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ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ: ΠΑΝΑΓΟΠΟΥΛΟΥ ΜΑΡΙΑ

ΘΕΜΑ: TIME SPENT IN PORT(CARGO HANDLING)

ΤΟΥ ΣΠΟΥΔΑΣΤΗ: ΡΑΠΤΟΠΟΥΛΟΣ ΑΝΔΡΕΑΣ
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Ημερομηνία ανάληψης της εργασίας:
Ημερομηνία παράδοσης της εργασίας:

Α/Α	*Ονοματεπώνυμο*	*Ειδικότητα*	*Αξιολόγηση*	*Υπογραφή*
1				
2				
3				
ΤΕΛΙΚΗ ΑΞΙΟΛΟΓΗΣΗ				

Ο ΔΙΕΥΘΥΝΤΗΣ ΣΧΟΛΗΣ : Cpt. ΤΣΟΥΛΗΣ ΝΙΚΟΛΑΟΣ

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INTRODUCTION

The transport of cargoes dates back through the centuries to the Egyptians, the Phoenicians, ancient Greeks and early Chinese, long before the Europeans, ventured beyond the shores of the Atlantic. In the past, commerce was very much alive with a variety of merchandise being transported over water. Products from the world's markets have grown considerably alongside technology. Bigger and better ships feed the world populations and the methods of faster and safer transport have evolved over the centuries. Ships remain the most efficient means of transport for all cargo parcels of any respectable weight or size. The demand for raw materials continues to sustain a major sector of the shipping industry.

Bulk products are shipped all over the world from their point of origin to that position of demand. The 'bulkers' transport every- thing from grain and coal to chemicals and iron ore. The bulk trades involve vast tonnage movement of any one commodity and such movement can present its own hazards and problems associated with the cargo. It is the science of cargo handling that the business of how it is loaded, how it is stowed and subsequently shipped to its destination will be investigated here. The Chief Officer is usually that person designated on board the vessel who is responsible for the handling and safe stowage of all cargoes loaded aboard the ship. He is responsible for receiving the cargoes and making sure that the holds are clean and ready to accept stowage and shipping in a safe manner. He is ultimately responsible for the carriage ventilation and delivery in good condition of all of the vessel's cargo.

In order to carry goods safely, the vessel must be seaworthy and the cargo spaces must be in such a condition as not to damage cargo parcels by ships sweat, taint or cause any other harmful factor. To this end the Chief Officer would cause a cargo plan to be constructed to ensure that separation of cargoes are easily identifiable and that no contamination of products could take place during the course of the voyage. The Chief Officer's prime areas of duty lie with the well-being and stability of the vessel together with the safe carriage of the cargo. Clearly, with the excessive weights involved with cargo parcels, the positive stability affecting the vessel's safe voyage could be impaired.

A correct order of loading with the capability of an effective discharge, often to several ports, must be achieved to comply with the safe execution of the voyage and also to stay within regulatory conditions. The loading/discharging period is the most important one for the Master and for his officers. Events happen quickly. Unexpected problems can arise if the cargo is unfamiliar or the port unknown and will require prompt attention to ensure that the ship and cargo are protected from damage throughout. The system used to be the deck officers for sharing the supervisory work during loading/discharging will be governed by the number of officers carried. The Master will hold himself available to advise where required or will take a more active supervisory role of his officers if they are inexperienced or when the manning provides only a Master and one mate. A high level of alertness will be required from the start to the end of the loading/discharging period.

In the later chapters, we will deal with specifics on the methods of handling, the practical stowage of goods and its proper documentation, which will be considered the essential element.

LOADING PERIOD

The Loading/Deballasting Plan: When a satisfactory distribution of cargo has been obtained, a plan must be devised for loading the cargo whilst keeping stresses within the permitted limits throughout the process and always maintaining a sufficient stern trim to assist efficient deballasting. Limited depth of water and height below the loading arm may restrict the draught and air draught which can be accepted. The plan should provide all the information required by deck officers and loading personnel, presented in a clear and logical manner. Copies of the completed plan should be available as working documents ashore and aboard, and a copy should be filed aboard ship as an actual record of the cargo and ballasting operation.

The loading plan lists each step in the deballasting, and the corresponding cargo pour. (A pour is the quantity of cargo poured into one hold as one step in the loading plan. Other expressions sometimes used for a pour are a 'run', a 'shot' and a 'drop'). A pass is composed of a pour into each of the holds to be loaded. Thus a ship loading five holds with 30.000 tons of cargo might load with a first pour of 3.000 tones in each hold. When the first pass was completed 15.000 tones would be distributed between the five holds. The second pass would be composed of a second pour of 3.000 tones into each of the five holds.

If a realistic loading/deballasting plan is to be devised, the following information is required:

- Maximum safe draught in berth.
- Minimum depth in the approach to the berth.
- Water density at the berth.
- Tidal range.
- Maximum arrival trim and propeller immersion required by the port.
- Maximum permitted sailing draught.
- The minimum air draught beneath the ship loader.
- Characteristics of loading equipment.
- Limits of movement of the loading equipment.
- The maximum theoretical loading rate.
- Any restrictions on the ship's freedom to load in any sequence and hold.
- Any restrictions on deballasting.
- The number of ship loaders to be used.

As a starting point it is normal to assume that each pour will consist of about half the total tonnage to be loaded into the compartment in question. On occasions when it is particularly desirable to minimize longitudinal stresses three pours, each consisting of about one third the total tonnage for the compartment, will be used. The loading sequence (or loading rotation) depends upon the size of ship and the number of holds to be loaded, but some guidelines can be offered.

- The first pour should where possible be into a midship or after hold to provide or maintain a reasonable trim by the stern for ballast stripping purposes.
- If the air draught is restricted it will be necessary to make the first pour into a hold which causes some increase in forward draught to ensure that the loading spout can continue to clear the hatch coamings of the forward holds.
- If the air draught is restricted the effect of a rising tide must be considered and deballasting may have to be stopped or the rate reduced if the clearance permitted by the port or the terminal.
- Successive pours should alternate between forward and holds to maintain a reasonable trim by the stern. Where safe to do so the trim by the stern should be 0.01 ship's length, or more, when stripping double bottom ballast tanks.
- The ends holds have the biggest effects upon trim. Where possible they should receive the last pours of the first pass, because the resulting large changes in the trim and maximum draught are likely to be least inconvenient at that point.
- The ballast which is likely to present most problems should be discharged first, the normal sequence commencing with ballast holds, continuing with double bottom tanks and wing tanks and concluding with peak tanks.
- Ballast should normally be discharged from a position close to the one where the cargo is being loaded at that time. For example, No.3 double bottom should be discharged whilst No.3 hold is being filled, if No.3 double bottom is below No.3 hold.
- The time required for a deballasting step should be matched with the time required for a loading pour. A pour of 3,000 tons at a loading rate of 1,500 tons/hour will take two hours. This should be programmed with a

deballasting step which will take less than two hours, so as to reduce the likelihood that the deballasting will overrun, and become out of step with the loading.

- The ballasting should be programmed to be completed several hours, at least, before completion of loading, and at a time when the vessel still has a stern trim, to assist the deballasting and stripping.
- On many bulk carriers trim can be quickly and conveniently changed by pumping ballast directly from forepeak to afterpeak, or vice versa.
- Rules imposed by the Classification Society and quoted in the loading manual may restrict the sequence of loading: they must be strictly observed. For example the manual may state that no hold can be completely filled until the mean draft is at least two thirds of the intended sailing draft.
- In exposed berths the ship should be maintained at a draft and trim at which she can put to sea at short notice if required. This precaution is particularly recommended in areas where ports must be evacuated on the approach of a tropical storm.

From a starting point with the ship in ballasted condition and ready to commence loading, calculations must be undertaken for each step in the loading program me. These calculations are similar to those already undertaken for each stage in the loaded voyage, and are intended to find the ship's draft, trim, stability and longitudinal stresses at each stage in the loading. They are essential to ensure that the ship is not subjected to excessive bending moments and shear forces during the course of the loading, and their importance cannot be overstated.

Whenever the calculations show that the draft, trim, stability or stresses at the end of a stage are unacceptable, the program me must be changed by changing the loading or deballasting sequence or quantities. Unfortunately it is sometimes necessary to amend a number of earlier stages to remove a problem which arises in the later stages. When this occurs the data for all the stages which have been amended must be recalculated.

When rearranging the ballast and the cargo pours aboard a vessel to alter her trim or stresses the rules quoted earlier are still applicable:

- To reduce trim by the head, or increase trim by the stern, load cargo aft or discharge ballast from forward.

- To reduce hogging stresses load cargo at midship or discharge ballast from the forward and after ends of the ship.

- To reduce shear forces and bending moments whilst maintaining the same trim move two equal weights in opposite directions at opposite ends of the ship.

Sometimes it will be found very difficult to devise a loading/deballasting program which remains within the stress limits. Difficulties are more likely if the ship is observing the at-sea stress limits whilst in port to increase the safety margin and reduce the danger of structural damage to the ship during the loading process. Several steps can be recommended to reduce the calculated stress values and improve the program, like:

- The pour sizes can be varied. Better results may be obtained if 60 per cent, say, of the tonnage is loaded in the first pour, and 40 per cent in the second, or vice versa.
- The number of pours can be increased, using three pours in holds where two give difficulties. Since each shift of the loading spout will take 10min or so, this will slightly increase the time required for loading making this option less attractive than safer loading achieved by varying the size or the sequence of the pours.

Tonnage Distribution of the Cargo: Having calculated the total tonnage of cargo to be loaded, it is necessary next to decide upon the tonnage to be loaded into each hold. Many factors have to be taken into consideration when making decision. Given the right combination of circumstances such as the ship's past record carrying the same cargo the decision can be a very easy one but when the requirements are more exacting skill, experience and patience will be required to find the best solution. The steps in the calculation are as follows:

- **Decide how many holds are to be loaded**. *If a full low-density cargo is to be carried, all holds will be loaded, though some may not be full.*

❖ **Share the total cargo between the holds**. *The first tentative sharing of the cargo between the holds can be based upon a standard condition from the ship's stability manual, the tonnages used on a previous voyage, or a sharing based upon proportion.*

❖ **Place fuel, fresh water and other weights in the positions intended for departure from the loading port**. *A position for the centre gravity of each item of weight must be used in the calculation*.

❖ **Calculate the ship's draught and trim on departure and ensure that they are acceptable**. *The mean draught will be as required, in case a mistake has been made a rearrangement of the cargo between holds must be made.*

❖ **Calculate the ship's stability characteristics on departure and ensure that they are acceptable**. *They will not be acceptable if the fail to meet the minimum requirements stated in the ship's loading manual.*

❖ **Calculate the shear forces and bending moments on departure and ensure that they are not excessive**. *The maximum allowable still water bending moments and shear forces will be stated in the loading manual.*

❖ **Check that the tonnage allotted to each hold is not greater than the classification society permits**. *This check is important to ensure that the ship is not overstressed, but often the requirement is not clearly stated in the loading manual, particularly on older ships.*

❖ **Check that the hold tanktop loadings are not excessive when the cargo is one such as steel coils or slabs**.

❖ **If the ship is to be block loaded ensure that the loadings for individual holds remains within the special block loading limits set by the classification society.**

❖ **Work through the voyage stage by stage**, *adjusting bunker quantities to reflect bunkers consumed and taken, and repeating the calculations at steps for arrival at and departure from each port.*

❖ **If any of the above steps given an unacceptable result the cargo tonnages or other weights must be redistributed**, *and the calculation must then be repeated*.

❖ **When an acceptable cargo distribution has been produced it must be carefully reconsidered**, *to see whether any errors have been introduced.*

Preloading Surveys: There will often be a requirement for a preloading survey of the holds and for a draught survey, before the loading starts. Where the vessel is a regular trader employed on a period time charter carrying the same commodity every voyage, preloading surveys of the holds are less likely to be required except when the cargo is easily contaminated. Draught surveys by independent surveyors are not required when the charter party states that the tonnage carried is to be established by some other means such as shore weighing, although ship's personnel should always make their own survey to calculate a ship's figure for cargo loaded.

Normally the ship's agent will be able to advise the Master whether surveys will be required, if there is any doubt. When surveys are undertaken it is sensible to treat surveyors with courtesy and consideration. A surveyor undertaking a preloading survey of holds should be accompanied by an officer, preferably the chief mate and a seaman, and should be helped to gain access to holds and assisted with lighting and ladders, if required. Radio contact between the hold inspection team and ship's staff on deck will expedite the inspection and also provide instant communication if any accident happen or any defects be found. The draught surveyor should also be accompanied by an officer when taking his readings. For soundings of bunker the chief or second engineer is usually the appropriate person.

When the vessel is berthed the cargo should be inspected ashore in the stockpile, silos, trucks or wagons or in the lighter before it is loaded, as it is always easier to object to unacceptable cargo before it has been loaded and many bulk ports do not have the facilities to discharge cargo from a ship's holds once it has been loaded. Officers must be on the lookout for any defects which would make the cargo unacceptable or which might later be blamed on the ship if not seen, recorded and made the subject of a protest. Whether the cargo cannot be inspected ashore it should be regularly inspected at the point of delivery aboard ship.

Monitoring the Loading: Monitoring of the cargo loading must have the highest priority because it is better to get things right the first time, since it can be very difficult to correct mistakes in loading. Ships' personnel must keep in mind the fact that the interests of the shippers of the cargo and of those employed to load it are not necessarily the same as those of the ship's personnel. What is convenient for one party may be quite the opposite for another.

The initial positioning of the shiploader arm must be watched to ensure that the calculated airdraught is available in practice. If the shiploader has insufficient height to plumb the hold it may be necessary to alter the

ballast. Alternatively, if the extra height needed is small, it may be possible to allow access to shiploader by using ballast to list the ship towards the quay. If the ship is already fully ballasted the list should be created by discharging ballast from an after topside or double bottom tank to avoid any decrease of the forward mean draught. As soon as sufficient cargo has been loaded to achieve the required increase in draught, ballast should be used to bring the ship upright again.

The OOW must regularly check that the loading is continuing in accordance with the loading program. Each pour must be loaded into the correct hold and into the correct hold and into the correct position in that hold. Ideally the cargo should be poured across the breadth and along the length of the hold to satisfy the requirement of the IMSBC Code (International Maritime Solid Bulk Cargoes) that the cargo should be trimmed reasonably level to the boundaries of the cargo space and to ensure that the load is distributed evenly throughout the hold. This can be readily achieved when the loading head is able to travel to positions in which it can plumb the full length and breadth of the hold. Provided that the loader keeps moving from port to starboard and back again, and does not dwell on one side of the centerline, the ship will be kept upright and the cargo will be symmetrically distributed. If there are valid reasons why the cargo need to be trimmed reasonably level the IMSBC Code requires the shippers to inform the Master in writing giving full details prior to loading. It is also necessary to ensure that the correct cargo is being loaded. If the loading program calls for iron ore fines in No.3 hold and iron ore pellets in No.5 hold, the OOW must ensure that the cargo being loaded in No.3 hold does look like fines, not pellets. From time to time during the pour he must confirm that the cargo continues to have the same appearance and that are no signs of contamination, or of excessive moisture.

