CHEMICAL TANKERS: A POCKET SAFETY GUIDE

3RD EDITION

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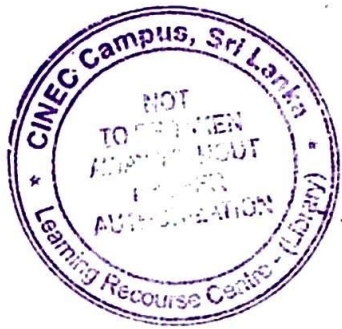

Chemical Tankers

A Pocket Safety Guide

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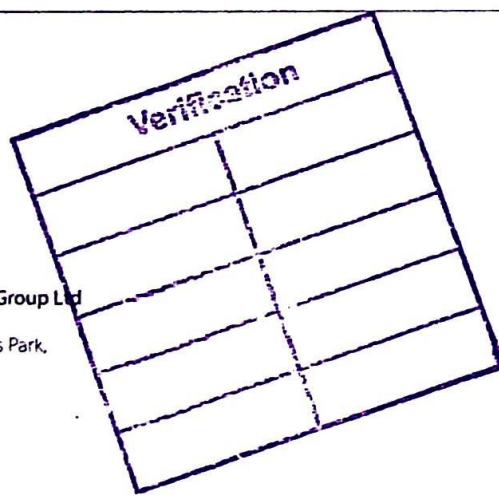

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Introduction

This book explores best practices on tankers carrying chemical and similar hazardous products and provides a good introduction to safe tanker practice, terminology and standards. It is not a detailed operational guide, but is aimed as basic safety information for seafarers of all ranks and positions. It is suitable for seafarers who may be rejoining a tanker after leave for example, or for a person with little or no experience on tankers, in particular cadets and new ratings. Ideally, it should be read to aid the familiarisation process whenever you join a tanker.

The International Safety Management (ISM) Code sets standards for your company's safety management system (SMS) and operating manuals. These will provide the details and procedures to allow you to work safely at sea, so you must follow them carefully. This book is an addition to these standards and not an alternative to them.

As a crew member working with dangerous cargoes, you should have a clear understanding of operations on board a tanker. Therefore, you are encouraged to seek further information and detail beyond the overview of subjects given here. In particular, you should read the CDI publication *'Bulk Liquid Chemical Handling Guide for Plants, Terminals, Storage and Distribution Depots (BLCH Guide)'*.

Not all of the cargoes carried on chemical tankers are hazardous. However, most do have some level of safety and/or pollution hazard connected to them. The marine industry recognises this and, through design, regulation and best practice, has controlled or removed many of the hazards.

When reading this book, you may find terms that are new to you. A glossary of technical terms is provided at the end and you should refer to this if you are uncertain about meanings. If you are still unsure, ask a senior officer or other responsible member of the crew.

Remember, no safety question is ever a foolish one. It is only foolish if you do not ask someone for help.

Safety – the Main Message

There are numerous reasons why chemical products are known as 'hazardous cargoes'. The hazards are real and the consequences can be significant if the hazards are not controlled and mitigated through best practice.

Work on board any ship, and in particular chemical tankers, should only be conducted following completion of a risk assessment, including, as required, a safety discussion (toolbox talk) and implementation of a permit to work (PTW). This will all be detailed in your company safety management system (SMS) and an overview is provided in this publication.

It is your responsibility to understand the operational and general safety practices in your company and on board. You should apply care and attention to all of your work and never take shortcuts when it comes to safety.

Everyone on board, including terminal personnel and visitors, has the authority to stop any work that they deem unsafe.

About this Book

This book provides the necessary information to enable you to carry out basic tasks safely. However, you will find that a great deal of the information is common sense. This book:

- Will tell you about the hazards on board
- will explain how to mitigate the risks through best practice
- will tell you what you should do if a problem arises.

However

- It cannot do your thinking for you
- it cannot make you take sufficient time and care
- it cannot take the place of your own common sense.

Working on board a tanker is a demanding and rewarding experience. Always take the time you need to complete any job you are assigned safely and properly.

Contents

Chapter 1
The Ships

Chemical tankers have been used for shipping cargoes since the mid-twentieth century. Tanker sizes have grown as ship owners seek to increase the efficiency and economy of their voyages. As a result, there is now a large range of tanker types and sizes, capable of carrying a variety of chemical products in different tank arrangements.

While the size of tanker and type of chemical cargo carried varies, the basic safety principles set out in this guide apply to each and every chemical tanker.

1.1 General Information

As of 2021, the latest published statistics indicated that there were at least 13,975 oil and chemical tankers in the global fleet, comprised as follows:

- 1,902 were < 500 GT
- 7,322 were between 500–25,000 GT
- 2,726 were between 25,000–60,000 GT
- 2,025 were > 60,000 GT.

The following definitions are commonly used throughout the shipping industry:

- Gross tonnage (GT) – a measurement of a ship's overall volume. It is not a weight measurement
- deadweight tonnage (dwt) – a measurement of how much weight a ship can carry. It includes the weight of cargo, ballast, bunkers, provisions, etc
- displacement – the weight of the volume of water displaced by a ship, ie the volume below the waterline.

You will come across a wide variety of terms and definitions during your time at sea, many of which will be used on a day-to-day basis. Take time to learn them and always ask if you are unsure of anything.

1.2 Cargo Categories

Chemical tankers are built to transport by sea the vast range of bulk liquid chemical cargoes, many requiring specific carriage criteria. Consequently, the construction and operation of these ships are, in general, more complex than other types of tanker. The flexibility needed to carry many different chemical cargoes on a single voyage, with total segregation, results in chemical tankers having more tanks, more valves, more pumps, more lines and more vents. The segregation capability and the high number of sub-divisions make chemical tankers some of the strongest and safest ships in operation, with excellent stability and survivability.

MARPOL Annex II and the IBC Code are applied to control the safe operation of chemical tankers and protect the environment from the potential polluting effects of the cargoes carried on board.

MARPOL Annex II sets out the following four pollution categories for noxious and liquid substances (X, Y, Z and OS (Other Substances)):

Category X

Noxious liquid substances that, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health and therefore justify the prohibition of discharge into the marine environment.

Category Y

Noxious liquid substances that, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of discharge into the marine environment.

Category Z

Noxious liquid substances that, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a minor hazard to either marine resources or human health and therefore justify less stringent restrictions on the quality and quantity of discharge into the marine environment.

Other Substances

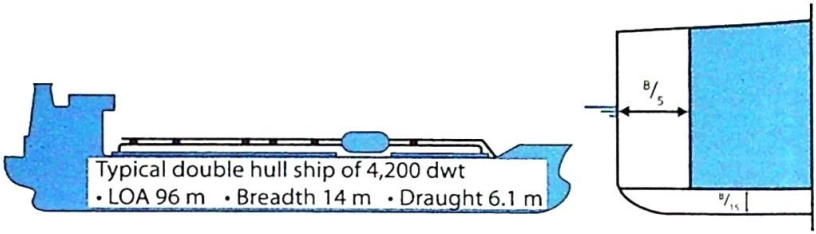
Substances that have been evaluated and found to fall outside Categories X, Y or Z because they are considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning or deballasting operations. The discharge of bilge or ballast water or other residues or mixtures containing these substances is not subject to any discharge requirements of MARPOL Annex II.

1.3 Ship Types

The IBC Code groups chemical tankers into the following three categories:

Ship Type 1

Type 1 chemical tankers are designed to carry chemicals with very severe environmental and safety hazards, which require the maximum preventative measures to preclude escape from containment.



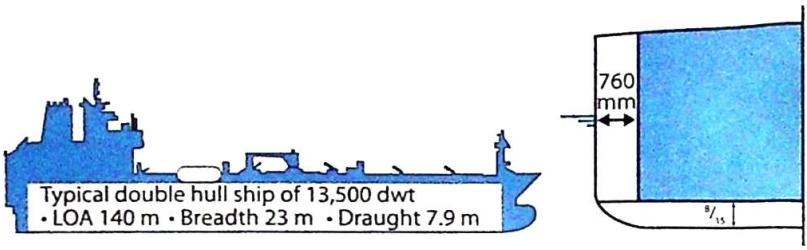
In simple terms, the regulations require Type 1 ships to have:

- Cargo tanks located at a minimum horizontal distance of B/5 or 11.5 m (whichever is less) from the ship side plating, and
- a minimum vertical distance of B/15 or 6 m (whichever is less) from the ship bottom plating.

The design principle is that the cargo carrying compartments have maximum protection and are guarded against potential release caused by collision or grounding. In addition, Type 1 chemical tankers must be capable of withstanding assumed side and bottom damage anywhere in their length.

Ship Type 2

Type 2 chemical tankers are designed to carry chemicals with appreciably severe environmental and safety hazards, which require significant preventative measures to preclude escape from containment.



In simple terms, the regulations require Type 2 ships to have:

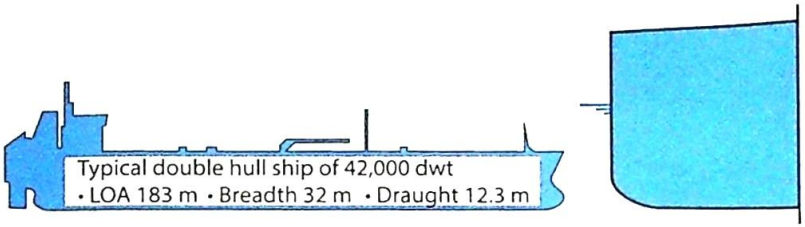
- Cargo tanks located at a minimum horizontal distance of 760 mm from the ship side plating, and
- a minimum vertical distance of B/15 or 6 m (whichever is less) from the ship bottom plating.

The design principle is that the cargo carrying compartments have a significant level of protection and are guarded against potential release caused by collision or grounding. In addition, Type 2 chemical tankers must be capable of withstanding assumed side and bottom damage depending on the length of the ship.

Ships over 150 m in length must withstand the same assumed damage as Type 1 ships.

Ship Type 3

Type 3 chemical tankers are designed to carry chemicals with sufficiently severe environmental and safety hazards to require a moderate degree of containment to increase survival capability in a damaged condition.



There are no horizontal or vertical restrictions for the location of cargo tanks in a Type 3 ship. Type 3 chemical tankers must however be capable of withstanding assumed side and bottom damage depending on their length.

Ships over 225 m in length must withstand the same assumed damage as Type 1 ships.

1.4 Cargo Tank Types

Irrespective of the ship type, cargo tanks are also given a type notation within the IBC Code, as follows:

Type 1 tanks are independent of the ship's hull structure. In effect, they can be lifted on and off without affecting the strength of the ship. Deck tanks are the most common examples of independent tanks on chemical tankers. Type 1 tanks are limited in size to a maximum capacity of 1,250 m^3.

Type 2 tanks are integral to the ship's hull. They are constructed when the ship is built and share the ship's structural strength. Type 2 tanks are the most common construction for chemical tankers and have a maximum capacity of 3,000 m^3.

Additionally, tanks are constructed to be 'Gravity' (G) tanks or 'Pressure' (P) tanks.

Gravity tanks have a maximum design pressure of 0.7 bar.

Pressure tanks have design pressures greater than this. Pressure tanks are less common on chemical tankers.

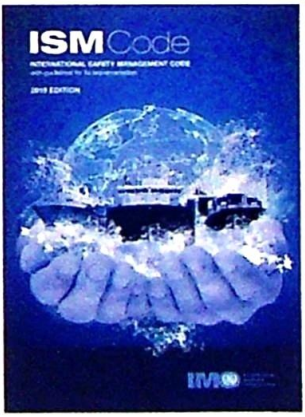
Examples of cargo tank notations are: Tank Type 1P and Tank Type 2G.

Chapter 2
Safety Systems

Maintaining safety on board your tanker is dependent on you and your fellow crew having a safety mindset.

A safety mindset is both an attitude and an outlook that requires you to have a heightened awareness of the risks and hazards that are part of life on a tanker. It is part common sense, part understanding and part education/training.

A crucial aspect of staying safe on board a tanker is not allowing yourself to become complacent with your job and surroundings. The majority of minor accidents and injuries on board are from routine, low risk tasks.



To comply with the requirements of the ISM Code, all ships must have a safety management system (SMS). This will include all procedures, policies and standards that relate to operational safety on board your tanker. You should be familiar with your tanker's SMS.

Publications available from your flag State or P&I Club may also be useful, for example the UK *'Code of Safe Working Practices for Merchant Seafarers'* (COSWP).

Risk assessments are the primary method for obtaining practical knowledge of the hazards specific to the work you may do on board. If you are fully informed about the hazards, it will help you remain safe, but only if you also apply the knowledge and procedures correctly.

A permit to work (PTW) is the main method of controlling the most hazardous operations identified in risk assessments.

Never ignore any points on a checklist or PTW, or tick without verifying that you are completely satisfied that the action has been completed. Risk assessments are a key tool in safety on board, but only if they are used effectively.

2.1 Risk Assessments

Before you undertake work tasks on board, a responsible officer or experienced crew member must carry out a risk assessment. This is a systematic and considered approach to assessing the potential hazards of a task or duty. It will identify any additional procedures you may need to follow (for many operations, this will require the subsequent completion of a PTW). Risk assessments should be documented within your tanker's SMS.

Two important terms you should be aware of are **hazard** and **risk**. A **hazard** is a source of potential harm that may result in injury or damage. A **risk** is an analysis based on two components: 1) the likelihood that harm might occur and 2) the severity of the harm if it were to occur.

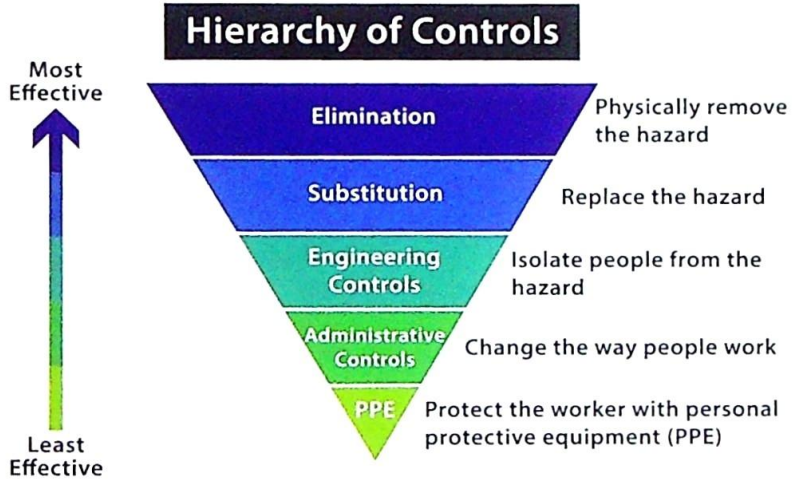
An effective risk assessment is therefore made up of the following stages:

- Identification of ALL hazards
- identification of ALL those who may be harmed and how
- calculation of the severity of the harm
- determination of the level of risk
- identification of control measures, such as a PTW.

Risk assessments should be relevant to the work you wish to complete, reviewed each time you undertake the task and updated as appropriate. There may be no need to update any of the information from the previous risk assessment, but a new risk assessment should still be completed.

Risk assessments should consider the nature of the operation, the location of the job site and the prevailing working conditions.

When you are controlling the risks identified in a risk assessment, you may come across some of the following methods (ordered here from most to least effective):



Do not start a task if you do not feel confident or comfortable to do so. Training and advice is always available on board – all you need to do is ask.

2.2 Permit to Work (PTW) Systems

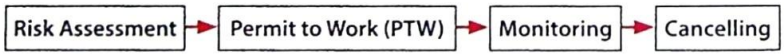
Permit to work (PTW) systems provide a structured and auditable approach to safe working. They help safeguard all those who may be affected by a particular task and ensure compliance with safety requirements at the work location. Any task on board should begin with a risk assessment. This is the crucial step in identifying whether additional risk management is required to complete the task safely. The company's SMS will give in-depth guidance as to when a PTW is required.

While the PTW system is essential to the safety of all personnel on board, it will only operate effectively if everyone involved fully understands and follows the system.

The main features of a PTW are:

- It provides a detailed and clear description of the specific work to be carried out
- it identifies who is undertaking and who is authorising the work
- it requires a named individual to confirm that the risks have been properly assessed and precautions taken
- it ensures that responsible personnel are aware of any work to be carried out within their area of responsibility.

The PTW process can be simplified into the following four steps:



Before authorising and issuing a permit, the permit issuer, often the Master or chief engineer, should discuss with the permit holder the hazards of the work, the controls that have been put in place and the precautions to be taken during the work. Ideally, this discussion should take place at the worksite. Where required, the safety officer should be consulted for specialist advice on the availability and use of protective clothing and equipment.

When preparing the permit, the applicant (the ultimate permit holder) will record:

- The location of the worksite, if necessary providing an Enclosed Space Entry Certificate, Working Aloft Certificate or Lifting Certificate
- the identification and status of the equipment, if necessary providing an Electrical Isolation Certificate, Process Isolation Certificate, Mechanical Isolation Certificate or Safety Systems Isolation Certificate
- a detailed description of the work to be conducted
- any equipment to be used that is not specifically detailed on the form
- any supporting plans or information that must be attached to the permit
- the names of personnel who will undertake the work
- the estimated time the task will take.

After discussing the details of the work, the preparations made and the controls specified on the permit, the permit issuer and the permit holder sign to authorise the permit. A copy of the permit should always be available at the job site, or as close as possible to where the work is taking place.

A commonly used term in risk assessments and PTWs is 'as low as reasonably practicable' (ALARP). This is when a hazard cannot be completely eliminated, so controls are added to reduce the risk to as low as possible.

Work that is covered under the PTW system can be divided into several categories:

Hot work involves a positive or potential source of ignition, for example:

- Welding, flame cutting and grinding
- use of electrical/electronic equipment not certified for use in flammable atmospheres
- opening and working on live electrical systems
- use of powered steel wire brushes, needle gunning
- dry grit/shot blasting.

Cold work refers to types of work where there is no risk of ignition but there is still a high risk potential. These tasks may be covered by a general PTW. Examples include:

- Pressure testing
- work affecting safety or emergency systems
- painting/fabric maintenance of the ship
- cleaning/using chemicals
- diving operations
- manual handling or carrying of heavier objects
- opening or disconnection of any closed pipeline or vessel.

Working at height (WAH) means working in a location where there is a risk of falling. This includes:

- Inside a tank
- near an opening, such as a hatch
- on a ladder or raised platform.

Lifting operations refers to work using cranes, davits or hoists where the load is too heavy or too large to be carried manually.

Isolations are used to achieve a zero energy state for sources of hazardous energy. Hazardous energy is that which can harm personnel and includes electrical, mechanical, hydraulic, pneumatic, chemical, thermal, gravitational, sound, motion and biological energy. Depending on the nature of the task, equipment may require a 'lock out, tag out' which prevents unauthorised starting or use of the equipment being worked on. Equipment isolations will be detailed within the company SMS.

Enclosed Space Entry refers to entering a space that has limited entry/exit points, inadequate ventilation and a potentially dangerous atmosphere. This is covered in depth in Chapters 8 and 9.

When creating, reading or signing a PTW, always think carefully to ensure you fully understand:

- The work scope and how that work is to be carried out
- the hazards and the required precautions
- the actions to be taken in the event of an emergency
- the responsibilities of yourself and others.

It is important that the permit holder copy is readily available for reference by the work party and by anyone conducting inspections of the work. If there is a change in conditions to the work, the work should be stopped and a new PTW issued.

No one is allowed to issue a permit to themself as this would defeat one of the prime objectives of a permit to work (PTW) system, ie having a second pair of eyes to critically review the proposed controls.

2.3 Toolbox Talk

Before work begins, an essential part of the onboard safety system will be a 'toolbox talk'. This is a briefing by the permit holder to everyone involved in the task. It is to ensure that all crew involved understand the scope of the work, the procedures to be followed, any potential hazards and individual responsibilities. It should be remembered that this is an opportunity to raise questions and concerns.

Items typically covered during a toolbox talk include:

- Why the work is required
- identified hazards and risks
- the permit itself
- the plan of action to complete the work
- responsibilities of the work party
- access, escape routes and emergency procedures
- the environment at the worksite
- equipment, tools and systems required or available
- materials to be used
- isolations required
- any work nearby
- conditions in which the job should be suspended or stopped
- questions from the work party.

