Chapter 18 – Bulk Oil Cargoes – Shortage and Contamination Claims

Claims arising from the carriage of oil cargoes are often substantial and may allege either shortage or contamination or both. This chapter provides guidance on how tanker operators can minimise the risk of cargo loss or damage and defend themselves should claims arise.

18.1 Oil Shortages

In general, oil shortage claims are based upon a discrepancy between the quantity of cargo as stated in the B/L and the outturn quantity as calculated in the discharge port. Both these figures are frequently derived from shore tank calibration data. The most common arguments are that:

- The ship is bound by the figure stated in the B/L
- the shore tank calibrations are more accurate than the ship's tank calibrations
- the oil has become contaminated by water after loading
- some oil remains on board the ship.

The carrier's defence is commonly based upon the accuracy of the ship's cargo figures and seeks to demonstrate that they were comparable with the B/L figure, that there was no significant in-transit loss, that any onboard quantity (OBQ) prior to loading has been taken into consideration and that all the cargo has been discharged with none remaining on board (ROB).

The following pages consider each phase of a typical tanker voyage and look at the likely causes of difficulty.

18.1.1 Before Arrival at the Load Port

The cargo officer should prepare a loading plan taking into account stability, trim and stress. Where draught restrictions permit, it may be advisable to plan to leave the load port with a trim that avoids the need for internal transfers of cargo during the loaded passage. The inert gas system, if fitted, should be fully operational in readiness for the forthcoming cargo operation. The oxygen content of the cargo tanks should be as low as possible before arrival and a record of all tank readings should be maintained.

18.1.2 On Arrival at the Berth

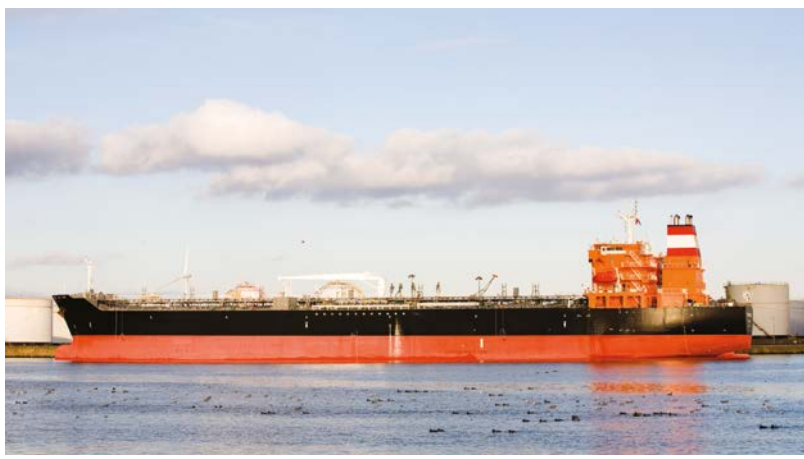


Figure 18.1: A berthed ship.

Once the ship is securely moored, it is important to liaise with representatives from the shore loading facility and to ensure continued good communications throughout the loading. All relevant information must be exchanged between ship and shore, including details of the ship's loading plan, maximum loading rates, shutdown procedures, safety regulations and cargo data. The appropriate Ship/Shore Safety Checklists should be completed.

18.1.3 Before Loading

The ship's cargo valves and pipelines should be correctly set for the reception of cargo and the relevant tank valves opened. Before loading, it is customary for a joint inspection of the cargo tanks to be made by the surveyor/shore representatives and ship's officers to confirm that the tanks are properly drained and in a suitable condition to load the designated cargo.

In general, the completion of such an inspection does not relieve the owner of their responsibility to ensure the correct condition of the cargo tanks.

In large tankers and where tanks are inerted to maintain the tank atmosphere, such inspections are difficult and it may be necessary to rely on the ship's gauging equipment rather than any visual inspection. The measurement of any OBQ should be carefully undertaken, preferably jointly with the shore representatives. The depth of any residues should be measured at as many locations as possible, and at least at the forward and after ends of the tanks. A wedge correction should be used, where applicable, to calculate liquid residues. Tank cleaning hatches should be utilised as appropriate.

It is never in the ship's interest for the OBQ to be underestimated. This will result in an overstatement of the ship loaded figure, exposing the ship to an unwarranted short delivery claim.

18.1.4 During Loading

The tank loading sequence should be planned in advance and in accordance with the ship's permissible stability and stress conditions. It is customary to begin loading at a slow rate, with the rate increased to maximum once it is established that cargo is entering the correct tanks and that there are no leaks from hose connections or any other difficulties. It is recommended that, at an early stage, the cargo officer should satisfy themself that the correct grade of cargo is being loaded, either by checking the specific gravity of a sample or, at least, by visual means. The ship's instrumentation may facilitate remote monitoring of temperatures during loading, but in any event it is essential to measure accurately and to record the temperature in each tank during loading. It is not advisable to use an average of the tank temperatures as this leads to inaccurate cargo figures.

The loading rate should be monitored and it is recommended that ullages and corresponding tank volumes, including those in idle tanks, are recorded in the deck log at least at hourly intervals.

The loading rate should be compared hourly with the shore tank discharge rates, where available, to help ensure that the cargo is not being misdirected in the loading terminal. Any changes in the loading rate or any stoppages must also be recorded. During the final stages of loading, the rate should be reduced to a minimum in order to permit measurement of the quantity of cargo so far loaded, to calculate the correct finishing ullage in the last cargo tank and to ensure cargo tanks are topped off safely.

18.1.5 On Completion of Loading

Before the cargo hoses are disconnected, the ship's figures must be calculated to check that the correct quantity of cargo has been loaded. While it is in the ship's interests to measure the cargo on board, it is customary for various witnesses (typically surveyors or loading Masters) to attend this operation and, in some cases, to make independent calculations. These witnesses may include representatives from the loading terminal, the shippers and the charterers. It is of prime importance that the

measurements of ullage, temperature and, where appropriate, water dips are agreed by all concerned, although it must be accepted that the methods of calculation employed thereafter may not always be consistent. It is generally accepted that the latest edition of the ASTM-IP-API *Petroleum Measurement Tables* (Reference 28) is more accurate than older tables, but it should be borne in mind that all tables are based on the average characteristics of a range of oils. Where a surveyor is attending on the ship's behalf, they should collaborate with the ship's officers to ensure that no inconsistencies arise in the calculations.