The method of loading must be kept under survey and the ship's requirements must be enforced. If the ship is to be kept upright and all cargo is to be poured amidships, the ship loader operator must be reminded as necessary of the requirement. If the cargo is to be spout trimmed in the hold involving some listing of the ship first one way and then the other, the operator must be warned if he exceeds an acceptable amount of list. When a list develops as a result of uneven the deballasting, the shiploader operator must be informed so that he does not try to eliminate it with cargo. Some bulk carriers are fitted with list indicator lights on the bridge wings. For example, a row of lights, green to starboard and red to port, with a single white light amidships, may be fitted. When the ship is listed 2 degrees to starboard two green lights will be lit. When indicators of this sort are available it may be necessary to bring them to the attention of the operator of the shiploader.

If the cargo is not evenly distributed in each hold – if the ship is kept upright by balancing the excess cargo on the starboard side of one hold with the excess cargo on the port side of another hold – the ship will be twisted and may suffer serious structural damage. It is essential that a ship which develops a list because there is too much cargo to starboard in No.2 hold is brought upright with cargo poured to port in the same hold. The ship should be upright at the completion of each pour.

The OOW will find it useful to have a reasonable idea of the loading rate. The time taken for the first pour will provide an indication of the rate in tones/hour. This can be checked against whatever rate the loading foreman or ship's agent has predicted. A slower rate than that predicted will be unsurprising since it is common practice to quote the best rate rather than the average rate. A faster rate than that forecast needs careful examination to confirm that it is correct and to consider its effect upon the rest of the loading/deballasting program.

It will also be useful to observe whether the loading rate is a steady or a fluctuating one. That can often be determined by watching the flow of cargo from the spout or by observing the method of delivery of the cargo to the loading conveyor. Once the loading rate and any variations in it have been observed, it can be used to predict the time when each pour will finish. Pours which finish unexpectedly early or continue excessively should be carefully checked to confirm that the correct tonnage has been delivered.

The quantity of cargo loaded in each pour must be monitored as far as possible. A useful check can be obtained by taking a set of draught readings and checking the soundings of the working ballast tanks when the loader moves from one loading position to the next. Provided that the readings can be obtained quickly whilst loading is stopped, the results can be studied after loading has resumed and should be in good agreement with the values shown in the loading program. If they are not in good agreement, there must be a mistake in the tonnage loaded, the quantity of ballast discharged or the loading program and it will be a matter of urgency to recheck everything and find the mistake.

Establishing Quantity of Cargo Loaded:

The quantity of cargo loaded aboard a bulk carrier can be measured in a variety of ways. The only method which directly involves the ship's personnel is the draught survey, but before considering this method in detail

it is worth giving brief consideration to methods which may be used ashore. An understanding of these methods will help in assessing their reliability.

❖ **Electronic weighing of cargo on conveyor belt:** The most common method of weighing used at modern loading terminals is the belt scale. This device continuously weighs the material on a selected length of the loading conveyor belt and multiplies this instantaneous weight value by the belt speed. The signal thus obtained is at all times proportional to the rate of material flow on the belt. Some commercial belt scales rely on magneto-elastic load cells. These devices rely upon the fact that the magnetic characteristics of steel are affected by mechanical stress. The accuracy of a belt scale depends largely on the design of the conveyor and the way it is used calibrated and maintained.

❖ **Electronic weighing of cargo in grab:** Cargo being discharged or loaded by grab can be weighed whilst in the grab by an electronic system. A computerized system can then record and total the tonnage handled. A working accuracy of 0.1 per cent is claimed by the manufacturers, but this is dependent upon the crane being motionless and in windless conditions when the weight is recorded. In practice these conditions are rarely met.

❖ **Tallying of number of grabloads:** It is reported that receivers have taken delivery of a part cargo with the claim that each grabload discharged, filled to capacity, and weighed two tones. This could not possibly be a reliable basis for measurement of the cargo and completion of discharge at the next port revealed a shortage of 514 tones.

❖ **Weighing of trucks on weighbridge:** For accuracy this method depends upon all trucks passing over the weighbridge with the results being accurately recorded and upon the tare weight of each truck being accurately known. This is best achieved by weighing the unloaded vehicle on its return journey. Accuracy also depends upon the truck fitting fully onto the weighbridge and this requirement has been ignored on occasion. Weighbridges have a potential accuracy of ±0.2 %.

❖ **Automatic bulk grain weighers:** These machines are suitable for weighing grain and free-flowing materials fed from elevators, conveyor belts, storage hoppers or silos. They are produced in various sizes and can record weights in cycles from 30kg up to 5 tons. They can deliver at rates of up to 1000 tons per hour. When this machinery is correctly installed and maintained by the manufacturers and regularly inspected by a reliable local regulatory authority an accuracy of ±0.1 per cent is to be anticipated. Such a degree of accuracy is a general requirement within the grain trade. It should however be stressed that the degree of accuracy attained depends upon the regularity of inspection, servicing and maintenance.

❖ **Shore based systems in general:** At best, all the foregoing methods can be only as accurate as the design of the weighing equipment allows. At worst, if the equipment is not regularly calibrated and if not all cargo is weighed, the results may bear little relationship to reality. Cargo which drops on the deck or into the dock from partly closed grabs or which leaks out of insecure or overloaded trucks can form a significant percentage of the total, and it is worthwhile keeping record of occasions when this is a problem backed up with photographic evidence where possible. Even cargo which blows away from open grabs, trucks or stockpiles represents a loss of weight and should be noted. Shore measurement can be useful, but the importance of independent measurements made by the ship cannot be too strongly emphasized. Mistakes are sometimes made by operators ashore or instruments develop faults, and some spectacular and embarrassing errors in loaded quantity have resulted from failure by ship's staff to take their own accurate independent measurements. It cannot be emphasized too strongly that the ship must make regular draught checks during loading to avoid ending up loaded too deeply.

❖ **Draught Survey:** The ship's method of determining the amount of cargo loaded is by means of draught surveys taken before and after the loading is carried out. With the data so obtained the ship's displacement before and after loading can be calculated. In simple terms the increase in displacement after loading, adjusted for any change in weights such as ballast, equals the weight of cargo loaded. The draught survey may be the method of measurement specified in the charter party for deciding the quantity of cargo carried, in which case one or several surveyors are likely to be employed to carry out the survey. When the charter party specifies that shore measurement is to be used for deciding the quantity of cargo carried, the Master will still be expected to calculate a ship's figure to provide a check. It is in his interests to do so and to ensure that the results are as accurate as possible. The conditions during the commencement of survey are no cargo being worked, no ballast-fuel-fresh water being pumped or run, no hatch covers being opened or closed, no spares or stores being shipped or landed, all ballast tanks need to be full or empty, ship should be upright, little or no tide or current running, temperature difference between sea water and ship's decks should not be excessive.

DISCHARGING PERIOD

Discharging/Ballasting Plan: The discharge and ballasting should be planned to ensure that longitudinal and local stress limits will not be exceeded at any stage, there is always sufficient under keel clearance and air draught, and the vessel may leave the berth at any time. The preparation of the discharging/ballasting program in compliance with the rules, following the same procedures as are described for the loading/deballasting program, is normally the work of the chief mate. If the information which the terminal has provided is sufficient the discharging plan should be finalized and transmitted to the terminal before the vessel's arrival. On arrival at the terminal, the chief mate will deliver copies of the completed program to the stevedore foreman, and to the officer of the watch, and ensure that it is understood. When discharging a full cargo of a single commodity at a single birth, the planning normally presents no problems and can be done before berthing, provided that the method of discharge is known in advance. If the cargo consists of several grades or consignments, or if the number of discharging grabs or type of discharging equipment cannot be forecast, it may be impossible to determine which grade or grades will be discharged first. In those circumstances the planning of the discharging and the ballasting must wait until arrival and must then be planned in conjunction with the stevedores. Every stage in the discharging program must be provided with a full discharging/deballasting program to be signed for on the document and on the Ship/Shore safety checklist.

Ballast tanks may be punctured by cargo gear during discharge, and the hopper sides should be inspected where possible before the tanks are ballasted to note damage and avoid pumping ballast water through a punctured tank wall into the cargo. Subject to draught restrictions and any other special requirements the ballasting should be planned to start when the discharge is about 25 per cent completed and should be complete well before completion of discharge. The ship's draught should be kept as deep as possible, thereby keeping the air draught low and minimizing the stresses on the double bottom, cross deck and transverse bulkhead structures. A large air draught slows the discharging rate, and may make it impossible to lift the front end loaders suspended below the grab into and out of the holds. Some large bulk carriers have holds which can be partly ballasted in port to reduce the air draught. These are not true ballast holds and cannot contain ballast water at sea. They do not have the strength to be fully ballasted, or the hatch cover fastenings to resist the sloshing of water in the hold. The vessel should be kept upright throughout discharge and ballasting. It becomes difficult or impossible to open and close hatches and to use shipboard cranes against a heavy list or trim. Water ballast should always be carried symmetrically in port and starboard tanks, with equal levels of filling to avoid tensional loads causing twisting of the hull girder. The ballasting should be carefully supervised to ensure that ballast is not allowed to overflow on deck or over side.

The procedures of cargo discharge will be mentioned and described in the following examples:

- **Continuous unloading**: Discharge by continuous unloading methods such as pneumatic hoses, Archimedes' screw or bucketwheel unloader calls for little comment. By a variety of methods these systems extract a steady flow of cargo from the hold through an enclosed system to the shore. Normally the only source of problems is accidental contact between the unloading equipment and the ship's structure. To prevent damage from contact, the equipment must be operated with care and the ship must not be allowed to surge in the berth. Some continuous unloaders have the operator's cab close to the business end of the system in the ship's hold, and this is to be welcomed as it reduces the likelihood of damage to ship or equipment as a result of accidental contact between them.
- **Grab discharge**: Discharge by grab is by far the most common method of discharging bulk cargoes because of the flexibility of the system, despite the number of theoretical disadvantages from which grabs suffer. In the early stages of the discharge of a cargo such as coal which fills the hold, plenty of cargo is available to the grab in the hatch square, and work can proceed at maximum rate whilst the first 20% of the cargo is discharged. This 'creaming' or 'cream digging' is followed by 'free digging' until 50% of the cargo has been discharged. During free digging the cargo is still accessible but is deeper in the hold, so the discharging rate falls as it continues to do during each stage thereafter. The cream digging and free digging stages will be reduced if the crane does not have sufficient outreach to plumb the outboard side of the hold. When that occurs, there are three methods which the crane driver can use to reach the cargo on the outboard side. He can swing the grab like a pendulum before lowering it at the limit of its swing, he can slide the grab down the sloping side of the stow, if it has not been trimmed level, or he can use a process known as hill digging. Stevedores prefer the pendulum method because it is quickest, but when grabbing close to the hopper tanks and tank top they should use the heel digging method, which is less violent and easier to control, to avoid damage. The next stage, intermediate digging, requires more care as the cargo is lying closer to the ship's structure and is less accessible. The final stage of discharge is the trimming, a process which must be

commenced when the hold is about 85% empty, by volume. During trimming, cargo is brought from the sides and ends of the holds by front end loaders and piled in the square for removal by grab, with the final cleaning and loading of the grab being done by trimmers – men working with shovels and brushes. In some berths the front end loaders may be lifted into the holds and used at an earlier stage to push more cargo into the path of the grab and speed the discharge. Some cargoes harden during the voyage and stick to the bulkheads and frames in large masses forming overhanging cargo faces which can be dangerous for trimmers in the later stages of discharge. When large quantities of cargo are seen to be clinging to the bulkheads during discharge trimmers should be employed to free the cargo from the bulkheads at an early stage, while the distance for the cargo to fall is small. The OOWs should be instructed to look out for cargo clinging to the bulkheads and to bring it to the attention of the foreman. Stevedores should never be allowed to land grabs or front end loaders on deck or on the hatch covers as they may damage the ship's structure.

- **Discharge by Cavalleto**: The Cavalleto system met in some Italian ports uses a substantial portable gantry which is lifted aboard ship. First, the hatch coamings are specially strengthened to receive a pair of fore & aft beams which are placed on them. A mobile gantry which houses grab, hopper and chute is then lifted on to the beams by a large shore or floating crane. Cargo is lifted from the hold by grab which is opened over the hopper, tipping cargo into barges or coasters lying alongside. The ship may be required to provide electric power for one or more such units. The process of rigging or shifting the Cavalleto takes six-eight hours and is very labour intensive, so the number of moves from hold to hold should be kept to a minimum.
- **Discharge by vacuvator**: Vacuvators are self-contained mobile suction units powered by diesel motors and usually weighing 3-5 tons. Their use is most common in berths where bulk cargoes are not regularly handled and in underdeveloped regions. When lifted on to the deck of a ship they can be used to discharge grain and similar cargoes into barges while at anchor or alongside or into road or rail wagons on the quay. When placed on deck they should be lashed or otherwise secured in position to prevent them from taking charge and rolling across the deck if the list changes or the ship surges at her moorings. Oil leakage from the vacuvator's motor may occur and must be prevented or contained.
- **Discharge by ship's gear**: When ship's cranes or derricks are used for discharge they are normally operated by shore drivers whose level of competence and goodwill is unknown. Their work must be carefully supervised by ship's officers to ensure that they work safely and do not damage the ship's gear. Continuous cargo work makes a heavy load for the ship's gear and it should be frequently and thoroughly inspected and tested to ensure that all is in order and that the gear remains operational.

Care for Cargo: During discharge the ships' officers must be alert to ensure that the cargo is not damaged. In the event of damage or dangerous behavior occurring photographs, particularly digital photographs which are easy to email to interested parties, should be taken. Hatches must be covered promptly for rain or snow if the cargo must not be wetted, and break-bulk and unitized cargoes such cargo from grabs on to the deck or the quay or into the dock, protests must be made by word and supported in writing. High winds may prevent the discharge of some cargoes because of high windblown losses, or because of unwelcome distribution of the cargo over nearby communities.

The OOW should look out for damage to the cargo from oil or hydraulic leaks from shore, or ship's gear. Where different parcels of cargo are carried in a single hold, officers must ensure that the stevedores find and observe the separations, whether they be in the form of colored ropes separating cargoes of logs, thin steel sheeting used to cocoon parcels of minerals from South Africa, or polythene sheeting or netting used between consignments of bagged cargoes. The completion of one parcel, removal of the separation and commencement of the next parcel should be observed by the duty officer to ensure that no mistakes are made and to make a record of the details separation material can often be saved to be reused or returned to the supplier. When two parcels of identical bulk cargo are carried in the same hold, without separation, every care must be taken to ensure by draught survey or other reliable method measuring the tonnage discharged, that the correct tonnage is delivered to both receivers.

