CARGO OPERATIONS MANUAL

Tankers
THIS MANUAL WILL NEED TO BE MADE AVAILABLE FOR INSPECTION ON OCCASIONS.

Record of Revisions

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1. **CHIEF OFFICER'S STANDING ORDERS**

This procedure requires Chief Officers to produce Standing Orders for the general guidance of junior officers on port/cargo watch, supplemented by Night Orders as necessary.

The Chief Officer is responsible for the issue and content of Standing and Night orders. Subordinates are accountable for the implementation of these instructions.

The Chief Officer prepares Standing Orders which provide guidance for deck officers keeping a watch in port, at offshore tanker terminals and during lightering operations. These Standing Orders incorporate key operating procedures unique to the particular vessel and include, instructions covering the following:

- Emergency shutdown procedures
- The circumstances under which the Chief Officer / Master must be called
- Response to emergencies
- Dealing with verbal and written enquiries from Terminal and Port Authorities
- Routine and hourly checks
- Checks on the pump room, including the bilges
- Mandatory entries in the port (cargo) logbook
- Instructions on the completion of company and Charterer's cargo records and returns
- Regular inspection of the tank deck and over the ship's side
- Moorings.

The Chief Officer's standing orders shall not conflict with this manual and must be available for reference in the cargo control room. Junior Officers are required to read these orders and then sign them to indicate acknowledgement and understanding. Supplementary night orders are required to provide instructions specific to the particular port and circumstances, and must also be signed by the duty deck officer to register understanding and compliance. A Night Order book shall be used for this with a copy of the Standing Orders affixed as a preface.
2. TANKER OPERATIONS - GENERAL PRECAUTIONS

This section prescribes general practices and precautions which shall be observed during all cargo handling operations.

Checklists

Before starting cargo operations the Chief Officer completes Company form as detailed in section 22 and any Terminal equivalent. Company Form contains the details included in ISGOTT checklist.

The Ship/Shore checklist shall be completed by the vessel and the terminal. Thereafter at intervals not exceeding four hours, the required sections shall be checked and verified by signature.

Gangway Fire and Spill Response Equipment

The cargo manifold shall be guarded by both fixed foam monitors and fire hoses with portable foam applicators. Dry powder fire extinguishers and foam compound shall also be located at the manifold. Oil spill response equipment and materials shall be deployed at the after end of the manifolds on each side of the vessel ready to be used.

Scuppers

Before starting cargo operations all deck scuppers must be plugged to contain on board any oil spilled as a consequence of accident or equipment failure. Accumulations of water shall be drained periodically as authorised by the Duty Officer (DO), and scupper plugs replaced immediately afterwards. Cargo manifold and fuel tank air pipe save-all plugs must also be in place including plugs around winch containment.

Deck Scuppers are to be effectively plugged at all times whilst alongside a berth and during any cargo/bunker operations whilst at sea, at anchor or during ship to ship transfer operations. Opened scuppers must not be left unattended at any time during this operation.

Fire Wires

One forward and one after fire wire is to be rigged in accordance with terminal requirements, or with the outboard eye at the water’s edge. The inboard end of the fire wires shall be turned up on bitts and lashed as per ISGOTT recommendation. The fire wires must be tended regularly by the deck watchmen as the draft changes, to keep the outboard eye at the water's edge.

Arm/Hose Manifold Connections/Disconnections

Connections and disconnections to the vessel's manifolds are normally carried out by Terminal personnel, but the ship's crew have to attend to remove and fit the blank flanges and provide any assistance requested.

Hose connection and disconnection at buoy moorings is normally made by the ship's crew, using equipment supplied by the terminal.

The connections and disconnections shall be always supervised by the responsible deck Officer who shall check that the whole operation is done in compliance with the best marine practice and Company procedures, paying a particular attention to, but not limited to:

✔ required and appropriate gaskets, as well as reducers, are used;
✔ selected and fair screwing bolts and nuts are used;
appropriate tools are utilized;
blank flanges are slowly disconnected, keeping under control any leakage and being ready to quickly close them again in case of emergency, thus avoiding any overflow of manifold spill containers;
contents of manifolds spill containers and their levels;
procedures (good practice, Company and pre-transfer conference meetings) are duly followed;
all crew are wearing appropriate and correct PPE;
presence of toxic gases or any other potential hazardous situation during the opening operations of arms/hoses;
emergency communications are established.
Additionally, great care shall be taken when draining hoses or arms to prevent the escape of gas (e.g. H2S).
On completion of loading, the Terminal will usually require to drop the contents of the loading hoses or arms into the vessel cargo tanks, and the manifolds valves and the finishing tank valve should be left open until this operation has been accomplished. The tank and manifolds valves must be then shut and the manifold drain valves opened before disconnecting the loading arms under the supervision of a responsible Officer. The manifold connections must be blanked immediately after disconnection.
On completion of loading and discharging operations, when arms/hoses are disconnected and manifolds are blanked, the Officer in charge shall check the condition of the involved manifolds spill container and any eventual trace of cargo shall be immediately removed and the container be dried.
Vessel/Master is not allowed to sail with traces of cargo inside the manifold spill containers. In the event that no sufficient time is grant when staying at the terminal, Master is required to clear the berth and stop the vessel in the closer safe position to adequately and properly clean the manifolds spill containers before starting the sea passage.

**Ship/Shore Bonding Cables**

A ship/shore bonding cable is not to be used.

**Accommodations Access**

All external doors, ports and windows in the accommodation block must be kept closed, and one door only designated for routine access to and from the exterior deck.

**IG System**

Before cargo operations begin the following checks shall be made of the IG system:

1. A visual inspection and check of the tank isolation valves and locking arrangements. Confirm that status of all valves is indicated on indication board in CCR.
2. Inspection of the deck seal to confirm water supply, drain valve open, correct water level, and operation of high and low level alarms.
3. Correct operation of the IG main non-return flap valve.
5. Correct operation of all IGS control equipment including the high temperature, high, low, and very low pressure alarms, and of the high oxygen alarm.
6. Correct operation of the fixed oxygen analyser, and the linked remote read-out in the cargo control room.

A Check Sheet from the IGS Log must be completed on every occasion that an inert gas operation is carried out.
An announcement is made by PA (Public Address) to notify all personnel when cargo handling operations begin, and that smoking is permitted only in designated areas.

The pump room must be regularly inspected during cargo operations. Such inspections will include a general check of lines and pumps, pump casing, bearing temperatures and pump room bilge.

Checks must be made at intervals not exceeding one hour and recorded in the port (cargo) logbook. Pump room entry procedures as stipulated in SQEMS must be followed at all times.

**Note:** When the cargo is a sour crude, the pump room is to be tested for \( \text{H}_2\text{S} \) gases on a daily basis both at sea and in port, and the result recorded in the log book.

**Safe Deck Watch**

The tank deck must never be left unattended. The deck watch shall normally comprise three deck ratings all equipped with walkie-talkie radios and personal \( \text{H}_2\text{S} \) monitor, if necessary.

One of the deck ratings shall maintain a continuous watch at the cargo manifold.

The duties of the deck ratings include:
1. Tending moorings and fire wires;
2. Tending the accommodation ladder;
3. Regular inspection round the tank deck and over side;
4. Checking the manifold and deck pipelines for leaks;
5. Fire patrols and accommodation checks;
6. Ensuring the correct display of signals and flags;
7. Assisting the Pump man/OOW with cargo work and operations;
8. Antipollution checks (air-sea);

**Air Conditioning and Ventilation Systems**

The air intakes for these systems must be selected to prevent the entry of petroleum gas, if necessary by re-circulation within the accommodation/machinery spaces.

**Signals**

The appropriate day and night signals prescribed for cargo handling operations must be correctly displayed.

**Ballast Tank and Void Spaces Within Cargo Tank Block - Gad Tests**

All ships shall carry out daily tests for flammable gases in all ballast tanks and void spaces located adjacent to cargo tanks during loaded passage. Results must recorded in the appropriate file, in the section provided.

**Hazardous Cargo Data Sheet**

Data sheets for the cargo being carried must be prominently posted in the accommodation.
3. **CARGO LOADING OPERATIONS**

This section prescribes the preparation of a written plan for the cargo loading operation, and the procedures to be followed in its implementation.

The Chief Officer is responsible for producing the loading plan. The Master is accountable for ensuring that the plan is written and implemented to the prescribed standard, corrected and acknowledged by other officers.

The loading process begins on receipt of the Charterer's voyage orders, on which basis the Chief Officer shall develop the loading plan using the vessel's computer and hydrostatic data.

The plan must be as flexible as the orders permit, to allow for possible changes in the cargo nomination and/or ports of discharge. It shall take account of the following:

- The plan must be sufficiently detailed to enable officers and crew members to both understand and implement it. It shall identify the valves and the sequence of their operation at each stage of the loading operation;
- The API or density and the loading temperature of the cargo;
- Bunker quantities and disposition;
- Cargo characteristics. Handling instructions for specialized crudes such as static accumulator oils, or those with high levels of hydrogen sulphide;
- Calculation of the total quantity to load in long tons, tonnes (Metric Tons), and US barrels at 60 deg F or cubic metres at 15 deg C;
- A stowage plan;
- Optimum load and discharge times;
- Segregation requirements and line up of tanks and groups;
- Draft and trim, air draft, Under Keel Clearance (Company established that UCK during loading operations should be never less than 2 feet), stresses (Shear forces and Bending moments) with estimated hogging or sagging and stability at intervals not greater than one hour, and in addition at any critical stage of cargo/ballast operations;
- Contingency plans for emergency situations;
- Finishing the loading operation on a slack tank;
- COW requirements at the discharge port;
- Load line zones enroute, and changes in sea/harbour water densities;
- Finishing loading on an even keel, if circumstances permit, and sailing with a small stern trim;
- Avoiding/minimising dead freight when loading more than one grade at more than one port;
- Handling of ballast and use of ballast pumps.
Unstable conditions developing during cargo operations

Vessels that have large width tanks may subject to reductions of intact stability due to free surface. Although such vessels may meet IMO intact stability criteria when in fully loaded or ballasted conditions, they may be passing through an unstable condition/situation when multiple tanks are slack during cargo or ballast transfer operations, or in intermediate states of loading. Trim and stability manuals generally deal only with arrival and departure conditions Officers should be alerted due to:

**stability problems may exist at intermediate stages during cargo transfers**

If a vessel has either large width cargo tanks, “U” section ballast tanks, or double bottom tanks without watertight centre line bulkheads, (that the vessel meets IMO intact stability criteria). Class approved loading instrument should be use to verify the intact stability at the worst case condition (All tanks slack, and maximum free surface) during cargo plan preparation for each operation.

**Unstable Condition**

A condition that may occur as a result of uncontrolled and/or unknown filling of a cargo and/or ballast tank during cargo operation. Such condition is considered to have occur if the vessel suddenly develop al list to any side, and this list is not created by a planned transfer of cargo/ballast in order to obtain a specific list condition.

Cargo Plan – a document prepared prior to any cargo and/or ballast operation, giving detailed information of the various steps that shall be conducted during the intended operation. The Cargo Officer is responsible for Intact Stability at all times, and shall pre-plan all cargo and ballast operations in accordance with the Trim and Stability Manual to ensure that the stability criteria are complied with. The Cargo Officer shall prepare a Cargo Plan detailing every step of operation throughout the intended cargo loading/discharge and/or ballast/de-ballast operations.

The Deck Officers in charge of cargo operations shall ensure that the Cargo Plan is followed and shall take any action required to verify that the actual condition of the vessel is following the Cargo Plan.

The Master shall approve the Cargo Plan in writing before any operation is commenced. All Deck Officers involved in cargo operations shall review the Cargo Plan and sign for their understanding of the intended sequence of operation. In the unlikely event that the vessel should develop an unstable condition, the Cargo Officer shall immediately be notified and the Deck Officer in charge shall take the following actions:

1. Immediately stop any cargo operation, and close all tank valves.
2. Immediately stop any bunker operation, and close all valves.
3. Immediately stop any ballast operation, and close all tank valves.
4. Inform the Terminal, and request immediate disconnection of any cargo connections.
5. Inform the Engine Room, and request all cargo equipment in stand by.
6. Inform the Master
7. Inform Company for worst case
The Cargo Officer shall as soon as possible survey and record the level in every cargo, ballast and bunker tank, including any tank or void space which may have influence on stability if they should have been accidentally filled or discharged. The result of the tank survey shall be compared with the Cargo Plan, at the actual step (or believed) step of operation. If there is any severe discrepancy, and/or there is evidence that the filling level in any tank does not correspond with the Cargo Plan, immediate actions shall be taken to Restore Stability.

**Actions to Restore Stability may include, but not be limited to the following considerations:**

1. No action to Restore Stability shall be initiated unless the cargo connections have been disconnected.
2. Mooring stations shall be manned during the operation to Restore Stability.
3. It shall be noted that if the vessel is listing away from the berth, and “hanging” in the moorings, the moorings shall be secured and not slacked out. If the vessel is listing towards the berth, the moorings should be tended just to pick up the slack, and maintained slack during restoring operation.
4. When it has been verified what is the reason for the Unstable Condition, the Load indicator shall be used to verify intended corrective actions, and these shall be documented.
5. If the Unstable Condition is due to excessive free surface in cargo and/or ballast tanks, extreme caution must be observed when filling liquid in tanks in order to upright the vessel. If the free surface effect is not reduced, the vessel is likely to tilt to the opposite side, with even more list than before. Therefore, the free surface effect should be reduced before trying to upright the vessel.
6. If the Unstable Condition is due to a severe difference in tank levels on opposite sides of the vessels, this uneven distribution may be corrected by filling or reducing the levels of the uneven tanks. The reason for the uneven distribution must be ascertained, and it must be ensured that this will not recur during continued operation.

**PRODUCT CARRIERS REQUIRED TO BE FITTED WITH AN INERT GAS SYSTEM**

The basic principles of inerting are exactly the same on product carriers as on crude carriers.

There are, however, some differences in operational detail, as outlined in the following paragraphs.

**Carriage of Products Having a Flashpoint Exceeding 60ºC**

The 1974 SOLAS Convention, as amended, implies that tankers may carry petroleum products having a flashpoint exceeding 60ºC (i.e. bitumens, lubricating oils, heavy fuel oils, high flashpoint, jet fuels and some diesel fuels, gas oils and special boiling point liquids) without inert gas systems having to be fitted or, if fitted, without tanks containing such cargoes having to be kept in the inert condition.

However, when cargoes with a flashpoint exceeding 60ºC are carried at a cargo temperature higher than their flashpoint less 5ºC, the tanks should be maintained in an inert condition because of the danger that a flammable condition may occur.
It is recommended that, if inert gas systems are fitted, cargo tanks are maintained in an inert condition whenever there is a possibility that the ullage space atmosphere could be within the flammable range.

When a non-volatile cargo is carried in a tank that has not been previously gas freed, the tank should be maintained in an inert condition.

**The hazards associated with the handling, storage and carriage of residual fuel oils**

Although residual fuel oil normally has a Flashpoint above 60°C, it is often stored and managed at temperatures close to, or even above, its Flashpoint. High Flashpoint fuels sometimes contain residual quantities of light components that slowly migrate into vapour spaces after loading, so raising the flammability. It must therefore never be assumed that the vapour spaces in, and emissions from, bunker tanks will always be safe simply on account of a high specified Flashpoint.

The first part of this section deals with the flammability hazards associated with residual fuel oils and provides information on Flashpoint and vapour composition measurement, together with recommended precautionary procedures to be adopted when handling, storing or carrying residual fuel oils.

It should be noted that this guidance refers only to residual fuel oils and **not** distillate fuels.

**Nature of hazard**

Residual fuel oils are capable of producing light hydrocarbons in the tank headspace such that the vapour composition may be near to or within the flammable range. This can occur even when the storage temperature is well below the measured Flashpoint.

This is not normally a function of the origin or manufacturing process of the fuel, although fuels containing cracked residues may show a greater tendency to generate light hydrocarbons.

Although light hydrocarbons may be present in the headspaces of residual fuel oil tanks, the risk associated with them is small unless the atmosphere is within the flammable range and an ignition source is present. In such a case an incident could result. It is therefore recommended that residual fuel oil headspaces are regarded as being potentially flammable.