Ship's tanks may be calibrated using imperial or metric units of volume and the quantity of cargo may be expressed in various units including long tons, tonnes or barrels. Whichever units are applied, it is essential to compare like with like. The use of standard volume may be considered preferable as it is less susceptible to misinterpretation by observers or laboratories. The glossary at the end of this chapter lists the common terms and abbreviations used in the measurement of liquid cargoes.

18.1.6 Ullaging

This is the measurement of the distance from the datum point at the top of a tank to the surface of the liquid cargo. Most ships use a combination of fixed and portable gauging equipment to measure the ullage in each tank. It is important to ensure that ullaging equipment has been verified as properly calibrated.

Ullaging is best carried out when the ship is on an even keel and with no list, otherwise inaccuracies may creep in despite the application of trim corrections.

A ship, whether afloat, alongside a jetty, at anchor or at sea, is a moving platform and even a slight movement will affect the accuracy of measurement. In any single tank, a difference of one inch in the ullage may involve a volume of several hundred barrels. Where a ship is pitching or rolling, it is recommended that five measurements are taken from each tank. The highest and lowest should be ignored and the middle three averaged. Weather and sea conditions at the time of the measurement survey should be logged.

Some factors may affect the calculation of OBQs, particularly residues on tank floors and structures, and these will vary with the age of the vessel and previous cargoes carried. It is not unusual for ullages to be recorded for the purpose of determining ROB and OBQ when the trim of the vessel, at the time of survey, is such that the ullaging tape or sounding rod is not perpendicular to the ship's tank bottom on contact. In such cases, it follows that the depth of ullage obtained must be inaccurate. Clingage is a further consideration because, while crude oil washing (COW) reduces clingage for most crudes, there are a few types where the reverse is true.

18.1.7 Temperature

The temperature of liquid in a ship's tank is obtained by the use of a cup case thermometer or electronic temperature sensing devices. Electronic devices can be fitted in the tank or are part of the portable ullaging system. Cup case thermometers are unreliable and errors of ±2 to 3°C are not unknown. Electronic temperature measurement devices have a greater accuracy, typically ±0.1°C. Great care should

be taken when using a manual thermometer to ensure it is not affected by the environmental temperature after it has been removed from the oil.

The vertical positioning of the thermometer in a vessel's tank, particularly at the discharge port, is critical because significant temperature variations can develop within the cargo tanks during the voyage. Cargo temperature may vary at different levels in the tank so, where possible, the temperature should be averaged from at least three readings (upper, middle and lower). Further, as temperatures vary from tank to tank, calculations of quantity must be calculated using individual temperature corrections for each tank.

The use of an arithmetical average for the whole ship is inaccurate and contributes to 'paper losses'. An error of 1°C in temperature produces an inaccuracy in the volume at standard temperature of approximately 0.1%.

18.1.8 Water Dips

Free water beneath a crude oil cargo is normally measured with a sounding rod. Water finding paste or electronic interface tapes may also be used for the detection of free water. Unfortunately, neither of these methods can be used to distinguish accurately between an emulsion and free water. Each method involves the risk of inaccuracies that can only be determined by proper sampling and analysis techniques.

18.1.9 Sampling

When calculating cargo quantities, the ship has to rely upon certain data supplied from the shore, in particular the density of the cargo that is calculated after the analysis of samples. Shoreline samples may, however, contain inaccuracies and cannot always be accepted as being representative of the cargo loaded. It is recommended that, with crude oils, the standard sampling 'thieves' should not be used. For all oil cargoes, clean sample bottles should be used to acquire individual samples from each level (ie top, middle and bottom of each of the ship's tanks) and from the manifold, as required. Samples should be clearly labelled.

During such an operation, volatile fractions may be lost to the atmosphere with the result that the density established from the final mix does not represent the true density of the cargo in each tank. This, in turn, may later have a significant effect upon the calculation of weight and bottom sediment and water. The importance of sampling as a measure to counter contamination claims is discussed further in Section 18.9.

18.1.10 Density

Despite practical difficulties, it is best practice to ensure that the density of the cargo on board is measured and compared with the figures supplied by the terminal. As an example, an error of 0.01 kg/l can alter the tonnage calculation on a VLCC by 3,000 T.

18.1.11 Measurement Errors

Studies by a major oil company revealed that a measurement error of ±0.21% may occur when calculating the measurement of volumes and an error of ±0.25% when calculating weights. Therefore, measurement errors may easily account for what has previously been termed a 'measurement error loss' or 'measurement tolerance'.

18.2 Completion of Documentation

Once calculation of the ship's figures has been completed, the shore installation will provide a shore figure. It is generally this figure that is used on the B/L. It is most unlikely that the two figures will precisely coincide, although in practice, and in the vast majority of cases, the discrepancy is small and of no great significance. Typically, the Master should have no difficulty in reconciling the figures nor in signing the B/Ls. In each case, the gross figures should be compared and the ship's experience factor should also be taken into consideration.

If there is an exceptional difference between the B/L figure and the ship's figure, the Master should decline to sign the B/L. They should insist on a thorough check of all measurements and calculations, including those ashore, in order to ascertain the cause of the discrepancy.

When checking the shore figures, difficulties may arise because the measurements taken in the shore tanks before loading cannot be verified once the cargo has been transferred. Checking of the shore figures may, therefore, depend upon the accuracy of the records kept at the shore terminal. In the majority of cases, this investigation is likely to be successful and the figures will be corrected and easily reconciled.

The reasons for gross inaccuracies may include:

- Ullages incorrectly measured
- tanks filled but not taken into account
- the contents of pipelines not allowed for
- incorrect temperatures or densities
- cargo mistakenly loaded on top of ballast
- cargo lost in the shore installation
- incorrect meter proving.

On occasion, despite such exhaustive checks, it may be that the two calculations cannot be reconciled and the Master faces a dilemma. The Hague-Visby Rules provide that:

"No carrier, master or agent of the carrier shall be bound to state or show in the bill of lading any marks, number, quantity, or weight which he has reasonable ground for suspecting not accurately to represent the goods actually received for which he has had no reasonable means of checking." (Reference 29)

However, the Master will be conscious of the commercial pressures, which dictate that the berth must be vacated and that the voyage must not be delayed. There is no one inflexible rule to be followed that will apply in every case.