Once the cargo has crossed the ship's rail it is more difficult for ship's personnel to prevent it from being damaged, but it is necessary to observe what happens to the cargo ashore. If quantities are spilt, if it is contaminated by loading into dirty trucks or waterlogged lighters, or by placing on contaminated or muddy quays, if different grades are mixed or if cargo which is sensitive to moisture is left in the open, this is cause for concern because an attempt may be made, at a later date, to blame the ship for this damage. The ship owners and their P&I Club should be informed immediately, so that a surveyor can attend to observe events, and the details should be recorded by the taking of photographs and by an entry in the ship's log book. In addition, a written protest should be issued to stevedores, agents or receivers.

Cargo shortages which occur during or after discharge can also lead to serious problems for the ship and officers should be on their guard for any irregular practices. Losses by leakage from grabs or by spillage from overloaded trucks often occur and weighbridge measurement can be reliable. In an extreme case a weighbridge was seen to be used to weigh the front end of trailer without uncoupling it, after which it was rolled forward to weigh the rear axle.

Routine Procedures: While the vessel is discharging the OOW must ensure that the moorings and gangway are tended and ISPS Code is observed with a written record kept of all visitors to the ship. Pollution must be avoided, the weather observed and recorded security for ship and cargo preserved and full records, including those for cargo and ballast, maintained. These requirements are described in chapter for the "LOADING PERIOD", in these respects the discharging period is no different. The OOW must also ensure that hatches are always secured to prevent them from moving, whether open or closed. Hatches must only be moved after the coamings have been completely swept clear of cargo residues and a visual inspection has been made to check that there are no obstructions on the trackway. They must not be moved when any quantity of spilt cargo is lying on them.

When planning the arrival at a discharging berth it is useful to know if a draught survey or cargo survey is to be held, and if discharge is to commence on arrival. When the ship is all fast alongside and a safe access has been provided the immediate priorities are to obtain a full set of draught readings for the ship's own draught survey and at the same time or immediately afterwards to agree the discharging/ballasting program and the ship/shore safety checklist with the terminal representative as required. The requirements of the receiving country must be satisfied when in transit fumigation of cargo has taken place. When these matters and any surveys have been completed discharge can commence. Hatches should not be opened until the vessel is in the berth and the above procedures have been completed.

There can be a case for amending the above sequence of tasks and opening some of the hatches in the sheltered approaches to the berth when the weather is favorable, the discharging program and the ship/shore safety checklist have been fully agreed in advance between ship and terminal, when tonnage is to be decided by shore scales, when no cargo or hatch surveys are scheduled and when no in transit fumigation has taken place. Occasions when all these requirements will be met are likely to be rare.

Some charter parties and charterers may instruct that all hatches are to be opened before berthing, and these instructions should be followed only provided that it is safe to do so and will not result in damage to the cargo or the ship's equipment, or to neglect of the other requirements mentioned above. When the hatches have been sealed, the weather is adverse or the cargo is sensitive it is prudent to keep all hatches closed until the vessel is berthed and clear information has been obtained from the receivers.

If water is lying on the hatch covers and could spill from them and damage the cargo, it is essential that free water is swept from the covers before they are opened. Rubber squeegees are very effective for this process.

The chief mate should always calculate the deadweight from the draughts on arrival to confirm the quantity to be discharged for the ship's records, regardless of whether or not an independent surveyor is appointed. If there is no formal draught survey he will rely upon his experience and knowledge of the ship to obtain accurate readings of ballast water strippings and bunkers at the first convenient opportunity, not necessarily exactly at the time of berthing.

The Master and his officers should always give high priority to an inspection of the cargo on arrival for any signs of damage from leakage, condensation, shifting, infestation or other cause. Where possible such inspection should be made at the anchorage or during the river transit. Ship's officers should make it a point of professional pride to find any damage before it is discovered by other parties. Minor damage such as slight leakage through the hatch covers should be fully recorded and noted for prompt repair. More substantial damage which seems likely to result in a cargo claim should be immediately reported to the vessel's owner with a view to arranging for the attendance of a P&I Club surveyor, who will advise on the best way to minimize the claim.

Very important is the good communication that must be maintained between the terminal representative and the chief mate and officer of the watch. Matters for discussion will be the discharging/ballasting program, air draught, new stevedores' damage, stevedores damage from previous ports if temporary patches have been fitted, as these may impede the work of the front end loader, trimming, care of ship's cargo gear if used and possible causes of interruption of cargo work. Also of interest will be the stevedores' working hours, any specialized equipment or procedures to be used, and the estimated time of completion. If the ship is required to

shift along the berth, discharge must stop and cargo gear must be lifted clear of the ship before the move takes place.

The foreman should be warned if cargo has been spilt on deck, so that trimmers can collect and discharge it. The chief mate should always insist on major spills being cleaned by trimmers to provide a safe access, as coating of some cargoes on a deck wet from rain or dew can make it like an ice rink. In some ports the trimmers will refuse to remove cargo spilt on deck, leaving such residues for the crew to clean at sea, but the attempt should be made to demand that they remove the spillage. A note of protest should be issued for excessive piles of cargo left on the main deck. On the completion of discharge the Master and the terminal representative should agree in writing that the ship has been unloaded in accordance with the agreed unloading plan, with the holds emptied and cleaned to the Master's requirements. They should also record any detected damage suffered by the ship.

Crew Work During Discharge: There are limits to the work that trimmers can be persuaded or compelled to do in the holds, and it is sometimes in the ship's interests to put crew members to work in the holds on supplementary cleaning. For example, some Masters recommend placing crew members in holds at an early stage in the discharge of grain when it is safe to do so, to stand on the cargo and sweep grain from surfaces such as the flanges of deck frames high in the hold where cargo settles and is later difficult to remove. Trimmers will often refuse to remove cargo which has fallen into hold bilge wells when a cover plate has been dislodged. If crew members remove the cargo from the bilge the stevedores will normally be co-operative about lifting it from the hold by grab, thus saving time and effort for the crew later. The same applies for completed holds. Extra cargo missed by the trimmers can be gathered by the crew and will usually be discharged by the stevedores, thus saving considerable extra effort for the crew.

As the discharge from particular holds is completed, the crew may be required to clean ballast holds before they are ballasted or in preparation for the loading of the next cargo.

Care for the Ship: Any kind of damage to the ship should be prevented by any mean. During discharge there are many chances the port facilities or our own operational mistakes to cause damage due to careless treatments. For instance:

❖ **Stevedores' damage**: A variety of methods for discharging ships are available. Most of them such as suction hoses, Archimedes' screws, or self-unloading by means of gravity feed to shipboard conveyor belt are used for special cargoes or ships and are unlikely to damage the ship. However, by far the most common means of discharging bulk cargoes is by means of grabs rigged on gantry cranes, luffing cranes, or ship's cranes or derricks. Grabs are very strongly made from toughened materials and when carelessly used can cause considerable damage to a ship's structure. Crane drivers who are careless or incompetent are also likely to cause damage, and officers must insist that they work more slowly and safely or are replaced by more skillful colleagues.

❖ **Damage by trimming**: Residues from some cargoes cling to the sides and end bulkheads and frames of holds and are difficult to dislodge, and a number of techniques have been developed for removing them. A widespread practice has been for grabs or bulldozers to be used to strike the bulkheads and ship's side frames to dislodge cargo, and pneumatic hammers have been used to vibrate the structure for the same purpose. It has been recognized for some years that these practices are likely to cause fatigue and fractures in the steelwork or the welding of the ship's structure, even when operators are skillful. Careful use of these techniques, if agreed in advance, is condoned by the Ship/Shore Safety Checklist. In practice it is rarely possible to avoid damage and Masters should intervene if necessary to prevent it. Unfortunately the situation is not straightforward. Although it is known that striking the steelwork causes long-term damage, ship-owners are reluctant to forbid the procedure entirely, as they fear that this will make their ships slow and difficult to discharge and therefore unpopular with shippers. Without clear and definite orders Masters hesitate to forbid hammering, unless damage can be seen because they fear that unmanageable quantities of residues will be left in the holds for them to remove after the ship has sailed. One Master with experience of this problem advises that the trimmers should be brought into the hold at an early stage to remove cargo from the bulkheads whilst standing on the cargo. Otherwise the Master should protest in the strongest terms and issue a letter of protest. There is nothing in any charter party that authorizes anyone to damage a vessel. In recent years systems such as the Caterpillar Hoeram have been used in the USA to vibrate the ship's steelwork violently. The machine is fitted on the boom of a mobile unit for cleaning after a cement cargo. It uses a heavy rubber pad.

❖ **Damage prevention**: The best way to deal with stevedore damage is to prevent it. A procedure which has helped one shipping company is to paintmark the holds prominently with the positions of all the fittings which may be damaged. From the diagram it can be seen that the inside of the hatch coaming is marked with heavy yellow stripes in way of the forward and after hold ladders. The ladders themselves are prominently painted with yellow paint. The lower stools are marked with yellow symbols close to the bilge wells and the lower hopper plates are similarly marked near the double bottom manhole covers. A thick, white horizontal line runs right around the hold at 2.4m height. These markings, when brought to the attention of the stevedores, have helped to reduce the damage done by discharging grabs and front end loaders working in the holds. When hold marking of this sort is reinforced by officers who keep a careful watch over the cargo work and protest in the strongest terms when the stevedores appear likely to cause damage that damage can be minimized. Officers who are out on deck keeping a watchful eye on the work are also best placed to notice damage as soon as it occurs or to be told about it by passing crew members or stevedores.

Mechanical Cargo Equipment of Ships'& Ports' Gear

Ships' Gear

Ships' Cranes (Pic.1): Cranes where first installed in ships around the beginning of the present century. They were small, often hydraulically powered, and were used principally for handling passenger baggage stores. Later cranes were used in warships for handling seaplanes. It was not until the late 1940s, with the construction of ships which were extensively fitted in cargo vessels.

Early cranes were expensive compared with derricks they were slower to operate and required more highly skilled operators. Moreover their capacity and outreach was limited and was often necessary for them to be fitted on transverse rails so that they could be maneuvered outboard of the hatch coaming in order to plumb both over side and the hatchway. For many ship operators, their ability to spot loads was insufficient advantage to outweigh these drawbacks.

With the increase in the carriage of unitized cargo, the practical value of the crane's accurate spotting ability has become more apparent. Thus cranes, often having a capacity of 25 tons, are sufficient to outreach to plumb two adjacent hatchways as well as over side. But where cost and other considerations are not overriding, the fast port operation and its financial benefits for the ship overcome any kind of doubt.

Shipboard cranes are usually of electro hydraulic design. A crane is normally required to perform three functions – namely, to hoist (or lower), to luff and to slew. Hoisting is the raising of the crane wire whilst the crane jib remains in a constant position. Luffing is the raising or lowering of the crane jib, and slewing is the swinging round (or rotating) of the crane. Cranes on a few ships are also able to travel along the deck on rails, but this is unusual.

It is common for shipboard cranes to be level luffing. This means that if the crane is topped from maximum to minimum radius, or vice versa, the crane hook will maintain a level path, allowing the load to move horizontally. The power which enables the crane to hoist, luff and slew is provided by electric motors which drive hydraulic pumps. The hydraulic pumps drive the winches required for the hoisting, and drive the machinery which enables the crane to luff and slew. Twin cranes have been fitted to some conbulk and forest product ships. The basic idea is extremely simple, and consists of two independent cranes of equal capacity mounted on a common platform. The common platform can be rotated independently and the cranes can be slewed relative to the platform. Each crane can be used by itself, with each serving an adjoining hold, but when a heavy lift is required the jibs are slewed parallel to one another and a lifting beam is attached between the crane hooks. This arrangement allows the lifting of loads of up to twice the safe working load of one crane. The speeds of the hoisting and luffing motions of the cranes are synchronized to ensure smooth operation.

When the cranes are operated in the twin mode the individual slewing motions are inoperable and only the platform slewing motion can be used. Operation of the platform slewing motion causes the platform to rotate and with it the two cranes, with their jibs parallel, thus enabling large loads to be safely slewed.

If shipboard cranes are intended to be used with grabs, as grabbing cranes they are likely to be fitted with rope-operated grabs, for which the crane will be provided with two rope drums and two wire ropes, one to hold the grab and the other to open and close it. Alternatively, electro-hydraulic grabs are easy to fit to existing cranes and grabs can also be operated be remote radio control. These systems replace the simple but inefficient self-dumping grabs which are used on a single fall of wire rope.

Self-unloaders (Pic.2): Self-unloading bulk carriers which discharge cargo by means of ship-mounted conveyor belts have been known on the Great Lakes for a hundred years and moved into the international trades in the 1980s where they now range in size from Mini-Bulkers to Panamax and there were, in 2008, 11 which are larger than 80.000 dwt.

Self-unloaders have a capital cost which is 20 – 35% higher than conventional bulkers and provide less space for cargo than do conventional ships of the same size. These disadvantages can be more than balanced by their reduced port time for discharging, so they are most profitable when employed in shuttle services with very frequent port calls.

The International Maritime Solid Bulk Cargoes (IMSBC) Code recognizes that self-unloaders have holds fitted at the bottom with non-airtight gravity unloading gates and therefore specifies special arrangements for the atmospheric monitoring and ventilation of the cargo spaces. If methane is detected in the tunnel it must be 'positive pressure' ventilated (more supply than exhaust in the tunnels to remove methane gas) and if carbon

monoxide is detected in the tunnel, it must be 'negative pressure' ventilated (more exhaust that supply in the tunnels to remove carbon monoxide).

Hybrid Self-unloaders (Pic.3): These vessels are conventional bulk carriers which have been converted to self-unloading by the fitting of a deck mounted boom conveyor fed by ship's cranes or excavators through a system of hoppers. A number of such vessels with Scandinavian and other North European owners are in service. They are cheaper to buy and to operate than full self-unloaders and can carry the full range of bulk and unitized cargoes when not required for self-unloading. They can also be discharged by shore gear if the ship's conveyor breaks down. They cannot compare with conventional self-unloaders for speed of discharge and for the handling of wet-sensitive cargoes when it is raining.

An excavator, a hopper and the boom conveyor are mounted on a platform which straddles the breath of the holds and travels along rails at each side of the hatches. The boom has an outreach of 22.2 m from the vessel's side and her overall discharging rate, which depends upon the presence of an expert excavator driver, is about 750 tons/hr which allows her to berth on one tide and sail on the next. In 2006 such vessels were engaged in the coal trade between Scotland and Ireland. Trimming of the final cargo residues for discharge is done by machine or by hand, a task undertaken by the ship's crew. The ship carries a bobcat for this purpose.

Mucking Winches (Pic.4): A mucking winch unit is a winch with a davit used for lifting sweepings and rubbish from the holds when they are being cleaned. The winch is usually powered by compressed air from the deck air line, which is used to drive the drum for the winch hoist wire. The equipment is normally portable, which allows it to be used at each hold in turn.