For watchkeepers, if you change watch while a PTW is in effect, you must take time with your relief to discuss the work status, covering the job itself, any relevant procedures and the safety checks and precautions taken

When the work is complete, all copies of the permit should be returned to the responsible officer for record keeping.

The PTW does not, in itself, make a job safe. You must strictly follow the control methods identified within the PTW, as well as your own judgment and common sense.

Chapter 3
Personal Safety

Every person on board a tanker plays an important part in the overall safety of the entire tanker and crew. We all have a responsibility for our own safety and we must also take reasonable care to protect the health and safety of our colleagues. This includes stopping work that you consider unsafe. Remember that you as an individual must exercise care in each and every action you do on board.

The risks and hazards on board will vary according to the nature and location of your work. Some risks, such as slips, trips and falls, you will need to proactively avoid each day, whereas others, such as operational hazards, may be occasional.

Always remember that you are the individual on board most responsible for your personal safety.

3.1 Induction and Familiarisation

As soon as you join the tanker, you should receive a safety induction and familiarisation.

Generally, this will involve a walk around most of the accessible parts of the tanker. It is very important that you listen to the safety information being provided and that you ask questions if you require clarification. It should also be emphasised to you that you should not conduct any work on board for which you are not sufficiently trained or competent.

If you are a sub-contractor or temporary personnel only on board for a short period, you may receive only a brief induction. However, BEFORE you carry out any work on the tanker, always ensure you have received an explanation of the safety procedures on board, including PTWs and the actions to be taken in an emergency/on hearing an alarm. Anyone remaining on board for a long period should receive an extensive familiarisation and your company will have procedures in place for this.

During an induction, important safety information should be provided to ensure that, in an emergency, everyone on board knows the appropriate action to take.

The following basic areas should be covered in your safety tour and during your induction:
Your role and responsibilities on board, including your job description, to whom you report and from whom you can ask for support in carrying out your job safely.
Information on the shipboard safety organisation, the safety officer, the designated person ashore (DPA) and how to extract information from the tanker's safety management system (SMS).
Alarm signals, muster stations and the location of designated lifeboats, lifejackets, survival suits, liferafts and other life-saving appliances, and your designated muster point in an emergency.
PPE requirements for all areas of the tanker. This should include verifying that you are issued with suitable PPE that is adequate for your tasks on board.
The actions to be taken if you discover a fire. This should include raising the alarm and identification of fire alarm activation points around the tanker. Fire-fighting appliances in all areas should be pointed out.
The actions to be taken in the event of a noxious liquid substance spill.
The actions to be taken in all other emergency scenarios, including man overboard and medical emergencies. This should include pointing out locations of first aid equipment and the ship's hospital.
The locations of permits to work (PTW) and areas where access is controlled by permit, safety plans, safety noticeboards, posters and copies of the muster list.
Escape routes around the tanker, including the nearest escape points from your assigned cabin.
Any restricted or hazardous areas and your designated ship security duties.
The tanker's garbage management plan and what to do with refuse while on board.
The tanker's smoking policy and the designated no smoking areas on board.
The tanker's cyber security procedures.
The location of emergency showers and eye wash stations.
The location of the current safety data sheet (SDS) and any safety noticeboards.

3.2 The Safety Officer

You should always discuss any safety concerns with your immediate superior on board; this may be your head of department or the supervisor of a specific work team. However, your primary contact on board for all occupational health and safety issues is the safety officer.

For most flag States, a ship is required to have an appointed safety officer. They are there to provide valuable assistance with all health and safety matters and should be approachable by anyone of any rank.

They should be familiar with the safety equipment on board, the company SMS and how to conduct risk assessments and PTWs. It is best practice for the safety officer to conduct your familiarisation tour, to include indication of your muster station and demonstration of how to use emergency equipment.

! It is your duty to report all unsafe acts and conditions immediately to a responsible person on board. This could be your head of department, the safety officer or the Master.

3.3 Slips, Trips and Falls

Slips, trips and falls (STF) are a major cause of injuries on board tankers. They can also be the initial cause for a range of other accident types, such as falls from height, a trip into a cargo tank or falling from a gangway.

Avoiding STF is partly about using your own common sense, but it principally requires you to be attentive to what you are doing and where you are going and that you do not hurry.

A study conducted among 6,896 seafarers from 11 countries (including China, Croatia, the Philippines, Poland, Russia, Spain and the United Kingdom) asked, "Were you injured during your latest trip at sea?" (including minor injuries) and "Did you fall, slip or trip in connection with the injury?"

The following statistics were drawn from the responses:

- STF accounted for 44% of all major injuries at sea
- in the study, the proportions of STF injuries against all other injuries were 37% in the engine room, 44% on the deck and 54% in the accommodation
- approximately 50% of STF injuries required a day off work
- 15% of serious falls happened on gangways or accommodation ladders
- STF injuries were slightly higher among officers, although this may be because they are more likely to report such injuries.

Some of the main environmental causes of STF are shown below:

Ship movements caused by rough seas.

Ice, rain, snow, thick fog, thunder, storms and humidity change are all climatic contributors to STF incidents.

Working in the engine room while the ship is moving, particularly doing repair work, chipping, painting and handling tools and parts.

During the handling of ropes, hooks and cargo lifting equipment.

Factors such as noise, vibration and poor illumination can all result in STF accidents, particularly where concentration is hampered by the surroundings.

Common STF hazards on board are.

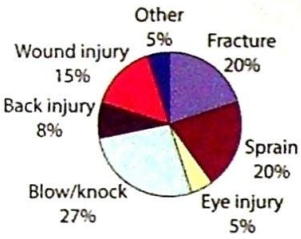
- Loose objects on the deck or walkways
- oily, greasy or wet walkways
- cables or hoses across walkways
- raised areas not marked
- items or equipment stored incorrectly.

The shipboard environment has many factors that combine to make a fall on board much more likely than when performing similar activities ashore These include walking surfaces made of smooth materials such as wood, fibreglass or steel, the constant movement of the ship and the constant presence of water Ships often have narrow, elevated walkways in engine rooms and around cargo areas and equipment.

Wearing unsuitable shoes is a major cause of STF accidents, both in the accommodation block and out on deck. This is compounded by hurrying or not using the marked walkways. Lack of attention to surroundings is a cause of STF incidents that can be attributed solely to the individual. Your attentiveness in moving about with care will help avoid this, as will ensuring your shoes are in good condition.

Inexperienced seafarers are more prone to accidents, partly because they have not yet adapted to the work and partly because they tend to take more risks. It is therefore important that, if you are at sea for the first time, you take care to move about the ship safely.

3.4 The Effects of Slips, Trips and Falls



Fractures, sprains, knocks and injuries to toes, feet or legs are the most frequent outcomes of STF incidents. Eye injuries or injuries to fingers, hands or arms are less common, but can still occur. STF incidents can also be fatal.

The pain from the after-effects of a slip, trip or fall can continue long after the incident.

3.5 Preventing Slips, Trips and Falls

As many causes of STF are behavioural, there is potential for prevention.

When moving around the tanker, remember to follow the old saying 'one hand for yourself and one hand for the ship'. You should have at least three points of contact when going up or down stairs and gangways. On companionways, you should always keep one hand free to grasp the handrail.

You can help prevent STF by adhering to the following aspects of best practice:

Move about the tanker carefully. Always keep a look-out for slippery areas, obstructions on deck, trailing leads or bights of rope and any unguarded openings.

Take responsibility. When obstructions or hazards are identified, take charge in rectifying the situation, provided you know how to do so safely, eg cleaning up a spillage or putting salt or sand over icy/slippery areas.

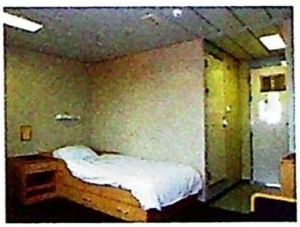
Wear the right footwear. Always wear footwear that is designed to resist slippage. This includes in the accommodation block. You should not, for example, wear loose-fitting sandals or flip-flops.

Remember you are at sea. Always be on your guard against any sudden movement of the tanker, regardless of your location on board or the activity you are undertaking. Most tankers will roll, so it is important to always be aware of where the nearest handrail is. This is obvious in heavy weather, but may be less so where, for example, the tanker alters course.

Move around safely. When walking on deck or in the engine room, always follow the marked walkways. These are anti-skid surfaces that help prevent slipping on wet decks. Do not run, even in an emergency.

Keep clear of operations if you are not involved. This is particularly important in mooring, anchoring, cargo handling and working at height operations. Only move in and around the area if you need to and it is deemed safe to do so.

Ensure you get as much proper rest as possible. While your rest hours are regulated under law and are determined by ship operations and emergencies, it is up to you to manage your rest hours effectively. Engaging in leisure activities is important, but it is also important to get sufficient sleep in between your watches or day work.



Make sure you have adequate lighting. Never attempt to carry out tasks without adequate illumination. Also remember that floodlights can create shadows and contrasts of light, so be careful when moving between lighted areas.

If you are experiencing fatigue or excessive tiredness, you should ensure that the proper authority, ie your head of department or officer, is notified. Remedial rest should be taken to ensure you are alert and vigilant, as you are more likely to have an STF if you are too tired to be attentive.

3.6 Life on Board

Life on a tanker can at times be stressful and tiring, particularly during frequent visits to ports and terminals. However, you must always comply with the requirements of your company and flag State with regard to:

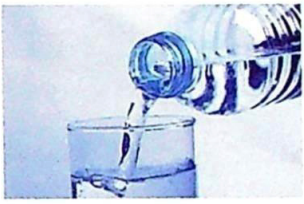
Hours of rest – you must ensure that you are fit for duty and have had sufficient hours of rest as per the regulations. This means being careful to gain adequate rest and avoiding entertainment that can impact on your working ability.

Drug use – illegal/recreational drug use is **PROHIBITED**. Prescribed medication should be taken in accordance with guidance from the issuing medical authority. The Master should be made aware of any off-the-shelf and/or prescribed medication in your possession.

Health and hygiene – it is your responsibility to practise a high standard of personal hygiene and to monitor and maintain your health. You should ensure that you take regular exercise and follow a sensible diet. Keep your working clothes in a clean condition, shower regularly and avoid wearing dirty or oily boiler suits as these pose a risk to your safety.

Alcohol and tobacco consumption – you must **ALWAYS** comply with the company alcohol and smoking policies. Only smoke in the designated area.

Climate – if you are working in hot or cold climates, always ensure you have adequate protection from the weather. In hot climates particularly, ensure you replace body fluids lost from perspiration and protect yourself from sunlight with clothing and sunscreen.



Environmental responsibilities – ensure you comply with your company procedures, including the tanker's garbage management plan and applicable MARPOL requirements, which, for example, restrict what type of garbage can be disposed of into the sea.

Responsibilities to others – be respectful to other crew members. For example, keep noise to a minimum while others are resting.

In the event of any personal problems, inform a responsible officer as soon as possible. There will be times on board when you have problems or issues at home, which you are unable to directly assist with due to the nature of your job. If this is ever the case, always feel free to raise the subject with someone on board. It can be easy to get distracted and overthink problems, which can in turn distract you from working as safely as you should be.

Never be afraid to ask for help. It is always better to ask others for help rather than keeping things to yourself.

Chapter 4
Manual Handling

This chapter sets out best practice to follow when manually handling items on board. Manual handling refers to a variety of tasks, such as carrying, lifting, lowering, pushing and pulling. We all do this daily with a range of objects and equipment. However, without the correct manual handling techniques, it can be easy to injure yourself, and it does not take something heavy or awkward to cause an injury.

A ship is not always a stable environment and it is critical that best practices are adopted to minimise the risk of injury on board.

Improper manual handling techniques are the second most common cause of injuries on board tankers, after slips, trips and falls. The majority of these result in back/spinal injuries.

4.1 Manual Handling

A wide variety of manual handling operations are undertaken on board ship, including:

Manual handling accidents can generally be avoided if proper techniques are used.

You should always begin any manual handling operation by carrying out an assessment. This will allow you to take sensible precautions, follow good lifting practice and minimise the risk of injury. You should also always follow any instructions and use any mechanical lifting equipment available.

4.1.1 Manual Handling – Assessment

This section lists the factors you should consider when making a manual handling assessment.

When assessing the potential risks of manual handling, first consider the impact of the tanker's general motion:

- Working and moving about within an unsteady environment, ie the ship rolling and pitching, can lead to loads being dropped
- there is increased risk of loss of balance and of slips, trips and falls, particularly when handling loads up and down stairs and ladders
- seasickness and tiredness from lack of sleep can lead to decreased manual handling capacity and increased operator fatigue.

Next, consider the load:

- Is it heavy or bulky and can it be made lighter or less bulky?
- is it difficult to grasp and hold?
- is it unstable or likely to move unpredictably (eg fluids) and can it be made more stable?
- is it harmful (eg sharp, hot)?
- is it awkwardly stacked?
- is it too large for the handler to see over?

Problems associated with moving loads on board a tanker must also be considered, eg:

- Restricted access, eg due to pipe arrangements
- hazardous external environment (eg snow, ice, tropical heat, wind, rain and seawater on deck)
- lack of space between or around items
- difficulty of moving trolleys around/over deck
- working at height
- risk of slips, trips and falls due to water/hydraulic fluid/oil spills on deck
- retention of loads on shelves in swell conditions
- handling loads up and down ladders.

In addition, some types of manual activity are more likely to warrant special consideration:

- Lifting items or smaller boxes from large packages onto manual handling equipment
- lifting/transferring loads from horizontal mechanical handling systems to crane hooks at hatch accesses
- handling within a confined space, eg cargo tanks
- handling hazardous loads, eg heavy awkward shapes, dirty or greasy items, moving parts
- handling liquid-filled containers
- team operations involving other crew, ie the need for clear communication
- handling near the ship side/over the edge, eg hoses and messenger lines (a harness and lifejacket may be required as a precaution).

Particular consideration should be given to movement within the accommodation and galley areas and between decks, including:

- The need for safety and fire doors to be kept closed, ie not propped open
- opening heavy marine doors and stepping over raised platforms/door coamings
- walking and carrying over distance
- avoiding excessive noise on cabin decks and around the accommodation
- carrying hot or hazardous loads
- moving loads vertically between decks and up/down stairwells
- carrying loads in or out of hatch accesses.

4.1.2 Manual Handling – Best Practice

The following points should be considered before undertaking lifting/carrying tasks on board:

Ensure PPE is worn if required. Avoid tight clothing and unsuitable footwear

Minimise the weight to be handled. Additionally:

- handling items with others in a team will help improve the total handling capacity
- split the load if safe to do so. Use smaller containers, preferably for one-handed use so the other hand is free for balance
- use mechanical equipment whenever this is safely possible, eg use of the crane
- use handles, hooks and other features on the objects themselves to get a firm grip
- balance and stabilise the contents

Fully consider all access routes during the handling process and:

- ensure there is clear space to stand close by the load when lifting and lowering
- ensure there is sufficient space to see over and around the load
- avoid reaching over or under anything to get to the load
- ensure there is sufficient space to undo, fit or remove securing straps, bolts, etc
- consider reducing the number of doors to be negotiated
- for large objects, check by measuring beforehand that it will fit through any openings or hatches
- identify the storage space prior to moving
- ensure that loads are not left in any public corridor spaces, etc

Minimise reach and lift distances, noting to:

- increase the height at which the lift is initiated
- stack objects no higher than shoulder height
- avoid working at height as much as practicable
- avoid manually handling up and down ladders and stairwells as much as practicable

Increase the time available for handling. Additionally:

- do not rush any handling or lifting operation. Ensure plenty of time is available
- reduce the frequency of handling operations by careful planning
- rotate jobs between crew members if possible
- consider the need for rest periods

Ensure others are aware of heavy, awkward or hazardous items. Importantly:

- highlight verbally such items to other crew, particularly if passing objects
- read the labels, packaging and accompanying delivery notes
- label heavy items, particularly if placing in stores for an indefinite period
- ensure hazardous items are identified and stored safely
- consider splitting heavy boxes into smaller, more manageable loads.

The recommended method for lifting an object safely is as follows:

Keep the load close to your waist. Ideally, keep it as close to your body for as long as possible and also keep the heaviest side of the load next to your body

Adopt a stable and good starting position. Ensure that your feet are apart with one leg slightly forward to maintain balance

Begin lifting correctly. Ensure that you only slightly bend your back, hips and knees, as fully flexing (stopping or squatting) should be avoided

Once the lift has begun, do not flex your back further

Avoid twisting your back or leaning sideways. Keep your shoulders level and facing in the same direction as your hips. If you need to turn, turn by moving your feet instead of twisting and lifting at the same time

Move smoothly and carefully. Keep your head up and look ahead and do not move quickly.

As a general rule, manual handling when the tanker is moving to any significant degree should be avoided.

Chapter 5
Personal Protective Equipment

Personal protective equipment (PPE) refers to clothing and equipment worn to protect the user.

The type of PPE required will depend on the task, the circumstances and the environmental conditions at the time. Your company's SMS should include a PPE matrix that identifies when and where to use what PPE.

Chemical cargoes present unique health hazards against which personnel must be additionally protected. Therefore, chemical tankers are required to carry specific PPE applicable to the cargo(es) being carried.

The selection of this additional PPE must be made after consulting the safety data sheet (SDS) for the cargo.

You should also keep in mind the following best practice when using PPE:

- Where the PPE is complex or new to you, ask for instruction to ensure you know how to use or wear it correctly and understand its limitations
- if you do not have adequate PPE to carry out a job, speak to the safety officer to obtain what you require

- inspect your PPE before use and replace any items that have become worn or damaged.

Remember that using PPE is not a substitute for taking other precautions or following the control measures that have been identified during a risk assessment.

5.1 Head Protection

Head injuries can be fatal, so you should always pay particular attention to head protection. You can be at risk during a variety of shipboard operations:

- Any activity that involves working below other personnel, or below fixed or temporary equipment, introduces the risk of injury from falling objects or substances
- any task near moving machinery, such as during lifeboat training, introduces a risk from contact with moving parts
- working at height or within enclosed spaces adds a risk of injury, eg at the top of a cargo tank
- operational tasks, such as cargo, anchoring or mooring operations, pose a potential risk of head injury, eg crane operations, connecting hoses and making fast ropes and wires.

If using a helmet, be sure to inspect it before use for any signs of damage and replace it if necessary.

For hygiene reasons, you should avoid sharing head protection. Keep any helmet, inserts and supporting straps clean, using soapy water.

Always use head protection if there is any possibility of injury or risk to your head. It is good practice to take head protection with you when leaving the accommodation.

Always use the supporting head strap, as this will keep the protection on your head if you have a slip, trip or fall.

5.2 Eye and Face Protection

Eye injuries can be irreversible and facial injuries can be traumatic. Tasks that present a risk of such injury include:

- Painting, shot blasting, welding or cutting operations
- the use of fixed and portable hand tools such as drills and grinders
- work involving chemicals
- activities that create dust particles or vapours.

Selection of the appropriate eye and face protection will depend on the task and may include:

- Safety spectacles – toughened glasses with or without side shields
- safety goggles – made of flexible plastic with an elasticated strap. When working with chemicals, these should be chemical resistant
- eye shields – normally a moulded box-type lens worn over ordinary spectacles
- chemical spray hoods – typically designed to protect the head, neck and shoulders
- face shields – designed to protect the full face. As they are not normally sealed, they will not fully protect against dust/vapour/gas.

Whenever you enter a working area, remember to put on your safety glasses, even if you are only passing through.

5.3 Respiratory Protective Equipment

Many onboard activities create an uncomfortable or hazardous atmosphere, necessitating the use of dust masks or respirators. Such activities include painting, grit blasting, burning, cutting and welding operations and any other task that generates dust particles in the atmosphere.

There are various types of respirator/filter mask:

- Dust respirator – generally a half mask of a simple lightweight construction that covers the nose and mouth. They protect against dust or aerosol sprays (eg paint)
- positive pressure respirator – a facepiece, hood or helmet with a battery-powered unit that blows air via a tube to create positive pressure inside the mask
- cartridge respirator – either a half or full facemask, with a replaceable cartridge and filter
- canister respirator – a full facemask connected to a separate canister.

