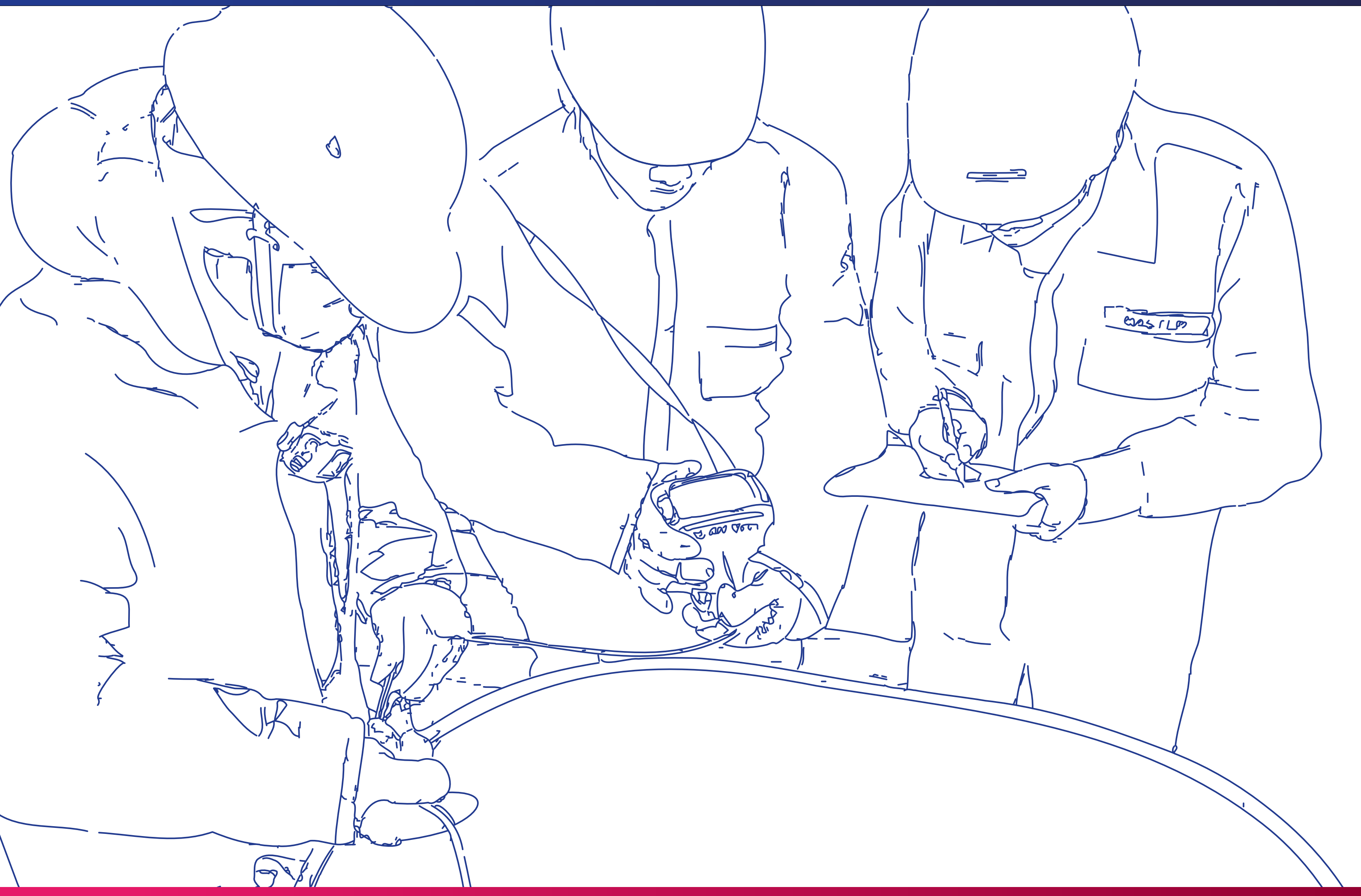
Standard Club

By your side

A Master's Guide to:

Enclosed space entry



About this Guide

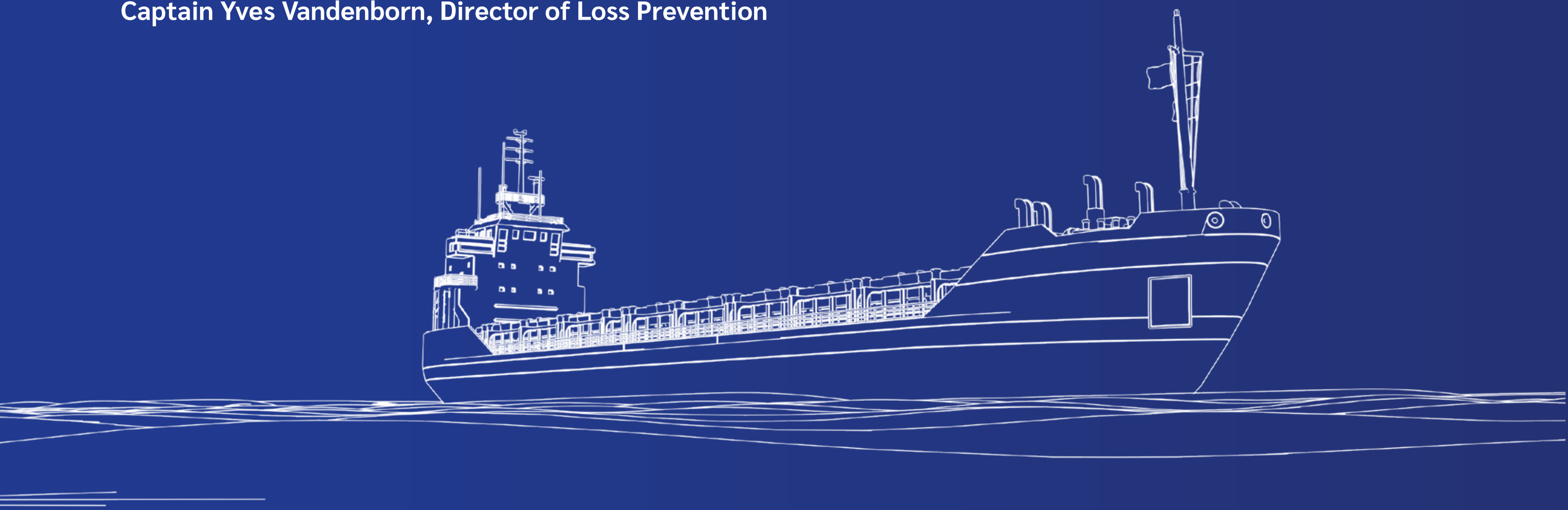
The purpose of this guide is to assist seafarers to enter enclosed spaces safely, in order to prevent enclosed space-related casualties.

Investigations into such incidents show that most are caused by poor training and knowledge of the correct entry procedures, or a disregard for them. It is therefore vital that all seafarers are aware of the danger of enclosed spaces and learn the correct entry procedures, whether or not it is a requirement of their role on board. Seafarers must understand that no enclosed space should be entered without following proper precautions, even in an emergency.

As part of the Loss Prevention department's continuing commitment to safety at sea, a number of 'Master's Guides' have been produced which focus on delivering best practice advice on key areas of vessel operations to avert avoidable claims and prevent accidents, casualties and incidents at sea. These guides were created by harnessing the professional knowledge of those members of the Loss Prevention team who have served at sea. The guide to Enclosed Space Entry is an original Standard Club document, composed of the work of Captain Yves Vandenborn, Director of Loss Prevention and Captain Akshat Arora, Senior Surveyor.

We express particular thanks to Chris Spencer, and the officers and crew of the Miss Benedetta for their assistance in providing technical and visual contributions to all editions of this guide.

Captain Yves Vandenborn, Director of Loss Prevention



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01. Example incidents

Examples of incidents are unfortunately numerous. Incident reports are available from multiple sources, including: The Standard Club's safety bulletins, flag state accident reports, industry safety journals and publications, and company accident and near miss reports. The examples here illustrate the different ways in which a seafarer can put himself and others in danger in an enclosed space.

Poor rescue plan and incorrect use of rescue equipment

Three experienced seamen died inside a chain locker. Two were overcome while tying off an anchor chain to prevent it from rattling in the spurling pipe. The third was a crew member attempting to rescue his two colleagues. Despite entering the chain locker wearing an Emergency Escape Breathing Device (EEBD), he removed its hood after being constrained by the device. All three men died from lack of oxygen inside the chain locker caused by the ongoing corrosion of its steel structure and anchor chain.

Migration of oxygen-deficient air to an adjacent space

Two seamen collapsed in a store room. The chief officer entered the store to try to rescue the men but was forced to leave when he became short of breath and his vision was affected. The two seamen had been asphyxiated. The store was adjacent 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 vent trunking 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 and, as a result, the storeroom's atmosphere was oxygen deficient.

Not recognising the dangers of an enclosed space

An experienced seaman died after he entered an almost empty ballast tank to carry out a quick inspection to confirm the water level. The tank's manhole cover was removed and the seaman was instructed to confirm the amount of water in the tank. It was not intended that the seaman enter the tank, so no entry permit 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 re-entered the tank but collapsed as he tried to recover his colleague. The ship's emergency response team provided air to both seafarers using breathing apparatus and the motorman recovered. The seaman 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.

Inexperience and not following procedures

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

Extreme heat

During a repair period, a shoreside technician fainted and fatally fell off a hold ladder whilst climbing out of a hold in extreme heat. He had worked long hours and was suffering from dehydration.