The mucking winch may be worked through the main hatch opening and on Cape-sized and Panamax vessels there may be suitable mounting permanently fixed at each hatch on a hinged davit which swings into position over the hold. Since hatches cannot be opened when the ship is working in a seaway this restricts the occasions when a mucking winch can be used. Alternatively, it may be positioned to work through a manhole cover in the hatch lids or through a grain trimming hatch if such is fitted, with the advantage that work can continue in rough weather. A Cape-sized vessel is likely to have a 0.5 ton winch fitted with 12mm wires, whilst a mucking winch on a Panamax vessel will probably be of 0.25 tons capacity with 8mm wire. Mucking winches are seldom provided for Handymax or smaller bulkers who are surprising as even in these vessels heavy weights require to be lifted in and out of the holds and the heights are substantial. Although such vessels are usually equipped with cranes or derricks they cannot be used when the ship is unsteady.

Cargo sweepings and the contents of the bilges are lifted from the hold in buckets or old paint drums. The davit is free to rotate so that the load can be swung clear of the coaming and landed on deck or, with smaller davits and lighter loads, the davit may be fixed and the container is pulled over the coaming and landed on deck.

The winch wire may be subjected to rough treatment that's why it should be inspected frequently and renewed as soon as it is seen to be damaged or worn. The oiler/filter unit on the air motor should be regularly checked and the unit should be checked for physical damage and greased when being stored away after the voyage's use. Every item of equipment, including the lifting handles fitted to the paint drums, must be in sound condition since the accidental dropping of a drum of rubbish could do fatal damage to a man below. Sufficient spare wires with certificates of test should be kept aboard and spares for the air motor should include a set of air vanes and a set of spare bearings.

Air hoses when used on deck, or indeed anywhere aboard ship, should be undamaged and should have end connections which are sound and secure. The consequences of contamination or pollution from an oil smeared hose could be serious so such hoses should never be used on deck.

Mobile Cranes: A mobile crane is a rare sight on Panamax and Cape-sized bulk carriers now that larger bulkers are built with side opening hatch covers which reduce clear deck space in which a crane can operate. On the few ships which carry a mobile crane, a ramp is provided between two of the hatches to allow the crane to cross over the deck pipework from one side of the ship to the other.

A mobile crane provides an alternative to a mucking winch for the removal of sweepings from the holds and a crane has also been used, in port, to hang the painting raft against the ship's side, providing a quickly movable platform from which the ship's overside paintwork can be touched up. A mobile crane is also useful for loading stores into the forecastle store. A mobile crane cannot be used when the ship is unsteady.

The crane wire, sheaves, jib, chassis and winch must be inspected, marked, maintained and certificated like any other item of lifting gear carried aboard ship. The handbrake system and any system for locking the

wheels must be maintained in efficient working order. Ships staff appointed to operate the crane should be instructed on its use and be provided with ship's in-house certificates that state that they are certified to operate the equipment.

Cherrypickers (Pic.5): Cherrypickers are self-contained units for raising a working platform attached to a series of folding arms to a height of 10-15 meters. A small portable cherrypicker suitable for a handy-sized vessel weighs about two tons. They are impractical for gearless bulk carriers which have no means of lowering them into the holds, but are standard equipment for some handy-sized geared bulk carriers where they are used for hold maintenance and inspection.

The cherrypicker can be lifted or wheeled into the desired position where solid base plates are jacked down to provide a stable foundation. The working platform can normally accommodate two workers, and controls for raising the platform are duplicated, with one set on the platform and a second set at the base. A cherrypicker provides a quick and efficient means of reaching otherwise inaccessible points high in the hold for cleaning, inspection, repair and painting. A cherrypicker should be maintained in accordance with the manufacturers' instruction manual. Ship's staff approved to operate the equipment should be instructed in its use.

Ports' Gear

Grab Ship Unloaders Cranes (Pic.6): Grab Ship unloaders are normally used for handling materials like coal, iron ore and bauxite. The grab-type ship unloader is the traditional method to unload bulk cargo and these cranes are used when high quantities of coal, iron ore and other bulk materials are to be handled. Gantry type grab unloaders incorporate a hopper that feeds the bulk materials direct to a conveyor belt system. The hoppers can be equipped with spraying devices or suction systems to minimize dust emissions.

Rail mounted unloaders are designed for handling large amounts of bulk materials. High capacity clamshell grabs offer high unloading rates and high efficiency. A clamshell bucket is cycled in and out of the ship's hold, typically unloading 15 - 20m3 with each scoop. The clamshell is suspended from a traversing trolley and is raised and lowered by a winch. Free digging rates of 3000 t per hour are common.
Ship unloaders are often supplied with a 90° grab-rotating system, so the grab can work with a longitudinal opening direction as well as with a transversal (cross) direction. An automated system controls part of the unloading cycle of the material once the grab has closed on its load into the ship. The grab is first hoisted to a safe height, and then travels at an optimum trajectory to reach the hopper, at this point it has a calculated angle of sway, and to discharge the material quickly the trolley speed is reversed to dampen the sway. For more accurate positioning, it is also possible to discharge the material in a fixed position with trolley at zero speed and no sway. Following the material discharge into the hopper, the grab is automatically positioned above the safety height and the operator can begin a new cycle.

The cranes are powered by an AC electrical supply from the dock (also known as shore power) which can be from 3,000V up to 12,000V.For safe operation, grab ship unloaders have various safety systems such as sensors to detect:

- *Over-load*
- *Hoist over-speed*
- *Wind speed Specific setting for storm tie-down*
- *Emergency push buttons are also installed around the crane.*

The crane is driven by an operator that sits in a cabin suspended from the trolley. The trolley runs along rails that are located on top or sides of the boom and girder. The operator runs the trolley over the ship to lift the bulk materials. Once the grab closes it is lifted and moved over the dock and discharged on a hopper to then be taken to the storage yard by conveyor belt.

Floating Grab Ship Unloader (Pic.7): Floating cranes are used for cargo handling on waterways with few quays or none at all or where the ship is unable to moor because the quay is too shallow or sometimes alongside existing handling equipment in order to increase capacity at times of peak demand. Floating cranes offer many benefits: autonomy, mobility on water and no need for the purchase of additional land or the construction of new quays. Floating harbor pontoon cranes and port harbor cranes on barges, are used for both ship-to- ship and ship-to-shore handling. The drive system used is a single quadrant rectifier and brake choppers. Since the crane is powered by a diesel engine/generator set, energy stored in the system cannot be regenerated. Large brake choppers are required to convert potential energy stored in the hoisting system, or kinetic energy stored in the moving masses, into heat. The brake resistors are mounted outside the control cabin. The crane control system requirements include slewing control, grab hoisting and closing and load dependent speed control on the hoist movement. All this functionality can be achieved without a PLC, using a plug-in application module built-in to the drives. On many conventional cranes, the slewing movement is undertaken with slip-ring motors. The slip-ring motor, in combination with rotor resistors, meets the crane driver's needs in most instances. There is good motor torque control for acceleration and deceleration, and it is possible to coast when the controller is moved to zero.

However, this method of control is very poor at low speeds, with sudden steps in torque between resistor steps, wasting a lot of energy, and the system requires very regular and intensive maintenance. When replacing the slip-ring motors with modern drive systems, the results can be very disappointing. To counter this effect, it has been developed a program that gives the crane driver optimal control over the swaying load, without the need for a PLC. The slewing control system provides the driver with control over both the speed and the motor torque. Speed control is important for accurate positioning at low speed. It also provides compensation for the wind forces on the load. Torque control is crucial for controlling the sway. In this way, the driver is always able to anticipate the movement of the load and compensate for it. By bringing the controller back to zero, the movement is effectively coasting, which gives a major damping effect on the sway of the load.

Slewing Cranes (Pic.8): Slewing cranes are common port and shipyard cranes. They can be used for efficient handling of various bulk materials and in some cases containers. Slewing cranes are built with single jib and double jib designs, Single jib cranes have a simpler construction and are lighter than double jib cranes. The main advantage of the double jib crane is the horizontal path of the load. During the luffing of the crane, the grab stays at practically the same height. This level luffing allows simple and precise positioning of the grab and offers high production rates. As cranes and their control systems became more sophisticated, it became possible to control the level of luffing directly, by winching the hoist cable in and out as needed. The first of these systems used mechanical clutches between luffing and hoist drums, giving simplicity and a "near level" result. Later systems have used modern electronic controls and quickly reversible motors with good slow-speed control on the hoist winch motors, so as to give a positioning accuracy of mm. Luffing mechanisms have also been applied to the driver's cabin being mounted on its own jib, following the movement of the crane's main jib. These are used for tasks such as ship unloading, where the view from the driver's cab is greatly improved by cantilevering it forwards and over the ship. Two drives manage the open/closed grab motor and the second drive manages the hoist. Travelling motors are managed by one or two drives (land and sea side). Luffing motors are managed by two drives in torque master-slave control and the slewing motors are controlled in a single or multi-drive system.

Continuous Ship Unloader and Loader (Pic.9): Continuous ship unloaders (CSU) are used for discharge bulk materials from a ship with high throughput rates. Ship loaders are used for loading bulk materials to ships. The discharge boom can be raised and lowered, with or without telescopic extendibility, and is either fixed or slewable or supported and guided on a slewing carriage. Traveling ship loaders are mounted on rails that are parallel to the ship and are fed by a conveyor belt, incorporating a tripper that travels with the ship loader. A belt conveyor is utilized on the boom and usually a shuttle head provides complete coverage of the ship's hold. The discharge spout incorporates a rotating spoon, which allows the operator greater flexibility when placing the material. Continuous ship unloaders are equipped with an L-shaped, bucket-elevator-type unloading device that is suspended from the boom. The material to be unloaded is scooped up by the bucket elevator at the horizontal segment of the "L", while at the vertical segment, the bucket elevator transports the

material to the top of the boom. It is then unloaded onto a belt conveyor. The entire L-shaped system can rotate 360°, allowing full access to the entire hold. The design of the horizontally suspended portion of the bucket-elevator-type unloading device allows for superior emptying, thus minimizing the manual clean-up needed by dozers. The continuous ship unloaders feature a cantilevered, but guided chain-and-bucket suspension that protects the bottom of a ship's hold. The CSU traverses on pier-mounted rails along the full length of a ship.

The quadrant-type ship loader features a fix bridge-type structure that pivots around a kingpin-type support, while the seaward side is supported on a series of bogies that travel along a circular rail. A telescoping boom traverses the top of the main structure, complete with telescoping loading chute and spoon. The extent of travel required by the telescoping boom depends on the rotation angle of the main structure to ensure access to each hold of the ship. By pivoting at the tail end, the ship loader is afforded accord the entire length of the ship. Rather than incorporating a shuttle conveyor, the entire upper structure travels on the fixed lower bridge section of the ship loader. The combination of bridge rotation and boom travel allows the operator to access all areas of the ship's hold.

Stockyard Reclaimer Cranes (Pic.10.11.12): Reclaimers are designed to gather bulk materials from stockpiles at ports, steel plants, mines and power stations in a quick, efficient and orderly way. They are available in several main types including:

- *Bucket wheel boom-type*
- *Scraper-type*
- *Bucket wheel bridge-type*
- *Drum-type*

There are in many configurations and sizes, with capacities from 500 to 20000 t/h and more. The choice of design depends on factors such as the size and shape of the stockpile, the type of material to be reclaimed, the required reclaiming rate and the need for blending or homogenization. Depending on the application, reclaimer designs drive concepts for each appropriate drive train. These can include variable speed drives (VFD), electromechanical constant speed drives with fluid coupling, as well as hydraulic drives, whatever is the most suitable drive for the field of application. Reclaimers were originally manually controlled machines with no remote control. Modern machines are typically semi-automatic or fully automated, with parameters remotely set. The control systems with its PLC and CMSI give the operator a wide range of settings and reclaiming options. This enables the operator to focus on maximizing his results in a comfortable environment. The bucket wheel, boom conveyor, luffing, slewing and gantry movements are carried out by AC motors controlled by variable speed drives. Active inputs for harmonic elimination and regenerating excess energy can be configured with standard drive modules, configured as motoring or regenerating. Onboard intelligence with high speed digital bus communications on modern AC drives can provide applications solutions enhancing crane performance.

Stockyard Stackers: Stackers effectively stockpile bulk materials in an efficient and orderly manner. Stationary or travelling, borne on rails or crawlers, they can be supplied in fixed, luffable or luffable- and-slewable boom designs. Capacities range from 150 to 20000 t/h. The choice of design depends on factors such as the stacking method and size of the stockpile, the type of material, the required throughput and the demand for mobility. Tripper cars or tripper systems for transferring material from the yard conveyor to the stacker are considered part of the stacker. The luffing stacker travels along the entire length of the longitudinal stockpile conveyor and serves to build a stockpile on one side of the conveyor only. The tripper is connected to the traveling stacker by way of connecting structure and serves to transfer material to the boom. The stacker consists of a rigid structural design with a boom pivot in the center. The luffing motion is often carried out by concrete counterweight design. The stacker and tripper are designed for variable speed travel and can be quickly relocated from one area of the stockpile to another.

Stockyard Stacker/Reclaimers: Stacker/reclaimers come in two main types to meet most storage requirements for bulk ports, terminals, electric power stations and other facilities where efficient stockpile management of raw materials is essential. Slewing-type stacker/reclaimers are typically used where large

quantities of material must be readily available, where blending of grades of material is required or where available yard length is limited. Two main types:

- **Bucket-wheel stacker/reclaimer**: Bucket-wheel models are for alternate stacking and reclaiming, and circular units, which normally stack and reclaim the material alternately but can be designed to do so simultaneously if required. Bucket-wheel models, normally supplied complete with tripper cars, are compact and economical for longitudinal stockyards where simultaneity is not required and where there can be large variations in the demand for stacking and reclaiming capacity. Trench-type stacker/reclaimer
- **Trench-type stacker/reclaimers**: Trench-type models are ideal for installations with low-volume, high-active storage pile capacities between 30,000 and 60,000 t, where reclaiming operations are accomplished by a longitudinal pass through the pile. Reclaim rates usually vary from 2000 to 4500 t.

Storing Ashore & Ships' Stowage of Bulk Cargoes

Storing Ashore

A basic knowledge of the methods used ashore for the handling of bulk cargoes can help with understanding of the reasons for interruptions in the loading or discharging process.

Stockpiles (Pic.13): The cargo may be stored in a stockpile in the open air. Stockpiles are large heaps of bulk cargo, often weighing thousands of tons, stacked upon an area of level land, the base of the stack resting upon hard packed soil or a concrete or a tarmac surface. The largest European storage yards have a stockpile capacity of more than 5 million tons in an area of 80 hectares. If the commodity is of high value, or if there is concern about the pollution which would result from dust blown away, the stockpile is likely to be protected by fresh water sprays. The Richards Bay Coal Terminal, for example, uses sprays to maintain surface moisture content of 6-9 % in its stockpiles.