Respirators/filter masks should not be used during cargo/tank cleaning operations. Respirators only protect the user by filtering dust or particles in the air, such as from paint spraying. They do not protect you against concentrations of toxic vapours or hydrocarbons or against oxygen deficiency.

Never confuse a respirator with 'breathing apparatus'. They are two different pieces of equipment. Breathing apparatus must always be used when an air supply is required for entry to an enclosed space in an emergency, such as during the rescue of a collapsed crew member.

5.4 Ear Protection

If you work in machinery spaces on board or carry out activities with a high level of noise, you must protect your hearing. For hygiene reasons, you should not share your ear protection. Ear protection may be either disposable or permanent:

- Ear plugs – these are simple to use and fit into the ear canal. In areas of high frequency, they are prone to vibration, which can reduce their effectiveness. It is recommended that ear plugs are of the disposable type and are not used by personnel with ear problems
- ear defenders – these are commonly constructed of rigid cups with padded surfaces and an adjustable headband. Ear defenders offer greater protection than ear plugs.

The IMO *Code on Noise Levels on Board Ships* states that hearing protection should be worn when entering or working in a space or working with machinery or equipment where the noise level exceeds 85 dB(A). This is equivalent to the noise from a truck driving past at 40 mph when you are standing 15 m away.

Hearing damage may not be noticeable straight away, but frequently ignoring the use of ear protection can have long-term detrimental effects on your hearing.

5.5 Body Protection

Body protection is essential in all work areas and should provide complete protection appropriate to the task, the environmental conditions and the substances being handled.

Basic body protection may include boiler suits (standard, thermal, lightweight and fire retardant), jackets, chemical suits, aprons and welding tunics.

Due to the hazardous nature of the cargoes, chemical tankers also carry chemical-resistant clothing and PPE to protect the wearer from contact with toxic or corrosive chemical products. In accordance with the IBC Code, the ship should provide large aprons, special gloves with long sleeves, suitable footwear, coveralls of chemical-resistant material and tight-fitting goggles.

Chemical-resistant protective suits, gloves and face protection should always be used where there is a risk of exposure to chemicals, for example during manifold operations, sampling and tank cleaning.

The type, design and degree of protection should be based on the properties of the chemicals being transported. Protection is typically categorised according to ISO or US NFPA standards. It is important that all PPE, including clothing, provides the correct protection against the risk of harm from the chemicals on board. Further guidance is available from the SDS of each product and in your company PPE matrix.

This PPE should be kept in readily accessible places, as well as special lockers, external to the accommodation. If the wearer is exposed to a hazardous chemical, the PPE should be washed down before removal and then cleaned and dried in accordance with the manufacturer's guidance.

Always take a moment to choose the body protection most appropriate to the task you are undertaking.

5.6 Hand and Finger Protection

Gloves are an essential form of protection for your hands and fingers. It is essential that they fit properly and will provide protection against the particular hazards associated with the task, eg:

- Chemicals and micro-organisms
- abrasion and penetration, ie cuts and puncture wounds
- high and low temperatures
- electric shock
- mechanical risks.

Different gloves are used for different purposes:

- Synthetic, PVC or rubber gloves – used when handling solvents or other substances
- heat-resistant or chemical-resistant gloves – used when contact with heat or chemicals is likely
- leather gloves – used when cuts and abrasions are likely.

If you have allergies to certain materials, you must ensure you select an appropriate alternative.

Always replace gloves that are oil or grease soaked. A common skin irritation called dermatitis can develop from skin being in prolonged contact with chemicals/oil/grease.

Hand and finger protection should be used in all circumstances where there is the potential for contact with harmful substances, chemical or thermal burns, abrasions, cuts, punctures or contact with equipment.

5.7 Foot Protection

Always ensure your footwear is in good condition, fits comfortably and is correctly laced.

Suitable footwear is essential because, in addition to avoiding discomfort from working on hard steel decks, it provides protection from:

- Slips, trips and falls
- dropped objects (crushing)
- penetration through the shoe's sole
- electrical hazards
- chemical hazards
- contact with abrasive and moving machinery.

Always wear foot protection that is suitable for work on board ship.

5.8 Fall Protection

Fall protection is required when working at height, but there are also situations at deck level or within tanks where the risk of a fall may be considerable, eg:

- Where access ways are removed or deck openings are in the open position for operational purposes, such as loading stores into the engine room
- over-the-side work, where there is the potential to fall into the water or onto the quayside
- gangway, pilot ladder or accommodation ladder rigging or unrigging operations
- work at height within tanks that have been made safe for entry
- maintenance work on cranes, derricks, masts or in the engine room.

Fall protection equipment includes:

- Work restraint – a lanyard that restricts the movement of users to safe areas only, ie it prevents users from getting too close to an edge
- work positioning – enables work to take place when suspended or under tension, eg a stage or bosun's chair. An additional safety line is required
- rope access – where two ropes are attached to a harness with one acting as a safety line. Ropework is used to access areas unsuitable for scaffolding or cradles
- fall arrestor – in the event of a fall, this device prevents the user from hitting the ground or limits the force of impact

The type of fall protection equipment required should be identified in the risk assessment and should be chosen and inspected by the officer in charge of the work.

Fall protection equipment is only effective if it is properly maintained and suitable for the task being undertaken. Using the wrong type of working at height equipment can have the same effect as not using any at all.

5.9 Buoyancy Aids

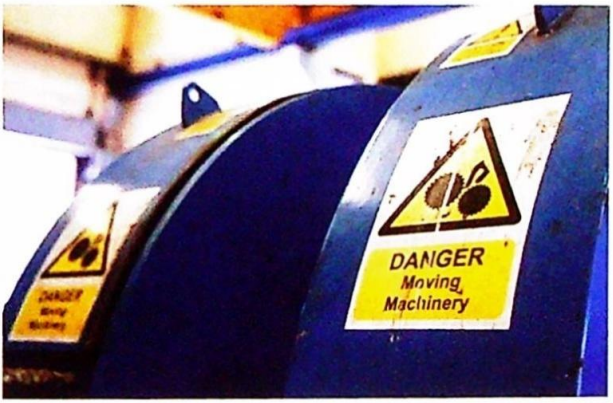
Buoyancy aids, lifejackets and immersion suits may need to be worn when working at, near or over the side of the tanker. The type of aids should be identified in the risk assessment and should be chosen and inspected by the officer in charge of the work.

Approved lifejackets and personal buoyancy aids will often be worn at the same time as thermal protective clothing, fall arrestor equipment and other forms of PPE. The equipment should not obstruct arm movement and must be correctly fitted.

If it is possible for you to fall overboard, a lifebuoy attached to a line should be nearby and readily available for immediate use. Ensure you are being monitored by another crew member who is in communication with the officer of the watch (OOW).

If there is any possibility of a fall overboard during an operation, buoyancy aids, including flotation/immersion suits and lifejackets, must be worn.

Chapter 6
Equipment Hazards



You will use a variety of work equipment during your time on board. This may include hand tools and portable equipment, or fixed appliances, installations and machinery (such as in the engine room workshop).

Regardless of the type of tool or equipment, make sure you inspect it before use, as damaged tools and equipment are a safety hazard to you and your fellow crew.

Ensure that you have been trained in the correct use of any equipment before operating.

6.1 Fixed Equipment

Fixed equipment on board will have specific guidelines on how to use it and the PPE you must wear while using it. Regardless of the type of equipment:

Always

- Visually inspect any equipment before you use it. Check that it is in good condition, correctly maintained, properly adjusted and suitable for the task
- use the tool or equipment for the purpose for which it is designed. Do not use an unsuitable tool or take shortcuts, as this often leads to accidents. Instead, use the correct tools and equipment, even if this means it takes additional time to complete the task
- follow the manufacturer's instructions, the training you have received and any company guidelines on the correct use of any onboard equipment
- know how to correctly use the safety features of the equipment, eg emergency stops, power isolation points, finger guards, etc.

Never

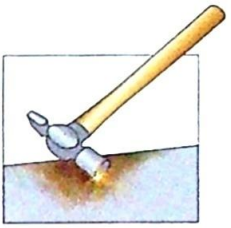
- Bypass or disable safety features
- use equipment if you are not confident in its operation
- use tools or equipment if they appear to be damaged or defective

6.2 Portable Tools and Equipment

If you are using portable tools, such as chipping tools and wire brushes, you must wear appropriate PPE, in particular to protect your eyes and hands. Take care to ensure that your tools do not present a tripping hazard to other crew members. If you are using pneumatic (air-powered) equipment, you must take adequate intervals of rest throughout the operation.

Portable tools should never be allowed to fall from your grasp. Falling tools can:

- Injure you or other crew members, particularly persons below you
- cause sparks if they strike against another metal (even 'non-sparking' tools can be a hazard)
- fall into a piece of machinery, causing it to jam or fail.



Tools should always be carried in a well-secured bag or safeguarded against falling using a lanyard.

If you are using pneumatic tools, a whip arrestor should be fitted at both the connection from the tanker's air supply to the hose and also from the hose to the hand tool. This is to prevent the hose flailing in the event of a break or failure.

When working in and around cargo tanks or spaces where flammable gases may be present, always use the approved equipment provided, such as air-driven tools.

Portable electrical equipment used outside the accommodation on a tanker must be of an approved type, ie suitably insulated/intrinsically safe. Standard electrical equipment (ie not approved) should not be used outside the accommodation due to the risk of ignition of flammable gases.

6.3 Hot Work

Hot work refers to any task that carries a risk of ignition, eg welding or grinding, or any similar activity that generates heat, flames or sparks. It should only be undertaken if there are no other practical means of completing the task. Before commencing hot work, ensure that:

- The SMS is consulted and a risk assessment conducted
- a competent person has authorised the job and there is a valid PTW
- the equipment has been inspected and deemed suitable for the work to be undertaken
- workers are trained in the safe use of the equipment and are wearing the correct PPE
- the atmosphere is tested before the start of the work and frequently thereafter, as specified on the PTW.

Hot work should not be conducted on a tanker unless a competent person has deemed it safe through a thorough risk assessment and testing of the atmosphere in the space.

6.4 Laundry Equipment

The ship's laundry is a common place for fires to start. Spontaneous combustion and fire can occur when there is a build-up of dust, lint and electrostatically-charged particles. To help keep risks to a minimum:

Always

- Read the instructions on how to safely use the laundry equipment
- clean the equipment and empty the lint collector before and after use so as to prevent combustible material accumulating

- practise good housekeeping in the laundry room, eg do not leave heaps of boiler suits around the space
- use the drying room and specialist equipment correctly and in a professional manner
- keep the fire door to the laundry compartment closed.

Never leave wet laundry on top of electrical equipment.

6.5 Use of Paints and Working Chemicals

During your time on board, you may use a variety of paints and chemicals in different maintenance and cleaning operations. Some of these substances may be hazardous if not used correctly. The following best practice should be observed:

Always

- Read the SDS and accompanying handling information before using paints and chemicals
- wear PPE when working with paints and chemicals so that substances do not come into contact with your eyes or skin
- ensure that any worksite is suitably ventilated and, if necessary, gas test the area
- take regular breaks for fresh air if working inside.

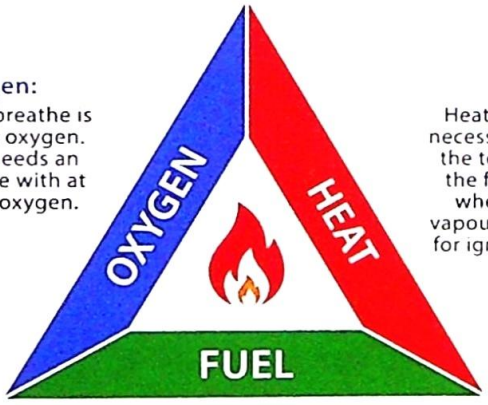
Never

- Leave paints and chemicals unattended. They should be stored safely when not in use, in a designated space on board with specific fire-fighting arrangements, such as the paint storage locker or the chemical storage locker.

Chapter 7
Fire Hazards and Extinguishing Fires

Fire is a chemical reaction involving rapid oxidation or burning of a fuel. The 'fire triangle' provides a good explanation of the three elements a fire needs to exist.

Oxygen:
The air we breathe is about 21% oxygen. Fire only needs an atmosphere with at least 16% oxygen.



Heat:
Heat is the energy necessary to increase the temperature of the fuel to a point where sufficient vapours are given off for ignition to occur.

Fuel:
Fuel can be any combustible material – solid, liquid or gas. Solids and liquids normally need to produce enough vapour or gas before they will burn.

Take away any one of these elements and fire cannot occur, or it will be extinguished if it was already burning.

7.1 Fire Hazards

Cargo flammability is one of the greatest hazards on a tanker. The presence of chemical vapours, in sufficient quantities, together with oxygen and an ignition source can lead to fire and explosion. This is why the cargo tanks are sometimes inerted.

Fire has the potential to destroy the tanker and therefore it is essential that you take the utmost care in fire prevention, by adhering to safe practices and specifically by controlling the potential sources of ignition on your tanker.

Potential sources of fuel for a fire include not only the cargo, but also any combustible material on board, such as rags, paper, gas cylinders and oils. This means that there is a risk of fire in all areas of the tanker, including the cargo spaces, accommodation, engine room and storage spaces. Additionally, flammable mixtures can be found in places where you least expect them, ie not just inside the cargo tanks. Piping and venting arrangements will also contain cargo residue, as may any space adjacent to the cargo tanks if there is a leak between spaces.

Common accidental sources of ignition include:

- Smoking – heat from lit tobacco, or even used tobacco, can ignite vapours drawn in through the ventilation system. A carelessly discarded cigarette may accidentally come into contact with combustible material
- lighters, matches and candles – these heat sources can come into contact with combustible materials or ignite vapours
- portable electrical equipment – only approved (intrinsically safe) electrical equipment should be used outside the accommodation
- electrostatic discharge (spark) – this can occur during certain operations, eg steam cleaning or cargo measurement

- poor housekeeping and carelessness – locations at risk include the laundry and storage spaces. Best practice should be followed on board, including good housekeeping and cleaning regimes. Always ensure that dirty rags and waste are suitably disposed of and that dirty boiler suits are cleaned thoroughly, particularly if contaminated with oil.

Never

- Smoke a cigarette, cigar, pipe or vaping device in any area of the tanker that is not specifically designated as a safe location
- smoke in your cabin, unless it is a designated safe location and even then never smoke in bed
- ignore onboard instructions about smoking. In some ports and terminals, local authorities will prohibit smoking both on board and ashore during the entirety of your port stay
- use a lighter; these should not be brought on board. Gangway security should ask all personnel if they are carrying a lighter and confiscate any that are found
- carry matches around the tanker. These should be kept in the designated safe locations only
- use candles or any items with a naked flame

Your company's SMS will contain a garbage management plan, which provides information regarding the correct procedures to dispose of various items, such as oily rags or flammable material. Oily rags, for example, should be stored in a metal container with a lid to limit the potential for spontaneous combustion.

Use of personal electronic devices outside of the accommodation block is prohibited. All personal electronic items, such as phones, smartwatches, electronic wristbands, laptops, tablets and audio players, should be left inside the accommodation. This applies to all persons on board, including inspectors and visitors. Only approved intrinsically safe electronic devices, such as insulated torches or gas detection equipment, should be used on deck.

7.2 Discovering a Fire

If you discover a fire on board, you should immediately attempt to inform others and raise the alarm. Getting as many people to respond and help is essential. You should only fight a fire yourself if:

- It is small and confined to the immediate area where it started. Generally, if you do not get to a fire within two minutes, you will be too late to stop it on your own
- you have a way out and can fight the fire with your back to the exit
- you have an extinguisher to hand that is rated for the class of fire in progress.

Remember:

F	Find a fire.
I	Inform others by raising the alarm – this can be verbally, by phoning the bridge/engine room etc or by shouting to nearby personnel. There are also fixed alarm points located around the tanker.
R	Restrict the spread of the fire by containment, such as closing a door.
E	Extinguish if possible.

Only attempt to fight a fire if the above criteria apply. If the smoke is too dense, close the door to the space and call for assistance. It may be possible to contain and extinguish the fire with support from the rest of the crew. If you have even the slightest doubt about whether you can extinguish the fire, then don't. Get help and do not risk your life.

7.3 Classes of Fire

Class A
Fires involving solid materials, usually of an organic nature, eg wood, paper.

Class B
Fires involving liquids or liquefiable solids.

Class C
Fires involving gases.

Class D
Fires involving metals.

Class E
Fires involving energised electrical equipment.

Class F
Fires involving cooking media used in cooking appliances, eg vegetable oil in a deep fat fryer.

Understanding the type of fire you are dealing with is critical in identifying how to respond effectively.

7.4 Types of Fire Extinguisher

As an individual, the primary method of fighting a fire on discovery will be to use a fire extinguisher, or a fire blanket if you are in the galley. A fire extinguisher works by taking away one or more elements of the fire triangle.

There are several different types (or classes) of fire extinguisher, each of which extinguishes specific types of fire.

Newer fire extinguishers are mostly coloured red and have a picture or colour labelling system to indicate the types of fires they can be used on.

The colour coding is generally as follows:

- Red – water
- blue – dry powder
- black – carbon dioxide (CO_2)
- cream – foam
- others – specialist purposes, eg chemicals.

On older fire extinguishers, the whole extinguisher is coloured, not just the label. Always read the label to make sure you are using the correct extinguisher.

The various extinguishers should be used as follows:

- Water extinguishers (red label) – these are suitable for most fires except:
  - » flammable liquids. Adding water to a burning liquid will only help to spread the fire
  - » electrical equipment. Water is a lethal conductor of electricity and improper use of a water extinguisher could cause death or serious injury
- dry powder (blue label) – dry powder is suitable for fires that involve flammable liquids or electrical appliances. The powder extinguishes the fire by smothering it and stopping it getting enough oxygen
- carbon dioxide (CO_2) (black label) – this type of extinguisher is also suitable for flammable liquids and electrical appliances. It works in a similar way to a dry powder extinguisher, ie it swamps the fire with carbon dioxide and prevents the fire getting enough oxygen
- foam (cream label) – this type of extinguisher works by smothering the fire, rather than cooling down and damping the flames. It is suitable for most fires involving flammable liquids, but should never be used on an electrical fire.

It is important to understand that there are different types of fire and the correct extinguishing method must be used for each. If you use the wrong type of fire extinguisher, you may make matters worse.

7.5 Using a Fire Extinguisher

All fire extinguishers work in a similar way and there is a useful acronym, PASS, that will help you to remember the correct method:

P	Pull out the pin at the top of the extinguisher. The pin prevents the handle from being pressed accidentally.
A	Aim the nozzle towards the base of the fire.
S	Stand approximately 8 ft (2.5 m) away from the fire and squeeze the handle to discharge the extinguisher. If you release the handle, the discharge will stop.
S	Sweep the nozzle back and forth at the base of the fire. After the fire appears to be out, watch it carefully, as it may reignite.

The following operational considerations also apply to certain types of extinguisher:

- Water extinguishers – aim the jet at the base of the flames and move it over the area of the fire
- dry powder extinguishers – aim the jet at the base of the flames and briskly sweep it from side to side. You must be aware that:
  - » the powder will not cool the fire well
  - » fires that seem out can reignite
  - » the powder does not penetrate small spaces, such as those inside electrical equipment
  - » using dry powder in a small or confined space can severely reduce the visibility inside, as well as create an unbreathable atmosphere
- carbon dioxide (CO_2) extinguishers – as the CO_2 disperses quickly, these extinguishers are only effective at distances of 3–8 ft (1–2.5 m) Care should be taken when using a CO_2 extinguisher in a small space as it will adversely affect the breathable atmosphere. The CO_2 is very cold as it comes out of the extinguisher, so it cools the fuel part of the fire triangle. The cooling effect of the CO_2 will often cause

ice to form around the 'horn' where the gas is expelled from the extinguisher. Do not hold the horn when operating the extinguisher as your hand could freeze to it. To prevent the fire from reigniting, it is important to continue to apply the CO_2, even after the fire appears to be out

- foam extinguishers – for solids, aim the jet at the base of the flames and move it over the area of the fire. For liquids, do not aim the foam straight at the fire, but instead aim it at a vertical surface or, if the fire is in a container, at the inside edge of the container. When using a foam extinguisher, water is likely to be discharged at the beginning before the foam is produced. On a liquid fire, this can cause a 'flash'.

