Drying

Once a vessel is ordered to receive a cargo of LNG following overhaul or delivery trials, all traces of water must be removed from the tanks. If this is not done, operating problems due to freezing may result. The dew point of IG or air in equipment must be low enough to prevent condensation of water vapour when in contact with the cold surfaces. Purging with dry gas refrigerated driers and dosing with methanol are not uncommon techniques for removing moisture.

Inerting

Once cargo tanks and associated equipment are suitably dried, air must be removed from the cargo system before loading to prevent the formation of explosive mixtures and also to prevent product contamination. Either IG from the ship's IG generator or a nitrogen supply from shore may be used. IG from a shipboard IG generator is of a relatively low purity content in comparison with 'pure' nitrogen from a shoreside supply and usually will contain up to 15% CO_2 and 0.5% O_2. This can lead to contamination problems with cargoes, such as ammonia, butadiene, etc. To prevent explosive mixture formation, the oxygen content of the tank must be reduced to 6% for hydrocarbon gases and 12% for ammonia using IG or nitrogen.

Purging

When the cargo tanks are suitably inerted, cargo vapours may be introduced to purge the tank of inerts. If the inerts are not completely purged from the tank, then operating problems will be encountered in the reliquefaction plant operations. IG is incondensable and can therefore lead to high pressure in the plant condenser with associated difficulties. The cargo vapours are introduced either at the top or bottom of the tank depending on the density of the gas, and the vapour IG mixture is either vented through the vapour return to the shore flare stack or, where local port regulations allow, to the ship's vent stack.

Cooling of cargo tanks

When about to load liquefied gases into tanks, which are essentially at ambient temperature, it is important to avoid thermal stresses being generated in the ship's structure by incurring high temperature differences. A correct pre-cooling procedure should be adopted to make sure that the tank is brought down in temperature at a rate not exceeding 10°C/h. The most common method of achieving this is to spray cargo liquid from ashore through the tank spray line situated at the top of the tank. This procedure is continued until liquid begins to form on the tank base. Cargo vapours are formed during this cooldown and are either returned through the vapour return line to the shore facility, or, more commonly, handled by the ship's reliquefaction plant on board.

Loading

When tanks have been cooled down, loading of the cargo can commence. Liquid is taken on board via the liquid crossover and fed to each tank through the liquid loading line; this line going to the base of each tank to avoid static electricity build-up. The loading rate is determined by the rate at which the vapours can be handled. Vapours are generated by: (a) flashing of warm liquid; (b) displacement and (c) heat in leak through the tank insulation.

The vapour may be either taken ashore for shoreside reliquefaction or handled by the ship's own plant facility. During the loading operation, cargo tanks must be loaded with regard to trim and stability of the vessel at all times. Cargo tanks must be fitted with high-level alarms to prevent overfilling. Loading rates should be reduced as the cargo levels approach desired values.

Discharging

Discharging can be accomplished by several different methods depending on the equipment which is available aboard the ship:

1. *By use of a compressor alone*: this is usually only associated with small pressurized carriers. The cargo is pressurized from the tank using a compressor taking suction from another cargo tank or with a vapour supply from ashore.
2. *By compressor with booster pump on deck*: the liquid over-pressured from the tank to the suction of the booster pump.
3. *By means of deepwell pumps or submersible pumps*: these are installed in the tank.
4. *By deepwell pumps operating in series with booster pumps mounted on deck*: this is required when discharging into pressurized or semi-pressurized facilities onshore and is carried out in conjunction with a cargo heater for heating the cargo.

An important feature when discharging cargoes is to remember that the cargo is a boiling liquid and will vaporize very easily under normal conditions. When the cargo has been discharged, the vapour remaining in the cargo tank is pumped ashore using the compressor, which would be subject to the design vacuum of the tank.

Working gas cargoes

Certificate of Fitness – an International Certificate of Fitness is required to be carried by any vessel engaged in the carriage of gases in bulk. The certificate is valid for a period not exceeding five (5) years or as specified by the Certifying Authority from the date of the initial survey or the periodical survey (Figure 5.31).

This certificate should be taken to mean that the vessel complies with the provisions of the Section of the Code and is designed and constructed under the International Provisions of 1.1.5 of the Code, and with the requirements of Section 1.5 of the International Bulk Chemical Code.

Fig. 5.31 The Monrovian Gas Tanker 'Annabella' seen starboard side to the Gas Terminal in Barcelona while engaged in gas cargo operations.

The certificate can be issued or endorsed by another government on request. No extension of the 5-year period of validity will be permitted. It will cease to be valid if the ship is transferred to another flag state. A new Certificate of Fitness is issued only when the Government issuing the new certificate is fully satisfied that the ship is in compliance with the requirements of 1.5.3.1 and 1.5.3.2 of the IGC Code.

Cargo conditioning while at sea

During the loaded passage, heat inleak through the tank insulation will cause the cargo pressure and the temperature to rise. The ship's reliquefaction plant should be used to maintain the cargo within the specified limits. In the event that malfunction occurs with the reliquefaction plant, then relief valves will blow vapour off to atmosphere via the ship's vent stack.

Changing cargoes

Depending on the nature of the cargoes it is often necessary to gas free cargo tanks before changing grades.

On completion of the discharge procedure there will always be a little cargo liquid left in the tanks. It is important that this is removed before any gas freeing is attempted, 1 m^3 of liquid forms 300 m^3 of vapour (depending on the substance), and this vapour formation could greatly extend the gas-freeing operation. The residual liquid is blown from the tank by means of an over-pressure created by IG and the liquid is generally blown overside

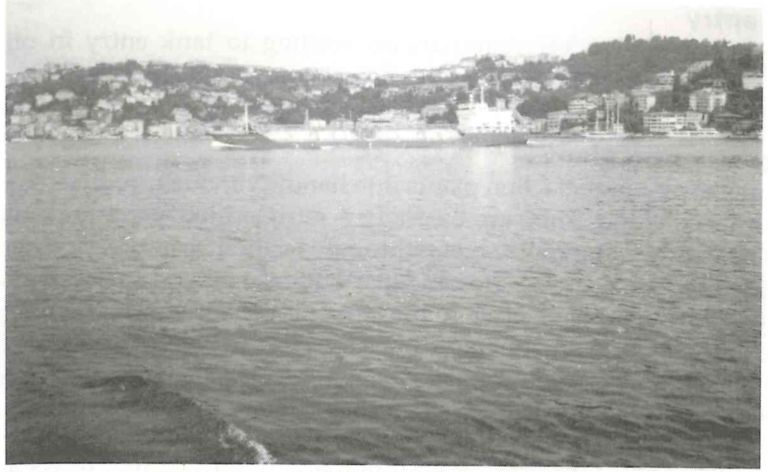
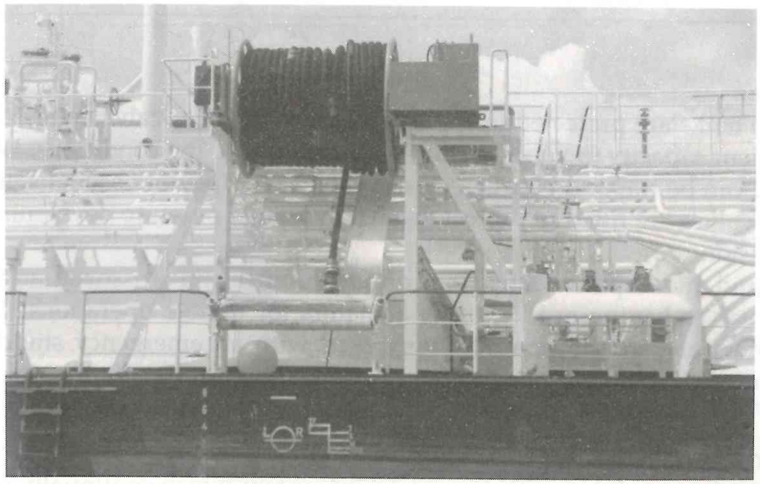


Fig. 5.32 A loaded LPG carrier, at sea, passing outward bound from the Bosporous and Black Sea Ports. Profile indicates prismatic tanks not spherical tanks.

When the tanks and pipework are known to be liquid free the cargo vapours are swept from the tank using IG or nitrogen.

> ***Note:*** *IG cannot be used when purging because of its high CO_2 content either before loading or after discharging 'ammonia' cargoes. Ammonia would react with CO_2 to form sticky white carbonates.*

The Charter's requirements regarding product purity determine the procedure to be adopted on changing cargoes. Some cargoes, such as VCM, may require visual tank inspection before they can be loaded.



Tank entry

The same general safety requirements relating to tank entry in oil and chemical carriers apply equally to gas carriers.

Reliquefaction plant

The function of reliquefaction plants is to handle vapours produced by heat inflow to the cargo. They are basically a refrigeration plant and may be direct where the vapours are taken through a vapour compression cycle or indirect where the vapours are condensed on refrigerated surfaces, such as cooling coils within or external to the tank (Figure 5.34).

The indirect cycle must be used for gases which cannot be compressed for chemical reasons, e.g. propylene.

The direct cycle can be either single stage or two stages where the cargo condenser is seawater cooled.

Cascade cycle is where the cargo condenser is refrigerated using a suitable refrigerant like Freon 22, within a separate direct expansion cycle.

Pump rooms

To reduce the risk of explosion, cargo compressors and booster pumps are sited in 'pump rooms', divided into at least two compartments with gas-tight bulkheads. The motor's driving compressors are positioned on opposite sides of the bulkheads with the connecting drive shafts fitted with bulkhead seals. Integrity of seals must be monitored and maintained at all times.

> ***Note:*** *Pump rooms are considered as 'enclosed spaces' and as such the full procedures for safe entry into enclosed spaces must be adopted by personnel, as per the CSWP. They are also equipped with emergency escape B/A (EEBA) and full emergency fire-fighting apparatus is readily available.*

Valves

Cargo tanks are protected from over-pressure by relief valves which have sufficient capacity to vent vapours produced under the conditions. Where liquid can be trapped between closed valves on pipework sections, liquid relief valves are fitted to protect against hydraulic pressure developing on expansion.

Liquid and vapour connections on tank domes and crossover are fitted with valves having quick closing actuators for remote operations. These actuators are, in addition, all interlocked with an emergency shutdown system with emergency operational buttons sited throughout the ship.

Instrumentation

Gas carriers are fitted with a gas detector system which continually moni-

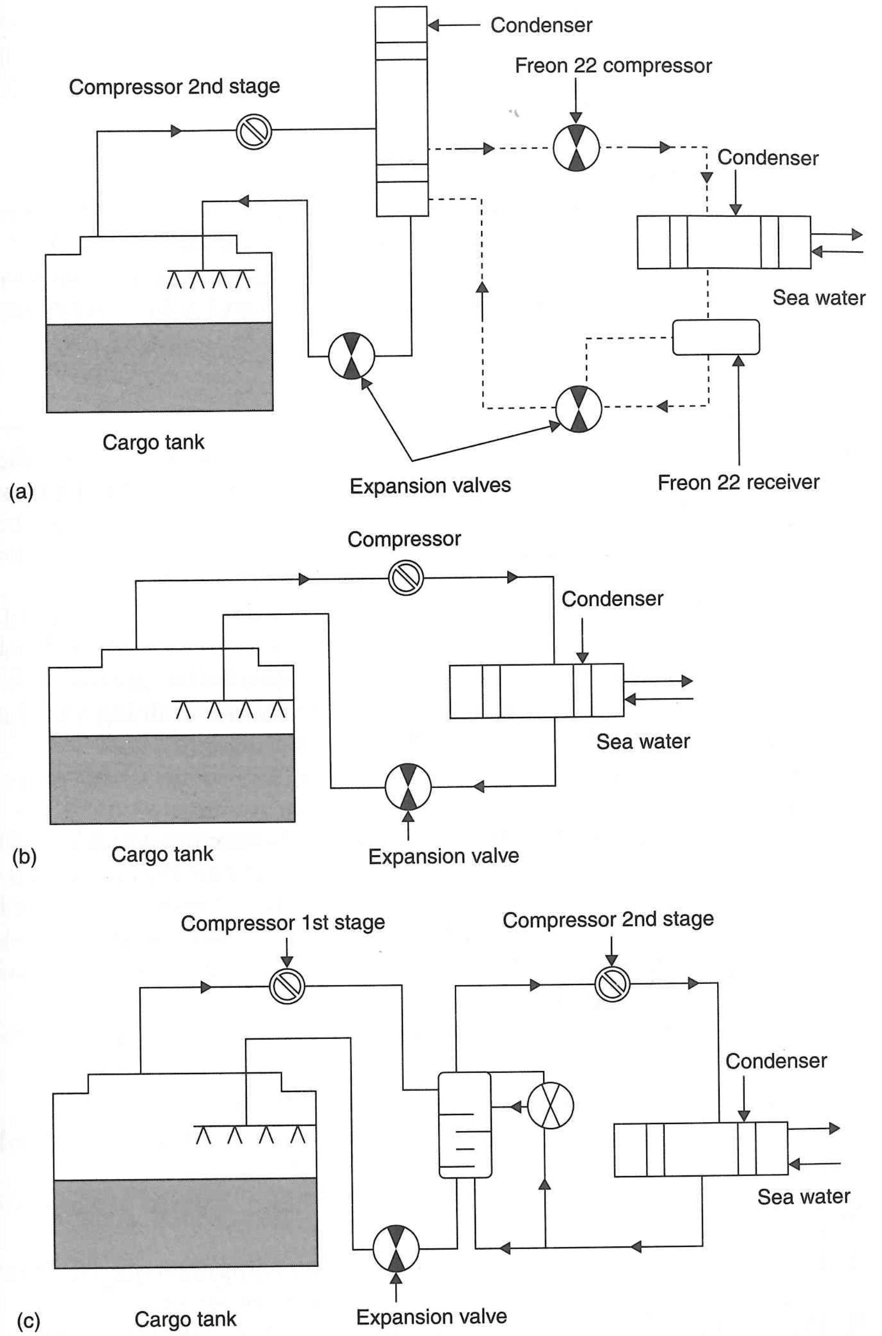


Fig. 5.34 Reliquefaction plant. (a) Direct cycle – cascade system; (b) direct cycle – single system and (c) direct cycle – two stage.

spaces, pump rooms, motor rooms and control rooms, etc. The analyser will alarm on any sampling point reaching 30% of the LEL. In addition, portable gas-detection equipment is provided as describes under oil cargoes.

Fire fighting

Under the IMO Gas Code, gas carriers must be fitted with a water spray system capable of covering such areas as tank domes, manifolds, etc.

Gas carriers must also be fitted with a fixed dry chemical powder system, actuated by IG under pressure having at least two hand-held nozzles connected to the system.

Entry into enclosed spaces

The reader should make additional reference to the Code of Safe Working Practice for Merchant Seaman (MCA publication), regarding the topic of making entry into an enclosed space. A 'Permit to Work' should also be obtained and a risk assessment completed prior to any person entering an enclosed space.

By definition, an enclosed space is one that has been closed or unventilated for some time; any space that may, because of cargo carried, containing harmful gases; any space which may be contaminated by cargo or gases leaking through a bulkhead or pipeline; any store room containing harmful materials; or any space which may be deficient of oxygen.

Examples of the above include chain lockers, pump rooms, void spaces, CO_2 rooms, cofferdams and cargo stowage compartments.

Any person intending to enter such an enclosed space must seek correct authorization from the Ship's Master or Officer-in-Charge. Entry would be permitted in accord with the conditions stipulated by a 'Permit to Work' for entry into enclosed spaces. The Senior Officer would also complete a risk assessment prior to entry taking place and all safety procedures must be monitored by an appropriate safety checklist.

A suggested line of action for permitted entry into enclosed compartments is suggested as follows:

1. Obtain correct authorization from the Ship's Chief Officer.
2. Ensure that the space to be entered has been well-ventilated and tested for oxygen content and/or toxic gases.
3. Check that ventilation arrangements are continued while persons are engaged inside the tank space.
4. Ensure that a rescue system and resuscitation equipment are available and ready for immediate use at the entrance to the space.
5. Persons entering have adequate communication equipment established and tested for contact to a stand-by man outside the enclosed space.
6. A responsible person is designated to stand by outside the space to be in constant attendance while person(s) are engaged inside the space (function of the stand-by individual is to raise the alarm in the event that difficulties are experienced by those persons entering the space).

7. Ensure that the space to be entered is adequately illuminated prior to entry and that any portable lights are intrinsically safe and of an appropriate type.
8. Regular arrangements for the testing of the atmosphere inside the space should be in place.
9. A copy of the 'Permit to Work' must be displayed at the entrance of the space to be entered.
10. Prior to entry, all operational personnel must have been briefed on withdrawal procedures from the space, in the event that such action is deemed necessary.

> ***Note:*** *When the atmosphere inside an enclosed space is known to be unsafe, entry should not be made into that space.*

Where the atmosphere in the compartment is suspect, the following additional safety precautions should be adopted with the use of 'B/A':

11. Ensure that the wearer of the B/A is fully trained in the use of the B/A.
12. Thorough checks on the B/A equipment must be made and the 'mask seal' on the face of the wearer must be a proper fit.
13. The stand-by man should monitor the times of entry and exit of all personnel to allow adequate time for leaving the enclosed space.
14. Rescue harness and lifeline must be worn.
15. If the low pressure whistle alarm is activated the wearer must leave the space immediately.
16. In the event of communication or ventilation system breakdown, persons should leave the space immediately.
17. Operational personnel should never take the mask of the B/A off when inside the space.
18. The function of the stand-by man is only to raise the alarm if necessary. He should not attempt to affect a single-handed rescue with possible consequences of escalating the incident.
19. Emergency signals and communications should be clarified and understood by all affected parties.
20. A risk assessment must be completed by the Officer-in-Charge to take account of the items covered by the safety checklist, the age and experience of the personnel involved, the prevailing weather conditions, the reliability of equipment in use, the possibility of related overlap of additional working practices ongoing, the technical expertise required to complete the task and the time factor of how long the task is expected to take.

In all cases of enclosed space entry, the use of protective clothing, suitable footwear and the need for eye protection must be considered as an essential

Chapter 6

Specialist cargoes – timber, refrigerated and livestock cargoes

Introduction

The shipping world is actively engaged in trading in virtually every commodity. Many such cargoes fall into specific categories like the container, or the Roll-on, Roll-off (Ro-Ro) trades, and are easy to collate together under a single title or group. However, when attempting to gather all cargoes under one roof so to speak, there is bound to be the odd product that falls outside the norm.

Such cargoes as timber and refrigerated (reefer) and livestock could be discussed to fill a book in their own right. However, the outline of such products falls within the scope of this text which is meant to provide the Cargo Officer with the means to make an educated judgment as to the rights and wrongs of the stowage of these cargo types.

It should be appreciated that cargo-handling methods have changed considerably over the years and the container and Ro-Ro trades have greatly affected quantities of raw products that were previously carried in open stow. No more so than in the refrigerated trades in foodstuffs and perishable goods, many of which are now shipped in refrigerated container units or freezer Ro-Ro trucks.

Timber products in the form of sawn timber in pre-slung bundles or logs can be stored above or below decks. Wood flooring, packaged or pallets may be shipped alongside wood pulp. Such is the variety of timber cargoes. The securing of timber deck cargoes, and the concern for ship security against water absorption is always of concern to a Ship's Master. Timber absorbs great quantities of water at a high deck level, while it burns off tonnes of fuel from low-situated tanks, and could dramatically affecting the ship's metacentric height (GM) and destroy the positive stability of the vessel.

Concern with the specialist cargo must be exercised at all times. It is the duty of the Deck Officer to ensure that not only is the interest of the shipper to be taken account of, but also that of the shipowner, and the well-being of the crew/passengers must be of a high consideration.

Definitions and terminology of specialized cargoes

Absorption – as associated with timber deck cargoes, an allowance made for weight of water absorbed by timber on deck which could have a detrimental affect on the ship's positive stability.

Cant – means a log which is slab-cut; i.e. ripped lengthwise so that the resulting thick pieces have two opposing, parallel flat sides and, in some cases, a third side sawn flat.

CSWP for Ships Carrying Timber Deck Cargoes (IMO 1991) – the Code of Safe Working Practice for the Carriage of Timber Deck Cargoes Aboard Ship.

Freon 12 – is a chlorofluorocarbon (CFC) used as a refrigerant in reefer ships. It is due to be phased out by the Montreal Protocol and is expected to be replaced by a gas (R134a) which has less ozone depletion potential (ODP) and a less greenhouse potential (Freon 22 has already been used in place of Freon 12).

Livestock – a term which describes all types of domestic, farm and wild animals.

Pit props – are straight, short lengths of timber of a cross-section suitable for shoring up the roof in a coal mine.

Reefer – is an expression meant to portray a refrigerated carrier.

Timber – should be taken to mean any sawn wood, or lumber, cants, logs, poles, pulpwood and all other types of timber in loose or packaged forms. The term does not include wood pulp or similar cargo.

Timber deck cargo – means a cargo of timber carried on an uncovered part of a freeboard or superstructure deck. The term does not include wood pulp or similar cargo.

Timber lashings – all lashings and securing components should possess a breaking strength of not less than 133 kN.

Timber loadline – a special loadline assigned to ships complying with certain conditions relating to their construction set out by the International Convention on Loadlines and used when the cargo complies with the stowage and securing conditions of this code.

Wood pulp – and similar substances are not included in the timber terminology as far as deck cargo regulations are concerned.

The air-dried chemical variety must be kept dry, as once it is allowed to get wet it will swell. This action could cause serious damage to the ship's structure and the compartment in which it is carried. To this end, all ventilators and air pipes should be closed off to restrict any possibility of water

Timber cargoes

Example

Timber is loaded in various forms with differing weights and methods being employed. Package timber is generally handled with rope slings while the heavier logs, depending on size, are slung with wire snotters or chain slings.

Battens – sawn timber more than 10 cm thick and approximately 15–18 cm wide. Usually shipped in standardized bundles and may be pre-slung for ease of handling.

Boards – sawn timber boards of less than 5 cm thick but may be of any width.

Cord – a volume of 128 ft^3 = 3.624 steres.

Deals – sawn timber of not less than 5 cm thick and up to about 25 cm in width. A 'Standard Deal' is a single piece of timber measuring 1.83 m $\times$ 0.08 m $\times$ 0.28 m.

Fathom – (as a timber measure) equals 216 ft^3 (6 ft $\times$ 6 ft $\times$ 6 ft).

Logs – large and heavy pieces of timber, hewn or sawn. May also be referred to as 'baulks'. Stowed above and below decks and individual logs may need to be considered as 'heavy lifts' for the safe working load (SWL) of the cargo-handling gear being used.

Pit props – short straight lengths of timber stripped of bark and used for shoring up the ceilings of mines. They are shipped in a variety of sizes.

Stack – a measure of timber equal to half a 'fathom' and equates to 108 ft^3.

Note: *The metric unit of timber measure is known as a 'Stere' and is 1 m^3 or 35.314 ft^3 or 0.2759 cords.*

Timber is generally shipped as logs, pit props or sawn packaged timber. The high SF of timber (1.39 m/tonne), generally indicates that a ship whose holds are full with forestry products will often not be down to her marks. For this reason an additional heavy cargo like ore is often booked alongside the timber cargo. Alternatively, the more common method is to split the timber cargo to positions both below and above decks.

Where timber forms part of the deck stow, some thought should be made to route planning in order to provide a good weather route. Prudent selection of a correct route could avoid prevailing bad weather and unnecessary concerns with the cargo absorbing high seawater quantities. The ship being loaded from the onset with adequate GM and sufficient positive stability could be directly affected in the event of shipping heavy seas in conjunction

Stowage and lashing of timber deck cargoes

Regulations for the stowage of timber emphasizes that timber deck cargoes should be compactly stowed and secured by a series of overall lashings of adequate strength. Where uprights are envisaged as part of the securing, these uprights should be not more than three (3) metres apart. The maximum height of the timber stow above the uppermost deck must not exceed one-third of the ship's breadth when the vessel is navigating inside a seasonal winter zone.

Additional regulations apply if and when timber loadlines are being used; i.e. when the vessel is being loaded beyond the appropriate normal marks. These regulations take account of timber being stowed solidly in wells at least to the height of the forecastle. If there is no superstructure, at the after end of the vessel, the timber must be stowed to at least the height of the forecastle. This stow must extend to at least the after end of the aftermost hatchway.

A further consideration is that the securing lashings should not be less than 19 mm close link chain (or flexible wire rope of equivalent strength). These lashings shall be independent of each other and spaced not more than three (3) metres apart. Such lashings will be fitted with slip hooks and stretching screws that must be accessible at all times. *Note*: Wire rope lashings must be fitted with a short length of long link chain to permit the length to be adjusted and regulated (Figure 6.1).

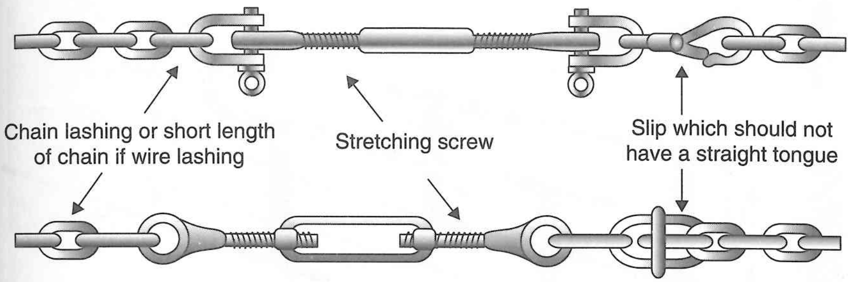


Fig. 6.1 An example of securing lashings.

Additional reference

Additional Reference should be made to Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 1991.

Lashing points

The lashings over timber cargoes are secured to eye plates attached to the sheer strake or deck stringer plate at intervals not exceeding more than 3 m bulkhead, but if there is no bulkhead, then eye plates and lashings are to be provided at 0.6 and 1.5 m from the ends of the timber deck stowage position. If the timber is in lengths of less than 3.6 m, the spacings of the lashings are to be reduced. Figures 6.2 and 6.3 indicate some of these points. Access to parts of the vessel fore and aft must be possible and when a capacity deck cargo is carried a walkway over the cargo is generally constructed.

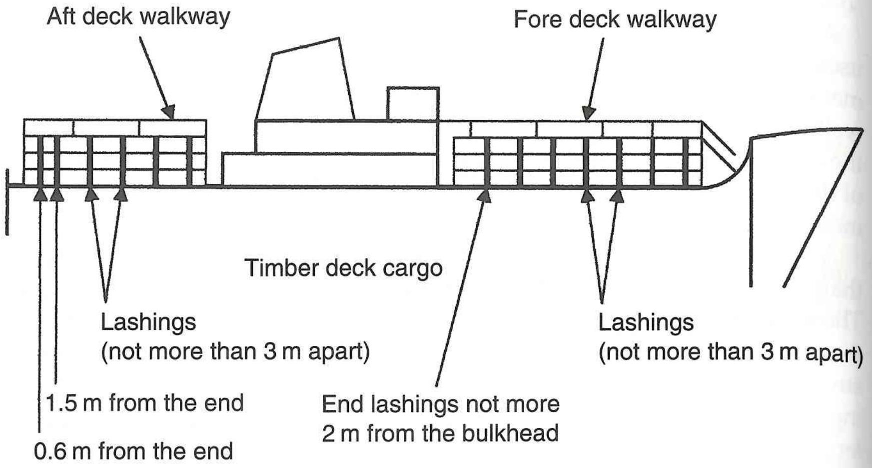


Fig. 6.2 Lashings over timber cargo deck stow.

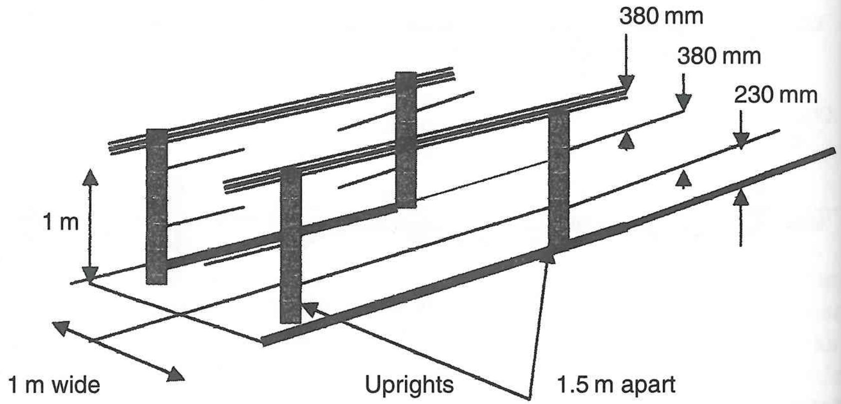


Fig. 6.3 Example walk way construction.

Stowage of logs

The Code of Safe Practice for Ships Carrying Timber Deck Cargoes (Appendix C) provides general guidelines for the underdeck stowage of logs.

Prior to loading logs below decks the compartment should be clean and hold bilges, and lighting tested. A pre-stow loading plan should be prepared

considering the length of the compartment and the various lengths of the logs to be loaded.