Cargo arrives at the stockpile by rail wagon, by barge, by conveyor belt or ropeway transportation system direct from the mine or quarry or by road truck if the quantities are relatively small. The cargo is likely to be placed in the stockpile by grab or by stacker. A stacker is an arrangement of conveyor belts and booms similar to a mechanical shiploader. It can be used to deliver the cargo to the stockpile after it has been tipped from the rail wagon or road truck, or grabbed from the barge into a hopper which pours it onto the conveyor belt.

Bulk cargo is removed from the stockpile by a reclaimer, which feeds the cargo onto a conveyor belt for delivery to the ship. A reclaimer is a machine which uses a bucket wheel or a scraper belt to remove cargo from a stockpile and feed it onto a conveyor. Often a single unit is built to operate as a combination stacker/reclaimer which will put cargo into a stockpile or remove cargo from the stockpile. At some loading terminals, where the mine is adjacent to the loading berth, the stockpile is underground within the mine.

Silos (Pic.14): These are used mainly for bulk grain, animal feeds and oilseeds, and for mineral cargoes such as cement with high values or dusty characteristics. Filling and emptying them can be achieved by mechanical means assisted by gravity or by pneumatic means. Handling capacities of 1.000 t/h or more can be achieved. When a ship is loaded from a silo the cargo will normally be delivered by means of a pipe or hose suspended from a boom. Whilst silos are large structures they may be subdivided into a large number of bins. The full contents of a bin may be the minimum pour that can be delivered.

Rail Wagons (Pic.15): When bulk cargoes are brought direct to the loading berth by rail wagons it is normal to use a railcar dumper system to capsize the wagons, sometimes two at a time, and tip out their contents into the hopper or hoppers situated below them. From the hopper the cargo will be delivered by conveyor to the stockpile or to the ship. Theoretical tripling rates can be as high as 7.300 t/h achieved with 75 wagons on single rail line, but this is dependent upon the faultless operation of an extensive marshalling yard and it is unlikely that it is often achieved in practice. Richards Bay Coal Terminal, however, has three railcar dumper systems in tandem, giving a theoretical rate of delivery to the stockpiles of more than 15.000 t/h.

Road Trucks (Pic.16): Road trucks delivering bulk cargo to a terminal will normally back up a ramp and tip their contents into a hopper, feeding a conveyor, serving the ship loader. Road trucks contribute a great a factor in the making of proper results in the port cargo management. Since off-road versions do not have to drive on roads at highway speeds, a typical top speed is just 25 miles per hour (40 km/h). It is rare for these vehicles to be on highways, so it was very unusual when a pedestrian was accidentally struck and dragged by a yard truck at an intersection in Bellevue, Washington, in February 2014.Autocar, Capacity Truck, Hoist Liftruck, Tico, and Kalmar Ottawa terminal tractors are manufactured in North America. Orange EV manufactures pure-electric terminal tractors in Missouri. Effenco manufactures hybrid systems that can be retrofitted on yard tractors. One of many European manufacturers is the Dutch company Terberg which has a US presence. Terberg has also introduced a fully electric yard tractor and an autonomous terminal tractor, the AutoTug. Assignment and scheduling of yard trucks in order to load/unload containers to/from ship obeying the stowage plan is an important problem for port operators. Efficient and real time solution methods are required by practitioners.

Barges (Pic.17): When bulk cargoes are delivered to the loading terminal by barge or by ship for transshipment, transfer to the loading ship or stockpile will often be achieved by grab unloaders, otherwise known as gantry cranes, though fixed or floating cranes, or vacuvators can also be used. Grabs with a capacity of 30-50 mt are common in the major bulk transshipping ports, and grabs with capacities as great as 85 mt have been built. Grab unloaders can also be used to load vessels by transferring cargo from the stockpile direct to the ship's hold.

Offshore transshipment: When trade develops faster than port capacity, as in the coal trade between Indonesia and India, there is a place for offshore transshipment of cargoes from larger ships to smaller vessels or lighters and transshipment is achieved by using geared bulk carriers, self unloaders or self propelled transshipping units designed to discharge and load cargo and to provide some storage.

Ships' Stowage

Grain (Pic.18): Some grain silos are very large structures containing a large number of separate bins. Each bin contains a consignment of grain and the specifications of the grain may vary from one bin to another. The specification required for a particular shipment is achieved by mixing the contents of different bins in suitable proportions. This may be monitored by inspectors, who will board the ship to sample the cargo to ensure that the correct mix has been loaded. If necessary they will order changes in the mix and have been known, in extreme cases, to order a vessel to be part discharged so that the cargo could be remixed to the correct grade. The contents of a bin may be the minimum pour that the vessel can call for.

The condition of the cargo should be regularly inspected during the course of loading. Ship's officers cannot be expected to be experts in the condition of grain, but they should have no difficulty in recognizing grain which is wet, sprouting, mouldy, discolored or contaminated with rat droppings or insects, dead or alive. All these and other signs should be a warning that the grain is in poor condition. It is not possible to view all the grain which is loaded, but a good impression of its general condition can be obtained from inspecting cargo in the holds during interruptions in the loading, cargo which is spilt on deck, and cargo within the hatch coaming during the final stages of loading each hold. In addition, it may be possible to inspect grain ashore before it is loaded if the method of delivery alongside allows. Grain which appears to be unfit for shipment should be rejected altogether and should charterers insist upon the shipment a survey should be held by surveyors acting on behalf of the owners and protest should be promptly noted.

Leakage of water into grain is a frequent and serious cause of claims, since any wetting of the grain will damage it. Every effort must be made to ensure that hatch covers and access hatches are absolutely watertight. When hatch covers are inspected, surveyed or tested for water tightness before the start of the voyage, that fact and the results should be recorded in the deck log book. When grain cargoes suffer from leakage through the hatch covers the Master is sometimes criticized if he did not seal the hatches with bitumastic sealing tape. However, its effectiveness is doubtful and the damage which it can cause to the hatch covers in the long term is substantial.

Effective surface ventilation of grain cargoes is often difficult or impossible to achieve because most compartments are filled and there is no route by which air can travel over the cargo from one ventilator at the fore end of the hold to another at the after end. In recent tonnage in which the only ventilators are fitted in the hatch covers, there is no provision for ventilation of the ends of the holds. There is, however, persuasive evidence that healthy grain cargoes require no ventilation. Cargoes of grain remain, unventilated, for months in silos and have been carried successfully in tankers where the tanks are unventilated. When a grain cargo is loaded cool and carried to a warmer area the cargo will be slowly warmed at its boundaries. With no ventilation there will be no danger of ship's or cargo sweat developing. When a grain cargo is loaded warm and carried to a cooler area there is some danger of ship's sweat developing on the steelwork within the hold but it is argued that ventilation to prevent ship's sweat will cool the surface of the cargo and is likely to cause damaging condensation of moisture within the surface layers of the cargo. The conclusion is that grain cargoes often cannot be ventilated effectively and that it is acceptable for them to remain unventilated.

Coal (Pic.19): A number of hazards are associated with the carriage of coal. It can produce explosions, go on fire, corrode the ship's structure, poison or smother those who breathe its gases, and liquefy, causing the cargo to shift and the ship to become unstable and capsize. Coal may release methane and hydrogen, both of which are flammable gases which can make an explosive mixture with air. Some coals are liable to spontaneous heating, which can cause fire, and may when heated emit flammable gases including carbon monoxide, which is also toxic. If coal is subject to oxidation within a cargo compartment the oxygen will be depleted and carbon dioxide will increase, creating an atmosphere in which breathing is impossible. The sulphur in coal when combined with moisture can produce sulphuric acid, which is liable to corrode the ship's structure. Some coals when composed of small particles can liquefy and shift when the moisture content is above that of the transportable moisture limit. Before loading there should be boundaries of cargo spaces where materials are carried shall be resistant to fire and liquids. It is dangerous to use water to cool coal cargoes. Liquid from other cargoes, from water ingress or for cooling could cause the cargo to liquefy. Coal shall be separated from other IMO categories of hazardous cargo, and shall not be stowed adjacent to hot areas. It is important the shipper to provide the Master with a written cargo declaration, before commencement of loading, of the cargo's contracted moisture content, sulphur content and size, and whether it may be liable to emit methane or to self-heat, and should provide more information if possible.

Coal cargoes having a moisture content in excess of the transportable moisture limit (TML) must never be carried. Coal cargoes with a moisture content approaching the TML must never be worked during rain or snowfall and holds which are not being worked should always be kept closed during precipitation. A high moisture content increases the danger of cargo shifting, self-heating, and creating corrosive sulphuric acid. Holds and bilge wells should be thoroughly cleaned and dry, and any residues and dunnage must be removed to prevent the formation of air pockets in the cargo, before loading commences. Means should be provided for measuring the temperature of the coal in the range 0-100° Celsius during loading and whilst carrying the coal, without the need to enter the holds. Some ships are provided with special temperatures tubes similar to sounding pipes placed midships at each end of the hold. When these are provided the thermometers can be left in position at all times lowered to a level well below the surface of the cargo and withdrawn when a reading is required. Alternatively, hold bilge sounding pipes can be used. Temperatures obtained from sounding pipes which run down engine room bulkheads will sometimes provide high readings which come from the machinery spaces, and not from the cargo. Where this is a possibility readings should be obtained from several positions. The temperatures of coal cargoes said to be liable to self heating should be monitored before loading and they should be accepted for loading only when the cargo temperature is not higher than 55° Celsius. The atmosphere over a cargo of coal must be monitored at regular intervals to detect methane, oxygen and carbon monoxide. The necessary preparations, equipment and procedures are described in ships' manuals about gas monitoring of coal cargoes. Smoking and naked flames near cargo spaces should be prohibited, and suitable notices posted. It is simplest, and most prudent, not to allow smoking forward of the accommodation.

The cargo shall be trimmed reasonably level to the boundaries of the cargo space to prevent the formation of gas pockets, and to minimize the mixing of air with the coal. Ventilator trunking leading down the bulkhead into the cargo stow should be adequately sealed. Trimming by spout is an effective way of leveling the cargo. Coal is loaded by either tipping or conveyor belt, bucket system. It is recommended that the first few truck loads are lowered to the holds, this reduces breakage as does a control rate of the chutes. Loading may take place from a single loading dispenser and, as such, it may become necessary to shift the ship to permit all compartments to be loaded. A loading plan to prevent undue stresses and minimum ship movements would normally be devised. Coal will need to be trimmed as its 'angle of repose' is quite high, especially for large coal. Small coal like 'mud coal', 'slurry' or 'duff' is liable to shift, but shifting is unlikely in large coal.

Iron Ore (Pic.20): The loading of iron ore cargoes has traditionally been thought to require no special attention, apart from the basic requirements to place the right quantities in the correct places in the planned sequence, and to keep the ship upright during the process. The traditional method of loading iron ore, still widespread, is to pour the cargo into the hold on the ship's centerline where it forms a broad based cone or heap. This method continues to be favored because some ports do not have the equipment to load in any other way. Iron ore stowed in this manner is not known to have been the direct cause of any casualties.

There is a variety of ways in which heavy bulk cargoes can be trimmed. A shiploader with the outreach to deliver cargo beyond the ship's centerline can distribute cargo in successive heaps across the hold. When the

loader has the ability to travel along the quay then cargo can also be delivered along the length of the hold, allowing cargo to be distributed over the entire tanktop. The same result can often be achieved with chutes or splasher plates used with the loading spout. An alternative approach, when either ship or terminal has suitable cranes or derricks, is for the trimming to be completed by a bulldozer or frontend loader lowered into the hold on top of the cargo stow. The benefits of trimming an ore cargo to the ship's side are that it reduces the possibility of cargo shift, reduces cargo oxidation, distributes the weight better over the tanktop and improves the ship's stability and sea kindliness by winging out the weights and increasing her period of roll. The disadvantages, from the point of view of the owners, shippers and crew, are that the procedure is costly, loading and discharging times are increased, the requirement for hold cleaning is increased by the increased contact between the ore and the ship's sides and when the trimming is done by bulldozer or frontend loader the cargo, besides being less accessible to the grabs, will be compacted and more difficult to discharge.

While discharging, holds should be well ventilated before they are entered. Iron ore is usually discharged by grab, and spillage from the grabs invariably occurs. Much of the spillage will land on the deck of the bulk carrier, or on her hatch covers if they are side rolling. This damages the paintwork, though chlorinated rubber paint seems to be damaged less easily than alkyd paint. Careful crane drivers spill less cargo from the grabs, so the ship should submit a damage claim in respect of spilt cargo as soon as spillage occurs. This may encourage the drivers to take greater care. When discharging iron ore normal procedures must be followed to ensure that a safe discharging and ballasting program is agreed and that no excessive longitudinal stresses are permitted to occur and a careful watch must be kept for stevedores' damage. The cargo calls for no exceptional precautions.

Iron and Steel Products (Pic.21.22): Steelwork is carried in various forms, notably as pig iron, steel billets, round bars, pipes, castings, railway iron, girders, steel coils, scrap metal or iron and steel swarf. It is without doubt one of the most dangerous of cargoes worked and carried at sea. Those products can be separated in the following forms:

- **Pig Iron:** If pig iron or billets are taken, they should be leveled and large quantities should not be carried in tween deck spaces. A preferred stow is to level in lower hold spaces and overstow by other suitable cargoes. If it has to be carried in tween deck spaces the maximum height to which it can be stowed should not exceed 0.22 the height of the tween deck space. Pig iron should be trimmed and stowed level in both tween deck and hold spaces in either a side to side or fore and aft stow. If it is not effectively overstowed it should be stowed in robust 'bins', with suitable shifting boards to prevent cargo movement. It is recommended that gloss finished pig iron is always stowed on wood ceiling or dunnage, to reduce steel-to-steel friction.
- **Round Bars and Pipes:** Should preferably be stowed in the lower hold compartments and leveled off. Securing should be in the form of strong cross wires over the top of the stow and secure 'toms' at the sides. Suitable car- goes can overstow this type of steelwork.
- **Railway Iron, Girders, Long Steel on the round:** Should be stowed in a fore and aft direction and packed as solidly as possible. If left exposed and not overstowed, chain lashings should be secured to prevent cargo shift.
- **Iron and Steel Swarf:** This may heat to dangerous levels while in transit, if the swarf is wet and contaminated with cutting oils. The carriage of 'swarf' requires that surface temperatures of the cargo are monitored at regular intervals during the loading process and whilst on the voyage. If, during loading, the temperature of an area is noted as 48°C (120°F), loading should be temporarily suspended until a distinct fall is observed. In the event that a temperature of 38°C is observed on passage, gentle raking the swarf surface area in the region of the high temperature, to a depth of about 0.3 m should cause the temperature to lower. If a temperature of 65°C is noted, the ship is recommended to make for the nearest port.
- **Scrap Metal:** Similar problems to other steel cargoes in that it is very heavy. It is generally loaded by elevator/conveyor or grabs and usually discharged by mechanical grabs. When loading, the first few loads are often lowered into the hold to prevent the possibility of excessive damage to ship's structures. Scrap metal tends to come in all shapes and sizes. As such, where mechanical grabs are engaged, metal pieces frequently become dislodged from the grab when in transit from the hold to the shore, while

discharging or loading. Deck officers should ensure that the working area is cordoned off and personnel on the deck area should wear hard hats and observe cargo operations from a safe distance.

