Fortum Shipping
TANKER SAFETY

We Care How We Carry
INTRODUCTION

Regulations concerning tankers

International regulations are followed in the design and construction of tankers and when working on them. The regulations are issued by the administration of the country under which flag the ship in question sails and they are based on the decisions of the International Maritime Organisation (IMO), which is a UN body, and on international standards.

Monitoring of regulations

The authorities of the country under which the ship sails and the representatives of the ship’s classification society monitor the technical condition of the ship by inspections which are carried out regularly. In addition, the ship and the competence of its crew are audited in inspections which are carried out without informing in beforehand. The inspections are based on the Paris Memorandum of Understanding signed between maritime countries. Furthermore, Port State Control inspections are carried out based on the Memorandum when a ship visits foreign ports. The authorities performing the inspections keep a database on the inspections which is available to everyone. This procedure aims at monitoring efficiently that deficiencies are corrected and at informing everyone openly.

The purpose of all inspections and regulations is to prevent accidents and to protect human lives and the environment.

In addition to the inspections carried out by authorities on tankers, an inspector of the customer (an oil company) or of a possible customer (charterer) carries out numerous so-called vetting inspections. They are based on a standard of the OCIMF (Oil Companies International Marine Forum) industry. With the inspections, the oil companies aim at ensuring that the ship complies with the safety requirements stated in international standards, which may deviate from the requirements set by authorities. Oil companies keep a joint SIRE database on the results of vetting inspections, which is available to members for internal use. Oil companies monitor the technical and operative condition of a ship by using the SIRE reports.

Purpose of the guide

This guide is aimed at the whole crew of a ship to inform them of risks which they face on a tanker. The guide does not cover everything on tanker safety and it is not binding by law. It is based on current practice and good occupational safety procedures. For more information, ask the officers of your ship or check publications of the field as well as laws, decrees and regulations.

The purpose of the guide is to protect you, the ship, the environment and the cargo. The instructions help you work safely.

Most of the information included in the guide is based on the ISGOTT (International Safety Guide for Oil Tankers and Terminals) publication, which is published by the ICS, OCIMF and IAPH. Recommendations and instructions given in the publication can be regarded as international standards of the petroleum industry, hence they must be adhered to unconditionally.

Colour codes

Red colour indicates danger.
Green colour indicates safety measures.
Black colour indicates general information.
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DEFINITIONS

1. Space between the ship hull and the cargo tank (void space)
A space in the cargo area, which is usually inerted and enclosed. It is not a cargo tank, ballast tank, bunker tank, cargo pumproom, compressor room or cofferdam.

2. Boil off
A gas which is formed by evaporation above the surface of a liquid which is as cargo. Evaporation is caused by heat loss through tank insulation.

3. Evaporation
All liquids can turn or be turned into steam. Turning into steam is called evaporation.

4. Inerting
The introduction of inert gas into a tank to lower the oxygen content and to keep it on a level in which combustion cannot take place.

5. Inert gas
Shield gas or steam which does not support combustion or life because it decreases the oxygen content in the atmosphere. For example carbon dioxide and nitrogen are used as shield gas, depending on the cargo.

6. Gas free
Gas free indicates that a tank, compartment or container has been checked using appropriate gauges for measuring gas content, and that the level of any flammable, toxic, or inert gas during the time of measuring is that required for a specific purpose.

7. Gas freeing
The introduction of fresh air into a tank, compartment or container to lower the level of toxic or inert gas to that required or adequate for a specific purpose (e.g. hot work, entry).

8. Boiling point
Temperature in which a liquid turns into gas or steam at a (certain) pressure.

9. TVL (threshold value limit)
Maximum concentration of, for example, gases the repeated daily exposure (8 hrs/day, 40 hrs/week) to which is not believed to cause any adverse effect on anyone on the ship.

10. LNG (liquefied natural gas)
Liquefied natural gas, the main component of which is methane.

11. LPG (liquefied petroleum gas)
Liquefied fuel gas - mainly propane or butane which are transported separately or as mixtures. They are by-products of the oil refining process or they are products of drilling crude oil or natural gas.

12. Ppm (parts per million)
The most common unit used for defining a concentration. Defines the concentration of gas and steam in air in parts per million by volume.

13. Primary barrier
The inner barrier of a double-barrier cargo tank.

14. Flammable range
Such gas concentrations in the atmosphere in which flammable mixtures are formed.

15. Flammable or inflammable
The word “flammable” includes the word flame. Flammable means an ability to ignite. Instead of “set on fire” we use the word “ignite”.

16. Incendive spark
A spark the temperature or energy of which is sufficient to ignite a flammable gas.
17. Asphyxiant gas
A gas the toxicity of which is low or hard to define but which may cause unconsciousness and death if it enters the air or if air is replaced by it. The oxygen intake of an organ or living creature is hindered.

18. Asphyxiation
Asphyxiation occurs when an insufficient amount of oxygen enters the blood, which causes unconsciousness and death.

19. Secondary barrier
The outer watertight barrier of a cargo tank, which has been designed to temporarily prevent the leaking of a liquid cargo through the primary barrier and to prevent the temperature of the ship’s structure from decreasing to a level which is too low in terms of safety.

20. Reliquefaction
Turning the gas which has evaporated from the cargo back to liquid by increasing the pressure or by lowering the temperature, or by both means.

21. (Crude oil washing (COW)
In crude oil carriers, the method of washing cargo tanks using a fixed apparatus which uses the ships cargo as a washing liquid to remove oil residue from the surface of a tank.
On tankers, there are always risks.