Even if you extinguish the fire in an initial reaction, it can easily reignite and you MUST still raise the alarm. Once support arrives from the tanker's fire response teams, you can then commence cooling of the adjacent boundaries and this will hopefully prevent the fire from reigniting and spreading. It is essential that the fire teams muster and respond as quickly as possible to a fire, so never forget the importance of communication.

The fire teams will assemble according to the muster list and response procedures. If you are responding to a fire alarm, report to your designated muster point. If you are part of the fire team, follow the training you have received ashore and on board.

The time to use an extinguisher is in the early stages. If the fire is already spreading quickly, you should leave the area, ensuring that you close all doors and vents behind you. If you suspect that the fire is producing toxic smoke, you should evacuate immediately. When using an extinguisher, always position yourself with an exit or other means of escape at your back.

Chapter 8
Chemical Cargoes and Vapours

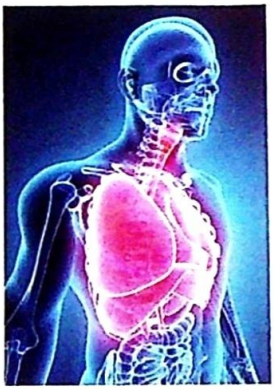
Chemical tankers carry a wide range of chemical cargoes, and the hazards connected with one type of cargo may not apply to another. Contact with hazardous/toxic substances or gases, or exposure to an oxygen-deficient atmosphere, must be prevented. If these hazards, known as environmental hazards, are understood and carefully mitigated through established best practice, the likelihood that you could be harmed will be significantly reduced.

An environmental hazard is anything that has the potential to adversely affect a person's health.

8.1 Safe Working Limits

Humans need a suitable atmospheric environment in which to live without adverse effects to health. Primarily, this requires sufficient oxygen (20.9%) for normal breathing, but it also includes the absence of noxious and toxic gases in any quantity that can cause harm. For example, when oxygen levels drop below 19.5%, our mental functions become impaired, our respiration struggles and, if concentrations go low enough, we may die.

In a similar manner, contact with toxic substances can have a severe effect on health. Toxic substances in high concentrations can cause injury to bodily organs, long-term medical problems and even death.



Therefore, safe working environmental limits for gases and substances will exist on board your tanker, as set by the relevant flag State (national authority). The terminology applied to working limits for hazardous materials varies between national regulations and you may encounter one or more of the following terms:

- Short-term exposure limit (STEL) – this is the average concentration permitted for a 15-minute exposure
- time-weighted average (TWA) – this is the average exposure over a specified period
- threshold limit value (TLV) – this is the average concentration under which most people can work consistently for 8 hours every day with no harmful effects
- workplace exposure limit (WEL) – this is the upper and lower legal limits for any substance or toxin that may have adverse health effects
- occupational exposure limit (OEL) – this is the value of a substance that is considered safe in the air of a workplace
- maximum admissible concentration (MAC) – this is the maximum exposure level of a physical or chemical agent allowed within a standard 8-hour working day.

Gases and vapours are expressed in parts per million (ppm). You can obtain further information about these limits from your flag State, your company SMS and any safety data sheets (SDS) carried on board.

Regardless of the terminology you may come across, you should NEVER exceed the limits and standards set by the flag State of your ship.

If you are required to enter or work in any space on board, you must ALWAYS ensure there is sufficient oxygen and an absence of toxic gases BEFORE you enter the space.

8.2 Safety Data Sheets (SDS)

It is a requirement for the ship to make cargo data sheets available to all personnel on board. They are generally posted on the safety notice board. SDS are unique to the product and are issued by the chemical manufacturer.

SDS should be consulted as part of a comprehensive risk assessment for any task, so that you can identify the risks, controls, appropriate equipment and PPE you may need for the job.

SDS may vary slightly in their presentation, but they will contain the same generic information on the chemical:

- Identification of product and manufacturer
- composition of the product
- main hazard identification
- first aid measures
- fire-fighting measures
- accidental release measures
- handling and storage
- exposure control and health data
- physical and chemical properties
- stability and reactivity

- toxicology information
- ecological information
- disposal considerations
- transport information
- regulatory information
- other information.

8.3 Chemical Hazards

The carriage of hazardous cargoes, and even the use of oils and chemicals on board for operational reasons (such as cleaning), may present a potential health hazard. These substances may be in mist/spray, vapour or liquid form.

The potential hazards of most liquid chemical cargoes can be categorised as:

- Corrosive
- poisonous and toxic
- flammable
- reactive.

Some chemicals may fall into more than one of these categories and should be handled in accordance with the properties of each hazard. Additionally, vegetable and animal oils have their own distinct hazards.

You may come across these chemicals in a variety of situations, eg during connection/disconnection of the manifold, as residue from certain operations or when a leak occurs from a pipeline under pressure.

Cargo vapours can be harmful if inhaled. Chemicals can also damage your skin, blocking pores and causing rashes and dermatitis. Additionally, some chemical cargoes can cause serious long-term effects and there is a risk of cancer if they are left on the skin for extended periods.

Never

- Stand under or inhale cargo mists or spray
- allow petroleum or chemicals to settle on your skin or saturate clothing. If your skin comes into contact with a substance, use water (and a recommended cleaner) to remove it as quickly as possible. Change your clothing for a clean set; do not wear an oily or dirty boiler suit
- stand or lean on pipelines under pressure and NEVER attempt to disconnect a pipe or manifold that is under pressure
- keep oily rags in your pocket. Once they have been used, ensure they are disposed of in accordance with your tanker's garbage management plan.

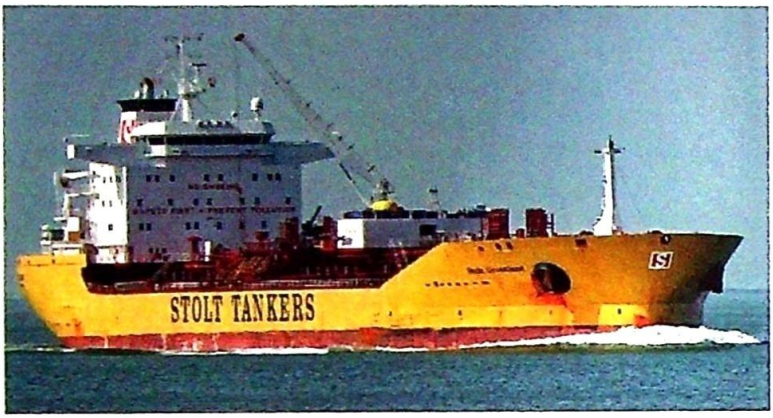
As part of onboard best practice, you should clean your working area whenever practical, but at least on completion of your task, so that other crew members do not come into contact with potentially harmful substances. Residual oil or chemicals may not be readily apparent to someone else.

You should also remember that you are in charge of your own personal hygiene. Not only can poor personal hygiene have negative effects on your body, but it can be uncomfortable for those around you as well.

Shower daily and clean your clothes regularly using the onboard facilities to ensure that no traces of cargo residue are left on your skin.

Always wear appropriate PPE, as determined by your company's PPE matrix, so that you are properly protected for the job you are undertaking.

8.4 Case Study: *'Stolt Groenland'*



Courtesy of UKMAIB

'Stolt Groenland' was a Cayman Island registered chemical/product tanker.

It loaded 5,250 t of styrene monomer in Houston, USA between 7th–8th August 2019.

Its destination was Ulsan, South Korea, after a transit through the Panama Canal and several other port calls between Japan and South Korea.

The chemicals

Styrene monomer is an industrial compound that is highly flammable and has a flashpoint of only 32°C. It is toxic and reactive, but is usually stable when carried at ambient temperatures. Is it commonly used in the production of plastic, paints and synthetic rubbers.

Certain chemicals, such as styrene monomer, carry a risk of polymerisation. This is a chemical reaction in which two or more molecules combine to form larger molecules. This reaction can be exothermic, which can cause a large increase in heat and subsequent pressure inside a cargo tank.

To reduce the possibility of polymerisation during transit, an inhibitor, in this case tert-butylcatechol (TBC), is added. An inhibitor is a substance that, when added to another chemical, can prevent chemical reactions or polymerisation taking place. This is provided enough inhibitor is added, at the correct ppm, to last for the duration of the voyage.

Exposure to water or higher temperatures can weaken or use up the inhibitor at a faster rate than expected. It is also important to maintain exposure to oxygen at the correct levels within ullage spaces for the inhibitor to work. Once the inhibitor is no longer effective, the chemical cargo is at serious risk of polymerisation.

The loading operation

Prior to loading the styrene monomer, the tanks of the *'Stolt Groenland'* were water washed and inspected. No problems or remaining water were recorded. In accordance with the loading instructions, the tanks were also not adjacent to any heated cargoes.

The loading operation in Houston was overseen by a cargo surveyor, who issued the certificate of inhibitor to verify that the styrene monomer had been inhibited with TBC.

It was stated that the inhibitor:

- Would be effective for between 60–90 days
- was oxygen dependent to work effectively
- had an ideal carriage temperature of between (15.5–29.4°C).

Note: The ship did not carry any additional inhibitor for the voyage.

The accident

At 10:43LT on the morning of 28th September 2019, cargo tank 9S, which was carrying the styrene monomer, began rapidly releasing vapour from its pressure/vacuum (P/V) valves. Two minutes later, the 95% followed quickly by the 98% high-high level alarms activated.

Soon after, there were two explosions in quick succession. The first was believed to be the tank itself rupturing from the pressure increase inside. The second was the styrene monomer vapour igniting, probably from static electricity, sparks or elevated steel deck plate temperatures resulting from the tank rupture.

Findings

The polymerisation of the styrene monomer was probably caused by an insufficient amount of cargo inhibitor by the time the ship arrived in Korea. This allowed the styrene monomer to begin to polymerise, which, as the reaction is exothermic, caused its temperature to rise to the point where the reaction is self-sustaining. This is referred to as 'runaway polymerisation' and is very difficult to stop under these conditions.

8.5 Corrosive Cargoes

Corrosive cargoes are mostly carried in stainless steel tanks and transferred through stainless steel pipelines, pumps and systems. Some corrosive cargoes may be carried in tanks that have resistant coatings, but cargo transfer systems are usually stainless steel.

Corrosive cargoes can adversely affect your health and safety in the following ways:

- Corrosive liquids destroy human tissue, causing serious damage that may be permanent
- they can corrode the cargo tank construction materials, pipes, pumps, other equipment and fittings
- corrosive liquids can become flammable and produce flammable gases when in contact with some materials.

If you are dealing with corrosive cargoes, the following precautions should be taken:

- When handling corrosive cargoes, you must wear the required PPE as indicated in the SDS and your company PPE matrix
- you should be aware of the nearest emergency shower and eye wash stations, as well as the emergency response procedures for contact with any corrosive chemicals
- exercise caution in all operations where you may potentially be exposed to the product, particularly when opening up a tank, space, valve, line or blank.

If you are splashed with corrosive liquid, remove your clothes and wash yourself with plenty of water. You should inform the duty officer immediately to obtain medical advice.

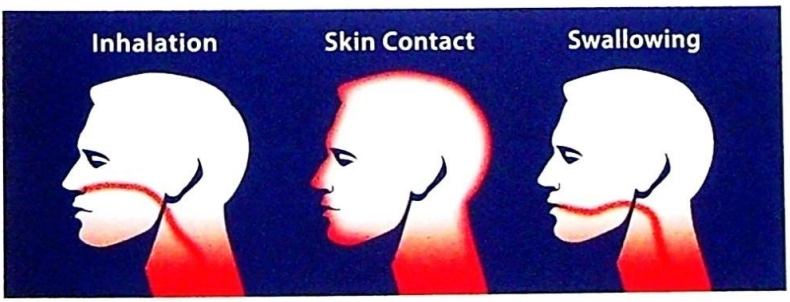
Report all accidents or spillages, including minor events, to the duty officer or Master.

8.6 Toxic and Poisonous Cargoes

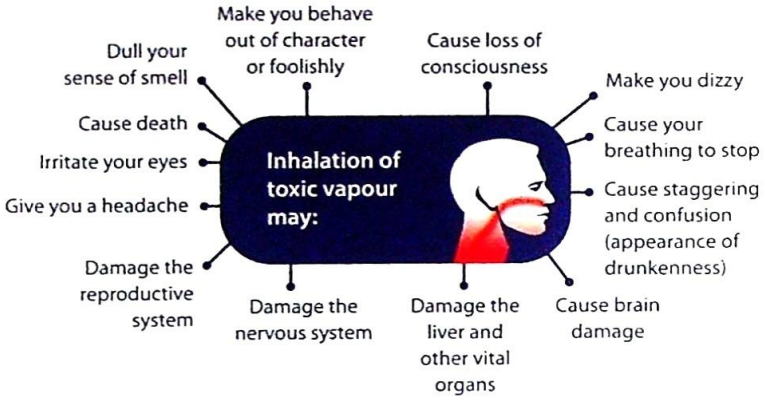
Toxic and poisonous cargoes are carried in both stainless steel and coated tanks. They are always handled under closed conditions and for some cargoes with particularly high toxicity the cargo vapour may need to be returned ashore. This is achieved by connecting the cargo tank venting system to the vapour return connection provided by the terminal.

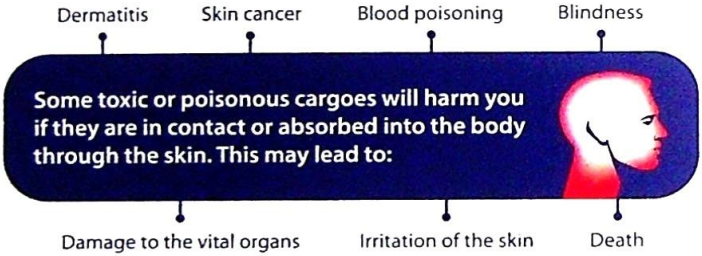
Toxicity is the ability of a substance to harm you or the environment, depending on the amount and concentration. Toxic and poisonous substances can kill in some circumstances.

There are three ways in which toxic and poisonous substances can enter your body:



Some of the effects of toxic and poisonous cargoes are as follows:





When handling toxic or poisonous cargoes:

Always

- Wear PPE as required by the SDS and your SMS
- be aware of the nearest emergency showers and eye wash stations
- keep your hands and clothing away from your mouth and face
- wash thoroughly after being involved in chemical operations
- remove your PPE or work clothes before entering the accommodation
- know how to raise the alarm in the event of a leak or spill.

If there is a leak or spillage of toxic or poisonous cargo:

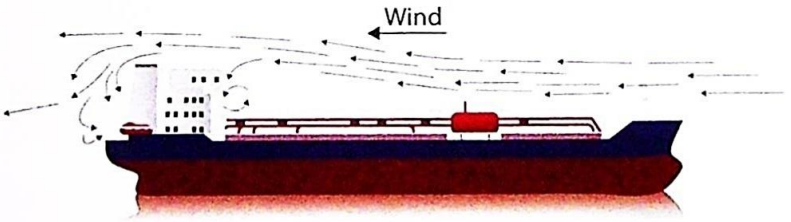
- Immediately get away from the area of the spill
- raise the alarm
- follow instructions from the emergency response team leader.

If you come into contact with toxic or poisonous cargo, remove contaminated clothing as soon as possible and use the emergency shower and eye wash stations to cleanse your body with large quantities of water. For some toxic cargoes, antidotes may also be available.

Liquid cargoes may generate toxic or flammable gases. These may simply be hydrocarbon vapours or they may be specific toxic gases, eg hydrogen sulphide (H_2S), carbon monoxide (CO) and benzene (C_6H_6). They may be invisible to the human eye and heavier than air, which means they can accumulate in zones that are lower than the tank deck, including:

- Inside any enclosed space, including cargo tanks, double bottoms, pump rooms, cofferdams and bilges. Be aware that sludge on the bottom of a tank, once disturbed, will often release harmful vapours
- emitted from the tanker's venting arrangements above the deck and/or unintentionally drawn into the accommodation
- in an adjacent space to the cargo tank, eg in a ballast tank when a leak has occurred.

In open air, a wind speed of 10 knots (this is like a light breeze across the tanker's deck) can move heavy vapours. In turbulence, they can form eddy currents around higher areas, such as the tanker's accommodation block. It is, therefore, possible for vapours to be drawn into ventilators or doorways.



Air flow over an accommodation block

It is standard practice to maintain positive pressure inside the accommodation and engine room during cargo operations to prevent entry of gases and vapours. The method will depend on the system on board, eg the accommodation system may be switched to internal recirculation.

If you sense vapours inside accommodation or machinery spaces, treat this as an emergency. Inform the responsible officer, check the atmosphere is safe and ensure there are no possible ignition sources.

Tankers are fitted with vapour emission control (VEC) systems. At certain terminals, these will be used to ensure that cargo vapours are transferred ashore by a vapour return line (VRL) for safe disposal or treatment.

Not everyone reacts in the same way to vapour exposure and you may be someone who has more tolerance. However, at higher concentrations, everyone is affected. Be aware of the effect that vapours may be having on others, not just on yourself.

You should keep in mind the following effects:

- At low concentrations, a person who has inhaled petroleum vapours might appear drunk. Effects can be very physical, for example a headache, eye irritation, slurred speech or dizziness
- at medium concentrations, you would begin to stagger, feel very confused and may even fall unconscious
- at high concentrations, the vapours can lead to death through stoppage of the heart or lungs.

It is good practice to remove yourself to direct fresh air at regular intervals, particularly when working in one place for any length of time.

8.7 Flammable Cargoes

Some liquids evaporate more readily than others and it is the vapour given off by a liquid that can ignite. Liquids that evaporate at low temperatures are the most dangerous; these are commonly referred to as having a low flashpoint (typically described as below 60°C). The flashpoint is the lowest temperature at which a liquid will evaporate sufficiently to form a combustible concentration of vapour, capable of being ignited with a spark or flame.

Flammable cargoes are generally considered to have a low flashpoint, but this is not the case with every chemical.

Flammable cargoes are carried in both stainless steel and coated tanks. They are always handled under closed conditions and it is often a requirement for them to be loaded into tanks inerted with nitrogen. The inerted tank atmosphere is maintained throughout the voyage, discharge and tank cleaning to prevent the cargo from entering its flammable range.

Flammable gases, such as acetylene, butane, propane, hydrogen, methane, natural or manufactured gases, or vapours from liquid hydrocarbons can become trapped in enclosed spaces. Gases that are heavier than air will settle in the lower levels of the space. In a closed top tank, gases that are lighter than air may rise and develop a flammable concentration above the opening.

A flammable atmosphere generally arises from enriched oxygen atmospheres, vaporisation of flammable liquids, by-products from work procedures, chemical reactions, concentrations of combustible dusts and desorption of chemicals from the inner surfaces of the space. An atmosphere becomes flammable when the ratio of oxygen to combustible material (hydrocarbons) in the air is neither too rich nor too lean for combustion to occur. Combustible gases or vapours will accumulate when there is inadequate ventilation in the space.

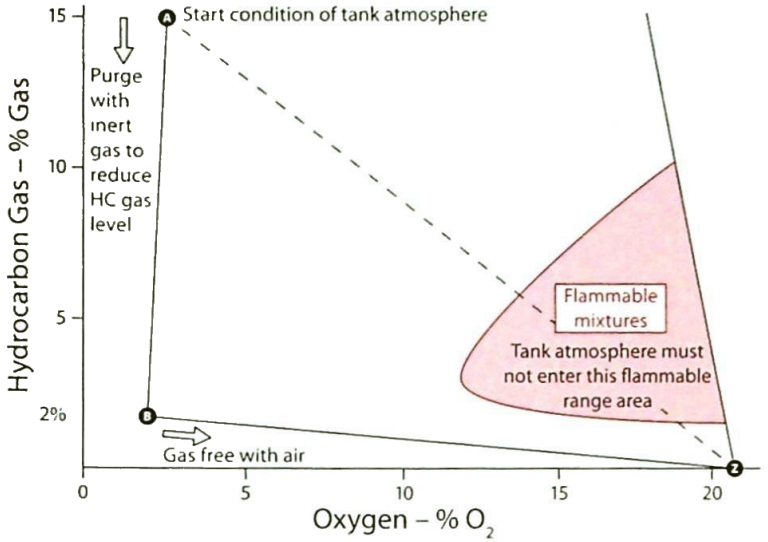
Specific kinds of work, such as spray painting, can result in the release of explosive gases or vapours. Welding in an enclosed space is a major cause of explosions in areas that contain combustible gas.