- **Steel Coils:** Steel coils are stored on the round and are frequently carried in the cargo holds of bulk carriers. The overall stow is secured by steel wire and bottle screw lashings. The sides of the stow are generally chocked tight, against the ship's side, if broken stowage is a feature of the cargo. Steel coils are classed as a heavy cargo, and would be leveled to no more than two tiers in height. Individually, a coil may weigh up to 10 tons, and they are frequently treated as "heavy lifts". They are prone to shifting, being stowed on the round, if the vessel encountered rough weather. Passage plans should bear this in mind and chart a "Port of Refuge" in case such a contingency is required.

Forest Products (Pic.23.24): It is important to remember that the weight of timber and lumber (packaged timber) is seldom known accurately before loading because that depends upon its moisture content which, in turn, is affected by past weather and where the cargo has been stored. It is, therefore, important to conduct draught surveys regularly during loading to check whether the weight of timber loaded corresponds to that expected. If it does not the stability calculations will have to be reworked and the stowage plan will have to be amended. Any filling or emptying of ballast tanks should be undertaken as early as possible during the loading and should be completed by the time that the deck cargo is being loaded. At this time the ship's positive stability will be approaching the minimum. Normally the deck cargo is not lashed until loading is completed and if a list develops the risk increases that cargo will topple out of the stow. Fork lift trucks weighing 4-7 tons are likely to be used when stowing the ends of the holds of conventional bulk carriers whilst all cargo will be landed directly into position by ship's or shore gear aboard open hatch ships. Preslinging of lumber cargo is now almost universal. Hatch covers should be fully secured for sea immediately that under deck loading is completed as they will not be accessible for opening and closing once loading on deck begins. Despite the fact that they will be enclosed within the deck cargo the ship will not be considered seaworthy if they are not secured. If ventilation of the cargo holds is considered necessary during the voyage, the ventilators must be accessible for opening and closing. If seasoned timber is to be carried it must be possible to inert the holds with CO2 and for this the ventilation hatches must be closed.

It is most important to ensure that any lumber carried on deck is documented as "on deck cargo" and that all parties involved have given their permission and have authorized the lumber to be stowed on deck. A timber or lumber deck cargo should be stowed in such a manner as to ensure that the ship has adequate stability, that the stow is tight, that the sides of the stow are continuous, that access to fire hydrants and fire hose boxes, ventilators, deck valves, sounding pipes and other items of deck equipment is ensured and that the view ahead from the navigating bridge is not impeded. Detailed practical advice, written for cargoes loaded on the west coast of Canada but with a wider application is available. On the Canadian west coast packaged lumber is usually loaded two units at a time with one above the other, resulting in a stow composed of successive "working tiers", each two units high. Packaged lumber is often supplied with narrow "attached dunnage" strapped to the base of the package and for this reason some shipowners do not place dunnage over the hatches beneath the deck cargo. It should be remembered that the weight of cargo on the hatch covers may be considerable and that a layer of loose dunnage may be required to reduce the "line loading" in way of the attatched dunnage and spread the weight of the cargo. A second reason for placing dunnage on the hatch covers is to obtain a level surface and take out the camber, in order to remove any slope towards the sides of the hatch covers. Packaged lumber on deck will normally be loaded on the hatch covers and over the full length of the deck to port and starboard of the hatch covers (sometimes known to stevedores as the "wings"). Frequent dunnage on deck beneath the packages of lumber should be placed in such a way as to transfer the weight to the deck beams and not to the unsupported deck plating between the beams. Competent stevedores and/or a competent supercargo or port captain will ensure a tight stow. Recommendations for achieving it include:

- *Using dunnage at the boundaries of the stow to tilt the packages slightly inwards.*
- *Keeping wrapped packages and custom cut packages (packages with uneven ends because the component planks are of different lengths) "buried" in the centre of the stow.*
- *Using athwartships dunnage or athwartships packages to tie the wing stow into the stow on the hatch covers.*
- *Using dunnage at every second tier to bind the stow together.*
- *Ensuring that the outside walls of the stow are composed of the longest bundles available and are straight and level.*

- *Ensuring, with the help of dunnage if necessary, that a good level stow is maintained at all times.*
- *Any voids or severe "cracks" which occur in the stow should be eliminated or choked off. Where they cannot be eliminated they should be staggered, not continuous.*

Consignments for different ports are normally separated with polypropylene rope or "log marking" paint. It is increasingly common, particularly on gantry vessels, for isolated "island" or "castle" stows of packaged lumber to be placed on individual hatch covers to allow discharge of part cargoes in different ports. The regulations appear to require no special treatment when lashing these castles, despite their lack of the protection which is given by a continuous stow but it is recommended that extra lashings are used or that the cargo is stepped down. A catwalk over the cargo will be required except when the ship has under deck passageways extending the length of the deck. Deck cargo ladders, gicing access to the top of the stow, will be required in any event. The variety of measurements used for forest products can be confusing. It is rare for the weight of a timber cargo to be known accurately before loading takes place. Approximate weights per unit volume may well be used by the shipper or charterer and will certainly be used in pre-loading calculations for stability purposes. It is essential that the weights be checked by draught survey during the course of loading. Round logs are listed by weight in some trades and notice is given of heavy units. Care should be taken in estimating stowage factors of logs from equatorial rain forests. Many such logs, such as vitex, have buttressed trunks. Logs sawn from the buttress ends have a star shaped cross-section and occupy considerably more space than conventional round logs.

Cement (Pic.25.26): The main ingredients of various grey cements are chalk (82%), sand (6%) and fly ash (12%0. Fly ash is the residual ash from the burning of coal. In white cement, a speciality of Aalborgh Portland, the fly ash is replaced by material with a high content of aluminum oxide. A "flow promoting" additive is often used in cement manufacture to make it flow more freely during the grinding and transportation processes. Several characteristics of cement in bulk make it a problem cargo. It is fine grained and potentially very dusty, when contaminated it is useless as a binding agent, when wet it sets solid, when manufactured it is hot and retains its heat and, when aerated (mixed with air) in a pneumatic loading system, it is fluid.

Much of the world trade in cement is carried in conventional bulk carriers. Holds must be clean, dry and free of all traces of previous cargoes and of rust scale, and regulars in the trade advise that a really thorough cleaning and removal of rust before loading will make the job of cleaning after discharge much easier. Fresh water rinsing, whilst always desirable, is not considered essential. Hold bilges must be sealed with sift proof-material. When cement is to be loaded following a cargo of sugar, particular attention must be paid to thorough cleaning of the holds as even small traces of sugar can render a cargo of cement worthless.

Loading berths are normally adjacent to cement silos where ships are required to shift back and forwards to bring successive holds under the loader. Loading methods vary considerably. Loading by conveyor belt into an open hold is very dusty and the combination of dust and dew can quickly coat much of the ship with a hard coating. This can be removed by applying a mild acid diluted with fresh water to 50% strength followed after 40 minutes with a high pressure water wash. The loading system which is most friendly to the environment and to the ship is a sealed pneumatic system. This requires the ship to have two circular holes in the hatch lids, a feeder hole for the displaced air. Neither of these holes needs be exactly amidships but the feeder hole should be near to midship. In some ports it is reported to be the practice to cut the necessary holes in the hatch covers of ships not already so equipped and to reweld them on completion of loading. This is easier to do with covers of open web construction than when the hatch panels are double skin sealed units. In either case the work should be agreed by the owners and approved by the vessel's classification society. To commence loading with a sealed system an electrically powered extractor fan and dust filter unit is bolted over the extractor hole. When running, this maintains a low pressure in the hold which encourages the flow of cement into the space, and ensures that no dust is released into the atmosphere. While the system is in operation all hold accesses, ventilators and coaming drains must be closed. The end of the loading hose is fitted with a trimming spout which extends to 1.5 m beneath the hatch cover when the hose is bolted in position. A handwheel mounted on and around the hose end allows the spout to be swung through 360°. Tending the trimming spout is a constant task for the duty deck officer who must ensure that the ship remains upright, or nearly so, to avoid the cement flowing to the low side and causing a dangerous list. The sealed system llows loading in all weathers and eliminates atmospheric pollution. Unsealed pneumatic loading systems, on the other hand, deliver the cement to the hold by hose and trimming spout and protect the cargo from the weather, but

have no filtering and extraction system, so cement dust will escape from the hold with the displaced air. The cement, aerated by the hydraulic loading system, flows almost like water to all parts of the hold where it settles, quickly losing its fluid properties. Its final profile is normally gently convex with height of cargo in the centre of the hold of a handy-sized vessel no more than about 0.5m higher than the height at the boundaries. There is no stability requirement for cement laden holds to be completely filled and, as cement is a dense cargo with an approximate stowage factor of 0.67 to 1.00 cubic/tons, it is seldom that they are.

Discharge may be by grab or by bucket wheel unloader but is more usually be pneumatic suction hose working through the open hatch and discharging to a silo. The ship is normally required to shift along the birth to work successive holds. Work must cease and hatches must close during rainfall. A bobcat will be used to move cargo from the wings and ends of the hold.

General & Break-Bulk Cargoes (Pic.27.28.29.30): Bulk carriers are not designed for the carriage of general cargoes, which are cargoes made up of small units of assorted raw materials and manufactured goods. When crates, cases, cartons, drums, loose machinery or casks are to be carried, often from several loading ports to several discharging ports, the several discharging ports, most suitable ship for such products is a tweendeck vessel. Such a vessel offers two advantages over a normal bulk carrier – a tweendeck vessel posseses at least twice as much deck area (ground space) within the cargo spaces, which permits much greater flexibility in arranging the loading and discharging sequence, and the heights of the compartmens in the tweendeck vessel are much lower, thus preventing stowage of cargo to an excessive height and consequent crushing.

Despite these disadvantages bulk carriers are required to carry general and breakbulk cargoes from time to time, perhaps because of the decreasing number of tweendeck vessels. In addition a charterer with unused space in his ship may sub-charter one or more holds to another shipper, who may provide such cargo. Full cargoes of rail wagons and of pallets of onions have been carried in handy-sized bulk carriers, with many bagged cargoes, and cargoes of steel products.

The following basic rules should be observed when required to carry general or breakbulk cargo:

Planning

- Draught, trim, stress and stability at every stage in the voyage must be planned as for a bulk cargo.
- Avoid excessive local loading on the tanktop, deck or hatch covers from cargo or fork lift trucks.
- No.1 hold, being close to the bows, is not box shaped. It is suitable for small items of cargo and bagged cargoes, but not suitable for large items of cargo. Where possible cargo for discharge by lighter at an anchorage port should not be stowed in No.1 hold because the water alongside No.1 hold is usually unsheltered, which will cause difficulties for the lighters.
- Bulky items of cargo such as casks of tobacco should be stowed in large holds where the loss of space due to broken stowage will be least. (Broken stowage is the unoccupied space around items of cargo.)
- Heavy items of cargo such as machinery should be stowed in the hatch square in positions where they can be landed directly and from which they can be discharged directly.
- Different cargoes can damage one another by taint, by dust and sweepings, by leakage of liquid contents, by insect infestation, by condensation from moisture content and by crushing. When stowing different cargoes together these dangers must be born in mind.
- Hazardous cargoes should be stowed under deck or on deck in accordance with the International Maritime Dangerous Goods (IMDG) Code.
- Heavy cargoes for loading or discharge with ship's gear must be stowed within reach of the appropriate ship's crane or derrick.
- Cargo for each loading port and each discharging port should be shared between all holds or several holds, as far as possible, so that several gangs of stevedores can be employed simultaneously, and the total loading and discharging time can be reduced as mush as possible.

Dunnage

- Dunnage, which normally consists of softwood planks with a cross-section of 150x30 mm, or of plywood sheets, should be used with all general cargoes to protect the cargo from moisture, to provide a non-slip base for heavy items and to bind the stow together. Beneath general cargo it is normal to place double dunnage, with the bottom layer consisting of 75x75 mm timber running fore and aft, to allow any water to drain to the after end of the hold, and the upper layer consisting of plywood sheets or

planks running athwartships. Cargo such as cartons or sacks which could be damaged by contact with the ship's steelwork and the moisture which could collect on it, should be protected with dunnage. Layers of dunnage or single pieces or sheets of dunnage can be placed within the stow to bind it together and stabilize it.

Stowage

- When heavy and light items are stowed together the light items (e.g., cartons) must be stowed over the heavy items (e.g., crates).
- When cargo is only stowed over part of a hold the vertical boundary of the stow is called the face. The face of the stow must be constructed with skill and care if it is not to collapse during the course of the voyage. A face which faces forward is likely to be more secure than one which faces aft, since the stern trim which is normal for most ships will tilt it slightly in the direction of security. A face in a stow of bags will normally be locked or made more secure, by stowing one tier of bags fore and aft, and the text tier athwartships. Each layer of bags is started at the face, to ensure that the bags in the face can be placed exactly as required.

Securing

- Cargo securing must be done in compliance with the ship's Cargo Securing Manual. If securing equipment or procedures which are not described in the Manual are required the approval of the authority must be obtained.
- Every item of cargo must be properly secured so that it cannot move and suffer damage when the ship works in a seaway. Cargo must be secured by forming part of a solid stow, by chocking with timber chocks which secure the cargo in position, or by lashing with wire lashings or flat metal strapping bands. Cargoes of steel coils are lashed together to form a solid mass, but are not lashed to the ship. This method of lashing cannot work for items such as locomotives and heavy items of industrial or agricultural machinery. They cannot be fastened tight together and must be individually lashed to the ship's structure it is usually necessary to weld a number of lashing eye plates to the ship's tanktop, hopper sides and frames. Project cargoes are often welded to the ship's structure under supervision of Class. Hot work of this sort will damage the coatings in adjacent compartments which should be repaired at the first opportunity.
- A block of cago should never be left unsecured when a ship goes to sea. It must be chocked, or it must be broken down or stepped down. Breaking down a block of cargo means lifting down the upper items and spreading the cargo in a level stow across the tanktop, so that it is impossible for it to fall further.
- The slopping hopper sides of the holds present problems for the stowage and securing of some general cargoes, though bagged cargoes are unaffected and cargoes such as steel reinforcing bars and girders can be stowed fore and aft across the entire breadth of the hold without difficulty. When square-sided items of cargo are to be stowed in holds with hopper sides, chocking must be used to create a series of steps.
- At various points in the foregoing notes it has been recommended that cargoes be secured with well-placed dunnage, chocking or lashing. In the sheltered waters of a port it is sometimes difficult to imagine the violence with which a ship can roll and slam in heavy seas, and to take all the precautions necessary to secure the cargo properly. Bulk carriers tend to be stiff ships, and can roll violently in a beam sea. All cargo securing should be done thoroughly and professionally using good quality materials and should be carefully inspected before it is accepted. If the Master has no previous experience of the cargo and is in doubt as to the securing which is appropriate he should consult his owners and ask them to arrange for a surveyor to advise him.

