Chapter 10

ENCLOSED SPACES

This Chapter describes the hazards associated with entry into enclosed spaces and the tests to be carried out to determine whether or not an enclosed space has been made safe for entry. The conditions for entry are set out, as well as the precautions to be taken before entry and while work is being carried out in an enclosed space.

Masters should be aware that terminal requirements for enclosed space entry might differ from this guidance as a result of national legislation.

10.1 Definition and General Caution

For the purpose of this Guide, an 'Enclosed Space' is defined as a space that has the following characteristics:

- Limited openings for entry and exit.
- Unfavourable natural ventilation.
- Not designed for continuous worker occupancy.

Enclosed spaces include, but are not limited to: cargo tanks, double bottoms, fuel tanks, ballast tanks, pumprooms, cofferdams, void spaces and sewage tanks.

Although pumprooms come within the above definition of an enclosed space, they have their own particular equipment, characteristics and risks which require special precautions and procedures. These are explained in Section 10.10.

Many of the casualties that have occurred in enclosed spaces on tankers have resulted from people entering an enclosed space without proper supervision or adherence to agreed procedures. In almost every case, the casualty would have been avoided if the simple guidance in this Chapter had been followed.
The rapid rescue of personnel who have collapsed in an enclosed space presents particular risk. It is a human reaction to go to the aid of a colleague in difficulties, but far too many additional and unnecessary casualties have occurred from impulsive and ill-prepared rescue attempts.

10.2 Hazards of Enclosed Spaces

10.2.1 Assessment of Risk

In order to ensure safety, a risk assessment should be carried out as described in Section 9.2.1. Gas tests carried out prior to entry into the space should reflect the contaminants that can reasonably be expected to be present within the space, taking into account the previous cargo carried, ventilation of the space, structure of the tank, coatings in the space and any other relevant factors.

When preparing for entry into a ballast tank or void space where cargo vapours may not normally be present, it is prudent to test the space for cargo vapours, oxygen deficiency or toxic gases if the space is adjacent to a cargo or bunker tank. This is particularly important if entry is being made to investigate the possibility of bulkhead defects.

10.2.2 Respiratory Hazards

Respiratory hazards from a number of sources could be present in an enclosed space. These could include one or more of the following:

- Oxygen deficiency caused by the presence of inert gas, oxidation (rusting) of bare steel surfaces, or by microbial activity.
- Cargo vapours.
- Toxic contaminants associated with organic vapours, such as aromatic hydrocarbons, benzene, toluene, etc.
- Toxic gases, such as hydrogen sulphide and mercaptans.
- Solid residues from inert gas and particulates, such as those from asbestos, welding operations and paint mists.

10.2.3 Cargo Vapours and Toxic Gases

During the carriage and after the discharge of a hazardous cargo, the presence of cargo vapour or toxic gases should always be suspected in enclosed spaces for the following reasons:

- Cargo may have leaked into compartments, including pumprooms, cofferdams, permanent ballast tanks and tanks adjacent to those that have carried cargo.
- Cargo residues may remain on the internal surfaces of tanks, even after cleaning and ventilation.
- Sludge and scale in a tank that has been declared gas free may give off further hazardous vapour if disturbed or subjected to a rise in temperature.
- Residues may remain in cargo or ballast pipelines and pumps.

The presence of gas should also be suspected in empty tanks or compartments if non-volatile cargoes have been loaded into non-gas free tanks or if there is a common ventilation system which could allow the free passage of vapours from one tank to another.

Toxic contaminants could be present in the space as residues from previous cargoes

To be considered safe for entry, whether for inspection, Cold Work or Hot Work, a reading of less than 1% LEL and/or the absence of any significant concentration of toxic gases must be obtained on suitable monitoring equipment. The results of the monitoring should be recorded.

10.2.4 Particular Toxic Vapours

10.2.4.1 Benzene

See Section 2.3.5 for a description of the hazards associated with benzene. Checks for benzene vapour should be made prior to entering any compartment in which a cargo that may have contained benzene has recently been carried. Entry should not be permitted without appropriate personal protective equipment, if statutory or recommended TLV-TWAs are likely to be exceeded (see Section 2.3.3.2). Tests for benzene vapours can only be undertaken using appropriate detector equipment, such as detector tubes. Detector equipment should be provided on board all tankers likely to carry cargoes in which benzene may be present.

10.2.4.2 Hydrogen Sulphide

See Section 2.3.6 for a description of the hazards associated with Hydrogen Sulphide (H_2S). H_2S can be present in some products in varying concentrations.