**Flashpoint**

Fuel oils are classified for their safety in storage, handling and transportation by reference to their closed cup Flashpoint. However, information on the relationship between the calculated flammability of a headspace atmosphere and the measured Flashpoint of the residual fuel oil has shown that there is no fixed correlation. A flammable atmosphere can therefore be produced in a tank headspace even when a residual fuel oil is stored at a temperature below its Flashpoint.

**Headspace Flammability**

Traditionally, gas detectors such as explosimeters have been used to check that enclosed spaces are gas free and they are entirely suited to this purpose. They have also been used to measure the “flammability” of headspaces in terms of percentage of the lower flammability limit (LFL).

Such detectors rely on a calibration carried out normally on a single hydrocarbon, such as methane, which may have LFL characteristics that are far removed from the hydrocarbons actually present in the headspace. When using an explosimeter to assess...
the degree of hazard in non-inerted residual fuel oil tank headspaces, it is recommended that the instrument is calibrated with a pentane/air or hexane/air mixture. This will result in a more conservative estimate of the flammability but the readings should still not be regarded as providing a precise measurement of the vapour space condition.

When taking measurements, the manufacturer’s operating instructions for the instrument should be closely followed and the instrument’s calibration should be frequently checked as oxidation catalyst detectors (pellisters) are likely to be susceptible to poisoning when exposed to residual fuel oil vapours.

In view of the problems associated with obtaining accurate measurements of the flammability of residual fuel tank headspaces using readily available portable equipment, the measured % LFL only broadly ranks fuels in terms of relative hazard. Care should therefore be exercised in interpretation of the figures obtained by such gas detectors.

**Cargo measurement, ullaging, dipping, and sampling**

Depending on the toxicity and/or volatility of the cargo, it may be necessary to prevent or minimize the release of vapour from the cargo tank headspace during measurement and sampling operations.

Wherever possible, this should be achieved by use of closed gauging and sampling equipment.

There are circumstances where it is considered essential to obtain clean samples for quality purposes, such as for high specification aviation fuels. The use of closed sampling equipment may cause cross contamination of product samples and, where this is the case, the terminal operator may wish to undertake open sampling. A risk assessment should be carried out to ascertain whether open sampling can be safely achieved taking into account the product volatility and toxicity. Risk mitigation measures, including the use of appropriate personal protective equipment, if necessary, should be put in place before starting the operation.

Closed gauging or sampling should be undertaken using the fixed gauging system or by using portable equipment passed through a vapour lock. Such equipment will enable ullages, temperatures, water cuts and interface measurements to be obtained with a minimum of cargo vapours being released. This portable equipment, passed through vapour locks, is sometimes referred to as ‘restricted gauging equipment’.

When it is not possible to undertake closed gauging and/or sampling operations, open gauging will need to be employed. This will involve the use of equipment passed into the tank via an ullage or sampling port or a sounding pipe and personnel may therefore be exposed to concentrations of cargo vapour.

As cargo compartments may be in a pressurised condition, the opening of vapour lock valves, ullage ports or covers and the controlled release of any pressure should be undertaken by authorized personnel only.

When measuring or sampling, care must be taken to avoid inhaling gas. Personnel should therefore keep their heads well away from the issuing gas and stand at right angles to the direction of the wind. Standing immediately upwind of the ullage port might create a back eddy of vapour towards the operator. In addition, depending on the nature of the cargo being handled, consideration may have to be given to the use of appropriate respiratory protective equipment.

When open gauging procedures are being employed, the tank opening should only be uncovered long enough to complete the operation.
Advice to Charterer

After approval of the completed loading plan the Master should notify the Charterer of the details specifically requested in the loading orders, always including the following information:

1. Confirmation or otherwise that the nominated cargo quantity can be loaded, with the total quantity in Metric tons/long tons, US barrels/m$^3$. The amount of any dead freight;
2. The cargo API or Density and temperature used;
3. The estimated arrival and departure drafts at the load and discharge ports.

If the voyage or loading orders fail to provide any basic data needed for the cargo uplift calculation, any assumptions must be stated clearly in the acknowledgement to the Charterer with a request for confirmation or correction of them.
Loading Preparations

Preparations for loading the cargo must be largely finished before the vessel's arrival at the loading terminal. Loading preparations should include:

- Check the cargo system pipeline and valve line up. The line up shall be checked by the Chief Officer and independently by another officer. All cargo and ballast tanks must be sounded/ullaged prior to starting cargo operations, and the results logged;
- The IG deck main non-return valve, block valve, and the engine room master valves confirmed shut; correct water level in the pressure/vacuum breaker and the deck seal;
- Cargo tank high velocity vent-valves (auto mode);
- All cargo tank openings must be confirmed closed and properly secured;
- Cargo control equipment such as hydraulics, pneumatics and instrumentation checked before arrival on the berth;
- Hydraulics must be test-operated to check for leaks. The hydraulic fluid service tank topped up to its working level, and a spare drum of oil kept nearby ready for use.
- Test communication systems and ensure that all radio batteries have been charged;
- Check of 02 content in all Cargo/Slop tanks below 8%.

Tank Survey Before Loading

Shore staff must be accompanied by the Chief Officer when the arrival condition survey is conducted. All tanks must be checked and a record made of dips and ullages and corresponding quantities of any oil, water or sediment found. An OBQ certificate is then drawn up by the Chief Officer for signature by all parties. The Chief Officer has a particular responsibility to protect the interests of the Company and the Charterer during tank surveys.

Pre-Transfer Conference (PTC)

The Chief Officer holds a meeting with Terminal authorities to discuss the cargo loading plan, ship/shore communications, safety regulations, pollution prevention and response measures, and emergency procedures. Before loading there must be agreement on the cargo quantity, loading API or Density and temperature, and whether a ship or shore stop applies; and also on starting, bulk loading and topping off rates, emergency shutdown procedures, etc.

Starting to Load

When the Terminal gives notice of readiness to start loading the Chief Officer shall make a final check of the line up, and then open the cargo manifold valve and the first tank valve. Deck Officer and Deck watch must be equipped with walkie-talkies, with the DO at the manifold, the pumpman to pumproom, a rating standing by on deck around the cargo lines, and the Chief Officer in the cargo control room (CCR).

Radar-gauging beams tend to reflect off internal tank structures and may give false readings during the early stages of loading a tank. In every case the manufacturer's specific operating and maintenance instructions must always be observed.

After confirming that cargo is entering the opened tank, and only that tank, the main deck and the manifold connection(s) must be checked for any signs of leakage. The pump room must be similarly checked. With all checks satisfactory the Chief Officer can proceed with the loading plan by opening the first-stage tanks and asking the Terminal slowly to increase to the requested bulk loading rate. The loading rate must not exceed the limits specified by the shipbuilder, which are based on the vessel's tank-venting capacity.
Once the requested loading rate has been made checks must again be made of all cargo tanks, deck and pump room. These areas must be kept under regular and frequent observation until the loading operation is completed and the cargo system is shut down as per company check list. The pump room must be inspected and the event recorded at intervals not exceeding one hour. No changes may be made to the written loading plan without the Chief Officer's knowledge and authority.

When the cargo flow into more than one cargo tank, levels must be monitored and controlled to prevent uneven loading and consequent listing or trimming. Only hydraulic valves should be adjusted to effect the required control, not manual valves. At an appropriate stage the loading rate of the working tanks should be controlled to stagger completion of each tank at safe intervals and in a convenient sequence. All completed or empty tanks shall be checked at each stage of the loading plan, and at regular intervals not exceeding one hour, to confirm that the tank valves are fully shut and tight. Prints of on-line cargo computer to be collected hourly.

Care must be taken to ensure that the required minimum number of hydraulic valves is fully open to accommodate the agreed loading rate. Hydraulic butterfly valves can creep when the valve controller is left in the neutral position, and may close under the pressure of oil flowing through the line. Valve controllers must therefore be left only in the open or shut positions.

The loading plan incorporates a plan for deballasting concurrent with loading cargo. It must be scheduled for completion well before starting to top off cargo tanks, and aim to strip dry all ballast tanks by means of the eductors while the vessel is trimmed well by the stern. The surface of the ballast in the tanks must be sighted and checked free of oil prior to commencing discharge, and overside checks made when deballasting begins. The Terminal must be notified before starting.

**Topping - Off**

This operation must be carefully organised and controlled throughout by the Chief Officer. It is essential that there are sufficient personnel to maintain continuous monitoring of all working tanks, and to maintain checks on any tanks, which have been shut down either temporarily or on completion. The Chief Officer shall ensure that the following steps are taken in good time before topping-off operations begin:

1. Inform the Terminal and confirm the loading rate;
2. Check the level of the hydraulic service tank;
3. Test the hydraulic valve emergency hand-pump, and station it in the vicinity of the valve box(es) for the working tanks;
4. Carefully test and confirm the full function of the working tank-valves, and those next in the loading sequence;
5. Cross check the remote ullaging equipment readings of these tanks against manual ullages;

Ensure that the maximum flow rate for tank valves is not exceeded.

Use should be made of the remote ullaging equipment display to maintain an overall view of the loading operation: but for final topping off the U.T.I./M.M.C. manual tape must be used.

Final ullage should be communicated to Chief Officer by radio to confirm radar reading in CCR.

The Chief Officer must liaise with the Terminal to agree on notice requirements for reducing the loading rate, and for stopping; and he must allow for the time needed by the Terminal to effect such requests.
**Loaded Tank Survey**

The cargo system pressure must be slightly positive during the tank survey. The cargo surveyor(s) shall be accompanied by the Chief Officer, Pumpman and one other member of the crew on the survey.

The Chief Officer must ensure that the survey is properly conducted and every requirement met to protect the interests of the vessel and owners, including the following:

1. Water cuts,
2. A mean of three ullages,
3. Temperatures at the top, middle and bottom levels of the cargo in every tank;
4. Oil/water interface of the slop tank(s) if applicable;
5. Observed drafts: forward, aft and midships (both sides at midship);
6. Check of pump room valves and seals;
7. Representative sampling.

Water cuts must never be omitted at the survey, and as a precaution all tanks shall be dipped again on passage to the discharge port. Any significant free water shall be recorded and reported to the Charterer and to the Company.

On completion of the tank survey the Chief Officer shall calculate the cargo quantity independently of the surveyor(s), and then compare the official ship's figure with theirs for an independent check. Since all will be using the same data and (usually) the same tables, there should be close accord between ship's and inspector's figures.

Any significant difference requires immediate investigation to identify the reason for any such discrepancy, and thence its resolution. Where early departure procedure has been agreed and the shore API and temperatures are not available the Chief Officer and the surveyor must both endorse, before the vessel leaves the berth, a record of agreed tank ullages and corresponding volumes and of observed temperatures and water dips. On receipt of the required cargo data from the Terminal they shall complete their calculations, exchange results and agree final figures by telex or other agreed means.

**Early Departure Procedure (EDP)**

EDP may be required by the Charterer to save time, by the Terminal to minimise occupancy of the berth, or to meet minimum UKC in some ports. The procedure may be summarised as follows:

1. Prior to arrival the Master requests EDP, or the Terminal advises that EDP is required;
2. Before completion of loading the Agent will submit the cargo shipping documents to the Master for his scrutiny and acceptance. These documents are then returned unsigned to the Agent who must provide the Master with a full set of copy documents for his reference;
3. The vessel leaves the berth immediately after final ullages, temperatures, water dips and for his reference;
4. The ship's official figures are calculated on receipt of the API with the bill of lading cargo figures from the Terminal. Provided ship and shore figures agree within specified limits the Master then authorises the agent by telex or fax to sign the bills of lading and the other associated shipping documents. Note that as specified below, the Master is required routinely to protest any difference between ship/shore figures, as described in appropriate WIN.

It is emphasised that under no circumstances shall the Master sign blank bills of lading himself in anticipation of the subsequent entry of accepted figures. For bill of lading instructions see apposite WIN.
Letters of Protests

Whether EDP applies or not protests must always be registered in the specific circumstances of the following list, which is not exhaustive:

1. There is any difference between ship and shore final cargo figures, however small, except on specific instructions to the contrary from the Charterer. For example, the Charterer may stipulate that protest shall not be made unless the ship/shore discrepancy exceeds defined limits;
2. The vessel is delayed waiting for a berth;
3. The vessel is delayed in the berth for Terminal requirements;
4. The loading rate is less than that requested by the vessel;
5. There is a significant difference between the API or temperature shown on the Cargo documents, and those quoted in the loading orders and used to calculate the vessel's cargo requirements and final figures;
6. The agreed cargo nomination was not supplied in full, or was significantly exceeded on a shore stop;
7. When the vessel's departure is delayed for Terminal requirements after leaving the berth (usually to await the delivery of cargo documents).

If there is an abnormal difference between ship and shore final figures the Master shall ask the Terminal to check and confirm their calculations, and instruct the Chief Officer similarly to check the ship's figures. If these checks confirm the ship/shore difference the Master shall first contact the Charterer and/or Company for guidance. If the shore figure is greater than the ship's by more than one percent the Owners must be notified and the Bills of Lading may be signed only after obtaining a letter of indemnity from the Charterers, in addition to registering the required routine letter of protest.

Securing the Vessels for Sea

On departure from the loadport the following routine procedure must be effected and confirmation reported positively to Chief Officer when complete:

1. Check the complete shutdown of the cargo system including all valves whether or not used during the loading operation;
2. Ensure that all tank and system pressure/vacuum valves are set in the service position;
3. Operate the IG system to generate a positive system pressure as appropriate in the prevailing circumstances.
4. Restow and secure all fire fighting and lifesaving equipment placed ready for use in the berth;
5. Remove and stow main deck scupper plugs;
6. Check the water level in the IG pressure/vacuum breaker and the deck seal;
7. Secure anchors, moorings and fire wires; accommodation ladders and all other loose deck equipment and fittings.
4. LOADED PASSAGE

This section specifies routine procedures to be followed during the passage to the discharge port.
The Chief Officer is responsible for ensuring compliance with this instruction. During the loaded passage the following procedures shall be implemented.

Pressurising Cargo Tanks

A positive pressure of inert gas must be maintained in the ullage space at all times in order to prevent the ingress of air. Loss of pressure is usually associated with leakages from the system, or falling air and sea temperatures. Every effort must be made to eliminate leaks at tank hatches, ullage caps, tank cleaning machine openings, PV valves etc. If the pressure falls below the low pressure alarm level the inert gas plant must be started to re-pressurise the system.

IG high pressure should be regulated in a controlled manner by opening PV valve according to Vocon operational procedure before the tank safety devices lift. These are normally set at 1400mm wg, therefore IG pressure should be released in good time to prevent this pressure being reached.

Pre-Arrival Checks and Tests

Operational tests of critical equipment and systems must be conducted and routine inspections made before the vessel's arrival at the discharge port. In order to allow sufficient time to rectify any defects found these checks shall be made two to three days before arrival, given a sufficiently long sea passage. Tests and inspections shall include but not be limited to the following:

Inert Gas System (IGS)

Checks to be performed as per company „checklist“ related to IGS.
A Check Sheet from the IGS Log must be completed on every occasion that an inert gas operation is carried out.

Cargo Hydraulics System

The hydraulic power unit must be run to pressurise the system to check for leaks and correct valve operation, and to confirm that both sets are operational. Control system alarms shall be tested, namely high and low pressure, low oil level, and also the automatic stop/start function. The portable emergency hand pumps must also be proved to be in good operational order.

Crude Oil Washing System (COW)

To check for leaks the COW system must be pressure tested to the maximum working pressure specified in the vessel's COW Operations and Equipment Manual. Any leaking flanges must be tightened up, or flange gaskets replaced as necessary and the tank-cleaning heater must be blanked to isolate it from the COW system. All portable tank-washing machine connections must also be blanked inboard of the branch valve. This is in order to avoid the possibility an oil leak should the valve fail. This has occurred in the past due to undrained water being trapped in valve body and expanding in freezing conditions. Any COW machine-drive units found defective when last used must be checked and overhauled as necessary. The gearing casings and turbines shall be topped up with oil and all moving parts such as speed controllers must be checked free and greased.
weekly routine shall be established requiring the pumpman to move each machine and its
delivery valve manually over the full operational range to verify and maintain their free
movement.
The checklist “pre-arrival at discharge port” in vessel’s approved COW manual should be
copied and completed satisfactorily.