Carbon monoxide migration

A port state inspector boarded a totally enclosed free-fall lifeboat stowed aft of the accommodation/engine housing. On entry, his personal gas meter alarmed. Investigation confirmed carbon monoxide had collected in the lifeboat. This was caused by the funnel exhaust being blown into the lifeboat due to the prevailing wind conditions during the voyage.

Oxygen-deficient atmosphere even after correct testing

An inspection was being carried out on a container ship's deep ballast tanks, which had been ventilated and tested before entry. However, when inspecting a smaller box-like structure within the tank, which was part of the ship's construction, the inspector's personal gas meter alarmed, showing a lack of oxygen. The poor atmosphere within the space may not have been detected previously due to the construction and layout of the space.

Poor rescue training

Three engineers died in the tunnel space whilst the ship was in port. An engineer and a fitter went to overhaul a storm valve. The line was isolated and the valve slackened off for removal. Poisonous gas was trapped in the pipeline and entered the enclosed tunnel space. Both seamen collapsed. Sometime later another engineer went to look for his two colleagues and also collapsed on entering the space. Later, a search team wearing breathing apparatus found that all three engineers had died from suffocation.

Figure 1: Pre-entry preparation

Fumigation incidents

A general cargo ship was discharging a cargo of grain after a two-week voyage. It became apparent that the fumigant was still active; the fumigant retainers that had been removed from the holds were still smoking. Cargo operations were immediately stopped, all the crew were evacuated, a 50-metre cordon was placed around the ship and nearby houses were evacuated. The crew and stevedores exposed to the phosphine gas were hospitalised for observation. The fumigant retainers were neutralised in water. It took five days before the ship's holds were considered safe.

A general cargo ship was loaded with grains and fumigated at the load port by applying aluminium phosphide pellets. During the short voyage, a crewman was found deceased in his cabin adjacent to the aft bulkhead of the hold. On investigation at the next port, high concentrations of phosphine gas (generated by the fumigation pellets) were found in the seaman's cabin. It is thought that the toxic gas migrated into the cabin, but initially no obvious leakage path was found, even after applying a smoke test. After descaling the area where the cabin and hold joined, some 'pin' holes were found in the steel work. All indications are that the seaman died of phosphine poisoning.

Not recognising the dangers of an enclosed space, poor emergency rescue training and equipment

Three deck crew died in a cargo hold of sawn timber whilst alongside the berth. Two crewmen were engaged in removing tarpaulins from the timber stow whilst the ship was discharging cargo from the hatch cover. They both entered the forward hold, also containing sawn timber, through the hold access hatch. A short while later, the chief officer saw the hatch access cover open and went down the hold. Another crewman saw the chief officer lying at the bottom of the hold and raised the alarm. The remaining crew and two stevedores who attempted to rescue the stricken crewmen also nearly succumbed due to the incorrect use of rescue equipment. The shoreside rescue services took oxygen readings and found that the open access hatch gave a normal atmosphere reading (20.9% oxygen). However, at main deck level within the access hatch, it was 10% oxygen, and between deck level and the bottom of the hold, it was 5% to 6% oxygen.

Natural ventilation insufficient

A multipurpose general cargo ship was discharging a cargo of bulk semi-coke (a product derived from coal). With the knowledge of the ship's staff, three stevedores entered the hold through the enclosed hold ladder access trunking to carry out sweeping operations with a bulldozer — a normal and routine operation. As they entered the hold access trunking, the oxygen-deficient atmosphere overcame the three stevedores. The alarm was raised shortly afterwards by another stevedore and a rescue party entered the hold. The three crewmen were taken out of the hold unconscious and were later certified dead in hospital. It was found that the oxygen content within the hold access trunking was less than 10%, despite the hold being open and naturally ventilated for over 15 hours.

Incomplete atmosphere testing, person not fit for entry

On a chemical tanker, a three-man team of shore workers entered a cargo tank to sweep the residues 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 after falling from the ladder in the tank.

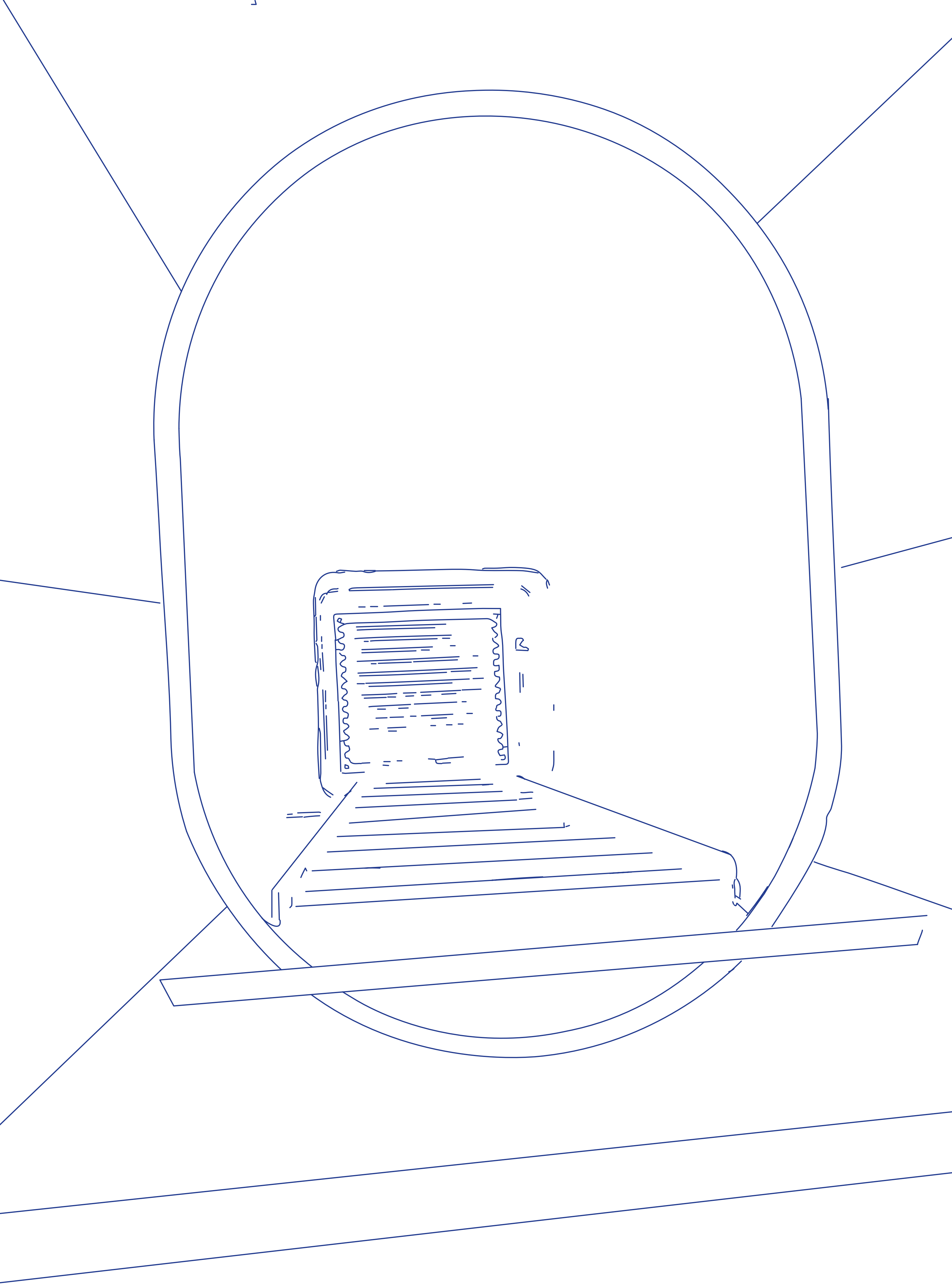
Risk assessments had been carried out by the ship, but no consideration had been given to using a safety harness despite the extreme waxy nature of the cargo. The shore supervisor gave two of the shore workers a short talk on the task, but no safety briefing. The ship's officers gave no safety input.

The atmosphere of the cargo tank was tested for oxygen levels, but the equipment used to test for other gases only reached halfway down the tank. 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, ie they deemed the safety equipment unfit for purpose.

The post-mortem toxicology report identified that the casualty had prescription and illegal drugs in his blood, which would have caused severe impairment. Risk of falling would have been exacerbated by his physical condition.

These cases highlight some common issues that cause incidents, including:

- poor training
- failure to follow proper procedures for enclosed space entry
- failure to recognise the danger of an enclosed space
- tendency to trust physical senses and forego testing or checks
- attempts to save a co-worker leading to short cuts and failure to follow procedures
- failure to manage safely any shore workers on board.



02. What is an enclosed space?

An enclosed space means a space that has any of the following characteristics:

- Limited openings for entry and exit
- Inadequate ventilation
- Not designed for continuous worker occupancy

The atmosphere in any enclosed space may be oxygen deficient or oxygen enriched and/or contain flammable and/or toxic gases or vapours. Such unsafe atmospheres create a risk of death or serious injury. Some enclosed spaces may not be immediately obvious. Examples of enclosed spaces are:

- Cargo spaces (holds, tanks, containers), cargo pump and compressor rooms
- Double-bottom tanks: ballast, fresh water, fuel and lubricating oil tanks, duct keels
- Engine room spaces: boilers, pressure vessels, sewage tanks, crankcases, scavenge air receivers, thruster spaces, generator spaces
- Under-deck spaces: cofferdams, void spaces, inter-barrier spaces, chain lockers
- Deck spaces: paint and chemical lockers, battery lockers, hollow spaces such as masts, gas bottle storage spaces, CO2 rooms
- Spaces affected by fire, chemical spills or gas release

Limited openings for entry and exit

Enclosed spaces are not always easily apparent and some have ordinary openings for entry and exit. Spaces such as paint and chemical lockers, CO2 rooms and battery lockers can be entered through weathertight or shipboard doors. These spaces should still be considered dangerous.