The target is to eliminate factors which endanger safety already during the design of the ship. The remaining risks can be avoided by being careful and by following closely the ship’s safety and quality manuals and the instructions given by the ship’s officers. The ship’s officers have been given training on correct working methods.

You must recognise the risks in order to avoid them.

This guide warns you of risks. The guide covers cargo types and the properties of cargoes that are transported and tells you how to be careful. Concepts and abbreviations are defined at the beginning of the publication. If you already understand them, be patient, because your colleague on board the ship may not understand them yet.

**Carefulness and caution are absolute prerequisites – during the whole work.**

- All cargoes are not hazardous even if there is some kind of a risk involved in all of them.
- Permanent instructions must be followed always, be the cargo hazardous or non-hazardous.
- You must know what cargo is transported on your ship.

**INITIATION**

Initiation is the first step in adopting safe working methods on a ship. According to law, an employee must be initiated to the task s/he has been chosen for or transferred to.

The employee must have valid licences for qualification and certificates for the ship type in question, in accordance with the STCW Convention. When the employee has entered the ship, s/he is initiated to the safe operations and the safety culture of a tanker.

Initiation covers the following issues:
- **Safety and quality responsibility**
- **Alarm signals and alarm practices**
- **Alarm stations**
- **Protective clothing**
- **The ship’s life-saving and fire-fighting equipment**
- **Tasks and special responsibilities**
- **Drug and alcohol policy**

The employee must be initiated to alarm signals and alarm stations as well as life-saving and fire-fighting equipment before the ship leaves port.
DRUG AND ALCOHOL POLICY

Oil companies have agreed on a uniform drug and alcohol policy which is applied internationally. In practice this means that a shipping company or an oil company cannot hire a person who does not agree to voluntary monitoring which is required by the drug and alcohol policy.

Find out the drug and alcohol policy of your company. You can find information on it from your company’s safety and quality manuals and from the ship’s officers.

FLAMMABILITY

◆ The main risk involved in crude oil and petroleum products is their flammability. Risks are also caused by the density and toxicity of volatile gases.
◆ Many cargoes carried on tankers are flammable. They may ignite or they may release gases which may form a flammable mixture.
◆ The part of a liquid hydrocarbon mixture, for example, gasoline which burns as a visible flame is the gas which is given off by the liquid.
◆ Hydrocarbon gases ignite and burn only when mixed with air in certain proportions. If there is too little or too much gas or air, the mixture cannot burn.
◆ Every precaution must be taken to eliminate the risk of a fire.
◆ Only smoke in areas designated for smoking.

A flammable mixture contains 1 - 10% hydrocarbon gas by volume and the rest is air.

Matches and cigarette lighters

On a tanker, cigarette lighters shall be kept in the place designated for smoking. Taking matches or a cigarette lighter outside the ship’s accommodation spaces or to the cargo deck is prohibited.

Torches

Conventional torches may cause sparks and they can ignite flammable gases.

Use only customised torches (EEX-approved torches). They are available from the ship’s officers.

Personal equipment

Personal equipment which may cause sparks and ignite a flammable gas include
◆ all electrical equipment which is not EEX-approved
◆ radios and recorders
◆ personal mobile phones (GSM).

Keep all your personal electrical equipment in your cabin. Never take a radio or other portable electrical equipment to an open deck because they are not EEX-approved.
Smoking

- You must always follow all the instructions on smoking.
- The master specifies where and when smoking is permitted.
- NEVER TAKE cigarettes, lighters or matches to an open deck!
- Smoking in secrecy is more dangerous than supervised smoking.
- In the toilets or closets, there may be flammable gases and they may have been released and entered the accommodation spaces through the air-conditioning system. Lots of cigarette smoke is dangerous because it may prevent gas odour from being detected.
- Never smoke in bed. It is dangerous on all ships and on a tanker it may be fatal.

Aluminium

- the pumprooms
- a space in which flammable mixtures can accumulate.

When removing slag or sludge, never use a ladle or spade made of aluminium or aluminium mixture.

Aluminium paint

Aluminium paint on rusty surfaces is also hazardous. If the surface is hammered or rubbed it may cause a hot glow.

Never let heavy objects smash against surfaces which are rusty and painted with aluminium paint.

Waste

Dirty waste, cloths, sawdust and other carbage pose a risk. The risk increases if carbage is left near steam pipes. Also waste containers pose a risk because heat may build up in them, which is enough to ignite flammable mixtures.

- Always remove all waste, cloths, sawdust, and other carbage when leaving the work location.

Cathodic protection

The tanks of some ships have cathodic protection to prevent rusting, in which case pieces of metal called anodes are installed on the supports in the tank. If such an anode or its support is hit or moved it may cause sparks.

- Never hit anodes or their supports in a tank.

Never drag an object made of aluminium or light metal across the deck. Never take a tool made of aluminium or aluminium mixture to

- a cargo tank
**Hand tools**

Metal tools may produce sparks when
- in impact with other metal tools
- in impact with other kinds of metal
- falling.

"Non-sparking" tools are hazardous because ferrous metals may become embedded in the material they are made of.

In all places where there may be hydrocarbons,
- prevent the impact of metal tools with other metal tools or other metal
- do not drop metal tools
- put hand tools made of metal into a sack or bag made of cloth before lowering them into a tank
- do not use non-sparking tools.