H_2S is very soluble in water. General practice and experience indicates that washing a tank with water after carrying a cargo containing H_2S should eliminate the hydrogen sulphide vapour within the space.

However, prior to entry into an enclosed space which has previously carried oil containing H_2S, or where the presence of H_2S vapour may be expected, the space should be ventilated to a reading of less than 1% LEL on a combustible gas indicator and tested for the presence of H_2S using a gas detector tube. Care should be taken not to rely on the use of catalytic H_2S sensors which may have a cross-sensitivity with cargo vapour.

Since H_2S is heavier than air, it is very important that the bottom of any space is thoroughly tested.

When carrying a cargo containing H_2S, particular attention should be given to the possibility of the presence of H_2S in locations such as pumprooms, deck stores and in ballast tanks. There is a high probability of the presence of H_2S in ballast tanks due to the gas being drawn into the tank when deballasting during the loading operation.

10.2.4.3 Mercaptans

See Section 2.3.7 for a description of the hazards associated with Mercaptans. Mercaptans are present in the vapours of pentane plus cargoes and in some crude oils. They may also be present where oil residues have been in contact with water for extended periods.

The presence of Mercaptans can be detected by the use of chemical detector tubes. Their concentration should be reduced to 0.5 ppm to avoid discomfort to personnel and nuisance smells.

10.2.5 Oxygen Deficiency

Before initial entry is allowed into any enclosed space, the atmosphere should be tested with an oxygen analyser to check that the air contains 21% oxygen. This is of particular importance when considering entry into any space, tank or compartment that has been previously inerted. Lack of oxygen should always be suspected in all enclosed spaces, particularly if they have contained water, have been subjected to damp or humid conditions, have contained inert gas or are adjacent to, or connected with, other inerted tanks.

10.2.6 N/A

10.3 Atmosphere Tests Prior to Entry

No decision to enter an enclosed space should be taken until the atmosphere within the space has been comprehensively tested from outside the space with test equipment that is of an approved type and that has recently been calibrated and checked for correct operation (see Section 8.2).

The appropriate atmosphere checks are:

- Oxygen content is 21% by volume.
- Cargo vapour concentration is less than 1% LEL.
- No measurable amount of toxic or other contaminants is present.

Care should be taken to obtain measurements from a representative cross-section of the compartment by sampling at various depths and through as many deck openings as practicable. When tests are being carried out from deck level, ventilation should be stopped and a minimum period of about ten minutes should be allowed to elapse before readings are taken.

Even when tests have shown a tank or compartment to be safe for entry, pockets of gas should always be suspected.

If extensive work is to be carried out within a large space, such as a cargo tank, it is recommended that a full assessment of the tank atmosphere is undertaken after the initial tests have been satisfactorily carried out and recorded.

On satisfactory completion of the atmosphere test, the results should be recorded as required by the appropriate safety procedure in the ship's safety management system.

While personnel are in a tank or compartment, ventilation should be continuous.

Regeneration of cargo vapours should always be considered possible, even after loose scale or sludge has been removed. Continual checks on the atmosphere in the space should be made as specified in the tanker's safety management system.

Atmosphere tests should always be made after any interruption or break in the work. Sufficient samples should be drawn to ensure that the resulting readings are representative of the condition of the entire space.

When entering cargo and bunker tanks, all the tanks and spaces adjacent to the space to be entered should also be tested for cargo vapours and/or toxic gases and oxygen content and, where appropriate, the inert gas pressure should be lowered to reduce the possibility of any inter-tank leakage. Notwithstanding this precaution, personnel should remain alert to the possibility of leakage of cargo vapours and/or toxic gases from adjacent spaces or from pipelines running through the tank.

10.4 Control of Entry into Enclosed Spaces

It is the responsibility of the Company to establish procedures for safe entry of personnel into enclosed spaces on board. The process of requesting, raising, issuing and documenting permits to enter into an enclosed space should be controlled by procedures in the tanker's safety management system (SMS). It is the Master's responsibility to ensure that the established procedures for entry into an enclosed space are implemented.

The Master and Responsible Person are responsible for determining whether entry into an enclosed space may be permitted. It is the duty of the Responsible Person to ensure:

- That the space is ventilated.
- That the atmosphere in the compartment is tested and found satisfactory.
- That safeguards are in place to protect personnel from the hazards that are identified.
- That appropriate means for controlling entry are in place.

Personnel carrying out work in an enclosed space are responsible for following the procedures and for using the safety equipment specified.