Recommendations are that logs should be stowed in the fore and aft direction in a compact manner. When loading, they should not be in a swinging motion and any swing should be stopped prior to lowering into the hatch. The heaviest logs should be loaded first and extreme pyramiding should be avoided as much as possible (Figure 6.5).

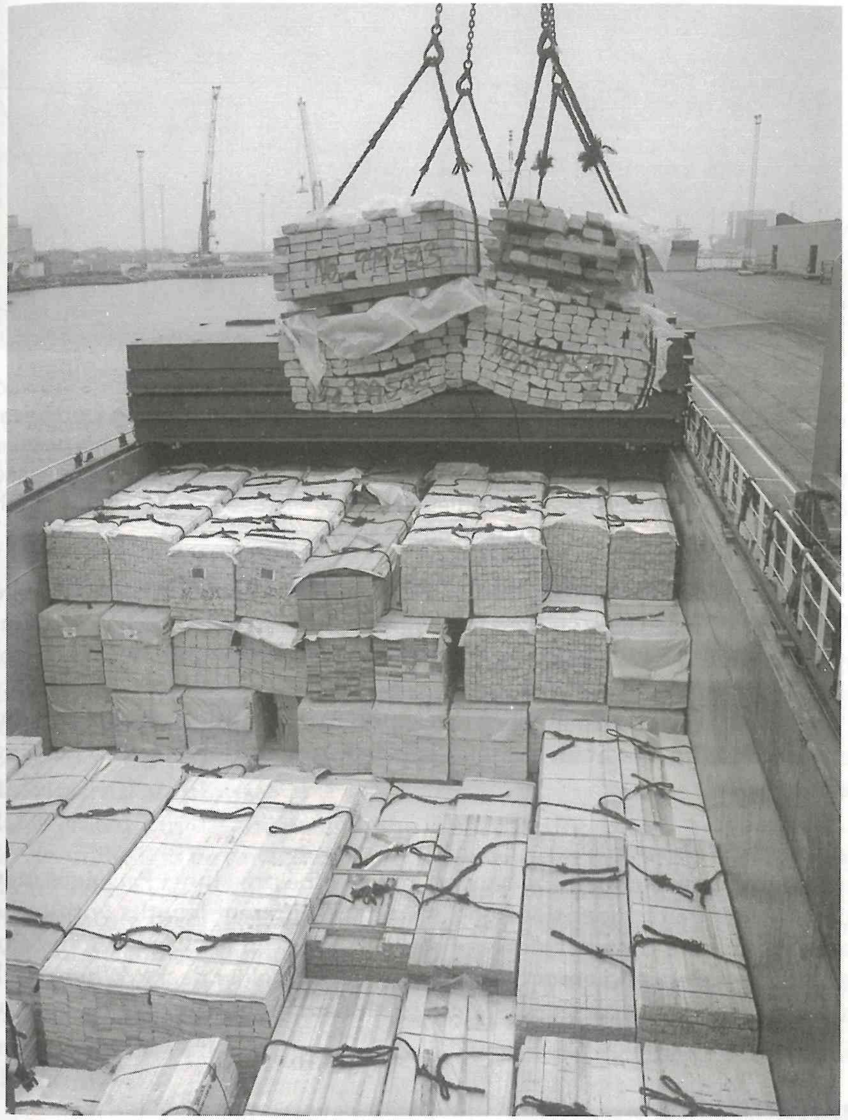


Fig. 6.4 Packaged timber being loaded onboard ship. Reproduced with kind

Fig. 6.5 Stowage and the Working of Timber Cargoes. A cargo of logs stowed underdecks in twin hatches, being discharged by multi-fold lifting purchase. Wire snotters are used to manoeuvre the logs to allow slings to be passed under, prior to discharging. Slings are often left in situ after loading to ease discharge but not always. Sawn bundles of lumber are seen stowed at the hatch side as deck cargo.

If void spaces exist at the fore and aft ends of log stows these may be filled with athwartships stowed logs. Logs loaded in between hatch coaming areas should be stowed as compact as possible to maximum capacity of the coaming space.

Logs are heavy and oscillations can expect to cause ship damage. Personnel are advised to maintain a careful watch during the loading/discharging periods.

Packaged timber

Packed timber will usually be banded and may be pre-slung. Packages may not have standard dimensions and may have different lengths within the package, making compact stowage difficult. Uneven packages should not be loaded on deck and are preferred to be loaded below decks. Where deck stowage is made the packages should be stowed in the fore and aft, lengthwise position (Figure 6.4).

Refrigerated cargoes

The increase in container and Ro-Ro trades has, to some extent, brought about the demise of the conventional 'reefer' ship (one that was dedicated

to carry refrigerated and chilled cargoes in its main cargo-carrying compartments), the compartments being constructed with insulation to act as very large giant refrigerators. Some of these vessels still operate, particularly in the 'Banana Trade', but generally the cost of handling cargoes into reefer ships has become uneconomic.

Refrigerated cargoes mainly fall into the category of foodstuffs by way of meat, dairy products, fruit, poultry, etc. as a high degree of cleanliness is expected throughout the cargo compartments. Prior to loading such products, the spaces are often surveyed and in virtually every case pre-cooling of dunnage and handling gear has to be carried out. Bilge bays must be cleaned out and sweetened, and the suctions tested to satisfaction. Brine traps should also be cleaned and refilled, brine traps serving a dual purpose by preventing cold air reaching the bilge areas and so freezing any residual water while at the same time preventing odours from the bilges reaching into cargo compartments.

Compartment insulation

All compartments are insulated for the purpose of reducing the load on the refrigeration plant and reducing heat loss from the compartment. It also provides time for engineers to instigate repairs in the event that machinery fails.

Qualities of a good insulation material are that it:

1. should not absorb moisture
2. should not harbour vermin
3. should be fire resistant
4. must be odourless
5. should be low cost and available worldwide
6. should be light for draught considerations
7. should not have excessive settling levels as this would require re-packing
8. should have strength and durability.

Examples in use include: polyurethane, plastics (PVC), aluminium foil, cork granules and glass wool.

Refrigeration plant

Refrigerated cargoes, other than those specifically carried in container or Ro-Ro units, will be carried under the operation of the ship's own refrigeration plant. Cargo Officers are expected to have a working knowledge of the hardware involved with this cooling plant, and the ramifications in the event of machinery failure.

The majority of refrigeration plants in the marine environment operate on the 'vapour compression system' (absorption refrigeration systems are generally not used in the marine environment because they need a horizontal platform).

Figure 6.6 shows a direct expansion, grid-cooling system. A refrigerant like Freon 12 ($C\ CL_2\ F_2$) in its gaseous form is compressed, then liquefied in the condenser. It is then passed through into the grid pipeline of the compartment via the regulator valve. As it passes through the pipes it expands, extracting the heat from the compartment and producing the cooling effect. Its operation is based on the principle that the boiling and condensation points of a liquid depend upon the pressure exerted on it, e.g. the boiling point of carbon dioxide (CO_2) at atmospheric pressure is about − 78°C, by increasing the pressure the temperature at which liquid CO_2 will vaporize is raised accordingly.

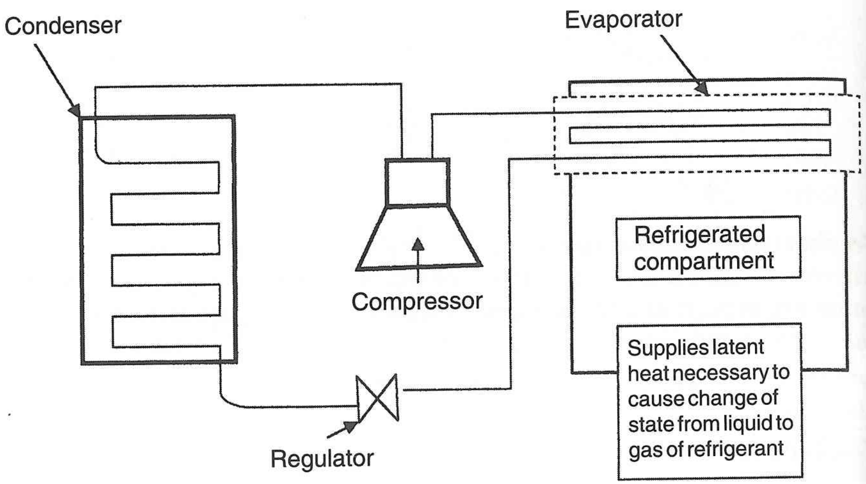


Fig. 6.6 Operation of a vapour compression refrigeration system.

In the past, many refrigerants have been employed in marine refrigeration plants including CO_2, ammonia and more recently the Freon's, but due to depletion of the ozone layer, more refined products are taking over from Freon 12.

Each refrigerant has specific qualities but the popular ones are those having least ODP and less greenhouse potential. It is non-poisonous, non-corrosive and requires only a low working pressure to vaporize and is probably the main one used in any remaining dedicated reefer vessels.

Qualities of a good refrigerant

1. A high thermal dynamic efficiency is required
2. Low cost
3. Low working pressure and low volume
4. Non-toxic, non-inflammable and not explosive
5. Easily available worldwide
6. High critical temperature
7. High value of latent heat
8. Non-corrosive

Refrigeration plant – monitoring system

In order to protect cargoes, continual monitoring of the refrigeration machinery is considered a necessity. This can be achieved by the introduction of a 'Data Logging System' to the relevant machinery and to the adjoining compartments. With such a system in operation there is less likelihood of damage because an earlier warning system would be activated giving more time to provide corrective action before valuable cargoes are effected by loss of the cooling element.

Sensors and transducers monitor the following points:

1. Temperatures of the cargo compartment
2. Temperature of the fan outlet, discharge air
3. Brine temperatures entering and leaving the evaporator
4. Compressor suction and compression discharge
5. Seawater temperature
6. External air temperature.

Feedback of the sensed parameters are transmitted to either the cargo control room, the engine control station or the navigation bridge (alarm circuits being established to 24 hour manned stations).

Principal refrigerated cargoes and respective carriage temperatures

Product	*Carriage temperature*
Meats: Frozen beef	About −10°C (15°F).
Frozen lamb/or mutton	From about −8° to −10°C (15° to 18°F).
Frozen pork	About −10°C (15°F).
Offal and sundries (includes hearts, kidneys, livers sweetbreads, tails and tongues)	Carried at as low a temperature as possible and not more than − 10°C (15°F). Usually carried in bags or cases. Any of which are blood-stained should be rejected.
Chilled beef	Loaded at about 0–2°C, and carried at about − 1.5°C (29–29.5°F), unless instructed otherwise by the shipper.
Note: Chilling meat only slows the decomposition process down and it remains in prime condition for about 30 days. This period could be extended by about 15 days if a 10% concentration of CO_2 is introduced into the compartment, assuming the compartment can be sealed and the environment is safe to permit such action.	
Poultry	Packed in cases and carried at −10°C to −12°C (10–15°F).
Dairy products	
Butter	Liable to taint and should not be stowed alongside other strong smelling cargoes in the

	same compartment, e.g. fruit. Generally packed in cartons. Carriage temperature about −10°C (15°F).
Cheese	Carriage temperature varies but generally carried at 5–7°C average. Usually stowed on double dunnage.
Shell eggs	Stored in cases and liable to taint. Normally not stowed above 10 cases high with air circulation channels on top of 50-mm dunnage. Carriage temperature 1°C (33°F).
Liquid eggs	Carried in tins at temperatures not over −10°C (15°F).
Bacon	Stow on double 50-mm dunnage, do not overstow. Carrying temperature −10°C (15°F).
Fish	Shipped in boxes or crates and should be stowed on 50-mm dunnage. Fish has a tendency to rapid deterioration, and should be carried at a low a temperature as possible, which should not exceed −12°C (10°F).

Fruits

Fresh fruits are generally carried in cardboard cartons or wood boxes, with ventilation holes. They can often be carried in non-refrigerated spaces on short haul runs Good ventilation must generally be given to prevent a concentration of CO_2 build-up. CO_2 must not be allowed to build up over 3% concentration as this would cause deterioration of the cargo. Frequent air changes are recommended to avoid this.

Apples	Carriage temperature will vary with the variety of apple but is usually in the range of −1–2°C.
Pears	Should not be stowed in the same compartment as apples. Carriage temperature −1°C to 0°C (30–32°F).
Grapes, peaches, plums	Carriage temperature −1°C to 2°C (31–35°F).
Oranges	Oranges must have adequate ventilation as they are very strong smelling and the compartment must be deodorized after carriage. Carrying temperature 2–5°C (36–41°F).
Lemons	Similar to oranges. Carrying temperature 5–7°C (41–45°F).
Grapefruits	Similar stow to oranges. Carriage at about 6°C (44°F).

Bananas	The banana trade is specialized and special ships are built for the purpose. Many of which use containers. The carriage temperature is critical as too low a temperature can permanently arrest the ripening process. Daily inspection of a compartment would be carried out and any fruit found to be ripe is removed. One ripe banana in a compartment can cause an acceleration of the ripening process throughout the compartment. Carriage temperature usually about 12°C (52–54°F).

The 'reefer' trade

It should be realized that many of the said cargoes are now shipped by refrigerated containers or Ro-Ro cold units. Some companies still operate designated refrigeration vessels like those employed by 'Lauritzen Cool' engaged on the New Zealand to the US West Coast meat service.

Other specialized parcels, like some drugs, often require refrigerated stowage and the instructions as to the carriage temperature would be issued by the shipper.

Prior to loading any refrigerated cargoes it is normal practice for a surveyor to inspect the compartment for cleanliness and to ensure that the compartment temperatures are correct. Dunnage and any cargo fitments would be pre-cooled and machinery would be tested to satisfaction. Cooled gas and chemical cargoes are referred to in Chapter 5.

Refrigerated container units

Lloyds Register have developed 'Rules for the Carriage of Refrigerated Containers in Holds'. These standards take account of the problem of heat emanating from an on-line refrigeration plant operating below decks in the cargo hold. The heat energy rejected by each unit is from the evaporator fans, the motor and the condenser. Concern for this rejected heat energy into the surrounding air of the hold is currently considered a problem that may or may not be resolved by improved ventilation methods.

The container sector of the industry is exploring ways to carry increased numbers of reefer units below decks. However, such increase would generate increased temperatures into the cargo space areas. An effective ventilation system would probably aim to retain the hold temperature as close as possible to the outside air temperature or a predetermined temperature to suit the internal hold environment.

The majority of refrigerated containers employ insulation, usually polyurethane, within the prefabricated construction of the container. This directly affects the heat transmitted through the insulated unit between the carriage temperature and the external ambient air temperature. Although the insulation will reduce the actual payload capacity of the unit, it is seen as a necessary trade off.

Example

Carriage temperatures for a 40-ft container:

Bananas	13.0°C
Chilled apples	2.0°C
Frozen	−18.0°C
Deep frozen	−29.0°C

Various ventilation systems operate throughout the industry. The one illustrated in Figure 6.7 is a semi-sealed louvred exhaust duct system. A vertical ducting fitted with an air supply fan delivers supply air to each stack of containers, specifically to each container condenser. The exhaust system operates in a similar manner, with the exception that the fan is an extraction fan as opposed to a supply fan. Isolation valves or flaps could be fitted to isolate 'cells' when not in use, each cell having its own inlet and outlet ducting (at time of writing modelled format only).

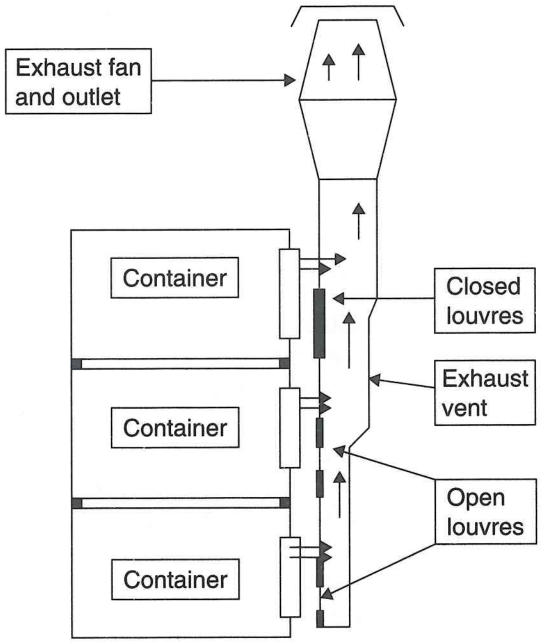


Fig. 6.7 Refrigerated Container – Hold Ventilation System.

The carriage of livestock

The carriage of animals, either domestic, farm or from the wild, is not an uncommon practice. The carriage is governed by the regulations laid down by the Ministry of Agriculture and Fisheries. Further advice can also be obtained from various animal protection societies who give advice on cage size, crates, etc. for use with animals.

Where large numbers of animals are to be carried – like sheep or cattle – designated livestock carriers are available. The ships tend to discharge the beasts directly into penned, quarantine areas. While in transit the animals are kept in pens or stalls which are protected from adverse weather and the sun.

Adequate straw and fodder would also be carried. The feeding and watering of animals would be to the shipper's instructions. It is not unusual for a shipper to send a supervisory attendant where large numbers of animals are carried or where specialist animals like valuable race horses are carried. If no attendant is carried, members of the crew would be designated to take care of the animals during the passage, cleaning stalls and feeding, etc.

Where one or two animals are carried by a non-designated vessel, they are usually carried in horse box-type stalls, or in caged kennels. These are generally kept on a sheltered area of the upper deck away from the prevailing weather. Each animal would be tallied and allotted a carriage number. In the event of the animal dying on passage, this number must be recorded. All vessels carrying livestock must carry a 'humane killer' with enough ammunition to be considered adequate.

Where a regular livestock trade is featured, like Australia/Middle East regions, shore facilities for loading and discharging are regularly inspected by the country's authorities. Ministry officials also inspect the cleanliness and the facilities aboard designated livestock carriers.

Documentation inclusive of veterinary certificates is usually shipped with the animal(s) together with routine welfare instructions. When landed, documentation is usually landed at the same time being handed to the shipper's representative or quarantine officials.

Chapter 7

Roll-on, Roll-off operations

Introduction

Some time after the start of containerization came a cargo revolution in the door-to-door service of Roll-on, Roll-off (Ro-Ro) handling procedures. The Ro-Ro traffic provided a shuttle service for containers as well as cutting delivery times to hours rather than weeks, previously experienced with conventional shipping. The Ro-Ro explosion was so great that ports changed their operations and ship design started to incorporate new concepts, to handle large vehicles.

The coastal traffic saw a new lease in life which opened up numerous avenues, in employment, cargo-handling methods, service industries and manufacturing. Ferry companies increased their tonnage maximums in a comparative blink of an eye. Port exports climbed beyond previous records, with Ro-Ro activity being the main cause. Ro-Ro was an efficient and cheap method of shipping merchandise which was quickly realized and expanded rapidly beyond anyone's wildest expectations.

The ship's new design included the stern door/ramp, open vehicle deck spaces, drive through capability with the bow visor. Vehicle lifts became a feature with open and enclosed deck cargo spaces. Units could be carrying liquid or dry cargoes, they could be refrigerated or not, as their load required. However, the most important fact was that they could be delivered in the shortest period of time.

The time factor was critical to ensure that goods reached markets in a pristine condition. Especially relevant to fresh produce like flowers, fruits, dairy foods, meats, etc. The ships were enhanced to ensure that deadlines were achieved. Ships docking in and out carrying such cargoes could not be delayed by the need for tugs. Bow/stern thrusters became essential features of ship design. Thruster units came alongside twin Controllable Pitch Propellers, while Masters were given Pilotage Exemption Certificates. Not only were the vessels fast, but also the procedures and concepts of ship handling had been changed to meet the needs of the trade.

The Ro-Ro trade has now become an essential segment of the shipping industry. Although it might be seen as the new boy on the block, it is already alongside the tanker traffic, the cruise trade and greatly attached to

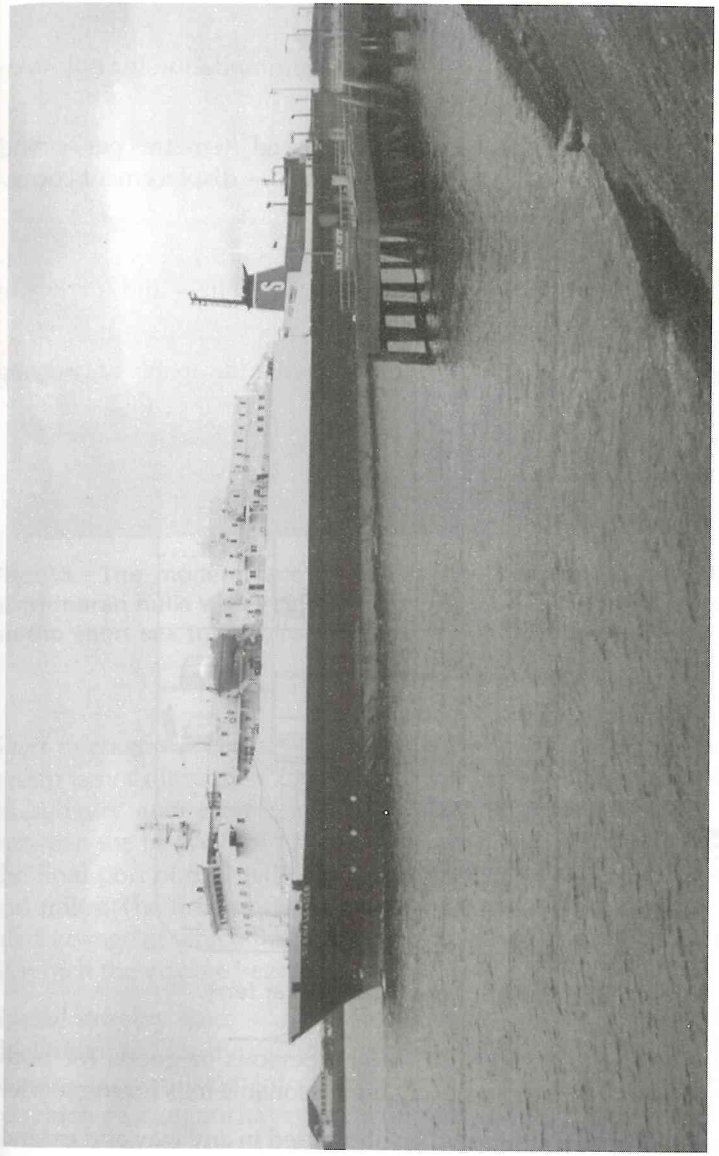


Fig. 7.1 Ro-Ro shipping. A typical Ro-Ro ferry the 'Stena Leader' (previously European Leader and ex-Buffalo, P&O Ferries) departs the Port of Fleetwood for her regular twice-daily voyage to Ireland. The vessel carries about 140 mobile units (40-ft container size) on three vehicle decks. The ship also accommodates a limited number of unit drivers.

the container business. The sector ships everything that was once shipped by general cargo vessels. These cargoes include hazardous goods, as well as heavy-lift units. The main difference is that such items are controlled by separate legislation and generally move with less bureaucracy (Figure 7.1).

Ro-Ro definitions and terminology

Freight only Ro-Ro ship – a Ro-Ro vessel with accommodation for not more than 12 (driver) passengers.

High-speed craft – a craft capable of a maximum speed, in metres per second (m/s). Equal to or exceeding $3.7V \times 0.1667$ where V = displacement corresponding to the design waterline (m^3).

Passenger car ferry – a passenger or ferry ship which has Ro-Ro access of sufficient dimensions to allow the carriage of Ro-Ro Trailers and/or Ro-Ro Passenger (Ro-Pax)/Ro-Ro Cars (Figure 7.2).

Reefer unit – a mobile/vehicle Ro-Ro unit, designed and capable of carrying refrigerated cargoes.

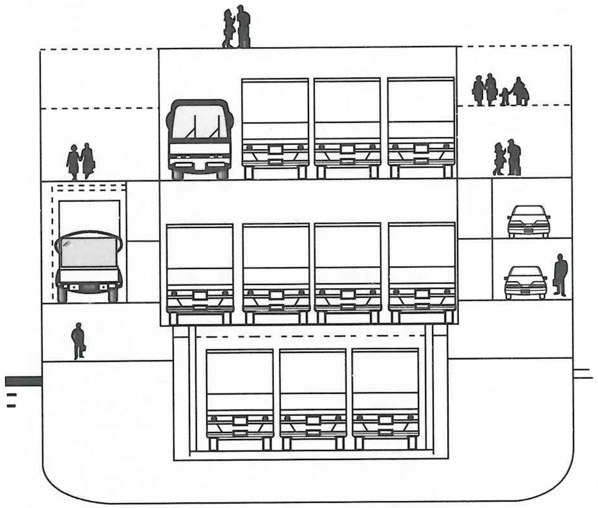


Fig. 7.2 Diagram of passenger car ferry.

Right of ferry – an exclusive right to convey persons or goods (or both) across a river or arm of the sea and to charge reasonable tolls for the service.

Ro-Ro cargo space – a space not normally subdivided in any way and extending to either a substantial length or the entire length of the vessel in which goods are carried (packaged or in bulk), in or on rail or road cars, vehicles (including road or rail tankers), trailers, containers, pallets demountable tanks in or on similar stowage units or other receptacles, can be loaded and unloaded normally in a horizontal direction.

Roll-on Roll-off vessel – a vessel which is provided with horizontal means of access and discharge for wheeled, tracked or mobile cargo (Figure 7.3).

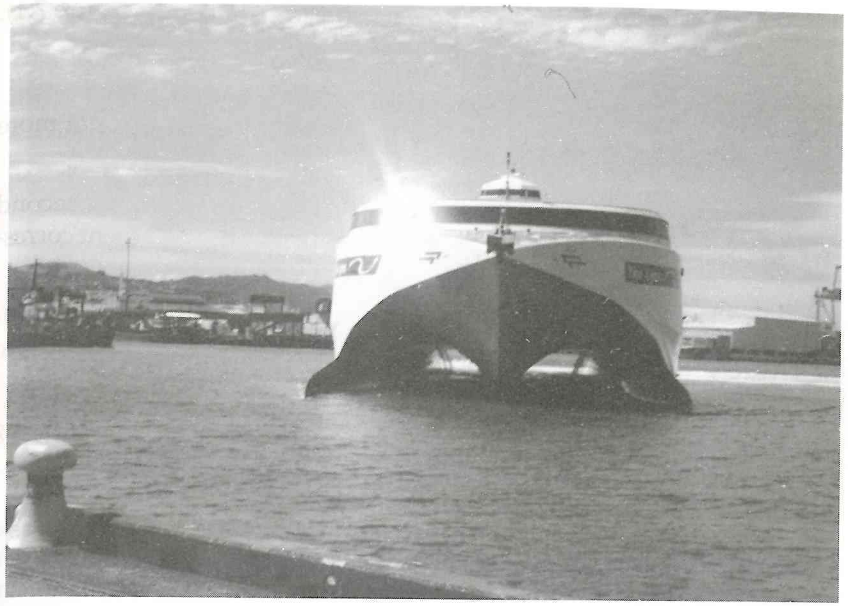


Fig. 7.3 The modern face of Ro-Pax type vessels. High-speed catamaran or tri-maran hulls with vehicle access from a stern ramp. Generally engaged on the short sea trades around the world, operating at service speeds up to 45 knots.

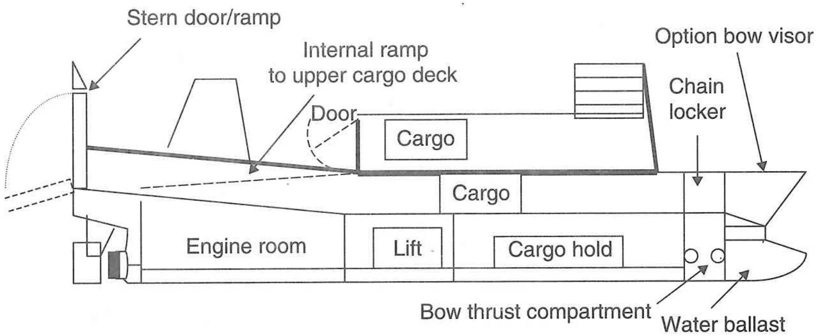
Short international voyage – an international voyage in the course of which a ship is not more than 200 nautical miles from the port or place in which passengers and crew could be placed in safety. Neither the distance between the last port of call in the country in which the voyage begins and the final port of destination, nor the return voyage, shall exceed 600 nautical miles. The final port of destination is the last port of call in the scheduled voyage at which the ship commences its return voyage to the country at which the voyage began.

Special category space – any enclosed space, above or below the bulkhead deck intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion, into and from which such vehicles can be driven and to which passengers have access (Figures 7.4–7.7).

Vehicle ramps

The design of Ro-Ro vessels is influenced from the onset of the design stage by the nature of the payload it is intended to transport. Generally, the cargo flow, securing and handling equipment can amount to about 5% of the lightweight

Fig. 7.4 Modern Ro-Ro (freight only) vessel. The 'ΜΥΚΟΝΟΣ' a modern Greek operated Ro-Ro vehicle ferry. Design features include all accommodation forward, with twin Port and Starboard smoke stacks seen aft either side of the upper vehicle deck. The stern door/combined vehicle ramp is positioned right aft in the upright closed position while the vessel is at sea.