Ro-Ro Cargo Items (Pic.31): Include all the various types of vehicles for road transport, roll trailers and other pieces which are driven aboard the vessel. Commercial vehicles include semi-trailers without towing tractor unit combination vehicles comprising a tractor unit with one or more towed vehicles and other commercial vehicles which are not articulate Roll trailers are used within port areas and on board ro-ro vessels for the carriage of large or heavy pieces of cargo via the stern or side door. Other pieces include caravans-trailers and constructions or road building machinery, farm machinery either wheeled or on tracks. These basic types will be dealt separately:

Road Vehicles: There are extensive recommendations and requirements with regard to the safe carriage of road vehicles aboard ro-ro vessels. The recommendations and requirements can be divided into those applying to the basic standards of acceptance of the vehicle, lashing equipment on board stowage and securing of the vehicle.

Basic Standards for Acceptance of Vehicles

All vehicles should be inspected before they are loaded to ensure that they are in a seaworthy condition and suitable for carriage on the intended voyage. This means that the vehicle must he suitable for securing on board and must have adequate strength to withstand the rigors of the voyage and the cargo on the vehicle must not shift during the voyage. The requirements are as follow:

- The cargo on the vehicle must be properly stowed and adequately secured such that it will not move during the voyage. Machinery on an Oat-bed trailer must be properly secured as if it were on the deck of the vessel. Pallets or other units within a box van must be adequately chocked and items of whatever type must be secured to the bed of a curtain-sided trailer (the side-curtains are not there to secure the cargo they are there to keep the rain out).
- The trailer should be fitted with an equal number of lashing points to each side in accordance with the following order:
  - Gross vehicle mass 3.5 tons to 20 tons - 2 lashing points
  - Gross vehicle mass 20 tons to 30 tons - 3 lashing points
  - Gross vehicle mass 30 tons to 40 tons - 4 lashing points
- Each lashing point should have strength. Without permanent deformation, of at least 120 kN or 12 tons. The lashing points should be fitted at suitable places on the vehicle so as to ensure efficient restraint of the vehicle by the lashings. The lashing point is capable of transferring the forces from the lashings to the chassis of the vehicle and such lashings can be readily and safely attached.
- When a semi-trailer is shipped unaccompanied. That is without a tractor unit. Its front end will be supported on a trestle placed below the chassis close to the rear of the draw plate. That area of the chassis should be suitably re-enforced for the purpose and that area should be clearly marked.
- Sometimes it will be necessary to jack-up the chassis in way of the angles. Such jacking-up points on the chassis should be suitably strengthened.

Lashing Equipment On Board

Ro-ro vessels designed for the carriage of vehicles will have their decks laid out and fitted for the purpose and they will have on board suitable lashing and stowage equipment. The primary items are as follows:

- The decks will be laid out in lanes with securing points fitted along each lane. Those securing points should be not more than 2.5 m apart in the fore-and-aft direction and the lane should not be less than 2.8 m, nor more than 3.0 m wide.
- The lashing points should have strength without permanent deformation of not less than 120 kN or 12 tones. If the securing points are designed to accommodate more than one lashing then the strength of the lashing points should be 120 kN times the number of lashings it can accommodate.
- Lashings should be of chain and should have strength without permanent deformation of not less than 120 kN or 12 tones.
- Lashings should be designed with a hook or other devices for attachment to the vehicle and an appropriate fitting to engage the deck securing point. They should also be fitted with an attachment which allows for initial tightening after attachment and further tightening if they become slack during the voyage.
- There should be sufficient trestles for the supporting of semi-trailers and sufficient jacks for the support of chassis in way of angles.

Stowage and Securing of the Vehicle

Vehicles should be stowed in the fore-and-aft line of the vessel with sufficient space around the vehicle for examinations to be carried out during the voyage. Each vehicle should be adequately and properly secured for the intended voyage. The primary points to be in mind are as follows:

- Only proper securing points on vehicles should be used for lashing purposes. Lashings should not be attached to lamp brackets, bumpers, side-guards, etc, unless they have been specifically designed for use as securing points on the vehicle.
- Only one lashing should be attached to any one securing point. Lashings are most effective on vehicles when they are made at an angle with the deck of between 30" and 60". When these optimum angles cannot be achieved additional lashings might be required.
- Lashings should be fitted such way that on each side of the vehicle there is at least one lashing leading forward, one lashing leading aft and one as far as possible leading athwart ships.
- Lashings should not be crossed from side to side but they should lead from the lashing point outboard and down to the deck fitting.
- The master should take into consideration the weather conditions likely to be encountered during the intended voyage and should decide upon the number of lashings to be fitted to each side of each vehicle.
- Consideration should be taken into account with regard to the position of individual vehicles on board when deciding upon the number of lashings to be fitted. Vehicles stowed right forward or right aft and outboard to port or to starboard may require the fitting of additional lashings in view of the large accelerations which will be experienced by vehicles at those locations.
- The parking breaks should be applied and locked and vehicles with diesel engines should not be left in gear during the voyage.
- The front end of the chassis of semi-trailers should be supported by a trestle positioned such that it does not restrict the connection of the wheel to the kingpin. Landing legs should be lifted clear of the deck.
- Road vehicles should be secured in such a way that they are kept as static as possible by not allowing free play in the suspension system. Compressed air suspension systems may lose air and therefore the air pressure should be released on vehicles fitted on such n system when necessary. If the air pressure is not released, the vehicle should be jacked-up to prevent any slackening of the lashings which would result from air leakage.

Roll Trailers: These trailers are specifically designed for use within port areas and on board ro-ro vessels that are not taken outside such areas. They are of length 20 ft. 30 ft. 40 ft. and 42 ft. that have small diameter solid rubber wheels at the rear on angles which do not have suspension and have a ridged support bar at the front, that they are horizontal when set down on to that bar. At the front end they have a coupling mouth which accepts the gooseneck of specially designed tractor units such as the trailers that can be lifted at their front end and towed without the tractor unit being actually coupled to the trailer, The trailers are used for the carriage of large or heavy pieces of cargo and have safe working loads in the range from 20 tones up to 200 tones. The appropriate size and strength of trailer should be used for the particular piece of cargo or pieces of cargo which are being shipped.

- These trailers are fitted with numerous lashing points and the cargo must be appropriately and adequately secured to the trailer for handling on the deck and on board. The type and number of lashings will depend upon the cargo being carried. It might be appropriate to use wire rope, chains, webbing or steel bands. Whichever type of lashing material is chosen, a suitable number of lashings variously leading to the front, to the rear and to both sides of the trailer should be fitted.
- The trailer should be stowed on board on the fore-and-aft line of the vessel. The support bar of the trailer should rest upon pieces of good quality timber dunnage or upon rubber matting supplied for the purpose.
- The trailer and its cargo should be secured to the deck of the vessel by either chain or wire rope. The required number of lashings should be calculated using the gross weight of the trailer. That is the trailer and the cargo, using either the Rule-of-Thumb or the Advanced Calculation Method.
- Lashings should be led from the trailer and from the cargo, as appropriate. To deck lashing points, variously leading forward. aft and athwart ships. As mentioned before. Lashings arc most effective when they make an angle with the deck of between 300 and 600. When the optimum angles cannot be achieved additional lashings might be required.
- As with other cargo. nil lashings should be examined at frequent and regular intervals and all lashings found to be slack should be fixed.

- ❖ The loud of each trailer should. so far as possible be examined to ensure that it is not moving on the trailer. If movement is found to be taking place all slack lashings should be re-tensioned and additional lashings to the trailer and/or the deck should be fitted.
- ❖ If adverse weather is predicted for a later part of the voyage additional lashings should be fined to the trailer and to the cargo.

Other pieces on wheels or tracks: These include smaller items on wheels such as caravans, boats, trailers, etc: wheeled vehicles which are not wad vehicles, such as building machinery and farming machinery and lastly tracked vehicles and machinery. All of these items have one thing in common and that is that they do not have specifically designed lashing points. Some of them are very heavy and of strong and substantial construction, whilst others are light in weight and of light construction like Caravans, Road Vehicles, Trailers, etc.

These are generally of light construction and might need to be supported from below as well as hoeing tied down. Some points to be in mind are the following:

❖ It might be appropriate to fit lashings to chassis members or towing bars. Other fittings such as bumpers, awning fittings or other fittings which appear to be lashing points might not have sufficient strength for the requirements of one lashing point. Lashings must not cause damage to the fitting being used. Lashings should not be crossed from side to side, they should lead from the lashing point outboard and down to deck fittings.

❖ The suspension might be fairly light and therefore it might be necessary to tit chocks below chassis members or jacking points before fitting the lashings in order that those lashings will hold the vehicle or trailer down onto the chocks rather than acting against the suspension.

❖ The item might not have any brakes and therefore chocking around the "heels to prevent movement might be appropriate.

❖ If there are no points for lashings, it will be necessary to lead lashings over the top of the piece. Before this is done the shippers should be contacted and asked for guidance as to when: best to lead the lashings.

❖ Lashings of webbing or fibred rope might be more appropriate for some light construction pieces but chains or wire rope might be needed for other types.

❖ As with all lashing systems, lashings should be lead forward an end to both the port and the starboard sides of the vessel.

Containers in Non-Container Vessels (Pic.32): Containers can be carried by vessels which are not container vessels, but special attention should be given to the stowage and securing of the containers. Non-container vessels can be divided into two types, those which are fitted with container securing devices and those which have none. If the vessel is provided with a full outfit, although she is not classed as a container vessel the recommendations given above for container vessels should be followed.

The Code of Safe Practice for Cargo Stowage and Securing gives some guidance for the stowage and securing of containers on the decks of vessels which are not specifically designed and fitted for containers. The illustrations given in the Code show containers stowed 2 high. The United Kingdom Department of Trade Merchant Shipping Notice no.624 - October 1971 stated that “Except where there is provision enabling a twist lock, or other similar devices, to be inserted in the bottom corner fittings of the container and into suitably designed recesses in the hatch covers or fabricated deck stools of appropriate strength, containers carried on-deck should be stowed one high only”. It is recommended here that if the vessel is fitted with deck or hatch top stools or seating devices containers may be stowed two high whereas if there are no such fittings containers should be stowed high only.

When stowing and securing containers on vessels fitted with deck or hatch top stools or seating devices the following points should be in mind:

- ❖ Containers should be stowed in the fore-and-aft direction and squarely supported on all four bottom comer castings.
- ❖ Containers should be stowed and secured such that there is sufficient space around each container, or stack of two containers, to allow personnel access to all securing arrangements during the voyage.
- ❖ The weight of the containers should not overstress the deck or hatch top.
- ❖ Container fittings such as twist-locks. Bridge fittings. Lashing chains and turnbuckles should be in good condition and working order. Adequately greased where appropriate.
- ❖ All securing devices should be used in accordance with the information given in the vessel's Cargo Securing Manual.

- If wire rope is used to secure the containers such wire should be of adequate strength, should be in good condition and eyes or grommets should be made up with the appropriate number of wire rope grips in the correct arrangement.
- On board a vessel fitted with deck stools and hatch-top fittings. The containers may be stowed two high and must be secured by the use of twist-locks. Chain or wire rope lashings. Turnbuckles and other fittings such as bridge fittings. Timber shores and chocks.
- When containers are to be stowed directly onto the deck or hatch-top the following additional points should be borne in mind:
- Containers should be stowed only one high.
- The comer castings should be stored on timber gratings or timber boards of sufficient thickness and rigidity such that the weight of the container is spread over a sufficient area of the deck or hatch top so as the maximum permissible loading is not exceeded.
- No dunnage should be placed such that it is in contact with the underneath of the floor structure, sills or side frames.
- Containers must be stowed and secured independently.
- Lashings must be of adequate strength for the weight of the container and lashings should be led from top comer castings to deck fitting of appropriate strength either crossed from side to side or leading down and outboard/inboard from the top comer castings. The requirement for the strength of the lashings should be calculated using the Rule-of-Thumb method or the Advanced Calculation Method depending upon the amount of information available.
- Foot lashings or foot chocks should be fitted in way of bottom comer castings. Foot lashings of either wire or chain should be lead from bottom comer castings directly outboard/inboard to deck lashing points. Alternatively. Foot chocks constructed from good quality timber should be fitted between bottom comer castings and the hatch coaming structure inboard and bulwark structure outboard. Such foot chocks should be of length no more than 2m.
- All lashings should be set tight by turnbuckles.
- If the container is not adequately secured it is likely to move and if the cargo in the container is not secured in the container that cargo is likely to move as well.

Safety Considerations During Cargo Handling

Unsafe Cargoes: Many dry bulk cargoes posses' features which create hazards for bulk carriers and those who serve aboard them. Cargoes which give off explosive or flammable gases, cargoes which may self heat or shift when their moisture content is too high, cargoes which deplete the oxygen content is too high, cargoes which deplete the oxygen content of the surrounding air all present a threat. It is most unlikely that any individual will know all the hazards presented by all the cargoes that may be offered. Masters should study the Declaration by Shipper, relevant entries in the International Maritime Dangerous Goods (IMDG) Code and dry bulk cargo databases such as that provided for members of BIMCO, and should ensure that all those aboard ship are aware of hazards and ways of countering them.

Hazards from Working Cargo: A number of bulk cargoes such as quartz, iron ore, pig iron and steel scrap contain sizeable lumps which can cause injury or death if they fall from a height and strike a person below. From time to time and frequently in some cases – lumps of cargo will fall from the conveyor belt of the ship loader or from the discharging grab on the deck of the ship or the quay alongside. Such spillage should be regularly cleared to maintain a safe access route along the deck. For experienced seafarers and stevedores it becomes second nature to avoid standing below the conveyor or the path of the grab, and this is a rule which should be firmly enforced upon any inexperienced people who have occasion to be in the vicinity of a bulk carrier when bulk cargoes are being loaded or discharged. It is good practice to forbid entry to the working side of the main deck except to those who have necessary work to do in that area. Those required to be on deck during the working of cargo should wear high visibility clothing, hard hats and industrial footwear.
Many bulk cargoes are dusty and some extremely so. The effects of breathing dust can never be beneficial and are probably harmful in some cases at least. Where possible it is always best to avoid exposure to cargo dust and employers and their representatives have a duty to minimize dust. When exposure to hazardous solids, liquids or gases cannot be avoided respiratory protective equipment (RPE) and safety goggles must be worn. The selection and use of the appropriate RPE is complex and extremely important. It should be part of the risk assessment process. Many different types of RPE are available to give protection against different hazards and the wrong respirator, for example, may be worse than none at all. The advice of a qualifies person who understands the circumstances where the RPE is to be used should be obtained. Anyone required to be on deck when a dusty cargo is being worked and anyone sweeping cargo with a brush or with air should wear a suitable respirator. For a respirator to be effective it must be of suitable design, in good condition and worn by a person who has been trained in its use. For general shipboard use a simple respirator with a disposable filter where the wearer's lungs are used to draw air through the filter should be suitable for cargoes which are not stated to be hazardous. The European (CEN) standard for disposable filtering face piece (FFP) respirators rates FFP1 as the lowest acceptable standard, removing about 80 % of the dust, whilst a face piece rated FFP3 removes about 98%. All types of respirator are less effective when the wearer is bearded, or unshaven. Filters should be renewed according to manufacturers' instructions or, in the absence of instructions, when soiled. Respiratory protective equipment (RPE) for use when engaged in spray painting must satisfy requirements quite different from a cargo dust mask as it must exclude gas and vapours, not dust particles. When entering a space which is deficient of oxygen no respirator will be of assistance. The air does not need to be filtered to remove impurities. Air to support life must be provided and in these circumstances a respirator will not do a breathing apparatus with an air supply is required.