**Portable Instruments**

The multipurpose U.T.I./M.M.C portable gauging tapes shall be carefully checked for
correct operation and for any signs of developing wear and tear. All portable oxygen
analysers, tankscopes, multi-gas detection units etc. shall be checked and calibrated as
necessary and the findings recorded in the dedicated file.

Note that this pre-arrival check does not supersede or cancel the requirement to complete
the portable analyser Instrument as scheduled. All UHF portable radios and torches must
be tested satisfactorily.

**Oil Spill Contingency Drill**

An oil spill drill shall be held on every loaded passage to ensure a practised and efficient
response in the event of an accidental spill. Such exercises shall be preceded by a briefing
session to ensure a clear understanding of the plan and its priorities, followed by a
debriefing to discuss and eliminate any identified failings, and to consider possible
improvements.

A record of the drill shall be entered in the deck logbook.

**Water Dips**

Water dips shall be taken of all cargo tanks the day before arrival at the discharge port,
and the findings recorded in the cargo logbook and reported to the Company.
5. CARGO DISCHARGE OPERATIONS

This section lays down the process of preparing a cargo discharge plan and prescribes the cargo operations and procedures associated with putting it into effect. The Chief Officer is responsible for the plan and its practical implementation, and the Master for approving and monitoring it.

The Discharge Plan

The Chief Officer shall prepare a detailed cargo discharge plan not less that 48 hours prior to arrival at the port of discharge, circumstances permitting. The plan must be presented to the Master and on approval circulated to the deck officers.

It is essential that the Chief Officer liaise closely with the First and Chief Engineers over his requirements for services and machinery, such as cargo and ballast pumps, inert gas, crude oil washing etc; and also regarding other port operations such as taking stores and arranging repairs.

The plan must provide the following:

1. An overview of the main objectives of the plan, including arrival and departure conditions and the estimated overall discharge time;
2. The discharge sequence of grades and tanks, with pump and valve lineup;
3. The ballasting operation sequence and lineup must be similarly detailed;
4. The condition of the vessel at least every six hours comprising draft and trim, airdraft, UKC, stresses with estimated hog or sag and stability, and estimates of quantities discharged and remaining-on-board;
5. A crude oil washing (COW) plan specifying washing cycles with an overall time estimate;
6. A narrative section summarising the sequence of discharge operations together with line up, pump and valve operations at each successive stage. It must be in sufficient detail to enable duty officers and ratings to follow the plan and verify all lining-up and changeover operations;
7. It should include which checklists to be completed and when.

Terminal Notification

If voyage sub-Charterers or cargo receivers do not request or accept COW beyond the mandatory Marpol requirements, the time-Charterer may be held liable for any delays resulting from additional COW operations. Protest must be noted holding the receivers liable for any consequent shortage in the out turn if they restrict COW.

The Master shall consult the time Charterer to agree the proposed COW programme in good time before arrival at the discharge port.

He should then request permission from the terminal authorities to COW, and provide them with the following information:

1. The discharge and COW plan;
2. The cargo stowage plan and percentage of tanks to be washed;
3. The estimated increase in discharge time resulting from COW operations, if any;
4. Details of personnel in charge of COW operations;
5. Confirmation of satisfactory COW line pressure tests, and operation of IGS.

Reports of various kinds may be required by different port authorities, for example the EEC tanker check list and USCG requirements.
Discharge Preparations
Preparations for loading operations, apply in the most part to discharge operations with particular attention being paid to line up. If more than one grade of oil is to be discharged, pumps and pipelines shall be segregated as far as circumstances permit. Contamination shall otherwise be minimised by draining pumps and pipelines before changing to a different grade. Particular attention should be paid to heated cargoes and the order in which they are discharged. Before arrival at the discharge port the Chief Officer shall conduct a meeting to explain and discuss the discharge and COW plan to all officers and ratings involved in these operations.

Pre-Transfer Conference
On arrival in the berth the discharge/COW plan must be discussed and agreed with the Terminal authorities before starting to discharge. Shore restrictions or limitations may require changes to the plan, and subsequent revisions shall be circulated to all concerned without delay.
In addition the PTC must cover the following:
1. Completion of the ISGOTT and Terminal safety checklists, signed by the Chief Officer and Terminal representative;
2. Ship and Terminal safety regulations and emergency procedures;
3. Ship/shore communications and notification requirements;
4. Pollution prevention and response measures;
5. Slop discharge (if any) and tank stripping procedures;
6. Procedures for draining shore hoses or hardarms on completion of discharge.

Tank Survey Before Discharge
The Chief Officer shall provide the attending cargo surveyor(s) with details of the discharge plan and the loadport cargo figures, and shall accompany him on the tank inspection to ensure its correct procedure and accuracy in the interests of the vessel and owners.
The arrival cargo figures shall be calculated by the Chief Officer independently of the surveyor(s) and then compared with their results. Any significant difference must be investigated and reconciled, and a final official figure agreed. The surveyor will usually take cargo samples on arrival at the berth.

Starting the Discharge
The Chief Officer shall notify the Terminal when he is ready to start the discharge, and then await confirmation of their readiness to receive cargo.
He shall make a final check of the starting lineup and confirm that:
1. All overboard discharges are blanked;
2. The cargo tank ullaging system are satisfactory working;
3. All IGS operational checks have been completed satisfactorily and that the system is functioning correctly;
4. Cargo pumps have been primed by means of the purge cocks on the pump casing. When the Terminal confirms readiness to receive cargo the Chief Officer shall observer the following procedure:
   ✓ Position of Duty Officer (DO) at the cargo manifold, the Pumpman in the pumproom, and one duty rating close to cargo lines, each equipped with a portable radio;
Notify the Terminal that the discharge of cargo is about to begin. When pump control has been transferred to the cargo control room (CCR) the emergency trip shall be operated to stop the pump. This trip test procedure must be observed on every occasion that a cargo pump is first started during cargo operations;

After confirming satisfactory operation of the emergency trips the cargo pump(s) can be restarted and the discharge proper begun;

Adjust IG pressure in the cargo system and switch to automatic. Always make an additional independent check that the IG delivery valve is open to each individual tank before starting to discharge from it

Open the cargo manifold valve(s) fully and the pump discharge valve about 10-15%. Obtain confirmation from the Terminal that they are receiving cargo and from the deck watch that cargo is passing in the manifold; then slowly increase pump speed in stages while monitoring the back pressure;

Check the manifold hose/arm connections, the tank deck, and the pump room for any sign of leakage, and also overboard right round the vessel;

Continue to increase pump revolutions while opening the pump discharge valve, and watch the back pressure and suction readings. Maintain close liaison with the engine room to keep them informed of the increasing demand on plant and machinery. If there is any sign of anything other than the normal and satisfactory operation of all systems, stop the discharge and investigate;

Once the first pump has been run up to the appropriate full speed and the discharge from the starting tank has settled down, the other first stage tanks can be opened and additional pumps started.

Care must be exercised when operating two pumps on a common discharge line. Discharge pressures of both pumps must be equalised to avoid uneven loading and consequent overheating of one or other pump. Pump revolutions must not differ significantly.

Keep an adequate back pressure on the pumps by throttling in the pump discharge valve as necessary: do not use the cargo manifold valves or deck line valves to control discharge pressures or rates.

**Bulk Discharge**

The contents of any tank to be used as a source of COW medium must first be discharged by at least one metre before being used, to ensure the removal of any water in the tank bottom. If slops are carried the slop tank(s) shall be discharged first and thoroughly crude oil washed, and then refilled with dry crude oil if they are to be used as the source of the washing medium.

During bulk discharge the following practices shall be maintained:

1. An hourly record of the manifold back pressure, pump control gauge readings, tank ullages and average discharge rate. The on line cargo computer shall print data every hour;
2. An hourly check of the pump room with a record;
3. Careful monitoring of the operating condition of the cargo pumps for overheating, excessive vibration, cavitation or hammering;
4. Continuous checks by the deck watchkeepers of the deck, manifold and cargo lines, and overboard.
5. Periodical inspections of the tank deck by the DO, subject to the proviso that the CCR shall never be left unattended.
Tank Draining and Stripping Operations

Basic procedure shall comply with the following:

1. Ensure that the vessel has a good trim before stripping operations begin. A stern-trim angle of about 1.5° from the horizontal will produce good drainage, but the Chief Officer shall liaise with the First Engineer to ensure that trim does not exceed any limit imposed by plant or engine room operations. SPM terminals may place limits on maximum trim.

2. Ensure that the stripping system is lined up in good time before stripping levels are reached. When stripping with a positive displacement reciprocating pump, the pump discharge valve must be fully open at all times, while adjusting the suction valve setting and pump speed as necessary to maintain good suction.

The following procedure shall be followed when stripping tanks using a MCP vac-strip system;

1. When the working-tank level has dropped to around one metre, progressively reduce pump revolutions to stripping speed, around 60%-70%. Monitor MCP discharge and suction pressures;

2. The automatic stripping system control will cut in at about this point. The Chief Officer must be thoroughly acquainted with the operation of the system and adhere to the instructions contained in the maker's manual;

3. Ensure that all tank valves are confirmed shut on completion of stripping;

4. Monitor the operation of the MCP closely and watch bearing temperatures. Listen for any abnormal noises, which may indicate that the pump has lost suction or is running dry;

5. Sound finished tanks periodically to ensure that all tank valves have been shut tight, and to check if any clingage has drained from internal surfaces to the tank bottom.

Operate the eductors on slop tank recirculation during the final stages of the discharge to make sure that all tanks are completely dry.

During the final stages of the discharge all empty tanks must be sounded again to check that there has been no ingress of cargo through leaking or improperly closed tank valves, or accumulation of clingage draining down from tank internals. It will usually be necessary at some stage to stop discharging ashore and carry out internal stripping to the slop tank, using the eductor(s) on slop tank recirculation. Further COW may also be considered desirable if time is available.

The Terminal must be notified in advance when the cargo manifold valves are to be closed for internal stripping/washing.

Stripping the slop tank(s) and the contents of the top and bottom cargo lines and MCPs is the final operation. The special small diameter line between the stripping pump and outboard of the cargo manifold valves (Marpol line) must be used for this, discharging into the shore line(s) designated by the Terminal authorities. On completion of the discharge no cargo should remain on board except the contents of the Marpol line.

Completion of Discharge

Notice of the estimated time of finishing the discharge shall be given to both the Terminal and the engine room. On completion of discharging, the Terminal's lines may be drained as agreed at the arrival PTC. The receiving tank for the line draining should be gauged by surveyor before the line is drained and this figure should be the final ROB for that tank.

The entire cargo system must be shut down and then positive report made to Chief Officer that same has been done. The manifold connections must be blanked immediately after disconnection.
The attending surveyors shall be accompanied by the Chief Officer or an experienced officer nominated by the Chief Officer on the final tank inspection following the completion of discharge. The results of sounding of all tanks must be recorded, including any sediment or unpumpable residues found.

The quantity of cargo remaining on board (ROB) will then be calculated by the Chief Officer and the surveyor(s) independently of each other.

The following documents are required after completion of the tank survey:

1. Any letters of protest
2. Arrival and completion tank survey ullage reports
3. Tank dry certificate and ROB
4. Statement of facts or time log

The Terminal Representative and the surveyor(s) must sign the letters of protests to indicate receipt, and the other documents to indicate agreement and acceptance of survey findings and the time log. In the event of any refusal to sign, the Agent shall be requested to endorse the document concerned to the effect that the Terminal or surveyor declined to sign.

This is particularly important in the case of letters of protest, which shall also be copy-telexed to the principal concerned in order to obtain clear proof of receipt.

When vessel discharge is interrupted, be it to change berth, await lightering vessels or to await ullage space ashore, particular caution should be paid to checking valve line up before and after each operation.
6. CRUDE OIL WASHING

This section summarises the objectives and prescribes the procedure for the crude oil washing (COW) of cargo tanks.

The Chief Officer is responsible for preparing the COW plan as an integral part of the overall cargo discharge plan, and for ensuring its correct and safe implementation.

The main objectives of COW are as follows:
1. A reduction in the potential for polluting the marine environment by oil;
2. The removal of oil fractions and sediment from cargo tanks, minimising or eliminating the need to water wash them;
3. An improved cargo discharge outturn;
4. A reduction in the extent and duration of tank de-sludging operations in preparation for drydock/repair periods;
5. Reduced corrosion of tank internals by minimising saltwater washing;
6. More efficient draining and stripping of tanks resulting from the removal of accumulating sediment and sludge;
7. A reduction in the wear and tear on cargo pumps caused by sediment and solids in the system;

The Chief Officer must prepare an integrated COW and discharge plan which as far as possible does not extend the overall discharge time, and which meets the Charterer's requirements. Approval of the vessel's COW intentions shall be obtained from the competent authority and the terminal at least 24 hours in advance of arrival. The plan must comply with the procedures laid down in the ship's Class-approved COW manual.

The checklists in the vessel's approved COW manual must be completed satisfactorily and recorded.

COW operations must be stopped in the following situations:
1. When the oxygen content in the tank cannot be maintained at 8% or less;
2. When instructed to do so by the Terminal;
3. When the IGS fails or is unreliable;
4. When the safety of the operation cannot be maintained.
7. **INERT GAS SYSTEM**

This instruction prescribes operational procedures for the inert gas system (IGS). Master is responsible for any decision relative to the use of IGS while Chief Engineer responsibility is the availability of a functional and efficient IGS Plant. The Chief Officer and the First Engineer are jointly responsible for the IGS management according with this instruction.

According with SOLAS, product tankers may carry petroleum products having a flashpoint exceeding 60°C (i.e. bitumens, heavy fuel oils, high jet point fuels, gas oils, etc.) without inert gas system having to be fitted, or, if fitted , without tanks containing such cargoes having to be kept in the inert condition. However, when cargoes with a flash point exceeding 60°C are carried at a cargo temperature higher than their flash point less 5°C, the tanks should be maintained in an inert condition because of the danger that a flammable condition may occur. Company recommend that, cargo tanks are to be maintained in an inert condition, whenever it’s possible.

Reference must be made to the ship's IGS instruction book.

**Loading Operations**

The IGS deck isolating valves shall be shut during loading operations, and safety barriers such as the deck seal and non-return flap valves confirmed operational. Individual tank HY JET in auto, I.G. branch line valves and the mast riser (or VECS manifold valve to shore reception facility) must be open to vent the cargo tanks during loading. All high velocity vent valves on each tank, must be in the service condition to provide a backup venting system.

**Loaded Passage**

On passage the IGS is to be used to maintain a safe positive atmosphere inside the cargo tanks. **VOC MANAGEMENT PLAN** is to be applied.

**Discharging Operations**

A positive IG pressure must be maintained in the cargo system throughout all cargo discharge operations. Pressurization of the cargo tanks improves cargo pump performance and reduces stripping time. During tank stripping, when the discharge rate is low, operation of the IGS shall be closely monitored and controlled to prevent prolonged periods of re-circulation.

The I.G. system must be capable of (1) delivering inert gas with an oxygen content of not more than 5% by volume in the inert gas supply main to the cargo tanks, at any required rate of flow; and (2) maintaining the atmosphere of any cargo tank with an oxygen content not exceeding 8% by volume, and a positive pressure at all times. Should the oxygen content of any tank rise above 8% all cargo operations must cease until satisfactory conditions are re-established.

The IGS oxygen and pressure dual recorder must be used whenever the plant is operated, and endorsed with the date, time and type of operation. These records are to be retained and filed for routine inspection and IGS survey.

A Check Sheet from the IGS Log must be completed on every occasion that an inert gas operation is carried out.

In the event of an inert gas plant failure, when its use was agreed with terminal (other vessel/barge for STS operation), prior to or during cargo discharge or de-ballasting operations (from cargo tanks), discharge should not commence or continue until the inert gas plan operation is restored.
8. **TANK CLEANING**

This section prescribes conventional water wash tank cleaning procedures. The Chief Officer is responsible for implementation of this instruction.

**General**

Water washing will promote corrosion in uncoated cargo tanks and should be minimised as far as possible. Fixed machines may be used for water as well as crude oil washing, but in addition portable machines can be used to great effect for spot washing. The number of machines which can be used simultaneously will depend on the capacity of the eductors or stripping pump.

Cold water is usually satisfactory for washing a tank to take clean ballast, but may not be very effective in removing accumulated sludge. Deposits of this kind contain hydrocarbon gas, which may prolong subsequent gas freeing operations.