- Open deck stowage of Ro-Ro cargo either side of the engine room smoke stack.
- Chain locker at the ships sides either side of the fore and aft line to facilitate the operation of separate Port and Starboard windlass operations.
- Bow visor option to permit drive through capability and is not always featured.
- Lift to lower cargo hold may be mechanical or of hydraulic operation.
- All cargo ramps are fitted with wheel tread, anti-skid, steel grips.
- All cargo decks are fitted with insert star lashing points and/or star domes.
- Accommodation for twelve (12) driver/passengers.

Fig. 7.5 General arrangement – modern Ro-Ro ferry (freight only) 1900-m

Fig. 7.6 Ro-Ro ferry example. Stern door/ramp access into the enclosed vehicle deck of a Ro-Pax ferry operating in the Mediterranean Sea.

Fig. 7.7 The bow visor of the passenger vessel 'Jupiter' (since renamed) seen in the open position against the skyline. The bow visor fitted with a stern ramp

tonnage. However, to avoid operational problems in the future such fittings need to take account of the types of rolling cargo which is anticipated. Commercial vehicles are limited to about six types (unlike military vehicles) and these need to be accommodated by respective access widths, ramp slopes, clearing heights, lane lengths, turning areas or drive through facilities.

Similarly, shoreside receptions must be compatible with a ship's facilities. Ramp slopes and break angles, for commercial traffic, will generally fall at about 1:8 or 1:10 in order to avoid the vehicle grounding while in transit from the ship to the shore. Where tidal waters are present and average rise or fall is expected, floating shore links or adjustable link spans tend to overcome excessive tidal movement, while at the same time keeping the break angle with the ship's ramp manageable (Figure 7.8).

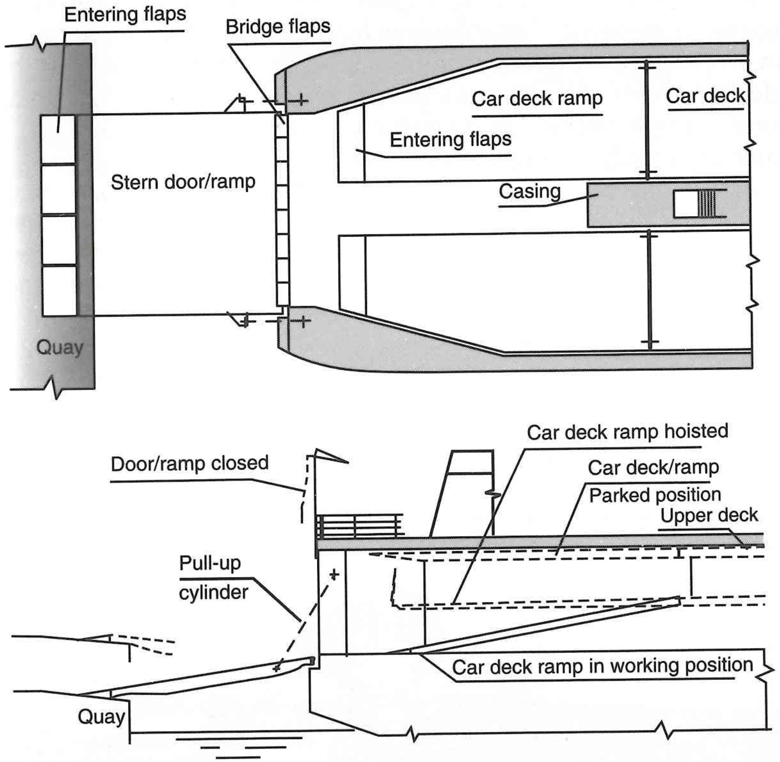


Fig. 7.8 Example stern door and vehicle ramp arrangement.

The design of equipment will be to the requirements of Lloyds Register or similar Classification Society, but would include specific features to satisfy operational needs. In order to match these needs and provide a suitable end product, a designer would include the following features:

1. Length of ramp (overall)

3. Total load on ramp (anticipated maximum)
4. Maximum axle loads
5. Hinging arrangement (top, bottom or guillotine)
6. Number of ramp sections and hinges within the structure
7. Maximum/minimum operating angles
8. Watertight sealing/securing arrangements
9. Cleating/locking arrangements
10. Power requirements (electric, hydraulic) with limitations
11. Operational lifting/lowering times
12. Supporting and preventor arrangements
13. Roadway landing area.

Many stern ramp arrangements open up all the transom to provide maximum width and height clearance. This effectively gives wide access to a variety of vehicles of differing lengths with comparative short load/discharge times involved. Other designs have employed stern quarter ramps (with or without bow quarter ramps). Such ramps are still required to meet the design criteria of the Classification Society but must also satisfy design features to meet specific vehicle traffic like 'car carriers' (Figure 7.9).

Ramps tend to be manufactured in steel with 'Chevron Pattern' anti-skid bars on the working surface. They are usually operated by twin hydraulic

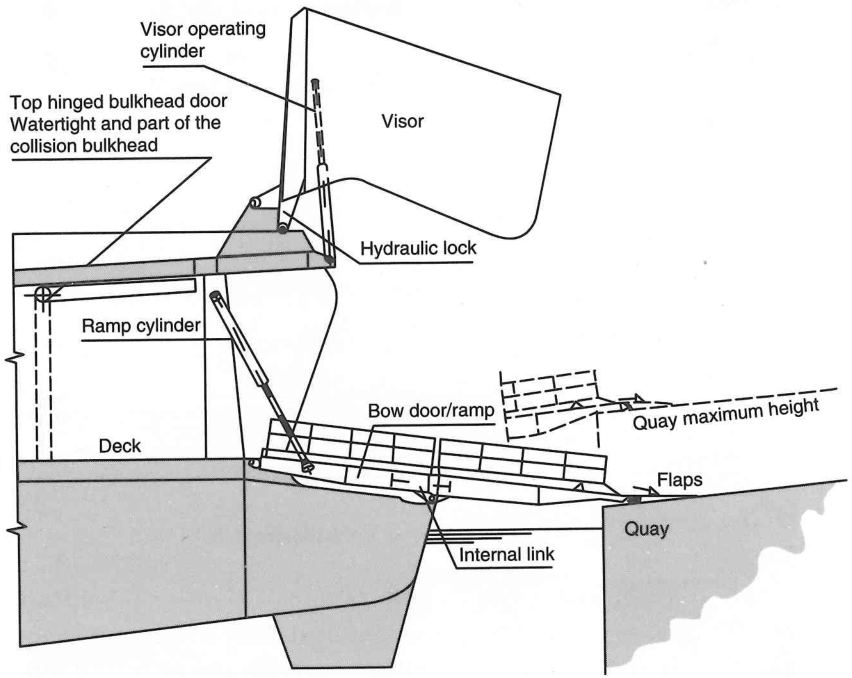


Fig. 7.9 Bow visor with combination inner bow door and vehicle ramp arrangement.

cylinder actions or winch arrangement. Watertight integrity is achieved with hydraulic pressure cleating in conjunction with a hard rubber seal, with the hinge arrangement being positioned above the waterline (Figures 7.10 and 7.11).

Fig. 7.10 Stern door of a Ro-Pax ferry seen in the stowed, closed position as she turns off the berth in the harbour at Tangier.

Fig. 7.11 The Ro-Pax ferry 'Sanasa' of the Comarit Ferry Group enters Tangier harbour. The vessel is fitted with a bow visor and stern/ramp door.

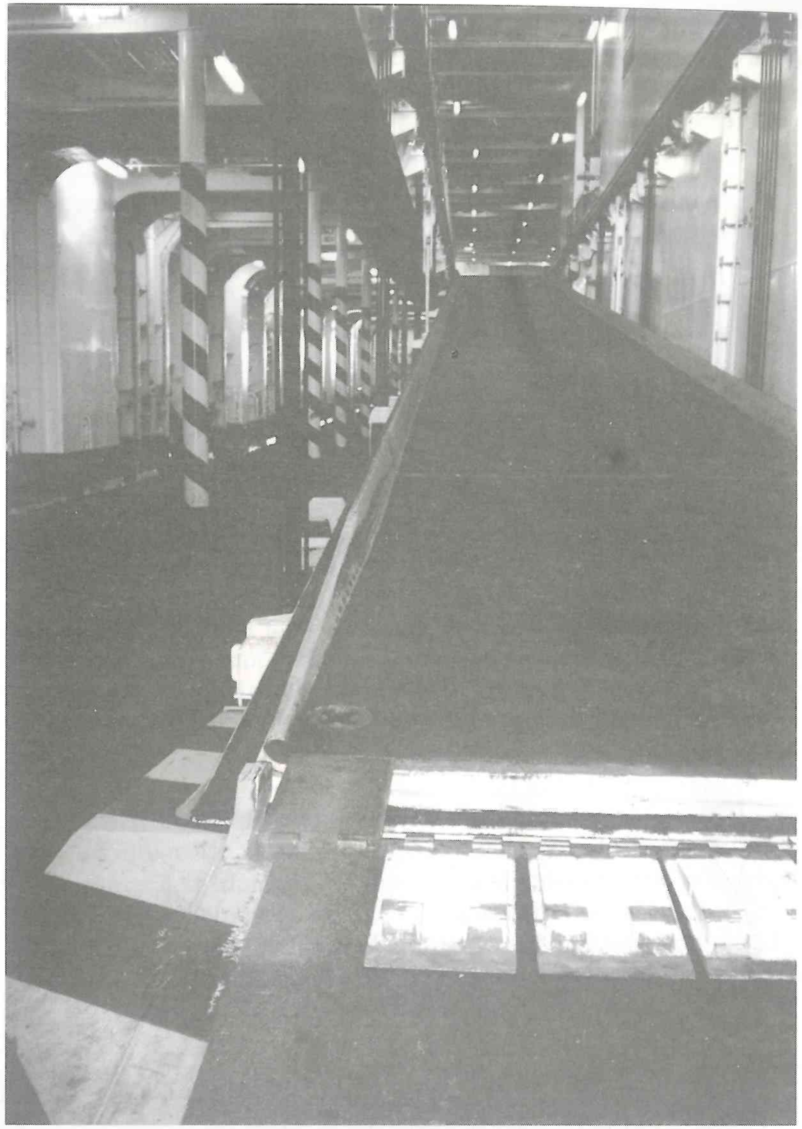


Fig. 7.12 An internal ramp that can tilt both forward and aft to suit stern load and/or bow discharge. It allows loading to a higher deck level 'three' where the lower hold level would be termed 'No. 1 Deck Level' and 'No. 2 Deck Level' would be considered as the main, largest of the three vehicle decks.

Internal ramps and elevators

The current generation of Ro-Ro vessels have moved into multi-deck construction with a totally enclosed main vehicle deck with access from either a stern ramp or bow door arrangement. This deck is often fitted with elevator access to a lower hold while an internal ramp to a partially covered upper vehicle deck, which permits access to the higher, uppermost continuous deck (Figures 7.13 and 7.14).

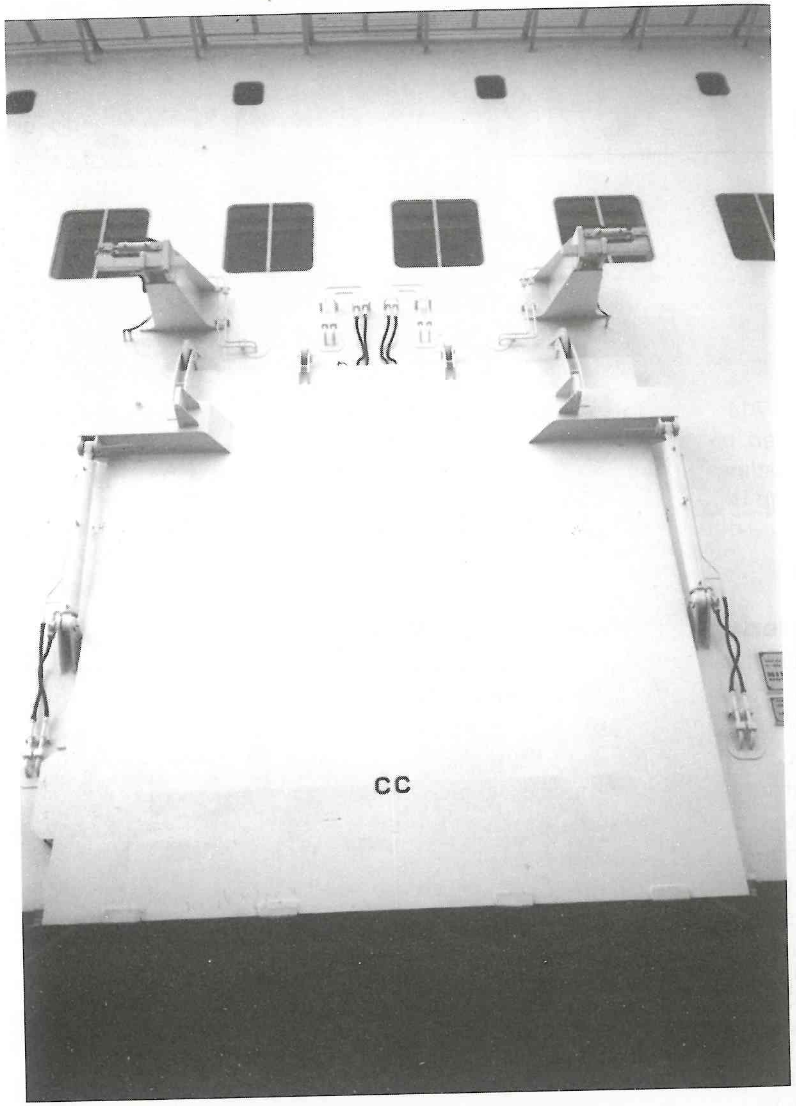


Fig. 7.13 Cargo doors. Upper deck hydraulic cargo door set in the bridge front and leading to an enclosed upper vehicle deck aboard a modern Ro-Pax ferry. Weather sealing of the door takes place against hard rubber seals with hydraulic cleating and positive pressure held on operational rams. When in the open position the door is locked with hydraulic securings and rams are fitted with

Fig. 7.14 Example vehicle deck of the enclosed cargo compartment of a high-speed passenger vehicle ferry operating in the Irish Sea region of the UK coastline. Steel pillars support aluminium upper decks and the internal, angled ramp is seen at the upper right-hand side of the view. The deck structures are manufactured in unpainted aluminium to save increased weight.

Internal cargo operations – Ro-Ro vessels

Vehicles require wide open deck space to be able to manoeuvre. Such deck areas are lane marked to ease vehicle stowage and alignment of mixed types of vehicles, e.g. private cars and commercial trucks. The deck areas are always well-illuminated by overhead lighting and fitted with extraction fans to change the air volume 10 times every hour. Such atmosphere replenishment prevents the build of exhaust gases from drive-on, drive-off operations.

Cargo vehicle decks are protected by sprinkler and/or water-drenching systems and well provided for with fire extinguishers at every 40 m length. Such protection dictates that the decks must also be fitted with an adequate drainage system to clear residual waters quickly (Figure 7.15).

Vessels without 'bow visor' facilities are generally denied drive through capabilities and usually must provide sufficient deck space to permit the turning of wagons ready for stern discharge at the arrival port. Vehicle decks have always been considered as a hazardous environment for both shore and shipboard personnel, especially where vehicles are turning. To this end speed of vehicles is strictly controlled by stowage marshals who usher units into designated lane spaces. With this in mind deck spaces are clearly sign painted to reflect basic instructions to driver personnel and car/passenger travellers (Figure 7.15).

Fig. 7.15 Typical bulkhead markings prominently displayed around vehicle decks to ensure safe and efficient loading of vehicle lanes.

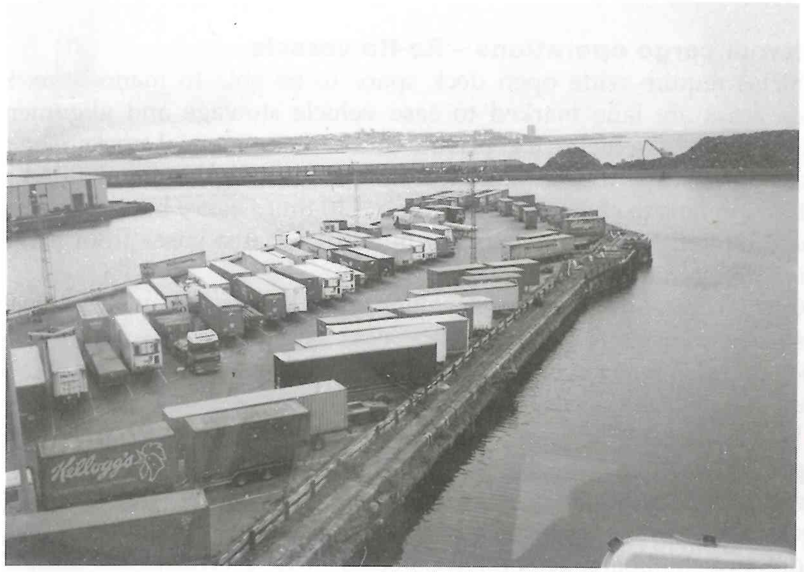


Fig. 7.16 Ro-Ro traffic trailer units, parked on the dock side at Liverpool ready for loading on to P&O, Irish sea ferries. Trailer units being lifted by mechanical 'tugs' and deposited on the vehicle decks of short sea ferries then similar 'tugs' attach to discharge the unit at the destination port.

Ventilation system

It is a requirement that Ro-Pax vessels carrying more than 36 passengers must be provided with a powered ventilation system (fans) sufficient to give 10 air changes per hour in spaces designated to carry vehicles (with fuel in their tanks for their own propulsion). If the vessel carries less than 36 passengers then the venting system need only provide six air changes per hour.

Ventilation ducting serving such spaces should be constructed in steel, and the system should be completely separate from other ventilation systems aboard the vessel. It must be capable of being controlled from outside the vehicle spaces and be operable at all times when vehicles are occupying the specific areas.

> ***Note:*** *Where special category spaces are employed, the administration may require an additional number of air changes when vehicles are being loaded or discharged.*

Ventilation systems must be fitted with rapid means of shut down, in the event of fire occurring. They must also have a means of monitoring any loss or reduction in the venting capacity with such data being indicated on the 'navigation bridge'.

Drainage systems

The hazards of slack water on large vehicle decks and the subsequent loss of stability which could occur are well known. The fixed pressure water spraying system, installed for fire prevention, if operated, could cause an accumulation of water on vehicle deck or decks. To ensure adequate stability at all times a suitable drainage system must be installed to effect rapid discharge of slack water.

Scuppers should be fitted to ensure discharge directly overboard. Special category spaces situated above the bulkhead deck, and in all Ro-Pax vessels which have positive means of closing scuppers by valve action, must keep such valves open while the vessel is at sea in accord with the 'loadline convention'.

In the case of special category spaces, the administration may require additional bilge pumping and drainage facilities over and above the specifications of Safety of Life at Sea (SOLAS), Regulation II-1/21.

Bilge pumping arrangements

Cargo ships and passenger vessels are required to have in place an efficient bilge pumping system, capable of pumping from and draining any watertight compartment. Passenger Ships are required to have at least three (3)

Cargo (vehicle) definitions

A vehicle – defined as a vehicle with wheels or a track laying vehicle.

A flat-bed trailer – defined as a flat-topped open-sided trailer or semi-trailer and includes a roll trailer and a draw-bar trailer.

Freight vehicle – defined as a vehicle which is a goods vehicle (flat-bed trailer) (road train) (articulated road train) combination of freight vehicles or a tank vehicle.

A semi-trailer – defined as a trailer which is designed to be coupled to a semi-trailer towing vehicle and to impose a substantial part of its total weight on the towing vehicle.

A tank vehicle – defined as a vehicle fitted with a tank which is rigidly and permanently attached to the vehicle during all normal operations of loading, discharging and transport and is neither filled nor discharged on board and driven on board by its own wheels.

Reefer unit – container box unit fitted with refrigeration plant. Employed to transport frozen/chilled produce by road and sea. Power for the freezer unit is generated by the drive motor of the unit when on the road and supplied from the ship's supply while the vessel is at sea. (Special stowage space is required for reefer units to ensure that they are positioned aboard the ferry close to a power supply connection.)

Fig. 7.17 Long load (sail for wind turbine) is loaded on adjustable stretch load trailer unit.

Ro-Ro vehicle types

The majority of freight vehicles engaged in Ro-Ro vessels vary in size and

most widely used is the drop trailer vans (40-ft container box/van stowed on a horse or trestle and the rear wheels of the unit). Other varieties include:

Curtain-sided trailers
Semi-trailer without sideboards (drop sides)
Semi-trailer with sideboards
Semi-trailer with sideboards and hood cover
Fully enclosed goods vehicle
Open flat-top truck
Flat-top truck with canvas-covered load
Articulated trailer
Road tanker
Framed container/tank
Freight container (20 × 8 × 8)
Freight container (400 × 8 × 8)
Draw-bar combination (two units)
Draw-bar combination (three units)
Refrigerated (reefer) vans
Low loaders (for heavy machinery/plant)
Adjustable (stretch) low loader (for exceptional long loads) (Figure 7.17).

Additional private vehicles such as coaches, furniture removal vans, buses, caravans, boats on trailers, military transports, etc. are also regularly shipped. Freight units of one kind or another, once discharged, may be reloaded but not in every case. Many units are often returned by the same ferry or a sister vessel in an empty state (Figures 7.18 and 7.19).

Fig. 7.18 Ro-Ro, unit types. Several Ro-Ro units on the quayside in Cadiz, Spain. From left to right: a flat-top trailer unit, a 40-ft container carrier, with two articulated container carriers on the end. A mobile tank container trailer unit is seen in the background.

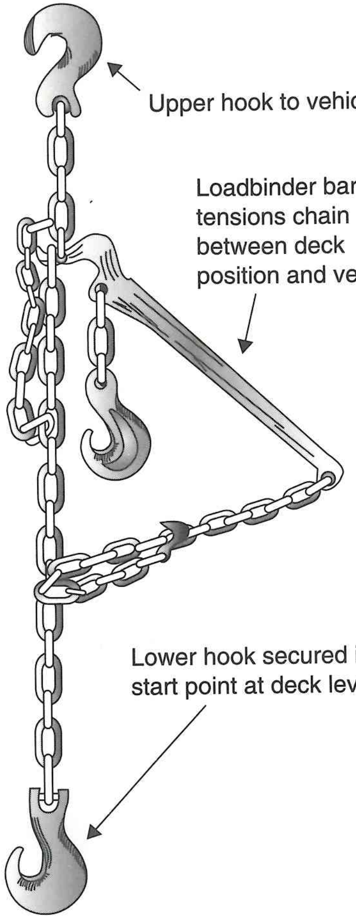


Fig. 7.19 Example of a chain lashing.

Vehicle stowage and securing

It is essential with vessels-carrying vehicles that a stable deck is maintained and this is why virtually all Ro-Ro ferries are now built with stabilizers of one form or another. However, cargo movement can still expect to occur in very rough sea conditions even when stabilization systems are operational. To this end individual vehicles are secured by various means to prevent movement at sea.

The stowage/securing arrangements of units should be supervised by a responsible Ship's Officer assisted by at least one other competent person. Vehicles should, as far as possible, be aligned fore and aft, with sufficient distance between vehicles so as to allow access through the vehicle deck. The parking brake on each vehicle/unit should be applied and where possible the unit should be placed in 'gear'. Where drop loads or uncoupled units are being carried these should be landed on trestles or equivalent support, prior to being secured by chain or other suitable securing constraint (Figure 7.21).

All vehicle/cargo units should be secured prior to the vessel leaving the berth and such securings should be at the master's discretion to be most effective. While on route these lashings should be regularly inspected to ensure they remain effective during the time at sea. It should also be realized that personnel so engaged on vehicle deck inspections should take extreme caution against injury from swaying vehicles. As such, Masters may feel it appropriate to alter the ship's course while such inspections are ongoing to reduce the motion on the vehicle deck.

Vehicles stowed on slanting decks should have the wheels 'chocked' and the hand brakes observed to be on and working. Suitable lashings against the incline should be secured and the unit left in an opposing gear. Any vehicle which is lashed should be secured at the correct securing points so designed on the vehicle and at the deck position.

All lashings applied whether of a 'hook' type or other variety should be secured in such a manner that in the event of them becoming slack, they are prevented from becoming detached. They should also be of a type which will permit tensioning in the event of them becoming slack during the voyage.

Note: *Lashings are considered to be most effective at between 30° and 60° to the deck line. Alternatively, additional lashings may be required. Crossed lashing should, where practical, not be used, as limited restraint against 'tipping' is experienced with this style of securing.*

Lashings should only be released once the ship is secured at the berth and personnel so engaged should take care when clearing securings. These may be under high tension following transit and cause injury if released without forethought.

Note: *Cargo units must be loaded, stowed and secured in accord with the Ship's* Cargo Securing Manual, *as approved by the Authority. (This Cargo Securing Manual is required to be carried aboard all types of ships engaged in the carriage of all cargoes, with the exception of bulk cargoes.)*

Unit securing – chain lashings

Ro-Ro units are secured in accordance with the Cargo Securing Manual of the vessel. In some short sea voyages, during the summer season and with a predominantly good weather forecast, units may not even be secured other than by the hand brakes and left in gear. However, at the Master's discretion, chain lashings could be applied by the crew if and when circumstances dictate that securing becomes necessary.

In virtually all cases, hazardous units would automatically be chained down. Chain lashings vary but tend to have a common theme of being able to be applied between a deck 'star' lashing point and the unit itself, then tensioned by a load binding lever.

Such lashings can be secured and tensioned quickly, and lend to labour saving. The number of lashings per unit will be variable, depending on the weight and size of the vehicle. However, a standard 40-ft unit would usually be fitted with a minimum of six (6) lashings.

Vehicle decks are built with star lashing points or 'elephants feet' type anchor points. Lashings will have a club-foot fitting into these points, with a hook at the opposite end. Alternatively, as shown in Figure 7.19, hooks at each end.

Ro-Ro ship stability

Modern Ro-Ro shipping has experienced some painful losses over the years, the most notable being the Herald of Free Enterprise (1987) the Estonia (1994) and more recently the Tricolour (2003) with 2800 cars, and the Hyundia No. 105 (2004) with more than 4000 vehicles on board. Clearly, the losses and subsequent salvage operations have rocked the marine insurance markets generating tighter legislation to cause improved conditions on Ro-Ro vessels.

Improvement features now include the following:

1. The stability of the vessel must be assured as adequate, with the main deck flooded to a depth of 50 cm of water.
2. Cargo-loading computers must have a direct link to the shoreside administration.
3. The vessel must be fitted with automatic draught gauges.
4. All access points to inner compartments must be monitored by Close Circuit Television (CCTV) and have light open/shut indicators displayed to the navigation bridge.
5. Increased drainage facilities must be fitted to vehicle decks.
6. Individual units must be weighed and respective kg measured ashore for transmission to the Vessel's Cargo Officer (Figure 7.20).

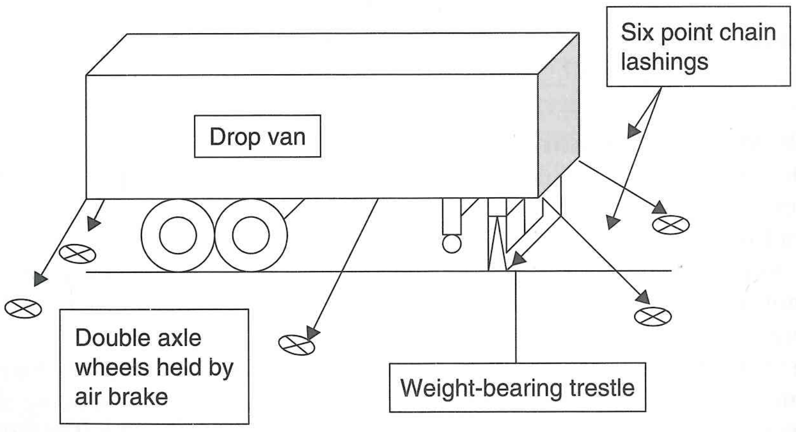


Fig. 7.20 Drop unit stowage.