The Master should make a note of protest, notifying the ship's agents and instructing them to urgently inform the owners of the problem as well as the charterers, the shippers and any consignee or notify party named on the B/L. The Master should give full details of the available figures and ask the parties notified to inform any potential purchaser of the B/L of the discrepancy. It may be difficult for the Master to contact all

the parties named, but the owner should do this at the earliest opportunity. Ideally, the Master should be able to clause the B/L, but in practice this creates many difficulties.

The Master should, therefore, decline to sign the B/L, or withhold authority for anyone else to sign, until the dispute has been resolved. In any event, the Master or owner should immediately contact their P&I Club or its correspondents.

18.3 Early Departure Procedures

Figure 18.2: The tanker MT *'Orkim Harmony'*.

In certain busy oil terminals, it is the practice, in the interests of expediting the turnaround of tankers, to offer the Master the opportunity to utilise the early departure procedure. This system was devised in the light of many years' experience of tanker operations and shore figures after loading. On arrival at the loading berth, the Master agrees that, on completion of loading, the loading hoses will be immediately disconnected and the ship will sail. As soon as the B/L figures are prepared, they are cabled to the Master who, if satisfied, authorises the agent to sign the B/L and other related documents on their behalf. On no account should Masters sign the B/L themselves before sailing without the correct figures already being inserted.

18.4 Shipboard Records

It is essential for the defence of possible cargo claims that the tanker maintains certain documentary records of cargo operations. Time charterers, particularly the oil majors, are likely to place their own documentation on board, which they will require to be returned promptly at the end of each voyage. Typical returns would include:

- A voyage abstract (deck and engine)
- notice of readiness (NOR)
- a port log
- pumping/loading records

- stowage plan
- loading and discharge port calculations
- details of any cargo transfers.

They may also include records of all oil transfers, whether loading, discharging or internal, and including bunkering operations. Such records will assist not only with the defence of shortage and contamination claims, but also with the handling of other possible disputes including performance claims and demurrage and dispatch disputes.

The need to keep full records of bunker quantities and to properly maintain the oil record book cannot be overemphasised.

18.5 During the Voyage

Provided the ship's fittings are properly maintained, the cargo will require little attention during the voyage unless heating is required. In such cases, it is important to follow the charterers' instructions, particularly bearing in mind the specifications of the cargo carried. In some cases, failure to heat the cargo properly may lead to severe difficulties. When crudes that require heating are carried, particularly those with a high wax content, it is important that the charterers provide clear instructions for heating both on the voyage and throughout discharge. Often, heating instructions are not sufficiently precise, with the charterers relying on the experience of the Master. Usually, it is wise to heat early in the voyage to maintain the temperature rather than being obliged to raise the temperature of the cargo more significantly at the end of the voyage. If there is doubt about the heating instructions, the Master should check with the charterers. The tank temperatures should be recorded twice daily.

Attention should be paid to the condition and operation of the pressure/vacuum (p/v) valves on the tank venting system to ensure that they are functioning correctly. Failure to operate these valves properly may lead to a significant loss of product during the voyage.

Finally, there should be no necessity to transfer cargo between cargo tanks during the voyage, which would create differences between ullages and soundings taken before and after the voyage and invariably lead to disputes when defending shortage claims. Ideally, the two sets of readings should not differ to any degree. Owners should discourage the practice and insist that any transfers that the Master considers urgent and essential be reported and properly recorded in the oil record book. Many charterparties require the Master to notify the charterers of any cargo transfers.

18.6 Arrival

18.6.1 Before Arrival at the Discharge Port

A proper discharging plan should be prepared, taking into account any restrictions or requirements. It must include a careful check of the trim condition during discharge, as well as the stress conditions. Care should be taken to ensure that the parameters laid down by the shipbuilders are adhered to. It is also important to take into account the required discharging temperature and the need to maintain this temperature throughout the discharge. When discharging in ports where low sea temperatures

prevail, this may require considerable vigilance. In tankers fitted with inert gas systems, COW or tank washing systems it will be necessary to ensure in advance that the systems are fully operational in readiness for the forthcoming discharge.

18.6.2 On Arrival at the Discharge Port

Figure 18.3: Ship arriving at a discharge port, aided by a tug.

On completion of the arrival formalities, the need to communicate with representatives of the discharging facility is no less important than at the load port. Full liaison should include the exchange of all relevant information about the cargo, including the maximum discharge rates, the discharge plan, safety procedures, shutdown procedures, scheduled shore stops and any local regulations.

If the ship is fitted with COW or tank washing equipment, it must be made clear whether tank washing is to be carried out, particularly bearing in mind any MARPOL requirements (Reference 30).

18.6.3 Before Discharge

As in the load port, the measurement of the cargo is undertaken in the presence of the cargo receivers and possibly other interested parties or their surveyors and including customs authorities. The remarks on cargo measurement in the load port apply equally in this instance. The utmost care should be taken in checking and double-checking the measurements. The measurement of temperature merits particular care, especially where heated cargoes are concerned. Again, it is stressed that apparently small discrepancies in temperature can lead to significant differences in the final calculations, and the temptation to 'round off' temperatures or to use convenient averages should be discouraged. It is essential to note the ship's trim and list at the time of ullaging – the ideal trim is with the ship on an even keel and with no list. When sampling cargo before

discharge, and particularly in the case of heated cargoes, samples should be taken from the top, middle and bottom of the cargo tank.

On completion of cargo measurement, a comparison should immediately be made with the loading ullages, tank by tank, to see whether there have been any appreciable changes since leaving the load port. Should any differences be noted, the reasons should be immediately investigated and fully recorded. The ship's responsibility should begin and end at the fixed manifold and the owners have no liability for measurements taken once the cargo has entered the piping that forms the receiving terminal. Claims are frequently presented on the basis of shore figures that are inaccurate and the most effective and economical way of reducing liability may be to recalculate these figures correctly. It would be beneficial for a surveyor representing the shipowner to check the shore reception facility, where it may be possible to witness the taking of shore measurements. They may also be able to check the pipeline system to verify its size and length and the method by which its contents are ascertained before and after discharge, noting whether any valves that lead off the pipelines are in use. Some shore facilities are reluctant to allow ship's representatives to make full checks in their terminals. If an inspection of the terminal or its operations is refused, this should be recorded.

Where shortage claims arise, they are usually based on the shore figures and the owners must defend themselves not only on the basis of the accuracy of the ship's figures, but also by challenging the accuracy of the shore figures. It will greatly assist if the owners' surveyor has made a thorough inspection of the terminal at the time of the discharge.