Prior to entry into an enclosed space, a risk assessment should be completed to identify the potential hazards and to determine the safeguards to be adopted. The resulting safe working practice should be documented and approved by the Responsible Person before being countersigned by the Master, who confirms that the practice is safe and in compliance with the tanker's safety management system. The permit, or other enabling document, should be sighted and completed by the person entering the space, prior to entry.

The controls required for safe entry vary with the task being performed and the potential hazards identified during the risk assessment. However, in most cases, an Entry Permit System will provide a convenient and effective means of ensuring and documenting that essential precautions have been taken and, where necessary, that physical safeguards have been put in place. The adoption of an Entry Permit System, which may include the use of a check-list, is therefore recommended.

Permission to continue work should only be given for a period sufficient to complete the task. Under no circumstances should the period exceed one day.

A copy of the permit should be prominently displayed at the entrance to the space to inform personnel of the precautions to be taken when entering the space and of any restrictions placed upon the activities permitted within the space.

The permit should be rendered invalid if ventilation of the space stops or if any of the conditions noted in the check-list change.

Restricting the issue of approvals, such as entry permits, so that all cargo tanks which are safe to enter are shown on one document, may be found to simplify the paper administration, avoid overlapping and reduce the possibility of confusion as to which approval applies to which tank. However, if such a system is used, there must be rigorous control to ensure cancellation of existing permits, and that the atmospheres of all named tanks are correctly tested at the time of issue so that an effective extension of a period of validity does not occur by default. It will be particularly important to ensure that the permit process is supplemented by the marking of tank lids with notices indicating which tanks are safe to enter.

Inspection of cargo tanks after cleaning and before loading can require an independent surveyor to enter the tank. All relevant tank entry procedures must be observed.

10.5 Safeguards for Enclosed Space Entry

Before allowing access to the space, the Responsible Person should ensure that:

- Appropriate atmosphere checks have been carried out.
- Before any person enters enclosed spaces:
  (a) When flammable dangerous substances of Classes 2, 3, 4.1, 6.1, 8 or 9 are carried on board the vessel, it should be established, by means of a gas detector that the gas concentration in these enclosed spaces is not more than 1% of the Lower Explosive Limit of the dangerous substance. For the cargo pump-rooms below deck this may be determined by means of a permanent gas detection system;
  (b) When toxic dangerous substances of Classes 2, 3, 4.1, 6.1, 8 or 9 are carried on board the vessel, it should be established, by means of a toximeter that the enclosed spaces do not contain any significant concentration of toxic gases.
  (c) Oxygen content is 21%, established by means of an oxygen meter.
- Piping, inert gas and ventilation systems have been isolated.
- Effective ventilation will be maintained continuously while the enclosed space is occupied.
- Fixed lighting, such as air-turbo lights, are ready for extended entry periods.
- Approved, self-contained, positive pressure breathing apparatus and, if available, resuscitation equipment is ready for use at the entrance to the space.
- The person entering the spaces is trained, has passed the necessary health checks and is physically fit at the time of entering the space.
- A responsible member of the tanker's crew is in constant attendance outside the enclosed space, in the immediate vicinity of the entrance and in direct contact with the Responsible Person.
- A rescue harness, complete with lifeline, is ready for immediate use at the entrance to the space.
- A fully charged approved safety torch is ready for immediate use at the entrance to the space.
- All persons involved in the operation should be trained in the actions to be taken in the event of an emergency.

- Lines of communications have been clearly established and are understood by all concerned.
- Names and times of entry will be recorded and monitored by personnel outside the space.

The personnel undertaking the task should ensure that such safeguards are put into effect prior to entering the space.

The personal protective equipment to be used by people entering the space must be prescribed. The following items should be considered:

- Protective clothing including work clothing or protective suits, safety boots, safety helmet, gloves and safety glasses.
- For large spaces, or where climbing access will be undertaken, the wearing of safety harnesses may also be appropriate.
- Approved safety torches.
- Personal gas detector or an area gas detector and alarm.

10.6 Emergency Procedures

10.6.1 Evacuation from Enclosed Spaces

If any of the conditions that are stated on the permit for entering the space change, or the conditions in the space are suspected of becoming unsafe after personnel have entered the space, personnel should be ordered to leave the space immediately and not be permitted to re-enter until the situation has been re-evaluated and the safe conditions stated on the permit have been restored.