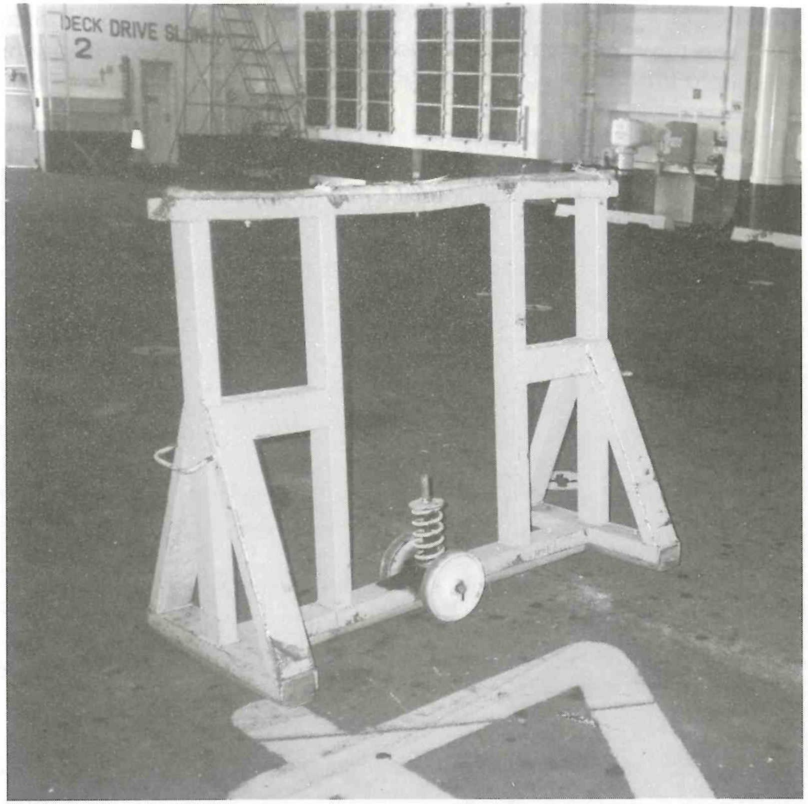


Fig. 7.21 Wheeled trestle is positioned under the unit before being detached from the motor tug. Trestles fitted with spring-loaded wheels to permit easy manoeuvring under the cargo unit.

Inherent dangers associated with Ro-Ro vessels

The ships themselves generally have high freeboards and expect to experience high windage over and above the waterline. Cargo units are by necessity loaded with a high kg value, which can be detrimental to the overall metacentric height (GM). In the event of bad weather conditions, these features tend to lend to the vessel rolling heavily, which may generate units shifting.

To improve these conditions most Ro-Ro vessels are equipped with stabilizer units of either the fin varieties (fixed or deployable) or tank sluice systems or a combination of both tanks and fins. Tank systems are extremely useful when loading/discharging, as they tend to keep the vessel upright throughout cargo operations. Provided over reliance on mechanical systems does not allow complacency to permit the vessel to list over, because it is coupled with imprudent loading schedules.

If the vessel is allowed to list the vehicle ramp(s) are likely to become twisted. This may cause damage to the ramps themselves but will inevitably stop all cargo units passing over the ramps.

Passenger and cargo terminal

A Ro-Pax Ship is a Passenger Ship with Ro-Ro cargo spaces or special category spaces as defined by SOLAS Regulation II-2/3 (Figure 7.22).

Fig. 7.22 Ro-Pax ferries seen in operation at the Dover Sea Terminal.

Ship-to-shore access Ro-Ro terminal features

Link spans

Access to Ro-Ro vessels must be capable of landing vehicles at all states of tide and, in order to operate successfully, the shipboard end of the link must be able to adjust for the rise and fall of the tidal conditions prevailing. A hoist structure with associated lifting machinery is built at the shipboard end of the link to allow movement of the span to suit the rise of tide and the freeboard of respective vessels (Figures 7.23 and 7.24).

High-speed craft

The image of the Ferry World has changed considerably over the last decade. The sleek lines of mono- and multi-hull craft now operate as Ro-Pax vessels all over the world. They provide a fast and regular service mostly on the short sea trades together with some more long-haul ventures (Figures 7.25 and 7.26).

Fig. 7.23 An example of the ship-to-shore, shore-to-ship access 'link spans' which operate at the Dover Terminal. The upper enclosed passage is for passenger transit, while the lower open top links accommodate car and truck vehicle traffic.

PCCs and PCTCs

These vessels are designated to the carriage of cars. It was estimated that over 8.7 million new cars were transported in 2003, compared with 8.3 million in 2002, the main trade countries for such cargoes being Japan and South Korea. The ships are employed with multi-decks, side-loading facilities and internal ramps to facilitate high-speed-loading/discharging rates.

The ships are designed with exceptionally high freeboards and as such are susceptible to wind pressure causing considerable leeway, slowing service speed and detrimentally affecting fuel burn. More recent designs have taken this into account, and the new generation car carriers have been fitted with an aerodynamically rounded bow and bevelled along the bowline with a view to reducing wind pressure from head winds. Six (6) PCCs operating with MOL shipping are now in service with this design feature (Figure 7.27).

Large car carriers are shipping up to 6500 car units at any one time, usually on a one-way trip, with limited prospects for return cargoes. With this in mind a high ballast capacity is generally a main feature of their operation. Where return cargoes are booked the Pure Car Carriers (PCCs) and Pure Car Truck Carriers (PCTCs) have greater flexibility.

Fig. 7.24 Link span operation. A typical link span machinery housing for hoisting and lowering the link span down to a position above the waterline. The stern ramp of the Ro-Ro ferry then lowers her stern ramp onto the links driveway to permit discharge of vehicles. The rise and fall of tide of 10.5 m is countered by the adjustment of height to the link span to allow continuous operations no matter what state of tide.

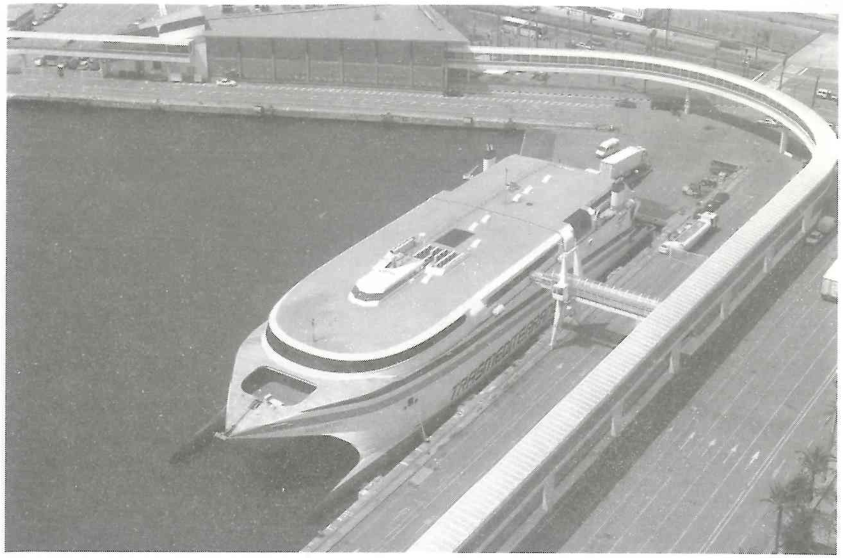


Fig. 7.25 The high-speed Ro-Pax catamaran vessel 'Millenium Dos' seen loading vehicles via the stern access, lying port side to the terminal in Barcelona, Spain.

Fig. 7.26 The Seacat Isle of Man, engaged on the Irish Sea trade between Liverpool and the Isle of Man carrying vehicles and passengers.

Fig. 7.27 The Huel Trotter car carrier manoeuvres with tug assistance fore and aft in the Port of Barcelona, Spain.

Features of the car carrier

Car carrier construction (Figure 7.28)

Typical build features:

Gross tonnage	60 587 GT	Panamax-sized vessel. Serviced by ship-to-shore
Draught	9.82 m	ramps, one at the stern (Starboard Quarter)
Air draught	52.0 m	the other midships (beam on).
Length O/A	121.08 m	Also has an option to carry refrigerated
Breadth	32.23 m	cargo on decks 5, 6 and 7 instead of doing
Service speed	21 kt	the return voyage in ballast.

The multi-deck configuration of the car carrier is in itself a striking constructional feature, the decks being interlinked by a fixed internal ramp system and elevator to lower holds. Rates of movement of car units vary directly with design but 1000 car equivalent units (CEUs) per eight (8) hour shift would not be unusual, the vessel turning round from empty, in a 48-h period.

Some decks are set at different heights to allow different head vehicles to be carried, particularly relevant where high-sided trucks may become an optional cargo. Other features of the same deck might also include higher and heavier structure to cater for the heavy-weight wheeled load. Some designs incorporate hoistable car decks offering alternative head room, as an added feature, providing additional flexibility to maximize cargo load.

A vehicle cargo mix tends to offer more options to shippers as well as

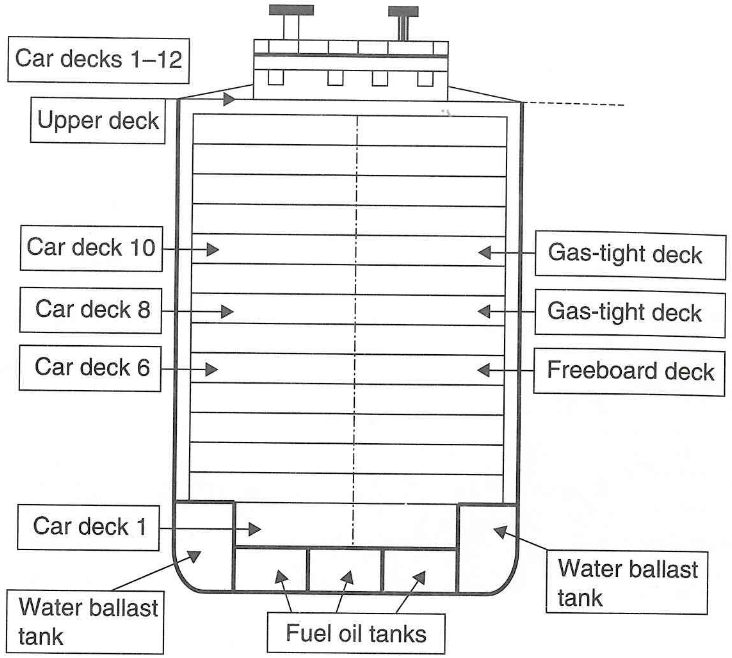


Fig. 7.28 Car carrier construction.

ship's running costs. Loading and discharge are generally achieved by a minimum of two vehicle ramps, one about the midships area while a side loading, quarter ramp, has become a popular feature of many car carriers and/or PCCs and PCTCs.

Fixed deck loading is usually about 2 tonne/m^2 throughout, though this may vary where hoistable decks are engaged. Decks are fitted with forced ventilation fan systems to clear exhaust fumes during loading and discharge periods.

As stated previously, the main disadvantage of these ships is in their construction, producing very high-sided vessels which are subject to massive wind effect when in open aspect sea conditions. As such, they experience considerable leeway which can generate increased fuel burn over a passage. Some efforts in design features, like the rounding of the bow area and bevelled bowlines, has been incorporated in some of the latest builds in an effort to increase fuel efficiency.

The ships tend to be fitted with a high ballast capacity because of the designated trade not lending to full return cargoes per voyage, although some mutual exchange cargoes that are suitable for the design decks – like palletized cargo/fork lift or tractor loading – can sometimes be arranged (Figures 7.29 and 7.30).

The new car trade is generally predominant from South Korea, Japan

Fig. 7.29 A specialist unit load system. The 'Republic Di Genova' one of Grimaldi's car carrier vessels seen in the Falmouth Dry Dock.

Fig. 7.30 A specialist unit load system. The angled quarter ramp and access point to vehicle decks of the above car carrier. These angled ramps have become a popular feature of car carrier vessels and are often employed with a midsection shell door ramp to improve the speed of load and discharge operations.

Australian markets. The main car carrier companies are MOL, Hual, Grimaldi and Wallenius Wilhelmsen being amongst the largest companies operating PCCs and PCTCs.

> ***Note:*** *Car carriers do not conform to conventional Ro-Ro regulations.*

The BACAT: BArge CATamaran

A double-hull catamaran shaped vessel which accommodates barges of up to about 140 tonnes. Barges are floated in from the stern and lifted from the water tunnel between the hulls by an elevator system. Additionally the 'Lighter Aboard SHip' (LASH) barges (375 tonnes) can be transported by the water tunnel with a stern door being closed up after the completion of loading.

The LASH system

A lift-on, lift-off system where lighters are raised to the upper deck by means of a moveable 'gantry crane'. They are often loaded into holds or on deck in a similar manner to containers. Alternatively, they are operated on a similar principle as the floating dock, where the parent vessel is ballasted down and the lighters are floated in via the stern, between the high-sided bulkheads. As the vessel de-ballasts, the barges are lifted into the transport.

The SeaBee: Sea barge

This system uses barge units of about 800 tonnes deadweight which are floated towards a stern elevator. An automatic transporter rolls under the barge, when at the required deck level, it is carried forward to the desired stowage position.

> ***Note:*** *LASH and SeaBee systems an also accommodate the carriage of containers.*

Chapter 8
Containers and containerization

Introduction

The first recognized container vessel was a converted World War II Tanker, named the 'Ideal X' and owned by Pan Atlantic. Her first container voyage shipped 58 containers on specially rigged decks from Port Newark, New Jersey in April 1956. Malcom P. Maclean (1914–2001) a liner-shipping pioneer, was probably the accepted founder of containerized traffic. He received the 'Admiral of the Ocean, Sea Award' in 1984 from President Reagan and 'Lloyds List' nominated him as one of the three most influential men of the twentieth century, alongside Aristotle Onassis and Ted Arison.

The first fully 'Cellular Container Ship' was a converted cargo vessel, the 'Gateway City', altered to carry 225 container units of 35 ft size. Her maiden voyage was between the Mexican Gulf and Puerto Rico but dock labour refused to work the vessel and the ship returned to the USA with her cargo.

Then the first transatlantic container line was started in 1966, and as they say, the rest is history. Door-to-door service met a huge customer demand and revolutionized the shipping industry. Containerization has all but obliterated general cargo handling, as the industry once new it. By the twenty-first century, nearly every commodity, apart from bulk products and heavy lifts, could be 'stuffed' into a container.

The largest container ships are currently being built to carry just under 10 000 TEU, and it must be anticipated that this barrier will soon be broken and even larger vessels will join the world's fleets. The system brought with it sister operations, like the Roll-on, Roll-off (Ro-Ro) system (see Chapter 7) which dovetailed with transhipping operations to feed the major terminals. Both sectors of the industry thrive today as main line contributors to cargo movement.

List of relevant container definitions and terms

Administration – means that Government of a Contracting Party, under whose authority containers are approved.

Approved – means approved by the administration.

Approval – means the decision by the administration that a design type or a container is safe within the terms of the present convention.

Cargo – is defined by any goods, wares, merchandize and articles of every kind whatsoever carried in the containers.

Cell – defined by that space which could be occupied by a single vertical stack of containers aboard a container vessel. Each stowage/hatch space would contain multiple cells, each serviced during loading/discharging by 'cell guides' (Figure 8.1).

Fig. 8.1 Empty cell guides numbered odd to starboard and even to port, situated at the fore end of the cargo container hold.

Cell guide – a vertical guidance track which permits loading and discharge of containers in and out of the ships holds, in a stable manner.

Container – is defined as an article of transport equipment: (a) of a permanent character and accordingly strong enough to be suitable for repeated use; (b) specially designed to facilitate the transport of goods, by one or more modes of transport, without intermediate reloading; (c) designed to be secured and/or readily handled, having corner fittings for these purposes; (d) of a size such that the area enclosed by the four outer bottom corners is either: (i) at least 14 m^2 (150 ft^2) or (ii) at least 7 m^2 (75 ft^2) if it is fitted with top corner fittings.

The term 'container' includes neither vehicles or packaging. However, containers when carried on chassis are included.

Container spreader beam – the engaging and lifting device used by gantry cranes to lock on, lift and load containers.

Corner fitting – is defined by an arrangement of apertures and faces at the top and/or bottom of a container for the purposes of handling, stacking and/or securing.

Existing container – is defined as a container, which is not a new container.

Flexible boxship – a term which describes a container vessel designed with flexible length deck cell guides, capable of handling different lengths of containers, e.g. 20, 30 and 40 ft units.

Gantry crane – a large heavy-lifting structure found at container terminals employed to load/discharge containers to and from container vessels. Some container vessels carry their own travelling gantry crane system on board (Figure 8.2).

Fig. 8.2 Gantry cranes engage in container cargo operations over the 'Zim California' berthed in Barcelona, Spain.

Hatchless holds – are defined as a container ship design with cell guides to the full height of the stowage without separate or intermediate hatch tops interrupting the stowage.

International transport – means transport between points of departure and destination situated in territory of two countries to at least one of which the present (CSC) Convention applies. The present convention will also apply when part of a transport operation between two countries takes place in the territory to which the present convention applies.

Karrilift – trade name for a mobile ground-handling container transporter. There are many variations of these container transporters found in and around terminals worldwide. Generally referred to as 'Elephant Trucks' or 'Straddle Trucks'.

Lashing frame/lashing platform – a mobile, or partly mobile, personnel carrier which lashing personnel can work on twist-locks at the top of the container stack without having to climb on the container tops.

Maximum operating gross weight – is defined by the maximum allowable combined weight of the container and its cargo.

Maximum permissible payload (P) – means the difference between the maximum operating gross weight or rating and the tare weight.

New container – is defined as a container the construction of which was commenced on or after the date of entry into force of the present convention.

Owner – means the owner as provided for under the national law of the contracting party or the lessee or bailee, if an agreement between the parties provides for the exercise of the owner's responsibility for maintenance and examination of the container by such lessee or bailee.

Prototype – means a container representative of those manufactured or to be manufactured in a design type series.

Rating (R) – see maximum operating gross weight.

Safety approval plate – is described as an information plate which is permanently affixed to an approved container. The plate provides general operating information inclusive of country of approval and date of manufacture, identification number, its maximum gross weight, its allowable stacking weight and racking test load value. The plate also carries 'end wall strength', the 'side wall strength' and the maintenance examination date.

Stack – a term when referring to containers, which represents the deck stowage of containers in 'tiers' and in 'bays' (Figure 8.3).

Fig. 8.3 The container stack on the deck of the 'ZIM ΣANIKAH' being discharged

Tare weight – means the weight of the empty container including permanently affixed ancillary equipment.

Terminal representative – is defined as that person appointed by the terminal or other facility where the ship is loading or unloading, who has responsibility for operations conducted by the terminal or facility with regard to that particular ship.

TEU – twenty feet equivalent unit. Used to express the cargo capacity of a container vessel.

Type of container – means the design type approved by the administration.

Type-series container – means any container manufactured in accordance with the approved design type (Figure 8.4).

Fig. 8.4 Working containers. The Mediterranean Shipping Company (MSC) Sintra lies starboard side to working containers by shoreside gantries in St John's, Newfoundland container terminal. The ships own two container cranes are turned outboard to permit access by the gantries.

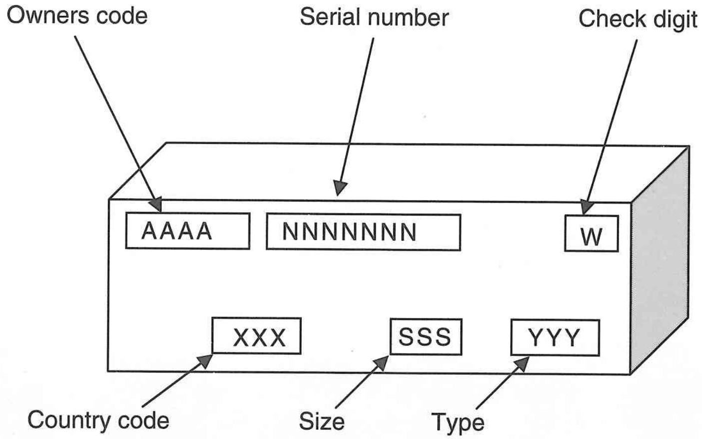
Loading containers

The order of loading, when the large container vessels are carrying currently up to 10 000 TEU, must be well planned and considered as a detailed operation. Planners are usually employed ashore to provide a practical order of loading, particularly important when the vessel is scheduled to discharge at two, three or more terminal ports.

Once loading in the cell guides is complete, the pontoon steel hatch

are then stowed on deck in 'stacks' often as high as six tiers. The overall height of the deck stowage container stack may well be determined by the construction of the vessel. It must allow sufficient vision for bridge watchkeepers, to be able to carry out their essential lookout duties. The stability criteria of the vessel, when carrying containers on deck, must also be compatible with the stowage tonnage below decks.

Any deck stowage requires effective securing and this is achieved usually by a rigging gang based at the terminal. As the 'stack' is built up, each container is secured by means of specialized fittings, between containers themselves and to the ship's structure.



Length (m)	Width (m)	Height (m)	Gross Weight (kg)	Tare Weight (kg)	Pay Load (kg)	Usable capacity (m³)	Imperial size (ft)
6.05	2.43	2.43	20 320.9	1590.30	18 730.6	30.75	(20′)
9.12	2.43	2.43	24 401.2	2092.92	23 308.3	46.84	(30′)
12.19	2.43	2.43	30 481.4	2593.64	27 887.0	62.92	(40′)

Fig. 8.5 Markings on containers.

Container transport

A fully laden container vessel is unlikely to be loaded down to her loadline marks despite having a container stack on deck of three or four high. Containers may weigh up to about 30-tonne gross weight each, when fully packed, but may also be empty. Hence a full capacity load may not necessarily equal the maximum permissible deadweight. If containers are carried on deck, they must be well secured by means of the iron rod lashings with associated rigging screws, fixed as part of the ship's structure. Empty or light containers could be affected by buoyancy when seas are shipped, and Deck Officers should be especially diligent when checking the upper

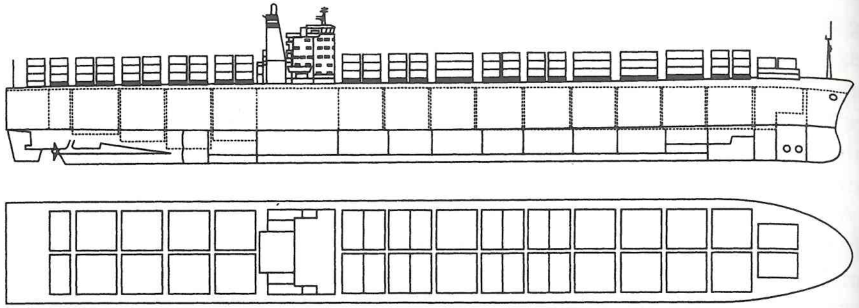


Fig. 8.6 Container vessel – upper deck stow showing stack of three high on the top of pontoon hatches. Below decks, containers secured in cell guides. The navigation bridge is not obscured for the vessels operational needs.

Fig. 8.7 The 'Dole America' container vessel manoeuvres with tugs in attendance inside harbour waters. Containers are stacked two high on deck and the two ships container cranes are seen in the stowed, fore and aft position.

Container Ship Cargo Plan

The modern type of container vessel will normally operate a container 'box' tracking system which allows continuous monitoring of any single container at any time during its transit. The plan shown in Figure 8.12 allows a six-figure number to track and identify its stowage position aboard the vessel. Distinct advantages of such a system tend to satisfy

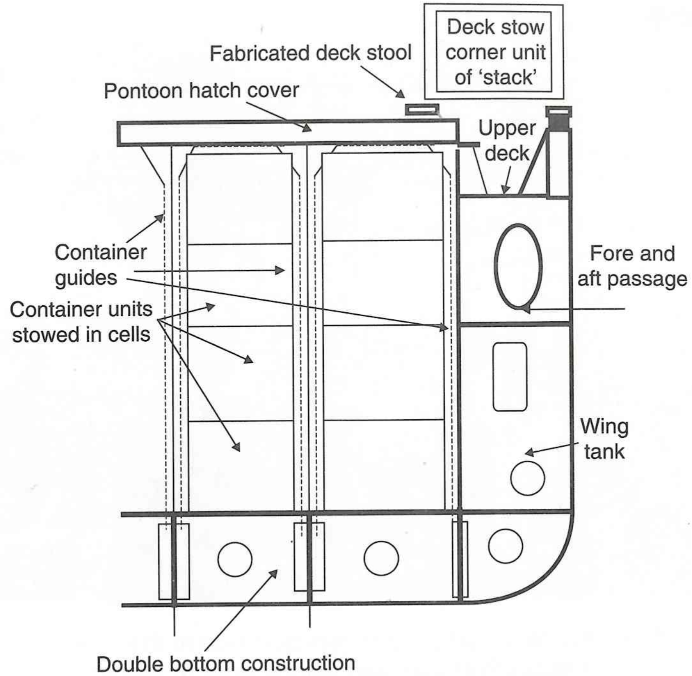
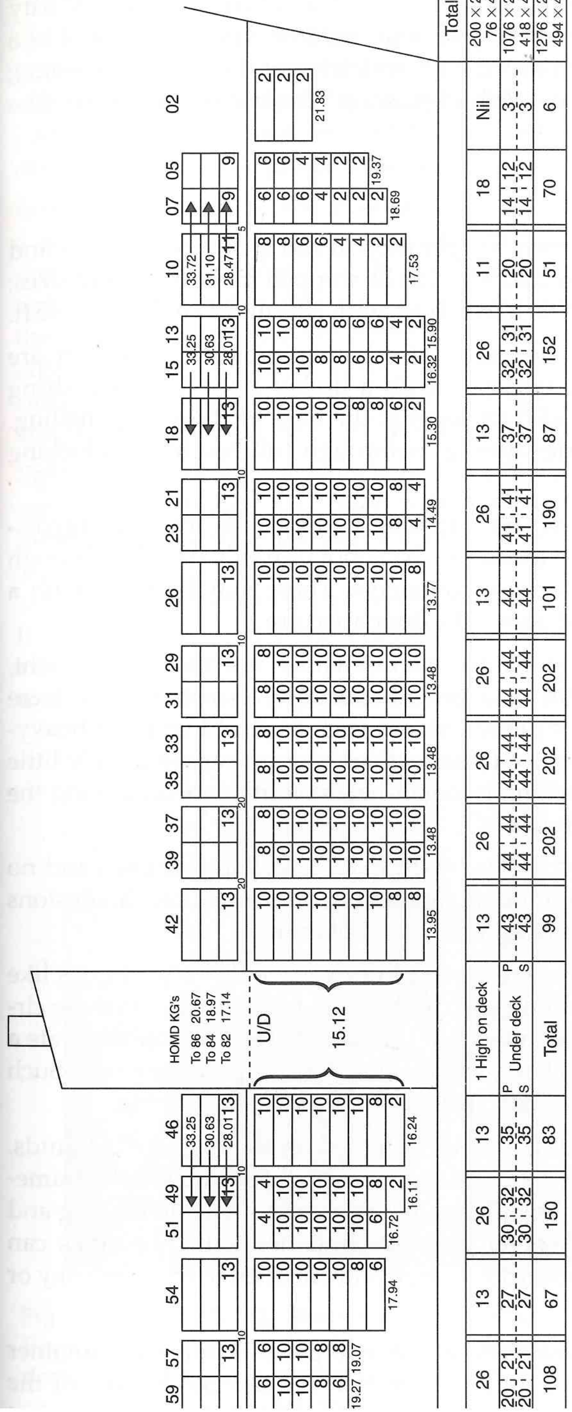


Fig. 8.8 Container vessel construction.

Fig. 8.9 The container spreader beam operates secured to the gantry crane travelling the length of the gantry jib to lift the containers on and off the vessel. The corners of the spreader beam are fitted with hinged droppable guides to ensure the beam locks can accurately locate the container corner recesses. The beam is also used to lift off pontoon hatch covers but when doing so does not deploy the hinged guides.

Fig. 8.10 The 'P&O Nedlloyd Susana' lies port side to the container terminal in Lisbon, Portugal, part loaded prior to sailing.

Fig. 8.11 The shoreside gantry cranes silhouetted against the Lisbon skyline after the P&O Nedlloyd Susana departs the berth.



he modern type of container vessel will normally operate a container 'box' tracking system which allows continuous monitoring of any single container t any time during its transit. The plan allows a six figure number to track and identify its stowage position aboard the vessel. Distinct advantages f such a system tend to satisfy shipper enquiries as well showing that the shipping company is efficient in its business.

ther aspects of secutiry are also clearly beneficial in a security conscious age.

n example tracking system could be typically:

The first two numbers of the six-digit number = The identification of the 'Bay' of stowage.
The second two numbers = The 'cell' of stowage
The last two numbers = The level/tier of stowage

Fig. 8.12 Container Ship Cargo Plan.

shipper enquiries as well as showing that the ship company is efficient in its business. Other aspects of security are also clearly beneficial in a security conscious age. An example tracking system could be typically: the first two numbers of the six-digit number (the identification of the 'bay' of stowage); the second two numbers (the 'cell' of stowage) the last two numbers (the 'level tier' of stowage).

Container types

There are many container types in operation to suit a variety of trades and merchandize. Sizes also vary and they can be shipped in the following sizes: 8 ft in width and 8 ft or 8 ft 6 inch in height, with lengths of 10, 20, 40 or 45 ft.

Conventional units (general purpose) – also known as a dry container are made from steel and fully enclosed with a timber floor. Cargo-securing lashing points are located at floor level at the base of the side panelling. Access for 'stuffing' and 'de-stuffing' is through full height twin locking doors at one end.

Open top containers – covered by tarpaulin and permits top loading/discharging for awkward sized loads which cannot be easily handled through the doorways of general purpose containers. These may be fitted with a removable top rail over and above the door aperture.