18.6.4 During Discharge

Once the necessary preparations have been completed aboard the ship, and the shore installation has confirmed that the discharge can commence, the cargo pumps are started in sequence. Where one or more grades of cargo are carried, it may be possible to discharge each grade simultaneously, subject to stress and trim considerations and any other restricting factors such as the design of the ship's pipeline system. Once it has been established that the cargo is flowing correctly, the discharge rate should be increased to the agreed maximum. The rate may be restricted either by back pressure or by the capacity of the ship's pumps. Ballast operations should then be carried out to ensure that ship stresses are kept within acceptable limits.

The rate of discharge should be carefully monitored throughout and recorded at intervals of no more than one hour. These records should show not only the amount of cargo discharged by volume, but also the shore back pressure, the pressure at the ship's manifold, the speed of the cargo pumps and steam pressure or, in the case of electrical pumps, the amperage. The unloading rate should be compared hourly with the shore tank reception rates, where available, to help ensure that the cargo is not being misdirected in the receiving terminal. If COW is being carried out, this operation must be closely monitored. Careful recording of the discharge in the ship's logs is essential if claims are to be successfully defended.

Effective stripping of the tanks is important since claims will undoubtedly be made against the owner for quantities of cargo remaining on board.

Figure 18.4: Ship discharging its cargo.

Provided the ship has a good stern trim, the tanks were well cleaned and prepared prior to loading, and the ship's pumps and pipelines are in sound condition, it should be possible to ensure that only a negligible quantity of cargo is left on board. Light or clean products should present no problem, although where heavier or heated cargoes are concerned there will inevitably be some clingage and perhaps some sediment remaining. Thorough tank washing will help to reduce these quantities and care should be exercised when stripping heated cargoes to ensure that the tanks are drained quickly as, once the level of the cargo falls below the heating coils, heat will be lost quickly and difficulties may be encountered.

Whatever type of oil is carried, it will be necessary to be able to demonstrate that ship's valves, lines and pumps were in good condition at the time of discharge because this has an impact on the question of 'pumpability'. From the point of view of cargo claims, it must be considered whether the cargo, even if it was liquid, could be pumped by the ship's equipment. It is possible that small quantities of oil, particularly where high gas cargoes are concerned, cannot be picked up by the pumps without the pumps gassing up. It is also possible that due to sediments from the cargo or shore restrictions on trim, the oil is liquid but cannot run to the suction (see Section 18.6.6). If pressure is applied to the ship to sail before the surveyor can attend, the Master should protest to the receivers and to the receivers' surveyor. If the surveyors are not prepared to certify cargo remaining on board as unpumpable, they should be invited to inspect the ship's pumps. The receivers should be informed that, if they consider the cargo to be pumpable, the ship is prepared to continue to attempt to pump it until the Club surveyor arrives. Owners should ensure that the maintenance records for the cargo pumps are carefully preserved and that they are available should such disputes arise. Surveyors who certify cargo as pumpable may be required to prove that they have tested the nature of the cargo and have ascertained that it can and does reach the suction in the cargo tank.

ROB claims may arise in three different ways:

- By loss of heating or inadequate heating on board ships, sometimes coupled with low ambient temperatures at the time of discharge
- as a result of the physical properties of the oil and the ability of the pumps to pump it. The possibility of pumps gassing up and loss of suction must be taken into consideration
- because cargo sediments or trim restrictions prevent the free flow of oil to the tank suction.

In the case of a crude that does not require heating, or that has a high vapour pressure, good COW and a good stern trim will overcome most problems.

Frequently, the charterparty will call for COW 'in accordance with MARPOL' and will allow additional time for discharge when COW is performed. If the receiving installation will not allow satisfactory stern trim, or if they refuse COW either in whole or in part, the Master should protest to the terminal and to the charterers, stating that the vessel cannot be held responsible for any resulting cargo losses.

18.6.5 On Completion of Discharge

When the cargo has been completely discharged, with all tanks and pipelines well drained, the cargo system should be shut down and all tank valves closed. A final tank inspection is then carried out and, inevitably, particular attention will be paid by the shore representatives to any cargo remaining on board. All void spaces, including ballast tanks and cofferdams, should be checked to ensure that no leakage of cargo has occurred.

18.6.6 Dry Tank Certificate

After discharge, a dry tank certificate should be issued, signed by an appropriate shore representative, describing any remaining cargo as 'unpumpable' and carrying an endorsement that the ship's equipment was in good working condition. In many places, shore cargo inspectors are reluctant to describe oil as 'unpumpable' and may prefer to use the terms 'liquid/non-liquid'. This is not satisfactory and should be avoided if at all possible because it leaves cargo owners in a position to claim pumpability and to attempt to activate a charterparty retention clause, albeit unlawfully, if the clause requires the cargo to be pumpable.

It is strongly recommended that Masters contact their Club representative and the ship's operators for advice if a dry tank certificate showing oil remaining on board as being unpumpable cannot be obtained.

18.7 In-transit Losses and their Potential Causes

The standard defence put forward by a shipowner to a cargo shortage claim used to be that the loss was below or equal to 0.5% of the total cargo. This figure, which originally stemmed from the cargo insurance deductible, was used for many years by shipowners and cargo insurers as an approximate guide for in-transit losses. However, a number of courts, particularly in the United States, have rejected the concept of an automatic 'loss allowance'.

However, there is every indication that the same courts would allow a ±0.5% 'measurement tolerance'. In-transit losses and their causes may be considered under four headings:

- The true in-transit losses during the voyage, where the ship's gross volume at standard temperature on loading is compared with the ship's gross volume at standard temperature prior to discharge
- theoretical in-transit losses, when the comparison of net volume on board at standard temperature on completion of loading is compared with the net volume on board prior to the commencement of discharge
- emptying and filling losses. This is particularly pertinent where a part discharge may take place into a lightering vessel or barge
- additional losses that may occur as a result of COW.

The third and the fourth items become apparent when accounting for volumetric losses on outturn.

The following factors may combine to cause a release of gases and an increase in pressure within the cargo tanks which, combined with the inert gas pressure, may cause venting through the pressure vent valves and consequent loss of product:

- Tanker design
- cargo density
- Reid vapour pressure
- cargo temperature
- ambient temperature and general weather conditions.

18.7.1 Losses During Discharge

The largest volumetric losses are likely to occur when there is transfer from one container to another. Quite large losses can occur when pumping the cargo from the ship to the shore. Where lightering is involved, there will, inevitably, be a greater risk of volumetric losses between the ocean-carrying ship and the shore tanks. Where COW is performed, the potential for volumetric losses is greater since the cargo is being formed into a high-pressure spray and partially atomised.