Ventilation by a blower or fan may be necessary to remove harmful gases and flammable mixtures from a space. However, in many cases, inert gas must first be introduced to ensure that the atmosphere does not enter the flammable range. Before forced ventilation is initiated, consideration should be given to restricted areas within the enclosed space, voids, the nature of the contaminants present, the size of the space, the type of work to be performed and the number of people involved.

Toxic or flammable mixtures may be present in enclosed spaces. Before entering the space:

Always

- Perform a risk assessment and complete a permit to work (PTW)
- test and verify that there is a safe atmosphere. There should be enough oxygen (20.9%) and an absence of toxic gases. Flammable vapour must be below 1% of the LFL before entry can proceed
- if necessary, reduce the concentration of flammable gases by an approved method such as purging with inert gas. NEVER introduce fresh air directly into the tank without verifying that it is safe to do so, ie do not allow the atmosphere in the space to enter the flammable range, as shown in the flammable range diagram.



Flammable range diagram example (note that different cargoes will have different flammable ranges)

It is essential that the method of ventilating a space does not create conditions in which combustion can occur, ie inside the flammable range.

8.8 Reactive Cargoes

Reactive cargoes are carried in both stainless steel and coated tanks, provided the cargo is not reactive with the material of construction and the tank coating. They are always handled under closed conditions and often require the tank to be inerted with nitrogen. Water-reactive cargoes can react with moisture in the air and in the cargo tanks. These cargoes need to be kept completely dry, which is achieved using air or nitrogen with a very low dew point.

A cargo can react in various ways:

- Self-reactive – commonly referred to as polymerisation. This kind of reaction generates heat which can further accelerate the reaction. If a chemical is flammable or has a low flashpoint, it may be easily ignited due to polymerisation

- reactive with air – this may lead to unstable oxygen compounds or allow the chemical to enter its flammable range, which can lead to an explosion
- reactive when in contact with another cargo – certain chemicals can react dangerously when mixed. Therefore, the SDS must be consulted for every cargo and appropriate segregation put in place before operations commence
- reactive with water – this may lead to the formation of hydrates, which, depending on the type of chemical, can cause carriage problems or put a cargo 'off-spec'.

Incompatible chemical cargoes should not come into contact with each other during loading, on passage, during discharge or while tank cleaning.

To avoid any dangerous chemical reaction between the different cargoes, there are strict compatibility requirements controlling the stowage and segregation of chemical cargoes. Further details of these requirements are provided in the IBC Code and also within the product SDS.

The loading (and discharge) of cargoes via a dedicated pipeline from the ship's manifold to the cargo tank is the most effective method of cargo segregation.

A cargo reaction may take a variety of forms and can:

- Produce heat (which is indicative of self-reaction taking place)
- produce a rise in pressure in the tank due to expansion
- release dangerous vapours
- cause polymerisation (solidification)
- increase the risk of fire or explosion
- affect the quality of the cargo.

The possibility of a cargo reaction can be removed in a variety of ways, such as:

- By separation and segregation of cargo tanks and systems
- for self-reactive cargoes, separation from any adjacent heated cargo and the addition to the cargo of a chemical inhibitor to make it more chemically stable
- inerting the cargo tank with nitrogen before loading, or padding the ullage space with nitrogen after loading, to prevent the cargo coming into contact with air
- avoiding the use of metals, or other materials, in the cargo system that the cargo might react with
- by carrying water-reactive cargoes in Type 1 or Type 2 ships, ensuring complete segregation from the ship's side plating
- by blanking-off the steam heating coils in tanks carrying water-reactive cargo and by using thermal oil heating systems
- by avoiding any drip tray contamination/mixing.

8.9 Vegetable and Animal Oils

Chemical tankers, due to their construction and capabilities, are the best option for the transportation of vegetable and animal oils. These products are widely used in the food industry and in the production of detergents and pharmaceuticals, as well as in the production process for biofuel.

Vegetable and animal oil cargoes are carried in both stainless steel and coated tanks. Coatings are typically pure epoxy. Absorption varies with the type of coating and is based on the cargo's free fatty acid (FFA) and moisture or mineral oil content. For solidifying products, smooth tanks with the minimum number of appendages are preferred.

Vegetable and animal oils generally have safe characteristics. However, they often involve high temperatures and may have some hidden dangers, such as:

- Burns – from live steam, steam coils, hot pipelines or hot cargo
- slips, trips and falls – residue from this type of cargo is inherently low in friction and you may encounter it on deck from connecting or disconnecting lines, sampling tanks or from cleaning equipment

- asphyxiation and poisoning – many vegetable and animal oils tend to oxidise, meaning they will absorb oxygen from the air, which creates an oxygen-deficient atmosphere inside a tank (or enclosed space). Oil residues can also decompose, and the resulting process releases toxic and asphyxiating gases, such as methane, carbon monoxide and hydrogen sulphide.

Solidifying vegetable and animal oil products will require cargo tank entry in the final stages of discharge to sweep the residues into the cargo pump sumps. Tank entry must always follow the appropriate enclosed space entry procedures.

Before entering a tank or space containing any remains of vegetable or animal oils or fats, all appropriate enclosed space entry procedures must be followed.

8.10 Hydrogen Sulphide (H_2S)

Hydrogen sulphide (H_2S) is a highly toxic gas that can cause serious harm or fatality even at low concentrations. Exposure can result in effects ranging in severity, including irritation, flu-like symptoms, nausea, bleeding, permanent cardio-vascular damage, respiratory arrest and death. Hydrogen sulphide is heavier than air and is primarily found in certain crude oils. It is also found in some heavy fuel oils (HFOs), gas

oils, naphtha, bitumens, natural gas, oily water, sewage and wastewater systems. You may find pockets of high level concentrations of H_2S in enclosed spaces that are poorly ventilated.

In most instances, but not all, its presence can be predicted and precautions taken to ensure the safety of personnel. However, the dangers should never be underestimated as there have been many fatalities after single exposures to high concentrations of H_2S.

H_2S is immediately recognised by its characteristic smell of rotten eggs, which may be detected at vapour concentrations as low as 01 to 03 ppm. However, exposure to vapour concentrations of more than 100 ppm can lead to rapid loss of the sense of smell. This can be extremely dangerous, as you may think the vapour has gone, but its presence is still there, you just can no longer smell it. The only way to be sure that H_2S is not present is to test for it. It is essential that all personnel realise that the installation of detection systems does not in itself provide protection. An understanding of the cargo, along with specific operational risks, eg disconnection of the manifold or purging/venting, is essential. A risk assessment and PTW are also essential in identifying the risks to yourself and others in potential H_2S environments.

As H_2S is highly toxic, it is essential that areas where it may be present are properly signed and monitored. Anyone working in such areas should be provided with personal monitoring systems. Regular gas testing of the atmosphere should also be carried out.

Never enter a space that may contain H_2S without taking all of the necessary precautions.

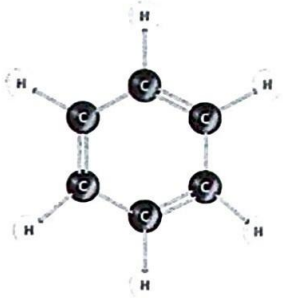
8.10.1 Effects of H_2S

Parts per million (ppm)	Effect
0.01–0.03	Smell of rotten eggs becomes apparent.
1–20	Offensive odour and possible nausea.
50–100	Eye and respiratory irritation within one hour.
100–200	Ability to smell completely disappears.
200–300	For a small percentage of the population, this level can cause irreversible effects after 30 minutes.
500–700	Dizziness, headache and nausea within 15 minutes of exposure. Loss of consciousness and even death can occur after 30–60 minutes.
700–900	Rapid unconsciousness. Death occurs within a few minutes.
1,000+	Instant collapse/death as breathing ceases.

Anyone suspected of exposure to H_2S should be removed to fresh air as soon as possible. NEVER enter a space to rescue someone without first taking precautions to ensure your own safety.

Even if the space has tested as safe, H_2S may still be released, eg if residue is disturbed in the space. You must understand how an uncontrolled release of H_2S could occur and what steps you should take in the case of an emergency.

8.11 Benzene (C_6H_6)



Benzene | C_6H_6

Benzene (C_6H_6) is a colourless liquid with a sweet odour. It is a strongly toxic substance that is found diluted in crude oils and in products such as motor gasoline and other 'white oils'. Breathing high levels of benzene can cause drowsiness, dizziness, rapid heart rate, headache, tremors, confusion and unconsciousness. Very high levels can be fatal. Long-term benzene exposure affects the bone marrow and can cause anaemia and cancer.

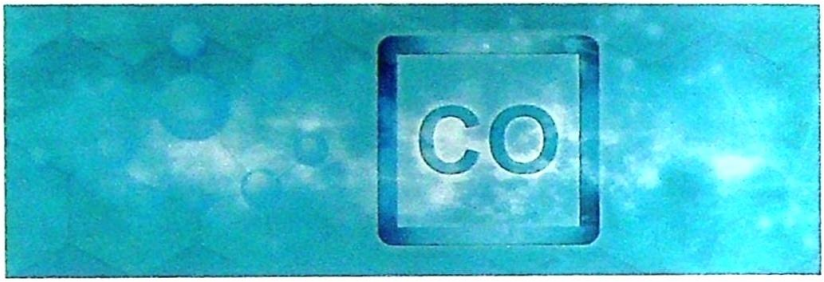
You may encounter benzene when working on deck or in enclosed spaces on a tanker that is carrying, or has a residue of, gasoline.

If benzene is suspected or known to be on board, you should use approved self-contained breathing apparatus with a full facemask, operated in positive pressure, in any space where it may be encountered.

If you come into contact with benzene:

- Remove yourself to fresh air
- inform the medical officer and seek medical help ashore
- wash the affected area with soap and water
- change clothing – do not allow contaminated clothing or cleaning tissues/rags to remain close to your skin.

8.12 Carbon Monoxide (CO)



Carbon monoxide (CO) is a poisonous, colourless, odourless and tasteless gas. It is harmful when inhaled because it deprives the heart, brain and other vital organs of oxygen.

Large amounts of CO can overcome you in minutes without warning, causing you to lose consciousness, suffocate and die. Symptoms of CO poisoning may include headache, fatigue, dizziness, drowsiness, nausea and vomiting. However, symptoms vary widely from person to person.

CO may be present in an inerted cargo tank that has carried crude oil, or in an enclosed space where there are unventilated engine or machinery fumes.

Adequate ventilation is essential and gas testing equipment should be used to verify the safety of the environment. CO can build up over time, so regular testing of the environment should be carried out if there is any possibility of emission.

As CO is odourless and tasteless, the only way to detect it is by using appropriate gas testing equipment.

8.13 Nitrogen (N_2)

78% of our atmosphere is made up of nitrogen, with the remainder comprising 21% oxygen and 1% others. It is undetectable to the human senses and there is no sensory warning when an atmosphere is oxygen deficient as a result of nitrogen displacement. Inhalation of nitrogen can cause loss of consciousness and possible death.

Nitrogen is:

- Inert
- non-flammable
- non-toxic
- colourless, odourless and tasteless
- marginally lighter than air.

Nitrogen has been in use for many years on chemical tankers as an inerting medium to reduce the oxygen content in empty tank spaces (and even occasionally adjacent void spaces) when carrying certain chemicals that may be adversely affected by oxygen. Inerting may also be required to prevent a flammable atmosphere from developing or for cargo quality reasons.

Whenever nitrogen is used, safety precautions must be in place. Refer to your company SMS for procedures and guidance. Compressed air breathing apparatus should be used when there is a risk of exposure to nitrogen; the use of canister-type filter masks is prohibited. There is a risk of exposure when working in close proximity to an opening to any space inerted with nitrogen or during the inerting process. Enclosed spaces inerted with nitrogen should be tagged with warning signs.

Personnel at risk of nitrogen exposure should:

- Keep clear of the hazardous area unless directly involved in an operation
- wear a personal oxygen meter
- be aware that the deck structure/lay-out may create areas that allow nitrogen to accumulate near nitrogen inerted spaces. This can result in an oxygen deficient atmosphere, even on open deck
- be aware of the risk of oxygen deficient atmospheres in all enclosed spaces on board. The atmosphere must always be tested and verified as safe before entry.

Be constantly vigilant during operations involving nitrogen. Inhalation of N_2 is possible even when standing in the open air.

For further guidance, refer to the *CDI Best Practice Recommendation Regarding the use of Nitrogen.*

Chapter 9
Enclosed Spaces

An enclosed space is a space that is not designed for continuous worker occupancy and has either or both of the following characteristics:

- Limited openings for entry or exit
- inadequate ventilation.

Accidental deaths at sea occur most frequently in enclosed spaces. ALWAYS follow the best practice set out in this chapter and NEVER underestimate the dangers that may exist in an enclosed space.

9.1 What is an Enclosed Space?

There will be numerous enclosed spaces on board your tanker, some of which may not be immediately obvious. Enclosed spaces are not necessarily limited to small, dark spaces, eg the engine crankcase, but will commonly have limited access and egress and a potentially dangerous atmosphere.

An enclosed space can also be dangerous due to:

- The design, construction, location or atmosphere
- the materials or substances within it
- the work activities being carried out in it
- mechanical, process and safety hazards

If you are unsure whether somewhere on board is an enclosed space, do not enter it and ask a responsible officer for advice.

9.2 Why are Enclosed Spaces Dangerous?

Some of the hazards of enclosed spaces include.

- Poor air quality – there may be an insufficient amount of oxygen for you to breathe or the presence of toxic gases. Natural ventilation alone will often not be sufficient to maintain breathable quality air
- exposure to hazardous liquids, chemicals and substances – there is a risk of skin contact or ingestion
- fire hazards – there may be an explosive/flammable atmosphere in the space or the presence of combustible dusts
- noise – this may include the noise from the task or accidental banging of equipment while working in the space

- safety hazards from the space itself, such as moving equipment, structural hazards, poor visibility, lack of lighting, risk of slips, trips or falls, trapping points and lightening holes, eg the design of a ballast tank
- temperature extremes and hot/cold surfaces
- shifting or collapse of bulk material(s)
- barrier or structural failure, resulting in a flood or release of a free-flowing substance, eg a cargo leak into an adjacent space
- uncontrolled energy sources, including electrical shock.

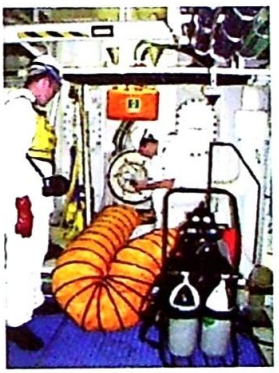
The enclosed space may present the following risks to workers and emergency responders:

- Being overcome by gas, fumes, vapour or lack of oxygen
- injury due to fire, explosion or toxic inhalation
- drowning
- being overcome by high temperatures.

If someone has collapsed in a space, do not enter to attempt rescue without taking adequate precautions to protect yourself. Almost 50% of enclosed space fatalities occur when someone enters unprotected to rescue a fallen colleague.

9.3 Entering an Enclosed Space

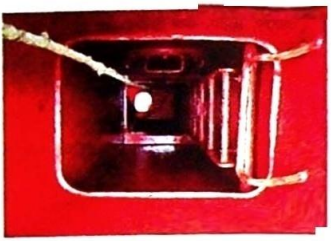
It must be considered whether it is absolutely necessary for the work to be conducted in the enclosed space.



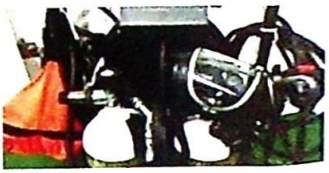
Entry is usually only deemed necessary to perform a function such as inspection, repair, maintenance (cleaning or painting) or similar operations. These are usually infrequent or irregular tasks.

In many cases where there have been deaths in enclosed spaces, the work could have been

carried out elsewhere. The main causes of death in enclosed spaces are unsound working practices and a failure to respond adequately to the high level of risk associated with enclosed spaces.



You should always take the following precautions:



- The operation must be evaluated by conducting a risk assessment and include a PTW
- before proceeding, ensure that a responsible person has tested the atmosphere in the enclosed space, using correctly calibrated equipment, and has cleared the space as safe for entry
- ensure that an attendant is at the entrance to the enclosed space at all times. They should maintain constant communication and ensure there is a means of escape
- ensure that sufficient ventilation to the space is maintained
- ensure there is sufficient lighting for the space
- ensure that the space is isolated from other systems and that lines under pressure are blanked off
- ensure that emergency procedures and equipment are established, eg rescue equipment and communication protocols
- ensure that operation-specific safety equipment, such as personal monitoring devices, safety harnesses, safety lines and emergency escape breathing devices (EEBDs), is available.

Make sure you fully understand your shipboard and company-specific instructions for enclosed space entry. Always carry out a risk assessment and ensure the atmosphere is tested PRIOR to entry.

It should always be assumed that the most unfavourable situation exists in every enclosed space and that the danger of explosion, poisoning and asphyxiation will be present. NEVER take any unnecessary risks.

9.4 Duties of the Attendant

Any worker acting as an attendant (historically referred to as the standby person) at the entrance to an enclosed space must be appropriately trained and understand their role in emergency response. This should include:

- Correct operation of the communication equipment used for communicating with workers in the enclosed space or for summoning emergency or rescue services
- authorised procedures for summoning rescue or other emergency services
- recognition of unusual behaviour of a fellow worker that could indicate they may be experiencing an adverse reaction to the atmosphere in the space. It is important that the attendant has no other duties that will interfere with their ability to maintain a watch of the enclosed space.

The role of the attendant is critical and you should not accept responsibility for the role if you are unsure about any aspect of it.

9.5 Duties of the Responsible Person/Competent Person

A responsible person is authorised to permit entry into an enclosed space based on their knowledge of procedures and compliance for safe entry.

A competent person will have sufficient knowledge and experience to make an informed assessment of the likely dangers of a dangerous atmosphere in a space.

The responsible person and the competent person may be the same person. However, the responsible person must:

- Ensure that all pre-entry requirements, as outlined on the permit, have been completed before any worker is allowed to enter the space
- ensure that any required pre-entry conditions have been met
- if a rescue team is to be used in the event of an emergency, ensure all members are available
- ensure that any communication equipment that would be used to summon the rescue team or other emergency assistance is operating correctly
- terminate the entry on becoming aware of a condition or set of conditions whose hazard potential exceeds the limits authorised by the entry permit.

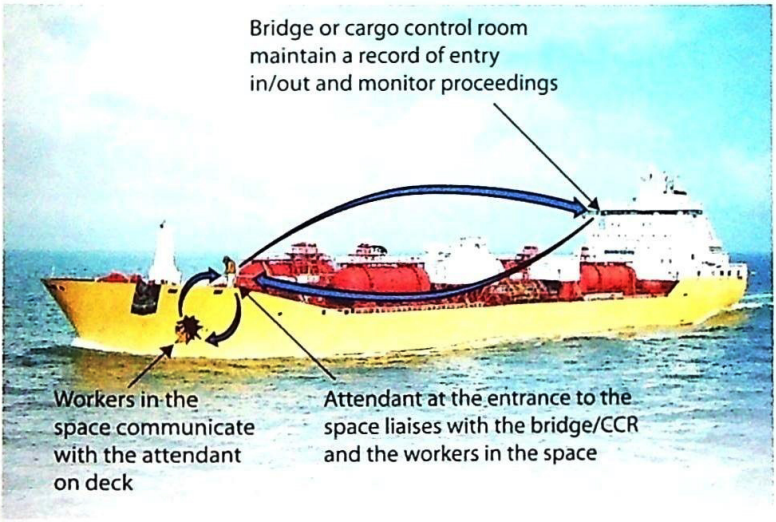
9.6 Communication

If a worker suddenly feels distressed and is unable to summon help, an injury could quickly become a fatality. If the worker becomes unconscious and falls to the ground, it may be difficult for the attendant to spot them.