Hot washing can be very effective in removing sludge residues, but washing with excessively hot water should be avoided as it may vaporise low pour-point components and leave heavy deposits of wax behind.

As a guide, the temperature of the wash water should be that of the cargo pour point plus about 40 degrees centigrade.

Alternatively, the appropriate hot wash temperature may be estimated by heating a sample of sludge and water until melting occurs, and then heating the wash water to this melt-temperature plus around 20 degrees centigrade.

The total number of machines, which can be used, simultaneously for hot washing will be governed by the heating capacity of the tank cleaning heater and/or slop tank heating coils in the case of closed cycle cleaning. A stern-trim angle of not less than 2.5° from the horizontal will facilitate good draining and efficient stripping.

An initial bottom wash will be necessary in tanks with heavy accumulations of sludge, to break it up and facilitate drainage and stripping. A normal top and side washing programme can then follow.

The nozzles of fixed machines can be set manually in elevation and direction to wash specific areas of a tank, by means of the machine control unit. Portable machines can also be positioned to clean identified shadow areas.

It may be considered necessary to purge, gas free and inspect a tank after the first wash to establish its effectiveness. Further spot washing or hot washing can then follow as necessary. The injection of chemical additives to wash water can promote the generation of static electricity within a tank, and must be authorised by the Company. The introduction of steam into cargo tanks is prohibited because of the hazard presented by static electricity generation.

Before tank cleaning operations can begin the IGS must be confirmed fully operational and delivering to the cargo tanks inert gas with an oxygen content of not more than 5% by volume.

The oxygen content of every tank must be 8% or less before washing begins, and must be maintained at this level.
Tank Cleaning Operation with Portable Machines

1. Before starting water washing with portable machines the following preparations and operational checks shall be carried out;
2. Remove blanks from Butterworth connections;
3. An operational test of tank cleaning machines also hose insulation and continuity of internal bonding;
4. The assembly and check of tank cleaning equipment and tools;
5. A check of safety equipment such as portable gas detectors and analysers, breathing apparatus, portable radios and torches;
6. Operational tests of remotely controlled equipment;
7. Deployment of fire fighting equipment;
8. Final stripping of tanks to be cleaned;
9. Setting up the slop tanks for closed-cycle cleaning;
10. Notification of the engine room for use of the cargo pumps;
11. Lining up for cleaning operations in accordance with a prepared plan;
12. For hot washing the heater must be pressure tested and commissioned, and thermometers and pressure gauges checked.

Check that a main cargo pump (MCP), heater, stripping pump, etc. are all ready for use. Install hose saddles on the openings and secure the hoses. Washing is effected in 3 or 4 stages at different levels, usually starting with an initial bottom wash for about thirty minutes to improve drainage, and then resuming at the top and working downwards. It is important that critical results of this kind are filed as a permanent record for the benefit of succeeding senior officers. A large capacity tank can be washed by dividing it into two or three vertical sections, starting at the forward end and working aft. Washing first the bay in which the tank suction is located should clear local sludge and sediment and improve drainage in this area.

Before starting washing operations connect a hose to the foremost tank cleaning line hydrant, lower the hose to the bottom of a tank to avoid a free fall of water, and then flush the line to clear any scale or debris.

Operate tank-cleaning line valves slowly to prevent pressure surges or excessive back pressure in the line. Start the MCP and confirm a flow through the system. Begin stripping. After a flow through the heater has been established and the output checked clean, adjust the steam supply to the heater to obtain the required temperature and then switch to automatic control. Either the Chief or First Engineer must be in attendance during this operation.

To prevent sudden changes in pressure or overloading of the heater, open delivery to the next group of machines before shutting down the working units. Change tanks one at a time, and if necessary use the hose outlet at the end of the tank-cleaning line to smooth the changeover. Check each machine for free movement in the vertical and horizontal planes, and for correct operation. Keep a check on thermometers and pressure gauges to ensure that the planned temperature and pressure are being maintained. Take regular and frequent manual soundings of the working tank(s) to ensure that no build-up of tank washings occurs, and monitor slop tank levels.

When washing has been completed, shut down the steam supply to the heater and continue the circulation of drive water until the output temperature has dropped to that of the supply. Examine all portable machines and service as necessary. Wash them in fresh water, and immerse them in an oil bath for storage. Inspect the tank-cleaning hoses and flush them with fresh water.
Tank Cleaning Operations with Fixed Machines

Set the nozzle angle of the machines, switch to automatic mode and open the branch lines. Confirm the line-up for closed cycle cleaning and start the pump. Crack open the cleaning line master valves to release displaced gas, then continue slowly to open up. The line pressure must be low (2 kg/cm² or less) when tank washing is started. Water hammer could result from the sudden delivery of water through wide open master valves which could damage machines and branch lines. Increase the line pressure slowly up to about 5 kg/cm² and maintain this pressure while checking the line and machines for leaks and any sign of abnormal operation. Increase the line pressure slowly up to the specified working pressure (around 8-10 kg/cm²).

Monitor slop tank ullages closely for change. Regular and frequent manual soundings shall also be taken of the working tank(s) to ensure that it is stripping properly. Ensure that the next tank in the planned sequence is ready in good time before the change-over, and that this operation is carried out slowly and carefully.

Liquid must not be left in the tank-cleaning line or any other closed piping when tank cleaning is finished or suspended. Heating and expansion of line contents could cause over-pressurisation and possible pipe rupture. Set the nozzle angle of the machines to zero and open branch valves to drain the branch lines and machines of any residual water or oil.

9. PURGING AND GAS FREEING

This section describes tank purging and gas freeing methods, and prescribes the procedures to be followed in their application.

The Chief Officer is responsible for the accomplishment of this procedure.

Instructions

1. Prior to a tank being gas freed it must be purged with inert gas to reduce the hydrocarbon content to 2% or less by volume, so that during the subsequent gas freeing no part of the tank atmosphere is brought within the flammable range;
2. Depending upon the design of the vessel, the replacement of a tank atmosphere with inert gas may be accomplished by one of two methods, dilution or displacement;
3. Dilution takes place when the incoming inert gas mixes with the original tank atmosphere to form a homogeneous mixture throughout the tank. This process requires maximum turbulence in the tank and the incoming gas must have sufficient entry velocity to penetrate to the tank bottom. Simultaneous inerting of more than one tank must therefore be limited to ensure this condition;
4. The displacement method uses the fact that inert gas is slightly lighter than hydrocarbon gas, so that by introducing it at the top of the tank the heavier hydrocarbon gas is pushed out via the bottom piping. This method requires a very low entry velocity to produce a stable horizontal interface between the incoming and escaping gas, and allows several tanks to be inerted or purged simultaneously;
5. After purging, the tank must be gas freed until gas concentration is not more than 1% of the LFL;
6. Gas freeing methods- By means of portable fans, hydraulically, pneumatically driven, delivering air to the tank through the tank cleaning openings. The IGS fans can be used, but have less effect and penetration than the portable units. The combined use of portable fans and the IG fans is usually the quickest and most efficient way to reach the required gas free condition;
7. The displaced gas/air mixture can be vented to the via the Hy-jet vent, bottom cargo lines, or purge pipes if fitted. The degree of ventilation and number of openings shall be controlled to produce an exit velocity sufficient to carry the gas clear of the deck. Venting must be maintained until the required gas free condition is attained. If a tank has been crude oil washed and is to be entered for inspection only, it may be possible to purge and gas free to the prescribed level of safety without water washing;

8. The gas freeing operation must follow a comprehensive written plan, and observe the following precautions:
   ✓ Keep all tank cleaning openings closed until ventilation is about to begin.
   ✓ Portable blowers must be of approved design and construction. They shall be placed in such positions that all parts of the tank are equally and effectively gas freed. Ventilation outlets shall be as remote as possible from the fans.
   ✓ Each tank shall be isolated to prevent the transfer of gas to or from other tanks. Internal corrosion can cause IG valves to so the line in question must be blanked. All tank IG valves/lines must be clearly marked to indicate whether they are open or shut. Check that there are no sources of ignition in the vicinity of tank exhaust outlets.

9. A log must be kept of the entire gas freeing operation, including periodic atmospheric test results.
10. HANDLING SPECIALISED CARGOES

This section identifies some specialised cargoes and prescribes appropriate handling procedures.

The Chief Officer is responsible for implementation of this instruction.

The handling of these specialised cargoes is prescribed in the following instructions.

10.1 HEATED CARGOES

Charterers normally specify the temperature at which the cargo must be maintained during the voyage, and at which it is to be discharged. Voyage orders often require the application of heating at the start of a lengthy voyage, even though there is ample time to reach the required discharge temperature by starting to heat much later in the loaded passage.

While it is clearly desirable to avoid unnecessary fuel consumption the Master should bear in mind that if specific written heating instructions from the Charterer are disregarded, he will be held responsible if the vessel arrives with the cargo below the specified discharge temperature. It may be prudent to heat early as instructed, rather than later in the voyage with the attendant risk of failing to reach the required temperature before arrival.

The Master must not expose the vessel and Owners to the risk of breaching charter party requirements as a result of delaying heating to economise on fuel consumption. In the event of any uncertainty the Master must seek clarification from the Charterers and keep the Company fully informed.

Preparation of the loading plan shall take account of the heating coil capacity of each tank. High viscosity or high pour point crudes should as far as possible be loaded into centre tanks to reduce heat loss to the sea, and via the shortest route to reduce the heat lost in pipelines during transfer. Due allowance must be made for cargo expansion as a consequence of heating during the passage to the discharge port.

Given the opportunity and sufficient notice, any waxy sludge should be removed or reduced by thorough crude oil washing at the preceding discharge port.

Heating coil pressure tests and any essential maintenance must be completed prior to arrival at the load port. All coils must be drained and checked for any sign of oil contamination.

When opening the steam supply to the coils, liaise closely with the engine room to avoid abrupt steam surges and the possibility of water hammer in the coils.

Raise the oil temperature slowly to avoid overheating and having to shut down for a time, as this will prolong the settling down period.

When loading is finished, or the operation is suspended for long periods, the lines used for loading are stripped before their contents solidify. Stripping pump strainers must be opened up and cleaned out following line stripping operations. The rate of temperature change in any tank depends on the volume of oil in it, how much heating is applied, tank location and local conditions. During loaded passage tank temperatures are taken twice daily at upper, middle and lower levels, and recorded with the sea temperature and weather. The indicated temperature trend and rate of change in known conditions can be used to decide if heating adjustments are necessary. There are two ways of controlling the temperature of the cargo during the loaded passage:

A specific temperature is maintained will be the pour point of the crude plus an allowance to prevent it from solidifying. This method requires heating sufficient only to reach the specified carriage/discharge throughout. In the case of HPPC the required temperature,
with minimum fuel consumption. Excessive heating will waste fuel and may cause
vaporisation of cargo light ends.

The cargo is left unheated at the start of the voyage. Heating is started in sufficient time to
reach the discharge port with the cargo at the temperature stipulated in the charter party
and/or voyage instructions. This method can save fuel as a result of a shorter heating
period. But there are risks associated with the timing of the start of heating, which must
take into account the characteristics of the crude, the expected weather and sea
temperature throughout the passage, and the vessel’s heating capacity.

Suspension of heating could cause layering and solidification at the tank bottom, and
impede or prevent further cargo discharge. The cargo temperature must be taken and
recorded daily on departure from the loading port, and twice daily after heating is started.
Thermometers used for this purpose shall be checked for accuracy.

Cargo must be heated to the temperature specified by the Charterer or consignee. The
pour point plus 20° to 25° C is considered a suitable discharge temperature range. If more
than one grade of oil is to be discharged, pumps and pipelines shall be segregated as far
as circumstances permit. Contamination shall otherwise be minimised by draining pumps
and pipelines before changing to a different grade. Any HPPC or HVC parcel should be
discharged last if possible, to avoid the risk of blocking lines with solidified cargo.

As the cargo level falls in a tank, adjust the supply of steam to the heating coils as
appropriate. Once the tank level falls below the heating coils the cargo will begin to cool,
particularly in winter conditions with low sea temperatures. To minimise the risks of
solidification ensure that the cargo is appropriately heated before stripping begins, and that
the stripping operation is done quickly. Bear in mind that excessive heating may cause
light ends to vaporise inside a MCP casing and cause the pump to lose suction. The
objective must be to discharge as much cargo as possible with the MCPs to minimise
stripping time. Should any cargo solidify between the heating coils and the tank bottom,
the transfer of heated crude from another tank combined with increased coil heating may
succeed in reliquifying it.

If any solidification of line contents occurs, try to reliquify it by recirculating part of the
cargo discharge back into a suitable tank via the drop lines. Use only one tank for this
purpose and keep a close check on the tank ullage. Alternatively, connect a steam hose
from the tank-cleaning heater to the manifold drain line to apply heat directly to the
solidified oil.

Crude oil washing. Some crude oils with high pour point temperatures or high viscosity
must not be used for this purpose. The list of such crudes shown the Crude Oil Washing
Operations and Equipment Manual should be regarded as a guide only: it is not
exhaustive. In general only crudes with a low viscosity or pour point should be used.

When COW is effected with a heated crude cargo great care must be taken to avoid
solidification of oil in pipelines and tank cleaning machines. Crude oil washing with high
pour point crudes must be avoided altogether in very cold climatic conditions. The
Charterer’s approval must be obtained before crude oil washing a tank with a grade more
suitable for this purpose, but different from that carried in the tank.

On completion of discharge any oil left lying in cargo lines and pumps must be stripped
back to the shore terminal or back to a suitable reception tank on board. If a parcel of
low pour point crude is to be discharged in addition to the heated cargo, permission shall
be sought from the terminal/Charterer to retain some on board for use as a final flush of all
cargo lines ashore.
10.2 CARGOES WITH HYDROGEN SULPHUR CONTENT

Invisible…Explosive…Flammable…Deadly…these words all describe Hydrogen Sulfide or H2S, a leading cause of death in the workplace. Because Hydrogen sulfide is so dangerous is required to follow certain safety standards such as monitoring the air in your workspace and providing engineering controls. But, most importantly, you must know how to protect yourself.

The ISGOTT Manual (to which please refer for completion of information) addresses two of the main operational impacts to be associated with this gas which are:

- The Safety of the Crew and others coming into contact with the gas, and
- The generation of Pyrophoric Iron Sulphide in reduced oxygen environments.

Crude oils containing 50 ppm of hydrogen sulphide (H2S) or over are defined as sour crudes. H2S is extremely toxic and crudes contain high concentrations of it. High levels of hydrogen sulphide are usually reduced by a stabilisation process before the crude is delivered to the vessel. However, the amount of stabilisation may be reduced temporarily at times, and some crudes are never stabilised and remain very high in H2S content. Instability of this type of crude oil can result in the release of large quantities of H2S gas which must be vented to control tank pressures. This gas is both toxic and explosive, and constitutes an extreme hazard to the safety of personnel and of the vessel. H2S gas is heavier than air and sinks to the deck in light air conditions. Air currents and eddies around the vessel may result in gas collecting in or near the accommodation or in enclosed spaces. Personnel who accidentally enter these pockets of highly toxic gas may suffer instantaneous collapse and cessation of breathing. All tank lids, ullage ports and tank cleaning openings on the main deck must be confirmed gastight before arrival at the loading port.