**Power tools**

Electrical equipment and power tools used during the cleaning of tanks or gas freeing may cause sparks if they
- are not in line with requirements
- are defective

When cleaning a tank or during gas freeing,
- always use electrical equipment which is in line with regulations
- inform others of defects that you have found in the equipment
- follow the instructions given by the officers.

**STATIC ELECTRICITY**

In some conditions, static electricity may be generated in the tank. This is not necessarily dangerous because electricity may be earthed to the ship’s hull. If the charge remains in the tank, a metal object brought into the tank may generate a spark. The discharge of a charge may cause sparking, which may result in an explosion.

It is prohibited to take any of the below equipment into a tank before earthing has been checked:
- manual metal level measuring tapes
- metal sample bottles
- metal measuring sticks
- unearthed mobile tank washing machines.

Materials conducting electricity are like conductors.

When loading volatile liquids,
- manual level measuring tapes
- metal sample bottles and
- metal measuring sticks
must be of non-conductive material.

**TANK CLEANING**

Flammable gases stay in the tank also after the cargo has been discharged. Flammable gases are a danger especially during tank cleaning if appropriate measures have not been taken.

During tank cleaning
- keep tank lids closed, if possible
- do not lower metal objects into the tank, except an earthed tank washing machine.
- do not remove tank washing hoses from their posts (or connections) before the washing machines have been removed from the tank. This is to make sure that they stay earthed until they are outside a space in which the gas content is so high that a explosion may take place
- do not leave tools or metal objects on the deck to prevent them from accidentally falling into a tank.
FLAMMABLE AND TOXIC GAS

Flammable or toxic gases may be present
◆ even after the loading or discharging of volatile or toxic cargo
◆ even after gas freeing.

If a space has been declared gas free, it means that the space was free at the time of measuring.

The space does not remain gas free and safe in all circumstances. In such circumstances regular measuring must take place.

Flammable or toxic gases may occur
◆ when tank coating material which is peeling off is moved
◆ after the heating coil has been opened
◆ when a pipeline or a valve is opened
◆ when a cargo pump is opened
◆ when the cargo vent outlets are opened
◆ whenever there is cargo residue in the tank, especially when it is moved.

Flammable or toxic gases may be in spaces into which flammable or toxic cargo may have leaked. Such spaces include
◆ pumprooms
◆ cofferdamms
◆ ballast tanks
◆ tanks equipped with a double bottom
◆ empty spaces adjacent to cargo tanks.
◆ Openings must be closed as quickly as possible.

A space is gas free if no flammable or toxic gases can be detected in it at the time of testing by using measuring equipment.

A space can be defined gas free by testing, and a certificate can be issued which indicates that the space is
◆ safe for humans (adequate oxygen content must be taken into consideration) and for cold work
◆ safe for hot work.

Hot work, for example welding, performed in the dirty parts of the tank may release flammable gases.

The deck officer in charge of operations at the time in question measures flammable and toxic gases. Chemical and gas tankers have fixed testing equipment for detecting
◆ gas emissions of cargo
◆ flammable gases released from volatile cargo
◆ oxygen content in the air by percentage.

Remember, that a space may contain:
◆ toxic gases
◆ corrosive gases
◆ flammable gases
◆ too little oxygen.

Gas dispersion

Most gases are heavier than air. Gases which have left the tank through tank openings and outlet valves during loading usually remain floating on the deck, from where they can get to the engine room and to the inlets of air-conditioning equipment through doors and other openings.
If the wind speed is low, approximately 2 metres/sec or lower, flammable or toxic mixtures do not disperse, instead, they accumulate on the decks. Gases can also be found near their original location.

**WORTEXES**

Air flowing at high speed past the ship’s deck structures forms vortexes around the structures. This happens especially below the wind. A wind flowing past increases the pressure level somewhat, as a result of which part of the moving air is drawn inwards in swirly flows.

Illustration: Wortexes

A wind blowing during cargo handling may
♦ contain flammable or toxic gases
♦ form vortexes which may contain flammable or toxic gases
♦ cause the accumulation of flammable or toxic gases into, for example, accommodation cabins, the kitchen area and deck storages

The entering of cargo gases into inner spaces must be prevented. If gas does enter the inner spaces, electrical equipment must not be used. The entering of gas into the engine room must also be prevented and flammable mixtures must not get in contact with the electrical equipment in the engine room.

During cargo handling, the main auxiliary engines must usually be ready for immediate use. If the entering of gases into the engine room cannot be prevented in some climate conditions, cargo handling must be stopped until the climate conditions change. Cargo handling must be stopped always if large quantities of cargo gases accumulate on the decks.

During cargo handling or always when hazardous gases may exist,
♦ follow closely the instructions on closing doors and openings
♦ follow closely instructions on air-conditioning and venting equipment
♦ keep windows and doors closed.

Take into consideration that
♦ the forming of vortexes depends on the direction and force of the wind
♦ wind blowing from the bow to the stern may promote the accumulation of gas around the stern side of deck structures that are in the wind’s path
♦ when the wind blows in the cross direction of the ship, gas tends to accumulate below the wind.

**FLAMMABLE CARGO**

♦ All liquids turn or can be turned into steam. Turning into steam is called evaporation and steam which is released from the liquid is called gas.
♦ Gases usually burn. The liquid itself does not usually burn.
♦ The evaporation speed and temperature of different liquids vary. Liquids which evaporate at a low temperature are the most hazardous.
♦ Most gases burn only if they are mixed with oxygen (O2). The oxygen content of air is approximately 21% by volume.
♦ When a mixture contains too little air for burning, it is too rich, and when it contains too much air for burning it is too lean.
A mixture burns only if it is not too rich or lean, in other words, if it is within its flammable limits and within the flammable range. The limits are called lower flammable limit (or lower explosive limit) and upper flammable limit (or upper explosive limit).