18.8 The Shore Installation

When assessing a claim for short delivery of an oil cargo, the ship's calculation and figures are scrutinised. It is of equal importance to examine the shore calculations at both the loading and discharge ports. The carrier's liability does not extend beyond the ship's manifold, and claims for apparent oil losses can sometimes be resolved by recalculation of the shore figures. The cargo interests should be asked to provide full details of the shore installation, including a plan showing all the storage tanks and the interconnecting pipelines as well as the position of isolating valves. The shore installation should be able to verify the maintenance of all their equipment and demonstrate that, for instance, all the isolating valves were tight and properly operating at the time of discharge. They should also be asked to demonstrate that the storage tanks were properly calibrated and show that the calibration was accurate. In some oil installations, the accuracy of the tank calibrations may be doubtful, particularly if they are of older

construction or built on unstable sites. A small measurement inaccuracy may correspond to a substantial difference in volume. Temperature measurements should also be closely considered as temperature gradients may exist when oil is stored in a large tank. In certain climatic conditions, there may be significant variations in the temperature within the tank. In a cold wind, there may be a horizontal temperature gradient as well as a vertical gradient. In many countries, the measurements taken at the time of custody transfer are witnessed by customs officials and, if appropriate, the official customs documents should be produced.

18.9 Oil Contamination Claims

Many oil shortage claims arise from the presence of excessive quantities of water that have settled out during the voyage and are found in crude oil cargoes at the discharge port. Oil contamination may occur in petroleum products, but a cross contamination between two grades of crude oil would, in most cases, not lead to a cargo claim. Crude oil cargoes are regularly blended before refining and, generally, for a cargo contamination to arise, a large cross contamination would need to take place.

This is not true of all grades of crude as there are some that have particular properties and must not be contaminated in any way.

Many refineries designed for the reception of cargoes carried by sea have desalination facilities to protect the distillation columns and refinery equipment from excessive corrosion. Such facilities, however, do not always exist. The presence of water in certain crude oil cargoes may also cause emulsions to form with the hydrocarbons. This in turn may cause ROB volumes to be excessive and possible sludging of land tanks if efficient water draining is not carried out.

It is quite possible that any alleged contamination could have taken place ashore before loading. It is recommended that prudent owners protect their interests by ensuring that the ship's personnel take cargo samples from each tank after loading and at the ship's manifold during loading, as a matter of routine, so that hard evidence is at hand to refute claims of this kind. Contamination claims are more likely to occur in the white oil trades, where it is common for a number of grades to be carried simultaneously. As many as eight or ten grades may be carried simultaneously and, on a purpose-built product carrier fitted with deep well pumps and dedicated loading lines, it may be possible to carry a different grade in each tank with complete segregation.

Aside from leakage, which may occur between cargo pipelines or cargo tanks and may result in contamination, the most likely cause of a product being off-specification is failure to properly prepare the tank or associated pipelines after carrying a previous incompatible grade.

18.9.1 Precautions Before Loading

Every care should be exercised to ensure that proper tank cleaning procedures are rigorously carried out and that tank coatings are in a suitable condition for the intended cargo. Particular care should be taken to ensure that all traces of the previous cargo are removed in the cleaning process.

When carrying multigrade cargoes, effective segregation is of prime importance. A minimum of two-valve segregation between different cargo grades should be considered. When preparing the loading plan, allowances must also be made for trim and draught restrictions. It is common for multigrade cargoes to be loaded in more than one port and for several discharge ports to be involved. In some cases, additional cargo may be loaded during the voyage after the discharge of other products. Careful planning is advisable, taking into consideration the quantity of cargo to be loaded and discharged, draught, trim and stress considerations, as well as the consumption of water and fuel.

Before loading, all concerned should have a clear knowledge of the intended loading plan, and the pipelines and valves must all be carefully set and double-checked. Because product cargoes generally have a low specific gravity, it is likely that the ship may not be loaded down to her marks even with all cargo tanks filled to the maximum permissible. When loading for a voyage that entails passing through areas where higher sea temperatures are expected to be encountered, it is advisable to take into account the expansion of the cargo that will occur as a result of those higher temperatures.

During the loading of sensitive products, it is common for 'foot samples' to be loaded and for samples to be taken and analysed before the rest of the product is taken on board. When carrying multigrades, it is good practice to take as many samples of the cargo as possible at various stages of the loading and discharge, including samples from the shorelines. If claims for contamination arise, the analysis of such samples will often identify the source of the problem and may assist the shipowner in rejecting liability.

If the following points are borne in mind by owners and Masters, there will be a much greater chance of success when defending oil cargo claims:

- Careful attention should be paid to all onboard surveys when loading and discharging with a view to avoiding 'paper losses'
- after discharge, try to ensure that a dry tank certificate is issued showing all cargo remaining on board to be unpumpable and endorsed to confirm that the ship's equipment was working correctly
- employ properly qualified surveyors and protest if it can be demonstrated that a surveyor employed by a cargo interest is not qualified or lacks experience.

18.10 Cargo Tank Preparation

Product and chemical tankers are often required to carry a wide variety of different liquid cargoes. The proper cleaning and preparation of cargo tanks and lines after one cargo and before loading a dissimilar commodity is of utmost importance if successive cargoes are to be carried without cross contamination.

18.10.1 MARPOL Pollution Categories

Tank cleaning and preparation methods are closely tied to the requirements of the MARPOL Convention, intended to prevent marine pollution.

Tanks containing residues of petroleum oil products must be cleaned out in accordance with the requirements of MARPOL Annex I. This Annex focuses on the prevention of discharge of oily residues into the sea by retaining slops on board for later disposal ashore. Annex I only allows the controlled discharge of oily wash water under the conditions set out in Regulation 34. Discharge is only allowed outside special areas under strictly controlled conditions. Full disposal records must be maintained by means of the Oil Record Book.

Tanks containing residues from cargoes of noxious liquid substances (NLS) in bulk must be cleaned in accordance with the requirements of MARPOL Annex II and the *International Bulk Chemical Code* (IBC Code). The IBC Code lists NLS according to their designated pollution category.