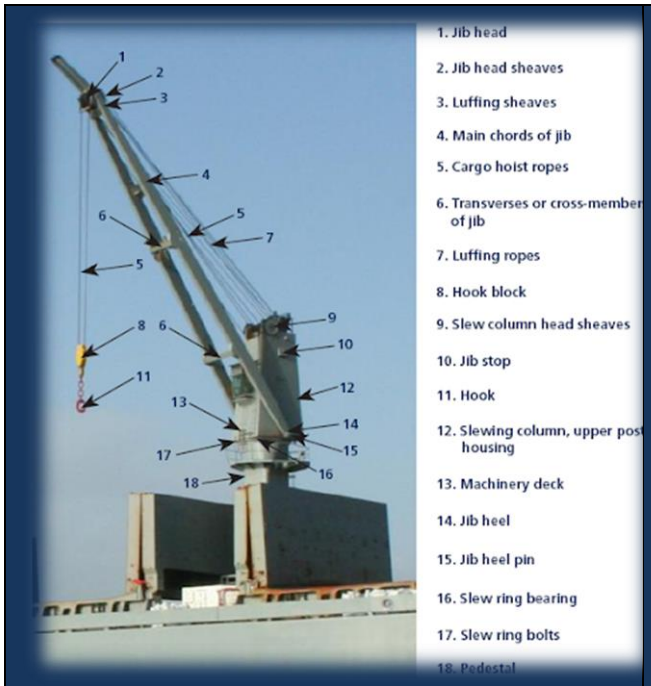
Smoking should not be allowed on deck when hazardous cargoes are being worked. Grain is a hazardous cargo in this respect: dust explosions have been known to occur in the vicinity of grain. Stevedores must be required to observe the same standards of safety as are required of ship's personnel. Hatch covers, whether open or closed, must always be secured so that they cannot roll in the event of a change in trim or list. A hold should never be entered when cargo is being worked except with the authority of the duty officer and the knowledge of the signaler for the cargo working equipment. Extra care must be taken when slippery cargo residues are on the deck.

Permit to Work System: In many situations aboard ship the routine actions of one person can endanger others. Before work is started it is necessary to identify the dangers and to remove them where possible. A most useful safety procedure and a tool of the professional ship's officer is the use of the 'permit to work' (PTW).

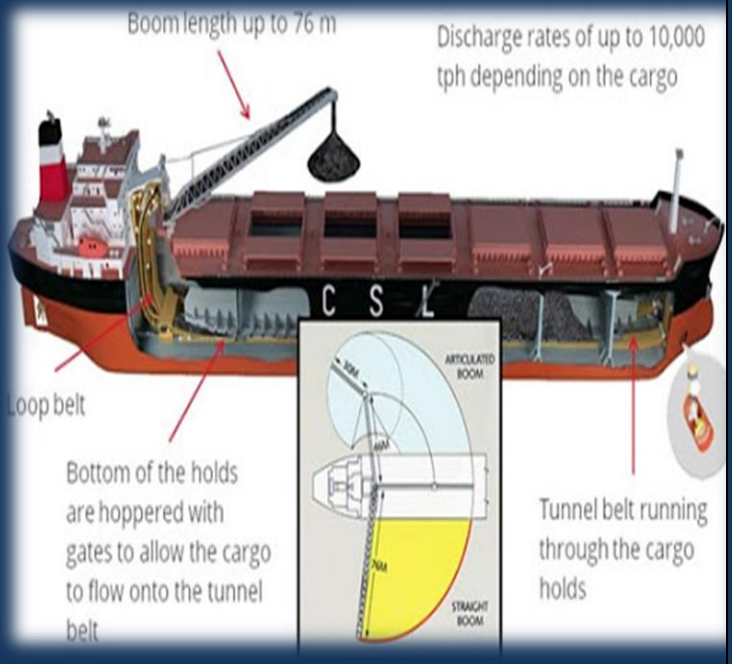
This system obliges everyone concerned with a particular task to concentrate his mind on the work to be done and serves to involve the team in anticipating where things might go wrong. It is also a training aid, since it indicates the correct way to set about and complete various onboard tasks. This makes permits to work most useful when instructing junior officers and ratings. The operation of the permit to work system is simple. A checklist consisting of a numbered list of questions relating to the proposed work is completed by using a tick or a cross against each question. The person who is to directly supervise the work will sign the permit only when he is satisfied that all questions on the checklist have been correctly answered. Only after it has been signed should the work commence. The permit should include a description of the work to be done, and should show the time when the permit expires, which should be no more than 24hrs after the issue of the permit. If there is a need for the work to continue after the permit has expired it must be renewed. Permits with suitable wording are required for a variety of different tasks. They can be written aboard ship, or the shipping company can supply them to all their ships. Permits can be produced in duplicate pads, with one copy issued to the person doing the work and a second retained by the person who issues the permit. Aboard many ships nowadays they are computerized and forms can be printed as required with one copy displayed on-site and another on the PTW board. A copy of each permit issued should be retained amongst the ship's papers for legal reasons and to demonstrate to auditors and safety inspectors that safe working systems are in operation. One word of warning must be sounded with regard to permits to work. If they are badly written and fail to list a necessary precaution, they can be the cause of that precautions being forgotten. A space for remarks should be provided so that additional precautions can be noted, an the permit should be revised from time to time to include necessary improvements. It has been estimated that 60% of all major claims are attributable to human error, whilst other authorities put the figure as high as 80%. The permit to work system is intended to reduce the opportunity for human error and by 2009 was used by most, if not all, bulk carrier operators as part of the SMS.

Safe use of Pesticides: In recent years the authorities have become increasingly concerned at the dangers associated with the use of pesticides aboard ships. There is the possibility that edible cargoes will be contaminated by the use of pesticides and that crew members will be harmed by contact with them. On at least one occasion ships' personnel and stevedores required treatment when they breathed fumigant laden dust from a grain cargo while it was being loaded. The ship should receive a warning about the cargo had been fumigated before loading. The Master should enquire whether the intended cargo is under fumigation or has been fumigated and should arrange for the supple of suitable approved protective masks if necessary. Full recommendations for the use of pesticides aboard ship have been published by the IMO. A copy of this document should be held aboard ship and studied before pesticides are used. The following paragraphs indicate the areas covered by the recommendations, but it must be emphasized that pesticides can kill and should not be used except when the full instructions have been studied. A ship may be infested by insects or by rats. Infestation by insects may exist aboard ship or may be brought aboard with the cargo. The purpose of its removal may be to satisfy the agricultural authorities in the discharge port or to ensure that the cargo remains acceptable to the receiver. Infestation can cause cargo to overheat. Infestation by rats must be eliminated in accordance with International Health Regulations. Infestation is assisted by dirt and cargo residues. Holds, accommodation, storerooms and machinery spaces should be kept very clean to remove any opportunity for infestation.

Cargo Liquefaction: The issue of liquefaction affects bulk carriers of all sizes, but liquefaction can affect all ships carrying bulk ores including dry general cargo ships that load parcels of bulk cargo. Solid bulk cargoes such as iron ore fines or nickel ore normally contain a degree of moisture within the particles. If the cargo has laid in piles at the mine, having been transported to the terminal in open barges or trucks and loaded onto the terminal stockpiles during heavy rain, there may be a dramatic increase in moisture levels. Masters loading mineral ore fines in rainy seasons should be warned that the certificate issued for the moisture content, transportable moisture limit, and flow moisture point may not represent the real condition of the cargo. When the cargo is subject to recurring cycles or cyclic forces, such as the movement of the ship and the volume of spaces between the particles reduces, which causes the pore water pressure to rise, reducing the shear strength of the particles. Pore water pressure refers to the pressure of water held within a soil or rock, in gaps between particles . If the pore water pressure increases enough, the cargo can reach its flow moisture point. The cargo enters a stage of transition whereby it begins to react like a fluid because of the loss of friction between the particles.



Pic.1 Ship's Cranes



Pic.2 Self-Unloaders

Pic.3 Hybrid Self-Unloaders

Pic.4 Mucking Winches

Pic.5 Cherrypickers

Pic.6 Grab Ship Unloaders Cranes

Pic.7 Floating Grab Shiploader

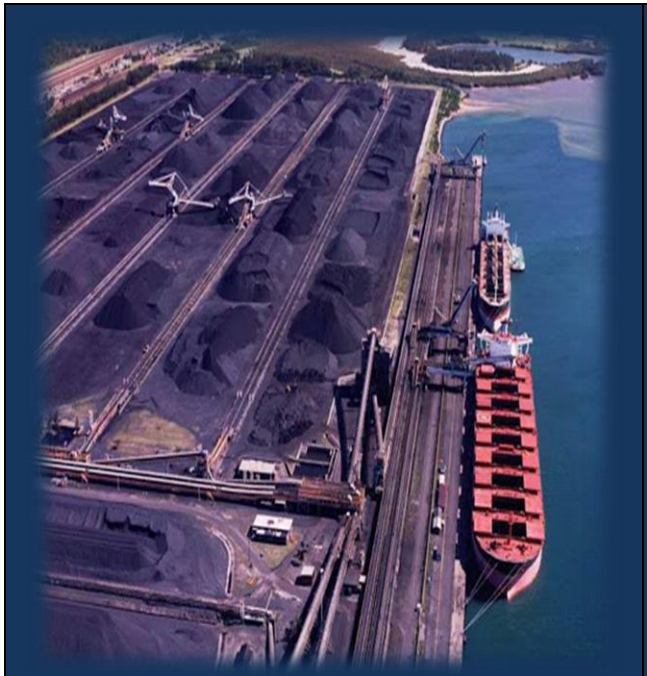
Pic.8 Slewing Cranes

Pic.9 Continuous Ship Unloader and Loader

Pic.10 Bucket-wheel Stacker/Reclaimer

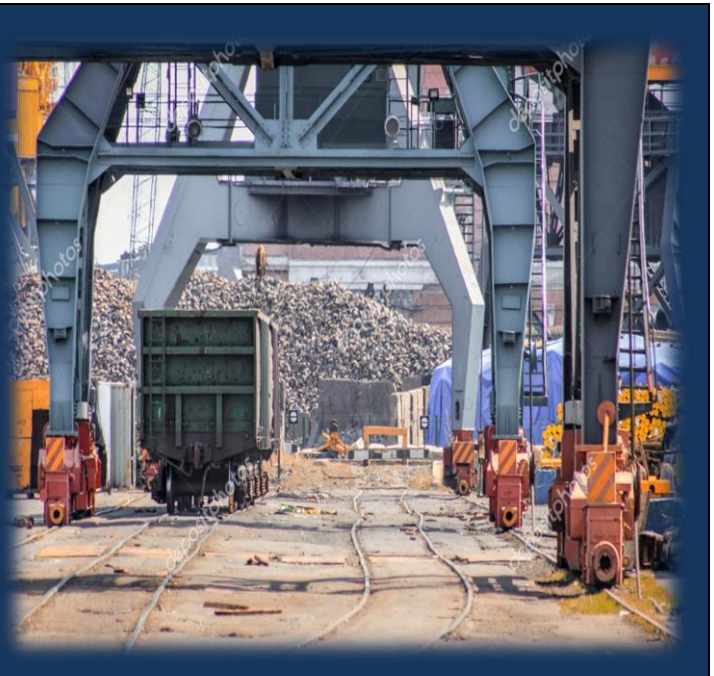
Pic.11 Stockyard Reclaimer Crane

Pic.12 Stockyard Reclaimer Crane



Pic.13 Stockpiles

Pic.14 Silos



Pic.15 Rail Wagons

Pic.16 Road Trucks

Pic.17 Barges

Pic.18 Grains

Pic.19 Coal

Pic.20 Iron Ore

Pic.21 Iron & Steel Products

Pic.22 Iron & Steel Products

Pic.23 Forest Products

Pic.24 Forest Products

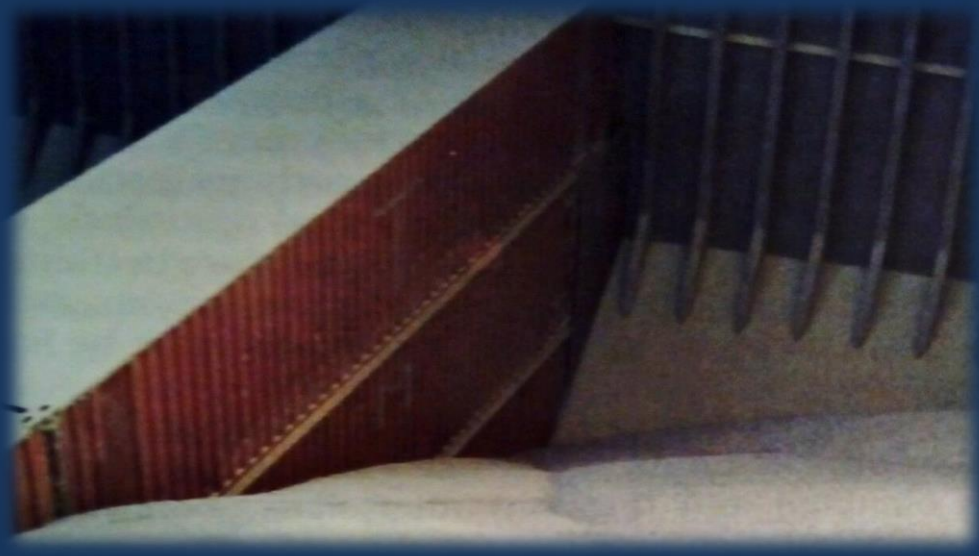
Pic.25 Cement

Pic.26 Cement

Pic.27 General & Break-Bulk Cargoes (Parcels of ore separated by temporary fences)

Pic.28 General & Break-Bulk Cargoes (Separation fences for pig iron)

Pic.29 General & Break-Bulk Cargoes (Contemporary Container Cargo Separations)



Pic.30 General & Break-Bulk Cargoes (Contemporary Container Cargo Separations)

Pic.31 RO-RO Cargo Items

Pic.32 Container Lashed on Deck

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