The flashpoint of flammable cargo is the lowest temperature in which a liquid gives off sufficient gas to form a flammable gas mixture. Many liquids give off a large amount of gas already in standard atmospheric pressure and temperature. The smallest spark can ignite a gas. The spark can originate from, for example, a torch which is not of the approved type.

Follow precautions to prevent sparking!

**INERT GAS**

Inert gas is uptake gas generated by the ship’s boilers the oxygen content of which is approximately 2 - 4%. Inert gas is used for reducing the oxygen content of cargo tanks to make combustion impossible. **Inert gas is hazardous if inhaled.**

**The effect of inert gas on flammability**

When inert gas is added to a hydrocarbon/air mixture, the lower flammable limit rises and the upper flammable limit sinks and the flammable range decreases.

The effect is described in principle in diagram xx (ISGOTT picture 15-1).

All the points on the diagram represent a certain mixture of hydrocarbon gas, air and inert gas. Axis x shows the percentage of oxygen by volume and axis y the percentage of hydrocarbon gas by volume of the whole mixture. Mixtures without any inert gas lie on line AB. As the hydrocarbon gas content increases the oxygen content decreases correspondingly. Points to the left of line AB represent mixtures the oxygen content of which has been reduced by adding inert gas into the mixture.

The lower flammable limit is represented by C and the upper by D. As the inert gas content in the mixture rises, the flammable range changes as shown by lines CE and DE. Mixtures are flammable only within the shaded area, outlined by the curve CED.

As air or inert gas is introduced into the mixture we move close to point A (clean air) or towards the point on axis x, which is defined by the oxygen content of the inert gas to be added to the mixture shown in the diagram at point F.

The diagram shows that when inert gas is added the flammable range decreases until the oxygen content is so low that no mixture can burn, i.e., approximately 11%. ISGOTT states that the oxygen content of a “safely inerted gas mixture” shall not exceed 8%.

When air is introduced into an inert mixture (point F), its composition moves along the line FA and therefore enters the shaded area of flammable mixtures. All mixtures that remain below the line GA are in the flammable range if
they are mixed with air during, for example, the 
gas freeing of a tank. Mixtures below line GA 
do not become flammable under any 
circumstances if they are diluted with air (for 
example point H). A mixture represented by 
point F can become like that represented by 
point H by adding inert gas into the mixture 
before it is diluted with air (reducing the 
hydrocarbon content of an already inerted 
mixture by introducing inert gas = purging).

**Hydrogen sulphide**

Many crude oil grades contain a large amount 
of hydrogen sulphide (H₂S). Hydrogen sulphide 
concentrations are usually lowered with a 
special stabilisation method before crude oil is 
loaded on board. Nonetheless, the hydrogen 
sulphide content of the cargo may still be 
higher than expected, for example as a result of 
less than usual stabilisation. Some crude oil 
grades are not stabilised at all, which means 
that their hydrogen sulphide content is always 
high. Hydrogen sulphide has an odour similar 
to that of a rotten egg. It is fatal above its 
odour threshold.

In addition to crude oil, hydrogen 
sulphide can be found in naphtha, fuel 
 oil and gas oils.

**HOT WORK**

♦ Hot work is all such work which involves 
welding or burning. Hot work covers also 
drilling, sandblasting, electrical work or the 
use on non-approved electrical equipment 
which may cause an incendive spark.
♦ If hot work is done outside the engine room 
or inside a bunker tank or pipe, the possible 
flammability of hydrocarbons must be taken 
into consideration. Hot work should be 
done outside the engine room only if no 
other method of repairing can be used.

Alternatives for hot work include making 
the repair as clod work or removing the part 
and repairing it in the engine room.
♦ Outside the engine room, hot work can be 
performed only if the space is gas free and 
if the work is performed in accordance with 
national and international regulations and 
taking into consideration the requirements 
of the port or the terminal, and in line with 
the special hot work permit procedure.
♦ Hot work for which a hot work permit is 
required is prohibited also in the engine 
room during cargo, ballast, tank washing, 
inert gas and venting operations.

**Planning of hot work**

The master of the ship decides whether there 
are enough grounds for performing hot work, 
whether it is safe to perform it and which are the 
necessary precautions that should be taken. Hot 
work outside the engine room cannot be started 
until the master has agreed with the shipping 
company or operator on procedures.

Before hot work is started, a safety meeting 
headed by the master should be held in which 
all the members of the crew who are involved 
in performing the hot work take part. In the 
meeting, the planned work and the precautions 
concerning it are discussed in detail. In the 
plan, an officer must be named who is 
responsible for supervising the implementation 
of the work and an officer who is responsible 
for the precautions, which include 
communication with and between the different 
parties.

All persons taking part in the work and in the 
preparations for the work have to be explained 
their particular duties. Everyone must also 
know which officer will supervise the work and 
which is responsible for precautions.

For each separate work, a written hot 
work permit must be obtained.
A hot work permit is issued only for a specified period of time and to specified persons. The validity of the hot work permit cannot exceed one workday.

Preparations for hot work

During the whole hot work performance, all such activities must be interrupted and must not be continued, in which the cargo or ballast system is used, including tank cleaning, inerting and gas freeing of tanks. If the hot work is interrupted for some reason, all precautionary measures must be re-checked, and a new hot work permit must be issued before the hot work is resumed.