If visual monitoring of the worker(s) is not possible because of the design of the enclosed space or the location of the entry hatch, a voice- or alarm-activated explosion-proof type of communication system will be necessary.

Noise in an enclosed space, although not intense enough to cause hearing damage, may still disrupt communication with the attendant. An adequate, reliable communication system will be needed and should enable communication:

- Between those inside the enclosed space
- between those inside the enclosed space and those outside
- to summon help in an emergency



Transmission discipline must be effective. The aim is to communicate messages in a logical format with good enunciation and then to smoothly hand over the communications channel. This is essential in 'press to talk' systems where you should wait a couple of seconds before speaking, rather than speaking immediately. Message confirmation should also be practised to confirm that instructions or information have been fully understood. This is commonly referred to as 'closed loop' communication.

Communication between the workers inside the space and the attendant outside is of utmost importance.

9.7 Breathing Apparatus

It may be necessary to wear full breathing apparatus in order to enter or work in an enclosed space. Types of breathing apparatus include:

Self-contained breathing apparatus (SCBA)

This comprises a cylinder of compressed air that supplies air to the user via a full facemask. This is a positive pressure system that provides a pressure barrier against the ingress of any harmful vapour.

Various sizes are available, providing working times of up to 45 minutes. These times are shorter where there is high heat stress. For example, in fully saturated air temperatures of 36°C, safe wearing time may be no more than 20 minutes.

Before using any SCBA, you must perform the checks recommended by the manufacturer, including a full test of the system, checking the gauge, whistle and mask.

Airline breathing apparatus

These systems are less common on board, but are used when working times of beyond 45 minutes are required. Types include fresh air, constant flow and demand flow systems, sometimes used in conjunction with backup cylinders. Demand flow airline systems can at best provide 100 m range, with simple fresh-air airlines limited to less than 10 m.

Not to be confused with breathing apparatus is the emergency escape breathing device (EEBD). This is a small cylinder and mask that can be carried by the user, either as a jacket or in a carry case. An EEBD can supply up to 15 minutes of breathable air, which would enable a worker to escape an area that has a fatal atmosphere. An EEBD must not be used when entering an enclosed space under any circumstances.

An EEBD is only to be used to escape an emergency situation. It should never be used as a means of breathing device to enter a space.

9.8 Rescue Operations

An attendant should be assigned to remain on the outside of the enclosed space and to be in constant contact (sight and sound) with the workers inside. The attendant should not have any other duties except to serve as a standby, with knowledge of who should be notified in an emergency. Attendant personnel should never enter an enclosed space until help arrives, and then only with proper protective equipment, lifelines and respirators.

Rescuers must be trained in and follow established emergency procedures, including use of equipment and techniques (lifelines, respiratory protection, lifting casualties, etc).

Steps for safe rescue should be included in all enclosed space entry procedures. Rescue should be well planned and drills should be conducted frequently.

Unplanned rescue, such as when someone instinctively rushes in to help a casualty, can easily result in a double fatality.

9.9 Specialised Areas

Some spaces on board, such as paint, chemical or sample lockers, may not necessarily be thought of as an enclosed space, but they still have the potential to generate a hazardous atmosphere.

These areas can generate high volumes of fumes, creating not only an oxygen-deficient atmosphere, but also an explosive one. They will usually be designed with natural vents, which remain open constantly, as well as a means of forced ventilation, eg a fan.

Always remember to start the forced ventilation prior to entry. If you experience any adverse effects, vacate the space immediately

If you are unsure about any aspect of this chapter, do not attempt to enter an enclosed space until you have received additional training and guidance from a responsible officer.

9.10 Sampling, Gauging and Tank Measurement

On a tanker, it is necessary to take regular samples and tank level measurements for commercial and stability purposes. Closed gauging and sampling systems help to protect both the seafarer and the environment and are usually a mandatory requirement for safe operations. However, you may come across some types of gauging and open sampling practices that have the potential to result in exposure to H_2S and other toxic gases; these are not recommended.

When you are gauging a tank with a high pressure, even though the gauging system is closed, gases can be forced up through the tank measurement unit, usually known as an ullage temperature interface (UTI) gauge. In addition, failure to ensure the ball valve is closed before removing the top of the UTI gauge can result in a blast of gas into your face. Some chemical cargoes are so hazardous that only the onboard closed gauging systems can be used. It is therefore wise to ascertain the characteristics of the cargo prior to sampling and tank measurement. This information should be available on the cargo SDS.

When working at ullage ports, ventilators, manifold openings and tank coamings, stand to one side to allow any wind to drive vapours away from you.

If you are using a ball valve or similar closing mechanism with a piece of equipment such as a UTI, ensure that the valve is fully closed before you remove the equipment.

If you think you can smell toxic gases such as H_2S or cargo vapour:

- Retract the tape or sampler and close the ball valve below the UTI or the sampling point
- move away from the area and try to go up wind where fresh air is most likely
- notify the officer in the cargo control room (CCR)
- conduct a test of the atmosphere and, if necessary, a risk assessment before resuming sampling or tank gauging.

Always use closed gauging and sampling equipment, particularly when the cargo has hazardous properties.

9.11 Gas Detection Equipment

SOLAS makes the carriage of appropriate atmosphere testing instruments a requirement on board your tanker. These should be used to detect whether there is an oxygen-deficient, flammable and/or toxic atmosphere present.

In addition to general portable testing systems, personal monitoring systems are also available. These will provide you with an early warning of increased concentrations of toxic gases such as H_2S and CO, usually via an audible alarm and a flashing light.

When using atmosphere testing and monitoring equipment, ensure that:

- The equipment is intrinsically safe and approved for use on board
- the monitor covers the toxic gas types and ranges likely to be found on board
- the monitor has internal fail-safe checks and alarm functions that have been tested (both a visual and audible warning)
- the sensing head is never shielded by clothes or other obstructions
- the battery is fully charged before use
- the equipment is recalibrated and checked frequently for correct operation, as recommended by the manufacturer (note that different detector tubes work in slightly different ways and the instructions should be strictly followed)
- you understand the system's capabilities and limits, as well as the actions to be taken when a personal monitor alarm is activated.

Remember that a lack of fresh air and oxygen causes immediate health effects. A space declared gas-free is only gas-free at the time of the test. Regular retesting of the atmosphere is essential

Even if you only move out of an area for a short break, the space must be retested prior to re-entry.

Personal monitoring systems and visual observation of crew mates is essential, particularly when working in a potentially hazardous environment.

9.12 Testing Hazardous Atmospheres

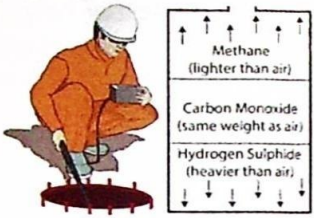
It is important to understand that some gases or vapours are heavier than air and will settle at the bottom of an enclosed space, and some gases are lighter than air so will be found at the top.

Before entry, it is essential to test the atmosphere in an enclosed space for oxygen levels, flammability and/or any toxic gases/contaminants that may be present. This testing must be carried out by a qualified person using equipment that has been approved for use in the space The testing equipment itself should be checked to make sure it is working properly before use.

If test results indicate that the atmospheric condition of the enclosed space is unacceptable, entry is prohibited until conditions are brought within acceptable limits. This may be done by purging, cleaning and/or ventilating the space. Ventilating is the method by which gases, vapours and other airborne impurities are displaced from an enclosed space.

The enclosed space may also be made non-flammable, non-explosive or otherwise chemically non-reactive by displacing or diluting the original atmosphere with inert gas that is non-reactive within that space, a process referred to as 'inerting'.

Before entry, the air within an enclosed space should be tested from the outside and a PTW should be in place. Ventilation should be stopped at least 10 minutes prior to the test.



Care should be taken to ensure that air is tested throughout the enclosed space, from side to side and top to bottom. A trained seafarer using detection equipment with remote probes and sampling lines should carry out the testing. Atmospheric testing is required to evaluate the hazards of the permit space and to provide verification that acceptable conditions exist for entry into that space, ie:

- The oxygen content is within safe limits
- a hazardous atmosphere (toxic gases, flammable atmosphere) is not present.

Always test all areas (top, middle and bottom) of an enclosed space with properly calibrated testing instruments to determine whether it is safe to enter.

Chapter 10
Operational Hazards

Full details of the operations carried out on your tanker will be held on board and can be sought from your company SMS or by asking a knowledgeable officer. It is also recommended that you study the ship's cargo manuals to familiarise yourself with the various systems before taking part in any operations.

Any type of operation carried out on a tanker should be considered a potentially hazardous situation.

10.1 Cargo Operations

Cargo operations on a chemical tanker require detailed planning prior to arrival, and then accurate application of the plan once the operations begin. Due to the complex segregation requirements of the various chemicals that may be carried on board, it is important that every person involved is fully aware of the plan and the line-up for the tanks/lines/valves, prior to connection of the manifolds. Many connections are made with marine loading arms (MLAs). These arms are usually connected by terminal staff, but the tanker crew may need to assist in bolting the flanges together. Some arms have hydraulically operated couplings, which are easier and quicker than bolts.

An officer should always be present when the manifold connection is taking place. Always stand well clear during the connection/disconnection process. You should monitor the connections, from the point of connection through to disconnection at the end of operations, to ensure there are no leaks.

Hard arm connections require careful monitoring while in use. Should a cargo connection leak occur, you should report it to the duty officer immediately. If you are discharging from the ship to the shore, you may be able to shut down operations using a nearby emergency stop button

While the majority of cargoes are transferred at shore jetties in port, sometimes cargo may be transferred at offshore locations, either ship to ship (STS) or via floating production storage offloading (FPSO) to ship.

These operations will use flexible hoses, rather than MLAs, to connect the manifolds and conduct the cargo transfer. These come with their own set of hazards and risks

When working with flexible hoses:

Always

- Ensure that hose connections are secured under the supervision of a responsible person and re-checked by a second person
- check that each length of hose is marked with the range of products it is suitable for, the safe working pressure, the last test date, the test pressure, the next test date and the temperature range
- ensure that hoses are properly supported and are not allowed to chafe against hard surfaces. Chafing could cause a rupture
- use large radius bends along the length of the hose. Tight bends can slow the flow rate or damage the hose.

Never suspend a hose solely by a singular wire or rope loop. This can damage the hose and lead to rupture. Use a support strop designated for use at the manifold.

During many cargo operations, your tanker will use an inert gas system (IGS). This supplies an inert gas (eg nitrogen) with a low oxygen content to the tank during the discharge of cargo. If operating correctly, this safeguards the cargo tank by removing the oxygen component of the fire triangle. When loading, the IGS is controlled through venting arrangements to ensure safe pressures within the cargo tanks.

The inert gas pressures are monitored by the officer in charge during cargo operations, but it is essential that all involved in cargo operations have an awareness of how the system operates. If you observe an unexpected over- or under-pressurisation of the system, always inform the officer in charge. Over-pressurisation can cause vapour to be expelled out of the tank and onto the deck, whereas under-pressurisation can cause air, and more importantly oxygen, to be drawn into the tank, removing the inert atmosphere.

Where isolating valves are used in the IGS, you should never use them without authorisation from the responsible ship's officer. The following diagram illustrates the components and safety features of an inert gas system.

IG Fans or Blowers

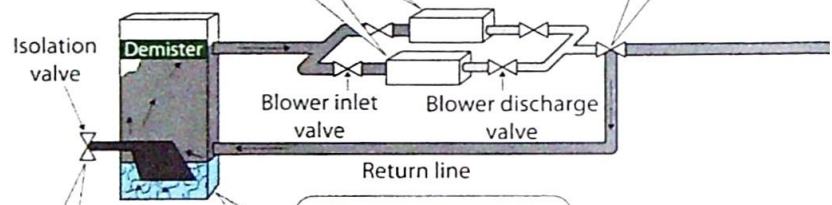
Rated to 125% capacity of the cargo pumps.

IG control valve

This permits the passage of inert gas to the deck distribution system if:

- The oxygen content is 5% or less
- the pressure in the distribution main on the cargo tank side of the deck seal is below the pressure at which the high level alarm activates
- the pressure in the distribution main on the cargo tank side of the deck seal is below the set pressure at which the control valve opens.

Otherwise, it will be diverted to the funnel or recirculated.



Flue gas from boiler

The gas is dirty and full of particles. Seawater combines with hot exhaust gases and becomes acidic so the pipes and scrubber are specially coated.

Scrubber tower and demister

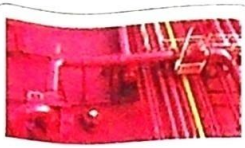
Exhaust gas is quenched, cooled and cleaned using seawater spray. Coarse filters remove solid particles, reducing:

- Sulphur dioxide by 90%
- solid particles by 95%
- temperature from 450°C to 3°C above seawater.

IG Distribution System

IG deck main

Normally one line, but a second line may be incorporated to prevent contamination between differing tank atmospheres.

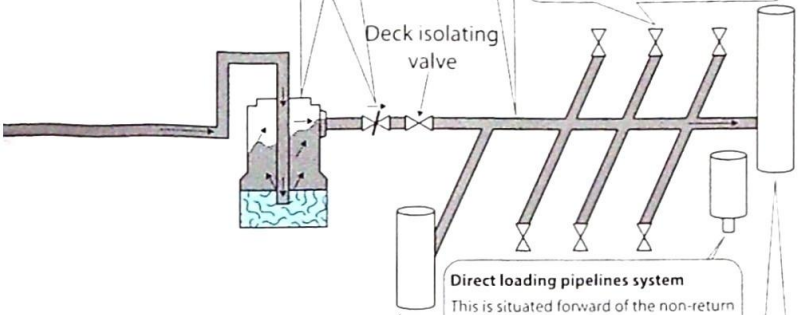


Deck water seal non-return valve and IG crossover

This prevents dangerous backflow of IG and cargo vapour to the engine room. It must have two independent safety non-return arrangements.

IG tank isolation valve and blank

Each tank must be capable of being isolated and blanked.



Direct loading pipelines system

This is situated forward of the non-return valves and is capable of being blanked. It permits the introduction of gas to the bottom of the cargo tank for changing the atmosphere.

The system will have one or more connections so an IG supply from an external source can be used if necessary. There may also be connections and valves fitted that allow the segregated ballast tanks and pump room to be inerted in the event of an emergency.

P/V breaker

Non-mechanical liquid sealing pressure vacuum relief device. Normally filled with a fresh water and glycol mixture to prevent freezing.

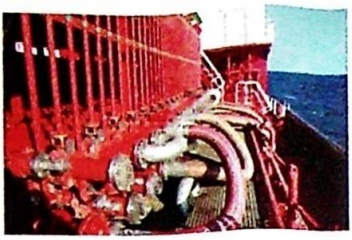
Tank P/V valve

Independent to prevent over- or under-pressurisation of cargo tanks.

Mast riser

Manually operated, enabling venting to relieve excessive pressure.

When involved in any cargo operations, you should be aware of the following:



- The hazards of the operation itself, including the nature of the cargo being transferred
- the contents of any risk assessment and/or control measures in place
- the cargo loading/discharge plan, including the cargo stowage and segregation requirements
- general operation of the IGS, including pressure safety components
- the PPE requirements and safe working practices for the area in which you are working
- escape routes and the use of any safety or fire equipment
- the light and sound that is activated by the cargo tank high level alarm system
- how to raise the alarm in the event of a leak or pollution incident
- the established communication method between the tanker and shore
- how to stop the cargo operation in the event of an emergency.

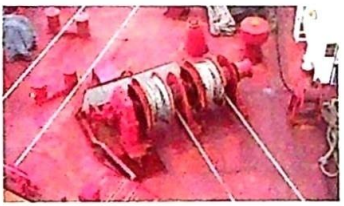
Certain cargoes may pose additional risks, for example polymerisation, and it is important you are familiar with the particular risks of your tanker. If in doubt, ask questions; part of the process of becoming a good seafarer on a tanker is learning how cargo operations are to be performed in the safest manner possible.

During cargo operations, you may have a number of visitors to the tanker, such as sampling personnel, cargo surveyors and personnel for connecting/disconnecting the ship/shore connection. It is important that they are given a brief safety induction before working on board. You must monitor the actions of visitors and ensure they do not place you, themselves or the tanker in any danger.

While it is the duty of the responsible officer to oversee safe cargo operations, all crew members have a duty to watch for and report any signs of pollution or any unsafe conditions.

10.2 Mooring Operations

An effective mooring system will keep the tanker safely moored alongside its jetty, berth or anchorage. During cargo transfer operations, it is important that the tanker does not range or drift while connected to the shore. If the tanker begins to move, it may go beyond the control of tanker crew and a major emergency can occur.



To be effective, ropes, wires and anchors must be utilised correctly and in accordance with established procedures and best practice. Further information is available from publications such as *'Effective Mooring'* and *'Mooring Equipment Guidelines'* published by OCIMF.

Regardless of the type of mooring operation, you must exercise constant vigilance to your surroundings.

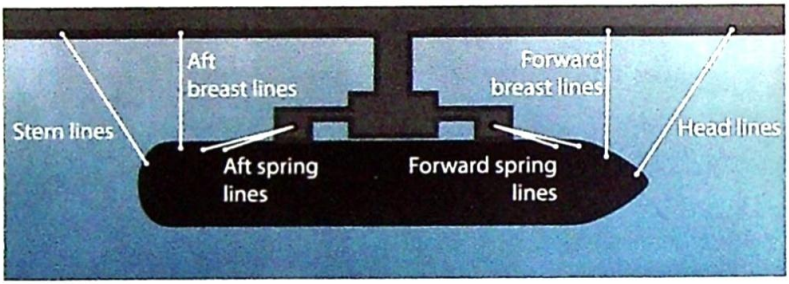
Always

- Consider the entire mooring area as a potential snapback zone
- ensure you have been instructed in how to use any mooring equipment correctly
- follow established procedures and all instructions given by the officer in charge of the mooring station
- remain in a position of safety, with an unobstructed view of the mooring area.

Never

- Stand in the bight of a rope or wire. If the line tightens, you could lose your leg or be dragged overboard
- slacken or heave a line without direction from the officer in charge
- use a weighted heaving line/monkey's fist. Receiving personnel have been injured by this practice, so only rope should be used.

During your stay in port, it will be necessary to remain observant and to make adjustments where necessary to maintain taut moorings at all times. Tides, wind and changes in the tanker's draught may all have an effect on the moorings. You should, for example, be aware of the tidal flow effect on a tanker moored alongside in a river.



The commonly used mooring lines are:

Spring lines – deployed either aft (from forward), or forward (from aft), they hold the tanker from ranging alongside the berth. They are commonly used to position the tanker correctly in relation to the manifold connections. Heaving on the aft springs will gradually pull the tanker forwards, whereas heaving on the forward springs will shift the tanker aft.

Breast lines – deployed perpendicular to the tanker, they hold the tanker against transverse motion (away from the berth). Too much tension on these lines can actually list the tanker in the direction of the jetty.

Head/stern lines – deployed as additional lines forward and aft, these consist of both transverse and longitudinal support.

The main hazard on a mooring deck is snapback, which occurs when a mooring rope or wire parts (breaks) and recoils at high speed. It is impossible to predict the recoil path of a line, as this will depend on where the line breaks and the material it is made from. Therefore, the entire mooring area should be considered a snapback zone.

Even if your tanker has painted snapback zones, be careful, as while you may feel that you are safe from any potential snapback, in reality you could still be in a dangerous position.

There have been numerous injuries and fatalities on mooring decks when personnel have stood within the snapback zone. Before you take part in any mooring operation, familiarise yourself with your company's procedures regarding mooring operations.

10.3 Towing Operations

A towing operation has the potential for an incident during making fast or releasing of the tow line. Tow lines can be under severe strain, so there is the potential for snapback. In addition, because the tugs and the ship may move suddenly, directional forces may be subject to change and the line may move rapidly.