Half-height containers – an open top container which is 4 ft 3 inch in height, i.e. half the standard height of a general purpose container. They were designed for the carriage of dense cargoes such as steel ingots, or heavy-steel cargoes or stone, etc. since these cargoes take up comparatively little space in relation to their weight, two half-height containers occupying the same space as the standard unit.

Flat rack container – this is a flat bed with fixed or collapsible ends and no roof. They are used to accommodate cargoes of non-compatible dimensions or special cargoes that require additional ventilation.

Bulk container – are containers designed to carry free flowing cargoes like grain, sugar or cement. Loading and discharging taking place via three circular access hatches situated in the roof of the unit. They also incorporate a small hatch at the base which allows free flow when tipping the unit. Such containers are usually fitted with steel floors to facilitate cleaning.

Tank containers – are framed tank units designed for the carriage of liquids. The cylindrical tank usually made of stainless steel is secured in the framework which is of standard dimensions to be accommodated in loading and discharging as a normal general purpose container unit. The tanks can carry hazardous and non-hazardous cargo and are often used for whisky or liquid chemicals.

Ventilated containers – generally designed as a general purpose container but with added full length ventilation grills at the top and bottom of the

are equally suitable for other cargoes, which require a high degree of ventilation during shipping.

Open-sided containers – these units are constructed with removable steel grate sides which are covered by poly vinyl chloride (PVC) sheeting. The side grates allow adequate ventilation when it is used to carry perishable goods and/or livestock. Such containers permit unrestricted loading and discharging with the grates removed.

Insulated containers – are insulated and often used in association with a refrigeration air-blower systems to keep perishable cargoes fresh, e.g. meats, fruits vegetables, etc. The container has two porthole extractors fitted to one end of the unit to allow the cool air circulation to operate from the cooling plant. They are generally stowed under deck and close to, or adjacent to, the ship's circulation ports. Other types of containers in this category rely only on the insulation and are not fitted with cooling plant, and these can be stowed in any position on the ship.

Refrigerated containers – more generally known as the reefer container, they are totally insulated and fitted with their own refrigeration plant. They must be connected to the ship's mains and require close stowage to a situated power point. They are usually employed for holding foodstuffs, meat and dairy products being prime examples. These units have become prolific and have caused a major reduction in the numbers of dedicated 'reefer ships', although reefer ships still operate they tend to be limited to specific trades like 'bananas' (Figures 8.13 and 8.14).

Fig. 8.13 The 'OOCL Shanghai' lies port side to the container terminal in Barcelona, Spain, after completing cargo loading with a full container load, the deck stack being at a six-tier height. The terminal 'gantry cranes' seen in the upright and clear position (the ship is not fitted with its own cranage).

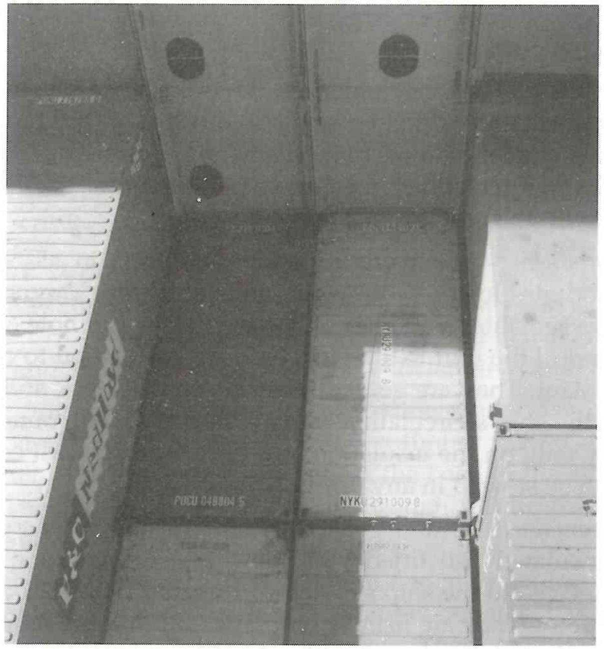


Fig. 8.14 Container (internal) hatch stowage. Container hatch with part load containers lying in the cell guides of the lower hold cargo space.

Reefer containers

With many of the chilled and frozen products being transported by sea containers there was bound to be an influence on the reefer trade; so much so that designated 'reefer' ships have been greatly reduced in number, other than possibly in the banana trade. Ro-Ro units, as well as the specified refrigerated containers, have now dominated the reefer commodity shipping markets.

The container units themselves are built with insulation and pre-cooled prior to being loading at the handling station, a shore power supply being used to activate the units cooling plant. Once packed and sealed the temperature of the unit is lowered to the desired level and monitored by a temperature sensor attached to the container. As soon as the unit is packed, the refrigeration machinery is activated either by the continued use of a shore supply or linked directly to the transporters (mobile) power source.

Terminals and container parks have specialized park areas to enable mobile units to switch to a static shore power supply, once the mobile transport supply is stopped. Disconnection of units takes place just prior to loading on board the ship. The supply is reconnected from the ship's mains once the unit is stowed in its allocated position aboard the vessel.

The modern container vessel can expect to carry numerous units with refrigerated cargoes, all plugged into the ship's power supply fitted to specified loading bays. They would, in the main, be fitted with a reefer container monitoring system to ensure that temperatures are retained within

'Reefer' container monitoring

Various types of monitoring systems are available for shipping operators, either stand-alone or integrated operations which could include tank gauge systems, ballast control, power management, fire fighting, etc.

The local control unit indicated could monitor up to 3000 cargo units, or numerous tanks for pressure, temperature, volume, viscosity, etc. (Figure 8.15).

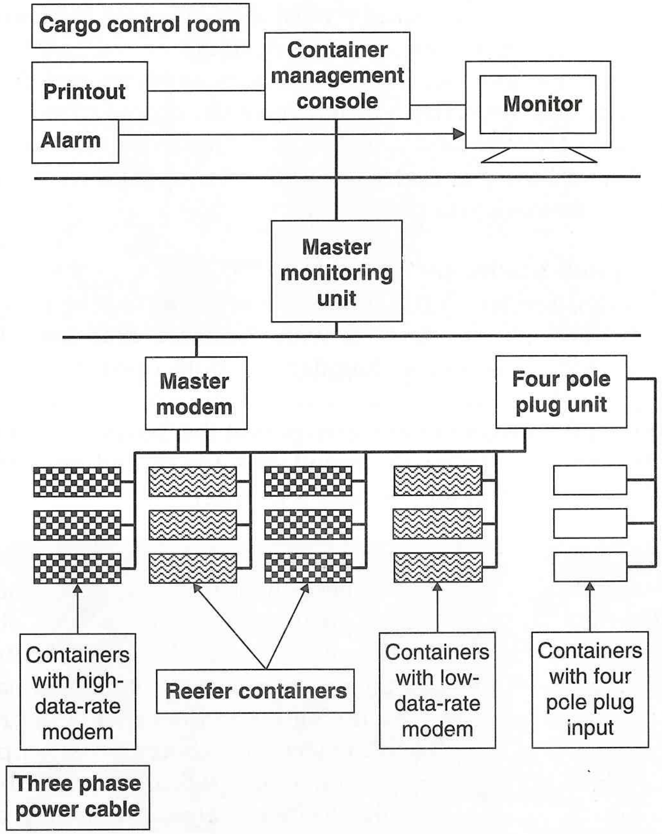


Fig. 8.15 Cargo control room – container monitoring.

Containers on deck

It is regular practice to carry containers on deck on both designated container vessels and general cargo/service vessels. Further recommendations on deck stowage are advised by 'M' Notice 1167.

Deck containers should be stowed and secured taking account of the following:

1. Containers should preferably be stowed in a fore and aft direction.
2. They should be stowed in such a position as not to deny safe access to

3. They should be effectively secured in such a manner that the bottom corners will be prevented from sliding and the top corners will be restrained to prevent tipping.
4. The unit should stowed in a manner that it does not extend over the ships side (many containers are stowed part on the hatch top and part on extending pedestal supports, but the perimeter of the unit is kept within the fine lines of the vessel).
5. Deck containers should be carried at a single height (one high). However, this may be increased if twist-locks are used to secure the bottom of the container to a fabricated deck stool.
6. Deck loads should not overstress the deck areas of stowage. Where units are on hatch tops, these hatch covers must be secured to the vessel.
7. No restraint system should cause excessive stress on the container.
8. Restraint systems and securings should have some means of tightening throughout the voyage period.

Container deck stowage

Container decks, and reinforced pontoon hatch tops to take the deck load capacity, are generally constructed with increased scantlings to satisfy Classification and Construction Regulations. Both open decks as seen in Figure 8.16 and the pontoon hatch cover (Figure 8.23), when fitted, are usually equipped with container feet to permit the 'boxes' to be locked into position. The first tier, being the foundation for second and subsequent tiers, would be stowed on top (Figures 8.17–8.22).

Fig. 8.16 The exposed container cargo deck of the 'Baltic Eider' seen with the container deck stool-securing points in uniform rows to form the basis of an even stow.

Fig. 8.17 Part loaded deck of the 'Sete Cidades'. Containers seen on the hatch tops as the vessel lies starboard side to the container terminal in Oporto. The ship's own two container cranes are turned outboard to allow access to the shoreside gantry cranes.

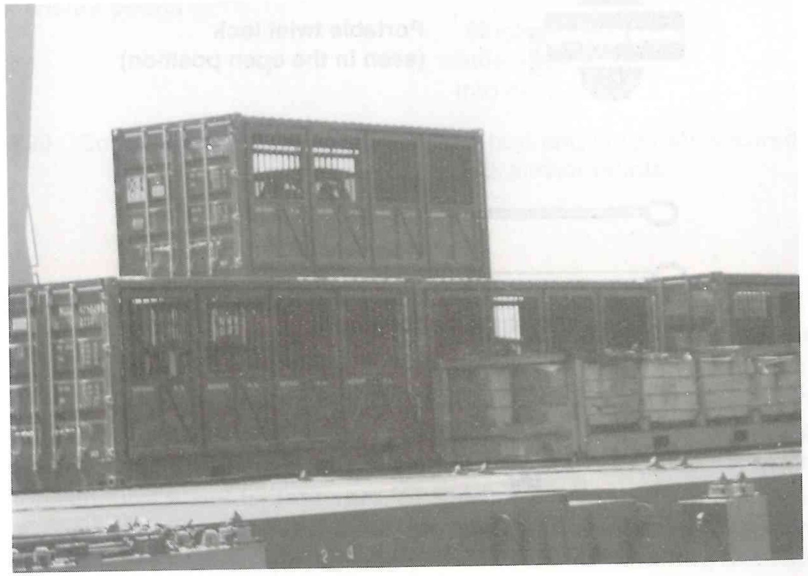


Fig. 8.18 Part loaded deck of the vessel 'Hydra J'. Containerized vehicles and half-height container seen clear of securings and ready for discharge.

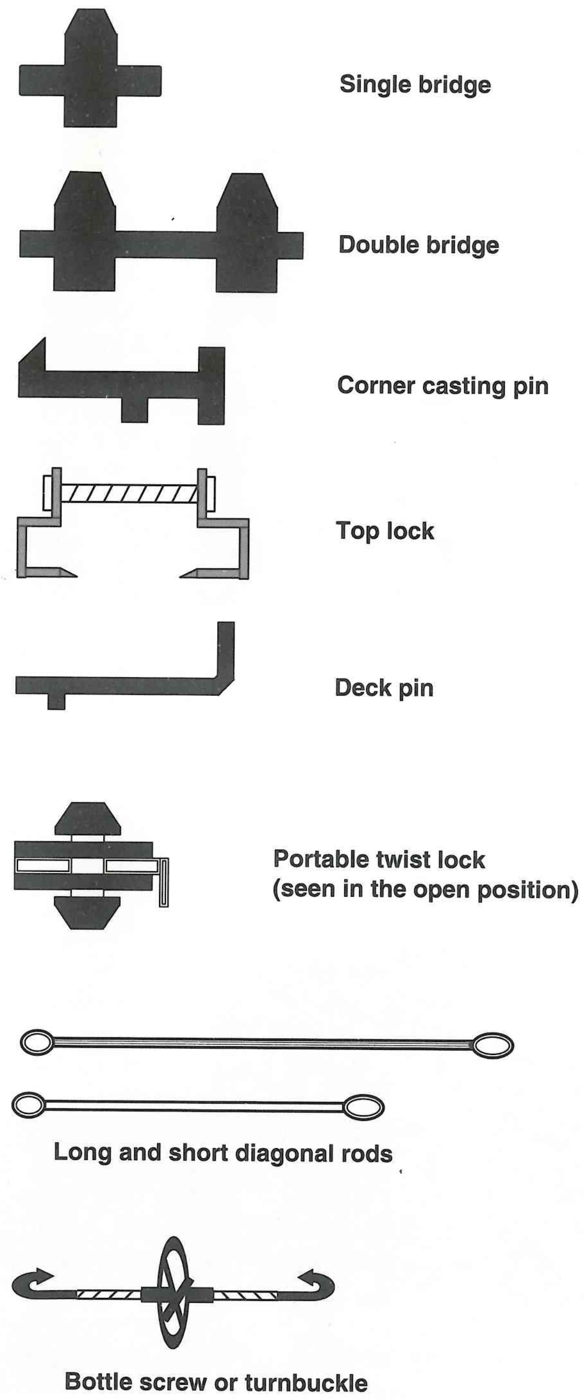


Fig. 8.19 Container lashing fitments.

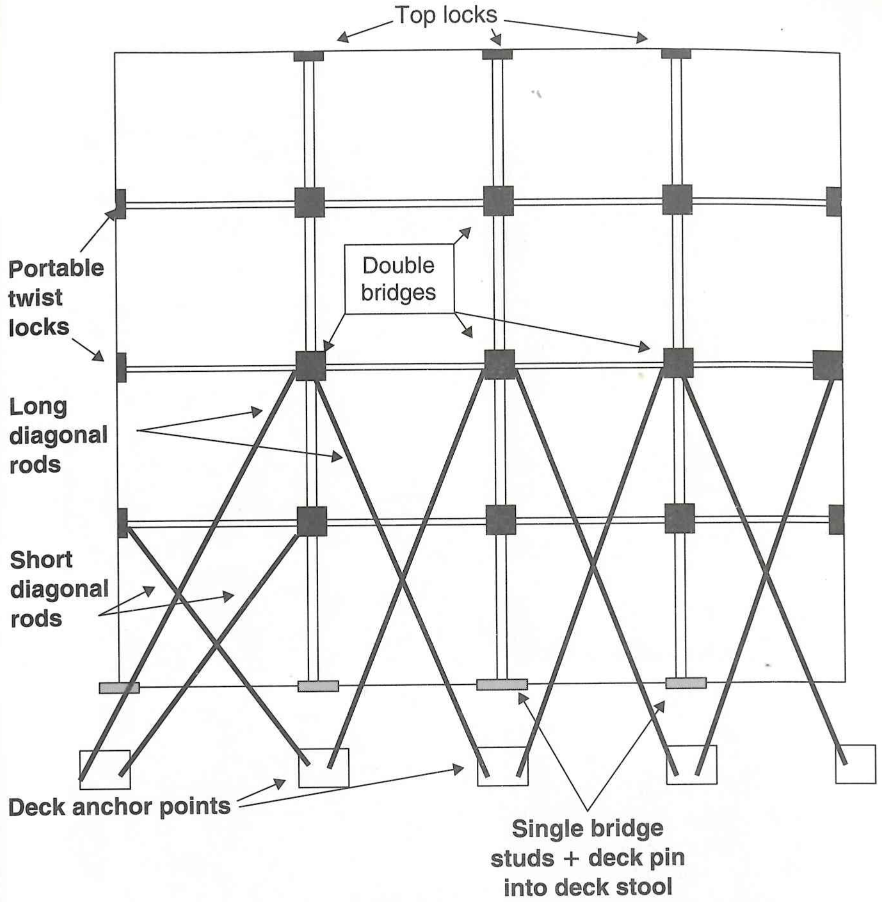


Fig. 8.20 Container deck stowage example. Short and long rods secured by bottle screw or turnbuckle to deck anchor points.

Loadicator and loading plan computers

Many ships are now equipped with loadicator systems or a loading computer with appropriate software. It is usually a conveniently sited visual display for the Master and the Loading Officers and is gainfully employed on Ro-Ro vessels, container ships, tankers and bulk carriers. The system should ideally be interlinked with the shoreside base to enable data transmissions on, unit weights/tonnages/or special stow arrangements.

The computer would permit the location and respective weights of cargo/units to be entered quickly and provide values of limiting measured distance between the keel and the centre of gravity of the vessel (KG) and 'metacentric height' (GM) together with deadweights at respective

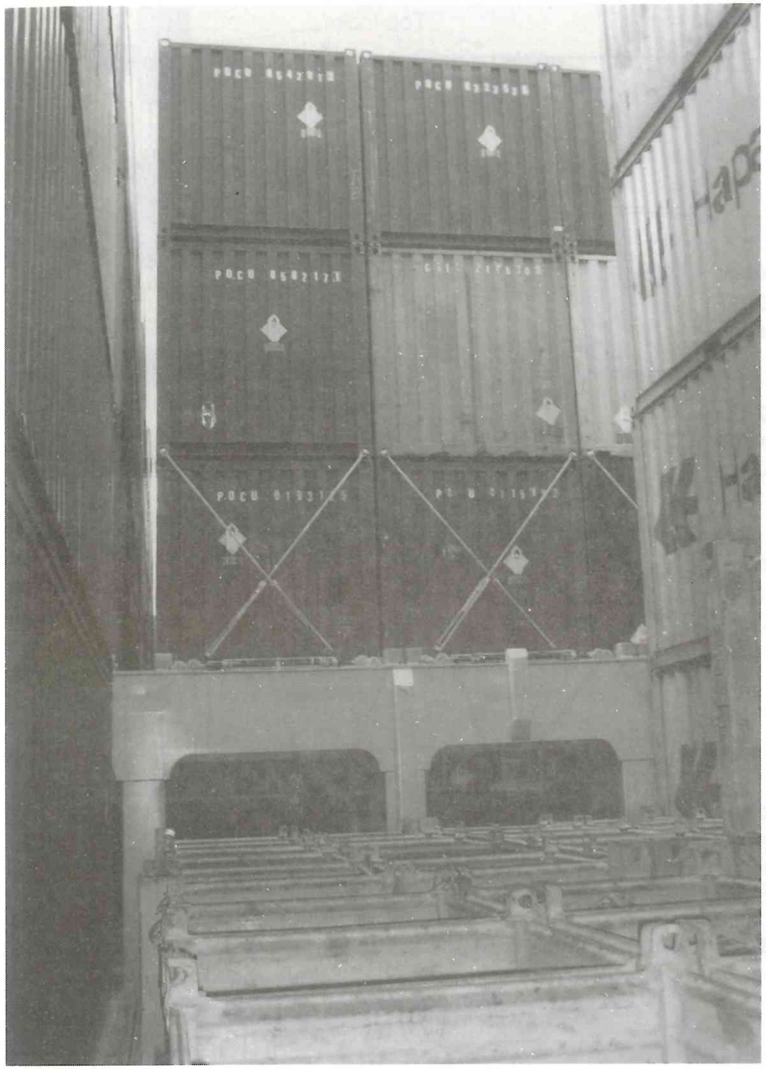


Fig. 8.21 Deck stowage and securing of container stack. The deck stow is seen in way of the edge of the pontoon hatch cover. The lashings are to the base, third tier container level by long bar (not shown). The second tier container level being secured by short bar lashings with the base containers locked to the pontoon.

printed record of the state of loading and show a visual warning in the event of an undesirable stability condition or overload occurring.

Distribution of the ship's tank weights, stores and consumables affecting final calculations, and total displacement would also be identifiable within the completed calculations. The primary aim of the loading computer is to

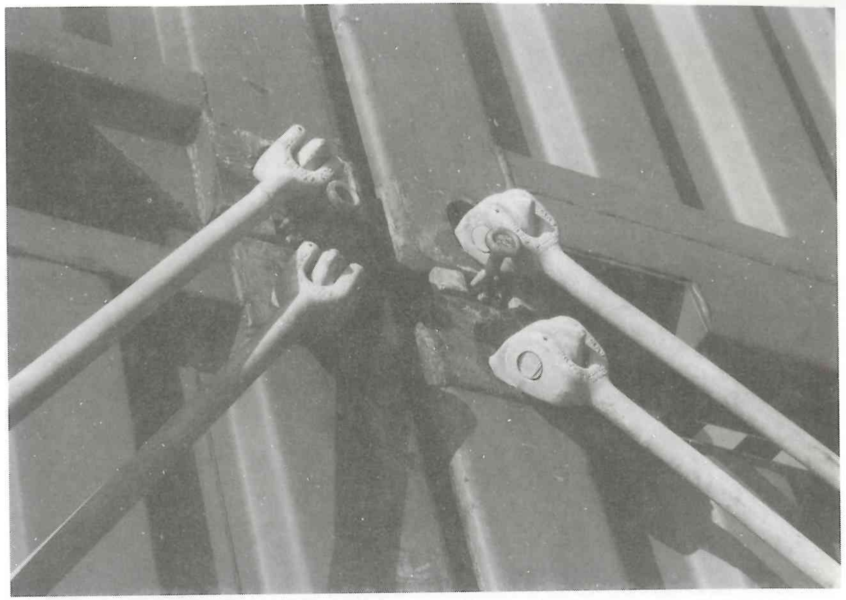


Fig. 8.22 Container lashing bars, seen secured from the main deck to the first and second tier of deck containers.

Fig. 8.23 The container hoist engaged in lifting the pontoon hatch covers clear of the cellular holds.

Fig. 8.24 Tracked shoreside 'gantry crane' for the loading of containers, semi-automatic, driverless transports deliver containers to its underside for loading aboard the container vessel.

Fig. 8.25 Shoreside container terminal showing automatic stacking cranes in the background.

ensure that the vessel always departs the berth with adequate stability for the voyage. If this situation can be achieved quickly, costly delays can be eliminated and safety criteria is complied with.

The data required to complete the stability calculations would need to be supplied by the shoreside base with regard to cargo weights. This in turn would be certificated by the driver – for Ro-Ro unit loads – obtaining a load weight certificate authorized from an approved 'weight bridge' prior to boarding the vessel. Draught information would inevitably come from a 'Draught Gauge System' for the larger vessel and be digitally processed during the period of loading.

A ship's personnel could expect to become familiar with manipulation of the changing variables very quickly alongside the fixed weight distribution throughout the ship. This would permit, in general, few major changes to the programme, especially on short sea ferry trade routes where limited amounts of bunkers, water and stores are consumed and values stay reasonably static.

Fixed weights are applicable to a variety of units or vehicles and, as such, where units are pre-booked for the sea passage, an early estimate of the ship's cargo load, and subsequent stability, can often be achieved even prior to the vessels arrival.

The loadicator programmes provide output in the form of:

- shear forces and bending moments affecting the vessel at its state of loading
- cargo, ballast and fuel tonnage distributions
- a statement of loaded 'GM', sailing draughts and deadweight.

Terminal operations

The sheer size of 'container terminals' around the world must generate cause for the tremendous volume of work which is employed in the transport, storage and shipping of the many units. The general public would only visibly see the number of units which a terminal has inside its perimeter at any one time. However, the maintenance of the gantry cranes, the ground-handling transports, the documentation concerning a single 'box unit' become the invisible operations that generate a successful terminal. They employ considerable manual workers with various skills, from the wharf men to personnel engaged in 'stuffing container units' – security personnel, administration staff, maintenance workers, ships planners, etc. not to mention the insurance and legal professionals engaged in the background.

The largest terminals in the world are shown in Table 8.1.

The increased growth of unit movements is based on figures from 2002/2003 and should not be considered for future years, as world trade is influenced by many factors: not least the strength of national economies,

Table 8.1 Main terminals throughout the world

Terminal port	*Number of TEU handled (millions)*	*Annual percentage increase (+/−)*
Hong Kong	20.82	+8.8
Singapore	18.41	+8.7
Shanghai	11.37	+32.1
Shenzhen	10.65	+39.9
Pusan	10.37	+9.7
Kaohsiung	8.81	+3.8
Rotterdam	7.10	+9.2
Los Angeles	6.61	+8.4
Hamburg	6.14	+14.2
Antwerp	5.44	+14.0

the strength of the US dollar, the emergence of China and Charter rates to mention but a few of the relevant influences.

However, what is clear is that if the location of the ports is noted then the geography would indicate that the USA, Europe, the Far East, and, in particular, China are emerging as the main trading blocks for containerized traffic. Feeder operators to Australasia, India, the Baltic and Mediterranean regions continue to flourish in support of the major operators (Figures 8.26–8.31).

Fig. 8.26 The container gantry cranes discharge the vessel 'Zim Marseille' which lies port side to the container terminal in Barcelona, Spain.

Fig. 8.27 A single gantry crane and a mobile dock side crane work the container cargo of the feeder container vessel 'Providence'. The ship's own container cranes are seen turned outboard to facilitate the shoreside loading systems in the port of Barcelona.

Fig. 8.28 Automated stacking cranes provide unit movements to the terminals container stack. The containers being loaded to driverless ground-handling transports.

Fig. 8.29 Automated, driverless ground-handling transports deliver container units from the terminal stack to the underside of ship/shore gantry cranes.

Fig. 8.30 Tracked, terminal stacking gantry cranes operate through the Lisbon container terminal. Rail and road transport having access to the container park.

Fig. 8.31 Walkways, road paths and track rails for gantry cranes seen alongside the berth, opposite the terminal stacking gantries. Container avenues lying parallel to the ships berth.

Container operations

Shipping and booking

In order to ship a container certain procedures and documentation processes are required and the freight office of a shipping company would require the following information:

1. Name and address of company booking the unit for export
2. Bill of Lading (B/L), with name and address of shipper if different from above
3. The quantity of cargo to be shipped: including weight, measurement, marks and numbers of packages
4. Name of port of discharge
5. Commodity details, hazardous, refrigeration required and/or precise description of goods
6. The place of delivery and acceptance
7. Place of packing the container
8. Earliest date of container availability
9. Customs assigned number
10. Customs status of cargo declaration.

The container would then be designated a booking reference number to allow a constant trace to be maintained on the unit while being exported.

The Export Container Packing Document: ECPD

A detailed packing list of the container is required and this serves as not only a list of container contents but also includes: (a) quarantine declaration (if required); (b) transport document for (i) receipt from shippers for empty container, (ii) receipt from shipping company for full container; (c) stated conditions which relate to the use of equipment at shippers premises and (d) Declaration of Customs Status.

B/L

The shipping company will produce a 'B/L' once they have been informed of all relevant details regarding the nature of the cargo. It would be normal practice that a 'freight invoice' would also be issued at this time, as the B/L and the freight invoice are both computer generated.

Shipping procedures

Figure 8.32 shows the likely procedure that would be followed in order for a smooth outcome to ensue. It is normal practice for the shipper to have a financial bond in place prior to shipment, the function of the bond being to guarantee payment at the country of entry of the goods.

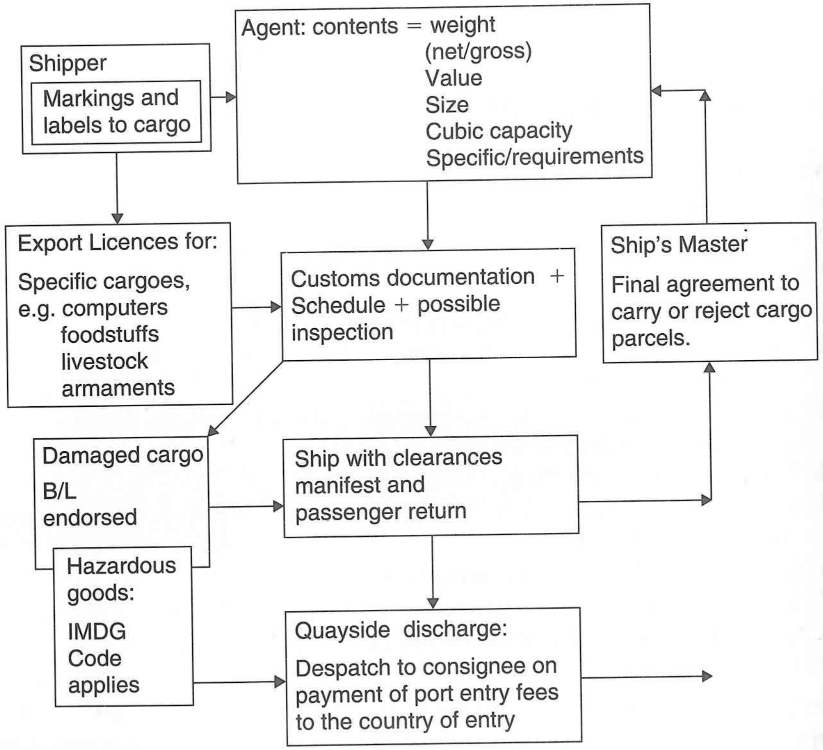


Fig. 8.32 Shipping procedures.

Fig. 8.33 Ground handling of containers – equipment and methods.

Fig. 8.35 Container terminal movement. Container transporter, with lift, transport, and stacking capability. A type of container karrilift based on the fork lift truck principle which is widely employed in container terminals worldwide.