All kind of hot work on bulkheads of bunker tanks or performing hot work closer than 0.5 metres from them is prohibited.

Hot work in an enclosed space / cargo tank

- The compartment in which the hot work will be performed must be cleaned and ventilated until tests show that the oxygen content of the space is at least 21% by volume and the hydrocarbon content is below 1% of the lower flammable limit.
- Before hot work, adjacent cargo tanks must be cleaned, also those located cornerwise. The tanks must be made gas free or they can be cleaned and purged of hydrocarbon to less than 1% by volume and kept inerted, or they can be filled completely with ballast water. The hydrocarbon content of other non-gas free tanks must be less than 2% by volume and they must be kept closed and inerted.
- On a ship which does not have inert gas equipment, all tanks except slop tanks must be cleaned and made gas free. Slops must be put in a tank or tanks which are located as far from the hot work as possible. The slop tanks have to be kept closed.

- Adjacent ballast tanks and other adjacent compartments (other than cargo tanks) must be checked to make sure that they are gas free and suitable for hot work. If the tanks are contaminated by cargo, the reason for contamination must be found out and the space must be cleaned and made gas free.
- All pipes which connect the space in which hot work is performed to other compartments must be flushed with water, emptied, ventilated, and isolated from the space on which hot work is performed. To seal off the pipes, cargo pipelines can be inerted, or filled with water, if necessary. Steam, cargo heating and inert gas pipelines must also be ventilated and sealed off.
- All cargo residue, sediment or other material from which flammable steam may evaporate must be removed in a radius of at least 10 metres from the hot work. Special attention must be paid to areas immediately behind or below the space on which hot work is performed. They must also be cleaned.
- An adjacent bunker tank containing heavy fuel oil can be regarded safe if tests on the ullage space in the bunker tank give a reading of not more than 1% LFL and if hot work does not cause heat transfer through the tank bulkhead.

Hot work on deck

- If hot work is performed on deck, cargo and slop tanks on a 30-metre radius must be cleaned. Their hydrocarbon content must be less than 1% by volume and the tanks must be inerted. Other cargo tanks must be kept closed and inerted.
- Adjacent ballast tanks and other spaces must be checked and made sure that they are gas free and safe for hot work. If cargo residue or cargo steam is found in them, they must be cleaned and made gas free.
- On ships which do not have an inert gas system, all cargo tanks except slop tanks must be cleaned and ventilated so that the
hydrocarbon content does not exceed 1% LFL. The slop tanks are kept closed and they must be located at least 30 metres from the location of hot work.

**Hot work on the piping**

Hot work on valves and piping should be permitted only if the part which needs to be repaired is first detached from the system by cold work and if the open-ended sections of the remaining system have been sealed off. The part to be repaired is cleaned and made safe for hot work, even if it has been removed to an area which is safe for hot work, for example, to an engine repair shop.

The parts of the cargo heating system must be opened and flushed to remove possible hydrocarbons from it.

**The officer who is responsible for the safety of hot work**

Makes sure that
- the oxygen content is 21% by volume just before the work is started
- the content of flammable gases does not exceed 1% LEL just before the work is started
- there is enough fire-fighting equipment ready for immediate use
- a fire watchman has been arranged for the duration of the hot work and for a sufficiently long period after the work has been completed
- The fire watchman also supervises, if possible, the areas around the hot work area which may possibly be in danger.
- the surrounding area has been protected against welding sparks and that the extinguishing of the sparks has been arranged
- ventilation in the work area is continuous and sufficient
- the oxygen and flammable gas content is measured at regular intervals during the work and before the resumption of work after a break.

If the hot work is welding, the condition of the welding equipment must be checked. Especially if welding is done by using electricity, the following must be checked:
- That the electrical connections of the welding equipment are in a gas free state
- That the electrical connection is sufficient for feeding the current required for the equipment without overloading and heating
- That the insulation of electric cables lying on the deck is undamaged
- That cables have been drawn to the work location using the safest possible route and that the route of the cables goes only above spaces which have been inerted or made gas free
- That the welding equipment is earthed appropriately.

If a situation or condition which has been the basis for the hot work permit changes, the permit expires and the hot work must be stopped. Work can be resumed only after all safety checks have been performed again and a new HOT WORK PERMIT has been granted.

**AN ENCLOSED SPACE**

In an enclosed space such as a cargo tank, cofferdam, double bottom tank, there may be oxygen deficiency, or hydrocarbons or toxic gases present. It is the master’s responsibility to identify such spaces and to establish procedures concerning safe entry to enclosed spaces.
**Precautions before entering an enclosed space**

Entering an enclosed space may be dangerous because there may be
- flammable mixtures
- toxic gases
- corrosive gases
- hazardous liquids or gases which have leaked from adjacent spaces
- oxygen deficiency.

Before entering an enclosed space, the officer who is in charge must
- inspect the space with approved equipment to detect possible gases or oxygen deficiency
- arrange ventilation and ensure the safety of persons entering the space and that the appropriate procedures are followed
- issue a **written entry permit** which is a prerequisite for starting work
- ensure that there is a guard outside the entrance which leads to the space who raises the alarm if there is a problem
- ensure that ventilation equipment works
- ensure that a person entering the space has a lifeline and wears a harness and that a breathing apparatus is outside the entrance leading to the space and ready for immediate use.

**Before starting work, always make sure that safety equipment works and that you know where it is located!**

If the person you are guarding faces a problem in an enclosed space
- think and stay calm
- do not rush to help. Instead raise the alarm and start preparing rescue operations
- do not enter the space without a breathing apparatus!