Always

- Wait for instructions from the Master/Pilot before beginning the operation
- communicate with the bridge and the tug(s) when the line is made fast or let go
- use an appropriate stopper when manually handling the lines
- when letting go, carefully lower the line down to the tug
- keep well clear of the tow line and operational area at all times

Never

- Make fast or let go a tug without direct instructions from the bridge
- work with the tow line while it is under tension.

During a towing operation, all parties must communicate clearly with each other.

When letting go, you should never attempt to heave in the messenger to release the tow before you have permission to do so and the weight has come off the line.

10.4 Anchoring Operations

Effective anchoring requires correct deployment of the tanker's anchors to hold the tanker to the seabed in the prevailing circumstances The anchor's hold depends on the horizontal pull exerted by the anchor chain run out on the seabed. Anchors, chains and windlasses hold a tremendous amount of power when holding the tanker. It is essential therefore that, if you are involved in anchoring operations, you are briefed in advance so that you are aware of the correct operation of any equipment, how to clear and secure the anchors and who is the officer in charge of the operation.

Always

- Stand in a position of safety, keeping clear of the windlass and anchor cable
- wear the correct PPE, particularly eye and ear protection, as mud and rust can be thrown from the cable during an anchoring operation
- communicate effectively between the bridge, the officer in charge and the anchor party
- keep checking over the tanker's side to watch the scope of the anchor cable, and to ensure there is nothing below capable of fouling it.

Never

- Carry out any task unless directed by the officer in charge, eg removing or applying the brake
- touch or stand next to the anchor cable, particularly while it is moving.

10.5 Safe Access

While in port, at anchor and during pilot boarding/disembarkation, it must be ensured that there is safe access for joining or disembarking the ship. A safe means of access may be via a gangway (ship or shore provided), accommodation ladder and/or pilot ladder.

Safety nets will be employed with ladders and gangways in case of a fall. A lifebuoy with a light and line should also be located close by.

Before rigging any means of access, a risk assessment should be conducted. This will identify whether the task involves working at height or working over water. In such circumstances, appropriate additional PPE may be required, such as safety harnesses and/or flotation devices.

Ensure that you know how to raise the alarm in the event of an incident during access to the ship and that you are aware of the nearest lifebuoy and/or light.

Just as you should take care to move safely while on board, you should also take care when using a means of access.

Many terminals and ports have strict safe access requirements. This normally involves following designated walking routes and wearing PPE while inside the terminal.

Never use an access arrangement without first visually inspecting it to ensure it is safe to use, ie it is properly rigged, in the correct position and suitably secured. Always maintain three points of contact and move at an appropriate pace.

10.6 Static Electricity

Static electrical charges can build up during tanker operations, creating a serious hazard as an ignition source. Static electrical charges build up when cargo and other tanks are filled with certain cargo types, particularly when working with lighter refined products. Splashing and turbulence inside the tanks, for example during tank washing, will also create this electrical charge.

Flammable mixtures, such as the liquid, vapour or mist produced during cargo operations, will become charged with static electricity. This will then discharge to earth through the steel structure of the tanker and seawater. During the period between charge and discharge, there is the potential for ignition of the flammable mixture.

An additional risk is when a conductor, such as an ullage tape or sampling unit, is introduced into a tank. This could act as a focus for conductivity and release an electrical discharge at the mouth of a tank. This often occurs during the loading or discharge of cargo, during tank cleaning and when dipping, ullaging or sampling.

It may also occur through the use of non-approved equipment, ie equipment that is not intrinsically safe. Certain synthetic materials should also be avoided because they can introduce an electrostatic hazard.

Some common objects that should be insulated in hazardous situations include:

- UTIs/ullaging and sampling equipment
- portable tank washing machines
- certain ship/shore connections

On shore, electrical circuits are safeguarded through the use of conductors into the earth, a method termed 'earthing' or 'grounding'. At sea, metal components are connected with a conducting strip to the physical structure of the ship, which in turn is naturally earthed directly through the sea, a method termed 'bonding'. In port, an isolation connection may be rigged between ship and shore.

Ship operations that generate water mist may give rise to electrostatic charges. The risks can be mitigated by following industry approved tank cleaning guidelines and ensuring that tanks are in an inert condition before operations begin.

Additionally, the use of plastic portable drums (non-conductive) for collecting flammable or non-conductive liquids should be avoided.

Be aware that introducing equipment into a hazardous atmosphere can act as a powerful ignition source, so safe working practices and precautions must be followed. You should never introduce a conductive piece of equipment without making sure it is safe to do so. Equipment such as UTIs are fitted with grounding cables for this purpose.

Chapter 11
Lifting Operations

Lifting equipment is any work equipment that is used for lifting and lowering loads, together with attachments used for anchoring, fixing or supporting the load. Equipment includes cranes, vacuum lifting cranes, hoists, scissor lifts, forklift trucks, passenger lifts, mobile elevating work platforms and pallet trucks. Attachments include chains, ropes, slings, strops, pulleys, eyebolts and shackles.

Incidents relating to lifting can have serious consequences, including damage to cargo and supplies and serious or fatal injury to personnel.

11.1 Lifting Equipment

Lifting equipment is always marked with designated safety information, such as the safe working load (SWL). Some lifting equipment, such as web slings, might also be colour coded to indicate lifting strength.

All equipment must be visually inspected before it is used in a lifting operation.

The manufacturer's instructions should be consulted and followed for examination and testing of equipment.

Colour coding of lifting equipment is an aid to identification and does not replace the requirement to conduct a detailed inspection of each item prior to use. It is not intended to replace other means of identifying lifting equipment, such as serial numbers, certifying stamps, etc.

11.2 Risk Assessment

Every lifting operation involves a level of risk. A risk assessment must be completed for every lifting operation in order to identify, assess and control the risks, with consideration given to the following:

- Planning the lift
- hazards and restricted areas
- the minimum number of people required to conduct the lifting operation
- communication of lift requirements and hazards
- procedures for changing the lift plan
- emergency, recovery and contingency plans.

Non-routine lifts, such as those listed below, should have detailed written procedures and walkthroughs:

- Lifts made directly over the top of operating facilities
- lifts with a centre of gravity that cannot be determined
- lifts requiring non-standard rigging configurations
- excessively heavy lifts
- lifts in excess of 5 m in height or width
- lifts in excess of 20 m in length
- lifts within restricted spaces.

Risk assessments are vital for capturing all of the potential hazards involved with the task. The inclusion of everyone involved with the lift in the risk assessment process will generate a superior risk assessment.

11.3 Safety Rules for Lifting Operations

The following best practice should be observed when working with lifting appliances:

- All personnel in a lifting operation must be suitably trained and aware of their responsibilities during each stage of the operation
- all lifting appliances and items of lifting gear must be clearly marked with safety information, such as their SWL, and a way of identifying the equipment

- any safety devices fitted to a lifting appliance, such as a limiting/cut-off switch, must be checked before work starts
- if a load is immersed in the sea for any reason, be aware of the probable increase in weight from water retention
- lifting operations should be stopped if wind and/or sea conditions make it unsafe to continue; the load should never be allowed to swing
- all loads should be properly slung and attached to the lifting gear and all gear must be properly attached to the appliance. Only qualified or trained personnel should do this
- when any lifting equipment, such as a hook or shackle, is replaced, care should be taken to ensure that the replacement is of the correct type, size and SWL for its intended use
- on completion of any gear overhaul, all working places should be cleaned of any excess oil or grease.

Always

- Ensure you know how to shut down lifting equipment, including use of the emergency stop function
- ensure that lifting appliances are securely anchored, supported or counterbalanced so they maintain stability throughout the lift
- ensure that access to the work area and to the lifting equipment is properly controlled, which may include the use of security measures and barriers.

Never

- Lift loads over personnel or walkways that are in use
- lift personnel, except where the lifting plant has been designed or adapted for such a purpose, or for rescue in emergency situations
- lift a load if you are unsure of its rigging/slinging arrangements.

Before any attempt is made to free equipment that has become jammed under load, every effort should first be made to take the load off safely. Precautions should be taken to guard against sudden or unexpected freeing. Anyone not directly engaged in the operation should remain in a safe or protected position.

It is very important that anyone operating any lifting appliance has, as far as practicable, a clear view of the whole operation. If the operator of the lifting appliance does not have a clear view, a properly trained signaller must give instructions to the operator either by manual signals or by radio.

11.4 Load Security

For most lifts, the load should remain level when clear of the ground. To achieve this, the hook must be positioned directly above the centre of gravity of the load. The legs of any slings or chains must be distributed as evenly as possible, as the angle each makes will affect the proportion of the load it takes.

For best practice, the load should be test lifted just clear of the deck to prove that stability and slinging arrangements are correct, before continuing with the operation.

A tag line should be fitted to the block of the crane hook and held tightly by a crew member to help reduce any swing from the block. Even a small amount of momentum can cause a large amount of damage or instability due to the weights involved with the lift.

The more unstable a load, the greater the support needed during the lift to protect it from toppling forces such as wind, acceleration, swinging or braking.

11.5 Cranes and Winches

Cranes should be operated and maintained in accordance with the manufacturer's instructions. The following criteria must always be observed:

- Length, size and SWL of falls and topping lifts
- SWL of all fittings

- boom limiting angles
- manufacturer's instructions for both regular maintenance, such as topping up hydraulics and greasing, and occasional maintenance, such as replacement of wires.

When a winch is changed from single to double gear, or vice versa, any load should first be released and the clutch secured.

When using a ship's crane, the position and operation of the crane can affect the ship's stability and this must be taken into account during the initial risk assessment.

An operator should always be at the controls while any powered lifting equipment is in operation. It should never be left to run unmanned with a control secured in the 'on' position.

11.6 Gantry Cranes

Anyone working in the vicinity of a gantry crane must:

- Stay clear of the lifted load at all times
- not work or move under a suspended load
- not ride on the hook or load.

All directional movement must be made smoothly and deliberately, avoiding rapid movements in any direction.

To avoid a swinging load:

- Locate the lifting hoist directly above the lifting point of the load before lifting
- lower loads directly below the hoist. Do not allow the load to be pulled to one side while suspended
- maintain a minimum of three full wraps of cable on the hoisting drum at all times.

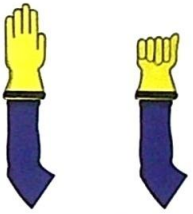
All loads must be lifted high enough to clear obstructions before moving the bridge or trolley. Wherever possible, maintain a minimum clearance of 30 cm above obstacles and to the sides of the load. Raise the load only to the height needed to clear obstacles.

It is important not to exceed the rated capacity of the crane, hoist, chain, sling or any other component.

11.7 Hand Signals for Lifting Operations

The following signals are commonly used for directing the movement of cranes.

Start

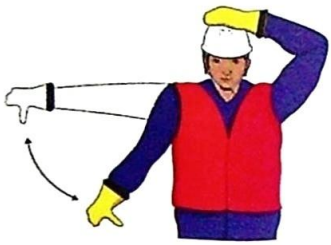


Take the strain

Raise hook

Lower hook

Jib up



Jib down

Extend the jib

Retract the jib

Move jib to right (direction of arm)

Move jib to left (direction of arm)

Stop

Emergency stop

The hand signals in use on board your tanker may differ slightly to those above – always learn the signals appropriate to your tanker.

Chapter 12
Inspections

A number of safety-related inspections will take place on board your tanker. They originate from a need to ensure compliance with the provisions of IMO Conventions and Codes, as well as with specific flag State legislation. While some inspections might occur on a port-by-port basis, others may be annual or periodic.

Inspections are a key component of tanker safety and verify that the tanker and its crew are complying with official rules and regulations.

12.1 Safety Inspections

Various regulatory inspections will take place on your tanker. The main inspections you may encounter are as follows:

Flag State inspection

Flag State inspections are used by the ship's assigned flag State to ensure their standards and procedures are being maintained on board.

Port State Control (PSC) inspection

PSC inspections are the inspection of foreign ships within national ports to check that the ship, its equipment and its personnel comply with international regulations and requirements.

Classification Society inspection

Classification Society inspections are carried out to verify the structural strength of the tanker, the integrity of essential parts of the ship's hull and the function of key ship systems, such as propulsion, power generation and steering systems. These inspections provide vital certification to allow a ship to trade.

CDI Inspection Process

The CDI-M inspection was created by the chemical industry to improve the safety and quality performance of bulk liquid chemical shipping. CDI ship inspection reports are focused on the operational safety standards of the world fleet of chemical tankers. CDI is managed by chemical industry members and reports are available to industry, Port State Authorities, terminals and others who have a vested interest in the safe operation of chemical tankers.

Ship Inspection Report Programme (SIRE) inspection

SIRE inspections were introduced by the Oil Companies International Marine Forum (OCIMF) to address concerns about sub-standard shipping. SIRE is a unique tanker risk assessment tool that is of value to charterers, ship operators, terminal operators and government bodies concerned with ship safety. The SIRE system is a very large database of up-to-date information about tankers.

Normally, the ship's officers will liaise with the inspectors, but any member of the ship may be asked questions or be expected to demonstrate that they can perform their job safely. If you are asked a question during an inspection but you are not sure of the answer, respond by saying where you might go to find out the information (such as from your SMS) or whom you can ask on board for help (the safety officer, for example).

You may also have inspectors and supervisors from your company/owner/charterer who are responsible for either ships, crew or cargoes under their control. They will inspect various aspects of the tanker to identify non-conformities and implement any necessary changes.

Inspectors from the various authorities mentioned in this chapter can order a ship to be detained in port if they are not satisfied with the safety conditions they find on board.

Chapter 13
Drills and Emergencies

During your time on board, you will carry out a variety of musters and drills. While certain musters and drills must be carried out at specified regular intervals or after crew changes, they are not purely to ensure that the tanker is compliant with regulations; they are essential in improving safety and in making sure you know how to react when the alarm sounds for real. Regular drills can help train crew to respond quickly and efficiently to potentially dangerous events.

An effective drill, in which information is given, tasks are performed and lessons are learned, can help you perform your duties safely in an emergency.

13.1 Drills

In most cases, you will muster on the sounding of an alarm, before carrying out a drill. You should always be aware of your responsibilities on the muster list.

Ideally, a briefing should take place before the drill commences. The main safety drills are as follows:

Fire – ensure you know how to respond on sounding of the alarm, where to muster and what your duties will be.

Enclosed space rescue – ensure you know how to respond and what your duties will be in such an emergency.

Abandon ship – ensure you know where to muster, how to don your lifejacket and immersion suit, and the location of your designated survival craft. Tankers are fitted with liferafts and freefall lifeboats. You should ensure you know how to operate the freefall lifeboat, including turning on the engine and water spray, as well as how to safely launch the lifeboat in an emergency. You should also know how to safely deploy the liferafts.

Man overboard (MOB) – ensure you know how to raise the alarm and where the lifebuoys are located on your tanker.

Pollution – ensure you are familiar with the shipboard marine pollution emergency plan (SMPEP) and you know where your pollution response gear is located.

Medical emergency – ensure you are confident with first aid response and you know where first aid equipment and the ship's hospital are located.

In an emergency, you may need to rig and use the emergency towing gear fitted on your tanker. This emergency towing gear is a requirement of SOLAS and separate arrangements are usually found fore and aft. Located close by, both forward and aft, will be an emergency towing booklet, which details every aspect of the equipment. You should ensure that you receive suitable training so that you know how to deploy the equipment in an emergency.

It is very important that you ask questions during drills and use the time to discuss feedback in the drill debrief. Such opportunities can make the difference in a real emergency between a poor response, with potentially deadly consequences, and a quick, efficient response that prevents an emergency becoming a catastrophe.

13.2 Emergency Response

Quick and efficient response to any emergency is critical in preventing the situation from getting out of control. A small incident can quickly escalate, and external assistance may be days away. Therefore, it is essential that everyone on board can react in a timely manner.

You must be familiar with your tanker's emergency response procedures, alarm signals and muster list duties. Upon joining a new ship, always familiarise yourself with that ship's specific systems, emergency equipment and muster locations as they may differ from what you have seen before.

Every person on board will be designated duties on the muster list. If you are unsure of your duties, or feel you are unable to complete them, raise this with the Master or the safety officer.

There may be situations where you must deputise in the absence of someone else, such as when an emergency team leader does not turn up on the sounding of the emergency alarm. It is therefore important that you are not only fully familiar with your own duties, but also familiar with those of your crew mates.

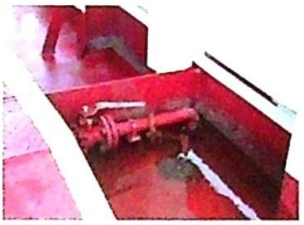
Practising for emergency conditions will build your confidence in dealing with any real emergency situations.

13.3 Actions in the Event of Pollution

One of the most important priorities in the event of a spill is to prevent it reaching the sea. A spill may have severe harmful effects on the environment and marine life, as well as possible legal and financial consequences.

Tankers are designed with fish plates around the edge of the deck and in front

of the accommodation block so that, in the event of a liquid cargo spill on deck, the cargo will not flow overboard immediately. It will usually pool at the aftmost fish plates, which can enable easier clean-up operations.



You should remember that many cargoes release flammable and possibly toxic vapours, posing additional risks not just to the marine environment but also to all on board the tanker. This vapour is easily flammable and can reach areas of the tanker where the potential for sparks is far higher than on the main deck.

In the event of a spill:

- Immediately notify a responsible officer
- avoid inhalation of any vapours
- assist in the shipboard marine pollution emergency plan (SMPEP), as instructed
- use SMPEP response gear as appropriate
- prevent any possible ignition sources by maintaining fire prevention practices.

A quick response is essential in the event of an oil or chemical spill on board. While the first priority is to prevent oil from going overboard, ensure that you never endanger your safety in doing so.

13.4 Shipboard Marine Pollution Emergency Plan (SMPEP)

MARPOL Annex II, Regulation 16 requires that every ship > 150 GT that is certified to carry noxious liquid substances in bulk must carry an approved shipboard marine pollution emergency plan for noxious liquid substances.

MARPOL Annex I, Regulation 37 states that oil tankers > 150 GT and all ships > 400 GT must carry an approved shipboard oil pollution emergency plan (SOPEP).

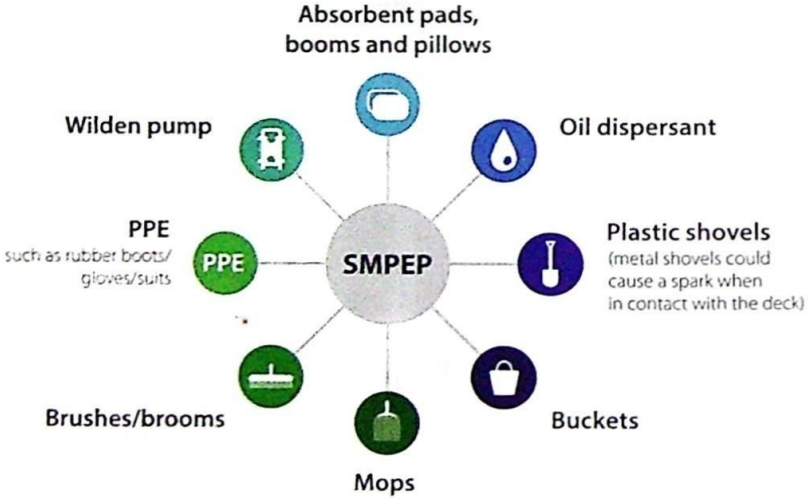
Ships covered by both regulations may carry a combined plan called the shipboard marine pollution emergency plan (SMPEP).

The plan provides guidance to the Master on the actions and decisions required when responding to a pollution incident.

The SMPEP must, as a minimum:

- Be simple, easy to use and be in the working language of the crew
- follow MARPOL guidelines
- contain the actions to be followed in the event of a noxious liquid substance pollution incident
- contain an emergency contacts list of authorities and persons to be notified in the event of a noxious liquid substance spill.

A ship carrying an SMPEP should have the following equipment on board.



Chapter 14
Cyber Security

Cyber security is the protection of ship systems (both IT and OT), networks and data from damage, disruption or compromise. Threats to systems can be either external or internal in origin, and malicious (known as 'cyber attacks') or unintentional.