Inadequate ventilation

Air in an enclosed space may not be able to flow freely. The atmosphere outside the enclosed space may be quite different from that within: toxic gases or poorly oxygenated atmosphere can be trapped in pockets within the space, such as within the bottom of a forepeak tank, even if the space has been ventilated and tested.

An enclosed space may initially be considered safe, but if adjacent to an unsafe space, it can soon become unsafe if migration of hazardous vapour occurs. Vapour and liquid migration can occur through cracked welds, damaged steel bulkheads or venting, poorly fitting blanks or valves in pipelines.

Spaces not designed for continuous worker occupancy

Most enclosed spaces are not designed for people to work in on a continuous basis. These can include certain store rooms and cargo spaces, where occasional entry is required for survey, inspection, repair and maintenance.

03. IMO/SOLAS regulations

SOLAS provides the obligations in respect to enclosed space entry:

SOLAS Chapter III Regulation 19. 3.6.2. Emergency training and drills. In force from 1 January 2015. This follows recommendations made in IMO Resolution A.1050(27) *'Revised recommendations for entering enclosed spaces aboard ships'*. These should be fully incorporated into the company Safety Management System. Unfortunately, the IMO Resolution A.1050(27) objectives are solely *'to encourage the adoption of safety procedures aimed at preventing casualties to ships' personnel entering enclosed spaces where there may be an oxygen-deficient, oxygen-enriched, flammable and/or toxic atmosphere'*. This resolution is not sufficiently broad, as there are also other hazards facing those entering an enclosed space. The amendments to SOLAS Chapter III are detailed in IMO Resolution MSC.350(92).

SOLAS Chapter XI 1, Regulation 7. Atmosphere testing instrument for enclosed spaces. In force from 1 July 2016. This follows the recommendations in IMO MSC.1/Circ 1477 *'Guidelines to facilitate the selection of portable atmosphere testing instruments for enclosed spaces'*. IMO encouraged early adoption of atmosphere testing for enclosed spaces through MSC.1/Circ.1485.

The main legislation is the ISM Code, which requires all known risks on board ships to be identified and taken account of. Enclosed spaces are known risks.

The International Safety Management (ISM) Code Part A, Section 7 on 'Shipboard Operations', requires that appropriate Confined Space Entry Procedures are in place and that *'the Company should establish 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 IMO has produced two major recommendations, which are now mandatory for all ships, to counter *'the continued loss of life resulting from personnel entering shipboard spaces in which the atmosphere is oxygen depleted, oxygen enriched, toxic or flammable'*.

Drill regulations

Enclosed space drills have been mandatory since 1 January 2015 (SOLAS Chapter III Regulation 19.3.6).

Crew members with enclosed space entry and rescue responsibilities must participate in corresponding safety drills at least once every two months.

Enclosed space entry and rescue drills must be planned and conducted taking account of the recommendations in IMO Resolution A.1050(27). This resolution lays out guidelines and advice for enclosed space entry.

Drills must include the following:

- Checking and use of personal protective equipment.
- Checking and use of communication equipment and procedures.
- Checking and use of instruments for measuring the atmosphere.
- Checking and use of rescue equipment and procedures.
- Instructions in first aid and resuscitation techniques.

Every crew member should be instructed about the risks associated with entering an enclosed space and the applicable onboard procedures. This instruction should be given at regular intervals as with the requirements for fire-fighting and life-saving drills. Enclosed space entry drills should be recorded in the ship's log book.

IMO Resolution A.1050(27) should be incorporated within the company Safety Management System.

Portable instruments regulations

SOLAS Chapter XI-1, Regulation 7 – which came into force on 1 July 2016 – requires ships to carry an appropriate portable atmosphere testing instrument, or instruments capable of measuring concentrations of oxygen, flammable gases or vapours, hydrogen sulphide and carbon monoxide.

> Note: These requirements are in addition to and separate from the requirement for a person entering an enclosed space to carry a personal gas meter.

IMO MSC. 1/Circ.1477 issued in June 2014 contains the 'Guidelines to facilitate the selection of portable atmosphere testing instruments for enclosed spaces' as required by SOLAS Chapter XI-1, Regulation 7. These guidelines are to be read in conjunction with the SOLAS requirement for enclosed space entry.

The IMO caveat should be noted that *'given a ship's specific characteristics and operations, additional atmospheric hazards in enclosed spaces may be present that may not be detected by the instruments recommended'*. It is the company's/ship's responsibility to assess which additional instruments are required.

Atmosphere testing instruments

These should be capable of measuring and displaying concentrations of:

- oxygen
- flammable gases or vapours (% of Lower Flammability Limit – LFL)
- carbon monoxide
- hydrogen sulphide.

The instrument must:

- be capable of remote sampling
- perform a 'self-test' to check the instrument is fully operational
- show clearly which gas is being measured
- be readable in all lighting conditions
- alarm at an appropriate danger level as determined by the flag state
- operate in all temperatures expected
- be easily carried
- be protected from dust and water ingress
- have a minimum ten-hour battery life
- be intrinsically safe
- have an instruction manual including calibration instructions.

04. Safety Management System (SMS)

The company SMS must provide instructions and procedures to ensure the safe operation of the ship and the protection of the environment. This requires establishing procedures, plans and instructions including checklists as appropriate for key shipboard operations. Entering an enclosed space is a key shipboard operation.

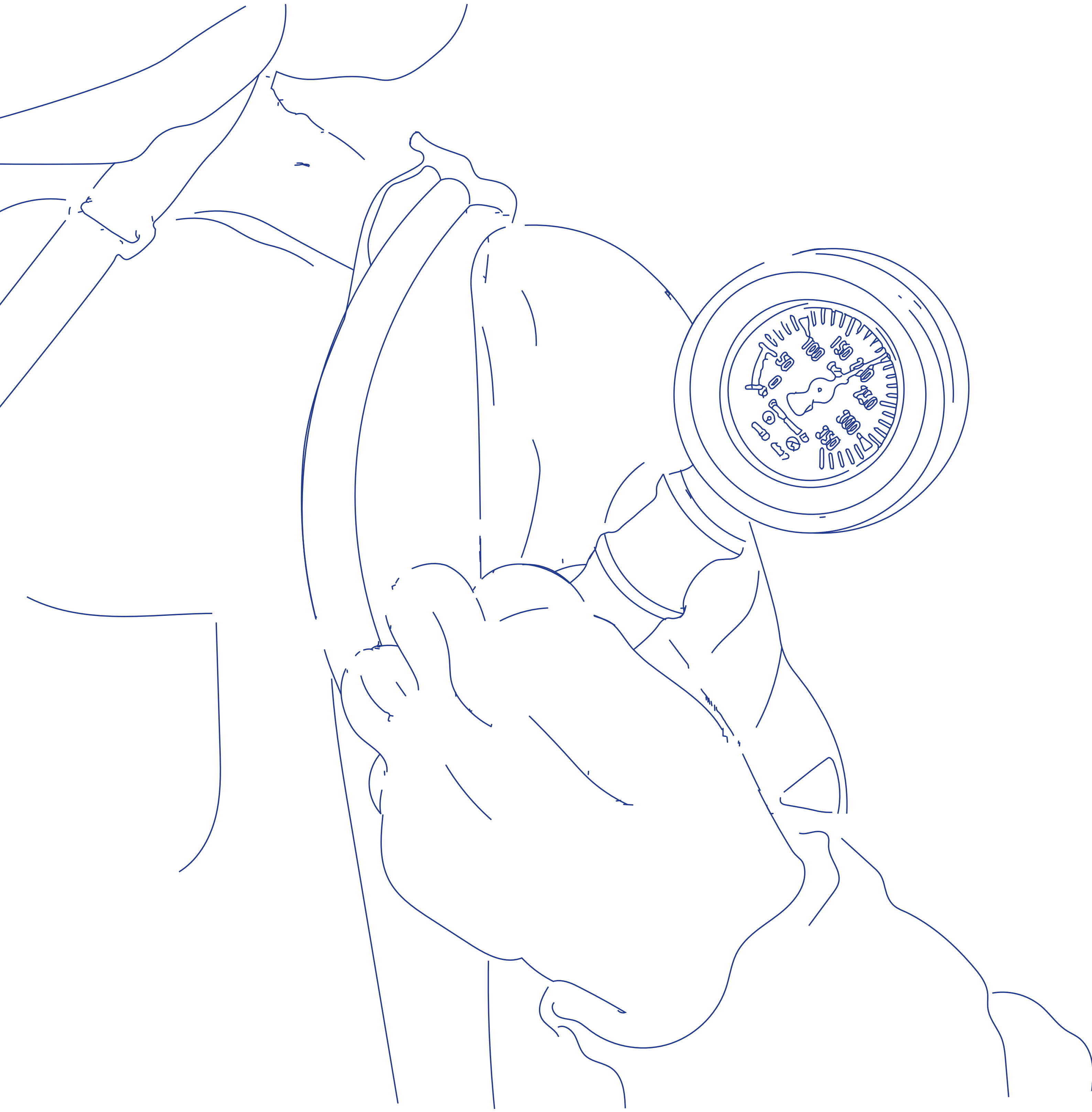
Figure 2: Completing risk assessment

The company should provide:

- procedures for entering enclosed spaces, including instructions, advice and checklists
- instructions for training, including the use of atmospheric testing instruments
- training for competent and responsible persons in the recognition, evaluation, measurement, control and elimination of the hazards within enclosed spaces
- training for crew members in enclosed space safety, including familiarisation with onboard procedures for recognising, evaluating and controlling the hazards of enclosed space entry
- an audit programme verifying that established enclosed space procedures are being followed.