10.6.2 Rescue from Enclosed Spaces

When an accident involving injury to personnel occurs in an enclosed space, the first action must be to raise the alarm. Although speed is often vital in the interests of saving life, rescue operations should not be attempted until the necessary assistance and equipment have been mustered. There are many examples of lives being lost through hasty, ill-prepared rescue attempts.

Prior organisation is of great value in arranging quick and effective response. Lifelines, rescue harness, breathing apparatus, resuscitation equipment (if available) and other items of rescue equipment should always be kept ready for use and trained personnel should be available. A means of communication should be agreed in advance.

Whenever it is suspected that an unsafe atmosphere has been a contributory factor to the accident, breathing apparatus and, where practicable, lifelines should be used by persons entering the space.

10.6.3 Resuscitation

Tanker and terminal personnel with safety responsibilities should be instructed in resuscitation techniques for the treatment of persons who have been overcome by toxic gases or fumes, or whose breathing has stopped from other causes such as electric shock or drowning.

Some tankers and terminals are provided with special apparatus for use in resuscitation. This apparatus can be of a number of different types. It is important that personnel are aware of its location and are trained in its proper use.

If available, the apparatus should be stowed where it is easily accessible and not kept locked up. The instructions provided with it should be clearly displayed. The apparatus and the contents of cylinders should be checked periodically. Adequate spare bottles should be carried.

10.7 Entry into Enclosed Spaces with Atmospheres Known or Suspected to be Unsafe for Entry

It is stressed that entry into any space that has not been proved safe for entry should only be considered in an emergency situation when no practical alternative exists. In this highly hazardous situation, it is essential that permission is obtained from the Company and a safe system of work is agreed.

Breathing apparatus, of the positive pressure type, should always be used whenever it is necessary to make an emergency entry into a space that is known to contain toxic vapours or gas, or to be deficient in oxygen, and/or is known to contain contaminants that cannot be effectively dealt with by air purifying equipment.

Entry into an enclosed space with an atmosphere known or suspected to be unsafe for entry should only be permitted in exceptional circumstances when no other practicable, safe alternative exists.

A written statement should be issued by the Master declaring that there is no practicable alternative to the proposed method of entry and that such entry is essential for the safe operation of the tanker.

Where it is agreed that such an operation is necessary, a risk assessment should be carried out and a safe system of work developed in agreement with the Company.

A Responsible Person must continuously supervise the operation and should ensure that:

- The personnel involved are well trained in the use of breathing apparatus and are aware of the dangers of removing their face masks while in the unsafe atmosphere.
- Personnel use positive pressure breathing apparatus.
- The number of persons entering the tank is kept to a minimum consistent with the work to be performed.
- Names and times of entry are recorded and monitored by personnel outside the space.
- Ventilation is provided where possible.
- Means of continuous communication are provided and a system of signals is agreed and understood by the personnel involved.
- Spare sets of breathing apparatus, a resuscitator (if available) and rescue equipment are available outside the space and a standby party, with breathing apparatus donned, is in attendance in case of an emergency.

- All essential work that is to be undertaken is carried out in a manner that will avoid creating an ignition hazard.
- If personnel are not connected to a lifeline, appropriate means should be in place to identify where the persons are whilst inside the space.

10.8 Respiratory Protective Equipment

A number of different types of respiratory protective equipment could be available for use on board tankers.

Some respiratory protective equipment is required to be carried to meet the fire safety provisions of, for example, SOLAS. However, if applicable, under the provisions of the ISM Code the Company is responsible for providing the level of equipment needed to safely manage all aspects of shipboard operational and safety activities. Respiratory protective equipment necessary to meet these provisions will, in most cases, exceed the minimum requirements of applicable legislation.

All protective equipment must be resistant to the products handled by the tanker.

10.8.1 Self-Contained Breathing Apparatus (SCBA)

This consists of a portable supply of compressed air contained in a cylinder or cylinders attached to a carrying frame and harness worn by the user. Air is provided to the user through a face mask, which can be adjusted to give an airtight fit. A pressure gauge indicates the pressure in the cylinder and an audible alarm sounds when the supply is running low. Only positive pressure type sets are recommended for use in enclosed spaces because, as their name implies, these maintain a positive pressure within the face mask at all times.

When using the equipment, the following should be noted:

- The pressure gauge must be checked before use.
- The operation of the audible low pressure alarm should be tested before use.
- The face mask must be checked and adjusted to ensure that it is airtight. In this regard, the presence of any facial hair may adversely affect the mask's seal and, should this be the case, another person should be selected to wear the apparatus. Alternatively, other specialist equipment may be provided that allows for facial hair.
- The pressure gauge should be monitored frequently during use to check on remaining air supply.
- Ample time should be allowed for getting out of the hazardous atmosphere. In any event, the user must exit immediately if the low pressure alarm sounds. It should be remembered that the duration of the air supply depends on the weight and fitness of the user and the extent of their exertion.