**Don’t be the next victim!**

There have been incidents in which people have rushed to help a person who has fallen senseless to the ground, which has resulted in more casualties. If a person who has entered an enclosed space becomes unsteady or dizzy or loses his/her consciousness, the persons involved in rescue operations must first protect themselves with a pneumatic appliance!

**An enclosed must never be entered before the safety of the space has been checked and a written permit has been granted!**

**Pumproom**

The pumproom is the space in which the most pipes are located on a ship. If volatile liquid leaks from the pipeline, it may quickly create a toxic and flammable atmosphere.

A pumproom may contain many serious fire hazards if the space is not maintained carefully in accordance with service and inspection instructions. The cargo pumproom must be checked regularly by the crew, hence special precautions are applied to them.

Pumproom bilges must be kept clean and dry to prevent a FIRE HAZARD. Especially the entering of cargo and vapour generated by cargo into a pumproom must be prevented.

The pumps and pipeline must be in perfect condition. Therefore leaks must always be repaired immediately. The pipeline must be checked by visual examination and also by performing a pressure test at regular intervals. The condition of the pipeline and the thickness of the pipeline walls can also be defined by ultrasonic testing, if necessary, which does not involve dismantling the system. The thickness of the pipeline walls can also be inspected by ultrasonic testing.
There must be instructions concerning the insulation of mud boxes and filters in connection with maintenance operations which require the opening of mud boxes and filters. The tightness of valves, drain cocks and the bulkhead ducts must be inspected regularly. The most important bolts of cargo pumps and equipment which is connected to cargo tanks must be inspected in accordance with a service programme agreed in beforehand.

Pumproom ventilation

SOLAS (Paragraph II-2) requires the mechanical ventilation of a pumproom due to the possible presence of hydrocarbons. Ventilation must be maintained during the whole cargo operation until access to the pumproom is no longer required or until the operations have been completed.

♦ A pumproom must be ventilated thoroughly before anyone enters it. The oxygen content of the atmosphere must be measured and it must be made sure that no hydrocarbons or toxic gases are present.

Pumproom entry

There must be separate instructions on supervising entry into a pumproom, even if the space had a fixed gas detection system. The ship must have clear instructions on inspections which have to be made and gas detection measures which have to be taken before entry into a pumproom as well as on regular monitoring of air quality which has to be performed after entry. The instructions must also require that everyone entering a pumproom use a personal gas indicator.

♦ The communication system must include a line between the pumproom, the bridge, the engine room and the cargo control room. In addition, the most important alarms, for example, the general alarm must be heard and seen from the pumproom.

♦ An efficient communication system must exist between persons in and outside the pumproom and its functioning must be tested at defined intervals. If there is no reply from the persons inside the pumproom, an alarm must be raised.

When defining the interval at which regular inspections are performed in the pumproom during cargo operations, the most important thing is to make sure that the crew’s exposure to possible hazards is minimal.

♦ A warning sign which states that unauthorised entry into the pumproom is prohibited must be placed on the pumproom door.

Service of electrical equipment in the pumproom

The tightness of gas-tight electrical equipment may be endangered if electrical equipment is not serviced in accordance with instructions. In even the most simple service operations, the manufacturer’s instructions must be followed to the letter to guarantee that the equipment stays safe. This applies especially to gas-tight illuminators because closing them incorrectly when the bulb is changed may endanger the tightness of the illuminator.

♦ Ships must have detailed service manuals on installed equipment to facilitate the service and repair of equipment and systems.

Inspection and service of ventilation fans

In pumproom ventilation, air is expelled from a space. As a result, possible gases exit the space through the fan blades and they may ignite if the blades touch the fan frame or if the bearings or seals overheat. Equipment must be checked
and serviced regularly to replace worn-out parts with new ones in time.

**To improve the safety of pumprooms, the following equipment and measures can be considered:**

- A fixed gas detection system which constantly monitors hydrocarbon gas concentration. If such a system has been installed, instructions must be defined on the regular testing and calibration of the equipment. In addition, instructions must be defined in case of emergencies, especially on evacuation and the stopping of cargo pumps.
- A fixed sample-taking system which enables the measuring of the oxygen content of the pumproom by a portable oxygen analyser from the deck. The system should enable efficient sample taking from the furthest parts of the pumproom.
- A cargo pump temperature measuring system by which the temperature of the pump, bearings, and bulkhead seals can be read outside the pumproom. In addition, instructions must be defined in case of alarms.
- A bilge alarm for the pumproom, which can be seen and heard to the cargo control room, the engine room and the bridge.
- Special attention is paid to fire-fighting equipment near cargo pumps.

**Pneumatic appliances which are ready to be used and easily available must be placed in the pumproom in case the space must be exited in an emergency.**

**Contamination of the Environment**

**Spillage**

Overspilled cargo is a hazard. It may accumulate and flammable mixtures may quickly form. A considerable amount of toxic gases may also be released, which may contaminate the sea and the air.

**Hoses and connections**

Defective hoses may cause a leakage. Connections which are defective and installed incorrectly can also cause a dangerous situation. Sudden pressure on hoses may damage hoses and connections and careless storing may damage equipment.

Cargo handling equipment must always be checked before they are used to detect possible defects. Deficiencies must be informed to the officers and leaks, no matter how small, must be informed to the deck officer supervising operations.