The company Safety Management System should ensure that a risk assessment is conducted ‘to identify all enclosed spaces on board ship’.

This assessment should be periodically revisited to ensure its continued validity.



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05. Enclosed space hazards

There are four main hazards:

1. Hazardous atmosphere
2. Physical or configuration hazard
3. Changing and hazardous conditions
4. Engulfment hazard

1. Hazardous atmosphere

Hazardous atmospheres may include the following:

- Oxygen depleted or oxygen enriched
- Presence of toxic gases, vapours or liquids
- Flammable atmosphere
- Presence of considerable dust
- Temperature extremes
- Absence of proper ventilation

Oxygen depleted or oxygen enriched

Lack of correct level of oxygen is one of the most dangerous factors in enclosed spaces. The acceptable range of oxygen (O_2) within an enclosed space is between 19.5% and 23.5%. Normal air contains 20.9% oxygen. A person can survive for only three minutes without oxygen.

Oxygen enriched

When the oxygen level is above 23.5%, this is considered an oxygen-enriched atmosphere and can cause flammable materials to burn violently when ignited.

Oxygen depleted

There are several reasons why the oxygen level can decrease below the level for which it is safe. All should be considered.

Consumption

Oxygen consumption is caused by:

- fire
- hot work: welding/cutting
- breathing
- chemical reactions (oxidisation of chemicals or metals)
- paint drying
- biological reaction (decomposing organic matter, eg in sewage tanks).

Displacement

Gases produced within the space may displace or lower the oxygen content. This can be caused by:

- use of cleaning agents, adhesives, paint or other chemicals
- carbon monoxide (CO) and other gases emitted from engine exhausts, from using generators for burning/welding, diesel-driven pumps or from faulty exhaust lines passing through the space
- people using oxygen and producing carbon dioxide in poorly ventilated spaces
- bio-decomposition, eg production of hydrogen sulphide and methane in sewage systems
- inert gases entering the space (fire-fighting CO_2/ nitrogen). Inert exhaust gases are also used to reduce the risk of explosion on certain tankers. These spaces should be safely assessed before entry. Inert gas pipelines should always be checked to ensure that they are safely isolated.

The health effects caused by the wrong level of oxygen are listed in the table below.

% Oxygen content	Effect
>23.5	Disorientation, breathing/vision difficulties.
19.5	Absolute minimum O2 level.
15–19	Impaired co-ordination, decreased ability to work effectively.
10–14	Respiration increases, poor judgement, lips become blue.
8–10	Mental failure, fainting, nausea, vomiting, unconsciousness.
6–8	Eight minutes of exposure is fatal, up to four minutes of exposure means recovery is possible.
4–6	Coma within 40 seconds, death within three minutes.

Carbon monoxide (CO) exposure

Carbon monoxide is a colourless, odourless gas which is slightly lighter than air and is known as 'the silent killer'. It is usually formed by the incomplete combustion of carbon products, such as fuel oil producing harmful exhaust gases or self-heating coal cargoes. Even very small quantities of CO are dangerous.

Exposure to a 100ppm carbon monoxide atmosphere for 20 minutes may not affect an average healthy person; however, an exposure for over two hours may produce headaches. An exposure of 400ppm can be life threatening within two to three hours. A 1,000ppm exposure can render a person unconscious within an hour and be life threatening (these are approximations and will vary from person to person and with the prevailing conditions).

Whilst working in an enclosed space, if the O_2 level has dropped to the minimum level of 19.5% because of carbon monoxide (CO) ingress, death can occur within a few minutes, even if the CO level is only 1.4%.

Hydrogen sulphide exposure

Hydrogen sulphide is a colourless gas with a distinctive smell of rotten eggs. It is heavier than air, very poisonous, flammable, corrosive and soluble in water. It is found in naturally occurring hydrocarbon gas, crude petroleum and sewage. Sewage systems and pipelines should be risk assessed if passing through an enclosed space or being worked on:

- Exposure to a 2ppm to 5ppm hydrogen sulphide atmosphere can cause nausea and eyes to tear.
- An exposure of over 20ppm causes headaches, dizziness and poor memory.
- A 100ppm exposure for 15 minutes will cause altered breathing and drowsiness, and following an increase in the severity of symptoms, death will occur within 48 hours.
- A 100ppm to 150ppm exposure will result in paralysis and a 500ppm exposure will cause death in 30 minutes.

Toxic atmospheres

These atmospheres are caused by the presence of toxic or flammable gases or liquids. This may stem from:

- a product stored in an enclosed space, eg leaking gas cylinders, paint or chemicals. Safety data sheets should always be consulted
- toxic gases migrating from adjacent spaces, such as cargo holds through poor venting systems
- work performed in the space producing toxic gases, eg exhaust gases, welding
- toxic gases migrating from poorly maintained or damaged pipelines or valves
- toxic gases or liquids leaking from adjacent cargo spaces or even inter-barrier void spaces. Accumulated residues can build up through undetected cracks in the steel work or welds between the spaces, eg bulk carrier holds, fore and aft hopper voids
- hydrogen gas produced from an electrolytic reaction within lead acid batteries, displacing oxygen and sometimes causing a potentially highly explosive atmosphere.

Flammable atmosphere

Two conditions make an atmosphere flammable: oxygen content and a flammable gas, vapour or dust (in a particular concentration and particle size). If these concentrations of oxygen and flammable gas are sufficient and there is a source of ignition, an explosion can occur.

The lowest concentration or percentage of a flammable vapour in air that makes it capable of igniting in the presence of an ignition source is known as the Lower Flammability Limit (LFL), usually expressed in volume %, at a given temperature and pressure.

Certain governments have prescribed Occupational Exposure Limits (OEL) for various hazardous substances. These are set to help protect the health of workers and will provide guidance for manufacturers in setting the alarm activations.

The table below shows approximate gas alarm concentrations for some common gases (note these may vary depending on manufacturer and national standards).

Gas	Alarm concentration % or parts per million (ppm)
Oxygen	<19.5%
Oxygen	>23%
Methane	5%
Propane	2%
CO (carbon monoxide)	30ppm
CO_2 (carbon dioxide)	5ppm
H_2S (hydrogen sulphide)	10ppm
Cl (chlorine)	0.5ppm
NO_2 (nitrogen dioxide)	3ppm
NH_3 (ammonia)	25ppm

Flammable gas detection instruments are designed to alarm before gases/vapours reach an explosive concentration.

Example sources of ignition:

- Smoking
- Welding or cutting operations
- Electrical lighting
- Non-intrinsically safe and/or poorly maintained electrical equipment, eg sparking electric tools
- Electrostatic

Presence of significant dust

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

Significant dust can occur when cleaning holds after cargoes of grain, coal, cement or breaking up cement boxes. Dust from certain materials such as asbestos have considerable toxic hazards. Asbestos can be found in pipeline jointing.

The use of machinery and powered tools may require special precautions, such as dust extraction vents.

Personnel should let dust settle or ventilate until the dust is gone before entering.

Temperature extremes

Temperature extremes (either hot or cold) may present a hazard to personnel working or entering an enclosed space. This hazard should be considered when entering an enclosed space and the risks must be assessed. Temperature extremes can reduce a person's situational awareness.

Heat

A person's core body temperature is 37°C. A person working in a very hot environment loses body water and salt through sweat. Heat stroke is caused by high temperatures and not drinking sufficient water. High temperatures will cause an increase in sweating, which leads to dehydration, which in turn leads to reduced sweating, allowing the core body temperature to rise. Water and salt intake should replace that lost through sweat to avoid dehydration.

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 site and personnel should be encouraged to drink water every 15 to 20 minutes. Alcoholic drinks should never be consumed, as alcohol dehydrates the body.

Heat stroke symptoms are hot, dry skin, increased heartbeat, decreased blood pressure, headache, lethargy, confusion and eventually unconsciousness. Working in an enclosed space in extreme heat can dangerously affect personnel when working aloft, climbing ladders or working on floors with openings that have no safety rails. Working within an enclosed space in extreme heat should be carefully monitored and working times should be restricted.

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 loss of co-ordination. Sufferers may experience pain in their extremities (for example hands, feet and ears) and severe shivering. Safety measures include correct warm work clothing, frequent breaks taken in warm areas and consuming hot drinks. Working within an enclosed space in extreme cold, especially if also in wet conditions, should be carefully monitored and working time appropriately restricted.

2. Physical or configuration hazard

The physical configuration of the enclosed space can present hazards which are determined by the structure of the space, the apparatus and the equipment connected to it. This will include the pipelines and ventilation trunking running into and through the space, lack of lighting, location of ladders, absence of railings and the presence of openings in floors. Many of these present trip and fall hazards. Strengthening frame work and box structures within the space may create areas where air exchange does not occur effectively when ventilated or sitting water has not been completely pumped out.