If the users suspect at any time that the equipment may not be operating satisfactorily or are concerned that the integrity of the face mask seal may be damaged, they should exit the space immediately.

Figure 10.1 – Self-Contained Breathing Apparatus

10.8.2 Air Line Breathing Apparatus

Air line breathing apparatus enables compressed air equipment to be used for longer periods than would be possible using self-contained equipment.

This equipment consists of a face mask or a clean air overpressure hood which is supplied with air through a small diameter hose leading outside the space where it is connected to either compressed air cylinders or an air line served by a compressor. If the tanker's air supply is used, it is essential that it is properly filtered and adequately monitored for toxic or hazardous constituents. The hose is attached to the user by means of a belt or other arrangement, which enables rapid disconnection in an emergency. Air to the face mask or hood is regulated by a flow control valve or orifice.

If the air supply is from a compressor, the arrangement will include an emergency supply of air cylinders for use in the event of the compressor failing. In such an emergency, the user should be signalled to vacate the space immediately.

A trained and competent person must be in control of the air line pressure and be alert to the need to change over to the alternative supply should normal working pressure not be maintained. It must be ensured that the audible low pressure alarm can be heard by this person.

When using the air line breathing apparatus:

- If a face mask is used: check and ensure that the face mask is adjusted to be airtight. The presence of facial hair may make this task harder to achieve.
- If a clean air overpressure hood is used, check and ensure the hood is free of any damage.
- Check the working pressure before each use.

- Check the audible low pressure alarm before each use.
- To avoid damage, keep the air lines clear of sharp projections.
- Ensure that the air hose has sufficient length for the intended operations but does not exceed 25 metres.
- Ensure the air hose is of a type that is kink free, antistatic and oil/chemical resistant.
- Allow ample time to vacate the space when the low pressure alarm sounds. The duration of the emergency air for the user will depend on the individual's weight, fitness and level of exertion, and each user should be aware of their particular limitations.

Should there be any doubt about the efficiency of the equipment, the user should vacate the space immediately.

It is recommended the user should carry a completely separate supply of clean air for use in emergency evacuation from the space in the event of the air line failing. It is recommended that the user should carry an Emergency Escape Breathing Device (EEBD).

10.8.3 Emergency Escape Breathing Device (EEBD)

This is a compressed air or oxygen breathing device used for escape from a compartment where the atmosphere has become hazardous while a person is within it. Additional sets should be provided for use as emergency escape equipment during enclosed space entry. Each set has a duration of not less than 10 minutes. The device can be one of two types:

Compressed Air Type

These sets consist of an air bottle, reducing valve, air hose, face mask or hood and a flame retardant high visibility bag or jacket. They are normally constant flow devices providing compressed air to the wearer at a rate of approximately 40 litres per minute, giving aduration of 10 (as a minimum) or 15 minutes, depending on the capacity of the bottle. Compressed air EEBDs can normally be recharged on board with a conventional SCBA compressor.

The pressure gauge, supply valve and hood should be checked before use.

Re-Breathing Type

These sets normally consist of a robust watertight carrying case, compressed oxygen cylinder, breathing bag, mouthpiece and a flame retardant hood. They are designed for single use by the wearer. When the hood is placed over the user's head and the set activated, exhaled air is mixed with compressed oxygen inside the breathing bag to allow the wearer to breath normally when escaping from a hazardous atmosphere.

It is stressed that EEBDs are for emergency escape, and should not be used as the primary means for entering oxygen deficient compartments, or while fighting fires.

10.8.4 Cartridge or Canister Face Masks

These units consist of a cartridge or canister attached to a face mask. They are designed to purify the air of specific contaminants. They do not supply any further air. It is important that they are only used for their designed purpose and within the limits prescribed by manufacturers. Such limits include an expiry date for the cartridge or canister.

Cartridge or canister face masks will not protect the user against concentrations of hydrocarbon or toxic vapours in excess of their design parameters, or against oxygen deficiency, and they should never be used in place of breathing apparatus or in enclosed spaces.

Figure 10.2 – Examples of Cartridges for use in Face Masks

10.8.5 Hose Mask (Fresh Air Breathing Apparatus)

This equipment consists of a mask supplied with air from a large diameter hose connected to a rotary pump or bellows. It is cumbersome and provides no seal against the entry of gases.

