured against entry Date _____ Time _____

The officer of the watch has been duly informed Date _____ Time _____

Signed upon completion of sections 4 and 5 by:

Responsible person supervising entry Date _____ Time _____

**THIS PERMIT IS RENDERED INVALID SHOULD VENTILATION OF THE SPACE STOP
OR IF ANY OF THE CONDITIONS NOTED IN THE CHECKLIST CHANGE**

Notes

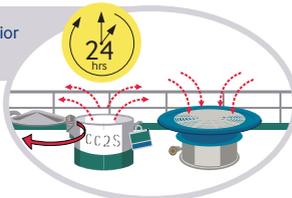
1. The permit should contain a clear indication as to its maximum period of validity.
2. In order to obtain a representative cross-section of the space's atmosphere, samples should be taken from several levels and through as many openings as possible. Ventilation should be stopped for about 10 minutes before the pre-entry atmosphere tests are taken.
3. Tests for specific toxic contaminants, such as benzene or hydrogen sulphide, should be undertaken depending on the nature of the previous contents of the space.

b) Safety Poster for Entry Into Enclosed Space

ENCLOSED SPACE

Think before you enter

Ventilate prior to entry



Check tank atmosphere for oxygen content and toxic gas



Follow and display enclosed space entry checklist



Personal safety equipment



Responsible officer standing by



Rescue equipment ready for immediate use



Chapter 8

▶ Acknowledgements

IACS

IACS “Confined Space Safe Practice” document.

IMO

IMO Resolution A.1050(27), Adopted on 30th November 2011 (Agenda item 9)
– Revised Recommendations for Entering Enclosed Spaces Aboard Ships.

MARINE ACCIDENT INVESTIGATION BRANCH (MAIB)

W www.maib.gov.uk

MCA

Code of Safe Working Practices (2015 edition), chapter 15 –

www.gov.uk/government/uploads/system/uploads/attachment_data/file/477576/Code_of_Safe_Working_Practices_for_Merchant_Seafarers_for_gov_uk.pdf

The Merchant Shipping (Entry into dangerous spaces) regulation 1988 SI 1638

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