Personnel should understand the layout of the enclosed space before entering. A risk assessment should include the physical configuration of the space and reference to the ship's plans before entering.

Figure 3: Tagging out procedure

3. Changing and hazardous conditions

Changing conditions within an enclosed space such as water ingress, oxygen-depleting work (burning, welding), ventilation failure and vapours from paint or cleaning materials must be monitored.

Sometimes working within an enclosed space can coincide with other activities being carried out elsewhere on board. Potentially hazardous changes to conditions within the enclosed space caused by external factors are also crucial but less easily managed. These may be caused by the inadvertent actions of other ship or shore staff, work in adjacent or connected spaces, cargo work, pumping ballast or fuel transfer and hot work, as well as communications of work being carried out in the enclosed space, for example, when there are shift or watch changes.

These risks can be mitigated by thorough and constant communication with all parties and departments, for example, safety meetings, pre work and tool box talks, tags for equipment, safety signage and permits to work.

4. Engulfment hazard

Engulfment can occur when a person entering an enclosed space 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 crumble 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, ballast or sea water) being inadvertently pumped or gravitated into the space or tank whilst people are inside. Risk assessments should include good communication with other departments and the use of safety/lock-out tags to ensure pumps and valves are not operated. There is a real risk of drowning within a tank from the accidental operation of a valve or pump system.

06. Risk assessment

The company Safety Management System should ensure that a risk assessment is conducted 'to identify all enclosed spaces on board ship'. This assessment should be periodically revisited to ensure its continued validity.

IMO Resolution A.1050(27) recommends that a competent person should always make an initial assessment of any potential hazards in the space being entered. These hazards should include those highlighted above.

The procedures to be followed for testing the atmosphere will depend upon whether the preliminary assessment shows that:

1. There is minimal risk to the health and life of personnel entering the space.
2. There is no immediate risk to health or life but a risk could arise during the work in the space.
3. A risk to health and life is identified.

If the preliminary assessment indicates minimal risk to life or health or a potential that risk may arise during the work being carried out, then the following precautions for entry into an enclosed space should be followed.

If the assessment is that there is a risk to health or life, then additional precautions are necessary and these are outlined later in this document on page 23.

The company should provide clear guidelines and training on how risk assessments are conducted. It is not within the scope of this document to provide such guidance.

Figure 4: Tool box talk

07. Entry procedures

Everyone has the right to refuse to enter a space they consider unsafe. No one should enter an enclosed space if there is any doubt that the correct entry procedures have been followed, even in an emergency.

No one should be allowed to enter an enclosed space if they are not physically fit or are suffering from an ailment or other issue that impairs their physical or mental ability.

Authorisation for entry

No person should enter an enclosed space without the express authorisation of the master or a nominated responsible person.

Entry into an enclosed space must be a planned process requiring proper precautions. An entry permit/ permit to work system or a similar alternative must be used. All crew should be aware of this system.

The person responsible for carrying out the work should not issue the permit but should countersign the entry permit. When the work is completed, the responsible person should cancel the permit.

An example of an 'Enclosed Space Entry Permit' is attached as an appendix to IMO Resolution A.1050(27) and a copy is at the end of this document. It is only an example and companies should amend the entry permit to be applicable for each ship and their risk assessments.

General precautions

All enclosed space access doors, hatches or manholes should be secured against inadvertent entry. It is recommended that all enclosed spaces are highlighted as being hazardous and requiring an entry permit before entering. This can be done using signs and warning notices.

An enclosed space that has its access door/hatch opened to allow for ventilation should be protected to prevent access, using barriers, warning signs or personnel stationed at the entrance.

Figure 5: Maintaining a proper cordon

The master or the responsible person should determine that it is safe to enter an enclosed space by ensuring the following:

- Potential hazards have been identified, isolated and made safe.
- The space has been properly ventilated to remove toxic or flammable gases.
- The atmosphere has been tested with properly calibrated and appropriate instruments to assess that the atmosphere within the space is safe.
- The space is secured for entry and proper illumination is available.
- A suitable communication system is available for all parties.
- A person is stationed at the entrance to the space.
- Rescue and resuscitation equipment is available at the entrance to the space.
- Personnel are properly clothed and equipped, including an appropriate personal atmosphere meter if entering the space.
- A permit has been issued to authorise entry.

Only trained personnel should be engaged in the duties associated with enclosed space entry. Ships' crews with first aid and rescue duties should be drilled in enclosed space emergencies. As a minimum, training should include:

- hazards likely to be faced during an enclosed space entry
- recognition of the signs of adverse health effects caused by exposure to the potential hazards
- knowledge of personal protective equipment required for entry – all equipment must be in a good working condition and checked before entry.

Ventilation

Before any enclosed space is entered, it should be properly ventilated by opening as many access points as possible. Ventilation should be continuous, effective and commensurate with the size, configuration and location of the space.

Natural ventilation may be acceptable in some circumstances, eg where a small space opens up directly to fresh air. However, most enclosed spaces will require mechanical ventilation. Some spaces will be fitted with fixed ventilation systems, such as holds and pump houses. Alternatively, a large-diameter ventilation hose in good condition can be attached to a fan and lowered into the enclosed space. The air intake of the hose should be placed in an area that will draw in fresh air only.

Ventilation should be stopped for the period when atmosphere testing is carried out and should be resumed after testing for the full duration of the entry. Due to the configuration of the space, some areas of the enclosed space may still have an unsafe atmosphere, so personnel should always enter with a personal oxygen/gas meter as applicable.

No space should be entered until it has been properly ventilated and atmosphere tested.

Testing the atmosphere

The atmosphere testing equipment must:

- have manufacturer's operating instructions available
- be kept in a known, safe location, in good order and properly calibrated
- be serviced in accordance with manufacturer's recommendations
- have calibration and service records maintained
- have the suitable capability to measure levels of oxygen, flammable vapours, carbon monoxide, hydrogen sulphide and toxic gases appropriate for the ship's trade.

Personal gas meters are not appropriate for carrying out the atmosphere testing.

Testing of the atmosphere should be carried out with calibrated equipment by persons trained in the use of the equipment. Manufacturer's instructions should always be followed. The space should be tested before any person enters it and at regular intervals until the work is completed. Ideally, the atmosphere of the space should be tested at different levels to obtain a representative sample of the atmosphere. Depending on the configuration of the space, this may be impossible without entering it at some level. The use of flexible hoses or fixed sampling lines may assist in reaching remote areas within the enclosed space. Due consideration should be given to the duration of the sampling to ensure the full length of the sampling line has been flushed with the atmosphere gases of the space to be measured.

For entry purposes, steady readings of all the following should be obtained:

- 21% oxygen by volume by oxygen content meter.
- Not more than 1% of Lower Flammable Limit (LFL) on a combustible gas indicator if there is potential for flammable gases or vapours.
- Not more than 50% of the Occupational Exposure Limit (OEL) of any toxic gases or vapours.

If these conditions cannot be met, additional ventilation should be applied to the space and retesting should be conducted after a suitable interval. Gas testing should only be carried out with ventilation to the enclosed space stopped.

The preliminary risk assessment should consider the possibility of toxic gases and if it is determined that there is potential for the presence of toxic gases and vapours, testing should be carried out using appropriate fixed or portable gas or vapour detection equipment. The readings obtained by this equipment should be below the Occupational Exposure Limits (OEL) for the toxic gases or vapours given in accepted national or international standards.

The configuration of the internal structure of the space, cargo and cargo residues and tank coatings may allow oxygen-deficient areas to exist, so due consideration must be given to testing in these areas.

The testing for flammability or oxygen content does not measure for toxicity, or vice versa.

Precautions during entry

The atmosphere should be tested frequently whilst the space is occupied and persons should be instructed to leave the space should there be deterioration in the conditions.

Persons entering enclosed spaces should be provided with calibrated and tested multi-gas detectors that monitor the levels of oxygen, carbon monoxide and other gases as appropriate.

Ventilation should continue during the period that the space is occupied and during temporary breaks. Before re-entry after a break, the atmosphere should be retested. In the event of failure of the ventilation system, personnel in the space should leave immediately.

Managing change during entry

Care should be taken to monitor and respond to changing conditions during the work. Changing conditions include an increase in ambient temperature, the use of oxygen-fuel torches, mobile plant work activities in the enclosed or adjacent space that could produce vapours, work breaks, changes in ventilation, or if the ship is ballasted or trimmed during the work.

In the event of an emergency, under no circumstances should the attending crew enter the space before help has arrived and the situation has been evaluated to ensure the safety of those entering the space. Only properly trained and equipped personnel should perform rescue operations in enclosed spaces.

Responsibilities

Personal responsibility

Every person has a responsibility to know the correct procedures for entering an enclosed space. A person entering an enclosed space is responsible for:

- not entering alone
- only entering if fit and well
- obtaining a valid enclosed space entry permit before entering
- ensuring that the space has been adequately ventilated, isolated, emptied or otherwise made safe for entry
- immediately exiting a space when advised to do so
- being familiar with the work in hand and following the safety rules/procedures that apply
- using the appropriate PPE.

Responsible person's responsibility

A responsible person is a person authorised to permit entry into an enclosed space and having the appropriate knowledge of the procedures complied with on board to ensure that the space is safe for entry. The responsible person completing the enclosed space entry permit should have visited the entry point and be satisfied that the hazards have been identified and the necessary safety precautions taken, particularly ventilation and atmosphere testing. It is this person's responsibility to:

- ensure good communication exists between all parties
- ensure a risk assessment and enclosed space entry permit have been properly completed
- oversee atmosphere testing and determine whether entry conditions are acceptable
- ensure that all personnel are aware of the hazards associated with the space
- authorise and oversee entry operations and ensure that all hazards are securely isolated
- support the attendant's authority in controlling access to an enclosed space
- ensure that rescue personnel and equipment are available before entry
- verify that all personnel have exited safely before closing the space
- verify that the entry permit is closed out after the operation ceases.