Although hose masks may be found on some tankers, they should not be used for enclosed space entry.
Although most legislations prescribe carriage of this type of breathing apparatus, it is not recognised as being adequate and safe respiratory equipment.

10.8.6 Equipment Maintenance

All respiratory protective equipment should be examined and tested by a Responsible Person at regular intervals. Defects should be made good promptly and a record should be kept of inspections and repairs. Air bottles must be recharged as soon as possible after use.

Air bottles must not be in a damaged or corroded condition and should be tested hydraulically, in accordance with legislative requirements.

Masks and helmets should be cleaned and disinfected after use. Any repair or maintenance must be carried out strictly in accordance with the manufacturer's instructions.

All respiratory protective equipment should be examined and certified by an authorised company in accordance with the intervals and conditions prescribed in manufacturer's instructions and/or (inter)national legislation.

10.8.7 Stowage

Breathing apparatus should be stowed fully assembled in a place where it is readily accessible. Air bottles should be fully charged and the adjusting straps kept slack. Units should be sited so as to be available for emergencies in different parts of the tanker.

10.8.8 Training

Practical demonstrations and training in the use of breathing apparatus should be carried out to give personnel experience in its use. Only trained personnel should use self-contained and air line breathing apparatus, since incorrect or inefficient use can endanger the user's life.

10.9 Work in Enclosed Spaces

10.9.1 General Requirements

All work carried out in enclosed spaces should be conducted under the control of the Safety Management System. All conditions for entry, including the use of an entry permit, should be observed

Additional precautions may be necessary to ensure there is no loose scale, sludge or combustible material in the vicinity of the work site which, if disturbed or heated, could give off toxic or flammable gases. Effective ventilation should be maintained and, where practicable, directed towards the work area.

10.9.2 Opening Equipment and Fittings

Whenever cargo pumps, pipelines, valves or heating coils are to be opened, they should first be thoroughly flushed with water. However, even after flushing, there will always be a possibility of some cargo remaining, which could be a source of further flammable or toxic gas. Whenever such equipment is to be opened, the safety management procedure should identify the minimum safe working practices to be adopted, including any requirement for additional gas tests.

10.9.3 Use of Tools

Tools should not be carried into enclosed spaces, but should be lowered in a plastic bucket or canvas bag to avoid the possibility of their being dropped. Before any hammering or chipping is undertaken, or any power tool is used, the Responsible Person should be satisfied that there is no likelihood of hazardous vapour being present in the vicinity.

10.9.4 Use of Electric Lights and Electrical Equipment

Unless a compartment is designated safe for Hot Work by an approved safe system of work, such as a Hot Work permit, non-approved lights or non-intrinsically safe electrical equipment must not be taken into an enclosed space.

Only approved safety lighting or intrinsically safe electrical equipment should be used in enclosed spaces that are liable to experience hazardous vapour re-contamination.

In port, any local regulations concerning the use of electric lights or electrical equipment should be observed.

10.9.5 Removal of Sludge, Scale and Sediment

When removing sludge, scale or sediment from an enclosed space, periodic gas tests should be undertaken and continuous ventilation should be maintained throughout the period the space is occupied.

There may be increases in gas concentrations in the immediate vicinity of the work and care should be taken to ensure that the atmosphere remains safe for personnel. It is strongly recommended that personal gas monitors are provided to some or all of the persons engaged in the work.

10.9.6 N/A

10.10 Pumproom Entry Precautions

Cargo pumprooms are to be considered as enclosed spaces and the requirements of this Chapter should be followed to the maximum extent possible. However, because of their location, design and the operational need for the space to be routinely entered by personnel, pumprooms present a particular hazard and therefore necessitate special precautions, which are described in the following Sections.

10.10.1 Ventilation

Because of the potential for the presence of flammable gas in the pumproom, the use of mechanical ventilation by extraction to maintain the atmosphere in a safe condition is required.

The cargo pump-room should be provided with a permanent gas-detection system which automatically indicates the presence of explosive gases or lack of oxygen by means of direct-measuring sensors and which actuates a visual and audible alarm when the gas concentration has reached 10% of the lower explosive limit. The sensors of this system should be placed at suitable positions at the bottom and directly below the deck.

Measurement should be continuous.

Audible and visual alarms should be installed in the wheelhouse and in the cargo pump-room and, when the alarm is actuated, the loading and unloading system should shut down. Failure of the gas detection system should be immediately signalled in the wheelhouse and on deck by means of audible and visual alarms.