Chapter 9

Special cargoes, hazardous goods and deck cargoes

Introduction

All cargoes must be considered special in some way, particularly so, if it is the first time that an individual has had experience of that specific cargo. It would take a lifetime for a mariner to carry every commodity and even then, certain products would be absent from the list. The interpretation of special cargoes can encompass many types of cargoes but it is generally accepted that those parcels that require special or additional attention for their safe transport and discharge, fall into this category.

Clearly, hazardous goods covered by the International Maritime Dangerous Goods (IMDG) Code are deeply entrenched under this particular umbrella of special cargoes. However, it is not just hazardous materials. Valuables, like bullion, bank notes, stamps, or personnel effects requiring lock-up stowage conditions, are also considered as specials.

Within the scope of this chapter falls 'deck cargoes'. They are exposed to the elements and are often the first to suffer from any misadventure which may befall the ship's voyage. Deck cargoes, by their very nature, may fall into the class of hazardous goods or they may, like timber deck cargoes, have their own inherent dangers, which may threaten the well-being of both ship and cargo.

Whatever goods are shipped, it is essential that correct stowage procedures are taken from the onset. They should be clearly noted on the stowage plan and relevant persons should be made aware of the nature of potential hazards or special precautions that should accompany the transport.

Definitions and terminology relating to hazardous cargoes

Auto-ignition temperature – is the lowest temperature at which a substance will start to burn without the aid of an external flame. Spontaneous combustion begins, provided that conditions are right, when auto-ignition temperature is attained.

Carrier – means any person's organization, or government, undertaking the transport of dangerous goods by any means of transport. This includes both carriers for hire or reward (known as common or contract carriers) and carriers on own account (known as private carriers).

Control temperature – means the maximum temperature at which certain substances (such as organic peroxides and self-reactive and related substances) can be safely transported during a prolonged period of time.

Cylinders – are transportable pressure receptacles of a water capacity not exceeding 150 l.

Dangerous goods – means substances, materials and articles covered by the IMDG Code.

Defined deck area – means that area of the weather deck of a ship or of a vehicle deck of a Roll-on, Roll-off (Ro-Ro) ship which is allocated for the stowage of dangerous goods.

Emergency temperature – means that temperature at which emergency procedures shall be implemented.

Flammable liquid – is a liquid having a flash point lower than 37.8°C. A combustible liquid is a liquid having a flash point of 37.8°C or above, e.g. gasoline is a flammable liquid, whereas kerosene is a combustible liquid.

Flammable range – the limits of flammable (explosive) range, in the range between the minimum and the maximum concentrations of vapour in air which forms a flammable (explosive) mixture. Usually abbreviated to LFL (lower flammable limit) and UFL (upper flammable limit). These are synonymous with the lower and upper explosive limits.

Flash point – is that lowest temperature at which a liquid gives off sufficient vapour to form a flammable mixture with air near the surface of the liquid, or within the apparatus used. Flash point represents the change point from safe to risk.

Harmful substances – are those substances that are identified as marine pollutants in the IMDG Code.

International Maritime Dangerous Goods Code – a mandatory code for the carriage of dangerous goods at sea as adopted by the Maritime Safety Committee (MSC) of the International Maritime Organization (IMO). Effective from 1 January 2004 this code is applicable to all ships to which the Safety of Life at Sea (SOLAS) convention applies (Resolution MSC. 122(75)).

Medical First Aid Guide – a section of the supplement to the IMDG Code which details guidelines for the application of first aid to persons exposed and affected by hazardous goods.

Packaged form – means the form of containment specified in the IMDG Code.

Settled pressure – means the pressure of the contents of a pressure receptacle in thermal and diffusive equilibrium.

Sift proof – is packaging which is impermeable to dry contents including fine solid materials released during transport.

Tank – means a portable tank (including a tank container) a road tank vehicle, a rail tank wagon or a receptacle with a capacity of not less than 450 l to contain solids, liquids or liquefied gases.

Water reactive – means any substance which in contact with water emits flammable gas.

Working pressure – means the settled pressure of a compressed gas at a reference temperature of 15°C in a full pressure receptacle.

The IMDG Code

The IMDG Code is the recognized code of practice for the carriage of hazardous cargoes and is covered by four volumes, plus a supplement.

IMDG Code Volume 1

This contains a general introduction and covers standards on the:

1. classification of goods
2. packaging of those goods
3. documentation required when shipping
4. marking labelling and placarding required
5. standards concerning explosives in passenger vessels.

Various sections cover the above standards for Classes 1–9 hazardous goods, in a more detailed format. Annex 1 follows the introduction and provides details on modes of packaging to UN standards.

An alphabetical General Index of all the substances, inclusive of the UN number, class, packaging group, follows the Annex. This index should be employed as the first step to retrieve information affecting a particular cargo substance. Included here is also the Medical First Aid section with the *Medical First Aid Guide* (MFAG) table numbers. Definitions, abbreviations and explanatory notes complete the volume.

IMDG Code Volume 2

This volume contains detailed instructions regarding the packing, labelling and stowing of explosives (including the specific requirements for the construction of magazines), together with individual schedules for substances in 'Class 1' explosives, 'Class 2' gases and 'Class 3' flammable liquids.

IMDG Code Volume 3

This volume covers 'Class 4' flammable solids and 'Class 5' oxidizing agents and organic peroxides. Each schedule contains specific instructions on the packaging and stowing, and relevant information regarding each class.

IMDG Code Volume 4

This volume covers Classes 6 (poisons), 7 (radioactive substances), 8 (corrosives) and 9 (miscellaneous). It also details specific information for each class including segregation details, toxicity level and radioactive rating scales, as well as radioactives for offshore supply vessels, package requirements for corrosives and miscellaneous substances.

Supplement of the IMDG Code

The supplement contains emergency procedures (EmS) and schedules for particular commodities, plus details of specialized equipment required for handling spills and fires. The MFAG provides information on symptoms and the body's reaction to exposure following an accident, as well as safe practice for handling of solid bulk cargoes, particularly concentrates. Methods of reporting procedures for vessels involved in incidents are also covered.

Shipping procedure for the loading and transport of hazardous goods

To transport dangerous goods by sea, they must pass through the following procedures:

1. The shipper is responsible for obtaining 'Export Licences' for the goods in question.
2. The shipper would also be responsible for marking and labelling the goods to be shipped in accord with the IMDG Code.
3. Following contact with the shipping company, agents must provide:
   - the number of packages together with their weight
   - the value of the goods
   - special requirements for carriage of the goods.
4. Customs clearance would be required as for any other cargo.
5. The Bill of Lading would be sighted and seen to be free of endorsements.
6. The goods would be entered on the ship's manifest and marked on the cargo stowage plan.
7. A ship's Officer would check the UN number, the details of the commodity, the labelling of the package and the condition of the packaging. Any special stowage arrangements would be noted and observed at this stage.
8. The Ship's Master has the right to accept or reject the cargo prior to loading.

Once the goods are stowed on board the vessel the requirements of the IMDG Code would be followed throughout the period of the voyage.

> **Note:** *Reference should also be made to Annex III of Maritime Pollution (MARPOL), regarding the Regulations for the Prevention of Pollution by Harmful Substances, carried at sea in packaged form.*

If appropriate, a 'Document of Compliance' for the carriage of certain

Documentation for shipping dangerous goods

1. Where dangerous goods are to be carried by sea, all documentation relating to the goods must carry the correct technical name where the goods are named. The use of a trade name alone must not be used.
2. Any shipping documents prepared by the shipper must include or be accompanied by a signed certificate or declaration that the shipment offered for carriage is correctly packaged and marked, labelled, etc. and is in proper condition for shipment.
3. The person responsible for the packing of dangerous goods in a freight container or road vehicle must provide a signed container packing certificate or a vehicle packing declaration, which states that the cargo in the unit has been correctly packed and secured and that all applicable transport requirements have been fulfilled.
4. In the event that a freight container or road vehicle containing dangerous goods is not compliant with the above, then such vehicle or container shall not be accepted for shipment.
5. Every ship carrying dangerous cargo shall have a special list or manifest of such dangerous goods on board contained within a detailed stowage plan. Such documents will identify by class and location all such dangerous goods on board the vessel. Copies of these documents will be available prior to departure to a person as designated by the Port State Authority.
6. In the case of marine pollutants, the signed shipping documents must also state that the parcel offered for shipment is a marine pollutant and that as such it is in a proper condition for carriage by sea.

> **Note:** *A copy of the stowage plan must be retained ashore until the harmful substances have been discharged from the vessel.*

Documentation detail – for shipping dangerous goods

One of the prime functions of any documentation that accompanies dangerous goods for shipping is to provide basic information associated with the hazardous substance. To this end, the shipping document for each product, material or article offered for shipment must include the following:

1. The proper shipping name.
2. The class and when assigned, and the division of the goods.
3. The UN number.
4. The packaging group for the substance carried under a 'Not Otherwise Specified' (NOS) notation or other generic entry which may include the possibility of the assignment of more than one packaging group.
5. For 'Class 7', radioactive materials only, the Class 7 schedule number.
6. Any empty or any packages containing residual dangerous goods must be marked by the words *empty uncleaned* or *residue-last contained*, before or after the proper shipping name of the substance.

7. Where dangerous goods waste (except radioactive waste) are being transported for disposal, the proper shipping name should be proceeded by the word *waste*.
8. The number and kind of packages together with the total quantity of dangerous goods covered by the description.
9. The minimum flash point if 61°C or below (°C closed cup test), or other additional hazard which is not communicated in the description of the dangerous goods.
10. The identification that the goods are *marine pollutants* and when declared under an NOS, or generic entry, the recognized chemical name of the marine pollutant in parentheses.
11. For Class 4.1 self-reacting substance or a Class 5.2 organic peroxide, the control and emergency temperatures, if applicable.

Additional information is required where special classes of dangerous goods are carried and this information is applicable for: all 'Class 1' goods, gases, infectious substances, radioactive materials, certain substances in Class 4.1 which may be exempt from display of an explosive subsidiary label, and certain organic substances that are also exempt from displaying the explosive subsidiary label.

Classes of dangerous goods

Dangerous goods are classified as follows:

Class 1 Explosives

Class 2 Flammable gases, poisonous gases, or compressed, liquefied, or dissolved gases which are neither flammable nor poisonous

Class 3 Flammable liquids, subdivided into three categories:

- 3.1 Low flash point group of liquids having a flash point below −18°C (0°F) closed cup test, or having a low flash point in combination with some dangerous property other than flammability
- 3.2 Intermediate flash point group of liquids having a flash point −18°C (0°F) up to but not including 23°C (73°F) closed cup test
- 3.3 High flash point group of liquids having a flash point of 23°C (73°F) up to and including 61°C (141°F) closed cup test

Class 4

- 4.1 Flammable solids
- 4.2 Flammable solids or substances liable to spontaneous combustion
- 4.3 Flammable solids or substances which in contact with water emit flammable gases

Class 5

- 5.1 Oxidizing substances

Class 6

- 6.1 Poisonous (toxic) substances
- 6.2 Infectious substances.

Class 7 Radioactive substances

Class 8 Corrosives

Class 9 Miscellaneous dangerous substances. That is, any other substance which experience has shown, or may show, to be of such a dangerous character, that this class should apply to it.

Stowage of Class 1: explosives

Explosives are categorized for stowage in one of the following methods:

1. Stowage Category I – goods not requiring a magazine stowage.
2. Stowage Category II, Type 'A' – a fixed magazine structure. This magazine should be close boarded on the inner sides and floor. Although cargo battens are sufficient on the ship's sides and bulkheads if they are not more than 150 mm apart.
3. Stowage Category II, Type 'B' – fixed magazine structure. Similar to 'Type A' but close boarding of sides and floor is not a requirement.
4. Stowage Category II, Type 'C' – a fixed magazine structure similar to 'Type B', but restrictions are placed on the permitted distance from the ship's side.
5. Stowage Category II – approved portable units.
6. Stowage Category II – freight containers.
7. Stowage Category III (pyrotechnics) – similar stowage to Category I, except that goods should not be overstowed with other cargo.
8. Stowage Category IV – the goods requiring this stowage should be placed as far as possible away from living accommodation and should not be overstowed. Deck stowage is preferred.

Package requirements for dangerous goods

All dangerous goods intended for carriage by sea must conform to the specifications and performance tests as recommended by the IMDG Code.

Packaging must be:

1. well made and in good condition,
2. sealed to prevent leakage,
3. of a package material which should not be adversely affected by the substance it is containing within. If necessary it should be provided by an inner coating capable of withstanding ordinary risks of handling and carriage by sea. Where the use of absorbent material or cushioning material is employed, that material shall be:
   - capable of minimizing the dangers to which the liquid may give rise,
   - so disposed as to prevent movement and ensure that the receptacle remains surrounded,
   - where reasonably possible, of sufficient quantity to absorb the liquid in the event that breakage of the receptacle occurs.

When filling packages/receptacles with liquids, sufficient ullage should be left to make an allowance for expansion which may be caused by rises in temperature.

Gas cylinders for gases under pressure must be adequately constructed and tested, maintained and correctly filled. When pressure may develop in a package by the emission of gas from the contents due to a rise in temperature, such a package may be fitted with a vent, provided that the gas emitted will not cause danger in any form to the surround.

Marking of dangerous goods (Ref. IMDG Code)

Packages of 'dangerous goods' must be transported in accordance with the provisions of the IMDG Code. Packages containing a harmful substance should be durably marked with the correct technical name (trade names alone should not be used). They should be marked to indicate that they are a marine pollutant and identified by additional means like by use of the relevant UN number.

Markings on packages containing harmful substances must be of such a durable nature as to withstand three (3) months immersion in sea water. They must be adequate to minimize the hazard to the marine environment having due regard to their specific contents.

> **Note:** *Packages that contain small quantities of harmful substances may be exempt from the marking requirements. Exemptions are referenced in the IMDG Code.*

Empty packages which have previously been used for the transport of harmful substances shall themselves be treated as harmful substances, unless adequate precautions have been taken to ensure that they contain no residues that are of a harmful nature to the marine environment.

Purpose of marking and labelling

The purpose of marking packages with the correct and proper shipping name, and the UN number of the substance, is to ensure that the material or substance can be readily identified during transportation of the goods. This identification is particularly important in determining the nature of emergency treatment which would be required in the event of a spillage or accident occurring (Figure 9.1).

Carriage in cargo transport units

The shipper is responsible for providing the transport documents; namely a signed certificate that the unit offered for carriage is properly packaged, marked and labelled or placarded, as appropriate. If dangerous goods have been packed in such a unit and the packing certificate is not available, the cargo transport unit should not be accepted for carriage.

Segregation

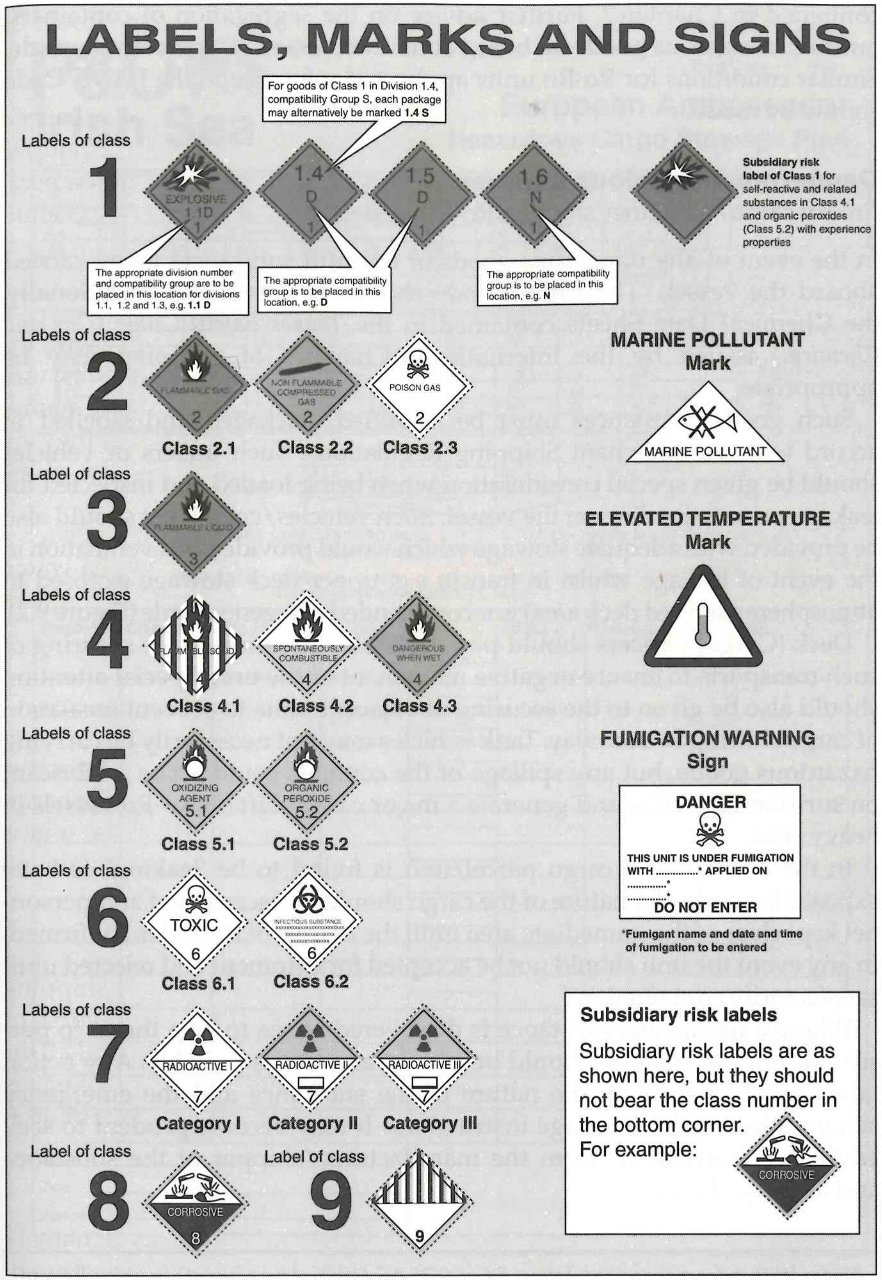


Fig. 9.1 Marking of dangerous classes of goods. Reproduced with kind permission from IMO.

contained in Chapter 7. Further advice on the segregation of containers, housing dangerous goods on board container vessels, is given in the code. Similar conditions for Ro-Ro units apply, and reference to the IMDG Code should be made.

Dangerous/hazardous cargoes

(in dry cargo/container ships or Ro-Ro vessels)

In the event of any dangerous goods or harmful substances being carried aboard the vessel, 'The IMDG Code should be consulted. Additionally, the Chemical Data Sheets contained in the *Tanker Safety Guide (Gas and Chemical)* issued by the International Chamber of Shipping may be appropriate.

Such goods/substances must be classified, packaged and labelled in accord with the Merchant Shipping Regulations. Such trailers or vehicles should be given special consideration when being loaded and inspected for leakage prior to loading on the vessel. Such vehicles/containers should also be provided with adequate stowage which would provide good ventilation in the event of leakage whilst in transit, e.g. upper deck stowage exposed to atmosphere (defined deck area) is recommended as a general rule (Figure 9.2).

Deck (Cargo) Officers should pay particular attention to the securing of such transports to ensure negative movement of the unit. Special attention should also be given to the securing of adjacent units to prevent escalation of cargo shifting in a seaway. Tank vehicles may not necessarily be carrying hazardous goods, but any spillage of the contents could act as a lubricant on surrounding units and generate a major cargo shift on Ro-Ro vessels in heavy seas.

In the event that a cargo parcel/unit is found to be 'leaking' or have exposed hazards, the nature of the cargo should be ascertained and personnel kept clear of the immediate area until the degree of hazard is confirmed. In any event the unit should not be accepted for shipment and rejected until satisfactorily contained.

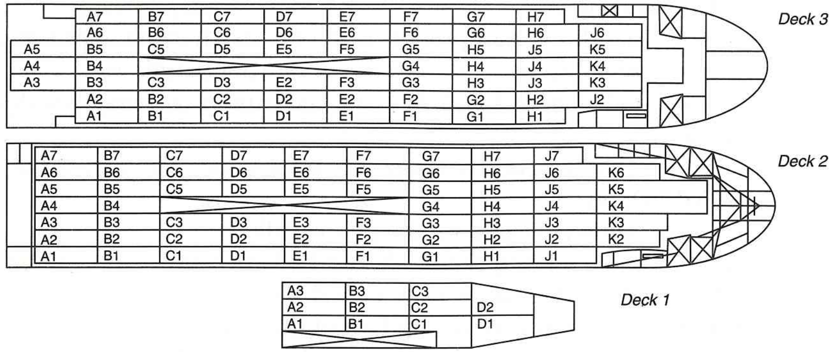
Where a hazardous substance is discovered at sea to be a threat to personnel, full information should be sought as soon as possible. Any action taken would reflect on the nature of the substance and the emergency actions stipulated in carriage instructions. It may become prudent to seek additional instructions from the manufacturer/shipper of the substance and act accordingly.

> ***Note:** With reference to Regulation 54 of SOLAS (1996 Amendment) in ships having Ro-Ro cargo spaces, a separation shall be provided between a closed Ro-Ro cargo space and the weather deck. The separation shall be such as to minimize the passage of dangerous vapours and liquids between such spaces. Alternatively, separation need not be provided if the arrangements of the closed Ro-Ro space are in accordance with those required for the dangerous goods carried on the adjacent weather deck.*

P&O Irish Sea

Top Copy – Shore
Second Copy – Ship
Third Copy – Ship

European Ambassador
Hazardous Cargo Stowage Plan



DK3: CLASS 1 LANE 3,4,5 UP TO FR. 39
LANE 1,2,6,7 FWD. FR. 25 TO FR. 39

Q = DECK 3 AFT OF FR.52 *ONLY*
DECK 1 & 2 O.K.

PHOHIBITED: DECK 1 & 2 : CLASS 1.1-1.6, 2.1, 3.1, 3.2, 5.2, 6.1(B), 8(B)
DECK 3: AS ABOVE BETWEEN FR. 35/39

Position	Class	Reg. No.	UN No.	EMS	MFAG	Remarks: Packaging, etc.

Date ______________________

Time ______________________

Voyage ______________________

Signature: Loading Officer

Fig. 9.2 Stowage and monitoring of hazardous goods in Ro-Ro units.

Precautions when loading/discharging hazardous goods

1. All documentation regarding the 'dangerous goods' should be in order and include the Container Packing Certificate, the Shipper's Declaration and relevant Emergency Information

2. All cargo operations should be supervised by a responsible officer who will be in possession of operational and emergency information.
3. No unauthorized person, or persons, intoxicated or under the influence of drugs should be allowed near to hazardous cargoes.
4. The compartment or deck area should be dry and clear, suitable for the stowage of the cargo.
5. Where cargo-handling equipment is to be used, such equipment should be inspected to be seen to be in good order before use.
6. Dangerous goods should not be handled under adverse weather conditions.
7. All packaging, labelling and segregation of the goods are carried out as per the IMDG Code.
8. Tanks, where applicable, should not be overfilled.
9. Suitable 'Emergency Equipment' should be kept readily available for any and every potential hazard associated with the goods.
10. Fire wires should be rigged fore and aft of the vessel.
11. Packages should be identified and stowed in an appropriate place to protect against accident.
12. Safe access to packages must be available in order to protect or move away from immediate hazards.
13. Emergency stations with suitable protective clothing should be identified in respect to the location of the cargo.
14. Correct signals, i.e. 'B' Flag should be displayed during the periods of loading and discharging.
15. Stowage positions should be such as to protect the goods from accidental damage due to heating. Combustible materials being stowed away from all sources of ignition.
16. Cargoes requiring special ventilation should be positioned to benefit from the designated ventilation system.
17. The Port Authority should be informed of all movements of hazardous goods.
18. Suitable security should be given to special cargoes like explosives.
19. All hazardous parcels should be tallied in and tallied out of the vessel.
20. Some packages may require daylight movement. Some operations may also be effected by rain or strong sunlight and appropriate loading schedules should reflect related hazards.

Note: *Emergency information on cargoes should include:*

- *The correct technical name of the product and its UN number*
- *Classification and any physical and/or chemical properties*
- *Quantity to load and the designated space to load*
- *The stated action in the event of leakage*
- *Fire fighting and spillage procedures, and any specific equipment required.*

Deck cargoes

The term 'weather deck' refers to an open deck which is exposed to the weather on a minimum of two sides. The phrase is synonymous with deck cargo being carried on exposed decks and running a greater risk of loss because of the stowage location. Below decks and unaffected by the elements of weather provides a level of assumed security completely opposite to the weather risks associated with deck cargoes.

Numerous Codes of Safe Practice, conventions and recommendations have been published to advise on the securing and safe transport of specific deck cargoes, inclusive of timber, containers, vehicles, steelwork, etc. The losses incurred over the years would indicate that the force and power of the elements may generate extreme forces on exposed cargoes, causing restraints to part, and cargo parcels to be lost overside.

Such losses, if noted frequently, would probably deter the carriage of any deck cargoes at all. However, certain cargoes must be categorized and classed as deck cargo because of inherent dangers if they were carried below decks, e.g. certain hazardous goods, such as acids and corrosives.

General observance of SOLAS (Chapters 6 and 7), together with the Code of Safe Working Practice for Cargo Stowage and Securing of Cargo Units Including Containers, have become recognized sources of information. Alongside these, full reference to the ship's Cargo Securing Manual should go some way to assisting the Cargo Officer with decisions concerning the number and positioning of securings and restraints on deck cargo loads.

The regulations require that the following criteria are met when carrying deck cargo:

1. That the vessel will have adequate stability at all stages of the voyage for the amount of cargo it is proposed to load. It should be borne in mind that cargoes like coke and timber may absorb up to about one-third of their own weight by water. Also, losses of bottom weight like fuel, oil and water from double bottom tanks would work against the positive stability of the vessel.
2. Adequate provision must be made for the safe access of the crew when passing from one part of the vessel to another. Deck cargoes that prevent access to crews' quarters, either along or underdeck, must be provided with a walkway over the cargo, and in any event walkways are required for ships with timber deck cargoes.
3. Steering gear arrangements must be protected against damage and in the event of a breakdown of the gear, enough deck space must be available to operate an emergency system.
4. If cargo is to be stowed on hatches, these hatches must be correctly battened down and of adequate strength to support the carriage of the cargoes.
5. Decks, designated for the stowage of deck cargo, must be of adequate strength to support the stowage

6. Deck cargo parcels are to be well-secured and, if necessary, protected from the weather elements including the heat of the sun. The height of any cargo should not interfere with the navigation of the vessel and obstruct the keeping of an efficient lookout.

Example deck cargoes

Acids and corrosives – liquid acids and dangerous corrosive substances are usually carried in glass containers known as carboys. These containers are straw protected by a steel wire frame and are often crated for shipping. They are always allocated deck stowage away from crews' quarters in accordance with the IMDG Code and would need to be well lashed and secured against movement. In the event of spillage, the accompanying documentation should be consulted and any persons involved in clear up procedures should be issued with protective clothing inclusive of goggles, gloves and suitable footwear.

Chemicals – the type of chemical substance and its form will depend on its style of packaging. Obviously, the numerous chemicals shipped vary considerably and stowage method would be advised by shippers and supplied documentation. Special attention should be paid to instructions in the event of spillage occuring, as some chemicals react with water or air, and become harmful to personnel if incorrect procedures are adopted.

Containers – regularly carried on open decks of container vessels in the 'stack'. However, containers carrying hazardous goods are identified and given appropriate segregated stowage. Where single containers with dangerous goods are carried on open decks on other than dedicated container vessels, suitable stowage and securing are expected to be provided. The main concern for Cargo Officers is that the goods themselves are secured inside the container and packed under correct supervision and delivered for shipment with a Container Packing Certificate, together with relevant documentation regarding the actual goods inside the container.

Gases – carried in cylinders of various sizes. These must be well-secured against unwanted movement. They should not be stowed near any heat source and protected from the sun's rays, usually by a tarpaulin.

Livestock (see Chapter 6) – most livestock would be carried on a sheltered part of the upper decks, along with shipper's instructions for feeding and hygiene.

Oil (drums) – can be carried below decks as well as above decks. Part cargoes are often carried as deck cargo to provide an improved stability condition without having to shut cargo out. Drums are usually of 50 gallon size and should be tightly packed, the most common being for the carriage and shipping of lubricating oil. Once stowed, they should be securely lashed and bowsed into the side bulwarks. If total deck coverage is employed then a walkway, similar to timber deck cargoes, would need to be constructed to provide crew access to fore and aft parts of the ship.

Steelwork – may be shipped in a variety of forms: castings, bulldozers, rail-

bearers are meant to reduce friction between the deck and load but also spread the deck load capacity weight. In every case, heavy-steel cargoes should be well secured preferably with chains and bottle screws. A combination of chains and wires is also considered as being suitable, depending on the nature of the load. Some loads may lend to being welded to the deck to prevent unwanted movement.