Attendant's responsibility

The attendant should not leave their post for any reason while personnel are in the space, unless relieved by another qualified attendant. Their duties are to:

- raise the alarm and summon assistance in an emergency or as needed
- maintain communication with those who have entered the space, the responsible person and the bridge and engine room as directed
- monitor and assist those who have entered the space to ensure their safety
- monitor conditions in the space as directed
- control access to the enclosed space and prevent unauthorised access
- 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 in the space of any changes to conditions.

08. Additional precautions where the atmosphere is known or suspected to be unsafe

All enclosed spaces that have not been tested should be considered unsafe. If the atmosphere in an enclosed space is suspected or known to be unsafe, the space should only be entered when no practical alternative exists.

Entry should only be made for further testing, essential operation, safety of life or safety of ship. The number of persons entering the space should be the minimum compatible with the work to be performed. Suitable breathing apparatus (eg of the air-line or self-contained type) should always be worn and only personnel trained in its use should be allowed to enter the space. Additional risk assessments may be required. In an emergency, an attempt to rescue a collapsed person within an enclosed space should only be made as part of a rescue team and using a self-contained breathing apparatus.

Persons entering enclosed spaces should be provided with calibrated and tested multi-gas detectors that monitor the levels of oxygen, carbon monoxide and other gases as appropriate for the ship and expected hazards.

Rescue harnesses should be worn and, unless impractical, lifelines should be used.

Appropriate protective clothing should be worn, particularly where there is any risk of toxic substances or chemicals meeting the skin or eyes. Additional emergency rescue provisions should be considered.

Figure 6: Pre-entry checks

Note: Air-purifying respirators (or gas masks) should not be used as they do not provide a supply of clean air from a source independent of the atmosphere within the space. These should never be used as a substitute for a breathing apparatus.

09. Hazards relating to ship types and cargo

Every company Safety Management System must address the risks that arise on its ship type and trade. A significant percentage of enclosed space incidents are related to cargo hazards and these are noted only in general terms in this guide.

Dangerous goods in packaged form

The atmosphere of any space containing dangerous goods may put at risk the health or life of any person entering it. Dangers may include flammable, toxic or corrosive gases or vapours that displace oxygen, as well as residues on packages and spilled material.

Figure 7: Properly equipped entry team

Hold spaces are in themselves dangerous and the same hazards may be present in spaces adjacent to the cargo spaces. Even if there is no evidence or suspicion that a leakage of a dangerous substance has occurred, enclosed space precautions should be followed when entering a cargo space. Dangerous goods may still be present due, for example, to undeclared or misdeclared dangerous cargo.

Personnel required to deal with spillages or to remove defective or damaged packages should be appropriately trained and wear suitable breathing apparatus and appropriate protective clothing.

Liquid bulk

The tanker industry has produced extensive advice, in the form of specialist international safety guides, to operators and crews of ships engaged in the bulk carriage of oil, chemicals and liquefied gases. The information in these on enclosed space entry supplements the general recommendations in this guide and should be used as the basis for preparing entry plans.

Solid bulk

On ships carrying solid bulk cargoes, dangerous atmospheres may develop in cargo spaces and adjacent spaces. The dangers may include flammability, toxicity, oxygen depletion or self-heating, as identified in the shipper's declaration. For additional information, reference should be made to the International Maritime Solid Bulk Cargoes (IMSBC) Code.

Some solid bulk cargoes are susceptible to oxidation, which may result in oxygen depletion, emission of toxic gases or fumes and self-heating. Some cargoes (e.g. ferrosilicon, silicomanganese, etc.) are not liable to oxidize but may emit toxic fumes, like phosphine, arsine and/or silane, particularly when wet. For quantitative measurements, suitable detectors for each gas or combination of gases shall be on board while such cargoes are carried.

Use of nitrogen as an inert gas

Nitrogen is a colourless and odourless gas that, when used as an inert gas, causes oxygen deficiency in enclosed spaces, at exhaust openings on deck during purging of tanks and void spaces, and in cargo holds. One deep breath of 100% nitrogen gas is fatal.

Oxygen-depleting cargoes and materials

Some cargoes cause oxygen depletion due to the inherent form of the cargo, for example, self-heating, oxidation of metals and ores, or decomposition of vegetable oils, fish oils, animal fats, grain and other organic materials or their residues. The materials listed below are known to cause oxygen depletion; however, the list is not exhaustive. Oxygen depletion may be caused by materials of vegetable or animal origin, by flammable or spontaneously combustible materials, or by materials with a high metal content, including, but not limited to:

- grain, grain products and residues from grain processing (such as bran, crushed grain, crushed malt or meal), hops, malt husks and spent malt
- oil seeds as well as products and residues from oil seeds (such as seed expellers, seed cake, oil cake and meal)
- copra
- wood in such forms as packaged timber, round wood, logs, pulp wood, prop woods, woodchips, wood shavings, wood pellets and sawdust
- jute, hemp, flax, sisal, kapok, cotton and other vegetable fibres (such as esparto grass/Spanish grass, hay, straw), empty bags, cotton waste, animal fibres, animal and vegetable fabric, wool waste and rags
- fish, fishmeal and fish scrap
- guano
- sulphidic ores and ore concentrates
- charcoal, coal, lignite and coal products
- direct reduced iron (DRI)
- dry ice
- metal wastes and chips, iron swarf, steel and other turnings, borings, drillings, shavings, filings and cuttings
- scrap metal.

Fumigation

SOLAS VI/4 on the use of pesticides in ships, state that appropriate precautions shall be taken in the use of pesticides in ships, in particular for the purposes of fumigation. IMDG and IMSBC codes provide similar recommendations to ensure safe and effective fumigation. Further guidance related to the fumigation of cargo are laid down in the following IMO circulars:

- Revised Recommendations on the safe use of pesticides in ships (MSC.1/Circ.1358)
- Recommendations on the safe use of pesticides in ships applicable to the fumigation of cargo holds (MSC.1/Circ.1264, as amended by MSC.1/Circ.1396)
- Revised Recommendations on the safe use of pesticides in ships applicable to the fumigation of cargo transport units (MSC.1/Circ.1361)

When a ship is fumigated, extremely hazardous chemicals are used in the process. These are not only toxic but some are flammable in certain conditions. The decomposition of the fumigants will vary due to several factors, including the temperature and moisture conditions, and voyage length. Therefore, residual fumigants may still be present.

The multi-gas detector usually provided on the ship measures concentration of oxygen, carbon monoxide, hydrogen sulphide and LFL (%). This equipment is generally not capable of detecting and measuring phosphine gas concentrations. As such, the ship has to be provided with suitable phosphine gas detection tubes.

Company Safety Management Systems should include information on the dangers of fumigation and refer to the IMO recommendations. Spaces adjacent to fumigated spaces should be treated as if fumigated.

Spaces that have been fumigated should be properly ventilated and a gas-free certificate should be issued. This will only be issued when tests show that all residual fumigants have been dispersed from the cargo space and the adjacent spaces.

10. Managing shoreside personnel

Shoreside workers are susceptible to the dangers presented by entry into an enclosed space on board a ship. It should be assumed that these workers are ignorant of the shipboard enclosed space procedures and may require some shipboard familiarisation. Any hazardous action seen being carried out by a shore worker should be stopped immediately.

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

Figure 8: Checking personnel off as they enter

11. Training, drills and rescue

Safety culture

Company and onboard safety culture is paramount to ensure crew remain safe. A safety culture can be promoted through:

- proper and meaningful ship safety familiarisation for new crew members
- tool box talks
- adherence to procedures such as entry and work permits
- supplying safety barriers such as signs indicating dangers
- use and supply of correct personal protective equipment (PPE)
- safety meetings
- engagement of all crew in safety issues and hazard reporting
- promoting safety through bulletins, safety notices and using training materials such as videos.

As part of the initial ship familiarisation, new-joining crew members, regardless of their experience, should be advised of the:

- enclosed space entry procedure
- dangers that an enclosed space can present
- precautions necessary to enter an enclosed space.

Training

Appropriate personnel should be trained in the use of all the equipment used for enclosed space entry, including the use, maintenance/servicing and calibration of atmosphere testing equipment and rescue equipment. This can be included in the enclosed space drills.

Those personnel using the atmosphere testing equipment must be:

- trained and able to use it correctly
- able to calibrate the equipment
- knowledgeable in the equipment's limitations
- knowledgeable of the applicable acceptable gas/vapour levels being tested.

Drills

Enclosed space drills have been mandatory since 1 January 2015.

Drills need to be realistic, focused, varied, interesting, challenging; and they need to test skills, knowledge and responses, while giving a scope to improve and develop. It is useful to have a human-sized training dummy available so that crew can practice moving a casualty through an enclosed space, while wearing breathing apparatus. Assessments of how the drill has been performed will enhance the reaction time in an emergency. Drills should include:

- realistic scenarios using a prearranged emergency plan
- training of crew and emergency teams to include the correct entry procedures to be followed, use of PPE, operation and understanding of all the gear, including breathing apparatus, and communication equipment for enclosed spaces

Additional training should cover the issues raised in this guide, including:

- what to do if a colleague is seen to collapse in an enclosed space
- the responsibilities of those entering an enclosed space
- the process of risk assessments
- the use of entry and work permits
- the use and procedures for atmosphere testing
- the hazards of enclosed spaces
- the circumstances and activities leading to dangerous atmospheres
- the management of shoreside contractors.