The ventilation system should have a capacity of not less than 30 changes of air per hour based on the total volume of the service space.

Ventilation should be continuous until access is no longer required, or cargo operations have been completed.

10.10.2 Pumproom Entry Procedures

Before anyone enters a pumproom, it should be thoroughly ventilated, the oxygen content of the atmosphere verified and the atmosphere checked for the presence of hydrocarbons and any toxic gas associated with the cargo being handled.

Only where a fixed gas detection system

- is correctly calibrated and tested and
- provides gas readings as a percentage LEL (% LEL) to a level of accuracy equivalent to portable gas instruments, at representative locations within the pumproom,

should this gas detecting system be used to provide information for safe entry into the space.

Formal procedures should be in place to control pumproom entry. The procedure used should be based on a risk assessment, and should ensure that risk mitigation measures are followed and that entries into the space are recorded.

A communications system should provide links between the pumproom, navigation bridge, engine room and cargo control room. In addition, audible and visual repeaters for essential alarm systems, such as the general alarm and the fixed extinguishing system alarm, should be provided within the pumproom.

Arrangements should be established to enable effective communication to be maintained at all times between personnel within the pumproom and those outside. Regular communication checks should be made at pre-agreed intervals and failure to respond should be cause to raise the alarm.

VHF/UHF communication should not be used as a primary communication method where it is known that reception may not be reliable or practicable due to noise. Where communication by VHF/UHF is difficult, it is recommended that a standby person is positioned on the pumproom top and that a visual and remote communication procedure is put in place.

The frequency of pumproom entry for routine inspection purposes during cargo operations should be reviewed with a view to minimising personnel exposure.

Notices should be displayed at the pumproom entrance prohibiting entry without formal permission.

The following instruction should be displayed at the entrance of the cargo pump-room:

Before entering the cargo pump-room, check whether it is free from gases and contains sufficient oxygen.

Do not open doors and entrance openings without the permission of the Master.

Leave immediately in the event of an alarm.

10.11 Pumproom Operational Precautions

A pumproom contains the largest concentration of cargo pipelines of any space within the tanker and leakage of a volatile product from any part of this system could lead to the rapid generation of a flammable or toxic atmosphere. The pumproom may also contain a number of potential ignition sources unless formal, structured maintenance, inspection and monitoring procedures are strictly followed.

10.11.1 General Precautions

Before starting any cargo operation:

- An inspection should be made to ensure that strainer covers, inspection plates and drain plugs are in position and secure.
- Drain valves in the pumproom cargo system, especially those on cargo oil pumps, should be firmly closed.
- Any bulkhead glands should be checked and adjusted or lubricated, as necessary, to ensure an efficient gas-tight seal between the pumproom and the machinery space.

During all cargo operations, including loading:

- The pumproom should be inspected at regular intervals to check for leakages from glands, drain plugs and drain valves, especially those fitted to the cargo pumps.
- If the pumps are in use, pump glands, bearings and the bulkhead glands (if fitted) should be checked for overheating. In the event of leakage or overheating, the pump should be stopped.
- No attempt should be made to adjust the pump glands on rotating shafts while the pump is in service.

10.11.2 Cargo and Ballast Line Draining Procedures

On some tankers, no provision is made for effective line draining and, in order to meet the demands of certain product trades, final line contents are drained to the pumproom bilge. This is an unsafe practice and it is recommended that cargo procedures be reviewed with the aim of preventing a volatile product being drained to the bilge.

It is strongly recommended that consideration is given to the provision of a comprehensive stripping arrangement to enable all lines and pumps to be drained effectively to a cargo tank, slop tank or dedicated reception tank, for subsequent discharge ashore.

Where lines that have been used for ballast have to be drained to the pumproom bilge on completion of deballasting, care must be taken to ensure that such drainings do not contain cargo remains.

10.11.3 Routine Maintenance and Housekeeping Issues

It is important that the integrity of pipelines and pumps is maintained and that any leaks are detected and rectified in a timely fashion.

Pumproom bilges should be kept clean and dry. Particular care should be taken to prevent the escape of flammable liquids or vapour into the pumproom.

Pipelines should be visually examined and subjected to routine pressure tests to verify their condition. Other means of non-destructive testing or examination, such as ultrasonic wall thickness measurement, may be considered appropriate, but should always be supplemented by visual examination.

Procedures should be established to verify that mud boxes and filters are properly sealed after they have been opened up for routine cleaning or examination.