General principles

Deck cargo should be stowed and distributed in a manner that will avoid undue stress on deck areas and ensure that adequate stability is retained throughout the voyage. Certain deck cargoes like timber have the associated danger of absorbing moisture at a position higher than the ship's centre of gravity. With the combined burning off of fuel and the consumption of fresh water from the lower tanks of the vessel the danger to generate a loss of metacentric height (GM) or even create a negative GM is readily apparent. Icing of cargoes, particularly container deck stows, could also be extremely detrimental to the stability of the vessel.

Other cargoes may be large or heavy and generate their own restrictions on the ship. Deck cargoes must not impair the working of the vessel, particularly obstructing the lookouts' duties or preventing access to the working spaces of the vessel. Large cargo parcels could increase the windage experienced by the ship and cause excessive leeway affects and such affects would need to be monitored by Navigation Officers (Figure 9.3).

Fig. 9.3 Securing deck cargoes. Steel pipes seen stowed on upper decks. Chain lashings are stretched across at intermediate lengths and tensioned by ratchet gear once in position. The pipes have been left pre-slung with wire snotters for speed of discharge.

During loading, Chief Officers are advised to ensure that decks are not overstressed by 'point loading' and that supporting structures about the loaded area are adequate to cater for the size and volume of load. All loads must be suitably secured to prevent movement in a seaway, and in the event of heavy weather, prior to sailing.

All deck cargoes should be loaded in accord with the Merchant Shipping (Load Lines) (Deck Cargo) Regulations and S.I. No. 1089 of 1968.

Offshore supply vessels

A major section of the industry is occupied with oil and gas recovery from offshore waters. Offshore installations, from the colossal Production Platforms, to the smaller drilling rigs have the need to be re-supplied on a continuous basis. Cargoes vary in this sector of the industry from the unusual in the form of 'mud' and/or cement, carried in underdeck tanks to the more mundane general stores packed in small containers. The offshore supply vessels, once in close proximity of the installation, are discharged by use of the rig's own cranes. The position of the vessel is held precariously close to the structure of the installation by dynamic position (DP) or by expert ship handling skills of the vessel's Master, weather permitting (Figure 9.4).

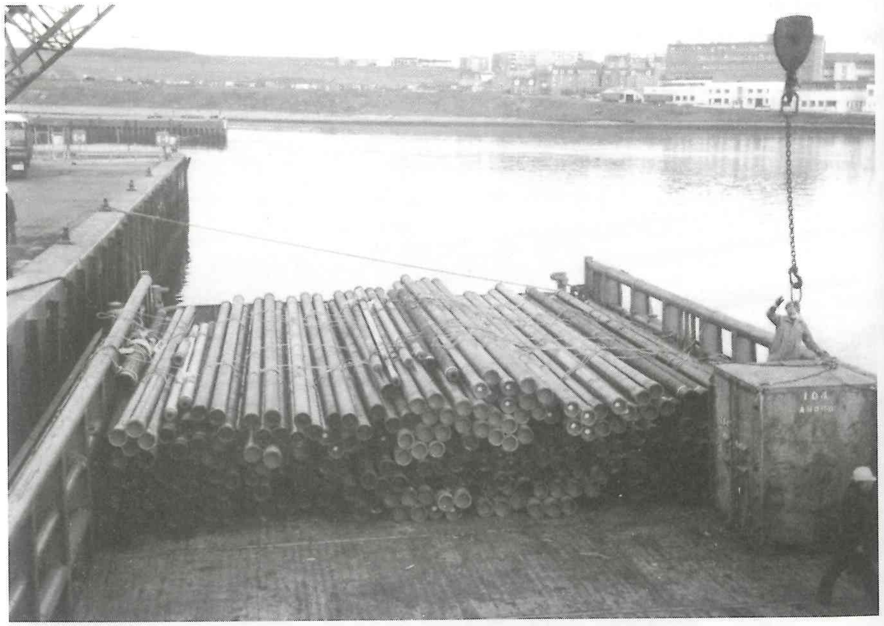


Fig. 9.4 Capped drilling pipes seen loaded on the wide beam cargo deck of an offshore supply vessel. The pipes are capped at each end to prevent water retention in the event of the vessel encountering rough weather. Any fluid in quantity being retained amongst deck cargoes could seriously affect the positive stability of the vessel.

Timber

Special regulations apply to the carriage of timber on deck (see Chapter 6). Separate loadlines may apply and specific securing arrangements are recommended as per the Code of Safe Practice for Ships Carrying Timber Deck Cargoes.

Vehicles

It is not unusual to see vehicles carried as deck cargo on board ships other than designated Ro-Ro types of vessel, especially tractors and other farm vehicles. Heavy-lift bulldozers, and similar tracked vehicles are frequently secured on deck or on hatch top squares. Private cars are generally carried below decks as protection from the weather elements is preferred.

Securing of vehicles on deck by means of rope, wire or even chains for heavy plant vehicles is expected for ocean-going vessels. Some form of chocking or tomming may also be desirable. Cargo Officers should pay particular attention to the securing of these cargoes. They are often the last parcels to be loaded and rigging gangs may be tempted to cut corners to be off the ship prior to sailing.

Once at sea, a prudent Chief Officer would order deck cargo lashings to be tightened, especially in the event of a heavy weather warning.

Chapter 10

Security, cargo documentation, stability examples

Introduction

Since the implementation of the International Ship and Port Facility Security (ISPS) Code in July of 2004, all Ship's Officers have been made aware of the need to be security conscious. This is not to say that before this time personnel were ignorant to the dangers and security risks which have always been associated with the maritime industries. The fact that ports have now installed better security fences, X-ray detection methods, close monitoring of dock transports, and tighter control of crews seems to have provided some degree of improved marine security.

For the Cargo Officer, vigilance is essential and on most ship's security starts with ensuring that correct documentation is presented by the crew members on joining, close inspection of the cargo manifests, correct shipping papers for specific cargoes, etc. It is from such information that the safety of the ship can be assured. The Chief Officer is able to take account of the vessel's stability criteria for all stages of the voyage. Hazardous parcels can be secured and monitored for the protection of personnel and cargo alike, while the function of the ship's crew is to protect the shipowner's interests and affect the delivery of all cargoes in good condition and a safe manner.

It has been said that information is power. It is also abundantly clear that cargo information is an essential element of the ship's well-being. To this end the ports around the world are moving rapidly to comply with the security measures required by the Code. Maritime authorities are continuing to work under the umbrella of the International Safety Management (ISM) System and monitoring the safe operation of vessels on the high seas.

Industry sectors such as Safe Navigation operate with external assistance such as VTS schemes, communication networks and hydrographic departments around the globe. The safe transport of cargoes now similarly employs equal support, in the way of customs, police and in some cases the military, to ensure a secure working environment in the modern world. However, these people cannot be all things to all men and it has become

clear that the Ship's Officer is closer to the front line of safety and security aboard ships than any other individual.

The ISPS Code and cargo security

Introduction

It is difficult to visualize Cargo Officers being directly involved in the cargo security aspects of an 8000 teu container vessel other than being vigilant during loading, discharging and while in transit. The practicalities of searching excessive numbers of containers are clearly beyond their scope. Sampling possibly a few containers at random must be considered the maximum that anyone could expect as being practical. Security of cargoes must therefore be considered at the start of the container's journey when it is empty, prior to the packing stage. The 'stuffing' of the unit must be carried out under supervision and receive a Packing Certificate. The goods would be subject to customs controls and inspection before being sealed.

Units should be provided with secure holding before delivery to the terminal. Once inside the container park, units fall under the security cordon expected by the ISPS Code. Full documentation of the unit is listed with the shipping agents and seals would be inspected prior to loading the unit on board the vessel.

The ability to detect security threats and take preventive action is paramount. The level of terminal security would vary from port to port and the degree of ship/port interface would be established with experience. It would be envisaged that the Port Security Officer (PSO) would liaise with the Ship Security Officer (SSO) regarding all aspects of 'cargo security'. Such liaison is expected to ensure that:

1. tampering of cargo is prevented, and
2. that cargo which is not intended for shipment, is prevented from being accepted and stored on board.

In order to retain a safe environment it is anticipated that such measures will be in place to include inventory and control applications, such precautions being supported by the identification of all cargo parcels on board the vessel. To this end, container companies have installed methods that allow the tracking of all 'box' units and Roll-on, Roll-off (Ro-Ro) units, showing as being approved for loading and shipping by the vessel.

Screening of stores, cargo parcels and unaccompanied baggage tends to rest with the port facility and is meant to be covered by the 'Port Facility Security Plan' (PFSP). Such screening may include the searching of baggage both ashore and on board. Scanning equipment and/or specially trained dogs may very well be used to ensure the security of packages.

The ISPS Code

Application

The ISPS Code is applicable to the following types of vessel on international voyages:

1. Passenger ships, inclusive of high-speed passenger craft
2. Cargo ships, including high-speed craft of 500 gross tonnage and upwards
3. Mobile offshore drilling units
4. Port facilities serving such ships engaged on international voyages.

Definitions effective within the ISPS Code

Ship Security Plan – means a plan developed to ensure the application of measures on board the ship designed to protect persons on board, cargo, cargo transport units, ship's stores, or the ship, from risks of a security incident.

Port Security Plan – means a plan developed to ensure the application of measures designed to protect the port facility and ships, persons, cargo, cargo transport units, and ships stores within the port facility from the risks of a security incident.

Ship Security Officer – that person on board the ship accountable to the master, designated by the company as responsible for the security of the ship, including implementation and maintenance of the Ship Security Plan and for the liaison with Port Facility Security Officers.
Note: The master can now be the designated SSO.

Company Security Officer – means that person designated by the company for ensuring that a ship security assessment is carried out; that a Ship's Security Plan is developed, submitted for approval and thereafter implemented and maintained, and for liaison with Port Facility Security Officers and the SSO.

Port Facility Security Officer – means the person designated as responsible for the development, implementation, revision and maintenance of the PFSP and for liaison with the SSO and the Company Security Officer (CSO).

Security 'Level 1' – means that level for which minimum appropriate protective security measures shall be maintained at all times.

Security 'Level 2' – means that level for which appropriate additional protective security measures shall be maintained for a period of time as a result of heightened risk of a security incident.

Security 'Level 3' – means that level for which further specific protective security measures shall be maintained for a limited period of time when a security incident is probable or imminent, although it may not be

Ship -- the term ship as used within the context of the code includes mobile offshore drilling units and high-speed craft as defined by Regulation XI-2/1.

Ship/port interface – means the interactions that occur when a ship is directly and immediately affected by actions involving the movement of persons, goods or the provisions of port services to or from the ship.

Ship-to-ship activity – means any activity not related to a port facility that involves the transfer of goods or persons from one ship to another.

Security incident – means any suspicious act or circumstance threatening the security of the ship, or of a port facility or any ship/port interface or ship-to-ship activity.

Security level – means the qualification of the degree of risk that a security incident will be attempted or will occur.

Security threats

Clearly in this day and age any threat to the ship or the port's facilities could have a direct consequence to personnel working aboard or within the port confines. The PFSP is meant to identify such threats and prioritize protective security actions. Such threats may take on a variety of forms from damage to the ship or port facilities – i.e. from an explosive device, arson, tampering with cargo, smuggling activities – to the extreme of nuclear, biological or chemical attack.

Cargo concerns

Anything that generates cause to affect the well-being of cargo parcels is of concern to Ship's Officers. Pilferage from open stow cargoes has long been an expensive activity and to some extent containerization went a long way to curb theft. However, thieves are known to hijack the whole container, often with insider knowledge as to its contents. Other cargoes are of a higher profile and more readily visible, requiring immediate and increased security – like, for instance, nuclear waste flasks (Figures 10.1 and 10.2).

Shipboard security activity

Many aspects of shipboard activity are exposed to abuse and threats to security. Some of these are listed and officers should be mindful of the security elements associated with the following:

1. The handling of cargo which may contain harmful substances or terrorist personnel
2. The handling of unaccompanied baggage
3. The handling and loading of ship's stores
4. Controlling access of persons who may have criminal intent
5. Monitoring berthing areas in close proximity to the ship's hull

Fig. 10.1 Nuclear waste flasks discharged with full heavy-lift precautions onto special transports in Japan monitored by security mobiles and specialized personnel. Open aspects and security fencing surround the working area of the port facility.

Fig. 10.2 Security personnel monitor nuclear waste flasks, following discharge into the port facility handling grounds. Customized transports are designated

7. Controlling the embarkation of persons and their effects (especially so with high-profile vessels carrying increased numbers of passengers) (Figure 10.3).

Fig. 10.3 High-profile passenger ship 'Queen Mary 2' lies port side to alongside the berth in Southampton. Such vessels require maximum security within the port facility and on all access points to the vessel.

Security progress

In order to be compliant with the ISPS code, Safety of Life at Sea (SOLAS) has been amended to include relevant requirements:

1. All ships on international voyages will be equipped with Automatic Identification System (AIS).
2. Companies will be expected to install Ship Security Alert Systems on their vessels.
3. Ships will run a continuous synopsis record while in service from the time of launching for new builds.
4. Companies must report to a flag, state-appointed, recognized security organization and create internal positions for dedicated CSO as well as on board SSO.
5. Companies will develop their own security plans to suit each individual vessel, which must be implemented on board.
6. Vessels which are compliant will be issued and International Ship Security Certificate (ISSC) by the companies recognized safety organization. This organization will also be responsible for conducting internal audits.

Application
The ramifications of the ISPS Code will mean that practical activities to safeguard the ship and cargoes will begin to operate; for example, masters being informed beforehand of the presence of self-igniting chemicals; containers being scanned inside the terminal before being loaded aboard the vessel; while tighter access controls into terminals and onto ships will expect to create a more security conscious environment.

Cargo documentation summary

Ballast Management Record – the dangers to aquatic life have instigated the need for tighter controls on the movement and in particular, the discharge of ballast waters. Positions of ballast change, dates, amount and tank location.

Bill of Lading (B/L) – are the consignee's title to the goods which have been shipped or are about to be shipped. The B/L will quantify the goods and refer their condition at the time of shipping and he/she would expect to receive the goods at the port of discharge in the same good condition as when shipped. In the event that the goods are damaged at receipt or in loading or discharging the B/L would be endorsed to specify the damage. Such an endorsed B/L would be considered as a dirty or foul B/L, as opposed to a clean B/L which is without endorsement. The B/Ls are usually drawn up by the shipping agent and signed by the Master of the Vessel.

Cargo manifest – the official listing of all cargo parcels carried on board the vessel. This document is what the master bases his declaration on when entering port; all cargoes being officially declared on the manifest which is subject to inspection by Customs Officers, and port security inspection.

Cargo Record Book – vessel engaged in the carriage of noxious liquid substances must carry a record of the cargo movements affecting the ship. The same ships would also be expected to carry a Maritime and Coastguard Agency (MCA) approved *Procedures and Arrangement Manual*, reflecting the operational aspects of the vessel.

Cargo Securing Manual – a legal requirement for every ship other than those engaged in the carriage of solid or liquid bulk cargoes. The purpose of the manual is to cover all relevant aspects of cargo stowage and securing. Securing devices and methods must meet acceptable criteria for strength, applicable to relevant cargo units, inclusive of containers and Ro-Ro transports. Each manual is prepared in a manner to reflect the individual ship's needs, relevant to the type of cargo parcels it is engaged to ship.

Cargo stowage plan – a charted plan of the vessel's cargo-carrying spaces which illustrates the type, tonnage and description of goods for designated discharge in the various intended ports of call for the voyage. The plan is constructed by the Cargo Officer and is meant to provide an overall illustration of the distribution of the ship's cargo. The plan is copied and despatched to the various ports of discharge prior to the ship's arrival on

the berth. It allows relevant cranes to be ordered and stevedore gangs to be employed in advance which subsequently speeds up the time of the vessel lying in port. It is considered essential for dry cargo vessels, tankers, bulk carriers and container vessels to all carry stowage plans respective to their relevant cargoes.

Certificate of Fitness – is required by every UK tanker and gas carrier. These are issued by the MCA and are valid for a period not exceeding five (5) years, being subject to initial, annual and intermediate surveys. This certificate cannot be extended.

Charter party – is a private contract between the principal parties to an agreement and is evidence of who the operator of the ship is. Charter parties are set in three categories: Time Charter, Voyage Charter or a Demise Charter (US Bare Boat Charter). Variations of the three categories are drawn up based on the operational requirements of the ship and the intended voyage.

Container Packing Certificate – the packing and unpacking of containers usually takes place at shore terminals or at the address of the shipper or consignee. Prior to loading on board the vessel, a valid Container Packing Certificate must be received as evidence that the goods have been packed in such a way as to withstand carriage at sea. It is also a security check that the unit does not contain contraband goods and that the merchandise is as what is described on the certificate. Container units are now electronically scanned at entry to many shipping terminals.

Document of Authorization – is a required certificate issued by a surveyor following survey of the ship's cargo holds and its ability to carry cargo safely. Unless the ship is in the possession of an Exemption Certificate, the Document of Authorization would be an official requirement.

Document of Compliance (dangerous goods) – a certificate of compliance issued to a type of ship that is permitted to carry certain categories of hazardous/dangerous goods. Not all ships can carry hazardous cargoes; for example, passenger vessels are not allowed to carry Class 1, explosives.

Enclosed space entry permit – a work permit which is issued prior to entry into an enclosed space compartment. The permit is issued only after all the required safety checks and inspections of the compartment have been made and the relevant precautions have been taken.

Export licences – these are supplied by the shipper as required for certain specific cargoes: computers, foodstuffs, livestock, armaments, etc. The export licence is required by Government/State Officials for certain types of cargoes which are subject to inspection by customs (e.g. armaments, drugs, etc.).

International Security Certificate – issued to a vessel by a recognized security organization confirming that the ship is compliant to the ISPS Code.

Mate's Receipt – a receipt for goods received and delivered on board the vessel. As the name implies, it is signed and issued by the Mate of the Ship, i.e. the Chief Officer. It may form the basis for the final B/L.

Note of Protest – is where the Master of a Ship makes a declaration of 'Protest' under oath before a Notary Public, Magistrate or British Consul. The declaration often affects cargo damaged or suspected of having damage due to a 'peril of the sea'. The main use of Protest in the UK is to support a cargo owner's claim against his underwriters. The Note of Protest is admissible as evidence before legal tribunals in many countries, but not in the UK unless both parties agree. Masters should note Protest as soon after arrival in port and before 'breaking bulk'. The master may extend 'Protest' once the situation has been further assessed and the full extent of damage is revealed.

Register of Lifting Appliances and Cargo-Handling Gear – a record of all the ship's cargo-handling equipment, usually retained and updated by the Ship's Chief Officer. It contains all the certificates for such items as shackles, blocks, wires, derrick and crane tests, hooks, chains, etc. The register is open to inspection by Port State Control Officers and would be required by the surveyor when carrying out the Cargo-Handling Equipment Survey.

Rigging plan – a ship's arrangement plan which illustrates the operational aspects of the ship's lifting appliances. Safe working loads and maximum permissible outreach limits would expect to be displayed alongside the related positions of cargo stowage compartments.

Stability information booklet – the ship's stability criteria may be in booklet format or in the form of a series of plans, or even carried in a combination format of both. Either way the documents are in the control of the Ship's Chief Officer and will include the following: general particulars of the vessel; a general arrangement plan showing cargo compartments and tank dispositions; special notes on the stability and loading procedures; hydrostatic particulars; metric conversion table; capacity plan showing centre of gravity of cargo stowage compartments (to include free surface moment of oil and water tanks); notes on the use of free surface moments; cross curves of stability (known as KN curves) with examples of their use; deadweight scale; list of ship conditions and typical condition sheets; statical stability curve for conditions; simplified stability information together with damaged stability criteria.

Transportable Moisture Limit (TML) Certificate – a certificate issued within 7 days of measuring the moisture limit of the bulk product to be shipped.

Abbreviations used in the following example calculations

A	Aft
AP	Aft perpendicular
C of G	Centre of gravity
cm	Centimetre
CoT	Change of trim
d	distance
DW	Dock water
DWA	Dock water allowance
F	Forward

G	Position of the ship's C of G
GG_1	Movement distance of the ship's C of G
GM	Metacentric height
KG	Measured distance between the keel and the C of G of the vessel
KM	Measured distance between the keel and the metacentre
L	Length of ship
l	A proportionate length of the ship's length
M	Metacentre
m	metres
MCTC	Moment to change trim 1 cm
mm	Millimetres
RD	Relative density
Stbd	Starboard
SW	Salt water
tan	tangent
TPC	Tonnes per centimetre
W	Displacement of vessel
w	added or discharged weight

Cargo work – stability examples

Example 1

A vessel of 5870 tonnes displacement has a load draught of 5.4 m with a TPC = 11. Calculate the load draught of the vessel if she is a working cargo in fresh water.

$$\text{FWA} = \frac{W}{4 \times \text{TPC}} = \frac{5870}{4 \times 11} = 133.4 \text{ mm}$$

$$= 0.133 \text{ m}$$

$$\text{Load draught in FW} = 5.40 + 0.133 = 5.533 \text{ m.}$$

Example 2

A vessel has a load draught in SW of 6.4 m. Calculate the maximum load draught in DW of RD 1.010. The ship's FWA is 75 mm.

$$\text{DWA} = \text{FWA} \times \frac{1025 - \text{density of DW}}{25}$$

$$= 75 \times \frac{1025 - 1010}{25}$$

$$= 75 \times \frac{15}{25}$$

$$= 45 \text{ mm} = 0.045 \text{ m}$$

$$\text{Maximum draught} = 6.40 + 0.045 = 6.445 \text{ m.}$$

Note: *DWA being the amount the vessel may legally submerge her disc (Plimsoll Line) when loading in a DW of less density than that of*

Example 3

A vessel of 10 000 tonnes displacement with a KG of 7.0 m loads 100 tonnes of KG 12 m. Calculate the new KG of the vessel, by taking moments about the keel.

Weight	*KG*	*Moment*
10 000	7.0	70 000
+100	12.0	+1200
10 100		71 200

$$\text{Final KG} = \frac{\text{total moment}}{\text{total weight}} = \frac{71\,200}{10\,100}$$
$$= 7.0495 \text{ m.}$$

Example 4

A vessel of 12 000 tonnes displacement has a KG of 7.8 m and a KM of 8.6 m. She then loads the following cargo parcels:

250 tonnes at KG of 11.0 m
100 tonnes at KG of 7.0 m and
50 tonnes at KG of 3.0 m

Calculate the vessel's final GM after completion of loading.

Weight	*KG*	*Moment*
12 000	7.8	93 600
+250	11.0	+2750
+100	7.0	+700
+50	3.0	+150
12 400		97 200

$$\text{Final KG} = \frac{\text{total moment}}{\text{total weight}} = \frac{97\,200}{12\,400} = 7.839 \text{ m.}$$

$$\text{GM} = \text{KM} - \text{KG} = 8.6 - 7.839$$
$$= 0.761 \text{ m}$$

Example 5

A vessel of 7500 tonnes displacement with KG of 6.0 m, and KM of 6.8 m, is expected to load timber on deck in a position of KG 11.0 m. Calculate the maximum weight of timber that can be loaded in order to arrive at the destination with a GM of 0.2 m if an allowance of 15% increase in weight is anticipated with water absorption by the deck cargo.

Let the weight of cargo to be loaded = w

Weight	*KG*	*Moment*
7500	6.0	45 000
1.15w	11.0	12.65w
7500 + 1.15w		45 000 + 12.65w

$$\text{Final KG} = 6.8 - 0.2 = 6.6$$

But

$$\text{Final KG} = \frac{\text{total moment}}{\text{total weight}} = \frac{45\,000 + 12.65w}{7500 + 1.15w}$$
$$\therefore 6.6 = \frac{45\,000 + 12.65w}{7500 + 1.15w}$$
$$\therefore 49\,500 + 7.59w = 45\,000 + 12.65w$$
$$4500 = 5.06w$$
$$w = \frac{4500}{5.06}$$
$$w = 889 \text{ tonnes of timber to load.}$$

Example 6

A ship of 10 000 tonnes displacement is to load a heavy lift of 100 tonnes with a KG of 3.0 m by means of the ship's heavy derrick. The head of the derrick is 24 m above the keel. The ship's KM was 7.0 m, with a KG of 6.2 m before loading. The load is to be stowed on the ship at a KG of 6.0 m.

Calculate: (a) the minimum GM experienced and (b) the final GM.

(a)
$$GG_1 = \frac{w \times d}{W}$$
$$= \frac{100 \times (24 - 3)}{10\,000}$$
$$= 0.21 \text{ m}$$

$$\therefore \text{KG} = 6.2 + 0.21 = 6.41 \text{ m}$$

$$\therefore \text{GM} = 7.0 - 6.41 = 0.59 \text{ m}$$

(b)

$$GG_1 = \frac{100 \times (6 - 3)}{10\,000} = 0.03\,\text{m}$$

$$\therefore KG = 6.2 + 0.03 = 6.23\,\text{m}$$
$$\therefore GM = 7.0 - 6.23 = 0.77\,\text{m}.$$

Example 7

Note: When the C of G of a vessel moves off centre, an upsetting lever is produced which causes the vessel to list until G and M are in the same vertical line. The angle of heel due to G being off centre is found by the formula

$$\tan\theta = \frac{\text{Transverse } GG_1}{GM} \quad \text{but} \quad GG_1 = \frac{w \times d}{W}$$
$$\therefore \tan\theta = \frac{w \times d}{W \times GM} = \frac{\text{listing moment}}{W \times GM}$$

A vessel with 4000 tonnes displacement which is initially upright moves a 12 tonnes weight 7 m transversely across the deck. The ship's GM with the weight on board is 0.3 m. Calculate the resulting list.

$$\tan\theta = \frac{w \times d}{W \times GM} = \frac{12 \times 7}{4000 \times 0.3}$$
$$\theta = 4°0'.$$

Example 8

A vessel of 11 000 tonnes initial displacement loads a 50 tonnes weight by a floating crane in a position 12 m to port off the ship's centre line. Assume that the KG and KM remain constant and that the vessel is upright prior to loading. Calculate the angle of list if the ship's GM is currently 0.25 m.

$$\tan\theta = \frac{w \times d}{W \times GM} = \frac{50 \times 12}{11050 \times 0.25}$$
$$\therefore \theta = 12°25' \text{ to port.}$$

Example 9

A vessel of 10 000 tonnes displacement with an initial GM of 0.2 m conducts the following cargo operations:

Loads 50 tonnes 4 m to Stbd of the centreline.
Loads 70 tonnes 5 m to port of the centreline.
Discharges 90 tonnes 3 m to Stbd of the centreline.
Shifts 40 tonnes 6 m to Stbd.
Assuming KG and KM

Weight	*Distance off centre*	*List moment*	
		Port	*Stbd*
10 000	–	–	–
+50	4 m Stbd		200
+70	5 m port	350	
−90 (discharge)	3 m Stbd	270	
+40 (transferred)	6 m Stbd		240
10 030		620	440
		440	
		180 (port)	

$$\therefore \tan\theta = \frac{180}{10\,030 \times 0.2}$$
$$\theta = 5°13' \text{ to port.}$$

Example 10

A vessel of 160 m length, loads 40 tonnes in a position 60 m from the AP. Calculate the final draughts if the initial draughts are forward 5.0 m aft 6.0 m. The longitude centre of floatation is 70 m forward of the AP. The ships TPC is 20, and MCTC is 100.

$$\text{Sinkage due to load} = \frac{\text{weight loaded}}{TPC} = \frac{40}{20} = 2\text{ cm}$$
$$CoT = \frac{w \times d}{MCTC} = \frac{40 \times 10}{100} = 4\text{ cm (by stern)}$$
$$\text{CoT aft due to CoT} = \frac{l}{L} \times CoT = \frac{70}{160} \times 4 = 1.75\text{ cm}$$
$$\text{CoT forward due to CoT} = 4 - 1.75 = 2.25\text{ cm}$$

	Forward	*Aft*
Initial draughts	5.0	6.0
Sinkage	0.02	0.02
	5.02	6.02
CoT	−0.0225	+0.0175
Final draughts	4.9975F	6.0375A.

Appendix A
Miscellaneous cargo information

Introduction

A text of this size cannot hope to cover every commodity or every situation that Ship's Officers encounter. Cargoes are varied and can be carried in many alternative forms. The following brief notes are meant to portray the fundamentals that go along with and support the various chapters and specifics expressed throughout this work.

Charter Party

A formal agreement to hire, rent or lease a ship. It is a private contract between two parties and may be written up in several formats, i.e. Time Charter, Bare Boat Charter or a Demise Charter.

Demurrage

Monies paid by the Charterer to the owner of the ship for delays in loading and unloading in accord with the terms of the Charter Party. The rate of demurrage is fixed and agreed between the owner and Charterer at the time of completing the Charter Party and cannot be altered. Can be taken in contrast with 'Despatch Money' opposite to demurrage where the owner pays reward money to the Charterer for completing loading and/or discharging earlier than the expiry of 'Laytime'.

Freeboard Form (FRE 13)

Following the completion of cargo operations in a port, the ship's draughts will expect to have changed. The draughts fore and aft should be read and the mean draught obtained.