Properties and Characteristics

What exactly is Hydrogen Sulfide or H2S? It’s a highly toxic, colorless gas whose molecules consist of 2 hydrogen atoms bonded to a single atom of sulfur. This molecule poses a direct threat to your life and health if not treated with the proper respect and personal protective equipment. H2S has an offensive odor similar to that of rotten eggs at low concentrations. That’s why it is often referred to as Sour Gas. Crude oils containing 50 ppm of hydrogen sulphide (H2S) or over are defined as sour crudes. High levels of hydrogen sulphide are usually reduced by a stabilisation process before the crude is delivered to the vessel. However, the amount of stabilisation may be reduced temporarily at times, and some crudes are never stabilised and remain very high in H2S content. Instability of this type of crude oil can result in the release of large quantities of H2S gas which must be vented to control tank pressures. H2S gas is heavier than air and sinks to the deck in light air conditions. Air currents and eddies around the vessel may result in gas collecting in or near the accommodation or in enclosed spaces. Hydrogen Sulfide rapidly deadens your sense of smell so your nose is a poor first line of defense. Don’t rely on your nose to alert you to the presence of H2S. Because of its rapid action Hydrogen Sulfide is considered one of the most dangerous industrial gases. H2S is also highly flammable. It has a flashpoint of 500 degrees Fahrenheit, meaning it will catch fire and burn at any temperature at or above 500 degrees if conditions are right. 500 degrees is lower than you might think when you consider that the end of a cigarette burns at approximately 1400 degrees. That’s why smoking must be prohibited in or near any area where there is a possibility of H2S.
Hydrogen sulfide is heavier than air having a “vapor density” of 1.19 with respect to air. Therefore, higher concentrations will be found at ground or lower levels. H2S is highly corrosive to certain metals and can cause a buildup of iron sulfide scale inside the pipe. When the moisture is removed from this compound, it can spontaneously combust and burn on its own. Prolonged contact with H2S may corrode and weaken metal pipes resulting in a major H2S leak and/or exposure incidents. There are many different hazards associated with this poisonous gas. The main hazard is inhalation. Absorption of the material through the skin is not considered a significant hazard. Low levels of exposure may cause the following symptoms individually or in combinations, increasing with longer exposure:

- Fatigue;
- Eye Irritation;
- Headache;
- Dizziness;
- Excitement;
- Coughing;
- Drowsiness;
- Nausea;
- Pain in the nose, throat and chest;
- Higher levels of exposure can intensify symptoms and if the concentration is high enough, death can result.

The way H2S affects you depends on the following factors:

- Duration or the length of time the individual is exposed;
- Frequency- how often the person is exposed?;
- Intensity- How high a concentration the individual was exposed to? And Individual Susceptibility or the person’s physiological makeup;

At .13 parts per million there is a minimal perceptible odor.
At 4.60 parts per million there is an easily detectable moderate odor.
At 10 parts per million, eye irritation begins
At 27 parts per million there is a strong, unpleasant odor.
At 100 parts per million there is coughing, eye irritation and a loss of smell after 2 to 15 minutes.
At 200 to 300 parts per million there is marked eye inflammation and respiratory tract irritation after 1 hour of exposure.
At 500 to 700 parts per million there will be rapid unconsciousness, cessation of breathing and death.
At 1000 parts per million and above, the victim falls unconscious immediately and dies within a few minutes.

The Threshold Limit Value or TLV of H2S is 10 parts per million.
The Short-term Exposure Limit or STEL is 15 parts per million.
The IDLH or Immediate Danger to Life and Health of H2S is 100 parts per million.
The PEL or Permissible Exposure Limit is 10 parts per million as established by OSHA.
Respiratory Protection

Anyone assigned to a work area that has a concentration of more than 10 parts per million of H2S must wear protective breathing equipment. If worn properly will protect the wearer from the potential dangers of H2S. If not worn properly, it does nothing at all! That is why you must be trained in proper respiratory protection procedures and know how to fit test your equipment properly.

Monitors and Detectors

There are different types of devices used to monitor a work-site for H2S gas. Mechanical detectors incorporate a pump, detector tube and a scale to give readings of H2S. The pump draws air to be tested through the detector tube to react with acetate-silica gel granules. Presence of H2S is shown by the development of a dark brown stain in the granules. Anytime a situation requires you to use a hand held detector, you are required to wear or to have ready for use the proper respiratory protective equipment. Where there is a continuous possibility of encountering H2S (i.e. in pump room), electronic monitors are installed to give an additional measure of protection to personnel. These electronic units continuously monitor the area for H2S. When the level of H2S reaches an established point, an alarm is triggered. There are usually two alarm points. The first is, at 10 parts per million and the second is at 20 parts per million. The first alarm is usually a visual alarm and the second alarm is usually audible. It’s important to know what is the setting of the alarms.

H2S Exposure and Concentration Limits

When the concentration of H2S is 10 ppm by volume or above all precautions must be taken to avoid any danger to the health of personnel on board. The working place must be all time at lowest possible gas concentration and the maximum exposure limit is 5 ppm over a period of eight hours.

Precautions when Handling Sour Cargoes

Prior to arrive at load port vessel has to require and to obtain the MSDS of each crude oil or product before loading in order to take all the preventive actions aimed to avoid unsafe working practices in cargo handling and to protect the health of the personnel and visitors. In case of impossibility to obtain the MSDS, checks must be carried out in order to be aware about the possible H2S content in the cargo. If the SMDS for the cargo to be loaded show presence of H2S followings precautions to be followed:

- To assure, through continuously checks and maintenance plan, the gas-tightness of the cargo tank/holds hatch covers, P/V valves, Vapour Lock System, I.G.S. and all others possible sources of gas leaks;
- To assure gas-tightness to all openings (doors, windows/portholes, air intake covers etc.) in communication with the accomodation spaces, engine room and pumproom, furthermore during the operations in port the external air intake covers must be closed and the air conditioning internal recirculation system in operation;
- All the operations to be performed according the Company Safety Procedures;
- To assure the good working condition of the H2S portable, personal and fixed analyzer/s
Accommodations and enclosed spaces where H2S is likely to be encountered in hazardous concentrations must be monitored regularly with portable and calibrated instrument in addition of fixed H2S detectors;

Before loading all crew members must be briefed and trained on the dangers of hydrogen sulphide and the precautions that must be followed during the entire operation to reduce the risks to acceptable level;

Posters and notices alerting crew must be posted in the accommodation alleyway;

All tank lids, ullage ports and tank cleaning openings on the main deck must be confirmed gastight before arrival at the loading port;

Closed cargo handling procedures must be used and the U.T.C. equipment must be checked before arrival to ensure that it is working correctly;

Exposure of personnel to H2S gas must be monitored by approved instrumentation (fixed, portable or personal) for detecting and measuring its concentration.

Personnel shall be required to wear respiratory protective equipment when:

permissible Exposure Limits 5 ppm is exceeded;

monitoring cannot be carried out;

and closed operations cannot be conducted for any reason, and H2S gas concentrations could exceed the PEL.

Personnel must work in pairs on the tank deck and shall be provided with EEBD and personal H2S monitoring instruments. In case their personal monitor activates the alarm the personnel should immediately don their EEBD and immediately leave the area to an upwind location informing the cargo control room for action;

Before arrival at the loading port the IGS must be pressure tested to ensure that there are no leaks. Every part of the system must be checked including deck seals, branch lines, high velocity vents and p/v valves, and any leaks stopped;

B.A. and resuscitation equipment must be placed ready for use in the accommodation and on the tank deck;

During loading and discharging operations the tank deck, pump room and all areas apart from the interior of the accommodation block and engine room must be regarded as hazardous areas;

Conditions on deck must be checked frequently to ensure that there is no concentration of gas anywhere. All tank openings must be checked gas tight. If concentrations exceed 10 ppm in the accommodation or 50 ppm at positions more than 3m from a gas-venting outlet, the loading rate must be reduced or stopped;

The pump room fans must be operated for 30 minutes and the atmosphere must be tested for gas before entry is permitted;

Great care must be taken when draining hoses or arms to prevent the escape of cargo liquid or gas. Cargo pumps, stripping pumps and other cargo equipment may also contain H2S gas. Opening these units or using their gas bleed devices could release high concentrations of hydrogen sulphide gas;

Pyrophoric iron sulphide deposits are formed when hydrogen sulphide reacts with rusted surfaces in the absence of oxygen. These deposits can heat to incandescence when coming into contact with air. The operation of the IGS in compliance with this manual must be ensured at all times;

Personnel involved with sampling/ gauging cargo/connecting & disconnecting loading lines/drainage to open containments and mopping up spills must work in
pairs and carry personal H2S monitors and emergency escape BA. Closed loading devices must be used. They must be kept under observation from a safe location so that the alarm can be raised if they appear to get into difficulties. When through accident, leakage, or necessary opening of a closed system, H2S becomes present in the atmosphere, employees shall wear prescribed respiratory protection;

- Any tank, or work area where H2S may be in the atmosphere, should be approached from upwind if possible. Respiratory equipment shall be worn if H2S is likely to exceed safe working limits;
- Wind socks or equivalent means should be placed at every work location where the concentration of H2S may be expected to reach or exceed 600 ppm.

**During the navigation:** If tank venting is necessary, course should be altered to put the wind on the beam to ensure that the vented gas is blown clear of the tank deck.

**Discharging “sour Cargoes”:** prior to arrive at disport vessel has to inform the receiver about the concentration of H2S in the cargo vapor space and to reduce the cargo tank pressure to the minimum safety level keeping this level if possible during all the discharging. This procedures are in addition to the other established for the loading.

**After completion of discharge** the cargo tanks will contain a high concentration of hydrogen sulphide gas. To avoid contamination and emission to the atmosphere in port all cargo tanks must be purged by displacement when in high sea taking all precautions as above described. It may be also necessary to wash cargo tanks to remove all traces of H2S gas prior to loading at some terminals. Masters shall establish in advance if this degree of preparation is required for the next loading.

**Entering CargoSpace that Contained High Concentrations of H2S**

In areas where H2S is prevalent, an automatic resuscitator, or its equivalent, with extra oxygen supply shall be kept available at all times. Oxygen must be Grade D breathing air or medical oxygen. Respirator face pieces should be cleaned after each day’s use by washing in warm water with mild soap or a cleaner-disinfectant solution made for this purpose. They shall be rinsed and thoroughly dried before being returned to the case. It is important to remove skin oil from the mask parts to prevent damage to the rubber. Use of chemicals or other cleaning or sterilization methods, unless recommended by the mask manufacturer, may damage the mask or cause skin irritation.

**Entering Void Space or Ballast Tanks**

When carrying, loading or discharging “Sour Cargoes” before entering any void spaces or ballast tank adjacent to the cargo tanks the dedicated company procedures to be followed including the risk assessment with particular attention to the possibility of H2S presence.

**General Nuisances**

Mostly of the ports limit or ban the release of H2S to the atmosphere and this is also the company policy therefore is necessary to maintain cargo tank pressure within acceptably low limits when discharging and/or cowing keeping in mind that tank vapour pressure will rapidly increase if cargo is heated or agitated or tanks cowed.
First Aid

Since the result of exposure to H2S is paralysis of the nerves controlling respiration, persons stop breathing and lose consciousness quickly. If the victim is promptly removed to a safe area and artificial respiration is started immediately, the chances of complete recovery are good.

Any delay in the start of artificial respiration appreciably reduces chances of recovery. Even though chances of recovery may seem slim, artificial respiration should be continued until normal breathing is resumed, or until a physician assumes full responsibility for the patient, or the rescuer is physically unable to continue.

Any person overcome by hydrogen sulfide should be treated for shock, that is, kept warm while artificial respiration is being applied and kept quiet until he can be checked and released by a physician.

Note: If your eyes become irritated or you notice a halo around an electric light while working in a place or area which has been determined to be “safe” from H2S, take the following precautions:

- Leave the area at once and move upwind
- Flush eyes thoroughly with water.
- Wear respiratory equipment with full face protection if necessary to return to safe location.

10.3 FUEL OIL CARGOES

Enormous amounts of bunker fuel are consumed each year by the world fleet of cargo and commercial vessels as well as the military ones. Recent estimates give figures around 290 million tons where about 80% is heavy fuel oil. Totally there are about 90,000 merchant vessels over 100 gross tons as well as almost 20,000 military vessels in the world (1).

The heavy fuel oil (HFO) mainly consists of residual refinery streams from the distillation or cracking units in the refineries. The crude quality as well as the refinery process governs, to a large extent, what type of HFO you’ll end up with. For example a high sulphur crude will result in a high sulphur HFO and catalytically cracked residual oil will contain more carcinogenic polycyclic aromatics (PCA*) than a “straight run” residual oil from atmospheric distillation (2).

Typical values for a European catalytically cracked HFO of the viscosity 380 cst, are around 2.6% sulphur and 13-18% polycyclic aromatics. Low sulphur fuel (~ 0.5% S) may have lower values of polycyclic aromatics. Other components from the crude like organo-metallic or metallic substances can also be found in the HFO as well as additives like “pour point depressants”, “combustion improvers” etc.(5)(6)(2).

All HFOs on the market are classified as carcinogenic (cat. 2), harmful and dangerous for the environment according to the EU Dangerous Substances Directive (3). Additionally there are reports about hazardous waste and other chemical waste streams finding the way into heavy fuel oils today (4).

Other bunker fuels than the HFO are the marine diesel oil (MDO) and the marine gas oil (MGO). These are distillates from the refinery process with much lower viscosity, lower sulphur content (MDO usually < 1%S, MGO<0.2%S) and usually lower PCA than the HFO (6)(7).
Bunker fuel – and especially the heavy fuel oil – may constitute a risk for man and environment on a number of occasions during its handling and use on board a ship:

1. Bunker operations – This is when the fuel is transferred from small bunker boats to the receiving ship. It can be done at berth but also out at sea, day or night all the year round. Large amounts are usually handled under sometimes bad conditions. Things can and have gone wrong and a large spill may have a crucial effect on the marine life.

2. Bunker handling on board – Inevitably there will a direct contact between the fuel and personnel in the engine room personnel in the engine room. HFO is classified as carcinogenic and there is also shown a higher frequency of certain cancer types among engine room personnel (lung, urinary bladder). Additionally it is shown that certain PCA components from the HFO are found in the urine of persons who have been exposed to HFO on the skin. It is also shown that a damage of the genetic material actually occurs (8)(9).

3. Emissions from fuel burning – Emissions mainly depending on fuel quality are those of sulphur and polycyclic aromatics. The larger the amount in the fuel the large the emission. Sulphur emissions from shipping are a major and increasing contributory cause of acid downfall which puts a heavy burden on forests, soil and lakes in for example Scandinavia. Sulphate particles may also create health problems in densely populated areas (10)(11)(12).

Emission of polycyclic aromatics are also shown to be proportional to their content in the fuel. An estimate made for Goteborg reveals that one big ship entering the harbour and using catalytically cracked HFO, emits the same amount of PCA as 1200 heavy trucks (13)(6).

4. Sludge handling and tank cleaning – Spills of fuel oil on board should end up in the sludge tank but today’s mixtures of fuel oils, lubricants, detergents, solvents and water often create stable emulsions in the bilge water tank.

Without modern bilge water cleaning equipment this may lead to either discharge of bilge water containing hazardous components at sea or leaving all waste water ashore. Harbours in their turn are usually not equipped with cleaning facilities for large amounts of these complex mixtures.

Despite over 20 years of international conventions and bans, cleaning of sludge tanks and product tanks is still going on at sea. This leads to an everlasting presence of thick oil-slicks all along the Swedish coast. Every year about 100.000 long-tailed duck die at Hoburg’s bank in the South Baltic Sea due to oil spills (14)(15).

SOLUTION

The best option is as usual to tackle the problem at its source. If, for example, sulphur and PCA were removed from the residuals or cleaner distillates were more used as bunker fuels, many of the risks would radically decrease.

The cost of desulphurized residual oil is calculated to be around 50-90 Euros extra per ton (2002). Today’s price of standard 380cST HFO is around 140 Euros/ton (5)(16). Almost no refineries in the world desulphurize or dearmatize the residual refinery streams – yet.

There’s a number of measures that can be taken at once though: Safety bunkering. The Port of Goteborg has carried through a successful project called “Green Bunkering” after having had a serious spill incident at a bunker operation. It was
a project in cooperation with the bunker companies, environmental authorities and the Coast Guard. A lot of safety measures were taken as better communication, information, equipment etc. An authorization scheme for bunker boats in the harbour was developed – the Green Bunker Card.

**Safer handling of bunker fuel on board.** Everyone on board should be fully aware of the fact that heavy fuel oils is carcinogenic and every contact with skin should be avoided. Oil resistant clothing and gloves should always be used in contact with the fuel. Better gloves should be developed for fine mechanical work.

**Cleaner fuels – especially in densely populated harbours.** Low sulphur and low PCA fuels should primarily be chosen to decrease the burden of acid downfall and the emission of carcinogenic compounds in the environment. The health aspects are especially important in harbours. There distillate fuels should be used as far as possible. Another option is to fit cleaning equipment on board such as scrubbers and particle filters.

**Fuel quality directive.** Today there is insufficient standardization and control of bunker fuel to ships. Ship-owners do not really know what they get until it can be too late. A fuel quality directive like the one for fuels ashore, should be developed. Primarily within the EU but in the long run globally. To prevent that waste is blended in the fuel parameters like polycyclic aromatics, calcium, zinc, phosphorous and organic halogens should be controlled before the fuel is delivered.