**Contamination**

Contamination does not directly endanger the health of the crew or the safety of the ship. It is, however, a very serious threat to everyone’s life and livelihood. Even a small amount of chemical which has leaked into the sea, especially into coastal waters, can have a devastating effect on the area’s flora and fauna.

To prevent contamination:

- Do not use defective hoses. Excess bending of hoses must be avoided. Hoses must be placed on suitable saddles. Metal loading arms must be checked regularly to ensure that excess tension is not directed on the joints and that the connections are tight. It must be ensured that hoses do not rub against anything at any circumstances.
Tanker mooring ropes must be handled with extreme care to prevent tension to and the breaking of hoses and connections.

If a connection in the cargo pipeline leaks,

- inform the deck officer who is monitoring the operations immediately so that he can start repair measures
- do not try to stop cargo operations
- do not try to close any valve in the loading system and do not start switch on the closing device.

During loading and discharge

- all deck scuppers must be securely closed
- operations must be monitored regularly to detect leakages.

SAFETY ON A CHEMICAL TANKER

Chemical tankers are more complex than conventional tankers. They usually have more tanks, valves, pumps, blind flanges and pipelines. They can carry several type of cargo simultaneously: bulk cargo, liquid chemicals, solvents, lubricating oil, vegetable and animal oil, refinery products and other similar liquids.

You do not have to make actual decisions concerning the cargo. The deck officers inform you about the cargo you have to handle or transport. Precautions which should be taken when handling a cargo are always informed.

Chemical tankers carry several type of cargo, and the hazardous situations caused by the cargo vary considerably, depending on the type of cargo. This guide lists some of the dangers posed by different type of cargo.

If you want to know more about the cargo, study the cargo specification. In addition, the “Tanker Safety Guide (Chemicals)” must be available on board the ship. The guide is published by The International Chamber of Shipping and it contains information on most chemicals transported on board your ship. Ask the officers where the guide is kept on the ship and inform yourself about the cargo you transport and handle.

The Tanker Safety Guide (Chemicals), Volume II, III and IV discuss the following:

- state
- odour
- main hazards
- emergency measures to be taken in an accident
- information on ignitability and explosiveness
- chemical information
- reactivity information
- health information
- impact of a liquid on different parts of the body
- impact of a gas on different parts of the body
- physical information.

CORROSIVE CARGO

Corrosive liquids have three special qualities:

- they harm the tissue of the body, therefore they can cause serious and permanent consequences
- they can corrode the material of tank structures, pipelines, pumps, etc. and hence jeopardise the safe handling of cargo
- they can ignite or gasify when becoming into contact with, for example, metal or fibrous material.

Metal + corrosive liquid = hydrogen gas
fibrous material + corrosive liquid = fire
Precautions for handling corrosive cargo

- The material used in tank structures and cargo equipment must be suitable for corrosive cargo.
- When handling flammable cargo, the right type of protective clothing must be worn, in accordance with the instructions of the officers. All body parts, especially the eyes, must be protected.
- When opening a tank lid, cargo space, valve or a blind, special precautions must be taken. You must wear protective clothing if you suspect that a corrosive substance may be present or may spatter.
- A cloth shall not be used to clean up corrosive liquids because corrosive liquids and cloths may cause a fire.
- If a corrosive liquid spatters on you, you must take off your clothes and wash yourself with running water. There are emergency showers on the deck for such an emergency.

Inform the officers of all accidents and close calls!

TOXIC CARGO

A fire is the most common dangerous situation on a tanker. On a chemical tanker, the toxicity of the cargo is also a hazard.

The effect of a toxic substance depends on the amount of substance that has entered the body and its toxic properties. Toxic substances enter the body mainly through the air that we breath, i.e., by inhaling.

If inhaled, a toxic cargo may
- impair the sense of smell
- cause dizziness
- diminish judgement
- cause headache
- cause eye irritation
- cause unsteadiness and symptoms of diminished responsibility (similar to drunkenness)
- cause unconsciousness
- cause cessation of breathing
- cause death.

Inhaling toxic cargo can also result in
- brain damage
- damage to the nervous system
- damage to the liver and other vital organs
- death.

When toxic substances are loaded into a tank, gases are vented to the atmosphere through an approved system. Due to the considerable toxicity risk or unpleasant smell, closed loading shall be applied. In closed loading, gases are returned onshore via a vapour return line connected to the gas line.

When opening tanks for sample taking or other purposes, which means that toxic gases become in contact with the outside air,
- wait for instructions from the deck officer in charge of operations
- wear protective clothing which gives you full protection and a breathing apparatus
- release pressure from the tank very carefully
- close the tank lid as quickly as possible.

When disconnecting hoses which have been used for handling toxic cargo,
- wait for instructions from the officers
- wear protective clothing and a breathing apparatus
- make sure that the hose has been drained correctly before opening the connection. Before disconnecting the hose, open the sampling valve to make sure that the line is free of pressure.

If toxic cargo is leaked,
- stay away from the leakage area
- raise the alarm
- ask the superior in charge of cargo handling for instructions.
Some toxic cargo may damage and penetrate the skin. This may result in:
- irritation of the skin
- a rash
- skin cancer
- blood poisoning
- damage to vital organs
- death.

When handling toxic cargo,
- avoid all direct skin contact with the cargo
- wear protective clothing defined by the officers
- follow the instructions of the officers carefully.

If you come into contact with this kind of cargo,
- take off the contaminated clothes
- wash the contaminated skin area with plenty of water
- always inform the officers
- the officers will arrange first-aid.