Properly conducted drills and training are imperative to impart knowledge to seafarers.

Rescue

If a rescue alarm is raised, no one should enter the enclosed space to attempt a rescue without taking the proper precautions. Many fatalities have occurred when well-intentioned crew have attempted a rescue without following the correct procedures.

12. Appropriate equipment

The appropriate safety and rescue equipment for entering an enclosed space may vary depending upon the space, ship type and work involved.

As a minimum, it will usually include:

- SCBA (self-contained breathing apparatus) with a spare cylinder
- life line and rescue harnesses
- lighting, including torches
- stretcher
- means of raising stretcher, ie tripod type arrangement
- communication equipment
- appropriate atmosphere testing equipment and personal gas meters.

An EEBD (emergency escape breathing device) should never be used in lieu of a SCBA set. They can only be used as an escape device.

Appropriate personal protection equipment (PPE), including a personal gas meter, should be worn by all personnel entering the enclosed space.

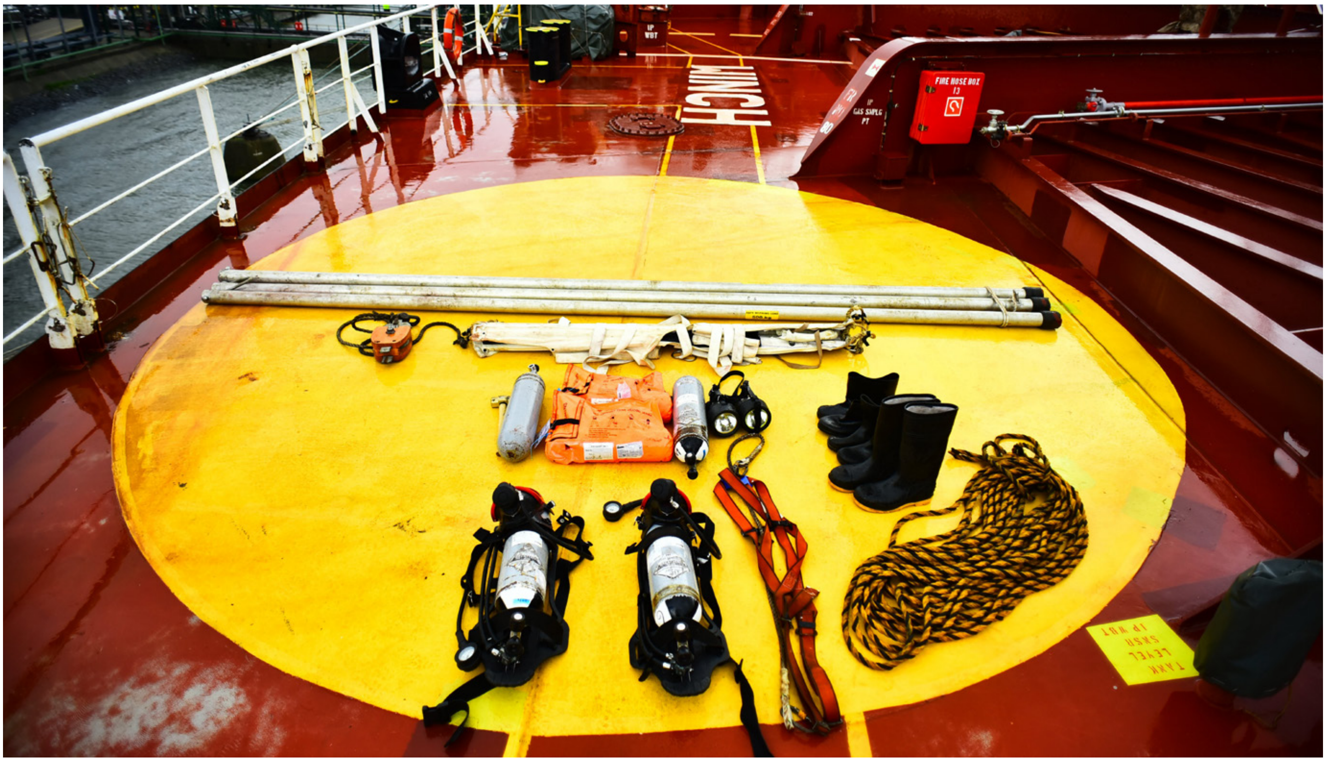
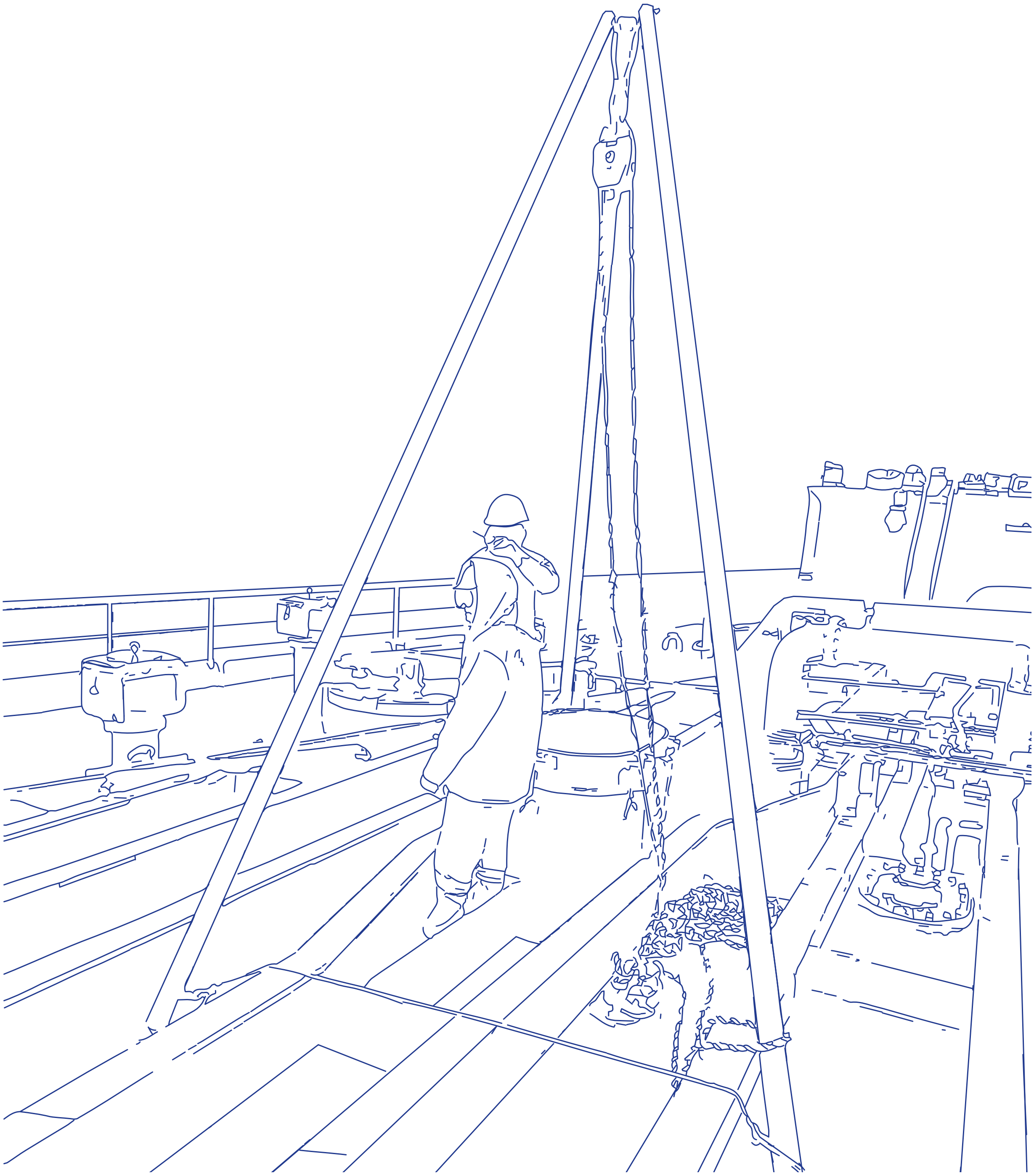