The Code requires that tanks containing certain substances must be pre-washed ashore at the receiving terminal before departure. This pre-wash is usually a relatively quick machine flush to remove most of the residues. The residues of cargoes in some pollution categories are permitted to be flushed into the sea under certain conditions, which may be after pre-washing. In all cases, the IBC Code must be consulted for proper compliance with the requirements of MARPOL. Full disposal records of NLS must be maintained by means of the Cargo Record Book.

18.10.2 Tank Cleaning Guides

There are several industry standard guides available to crew to help and inform their decision making regarding suggested tank cleaning methods, depending upon the type of cargo switch that is proposed.

At the simplest end of the scale are the tank cleaning guides produced by the oil majors. These are usually in the form of a matrix listing the typical oil product groups (jet, kerosene, gasoline, diesel fuel oil, etc) and give suggested washing methods from one group to another. The matrix will suggest washing procedures, or indicate when no washing is required at all. Such guides may form an integral part of voyage instructions or charterparty directions when a ship is changing from carrying one listed oil product to another.

On chemical tankers the variety of cargoes likely to be carried is much more extensive and the type of washing required to remove traces of one type of cargo in readiness for the next cargo is more complex. Guides are available in book form which may detail procedures and suggested cleaning steps, including techniques such as: ambient seawater flush, hot chemical recirculation, hot seawater rinsing, fresh water rinsing, ventilation, draining, mopping and drying.

More recently, various online, subscription-based guides have become available (Miracle and Milbro). These are interactive programs that enable the user to choose from a huge range of listed chemicals as last (From) and next (To) cargoes. The search can also be refined as to tank coating type. These online guides can also consider the requirements of the MARPOL regulations pertaining to each commodity and its pollution category.

Some of the major parcel tanker operators have their own interactive computer-based tank cleaning guides to include similar recommendations.

Figure 18.5: Tank cleaning in progress.

18.10.3 Cleaning Chemicals

Numerous off-the-shelf, proprietary tank cleaning chemicals are marketed on a worldwide basis. The chemicals are produced for specific purposes, which may include alkaline degreasers for oils and fats, non-alkaline detergents, acidic based metal brighteners, etc. Each chemical will come with its own MSDS and manufacturer's recommendations. These recommendations will include the optimum dilution dosage, means of application, ideal temperature and whether to use with salt or fresh water. The manufacturer's guidelines should be followed for optimum results.

Those responsible for tank cleaning after any given cargo should ensure that the ship is provided with an adequate stock of the appropriate chemical needed to clean after the cargo being carried, at least before that cargo is discharged. Many chemical tankers will hold a stock of various cleaning chemicals in drums ready for use. They should maintain an inventory of their stocks, noting the litres remaining and including the date of receipt or manufacture. The condition of the containers should also be noted as steel drums can corrode and leak.

Users must be aware of the limitations of certain chemicals in respect of their cargo tank coating types. For example, zinc silicate coatings are liable to be damaged by acidic or alkaline cleaning chemicals, so only those chemicals with an acceptable neutral pH should be considered. The coating manufacturer's recommendations and resistance lists must be consulted regarding the cleaning chemicals, as with the cargo to be loaded.

Degreasing chemicals act as surfactants to help to break down oils and fats in much the same way as washing-up detergent is used to clean greasy crockery. Heat also helps to liquify, break down and remove greasy residues. However, surfactants can cause some fats such as vegetable oils to saponify, causing unsightly white deposits. Acidic metal brighteners can be used to neutralise the deposits in follow-on washing, coatings permitting.

Tanks should be substantially cleaned by hot water washing before cleaning chemicals are employed. Their role is to remove greasiness, not to remove visible residues.

18.10.4 Washing Methods

Physical cleaning of a cargo tank (as opposed to crude oil washing (COW) where the cargo is used as the washing medium) is primarily carried out by water washing. Seawater is usually available in copious quantities and is the principal washing medium employed. There are limitations in its use, as seawater can be damaging to stainless steel and should only be used in accordance with the ship builder's recommendations. If used in a stainless-steel tank, the salt from seawater should be immediately rinsed with fresh water as part of the cleaning plan. Most tank cleaning will include a rinsing stage.

Seawater is usually applied via tank washing machines. These are either fixed (as part of the tank fittings) or portable (where they are introduced on the end of a hose through tank openings). The wash water medium is introduced at pressure either from the ship's washing main or from a cargo pump (when recirculation washing is required). The machines can be programmable, in which their arcs of operation can be limited (ie top, middle or bottom of a tank), or non-programmable where their nozzles describe an overall coverage pattern. Fixed machines should be sited at a sufficient number of locations within a tank and at such positions that shadows (areas not directly impinged by the washing medium) are minimised. Portable machines can be positioned at specific heights and locations to cover shadows, and access openings may be provided in the deck for that purpose. Shadow diagrams should be available to guide mariners as to the best coverage and positions.

In ships with no or few fixed machines, portable machines should be periodically lowered during the wash cycle (drops) to cover all areas of the tanks.

The washing medium can be applied direct (straight from the sea or a freshwater storage tank) or recirculated. Water can be supplied at an ambient temperature or it can be passed through a heat exchanger to raise the temperature, as desired. Any tank coating temperature limits should be observed. Water can be heated up to about 80°C, but above that temperature the water can convert to steam as it leaves the washing machine nozzles and, as a result, the washing effect through mechanical impingement will be lost. During direct washing, chemical cleaners can be injected into the washing medium downstream of the heater by means of a barrel pump. The chemical dose rate can be monitored by adjusting the injection pump rate in relation to the throughput of the washing machines in use. Dosing can be continuous or periodic during the washing cycle depending upon manufacturer's recommendations. After chemical injection has been turned off, the 'clean' washing medium should be continued until all chemicals have been rinsed away.

During washing, the washed tank must be continuously stripped to avoid any build-up of wash water. Any build-up can adversely affect the cleaning efficiency, especially when oils and fats are being cleaned. The spent washing water pumped out will either be stored on board (in the slop tank) or pumped overboard, either directly or after decanting, depending upon the requirements of MARPOL for the previous cargo and the cleaning chemicals used.

The action of stripping out the wash water also ensures that the pump and lines are flushed through and cleaned. This is the main way in which the inside of the cargo lines are cleared of the previous cargo. During washing, all parts of the line system should

be flushed, including both sides of manifolds, drop lines, drains and any connecting branches, paying particular attention to ensuring that no dead ends are left unflushed.