**Tanks assigned for the carriage of fuel oil following a previous cargo of crude oil must be cleaned in strict accordance with the Charterer's instructions.** If no clear instructions on tank preparation are issued with the voyage orders they must be obtained from the Charterer.

Protest shall be noted if the vessel is instructed to load a cargo comprising both fuel and crude oil parcels. The heavy fuel and crude oil consignments shall be loaded and discharged in strict segregation. If the vessel is directed to use one or more lines or pumps for both parcels advance agreement to such a proposal must be obtained from the Charterer and/or the receivers, and protest noted. The lines and pumps concerned must be drained between grades to minimise the risk of contamination of the fuel oil parcel.

**Fuel Oil Containing H2S**

H2S as a substance can be found in bunkers in either a dissolved state (that is in the liquid phase) or as an evolved gas originating from the bunker fuel. The example supplied within the ISGOTT Publication suggests a correlation between the dissolved state and the equivalent quantity of evolved gas is a factor of 100, e.g. 1 ppm dissolved in the liquid phase will potentially create 100 ppm concentration of gas in the vapour or head space.

**Due to the relatively low concentrations of this substance in the liquid phase, there will be negligible impact upon the total Sulphur content of the fuel oil as delivered.** Thus vessel’s personnel will not necessarily be aware of the presence of this type of substance in a bunker fuel on or prior to delivery to a vessel but, subject to its concentration, may detect it by smell (it smells like that of rotten eggs).
Given the TLV (Threshold Limit Value) of H2S gas at 10 ppm it can be readily seen that the extent of H2S in the dissolved state needs only to be at levels in excess of 0.1 ppm before health/safety problems can occur. The ISGOTT Publication supplies a series of expected symptoms for those suspected of inhaling this gas, which are as follows:

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 – 100 ppm</td>
<td>Eye and respiratory tract irritation after exposure of one hour.</td>
</tr>
<tr>
<td>200 – 300 ppm</td>
<td>Marked eye and respiratory tract irritation after exposure of 1 hour</td>
</tr>
<tr>
<td>500–700 ppm</td>
<td>Dizziness, headache, nausea, etc. within 15 minutes, loss of consciousness and possible death after 30-60 minutes exposure.</td>
</tr>
<tr>
<td>700 – 900 ppm</td>
<td>Rapid unconsciousness, death occurring a few minutes later</td>
</tr>
<tr>
<td>1000-2000 ppm</td>
<td>Instantaneous collapse and cessation of breathing</td>
</tr>
</tbody>
</table>

Given the refining and production process involved to generate the oils used for blending to create an acceptable quality bunker fuel, it is not to be expected that substances such as H2S would be present. Given that H2S has a boiling point of roughly –60 degrees Centigrade, this substance would have been removed during the primary distillation of the crude oil, if present in the original crude oil feed stock. Thus in order to find a possible alternative source for this substance in a fuel oil it is perhaps necessary to look to sulphur degradation caused by micro-organisms – typically Sulphate Reducing Bacteria (SRBs). If this is the source of the production of H2S in the bunker fuel, which is a possibility, then fuel tanks onboard the vessel will become infested creating potential longer term problems for the vessel particularly with regard to efficient purification of the fuel and the potential for blockage of filter systems within the fuel supply system to the main engine. These later problems are caused by the generation of sludges and emulsions created by these organisms.

Hydrogen Sulphide (H2S) is a flammable gas having explosive limits created by a mixture of between 4.3% to 46% with air. Further H2S is soluble in water creating a very acidic (sour) water or water droplet. This sour water droplet will be a very good electrolyte promoting corrosion activity in the head space or vapour phase of the storage tank. Some crude oil tankers have already experienced the intensive pitting created by the “by products” of SRBs in their cargo tanks.

Thus, in conclusion, it is recommended that great care be exercised on board when it is suspected (by smell) that a bunker fuel contains H2S particularly if the evolution of this substance is due to the infestation of the bunker fuel by SRBs.

### 10.4 HIGH POUR POINT CRUDE (HPPC)

This type of crude has a pour point higher than normal ambient temperatures and it will therefore solidify without heating. Moreover wax separation and sedimentation will begin when the temperature falls through the cloud point, usually some 15 degrees centigrade above the pour point temperature.

In some cases the wax cannot be reliquified by subsequent heating, leading to a high unpumpable sediment remaining on board at discharge, and the possibility of a consequent cargo damage claim.

HPPC is loaded in a heated condition and usually the Charterer's voyage orders will specify heating requirements. If heating instructions are not received or are unclear, heating must begin on loading and the Company must be notified immediately. In this situation and until explicit instructions are received from the Charterers or the Company, carriage temperature shall be the published pour point for the particular crude plus 15 degrees centigrade.

Heating must be controlled and continuous. Suspension for any appreciable period might
halt thermal circulation and could result in convective layering, with wax sedimentation occurring in the cooler layers. This condition is not readily corrected by a resumption of heating, which can sometimes augment layering. Cargo temperatures must be taken daily during carriage and recorded at a range of depths down to and including the bottom plating.

**Precautions when handling**

The pour point and the cloud point are 2 parameters that must be known when handling any petroleum cargoes because are very useful during the loading, carriage and discharging in order to safely handle the cargoes with no loss of cargo at discharging port. The pour point of petroleum product is the minimum temperature at which the fluid will pour or flow under test conditions. This is an indicator of the ability of a fluid crude or distillate fuel to flow at cold operating temperatures.

The cloud point is the temperature at which a wax cloud first appears on cooling crude or product under specific conditions. At cloud point, the wax crystals tend to clog filter preventing proper equipment operation.

Both, or at least the pour point, of above parameters are found in the cargo quality certificate and SMDS. Once again the SMDS must be received prior the loading in order to know also the cargo characteristics, if not received, during the pre-loading operation Ch.Officer must require at least the Pour Point of the cargo to be loaded.

A HPPC (high pour point crude) is a crude that has a pour point higher than normal ambient temperatures and it will therefore solidify without heating, usually occurs in crude oils that have significant paraffin content. Moreover wax separation and sedimentation will begin when the temperature falls through the cloud point, usually some 15 degrees centigrade above the pour point temperature.

In some cases the wax cannot be reliquified by subsequent heating, leading to a high unpumpable sediment remaining on board at discharge, and the possibility of a consequent cargo damage claim.

HPPC is loaded in a heated condition and usually the Charterer's voyage orders will specify heating requirements (see heated cargoes section instructions). When a HPPC is to load or discharge the cargo loading/discharging plan must be prepared taking on account the pour point of the cargo to load, the ambient and the on board ballast water temperatures with the aim to avoid cargo cooling due to its contact with the bulkhead between cargo and ballast tanks. For this reason when loading/discharging the HPPC all around the tank to be loaded no ballast water must be in contact with the bulkhead of related cargo tank unless for safety or stability or stress reasons, unless the ballast water has at least the same temperature of cargo to be loaded or discharged.

Same precautions to be used during the carriage of HPPC.

During the discharge or loading, in case of stoppages, the lines must be drained if external temperature is not at least the same of cargo loaded or discharged.

During the discharging all precautions taken as detailed in the heated cargo sections must be also followed.

**10.5 HIGH VISCOSITY CRUDE (HVC)**

In general HVC does not solidify at ambient temperature, but is difficult to discharge because of its high viscosity.

The viscosity of an oil increases with a decrease in temperature, and vice versa. A
centrifugal cargo pump should be capable of discharging cargo at up to 1000 cSt but, to reduce the likelihood of damage to the pump mechanical seal and ensure smooth operation, viscosity should be lowered to less than 500 cSt.

Reference should be made to the viscosity/temperature conversion table on the following page to estimate the viscosity corresponding to the temperature of a particular crude oil. This will indicate whether heating is advisable to lower its viscosity before discharge.

10.6 HIGH VAPOUR PRESSURE CRUDE (HVPC)

Crude oils of this category are defined as having a true vapour pressure (TVP) of 1.0 bar or higher, and a resultant tendency to vapour loss during carriage.

During loading the following precautions shall be observed:

- Avoid loading when the wind velocity is less than five knots;
- Ensure a very low initial flow rate into tanks;
- Ensure very low topping off rates;
- Avoid creating a partial vacuum in the loading line;
- Maintain closed loading as far as possible;
- Monitor gas dispersion and ensure compliance with all safety requirement.

During discharge the following precautions shall be observed:

- Reduce the speed of the MCPs in sufficient time to prevent cavitation and loss of pump suction at low tank levels;
- Bleed off gas from MCP casings as necessary;
- Pressurise the cargo tanks with inert gas to raise the suction head of the cargo pump(s).

Completion of tanks should be staggered because stripping is more critical with crudes of this kind, often requiring pump priming from tanks with a greater head of cargo.

If a parcel of heavier crude or one with a low vapour pressure is also carried, permission should be requested from the Charterer or consignee to draw from this parcel when pumping HVPC at low tank levels and when stripping. The resultant blend should pump better, prolong the use of the MCPs, and minimize any unpumpable HVPC remaining on board.

As far as possible HVPC should be loaded in tanks chosen to maintain the carriage temperature, assist cooling, and facilitate efficient pumping, according to circumstances. For example, centre tanks for a summer zone discharge port, wing tanks for a winter zone discharge port, and after tanks for proximity to the pumps.
Bilge water cleaning and stopped dumping. The tradition gravimetric bilge water separation is not sufficient for the complex mixtures of oils, surfactants, solvents and water going down to the keelson in modern ships. Active cleaning equipment breaking the stable emulsions should be installed if the bilge water is to be discharged in the sea.

The “no-special fee” system in combination with active surveillance and powerful enforcement of environmental laws should be able to decrease the dumping of oil at sea.

* PCA or polycyclic aromatics is a parameter including polyaromatic hydrocarbons (PAH) but is also covering substituted PAHs with for example sulphur, nitrogen or oxygen.
10A. BLENDING OF CARGOES ON BOARD

For logistical and economic reasons, there is an increasing trend (especially in the oil trade) for blending, doping and dyeing cargoes on board vessels.

Blending is the commingling of two or more products into a single cargo. In the commodities market, blending represents a quick and economical means of producing a variety of products at short notice, using existing inventory or component products that are cheaply and/or readily available.

Blending might be carried out to:

- alter existing stock so that it meets the specifications in a new contract;
- make a completely new product to meet demand in the market; or
- decontaminate an existing product.

Alternatively or in addition, a cargo may be "doped" with additives to modify its performance (either for economic or for legal/regulatory compliance purposes) and cargoes may be dyed to comply with local laws and regulations.

From a supplier's point of view, blending, doping and dyeing on board has a number of advantages.

First, in order to blend, etc. upstream or onshore, a supplier must invest in or lease appropriate blending equipment and/or storage tanks. This not only represents an upfront cost but can cause logistical issues if demand for storage and blending facilities exceeds capacity.

Second, creating a cargo on board allows a supplier to source product from a wider geographical area and at shorter notice. For example if a supplier needs two products to produce the cargo it requires, it does not have to wait until both products are available at the same loadport or send its vessel to a port where the two components are available at the same time. Instead, it can load the first product and direct the vessel to the source of the second. This saves time (and potentially storage and transport costs) and therefore allows suppliers to respond promptly to demand, blending new cargoes en route to the Buyer.

According with SOLAS regulation VI/5-2 the physical blending of bulk liquid cargoes and any production process onboard a ship during sea voyages is prohibited, unless the cargo transfer is performed to grant either the safety of crew and of the vessel or the marine environment is involved.

**Blending of cargoes can be done only in port or at the anchors, if explicitly and previously authorized by the Company.**

Sometimes Charter Parties may contain special provisions or specific clauses related to the possibility for the Charterers to order some operations on board as:

1. To commingle different grades of cargoes
2. To dope the cargo with additives supplied by Charterers
3. To add dye supplied by Charterers to the cargo
4. To blend cargoes on board

In case ordered and authorized it shall be clear that the operations are always subject to ship’s safety, provided they are safe in the opinion of the master and always within the technical capabilities of the vessel.

Before the ordered operation is carried out, the relevant LOI (letter of indemnity) shall be given by Charterers to the Owners. Only upon having received the necessary LOI, the Owners will authorize the Master to carry out the required operation.

In case of any difficulty will arise, the vessel’s P&I shall be immediately contacted for support and assistance.
11. **TANK CLEANING AND GAS FREEING FOR DRYDOCKING**

This procedure prescribes the preparation of the vessel's cargo tanks for drydocking and major repairs.

The Chief Officer is responsible for the implementation of this instruction.

In the months preceding a scheduled drydocking or major repair undertaking, all cargo tanks shall be inspected to determine the extent and location of sludge accumulations. Every opportunity should be taken to progress crude oil washing of the tanks, in particular bottom washing at slow speed to remove sludge. During the final cargo discharge before dry docking a very thorough COW of all tanks must be carried out.

**Planning Considerations**

A tank cleaning plan shall be prepared by the Chief Officer and submitted in good time to the Master and Chief Engineer for discussion and confirmation. The plan shall then be passed to the Company for final approval. It must comprise a daily itinerary and timetable, and encompass washing, purging, gas-freeing, inspection, hotwashing and de-sludging of tanks; also associated operations such as cleaning pumps and main/stripping-lines and vent systems, and work schedules for mucking gangs or riding squads as appropriate. The following factors shall be considered:

1. The length of the ballast voyage and manpower available to accomplish the plan;
2. Weather conditions expected en route to the repair port, which might adversely affect tank cleaning operations, such as cold air and sea temperatures, and bad weather;
3. The number and capacity of fixed and portable tank cleaning machines and gas freeing fans;
4. The capacity of the tank cleaning heater;
5. Ballast requirements for the repair berth or dry dock;
6. Contingency arrangements for equipment failure, operational difficulties, and delays;
7. Assessment of equipment, consumables and fuel needed for the proposed cleaning operation. Additional equipment and stores might include the following:
   - Portable washing machines, hoses and couplings
   - Portable gas-freeing fans, ventilation tubing and air ducts
   - Portable gas detection instrument
   - Air driven turbo-lamps
   - Air hoists and spare wires
   - Spare parts for all tank cleaning equipment
   - Shovels, brushes, mops, tools, buckets, ladders, stages, rope
   - Cleaning rags, sawdust, chemicals, oil and grease remover
   - Sludge sacks, plywood, Personal protective equipment

**The Tank Cleaning Plan**

The precise details of the plan will be ship-specific, but shall conform with the following outline:

1. Wash top and bottom cargo lines, manifold and pumps, flushing back to the slop tanks.
2. Commission the tank cleaning heater and slop tank heating coils. Hot wash all cargo tanks with the fixed machines on a full washing programme.
3. Purge and gas free the tanks, and check that the atmosphere is safe. Inspect all tanks and start de-sludging operations.
4. Inspect each tank on completion of desludging, and decide if any further cleaning is necessary. Use portable washing machines to hot spotwash any areas where sludge
or oily residues remain.
5. Make a final inspection to ensure that all tanks are free of oil and sludge.
6. Inspect and clean the pumproom bilges as necessary.
7. After completion of all tank cleaning operations carry out a final wash of top and bottom cargo lines.
8. Allow the slop tanks to settle and decant same.
   Transfer the contents of the starboard slop tank to the port tank. Hot wash the starboard tank, purge, gas free and desludge as necessary. Wash and clean the mast riser, manifold drain trays and vac-strip system if fitted, using high pressure washing hoses and chemicals as necessary.
9. Perform a final wash of MCPs, stripping pumps and eductors.
10. Discharge the port slop tank to a reception vessel and hotwash the slop tank. Weigh a sample of sludge bags to determine the average weight, tally the total number and land them against a receipt for the total weight.
11 Purge, gas free and desludge the port slop tank.

Safe Practice
The accumulation of sludge in bags on deck is a pollution risk as well as a fire hazard. Individual bags must be sealed and stowed on plywood or timber covered with plastic sheeting to protect them from the weather and sea spray. It is important to keep the deck clean and free of oil and sludge, and sawdust or other absorbent materials must be used to clean up any leakage from the bags.