Toxic substances can also affect through the digestive system. When handling toxic cargo,
- do not put your hand in your mouth or on your face
- never let your clothes touch your mouth
- wash yourself carefully before leaving work and before eating.

When toxic cargo is loaded or discharged using pumproom pipelines,
- pumproom ventilation must be started at least 15 minutes before operations are started
- pumproom ventilation must be kept on during the whole cargo handling operation
- it must be ensured that such cargo does not accumulate in the pumproom bilges
- the atmosphere in the pumproom must be monitored continuously
- cargo operations must be stopped immediately if there are leakages
- the pumps should be monitored from outside the pumproom (if possible)
- the pumproom shall never be entered alone, unless it is necessary
- when entering the pumproom, instructions on protective clothing and breathing apparatus must be followed.

**REACTING CARGO**

Some cargo may be reactant. They may
- be self-reacting
- react with air
- react with other cargo
- react with water.

If a cargo reacts, it may
- form heat
- release gases
- cause pressure to rise in the tank
- affect cargo quality
- increase fire and explosion hazard
- endanger health
- solidificate (polymerisation).

A cargo must never come into contact with other cargo during loading, the voyage or discharge in order to
- avoid a dangerous chemical reaction involving two or several cargoes
- avoid cargo contamination.

The possibility of a reaction can be eliminated by taking the following measures:
by adding an inhibitor to the cargo to keep it stable and safe. An inhibitor is a substance which slows or prevents a chemical reaction, such as polymerisation, oxidation or corrosion, when added into a cargo.

■ by using inert gas in the ullage space in the upper part of the cargo tanks. Inert gas prevents the cargo from coming into contact with air.

■ by avoiding the use of certain metals and other substances in the cargo system, where the cargo may react with them.

■ by placing cargo which may react with each other into spaces which are isolated by a cofferdam, pumproom or other empty space, or by placing such cargo between the cargoes which does not react with either of them.

■ by placing cargo which reacts with water into a space which is protected with a double-skin.

■ by blinding the heating coil leading into the tanks of cargoes which react with water.

■ by using oil as a heating medium for heating cargo which reacts with water.

When you are in a tank or a space,

■ measure the oxygen content regularly to make sure that the oxygen content does not decrease

■ make sure that someone remains on the deck beside the manhole so that he can raise the alarm in case of difficulties.

GAS TANKER TYPES

Fully-pressurised ships

Fully-pressurised ships carry cargo in pressurised receptacles made of steel which can take a pressure of approximately 17 kg/cm². The ships are usually small, with a maximum cargo capacity of approximately 1,000 m³. The ship has two tanks which are installed horizontally. The tanks are usually of cylinder shape. Some ships have several spherical tanks, or cylinders placed vertically, or a combination of them.

The ships usually carry LPG or ammonia for a short voyage. The ships’ tanks are usually equipped with a double bottom and some have ballast tanks which are above the cargo tanks. The hold space, which contains the cargo tanks, is ventilated in a way that there is either dry air or inert gas.

Semi-refrigerated ships

The concept semi-refrigerated ships covers a variety of ships. They all have a cargo system of pressurised receptacles, which is suitable for cargo the temperature of which is lower than that of ambient air. The temperature range depends on the steel used. The usual or general temperatures are -33 °C (for ammonia) and -50 °C (for LPG).

Fully-refrigerated LPG ships

These ships transport LPG in a temperature of -55°C to +0,5°C. They may be equipped to transport ammonia and they are usually suitable

VEGETABLE AND ANIMAL OIL

Some cargo is oil or grease which is vegetable or animal-based. They are usually safe but they may oxidate. They use oxygen contained in the atmosphere, which may lower the oxygen content in the tank to a dangerous level.

Before entering a tank or a space which has contained vegetable or animal fat residue,

■ a permission must be obtained from the supervising superior

■ the oxygen content of the space must be measured and made sure that the space is safe.

Remember: The explosiometer (combustible gas indicator) does not show the oxygen content!
for transporting all types of hydrocarbons up to a temperature of -55°C. The tanks are made of carbon manganese steel and they are insulated. They have re-liquefaction equipment. The ships are large: their tank capacity is 5,000 to 150,000 m³.

**Ethylene ships**

The cargo is usually fully-refrigerated to -104°C and the cargo tanks are made of aluminium, nickel steel or of stainless (austenitic) steel. They are insulated and they have re-liquefaction equipment. The cargo tanks are not fixed.

**LNG ships**

Cargo is transported in a fully-refrigerated state: the temperature of the cargo is -163°C. The cargo tanks are made of aluminium, nickel steel or of stainless (austenitic) steel. They are insulated but they do not usually have re-liquefaction equipment, hence the (boiling) over pressure gas is released into the air or burnt in the main engine.

**FROSTBITES – A PROBLEM ESPECIALLY ON A GAS CARRIER**

On a gas carrier, hazards caused by the cargo can never be emphasised enough. Ignition and toxic hazards have already been described. Frostbites can also be a hazard. Several type of cargo is transported or handled at some point in a very low temperature.

When you take part in cargo handling, direct contact with a cold liquid or gas or touching uninsulated pipes or equipment may cause

- frostbites
- permanent damage to some organs (for example the lungs).

When you are on the cargo deck but do not take part in cargo handling,

- wear appropriate clothing which covers your whole body.

If your skin gets frostbitten,

- remove clothes which may hinder blood circulation to the frozen part of the body
- immediately dip the exposed part of the body into warm water of +40 to +46 °C degrees.

**NEVER WARM FROZEN TISSUE QUICKLY.**