It is a legal requirement that before the ship sails outward, the 'Freeboard Certificate' is completed and displayed for the crew to see that the vessel is not overloaded and the minimum bow height is not exceeded (Figure A.1).

DRAUGHT OF WATER AND FREEBOARD NOTICE

Form FRE 13

Issued by the Department of Transport pursuant to Section 10 (2) of the Merchant Shipping (Load Lines) Act 1967

SHIP ....PORT OF REGISTRY ....

GROSS TONNAGE ....

(Where a ship has alternative gross tonnages, both must be given)

(1) Summer freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to .... feet .... inches).
(2) Winter freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to .... feet .... inches).
(3) Tropical freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to .... feet .... inches).
(4) Winter North Atlantic freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to .... feet .... inches).
(5) Allowance for fresh water for ail freeboards other than timber freeboards* .... millimetres.
(6) Timber Summer freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to .... feet .... inches).
(7) Timber Winter freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to .... feet .... inches).
(8) Timber Tropical freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to............ feet .... inches).
(9) Timber Winter North Atlantic freeboard* .... millimetres corresponding to a mean draught † of .... millimetres (equal to .... feet .... inches).
(10) Allowance for fresh water for timber freeboards* .... millimetres.

* Particulars to be given above of freeboards and allowance for fresh water are to be taken from the load line certificate currently in force in respect of the ship. Paragraphs referring to freeboards which the certificate shows have not been assigned to the ship must must be deleted.

† The mean draught to be given below is the mean of the draughts which would be shown on the scales of measurement on the stem and on the stem post of the ship if it were so loaded that the upper edge of the load line on each side of the ship appropriate to the particular freeboard were on the surface of the water.

Where the draught is shown on the scales of measurement on the stem and on the stem post of the ship in feet the mean draught must be given in both millimetres and feet and inches using an equivalent of 25.4 millimetres to one inch.

PARTICULARS OF LOADING								
1	2	3	4	5	6	7	8	9
Date	Place	ACTUAL DRAUGHT			MEAN FREEBOARD		SIGNATURE OF MASTER AND AN OFFICER	
		Forward	Aft	Mean	Actual (see notes 1 and 2 below)	Corrected (see note 3 below)	Master	An Officer

NOTES (1) The actual mean freeboard (column 6) is the mean of the freeboards on each side of the ship at the time when the ship is loaded and ready to leave.
(2) If the actual mean freeboard is less than the appropriate minimum salt water freeboard as shown on the load line certificate there must be entered in Column 7 the corrected freeboard arrived at after making any allowances for density of water, rubbish to be discharged overboard and fuel, water and stores to be consumed on any stretch of river or inland water, being allowances duly entered in the ship's official log book.
(3) If the actual mean freeboard is greater than the appropriate salt water freeboard, Column 7 need not be filled in.

This Notice should be posted in some conspicuous place on board the ship, where it can be seen by all members of the crew, before the ship leaves any dock, wharf, harbour or other place for the purpose of proceeding to sea and is to be kept so posted until after the ship arrives at any other dock, wharf, harbour or place.

The date and time of recording the above particulars on each occasion must be entered in the Official Log Book.

This Form should not be handed in with the Official Log Book and Agreement at the termination of the Agreement. It can be used until completed, when a further copy should be obtained.

Fig. A.1.

Freight
Charges made for carriage of the cargo. Advance freight is money paid before the delivery of the cargo – freight being payable concurrently with delivery of the cargo at the port of destination.

Heavy weather and cargo procedures
In the event of heavy weather possibly affecting a ship's passage, certain obvious precautions, depending on the nature of the cargo carried, can be adopted to protect the cargo condition:

1. Investigate an alternative route for the vessel clear of weather-affected areas.
2. Improve the ship's stability and reduce any free surface effects.
3. Tighten up on any cargo lashings, especially deck cargo lashings and heavy lifts.
4. Reduce speed in ample time to avoid the vessel pounding.
5. Adjust the ship's head to avoid excessive rolling.
6. Close up ventilators to avoid water ingress.
7. Check all hatch and access seals are secure.

Laytime
Described as that time which is available to the Charterer to load or discharge the Chartered Cargo, free of any charge other than the freight charges. Laytime cannot commence until three conditions have been satisfied that:

1. the vessel is an arrived ship (under legal terms)
2. Notice of Arrival has been tended (it does not need to have been accepted)
3. the vessel is in all respects ready to load or discharge.

Lifting plant – tests and examination
It is a legal requirement that lifting apparatus like derricks and cranes are periodically tested:

- after installation when new
- following any defect and major repair to the plant
- at intervals not exceeding five (5) years.

Additionally, it would be considered a normal practice for the Cargo Officer to inspect the lifting appliances prior to their use. Each apparatus would also be thoroughly examined by a responsible person (i.e. the Chief Officer) at least every twelve (12) months.

Notice of protest
Masters would 'Note Protest' for any of the following cargo reasons:

1. Whether damage has been caused or is suspected of being caused to cargo.
2. Whenever the ship has encountered heavy weather which may have

3. Where cargo is known to have been damaged through a peril of the sea.
4. Where cargo is shipped in such a state that it is likely to deteriorate during the voyage (Bills of Lading (B/L) should be also endorsed in this case).
5. Where a serious breach of the Charter Party has occurred by the Charterer or his agent, e.g. refusing to load cargo, or delaying the loading, loading improper cargo.
6. In all cases of general average being declared.
7. When consignees fail to take delivery of cargo and pay due freight in accord with the terms of the Charter Party or B/L.

Oil-filtering and monitoring equipment (oil water separators)
Every ship of 400 GT and above, but less than 10 000 GT, shall be fitted with oil-filtering equipment which complies with an approved design in accordance with the specifications for such equipment as set out in the recommendations on International Performance and Test Specifications for oily water separating equipment and oil content meters.

Every ship over 10 000 GT and above shall be provided with:

1. oil-filtering equipment (as stated)
2. oil-content-measuring equipment fitted with a 15 parts per million (ppm) alarm device and with arrangements for automatically stopping any discharge of oily mixture when the oil content in the effluent exceeds 15 ppm.

Oil record books
Current legislation require oil tanker vessels to carry two (2) Oil Record Books, one for cargo movement and one for fuel movements. Non-tanker type vessels are only required to carry one (1) Oil Record Book.

Entries into Oil Record Books should cover any movement of oil in or out of the vessel, including internal transfers between tanks. Each entry in the book should be signed by the Ship's Master and another officer.

Security
The Master of the Vessel should not be constrained by the company, the Charterer or any other person, from making a decision which, in his professional judgement as the master, is necessary to maintain the safety and security of the ship. This includes the loading of cargo, including containers or other enclosed cargo transport units, which may have a direct threat to the well-being of the vessel or personnel on-board.

Vapour-recovery systems (protecting the environment)
More and more use is being made of Vapour-Recovery Systems in order to reduce emissions of volatile organic compounds (VOCs) in offshore

introducing legislation to ensure that all offshore loading operations have reduction plants in operation by 2005. When cargo tanks are loaded with crude, hydrocarbon gas emissions are vented to air and the loss may be estimated to between 100 and 300 tonnes for each loading. The recovery systems are meant to be economic and currently three types are employed:

1. *Absorption* of non-methane VOCs (NMVOCs) into the crude being loaded.
2. *Liquefaction and the storage* of NMVOCs to be discharged at a later time, or used as onboard fuel.
3. *Sequential transfers* of tank atmospheres during the cargo operations of loading and discharging.

Reliquefied VOC emissions can be used to fuel the VOC recovery plant as well as similar steam-driven on-board systems. It can also be used as a blanket gas in cargo tanks instead of inert combustion gases. Further use can be achieved by discharging it ashore for use as fuel or further refining.

Appendix B

Self-examiner – questions and recommended answers to cargo related examples

Calculations and questions

Example 1

Calculate by how many millimetres a ship may submerge her loadline when she is currently loading in dock water of relative density (RD) 1.013, if the vessel has a fresh water allowance (FWA) of 190 mm.

$$\text{Dock Water Allowance} = \text{FWA} \times \frac{(1.025 - \text{water density number})}{1.025 - 1.000}$$

$$= 190 \times \frac{(1.025 - 1.013)}{0.025}$$

$$= 190 \times \frac{(0.012)}{0.025}$$

$$= 91 \text{ mm}$$

Summer loadline may be submerged by 91 mm.

Example 2

A rectangular tank of 9 m length and 6 m breadth has a depth from the ullage plug of 11 m. Find how many tonnes of oil of a RD of 0.83 does the tank contain when the ullage is 350 mm?

Depth of tank = 11.0 m
Ullage = <u>0.35 m</u>
Depth of oil = 10.65 m

Therefore the volume of oil $= 9 \times 6 \times 10.65\ m^3$
$= 575.1\ m^3$

Weight of Oil = Volume × Density
$= 575.1 \times 0.83$
$= 477.33$ tonnes.

Example 3

What is the smallest purchase that could be used to lift a 5 tonne weight with flexible steel wire rope having a safe working load (SWL) of the wire equal to 3.125 tonnes?

$$S \times P = W + \frac{nW}{10}$$

Assuming the purchase is to be used to disadvantage P = n.

$$\text{Then} \quad 3.125 \times P = \frac{(5 \times P)}{10} + 5$$
$$2.625P = 5$$
$$P = 2$$

Therefore a gun tackle is the minimum purchase to use for this lift.

Example 4

Calculate the maximum number of tonnes which can still be loaded into a vessel whose tonnes per centimetre (TPC) = 19 and FWA = 190 mm. Her loaded salt water freeboard is 2310 mm and her present freeboards are 2420 (starboard (Stbd)) and 2404 mm (port), in water of RD 1.009.

Present freeboards 2420 mm Stbd, 2404 mm Port } true mean freeboard = 2412 mm

$$DWA = 190 \times \frac{(1.025 - 1.009)}{1.025 - 1.000}$$
$$= 121.6 \text{ mm}$$

Corresponding salt freeboard

2412 + 121.6 = 2533.6 mm

Permitted freeboard = <u>2310 mm</u>

Sinkage allowed = 223.6 mm

(TPC = 19, TPmm = 1.9) × <u>1.9</u>

Cargo to load = <u>424.84 tonnes</u>

where TPmm represents tonnes per millimetre.

Example 5

A cargo tank with an area of 75 m^2 is being filled from a pipe of 200 mm in diameter. The ullage is now 1.6 m. Calculate how much longer the filling valve must be left open to obtain an ullage of 800 mm, if the average rate of flow through the pipe is 1.75 m/s?

Difference in ullages = 1600 mm − 800 mm = 800 mm (0.8 m)

Volume of liquid to load = 75 m^2 × 0.8 m = 60 m^3

Area of pipe $= \pi r^2 = 3.1416 \times 100 \times 100$

$$= 31416 \text{ mm}^2$$
$$= \frac{31416}{1000 \times 1000} \text{m}^2$$

Volume of liquid loaded per second

$$= \frac{31416}{1000 \times 1000} \times 1.75 \text{m}^3$$

Time to load 60 m^3

$$= \frac{60 \times 1000 \times 1000}{31416 \times 1.75} \text{s}$$
$$= 1091 \text{ s or } 18.18 \text{m}$$

The valve should be left open for a further 18 min.

Example 6

A ship is 140 m long and displaces 10 000 tonnes is floating at draughts 6.5 m forward and 7.7 m aft. The vessel is scheduled to enter a canal where the maximum draught allowed is 7.2 m. Calculate the minimum amount of cargo to discharge from a compartment which is 30 m forward of the aft perpendicular. The ship's TPC = 16, moment to change trim (MCTC) = 180 and the centre of floatation is amidships.

Change in draught aft = 7.7 − 7.2 = 0.5 m (50 cm)

Change in draught aft = Rise + Change due to Change of Trim

$$\text{Therefore} \quad 50 = \frac{w}{TPC} + \frac{1}{2} \times \frac{(w \times d)}{MCTC}$$
$$= \frac{w}{16} + \frac{1}{2} \times \frac{w \times (70 - 30)}{180}$$
$$= \frac{360w + (16 \times 40w)}{16 \times 360}$$
$$50 \times 16 \times 360 = 369w + (16 \times 40w)$$
$$288\,000 = 360w + 640w$$
$$w = \frac{288\,000}{1000}$$

w = 288 tonnes represents the minimum cargo to discharge.

Example 7

What do you understand by the term 'loadicator' and what information would you obtain from it?

Answer

A loadicator is the term given to a cargo-loading computer, which is configured to suit the ship's loading programmes. The loadicator will provide the Cargo Officer with the following information once the weight distribution is entered into the programme. Distribution of weights or cargo units in the ship's compartments, the status of relevant tank weights and commodities, the sea-going shear force and bending moment conditions, and the stability aspect with values for measured distance between the keel and the centre of gravity (C of G) of the vessel (KG) and metacentric height (GM). Ballast distribution and quantity would also be available.

The loadicator is often linked to a shoreside monitor to allow data transmission on unit weights for cargo distribution and special stowage requirements. Particularly relevant to a Roll-on, Roll-off (Ro-Ro) vessel engaged on fast turn round, short voyage trades.

Example 8
How would you load a bulk carrier with iron ore?
Answer
Ensure that the hold is clean and that bilge suctions are tested to satisfaction prior to commencing loading. Draw up a pre-load plan and a ballast/deballast plan calculating the stress factors affecting the ship throughout the proposed loading programme. The maximum angle of heel would also be calculated for a potential shift in the cargo volume, bearing in mind that a moisture content is present in the cargo.

The loading rates for the cargo would commence slowly and gradually increase. Fast rates of loading can cause serious damage by generating rapid stress values throughout the ship's length. The important aspect is that iron ore is a dense cargo and heavy. The cargo compartments would only be about one-fourth full. The Chief Officer would calculate the stability based on the load draughts. Condition formats for the bending moment and shear force affecting the loaded condition would be drawn up (stowage factor (SF) iron ore 0.34/0.50).

Example 9
What are the concerns for the Master of a Container Vessel, carrying containers stacked on deck, engaged on the North Atlantic trade in winter?
Answer
The Master, and his Chief Officer would be concerned about the positive stability of the vessel, bearing in mind that the possibility of encountering sub-freezing air temperatures on this trade route at this time is likely. Such conditions could lead to ice accretion, and added weight from icing of the container stack could detrimentally affect the stability of the vessel.

Masters would monitor all weather reports and consider re-routing farther south to warmer latitudes if practical. A reduction in speed could also effectively reduce the rate of ice accretion occurring on the vessel. Where possible, the crew should be ordered to make their best endeavours to remove ice formations if safe to do so.

Example 10
When working as a Cargo Officer aboard an oil tanker, how would you keep the tanks outside the 'flammable limit'?

Answer
The introduction of inert gas into any tank containing hydrocarbon gas/air mixture will decrease the flammable range until a point is reached where the lower flammable limit (LFL) and the upper flammable limit (UFL) coincide. This point corresponds to the oxygen content approximately 11% at which no hydrocarbon gas/air mixture can burn.

> ***Note:*** *Additional reference should be made to the 'Flammability Composition Diagram' found in International Safety Guide for Oil Tankers and Terminals (ISGOTT).*

Example 11
What and when is 'lateral drag' evident and what can the Cargo Officer do to reduce the effects?
Answer
Lateral drag is associated with heavy lifts causing the vessel to heel over as the weight is taken up by the ship's derrick/crane. It can occur during loading or discharging of the load and is effectively a sideways movement of the load as the vessel returns to the upright. If unprepared for, the lateral movement of the load can be violent as the ship rolls against the angle of list.

The effects of lateral drag can be reduced by retaining the line of plumb of the derrick head above the point of landing. This can be achieved by 'coming back' on the topping lift and cargo hoist runner, quickly. This action tends to reduce movement of the load when discharging. If loading the weight a steady slow lifting operation should be carried out.

Example 12
When about to make a heavy lift by means of the ship's heavy derrick, how can the vessel's stability condition be improved so that positive stability is retained throughout the loading period?
Answer
The concern with loading a heavy weight is that the C of G of the weight effectively acts from the head of the derrick. The GM of the ship should be increased by filling the double bottom tanks before the lift is made. This will increase the GM value. Additionally, eliminate any free surface moments in tanks, as this also will reduce the GM value.

Example 13
How can the risk of a grain cargo shifting be reduced?
Answer
Grain should be loaded in accord with the 'Grain Regulations' and the risk of 'shifting' of the cargo can be reduced by:

1. fitting of temporary longitudinal subdivisions (shifting boards)
2. use of bagged cargo in a saucer formation
3. bundling in bulk

Example 14
How would you describe the 'SF' of a commodity?
Answer
The SF can be defined as that volume that is occupied by a unit weight of cargo and is usually expressed in cubic metres per tonne (m^3/tonne).

$$\text{By example: SF} = \frac{\text{Volume of space}}{\text{Tonnage}}$$

For example, how much cotton at a SF of 2.0 m^3/tonnes could be loaded into a tween deck space of 200 m^3

$$\text{Tonnage} = \frac{\text{Volume of space}}{\text{SF}} = \frac{200}{2}$$
$$= 100 \text{ tonnes cotton.}$$

Example 15
When loading drop trailers and mobile units aboard a Ro-Ro ferry, explain why it is essential that the vessel is kept in the upright position.
Answer
Ro-Ro ferries load their mobile units via vehicle ramps either at the bow or more often through the stern door. These ramps are lowered onto link spans that provide the landing connection between ship and shore. If the vessel develops a list the ramps become angled to the flat shore connection and prevents the movement of vehicles to and from the ship's garage spaces.

Most modern ferries will have automatic stabilizing tank systems to counter any overload to Port or Starboard, so keeping the vessel always in the upright position and vehicle ramps flush on the shore or the link span.

> ***Note:*** *Over-reliability on tank stabilizers should be avoided and safe practice is always to load and discharge in an even manner to avoid any one side ever become adversely affected by localized tonnage.*

Example 16
When would it be considered appropriate to carry out a 'draught survey'?
Answer
The purpose of a draught survey being conducted would usually be to:

1. ascertain any bending along the length of the vessel, usually after the loading of a bulk cargo
2. determine the exact displacement in order to calculate the total weight of cargo loaded.

Example 17
A vessel is scheduled to load sacks of mail. How would these be loaded on a general cargo vessel if they are loose and not in a container, and what precautions would a prudent Chief Officer take? (Figure B.1)

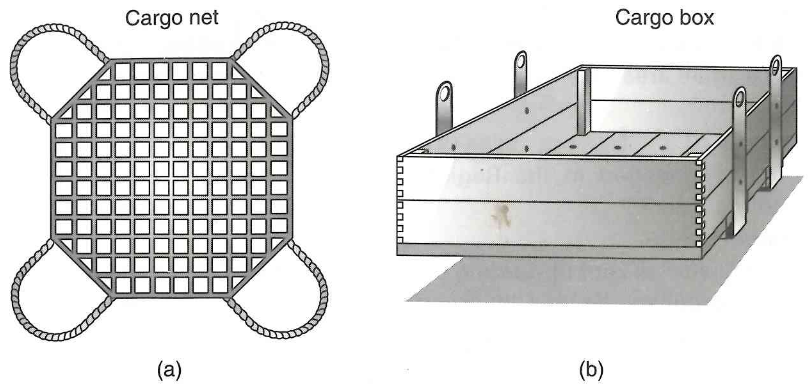


Fig. B.1

Answer
Mails are classed as a specialized cargo and as such would be given lock-up stow.

The bags would be tallied in and tallied out at the ports of loading and discharge, respectively. Watchmen or responsible Ship's Officers would monitor the movement of the mails probably being loaded by means of cargo nets or cargo boxes.

Example 18
What cargo information would the Master of a 'Bulk Carrier' pass to the loading terminal when expecting to berth, to take a full cargo of coal?
Answer
1. In addition to passing the ship's particulars, a pre-loading plan of cargo stowage by hatch, together with the hatch loading order and respective quantities on each pour, assuming that the vessel has sufficient information to prepare such a plan. Confirmation that holds were in a state of readiness to load.
2. The provisional arrival and departure draughts together with details of the ship's own cargo-handling gear and respective capacities of same; details of the ballast capacity and the time required to de-ballast.
3. Additional ship-keeping details reflecting the 'gangway' position, the number of moorings, etc. would also be included as standard information.

Example 19

For what purpose would a Cargo Officer use the 'load density plan'?

Answer

The Ship's Chief Officer would use the load density plan to check the capacity of cargo compartments to ascertain the volume of the space and consider the 'point loading' factor to ensure that the deck strength is adequate to accommodate the intended cargo tonnage to be stowed in the space. Particularly useful with heavy lifts where a concentrated weight over a small area may be seen to exceed the tonnage per square metre.

Example 20

What is contained in the Register of Lifting Appliances and Cargo-Handling Gear?

Answer

The 'Register' is kept up-to-date by the Ship's Chief Officer and contains all the certificates for the lifting appliances, the wires, shackles hooks, chains, etc. used aboard the vessel, for cargo operations.

Appendix C

Codes and conventions affecting cargo work operations, additional references and bibliography

Codes and conventions effecting cargo work operations

Code of Safe Working Practice for Merchant Seaman

Code of Safe Working Practice for the Loading and Unloading of Bulk Cargoes

Inert Gas Code

IMDG, Code (Hazardous Cargoes)

IMO (BLU Code)

IMO, Code of Safe Working Practice for Cargo Stowage

IMO, Construction and Equipment Code (Ships Carrying Dangerous Chemicals in Bulk)

IMO, Grain Regulations

IMO, ISPS Code

International Bulk Cargo Code
International Code for the Safe Carriage of Grain
International Safety Management Code

MARPOL Convention and Subsequent Amendments

Merchant Shipping Regulations for Control of Noxious Liquid Substances in Bulk

Merchant Shipping (Load Lines) (Deck Cargo) Regulations

SOLAS '74 Convention (and Subsequent Amendments)

ICS Tanker Safety Guide (Chemicals)

Additional references

Statutory instruments

S.I. 1509: 1997, The Merchant Shipping (Cargo Ship Construction) Regulations 1997

S.I. 1644: 1999, The Merchant Shipping (Additional Safety Measures for Bulk Carriers)

S.I. 336: 1999 Merchant Shipping-Safety. M.S. (Carriage of Cargoes) Regulations

S.I. 929: 2004, Gas Carrier Amendment Regulations

S.I. 930: 2004, Dangerous or Noxious Liquid Substances in Bulk: Amendment Regulations

MGN 144, The Merchant Shipping (Additional Safety Measures for Bulk Carriers) Regulations 1999

MGN 157, Safety of Personnel during Container Securing Operations, MCA

MIN 154 (M) Safe Loading of Bulk Carriers

Bibliography

Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas, IMO

Cargo Access Equipment, published by Clarke Chapman

Cargo Stowage and Securing, A Guide to Good Practice, Charles Bliault

Code of Safe Practice for Cargo Stowage and Securing, IMO

Code of Safe Practice for Ships Carrying Timber Deck Cargoes, IMO

Design and Operation of Ships Derrick Rigs, British Standards Institute

Hatch Cover Inspections, W. Vervloesem, Nautical Institute

International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships, IMO

International Safety Guide for Oil Tankers and Terminals (ISGOTT), Witherbys

Lashing and Securing of Deck Cargoes, Capt. J.R. Knott, BA.FNI, Nautical Institute

Thomas' Stowage, Brown Son and Ferguson

Commodity and detail index

This commodity index, lists numerous cargo type and product varieties, but it is not exhaustive. Not all items are detailed within the main text and users are advised to reference shipper's documentation as well as other associated works.

Limited detail on commodities is enclosed together with the stowage factor where appropriate and the relevant page number if considered within the main body of this work.

	Commodity name and details	Stowage factor (m^3/tonne)	Page reference
Oil (Palm)	Heating required - Bulk	1.09	
	Barrels	1.62–1.67	
Oil cake	In bags	1.53–1.95	
	IMDG code	Varies	
Olives	In kegs or drums	1.90–1.95	
Olive oil	Barrels drums or bulk	1.67–1.73	
Onions	Good ventilation		199
	May taint. Cases and crates	2.23–2.29	200
	20 bags per ton	2.37–2.51	
Oranges	Cases or cartons	1.67–1.81	198
	Tainting damage possible		
Ores	Various types of varying densities (in bulk or stated otherwise)		119
	Iron	0.33–0.42	
	Zinc	0.56–0.67	
	Bismuth in bags	0.84	
	Chrome	0.34	
	Aluminium	0.84–0.92	
	Manganese	0.47–0.50	
	(Galena) Lead	0.36–0.39	
Paint	In drums	0.50–0.56	86
Paper	Keep dry and requires careful handling		87
	Reels	1.20–2.65	
	Bales	1.3–1.8	
	Rolls	1.67 and 1.81	
Peaches	In cartons. Refrigeration.	3.78	87, 88
Pears	Fruit cases or cartons	2.05–2.96	87, 88
Pepper/spices	In bags	2.06–2.51	91
Personal Effects	Usually in crates	2.83	88, 89
Phosphates	In bulk: granular	1.12	121
	Rock	0.92–0.98	
Pig Iron	Bulk. Angle of repose 36°	0.30	118
Pipes	Bundles	1.67	273, 274
Pit Props	In bundles	6.41–7.25	190
Plums	In cartons	2.34–2.41	87, 88
Potatoes	Bags	1.53–1.81	79
	Crates or cartons	1.62–1.90	
Poultry	Crates or cartons. Deep frozen	1.67–2.23	197
Prunes	In cases or bags (Dried fruit)	1.39–1.45	87
Pulses	Bulk	0.47	107
Radio active materials	Stow away from crew reference IMDG code	Varies 1.53–2.09	261, 263

	Commodity name and details	Stowage factor (m^3/tonne)	Page reference
Rice	In bags. Liable to heat and sweat and susceptible to strong odours. Must be kept dry	79, 80, 107	
	Paddy rice	1.81–1.95	
	White rice	1.39–1.45	
Rope	In coils	2.23–2.78	
Rubber	In block or crepe form. Cases	1.90–1.95	81
	Bales	1.81–1.87	
	Sheet	1.67	
	Crepe	3.34	
Rum	See spirits		
Rye	Grain regulations apply. Requires extensive trimming		
	Bulk	1.39	107
	Bags	1.53	
Salt	In bags or bulk. Bags	1.06–1.11	122
	Bulk	0.98–1.11	
Salt rock	Granules. Angle of repose 30°. Bulk	0.98–1.06	
Sand	In bulk	0.53–0.56	
Sanitary ware	In cases/crates	4.18	
Seeds	Stowage factor varies with product	1.28 to 3.76	107
Sheep dip	In drums	1.25–1.53	86
Soda Ash	In bags (Treat as dirty cargo)	1.11–1.25	79
Soya bean	Bulk or bags. Bulk	1.23–1.28	
	Bags, from US	1.59–1.62	
Spirits	In cartons. Inflammable. Special lock up stow, highly pilferable. Also carried in bulk tank containers	1.67–1.81	82
Steel work	Heavy cargo		74–77, 117–119, 272
	Bars	0.33–0.45	
	Billets	0.28–0.39	
	Castings	1.12–1.39	
	Plates	0.28–0.33	
	Pig Iron	0.28–0.33	
Scrap		Various	104, 118
Steel coils	May weigh up to 20 tonnes. Also as pipes, castings and plant machinery	Various	33, 76, 77, 119
Sugar	Dry sugar and Green, (raw wet sugar)		79, 121, 132, 240
	Dry sugar in bulk	1.11–1.25	
	Dry sugar in bags	1.28–1.34	
	Green sugar in bags	1.11–1.17	
Sulphur-	Shipped in bulk. Fire, dangerous	0.84–0.89	121, 122

	Commodity name and details	Stowage factor (m³/tonne)	Page reference
Tallow	Deep tank stow with heating	1.67–1.78	92
Tea	Chests: Delicate cargo and must be stowed away from odorous commodities	2.79–3.07	91
Tiles	Crates	0.98–1.39	
Timber	Carried in many forms and as deck cargo. Danger from absorption when on deck	Various	188–194, 275
Tin	See ingots		86
Tin plate	Bulk packs	0.28–0.39	
Tobacco	In cases	2.23–3.34	81, 91
Tomatoes	In crates and boxes	1.95–2.09	
Tyres		4.18–4.87	
Vegetable oils	Oil or fat from plants. Shipped in drums or deep tanks	1.67	94, 162
Vehicles	See cars. Ro-Ro and car carriers		
Whale oil	In drums	2.09	162
	In bulk	1.14	
Wheat	Bagged or bulk. Grain regulations apply		82, 84, 107, 162
	Bulk	1.18–1.34	
	Bags	1.34–1.50	
Whiskey	Bottled in cartons (see spirits) S/F 1.67. Also in bulk in container tanks		
Wild animals	Livestock	–	200, 201
Wine	Cases (bottled) Also now in bulk tanker vessels. Cases	1.67–1.95	6, 82–84, 126
Wood pulp	Liable to damage by moisture. Shipped in bales	1.25–1.39	81, 189
Wool	In bales will vary depending on country of origin. Average	0.48	81

The reader should note that modernization, especially the use of containers has rendered many packaging systems obsolete. However, produce packed into containers tends to generally follow the normal standards regarded as necessary for the safe carriage of commodities as 'General Cargo' procedures dictated.

General index

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