For transfer of slops and sludge to a barge, the transfer must be discussed with the Master of the receiving vessel, and all procedures must conform with those prescribed in the ISGOTT manual. The Chief Officer must ensure that correct ship-to-ship transfer and emergency shutdown procedures are observed, and shall carefully check the following:
1. The condition of the transfer hoses;
2. The transfer line-up of valves;
3. Inter-ship communications;
4. Pollution prevention and response measures;
5. Safety arrangements;
6. The condition of sludge bag lifting-gear;
7. The use of booms and nets to safeguard against sludge bags falling over the side;
8. Assignment of ship's staff to control and monitor transfer operations.

Riding Squads for Tank Cleaning Operations
If riding squads are provided to assist in cleaning operations it is the responsibility of the Chief Officer through the Master to ensure their safety on board. He must confirm the safety of their working conditions and ensure that they perform their duties efficiently and safely.

The Master shall be provided with a copy of the riding squad employment contract, which will detail their working hours and overtime agreement. The contract will also specify victualling arrangements, work procedures and general safety matters, including the working and safety equipment, which the riding squad will bring with them.

The Master and the Chief Officer must discuss the tank cleaning plan with the squad foreman on his arrival on board. All riding labour must be fully briefed on the requirements of the Company's Safety Management System and of their obligation to observe them.
The Chief Officer will remain in charge of operations and will maintain close liaison with the foreman throughout. Riding squads are prohibited from entering any tank without the authority of the Chief Officer who will observe the enclosed space entry procedure on every occasion, and regularly monitor conditions inside any tank in which men are working.

11A. CLEANING PROCEDURE FOR CHANGE OF PRODUCTS

In case the vessel has to change product it is normally requested one tank cleaning of those tanks dedicated to load the new product. The “Tank Cleaning Guide” (on board of all managed Vessels) reports what preparation is necessary to load the products. Two sections of the Guide give the cleaning procedures (e.g. only cargo line and pump stripping or butterworth with cold water for two hours, etc.). Ship’s Command has to follow this Guide and consider it as Company procedure. Technical procedures for cleaning are the same described in sections of this Manual.

For those Vessels in TC Charterers/Shipper/Receivers may request not to clean before new loading operations. In this case, request should be a formal request and Company Ops Dept. should be contacted for information/confirmation.

12. BALLASTING OPERATIONS

The Chief Officer is responsible for the ballast operation during the cargo handling (ballast is concurrently with cargo operations) so when making the loading/unloading plan the ballast/deballast plan is to be inserted accordingly.

See Company BALLAST MANAGEMENT MANUAL.

Typical Procedures for Ballasting and the Method of Preventing Hydrocarbon emission (for Aframax Class vessel type)

This Section is not applicable to this vessel as being a SBT tanker.

However, if it becomes necessary to ballast empty cargo tanks due to severe weather conditions such ballast is only allowed to be carried in tanks which have been crude oil washed during the last discharge of cargo. Any such ballast must be treated and discharged in accordance with the requirements in Section 16. In case the vessel has carried a cargo or a part cargo that is not suitable for crude oil washing arrangements must be made to wash the tank with a lighter crude oil or with hot water before it can be used for carriage of heavy weather ballast.

Heavy weather ballast can, when necessary, be loaded over top into cargo tank #4 via a spool piece connection on deck from the port side ballast line.

13. NOTES ON MAIN CARGO PUMP OPERATION

Officers shall familiarise themselves with the content of the cargo pump manufacturers’ instruction manual.

The following general operational points shall be observed:

- Notify the engine room in good time before the pump is required, and ask them to start warming through;
- Check that the discharge valve is shut and the suction valve fully open;
Prime the pump by opening the air vent valve on top of the pump casing: shut it when liquid appears. If the tank level is lower than the pump then the air vent valve must be kept closed and the pump primed using the stripping pump, or vac-strip equipment if fitted;

Check that the pump speed governor is in manual control and set at minimum, and ask the engine room to start the pump turbine and bring the pump up to slow speed. Do not adjust the pump speed before the engine room indicate that control has been passed to the cargo control room (CCR);

Increase pump speed gradually and as the discharge pressure rises slowly open the discharge valve to its maximum;

Check the pump for normal operation;

Check the MCP casing and bearing temperatures, and if necessary stop the pump and vent air/gas from the pump casing;

Reduce pump speed to maintain pumping capacity when cavitation starts. When cavitation occurs after pump speed has been reduced to a minimum, shut in the discharge valve to maintain pumping: if this response is unsuccessful, stop the pump. Exercise particular caution when using a self-priming MCP for stripping operations;

Give the engine room at least 30 minutes notice before stopping cargo pumps. Slowly reduce the pump speed and shut in the discharge valve. When the pump is on minimum control rpm, stop it and shut down the system;

In an emergency press the emergency stop button to stop the cargo pump(s), and then inform the engine room.

When pumps are being used in parallel adjust individual pump speeds as necessary to keep their discharge pressures equal. If the speed of one pump decreases and its shut-off pressure drops below the discharge pressure of the other pump(s), it will cease to discharge and the pump casing will rapidly overheat. All pump speed alterations must be made slowly.

To prevent surge pressures on cargo and COW lines, cargo pump speed must be reduced to a minimum before changing the valve lineup or pressure testing the COW line during discharge operations. Surge pressures can easily damage cargo and COW lines.

14. NOTES ON STRIPPING PUMP OPERATION

Before using a stripping pump notify the engine room in good time and ask them to be ready to start warming through. Open the drain, exhaust, suction and discharge valves. Lubricate moving parts as necessary, and check that all bolts and nuts are tight. Crack open the steam supply valve to move the pump very slowly and drain off water in the system. Shut the drain valve when all water has been displaced and drained. Open the test valve on the valve box cover to vent any air in the system.

With all water drained off and the pump warmed through, gradually open up the steam supply valve until the required steam pressure and pump speed is reached. Check the operation of the pump for leaks or any indication of malfunction. The pump should be started from the local control position so that the pumpman can monitor its initial operation.

If this is satisfactory, control of the pump can then be transferred to the CCR. The discharge side of the pump must be kept fully open at all times, while the suction valve setting and pump speed should be adjusted as necessary to maintain good suction. The pump must be checked and oiled at intervals not exceeding one hour. The
pumpman's checks must include an inspection of steam gland packing, which must be tightened up evenly if there is steam leakage. The stripping pump gauges must be monitored closely for any indication that the pump has become vapour- or air-locked. This will result in the loss of suction and short stoking of the pump, which can cause damage if prolonged: the pump must not be run dry. To recover the suction reduce pump speed, close in on the suction side, and prime from another tank with a greater head of oil if necessary. On completion of stripping operations, the pump should be slowed down and stopped. Close the steam valves and open the drain valve. Close the exhaust, suction and discharge valves, and inform the engine room that stripping steam is no longer required.

15. NOTES ON EDUCTOR OPERATION

Eductors can be used alone or in parallel. When used in parallel total stripping capacity is greatly increased. The drive for eductors is taken from a MCP, which may also be used to drive COW machines. When tank washing ensure that the eductor capacity substantially exceeds the delivery of the COW machines. All eductor inlet and outlet valves must be opened fully before starting. Monitor the suction pressure gauge to ensure that there is a good vacuum before opening up the suction valves to the tank.

For optimum performance of the eductors the drive pressure must be as specified by the makers. Ensure that this drive pressure is known and maintained by all operators. For best effect operate the eductors on stripping rather than main cargo lines and valves. Keep a close check on slop tank levels when using the eductors. To stop eductor operations shut the tank and eductor suction valves, reduce the drive-pump speed, and then shut the eductor drive and discharge valves.
16. **NOTES ON PRESSURE SURGE AND WATER HAMMER IN PIPELINES**

The incorrect operation of pumps and valves can produce pressure surges or water hammer in a pipeline system. These surges may be sufficiently severe to cause damage to the pipeline, hoses or硬arms. One of the most vulnerable parts of the system is the ship to shore connection. Pressure surges are produced upstream of a closing valve and may become excessive if the valve is closed too quickly. They are more likely to be severe where long pipelines and high flow rates are involved.

Where the risk of pressure surges exists, information should be exchanged and written agreement reached between the tanker and the terminal concerning the control of flow rates, the rate of valve closure, and pump speeds. This should include the closure period of remote controlled and automatic shutdown valves. These arrangements should be included in the ship's cargo plan.

A pressure surge and/or water hammer may result from the following actions:

1. Shutting a valve against the flow of liquid in a line;
2. The sudden stopping of MCPs or large and sudden changes of pump speed;
3. Abrupt or incorrect changeover of valves or pumps during cargo operations;
4. Introducing liquid under pressure into an empty pipeline;
5. Moving a mixture of liquid and vapour under pressure through a cargo pipeline, or a mixture of water and steam through a steam line;
6. Failure to drain steam lines of water before opening the steam supply valve.

Pressure surges and water hammer can cause serious damage to cargo lines and steam lines, and may also lead to personal injury. They must be avoided.

17. **NOTES ON CARGO CALCULATIONS**

**Tank Survey After Loading**

The survey requires accurate ullaging and water cut/measurements, with water samples if the water layer is deep enough. Temperatures must be taken at the midpoint of each tank as a minimum, and at several levels for some specialised cargoes.

Cargo samples must be taken from each tank; and ballast tanks and all other non-designated cargo spaces must be checked.

**Vessel Cargo Calculations**

Using agreed figures obtained at the tank survey the cargo quantity is calculated as prescribed below. Some inspectors will use calculation methods, which differ from those used by the Chief Officer. However the Chief Officer's calculations must conform to API guidelines, using the attached example pro-form capacity report.

**Total Observed Volume (TOV)**

Apply trim and list corrections to the observed tank ullage, double-checking that they are added or subtracted correctly. Enter calibration tables with the corrected ullage. Record TOV in bbls or m$^3$.

**Free water (FW)**

Apply any list or trim corrections to the observed sounding for water dips. Enter the calibration tables and extract the free water volume (bbls/m$^3$).

Gross Observed Volume (GOV)
To obtain the GOV, simply subtract the FW volume from the TOV in each tank.

Temperature
Record the observed average temperature for each tank.

API Gravity/ SG
Note the API or SG as supplied by the Terminal, ensuring that this is at standard temperature and in air. If the SG is given 'in vacuo' it must be corrected to 'in air'.

Volume correction Factor (VCF)
Enter Table 6A (generalized crude oils) with the observed temperature and API gravity to find the volume correction factor for each tank. Round the API figure to the nearest 0.5 degree API. **Do not interpolate:** eg for a given API of 30.7, use API 30.5 in table 6A.

Gross Standard Volume (GSV)
Multiply the GOV by the VCF to obtain the GSV

Weight Correction Factor
Multiply the gross standard volume of oil by the correction factor in Table 11 (long tons) or Table 13 (metric tons).
Table 11 can be read to the nearest decimal, so interpolation is necessary.

Ship's pipeline contents
The vessel should have details of the diameter and length of all the cargo pipelines, from which the total volume can be calculated.

Vessel Experience Factors
The vessel experience factor (VEF) is the ratio of the total calculated volume (TCV) of vessel measurements, corrected for on board quantity (OBQ) or remaining on board (ROB), to the corresponding shore terminal TCV measurements, for a minimum of five full-cargo voyages.

\[
\text{Loading vessel ratio (LVR)} = \frac{\text{TCV on sailing - OBQ}}{\text{TCV received from shore}}
\]

\[
\text{Discharge vessel ratio (DVR)} = \frac{\text{TCV on arrival - ROB}}{\text{TCV shore outturn}}
\]

If a TCV ratio (vessel/shore) appears to be in gross error, the ratio may be deleted with the written agreement of both parties.


Notes On The Wedge Formula
Dimensions for Wedge calculation
The Wedge formula is :-

\[
\text{Volume (V)} = \frac{L \times B \times p^2}{2 \times T}
\]

Where
\[
\begin{align*}
V & = \text{volume} \\
L & = \text{LBP} \\
T & = \text{Trim (Between Perpendiculars)} \\
p & = \text{Corrected dip} \\
B & = \text{Breadth of Tank} \\
p & = (p_1 \text{ cosec } \theta + (y - d \tan \theta)) \tan \theta.
\end{align*}
\]
Where \( p_1 \) = Measured dip
\( y \) = Distance from measuring point to aft bulkhead of tank
\( d \) = Tank ref height
\( \Theta \) = Trim angle in degrees ( \( \tan^{-1} \) Trim )
LBP

This formula assumes that the liquid is free flowing and that the vessel is upright at the time of measurement.

**Worked Example**

VLCC, LBP 320m, Breadth of Tank 20m, \( y = 4m \), ref height \( d = 30.5m \), measured dip, \( p_1 = 40 \) cm. Trim = 8m. Calculate the volume of liquid remaining in tank.

Trim angle \( \Theta = 1.432 \) degrees
\( p = (0.4 \times \cosec 1.432 + (4 - 30.5 \tan 1.432)) \tan 1.432 \)
\( = 0.48m \)
\( V = (320 \times 20 \times 0.48^2)/16 \)
\( = 92.2m^3 \)

**18. NOTES ON STATIC ELECTRICITY AND ITS PREVENTION**

**Static Electricity**

There are three basic stages leading up to a potential static hazard: charge separation, charge accumulation and electrostatic discharge. All three are necessary for an electrostatic ignition.

Certain operations can give rise to accumulations of electric charge, which may be released suddenly in electrostatic discharge with sufficient energy to ignite flammable hydrocarbon gas/air mixtures. The minimum amount of energy thought necessary to ignite petroleum gas is about 0.2 mJ.

There is of course no risk of ignition without the presence of a flammable mixture. The phenomenon of charge separation occurs at the interface of two dissimilar materials. At the interface a positive charge, say, moves from one material to the other so that the two materials become respectively negatively and positively charged.

While the materials stay in contact and immobile relative to each other the charges are very close together and the voltage difference between the two oppositely-signed charges is small, so that no hazard exists.

However, charges can be widely separated by many processes, for example:

1. The ejection of droplets from a nozzle, as in the case of high pressure jets of sea water or oil from tank cleaning machines, or the injection of steam under pressure;
2. The flow of petroleum or water/petroleum mixtures through pipes or fine filters;
3. The settling of a solid or an immiscible liquid through a liquid, such as rust or water through petroleum;
4. The splashing or agitation of a liquid against a solid surface, such as the impact of high pressure water or oil jet during tank cleaning;
5. Friction and the subsequent separation of synthetic polymers, for example the sliding of a nylon rope through PVC-gloved hands.

When the charges are separated a large voltage difference develops between them, and an electrostatic field or voltage gradient is established in the neighbouring space. For example, the charge on a water mist caused by tank washing produces an electrostatic field throughout the tank.
Electrical breakdown between any two points (electrodes) which gives rise to a
discharge is dependent on the strength of the electrostatic field in the space
between the two points.
Examples of a discharge between two adjacent electrodes are:
1. Between sampling apparatus in a tank, and the surface of a charged petroleum liquid;
2. Between unearthed equipment suspended in a tank, and the adjacent tank structure.

A two-electrode discharge may be incentive if the following conditions are met:
- The discharge gap is short enough to allow the discharge to take place, but not so
  short that the resulting flame is quenched.
- There is sufficient electrical energy to supply the minimum amount of energy to initiate
  combustion.

The release of this energy into the discharge gap is nearly instantaneous. Electrostatic
discharges can occur as a result of accumulations of charge on:
1. Liquid or solid non-conductors, for example a static accumulator oil such as kerosene
   pumped into a tank, or a polypropylene rope;
2. Electrically isolated liquid or solid conductors, for example mists, sprays or particulate
   suspensions in air, or a metal rod suspended on the end of a synthetic fibre rope.

During tank cleaning the risk of electric charge accumulation and subsequent electrostatic
discharge is high when:
1. The wash-liquid pressure is high;
2. The temperature of the washing medium is high;
3. The washing medium is crude oil contaminated by water;
4. The washing medium is sea water contaminated with oil;
5. A detergent is added to the washing liquid;
6. A large number of machines are in use;
7. The wash-liquid flow rate is high;
8. The last cargo was refined white product, rather than black oil;
9. The capacity of the tank being washed is large.