Further, in-depth guidance on cyber security can be found in *'Cyber Security Workbook for On Board Ship Use'*, published by Witherbys.

All new crew members should receive cyber security familiarisation as part of their safety induction. This should highlight the ship's cyber security procedures and cover topics such as:

- Use of personal devices
- how to connect to the ship's WiFi and rules for general WiFi usage
- the use of emails, including how to identify potentially malicious or compromised emails
- how to share files in a safe manner (including the use of USBs)
- the procedures for software updates and anti-virus scans
- who the cyber security officer is for the ship
- where to find the tanker's cyber security incident response plan
- actions to take in the event of a cyber security incident.

Crew should also receive regular cyber security training, which may take the form of presentations, drills or table-top exercises. Cyber security is a complex issue and the risks of cyber attack will vary depending on the systems installed on board. Training should be tailored to specific company and/or ship needs.

Your company will usually set out the relevant parts of its cyber security plan within the SMS. It is important that you are aware of your responsibilities in maintaining cyber security. Usually, the Master, chief officer or chief engineer will be the cyber security officer on board your tanker.

When using digital and IT equipment on board, you should:

- Use only authorised equipment – you should never connect an unauthorised USB memory stick to any system on board. If you are using an authorised USB memory stick, ensure it is scanned for malware and viruses. Personal equipment such as phones, laptops, tablets, etc should be used in line with company policy and should never be connected to ship systems or business networks
- minimise threats from external attacks – never open an email or its attachments unless you are certain it is from a trusted source. If you have access to the internet on board, be vigilant when clicking on weblinks
- report suspicious or unusual problems – you should be attentive and aware of what to do when you encounter any suspicious emails or files. You should report any abnormalities to the cyber security officer and, as required, to your company IT department

Always ensure you are vigilant when communicating via email. You should never disclose passwords for systems to an external party. Do not respond to emails with information, attachments or data unless it is to an authorised or trusted source (note that sometimes attackers may impersonate a trusted source and the email address may look correct. Watch for other signs, such as typos, strange greetings or unexpected requests). You should think carefully before sharing information relating to your tanker, company or job online via social media, forums or personal email. In some instances, this may be specifically prohibited by your company.

The consequences of cyber incidents can be catastrophic and you should be aware that:

- Opening files or links from non-trusted sources may trigger the downloading of dangerous programs or files, which can lead to the loss of IT or OT system functionality on board and ashore
- there is a potential threat to onboard systems that could lead to errors in navigation and threaten the ultimate wellbeing of those on board your tanker. An attack on specific systems on your tanker is possible, causing systems to slow down or crash and rendering them unusable
- there is a potential for loss of corporate data, including sensitive information from terminal/shore operations

- financial and operational data about your company, cargo or operations may be stolen or accidentally revealed. This could result in significant financial loss for your company and/or other organisations. Large sections of the maritime industry may be affected by a single incident.

Failure to follow your company's SMS procedures may put the tanker or company at risk of a cyber attack and the consequences for tanker safety can be significant. Attackers may seek to damage the tanker and therefore you must always be vigilant.

14.2 Types of Cyber Attack

A cyber attack is any type of offensive manoeuvre that targets ship systems, computer networks and/or personal electronic devices. The goal of an attack is to compromise, destroy or access systems and data.

There are several types of cyber attack:

- Malware – malicious software designed to access or damage a computer, network or system without the knowledge of the owner
- ransomware – this restricts access to the systems that it infects, encrypting data so that files cannot be accessed without first paying a 'ransom' (usually a specific amount of money or digital currency)
- viruses – these can create, move or erase files and disrupt a device's memory or start-up system
- worms – similar to viruses, but designed to spread to multiple systems or computers
- trojans – a form of malware that disguises itself as legitimate software but is designed to retrieve confidential information
- spyware – software that 'spies' on a computer and can capture information such as web browsing, emails, usernames, passwords and credit card information.

It may not be immediately obvious which kind of cyber attack, if any, has occurred. However, if you have any suspicions, you should immediately inform the tanker's cyber security officer.

14.3 Protection from Cyber Attacks

While it is impossible for any system to be completely cyber secure, effective cyber security management can lessen the likelihood and severity of an attack. Creating a culture of cyber security awareness on board is crucial.

Anti-virus software (sometimes known as 'endpoint protection') is another key component of cyber security and will defend against basic cyber attacks. Keeping anti-virus software up to date is essential in order for it to work correctly.

Software updates are regularly released by software developers to address security issues identified by the manufacturer. If your systems are not fully updated, they might not include defence against the most recent cyber attacks.

Software updates for personal electronic equipment may be blocked by the tanker's administrator. If this happens, contact the tanker's cyber security officer.

14.4 Identifying a Cyber Security Attack

It may not be immediately noticeable that you or the tanker has been the victim of a cyber security attack. Some potential warning signs of a cyber security incident include:

- Unresponsive or slow systems
- unexpected changes to passwords, user permissions or network credentials
- unusual or suspicious email activity

- network connectivity issues
- system crashes or program errors
- unexpected changes to browser settings
- unusual hard drive or processor activity
- unexplainable changes to disk space or memory availability.

If you think that you have been the victim of any type of cyber security attack, inform the tanker's cyber security officer immediately.

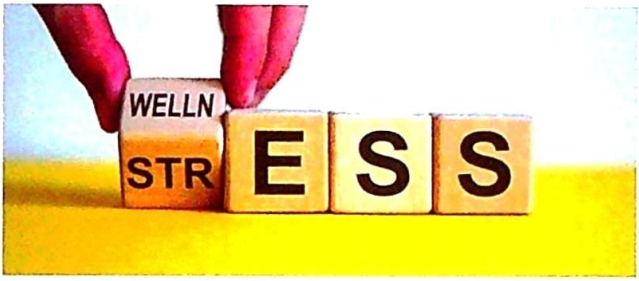
14.5 Passwords

Passwords that are easy to crack are a major risk to cyber security. All passwords (both business and personal) should be long and complex, but still memorable, and changed periodically (particularly in cases of high crew turnover). Some recommendations for creating a complex but memorable password include:

- Use a combination of upper case/lower case characters, numbers and symbols
- avoid using single, common dictionary words and obvious letter/number substitutions (eg a '3' instead of the letter 'e' etc)
- remember a sentence and use the first character of each word
- choose a combination of three random words.

Never disclose sensitive information, data or passwords to anyone.

Chapter 15
Health and Wellbeing



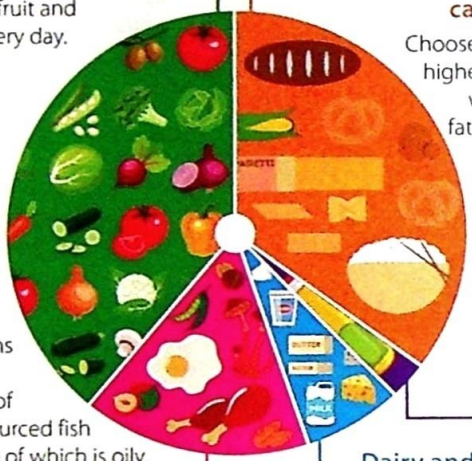
Your personal health and wellbeing on board is important. A fit and healthy lifestyle has numerous physical and mental benefits and will allow you to better enjoy your time at sea.

Being unfit and/or unwell on board can affect your ability to do your job safely.

15.1 Healthy Eating

A crucial aspect of living a healthy lifestyle, both on board and at home, is down to the food that you eat. Everyone should try to eat five portions of fruit and vegetables every day, as well as drinking plenty of water. It is recommended that adults should drink approximately two litres of water every day in ambient temperatures (this will increase dramatically when working in warmer climates).

The following image can be used as a guide to a balanced diet.



Fruit and vegetables
Eat at least five portions of a variety of fruit and vegetables every day.

Potatoes, bread, rice, pasta and other starchy carbohydrates
Choose wholegrain or higher fibre versions with less added fat, salt and sugar.

Beans, pulses, fish, eggs, meat and other proteins
Eat more beans and pulses, two portions of sustainably sourced fish per week, one of which is oily. Eat less red and processed meat.

Oils and spreads
Choose unsaturated oils and use in small amounts.

Dairy and alternatives
Choose lower fat and lower sugar options.

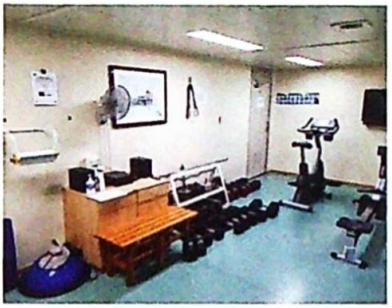
Water, lower fat milk and sugar-free drinks, including tea and coffee, all count.
Limit fruit juice and/or smoothies to a total of 150 ml a day.

Eat less often and in small amounts.

Calories Per Day 2,000 **Calories Per Day** 2,500 = **All Food and Drinks**

15.2 Fitness and Exercise

Many larger chemical tankers will have a gym or exercise equipment on board. This can range from treadmills, exercise bikes and cable machines to loose equipment such as skipping ropes and dumbbells. If your tanker does not have any accessible exercise equipment, there are numerous body weight exercises you can complete inside your own cabin.



It is recommended that you complete up to five 30-minute exercise sessions per week, where possible.

15.3 Heat Stress

An important factor to consider when working on board a tanker is heat stress. Heat stress occurs when your body begins struggling to maintain its regular body temperature. Air temperature, humidity, heavier than usual work rate and even the clothing you are wearing can contribute to this.

Your body reacts to this higher operating temperature by sweating more, which has a cooling effect on your skin. This is designed to lower your body temperature. If this is restricted in any way, such as by the clothing you are wearing or by high humidity, it will not be as effective.

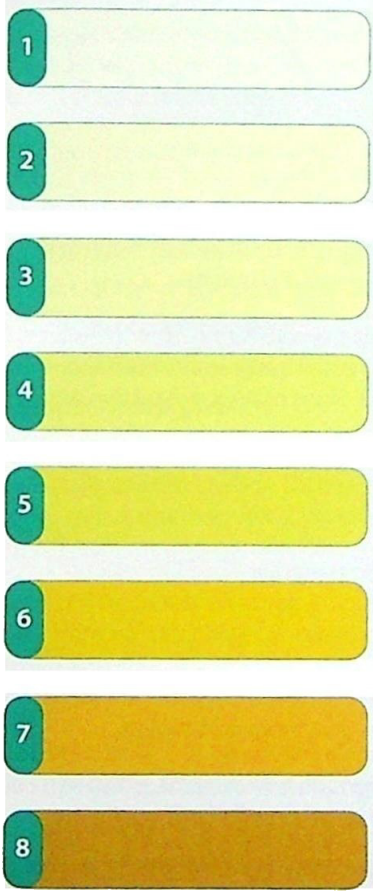
An increased level of sweating can quickly result in dehydration. Dehydration occurs when your body does not have enough water to function properly, and can occur quickly if you are losing more water than you are taking in. As your body has less water available for sweating, it cannot cool you down by this method.

The first sign of your body suffering from heat stress is usually feeling thirsty. If you are already thirsty, you are likely to be in the early stages of dehydration.

Another quick method for determining whether you are dehydrated is from your urine. A hydrated person's urine will be clear or lightly coloured, whereas when you are dehydrated it will be a darker colour.

Dehydration can occur quickly and easily on board without you realising. Remember to drink regularly and often throughout the day.

Use this urine colour chart to assess how hydrated you are. It is important to drink plenty of water every day to stay healthy.



1 to 2: Hydrated
Pale, odourless and plentiful urine is often an indication that you are well hydrated.
Keep drinking at the same rate.

3 to 4: Mildly Hydrated
Slightly darker yellow urine can indicate that you need to drink more water.
Drink a glass of water now.

5 to 6: Dehydrated
Medium-dark yellow urine is often an indication that you are dehydrated.
Drink 2–3 glasses of water now.

7 to 8: Very Dehydrated
Darker, strong-smelling urine in small amounts can be a sign of dehydration.
Drink a large bottle of water immediately.

Note that certain foods, medications and vitamin supplements may change the colour of your urine even if you are hydrated.

Soft drinks, coffee, tea and fruit juices are not good at rehydrating the body. Water is the best source of hydration available on board.

15.3.1 Effects of Heat Stress

The effects of heat stress can vary from person to person, but usually include:

- Inability to concentrate
- cramp
- feeling thirsty
- a heat rash or irritation of the skin.

If the effects of heat stress continue, they can result in heat exhaustion and then finally heat stroke, a far more serious problem.

Heat exhaustion is when your body has been suffering from the effects of heat stress for a prolonged period. This is still easily reversible if the person is cooled down and rehydrated. Signs of heat exhaustion are:

- Headaches and/or dizziness
- clammy skin
- increased breathing rates
- a higher than usual core body temperature
- extreme thirst
- nausea.

If the situation worsens still, or the signs of heat exhaustion are not acted upon quickly enough, it is possible for heat stroke to develop.

Heat stroke occurs after prolonged exposure to heat exhaustion and can be life-threatening.

If you suspect that you, or any member of the tanker's crew, might be suffering from the above effects, contact the medical officer immediately.

15.4 Mental Health

Good mental health is vital for being able to sleep, concentrate, think and interact with crew or equipment. As poor mental health is not as noticeable as signs of poor physical health, it can be harder to detect in yourself or your fellow crew.

Below are some of the more common causes of poor mental health at sea:

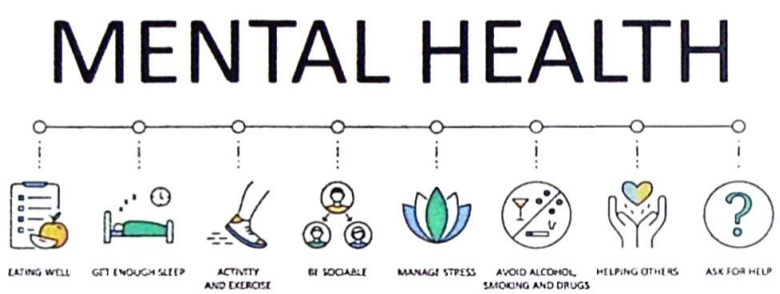
- Anxiety/stress
- feelings of loneliness or isolation
- lack of communication with friends and family
- length of time on board
- onboard relationships
- work-related pressure.

Poor mental health can affect a person's social interactions and thought processes and even change their personality. It can range from feeling anxious to not sleeping or eating and even negative feelings towards themselves.

Due to the demands of working on board a tanker, negative effects stemming from poor mental health can have serious consequences to yourself and your fellow crew if they are not acknowledged and dealt with proactively.

If you feel that any of your fellow crew are suffering from any of these issues, reach out to them and encourage them to talk.

15.4.1 Ways to Improve Your Mental Health



There will be plenty of opportunities during your trip on board to improve your mental health and wellbeing. You may find some of the following ideas helpful:

- Exercise
- go ashore when possible
- eat healthily
- catch up on sleep
- socialise with other crew members
- consider reducing or cutting out completely smoking and/or alcohol consumption.

15.5 Bullying and Discrimination

Bullying is any behaviour that is intended to hurt another person, either emotionally or physically. Bullying in any form is completely unacceptable and should be reported immediately.

On board, this may mean speaking to your head of department, the Master or even a company representative ashore, known as the designated person ashore (DPA). The DPA should only be contacted when you cannot safely raise the issue on board with an officer or the Master.

Another factor to be aware of is discrimination. Discrimination means treating someone unfairly because they possess certain characteristics. There are many different types of discrimination and some may not be as noticeable as others. Characteristics that may lead to discrimination include:

- Race
- sex
- age
- religious beliefs
- sexual orientation
- disability
- gender reassignment
- marriage and civil partnership
- pregnancy and maternity.

Glossary

Combustible Combustible means capable of catching fire and burning.

Competent Person A person who has been adequately trained and is suitably qualified to carry out a task on board that is within their job description.

Corrosives Substances that, by chemical action, will cause severe damage, particularly when in contact with living tissue. Corrosive cargoes can react with metals and release hydrogen, a highly flammable gas that can explode. Some corrosives can cause cloth to spontaneously combust and this should be kept in mind following clean up of spillages.

Dew Point The temperature below which water vapour in the air will condense into liquid water. Very dry air has a dew point of less than −45°C.

Evaporation The process by which liquids can change, or be changed, into vapour. It is usual to refer to such vapours as gases.

Exothermic A chemical reaction in which heat is produced.

Expansion Most substances expand, ie increase in size, when heated. Cargo expansion will cause an increase in pressure inside the tank, which may be relieved by operating pressure relief valves fitted to the tank.

Flammable Flammable means easy to set on fire.

Flammable Limits If a mixture contains either too little (too lean) or too much (too rich) petroleum vapour, it will not be able to burn. This means it will be outside the 'flammable limits'.

Flammable Mixture In this book, flammable mixture usually refers to a mixture of petroleum vapour and air.

Flammable Range A flammable mixture will only burn if the fuel concentration lies within the upper and lower flammable limits. This may be quite a narrow band and it is known as the 'flammable range'. Flammable limits and flammable range are sometimes referred to as the 'explosive limits' and 'explosive range'.

Flashpoint The lowest temperature at which a liquid will evaporate sufficiently to form a combustible concentration of gas.

Gas Free This term usually refers to a cargo tank or compartment that has had sufficient fresh air introduced to it so that it is safe for work or entry.

IBC Code International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, published by the IMO.

Ignition Point/ Auto-ignition Point The minimum temperature required to ignite a gas or vapour in air without a spark or flame being present. It is not the same as the flashpoint.

You do not necessarily need an open flame to ignite the gas. A hot surface, such as a heating element, or a warm machine will ignite a product once it passes its auto-ignition point.

IMO The International Maritime Organization – the UN specialised agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships.

Inert Atmosphere An atmosphere that has insufficient oxygen to support combustion.

Inert Gas Any gas that has insufficient oxygen to support combustion.

Inflammable An alternative word for 'flammable', with the same meaning.

Inhibitor A general term for a chemical compound that, when added to the cargo, has the effect of slowing down or stopping a chemical reaction, such as polymerisation, oxidation or corrosion.

Inorganic Inorganic chemicals have no carbon content. The most common groups are acids, alkalies and hydroxides.

ISM Code The International Safety Management Code, published by the IMO.

MARPOL The International Convention for the Prevention of Pollution from Ships, published by the IMO.

Non-volatile A non-volatile liquid does not readily evaporate into a gas under existing conditions. Products with a flashpoint of over 60°C (140°F) are classed as non-volatile.

Noxious Liquid Substance Chemical cargoes that are harmful to living organisms and to the environment as listed in Chapters 17 and 18 of the IBC Code, all of which must be carried under the provisions of MARPOL Annex II

Organic An organic chemical is carbon based. These chemicals include the vast number of petrochemical cargoes that are derived from oil, gas or coal, but they also include cargoes derived through fermentation, such as butanol and ethanol.

Padding	Padding is the process of introducing nitrogen after loading to reduce the oxygen content of the tank space above the cargo (also see Purging).
Petroleum	A general term used for crude oil and the products that are refined from it.
Polymerisation	A chemical reaction in which two or more molecules combine to form larger molecules. The reaction is exothermic and the temperature may rise to a level at which polymerisation is self-sustaining and very rapid, termed 'runaway polymerisation'.
PPE	Personal protective equipment.
Purging	The process of adding additional inert gas into an already inerted tank to further reduce the oxygen content.
SDS	Safety data sheet – document providing information on a particular chemical substance, including hazards, handling, storage and emergency procedures. Formerly known as a material safety data sheet (MSDS).
SMS	Safety management system.
SMPEP	Shipboard marine pollution emergency plan.
SOPEP	Shipboard oil pollution emergency plan.
SWL	Safe working load – the maximum load (weight or force) that a piece of equipment can safely handle.
Toxicity	The degree of harm a substance may cause to humans or the environment.
Ullage	The space that exists in a tank above a liquid, usually measured as the distance from the sounding point to the surface of the liquid.

VECS Vapour emission control system – an arrangement of piping and hoses used to control vapour emissions on board.

Volatile Liquids that evaporate readily are known as volatile liquids. Any petroleum product with a flashpoint of 60°C (140°F) or lower is known as a volatile petroleum product.

If you are unsure about any of these definitions, seek clarification from an officer or other competent person.