Figure 9: Safety and rescue equipment for entering an enclosed space

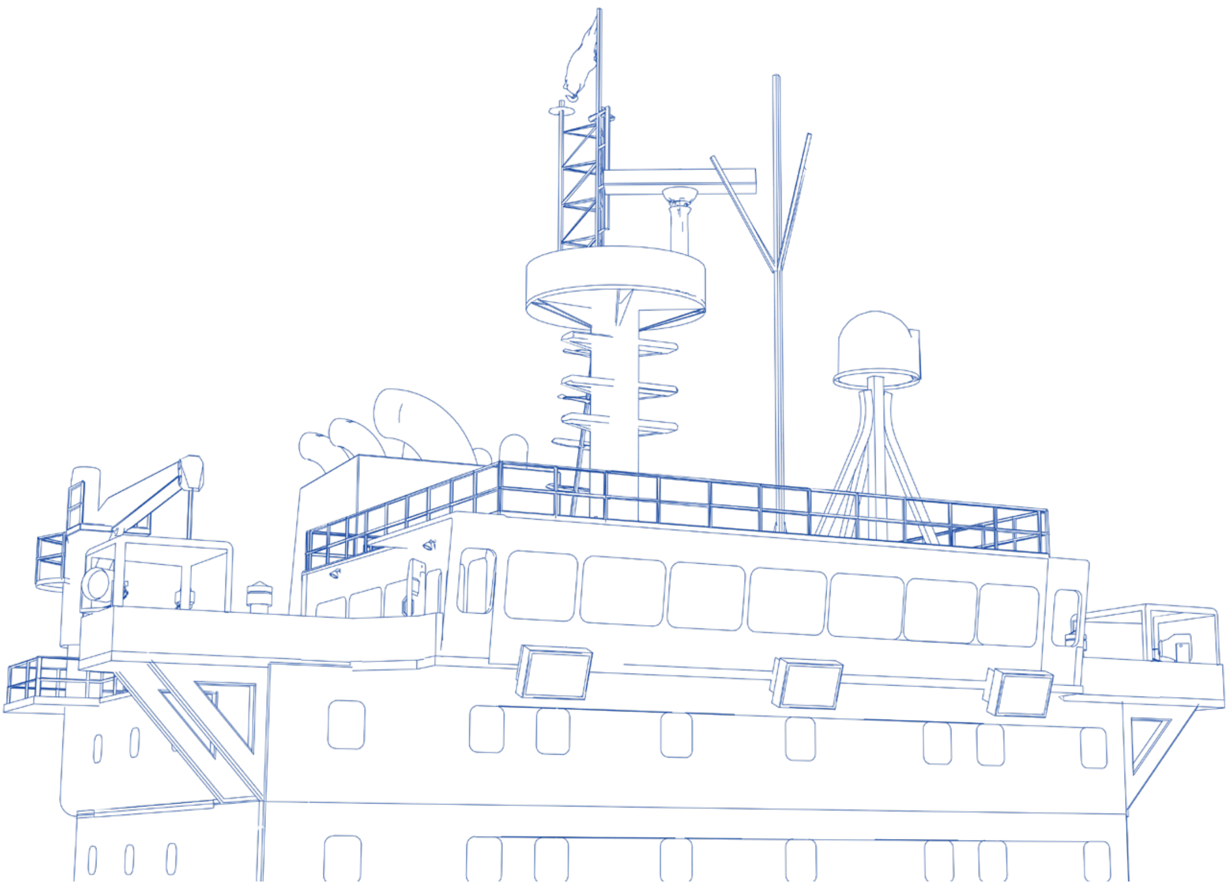
13. Conclusion

Failure to observe and understand simple enclosed space entry procedures can lead to persons being unexpectedly overcome when entering enclosed spaces. Observance of the principles and procedures outlined will form a reliable basis in reducing the risks for enclosed space entry.



References

- IMO Resolution A.1050(27) 'Revised recommendations for entering enclosed spaces aboard ships'
- IMO 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
- MSC.1/Circ.1485 on Early Implementation of SOLAS Regulation XI – 1/7 on Atmosphere Testing Instrument for Enclosed Spaces
- IMO MSC.350(92). Amendments to the International Convention for the Safety of Life at Sea (SOLAS) 1974
- SOLAS Chapter III Regulation 19.3.6.2. Emergency training and drills
- SOLAS Chapter XI – 1 Regulation 7. Atmosphere testing instrument for enclosed spaces
- Maritime and Coastguard Agency (MCA) Code of Safe Working Practices for Seamen (COSWP), Ch 4 (Emergency Drills and Procedures) and Ch 15 (Entering Dangerous (Enclosed) Spaces)



Appendix

Example of an enclosed space entry permit

This permit relates to entry into any enclosed space and should be completed by the master or responsible person and by any persons entering the space, eg competent person and attendant.

GENERAL

Location/name of enclosed space

Reason for entry: ....

This permit is valid from: .... hrs Date: ....

to: .... hrs Date: .... (See note 1)

SECTION 1 – PRE-ENTRY PREPARATION

(To be checked by the master or nominated responsible person)

	YES	NO
• Has the space been thoroughly ventilated by mechanical means?	....	....
• Has the space been segregated by blanking off or isolating all connecting pipelines or valves and electrical power/equipment?	....	....
• Has the space been cleaned where necessary?	....	....
• Has the space been tested and found safe for entry? (See note 2)	....	....
• Pre-entry atmosphere test readings:		
- oxygen .... % vol (21%)*	By:	
- hydrocarbon .... % LFL (less than 1%)	Time:	
- toxic gases .... ppm (less than 50% OEL of the specific gas) (See note 3)		
• Have arrangements been made for frequent atmosphere checks to be made while the space is occupied and after work breaks?	....	....
• Have arrangements been made for the space to be continuously ventilated throughout the period of occupation and during work breaks?	....	....
• Are access and illumination adequate?	....	....
• Is rescue and resuscitation equipment available for immediate use by the entrance to the space?	....	....
• Has an attendant been designated to be in constant attendance at the entrance to the space?	....	....
• Has the officer of the watch (bridge, engine-room, cargo control room) been advised of the planned entry?	....	....
• Has a system of communication between all parties been tested and emergency signals agreed?	....	....
• Are emergency and evacuation procedures established and understood by all personnel involved with the enclosed space entry?	....	....
• Is all equipment used in good working condition and inspected prior to entry?	....	....
• Are personnel properly clothed and equipped?	....	....

* Note that national requirements may determine the safe atmosphere range.

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	…………	…………
• The means of communication has been tested and emergency signals agreed	…………	…………
• All personnel entering the space have been provided with rescue harnesses and, 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:

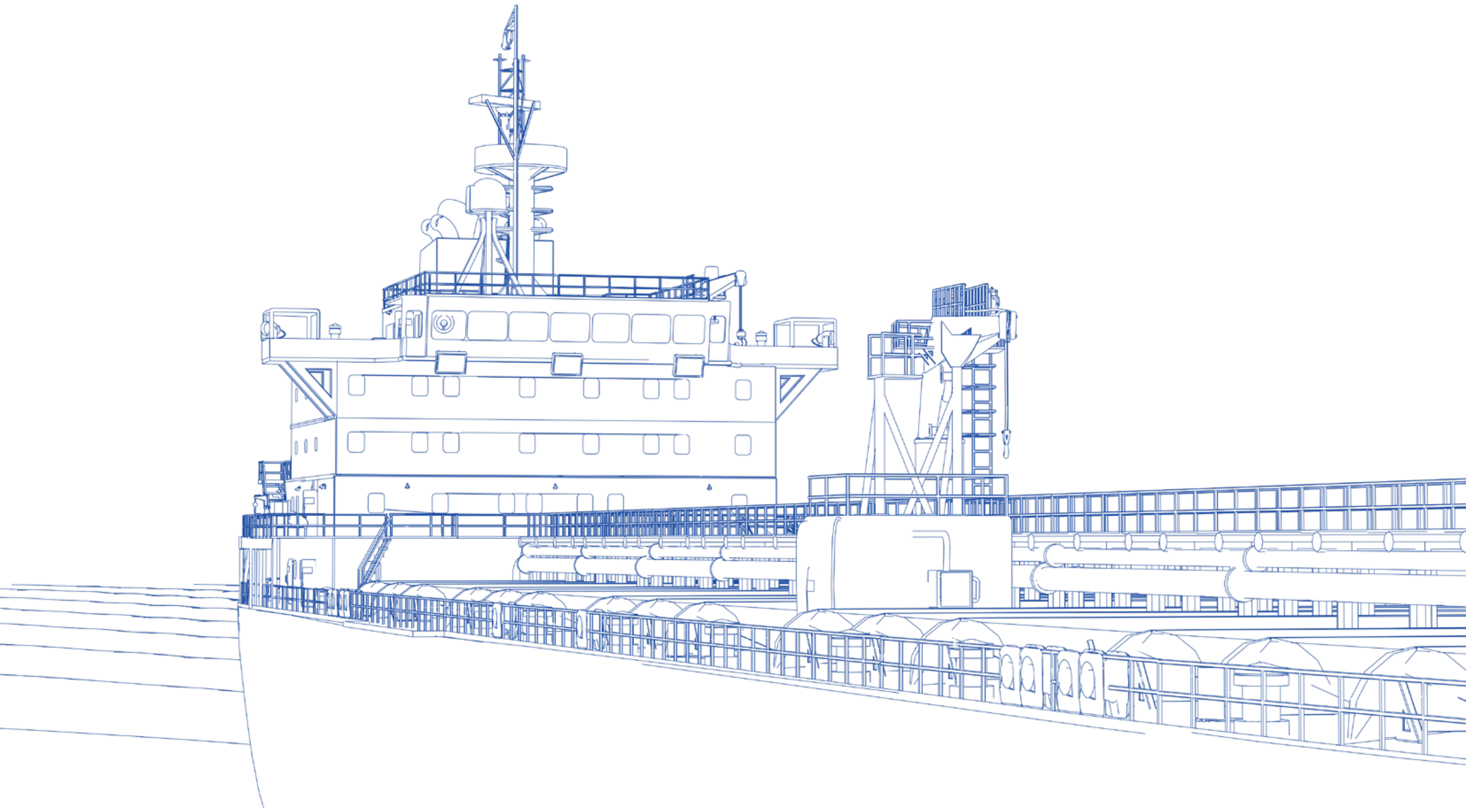
Responsible person supervising entry .... Date: .... Time: ....

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.

List of photos



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August 2021