Recirculation washing is achieved by formulating a prepared dose of wash medium in a clean cargo tank (the recirculation tank). The wash medium can be heated, either by filling the recirculation tank via the main tank cleaning heat exchanger or by means of the heating coils within the tank. The recirculation wash medium is then pumped out to deck, where hose connection is made to the machines in the tank to be cleaned. The recirculation tank cargo pump is run at sufficient speed and pressure to drive the machines inside the tank being washed. The pump of the washed tank is used to return the medium back to the recirculation tank. The two pump speeds are regulated to ensure that the wash medium is continually stripped out of the washed tank. The volume of the recirculation medium must be sufficient to ensure that the system remains full and effective.

The advantage of direct washing is that the cleaning medium is continuously renewed with clean water. The main disadvantages are that this increases the overall volume of wash water used (which matters if the dirty water must be stored on board) and it is more expensive in terms of heating.

Conversely, the advantages of recirculation are that heat losses are reduced and the volume of wash water is controlled and known. The big disadvantage of recirculation washing is that if the wash medium becomes too dirtied, the washing effect can be minimised, or even reversed if cargo residues are carried back into the tank being washed. In practice, some combination of direct washing and recirculation washing may be employed. This can be advantageous if only a limited cleaning chemical dosage is available, and recirculation is used as the finishing cleaning effort. That is why the cleaning guides will usually specify recirculation washing only as the secondary wash after the tank has been substantially cleaned.

In either case, both methods can be applied to individual cargo tanks or groups of several tanks. Tanks can be washed sequentially in pairs in a rolling programme, so that as soon as one pair has completed a stage, that stage can be rolled forward to the next pair. If recirculation washing is applied to a group of several tanks, there must be sufficient volume and dosage concentration so that the final tank of the batch receives the same cleaning effect as did the first tank of the batch. The recirculation medium must be monitored to ensure that it does not become too contaminated. If necessary, the concentration of the dose can be topped up to maintain its surfactant properties.

Effective tank washing is a balance of wash water pressure, temperature and good stripping. Good pressure and temperature should be maintained by balancing the number of washing machines used at any one time. More machines equal faster water throughflow, resulting in reduced pressure, temperature and cleaning effect. During washing the pressure and temperature of the wash water should be constantly maintained and monitored. It is also important to regularly check that the washing machines are turning correctly. This can be gauged by the sound that impinging water makes on the ship's structure. The water level inside the washed tank should also be constantly checked to ensure that there is no build up.

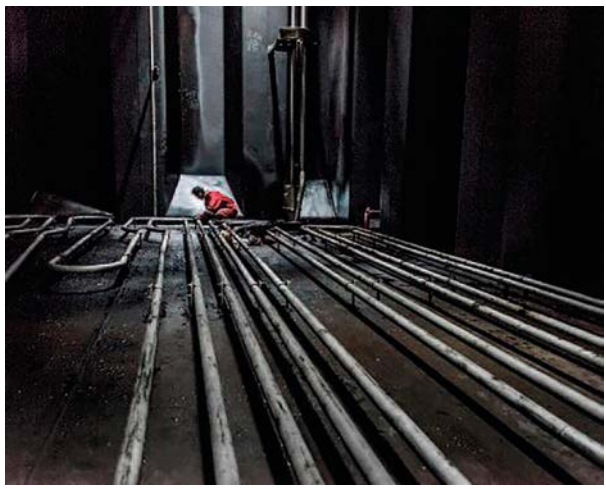


Figure 18.6: Tank cleaning.

18.10.5 Fresh Water Rinsing

After completion of saltwater washing, and after the cleaning chemical has been rinsed out by clean salt water, all traces of salt should be removed by thorough freshwater rinsing.

After difficult cargoes (such as palm oils) freshwater rinsing can be delayed until a cleanliness evaluation has been made. There is no point in wasting fresh water until the tank is assessed as being sufficiently free from previous cargo to move on to the next cleaning stage.

Hot washing will cause steam in the tanks and condensation on the ship's structure will assist in reducing the salt down to lower levels. However, freshwater rinsing is usually necessary as a final rinsing stage. This is accomplished by running the fresh water through the tank cleaning system. Sometimes, dedicated freshwater washing mains or lines are provided on deck for the purpose.

Some chemical cargoes (such as methanol and MEG) require the tanks to be virtually free from chlorides (a component of salt water) before loading. The chloride levels are assessed by means of wall wash testing. Fresh waters usually contain some trace amounts of salts, which may mean that they are incapable of rinsing to the required very low levels of chlorides. In which case, de-ionised (DI) water, which is chloride free, is used in the final rinsing. DI water can be provided to a ship in drum form. Alternatively, it can be produced on board, by passing the ship's fresh water through special resin filters. The DI water will usually be sprayed on the tank surfaces using a barrel pump and a handheld lance to reach all surfaces from within the tank.

Steaming with live steam (steam under pressure) can also be an effective way of rinsing out salts and odours. The resulting condensation will need to be pumped away. Live steaming should only ever be attempted in gas free tanks, as it can be a source of ignition through static generation.

18.10.6 Inert Gas

Hot water washing after flammable cargoes should always be carried out in accordance with the applicable SOLAS regulations. This will normally be either after the tank has been checked as being gas free or is properly inerted, so that the oxygen content is below 8%. In accordance with SOLAS, in tanks of less than 3,000 m^3 capacity in chemical carriers, inert gas may not be required, provided the throughput of the combined washing machines does not exceed 17.5 m^3/h and the total combined throughput from the number of machines in use in a cargo tank at any one time does not exceed 110 m^3/h (SOLAS Chapter I I-2 B Regulation 4 5.5.2.1).

After cleaning in an inert atmosphere from flammable products, and if it is required to be gas free for the next cargo, the tank should first be purged with inert gas to reduce the hydrocarbon content to 2% or less by volume. This is so that, during the subsequent gas freeing operation, no portion of the tank atmosphere is brought within the flammable range.

18.10.7 Tank Cleaning Plan

Any tank cleaning operation should be well planned and there will usually be a ship-specific tank cleaning form in the safety management system (SMS). If followed correctly, the form can be used as evidence of the nature of washing that was carried out. Those involved can therefore know at any point in the cleaning operation what point has been reached and the likely completion time. Copies of the plan should be circulated amongst all those involved in the operation so that everybody knows the sequence involved.

18.10.8 Drying and Venting

As well as being properly cleaned, cargo tanks will usually need to be presented gas free and dry for the next cargo. Drying will usually require entry into the tank for hand pumping and mopping of any water remaining after stripping, and for final wiping and checking. Tank entry should only be carried out after all the proper procedures for entry into enclosed spaces have been followed.