**Measures to Prevent Static Electricity Generation and/or Discharge:**

The most important countermeasure that must be taken to prevent an electrostatic hazard
is to bond all metal objects together. Bonding eliminates the risk of discharges between
metal objects, which can be very energetic and dangerous.
- Earth all rods, detectors and equipment before introduction into a tank;
- Prohibit the free fall of water or slops into tanks;
- Thoroughly flush and strip any tank having carried accumulator oil before water
  washing, if not inerted;
- Prohibit steam injection into any tank;
- Ensure that the tank-washing liquid is either clean crude oil free of water, or clean
  water free of oil;
- When loading products such as petroleum or kerosene restrict the pipeline flow-rate to
  one m/sec or less, until the bottom longitudinal are covered. The flow rate must then
  be restricted to 3 to 4 m/sec in the case of rubber loading hoses, and to 12 m/sec in
  the case of metal hardarms;
- Avoid pumping mixtures of refined oil and water. A mixture of oil and water may occur
during the initial stages of loading a refined product, and the flow rate must be
  restricted to less than one m/sec;
✓ Strainers, fittings and other obstructions should be located as far from tanks as possible;
✓ Ensure the strict use of anti-static clothing and personal protection equipment on deck.
✓ Ground all conductors;
✓ Check tanks for debris after repairs, maintenance or inspection;
✓ Ensure the proper maintenance of float gauge guide wires, if fitted;
✓ Avoid structural protrusions inside tanks as far as is practicable;
✓ Impose a delay of at least 30 minutes after completion of loading, before sampling/ullaging refined oil cargoes such as petroleum or kerosene;
✓ Whenever possible ensure that transfer pipelines are of metal and that all metal parts are grounded.

19. PROPERTIES OF CRUDE OIL AND CRUDE OIL GAS

Crude Oil
Although rudimentary oils differ considerably depending on their place of origin, they are generally made up of the following elements:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>83 to 87%</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>11 to 14%</td>
</tr>
<tr>
<td>Sulphur</td>
<td>5% or less</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.4% or less</td>
</tr>
<tr>
<td>Oxygen</td>
<td>0.5% or less</td>
</tr>
<tr>
<td>Metal</td>
<td>0.5% or less</td>
</tr>
</tbody>
</table>

Crude Oil Gas
Crude oil contains gases such as methane and ethane, hydrogen sulphide.

Toxic Hazards of Crude Oil Gas

General
The inhalation of crude oil gas leads to a feeling of light headedness, drunkenness or dizziness. If large quantities of gas are inhaled, death may occur. These symptoms manifest themselves at a density well below the lower flammable limit. The physiological effects of petroleum gas on human beings can differ widely, according to individual levels of tolerance. Even if a certain exposure to gas can be sustained with no apparent adverse effect, it must not be assumed that the gas concentration is in the safe range.
The odour of crude oil gas mixtures is not uniform and can paralyse the sense of smell. Hydrogen sulphide gas is a prime example, and is very dangerous.
Never assume that toxic gas is absent because there is no odour. Gases released from oil are composed of various hydrocarbons, whose toxicity is almost the same. Generally the toxicity of a gas is more severe when the number of carbon atoms is large.
The toxicity of crude oil gas is acute but it does not accumulate in the human body. Methane (CH₄) has no toxicity, but if its concentration is high then death from lack of oxygen may occur.
Table of Crude Oil Gas Toxicity

The following table shows gas concentration (volumetric percentage against air), and its estimated effect on the human body.

<table>
<thead>
<tr>
<th>Gas concentration (by volume)</th>
<th>Effect on human body</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1%</td>
<td>1,000 ppm Irritation to the eyes within one hour</td>
</tr>
<tr>
<td>0.2%</td>
<td>2,000 ppm Irritation of the eyes, nose and throat, dizziness and unsteadiness within half an hour</td>
</tr>
<tr>
<td>0.7%</td>
<td>7,000 ppm Symptoms as of drunkenness within 15 minutes</td>
</tr>
<tr>
<td>1.0%</td>
<td>10,000 ppm Rapid onset of &quot;drunkenness&quot; which may lead to unconsciousness and death if exposure continues</td>
</tr>
<tr>
<td>2.0%</td>
<td>20,000 ppm Paralysis and death occur very rapidly</td>
</tr>
</tbody>
</table>

Flammability and toxicity of a gas are not related. Measurement of a gas concentration below the LEL does not imply that it is safe to enter a tank.

Toxic Hazards of Hydrogen Sulphide

Most crude oils contain hydrogen sulphide (H₂S), and some grades contain very high concentrations of it.

Crude oils containing 50 ppm H₂S or over are called sour crudes. Although hydrogen sulphide is usually removed from crude oil before shipment, some grades of crude oil are loaded containing substantial residues of H₂S.

Loading terminals, which export oil with a high concentration of hydrogen sulphide gas usually, notify the vessel of analysis results and the degree of concentration. Because hydrogen sulphide has a low boiling point it evaporates in the tank in the early stages of loading and accumulates in the upper part of the ullage space. It is highly concentrated because of its low density (relative to propane and butane for example).

As shown in the following table hydrogen sulphide is very toxic and if inhaled at concentrations of 1000 ppm or more, natural breathing is paralysed immediately.

At a concentration of around one ppm it can be recognised by its odour of rotten eggs. However, H₂S quickly impairs the sense of smell, which can prove fatal in conditions of increasing concentration.

The absence of smell must never be taken to indicate the absence of gas.
Table of H₂S Gas Toxicity

The Permissible Exposure Limit (PEL) of H₂S expressed as a Time Weighted Average (TWA) is 5 ppm. The following table shows the effects of the gas at concentrations in air in excess of the TWA:

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-100</td>
<td>Eye and respiratory tract irritation after exposure of one hour.</td>
</tr>
<tr>
<td>200-300</td>
<td>Marked eye and respiratory tract irritation after exposure of one hour.</td>
</tr>
<tr>
<td>500-700</td>
<td>Dizziness, headache, nausea etc. within 15 minutes, loss of consciousness and possible death after 30-60 minutes exposure.</td>
</tr>
<tr>
<td>700-900</td>
<td>Rapid unconsciousness, death occurring a few minutes later.</td>
</tr>
<tr>
<td>1000-2000</td>
<td>Instantaneous collapse and cessation of breathing.</td>
</tr>
</tbody>
</table>

It is important to distinguish between concentrations of H₂S in the atmosphere expressed in ppm by volume, and concentrations in liquid expressed in ppm by weight. For example a crude oil containing 70 ppm (by weight) H₂S has been shown to produce a concentration of 5000ppm (by volume) in the gas stream leaving an ullage port above the cargo tank. Thus it is not possible to predict the likely vapour concentration from known liquid concentrations.

Toxic Hazards of other Gases

Benzene (benzol)

Benzene is an aromatic hydrocarbon and is carried in bulk on board tankers. It is the most toxic of all hydrocarbons and can be accumulated in the human body. It requires extreme caution.

The Threshold Limit Valve (TLV) of benzene is 1 ppm. The TLV is the maximum concentration, which is considered safe to humans for 8 hours/day and a total of 40 hours/week. As benzene is absorbed through the skin as well as by respiration it is necessary to protect the skin from contact with it. Crude oil usually contains only a slight amount of benzene and it is not a matter of concern provided the concentration remains below the TLV.
Table of Benzene Gas Toxicity

<table>
<thead>
<tr>
<th>Benzene concentration in the atmosphere</th>
<th>Hours of exposure to benzene</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 ppm 0.0025%</td>
<td>Men can work for 8 hours in atmosphere. Slight odour noticeable. No possibility of poisoning below this level.</td>
</tr>
<tr>
<td>2,000 ppm or over 0.2% or over</td>
<td>Possibility of acute poisoning. After a condition similar to drunkenness, muscle spasms occur with a sense of sleepiness and exhaustion.</td>
</tr>
<tr>
<td>7,500 ppm 0.75%</td>
<td>Life is endangered in 30 to 60 minutes</td>
</tr>
<tr>
<td>20,000 ppm 2.00%</td>
<td>Death in 5 to 10 minutes.</td>
</tr>
</tbody>
</table>

Gasoline Fractions (naphtha, unleaded gasoline jet fuel, etc)

Paralysis as well as headaches, nausea, dizziness, coughing, and muscle spasms can be caused by the inhalation of gasoline vapour. An atmosphere containing a vapour concentration of more than 0.15% by volume is unsafe for work.

**Death will occur in an atmosphere with a concentration of 2.4% or over.**

Table of Gasoline Gas Concentrations

<table>
<thead>
<tr>
<th>Concentration in the air</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.03%</td>
<td>Slight odour.</td>
</tr>
<tr>
<td>0.07 to 0.28%</td>
<td>Dizziness in 14 to 15 minutes</td>
</tr>
<tr>
<td>1.13 to 2.22%</td>
<td>Dizziness in 3 minutes</td>
</tr>
<tr>
<td>2.2 to 2.6%</td>
<td>Dizziness after inhaling 10 to 12 times</td>
</tr>
</tbody>
</table>

Many hydrocarbon gases and others of crude oil origin have carcinogenic or other long term adverse medical effects.

**Inhalation, even of concentrations considered safe in the short term, must be avoided.**
20. SHORTAGE AND CONTAMINATION CLAIMS

Shortages

Shortage claims arise from a discrepancy between the quantity of cargo stated in the bill of lading and the outturn quantity determined by the receivers at the discharge port. Both figures are frequently derived from shore-tank or meter-measured data.

The most common arguments cited in support of the shipper/receiver's case are that:

1. The ship is jump by the figure stated in the bill of lading;
2. The shore tank calibrations are more accurate than the ship's tank calibrations;
3. The oil has become contaminated by water after loading;
4. Some oil remains on board the ship.

The owner's defence is usually based on the accuracy of the ship's cargo figures and seeks to demonstrate that the cargo quantity discharged was comparable with the cargo quantity loaded, that there was no significant in-transit loss, that any on board quantity (OBQ) prior to loading has been taken in to consideration and that all the cargo has been discharged with nothing remaining on board (nil ROB).

The following practices shall be included in the Chief Officer's loading/discharging plan:

1. The hourly recording of tank ullages and corresponding loading/discharging rates;
2. Careful documentation of any delays to operations which are the responsibility of the terminal or any other party, detailing the cause of the delay and all relevant communications with the terminal.
3. Ensuring tank survey agreement on ullage, temperature, and water cut measurements etc. by all concerned. The methods used by the ship and shore representatives to calculate the cargo quantity from agreed tank measurements may differ, but should produce results which are closely in accord. The Chief Officer and any surveyor attending on the ship's behalf should check that there are no inconsistencies in the calculations. The new petroleum measurement tables are generally more accurate than the old tables, but it must be remembered that they are based on the average characteristics of average oil and are extrapolated from a relatively narrow band.

Ship's tanks may be calibrated using imperial, US or metric units of volume and the quantity of cargo may be expressed in various units including long tons, tonnes or barrels. Comparison of standard volume is preferable as it does not involve the application of conversion factors based on density data, which may differ between two observers or laboratories.

Measurement Accuracy

To calculate cargo quantities vessels rely on the Terminal for the API gravity of the cargo. Samples taken from the shore pipeline may not be representative of the cargo loaded. Clean and clearly labelled bottles shall be used for taking individual samples from the top, middle and bottom of each of the ship's tanks. Sampling must not be effected by using a standard sampling can and then decanting the three samples into a single larger can. Volatile fractions can be lost to the atmosphere during this process and the density established from the final mix may not represent the true density of the cargo in each tank. This may later have a significant effect upon the calculation of weight and bottom sediment and water.

Once the calculation of the ship's figure has been completed the terminal will provide the shore figure, which normally appears on the bill of lading. It is unlikely that the shore and ship figures will be identical, but usually the discrepancy is small and there will be no
impediment to signing the bills of lading. In every case it is the gross figures, which should be compared, and the ship's experience factor should also be taken into consideration.

The Master must decline to sign the bills of lading if there is an abnormal difference between the bill of lading figure and the ship's figure. He must insist on a thorough check of all measurements and calculations, both on board and ashore. Difficulties may arise because measurements taken of the shore tanks before loading cannot be verified once the cargo has been transferred. The accuracy of shore figures will then depend upon the accuracy of the records kept by the terminal.

If the figures cannot be reconciled, the Master must then decline to sign the bills of lading and seek instruction from the Company/Owners, who may require the charterers to provide a letter of indemnity before authorising the Master to sign.

It is essential for the defence of cargo claims that the ship maintains a complete documentary record of cargo operations. Time charterers will place on board their own documentation, the prompt return of which they will require at the end of each voyage.

These will include:
1. Deck and engine voyage abstracts;
2. Notice of Readiness
3. Port log
4. Pumping/loading record
5. Stowage plan
6. Loading and discharge port calculations
7. Records of any cargo transfers

**Loading and Discharging Operations**

Records of all oil transfers, loading, discharging, internal, and including bunkering operations, will also be required. Such records will assist not only with the defence of shortage and contamination claims but also with the handling of other possible disputes.

Internal transfer of cargo shall be avoided unless absolutely necessary: The Company must be consulted before any internal transfers take place unless the Master considers it urgent or otherwise essential. Such action must be reported and properly recorded in the Oil Record Book. Charter Parties also usually require the Master to notify the charterers of any internal transfer of cargo.

The owners have no liability for measurements taken once the cargo has left the vessel. Claims are frequently presented on the basis of shore outturn figures which can be inaccurate.

The effective stripping of the tanks is important since claims will undoubtedly be made against the Company for any cargo remaining on board. Crude oil washing can be expected to minimise the ROB of most types of crude oil cargoes.

It will be necessary to demonstrate that ship's valves, lines and pumps were in good condition at the time of discharge, because of its relevance to the question of pumpability. If any ROB is in liquid form it must first be decided if it was reachable, and if so whether it could be pumped by the vessel's equipment. If this is the case, then it should be pumped ashore.
The Master must call in a local P & I surveyor and notify the Company if he experiences difficulty in obtaining a suitable ROB certificate. If pressure is applied to the ship to sail before the surveyor can attend, the Master shall protest to the receivers and to the receivers' surveyor. If the surveyors are not prepared to certify cargo remaining on board as unpumpable/unreachable, they must be invited to inspect the ship's pumps. The receivers must be informed that if they consider the cargo to be pumpable, the ship will continue to attempt to pump it until the P & I surveyor arrives.

It is essential that maintenance records for the cargo pumps are preserved and that they are available if such disputes arise. Surveyors who certify cargo as pumpable must be required to prove that they have assessed the physical characteristics of the cargo and have ascertained that it is within reach of the cargo pumps.

ROB claims can arise for many different reasons, for example:

- The alleged inadequacy of the vessel's cargo heating capability, often coupled with low ambient temperatures at the time of discharge;
- Because of the physical properties of a particular crude, and consequent pumping difficulties;
- Because of an accumulation of sediment or scale in the cargo tanks, restricting the free flow of oil to tank suctions;
- Trim restrictions in the berth;
- The alleged poor condition of the vessel and its equipment.

After discharge an ROB certificate will be issued signed by an appropriate shore representative and, ideally, describing any remaining cargo as unpumpable residue. Any alleged contamination could have taken place ashore before loading. It is therefore Company policy that ship’s staff routinely takes cargo samples from each tank after loading, and if feasible at the ship's manifold during loading, in order to refute claims of this kind. Sample bottles must be labelled and retained for three voyages. This sampling shall ideally be witnessed and acknowledged by an independent cargo inspector. Apart from cargo contamination resulting from leakages between cargo pipelines or cargo tanks, the most likely cause of cargo being off specification is a failure to prepare appropriately the tanks and associated pipelines to load a cargo which is incompatible with the previous cargo with the previous cargo.

21. LIST OF DOCUMENTS AND CHECK LIST TO BE USED FOR CARGO OPERATION

1. CHIEF OFFICER STANDING ORDERS (REF. SECT.2)
2. NIGHT ORDER BOOK (REF. SECT. 2)
3. CHECK LIST PRIOR ARRIVAL (REF. SECT. 2)
4. SHIP-SHORE CHECK BOOK (REF. SECT. 3)
5. IGS LOG (REF. SECT. 3)
6. LOADING PLAN ( REF. SECT. 4)
7. PRE-TRANSFER CONFERENCE (REF. SECT.4)
8. WALKABOUT SAFETY CHECK LIST (REF. SECT. 3)
9. HOURLY LOG DURING CARGO OPERATION (REF. SECT. 6)
10. COW CHECK LISTS AND COW PLAN (REF. SECT. 7)
11. DISCHARGE PLAN (REF. SECT. 6)
12. PUMPING LOG (REF.SECT. 6)
13. ULLAGE REPORT, VEF REPORT, TIME SHEET (REF. SECT. 4)
14. LETTERS OF PROTEST (REF.SECT. 4)