Valve glands and drain cocks should be regularly inspected to ensure that they do not leak.

Bulkhead penetrations should be routinely checked to ensure the effectiveness of seals.

Critical bolts on the cargo pumps and associated fittings, such as pedestal fixing bolts, pump casing bolts and bolts securing shaft guards, should be secure. In addition, requirements for their examination should be included in routine maintenance procedures.

The pumproom rescue harness and rope should be checked regularly to ensure it is fit for use and rigged for immediate operation.

Emergency escape routes should be checked regularly to ensure that they are properly marked and clear of obstructions. Where an escape trunk is fitted, doors should be checked for ease of operation, door seals should be effective and lighting within the trunk should be operational.

10.11.4 Maintenance of Electrical Equipment in the Pumproom

The integrity of the protection afforded by the design of explosion-proof or intrinsically safe electrical equipment may be compromised by incorrect maintenance procedures. Even the simplest of repair and maintenance operations must be carried out in strict compliance with the manufacturer's instructions in order to ensure that such equipment remains in a safe condition.

Maintenance of explosion-proof and intrinsically safe equipment should only be carried out by personnel qualified to undertake such work. This is particularly relevant in the case of explosion-proof lights, where incorrect closure after changing a lamp could compromise the integrity of the light.

In order to assist with such routine servicing and repair, tankers should be provided with detailed maintenance instructions for the specific systems and arrangements as fitted on board.

10.11.5 Inspection and Maintenance of Pumproom Ventilation Fans

Pumproom ventilation fans are required to operate by drawing air out of the space. As a consequence, should gas be present in the pumproom, the vapours will be drawn through the blades of the fan impeller and could be ignited if the blades contact the casing or if the fan bearings or seals overheat.

Pumproom extractor fans, including impellers, shafts and gas seals, should be inspected on a regular basis.

The condition of the fan trunking should be inspected and the proper operation of changeover flaps and fire dampers confirmed.

Routine vibration monitoring and analysis should be considered as a means for providing early detection of component wear.

10.11.6 Testing of Alarms and Trips

Pump alarms and trips, level alarms, etc, where fitted, should be tested regularly to ensure that they are functioning correctly, and the results of these tests should be recorded.

These tests should be as thorough as possible to verify the full and complete operability of the system and should not be limited to an electrical function test of the alarm itself.

10.11.7 Miscellaneous

There are a number of other ways to enhance the safety of pumprooms, some of which are mandatory for certain tankers:

- A fixed gas detection system capable of continuously monitoring for the presence of flammable gas. Where such equipment is fitted, procedures should be developed to ensure it is regularly inspected and calibrated. Procedures should also be developed with regard to the action to be taken in the event of an alarm occurring, especially for vacating the space and stopping the cargo pumps. Whenever practicable, gas detection should monitor a number of levels within the pumproom, not just the lower area.

- A fixed sampling arrangement to enable the oxygen content within the pumproom to be monitored from the deck by a portable meter prior to pumproom entry. Where such an arrangement is fitted, it should ensure that remote parts of the pumproom can be monitored.
- Temperature monitoring devices fitted to the main cargo pumps in order to provide remote indication of the temperature of pump casings, bearings and bulkhead seals. Where such equipment is fitted, procedures should be developed with regard to the action to be taken in the event of an alarm occurring.
- A high level alarm in pumproom bilges which activates audible and visual alarms in the cargo control room, engine room and the navigating bridge.
- Manually activated trips for the main cargo pumps provided at the lower pumproom level and at the top (main deck) level.
- Spray arrestors around the glands of all rotary cargo pumps in order to reduce the formation of mists in the event of minor leakage from the gland.
- Examining the feasibility of fitting a double seal arrangement to contain any leakage from the primary seal and to activate a remote alarm to indicate that leakage has occurred. However, the impact of any retrofit on the integrity of the pump will need to be clearly assessed in conjunction with the pump manufacturer.
- Particular attention to be given to the adequacy of fire protection in the immediate vicinity of the cargo pumps.
- Because of the problems associated with flashback re-ignition after the use of the primary fire-fighting medium, consideration should be given to the need to provide a backup system, such as high expansion foam or water drenching, to supplement the existing system.
- On tankers fitted with an inert gas system, the provision of an emergency facility for inerting the pumproom could be an option, although careful attention must be paid to the safety and integrity of the arrangement.
- The provision of Emergency Escape Breathing Devices (EEBDs) located within the pumproom and readily accessible.