Figure 18.7: Removing tank cleaning residues.

Venting of tanks by mechanical means will not only remove previous cargo vapours and odours but will also help dry the tank coatings of humidity after washing. The pipes and lines should be opened, thoroughly drained and blown through as part of the tank drying process.

Tank cleaning of any sort may not be permitted alongside some oil terminals in port. Local regulations in that respect should always be followed.

18.11 Glossary of Measurement Terms

API = API gravity
Petroleum industry expression for density of petroleum liquid expressed in API units. API gravity is obtained by means of simultaneous hydrometer/temperature readings, equated to and generally expressed at 15°C (60°F). The relative density to API gravity relation is:

$$\frac{141.5}{-131.5}$$

Relative density 15°C (60°F).

Automatic sampler
A device installed for indicating the level of product from a location remote to the manual gauge site.

Barrel
Petroleum industry measurement unit equal to 42 US gallons.

Clingage
The oil that remains adhered to the inner surface and structure of a tank after it has been emptied.

Crude oil washing (COW)
The technique of washing cargo tanks of oil tankers during the discharge of crude oil cargoes, using the crude oil cargo itself.

Density
The mass per unit volume at a specified temperature used to determine weight for a volume at a standard temperature.

Dip
Depth of liquid. American expression: gauge.

Free water
Water within a container that is not entrained in the cargo.

Gauge reference height
The distance from the tank's strike point to the bench mark or reference point.

Gross observed volume (GOV)
The total volume of all petroleum liquids, including sediment and water (S&W), but excluding free water, at observed temperature and pressure.

Gross standard volume (GSV)
The total volume of all petroleum liquids and S&W, corrected by the appropriate temperature correction factor (Ct1) for the observed temperature and API gravity, relative density or density to a standard temperature such as 60°F or 15°C and also corrected by the applicable pressure correction factor.

Load on top (LOT)
The procedure of allowing hydrocarbon material recovered during tank washing to be commingled with the next cargo.

Net OBQ
Onboard quantity (OBQ) less free water in cargo, slop tanks and lines, and water in suspension in slop tanks.

Net observed volume (NOV)
The total volume of all petroleum liquids, excluding S&W, and free water at observed temperature and pressure.

Onboard quantity (OBQ)
Cargo tank quantities of any material on board a ship after deballasting immediately prior to loading. Can include oil, oil/water emulsions, water, non-liquid hydrocarbons and slops.

Remaining on board (ROB)
Cargo or residues remaining on board the ship after discharge.

Sediment and water (S&W)
Non-hydrocarbon materials that are entrained in oil. Material may include sand, clay, rust, unidentified particulates and immiscible water.

Ship's composite sample
A sample comprised of proportional portions from running samples drawn from each tank on the ship.

Ship figures
Stated volume extracted from ship's calibration tables based on measurements taken from cargo tanks.

Slop tank
A tank into which the tank washings (slops) are collected for the separation of the hydrocarbon material and water, the recovery most often becoming LOT (load on top).

Total calculated volume (TCV)
The total volume of the petroleum liquids and S&W, corrected by the appropriate temperature correction factor (Ct1) for the observed temperature and API gravity, relative density or density to a standard temperature such as 60°F or 15°C and also corrected by the applicable pressure factor and all free water measured at observed temperature and pressure (gross standard volume plus free water).

Total delivered volume (ship)
The total calculated volume less ROB.

Total observed volume (TOV)
The total measured volume of all petroleum liquids, S&W and free water at observed temperature and pressure.

Total received volume (ship)
The total calculated volume less OBQ.

Ullage (outage gauge)
Measurement of the distance from the datum point at the top of a tank to the surface of the liquid cargo.

Volume correction factor (VCF)
The coefficient of expansion for petroleum liquids at a given temperature and density. The product of the petroleum liquid volume and the volume correction factor equals the liquid volume at a standard temperature of either 60°F or 15°C.

Water (dip) gauge
a) The depth of water found above the strike point, or
b) To gauge for water.

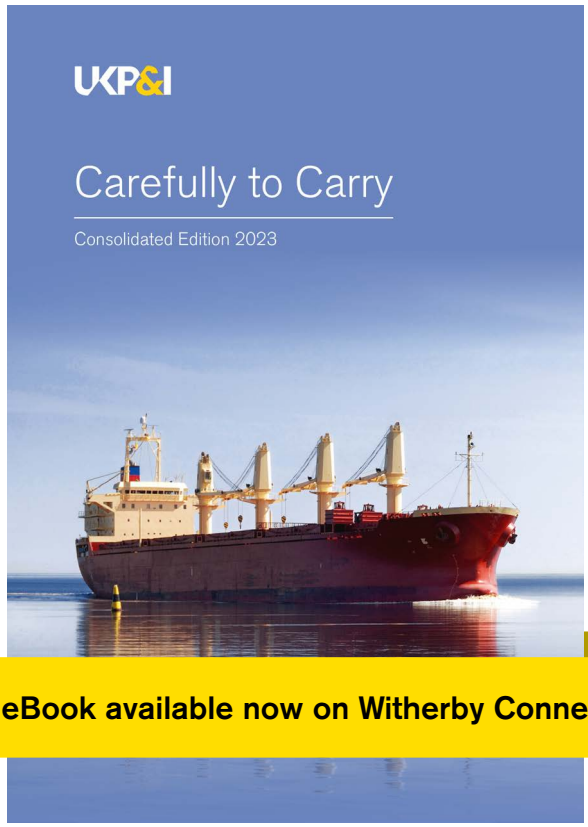
Water finding paste
A paste applied to a bob or rule to indicate the water/product interface by a change in colour at the cut.

Wedge correction
An adjustment made to the measurement of a wedge-shaped volume of oil, so as to allow for the vessel's trim.

Weight conversion factor (WCF)
A variable factor related to density for use when converting volume at standard temperature to weight.

Carefully to Carry

Consolidated Edition 2023



Full eBook available now on Witherby Connect

Price: £95

This comprehensive publication, compiled by the UK P&I Club, details best practice for the carriage, loading and storage requirements of a wide range of cargoes. It also contains essential information on draught surveys and preparing cargo plans.

Outlining and expanding on all major international cargo regulations and guidelines, it also includes detailed checklists, information on draught surveys and guides to preparing cargo plans. Cargoes covered include timber, gas, grain, steel and other metals, bulk goods and refrigerated goods.