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ΘΕΜΑ:ANCHORING BERTHING & UNBERTHING

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1				
2				
3				

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CONTENTS

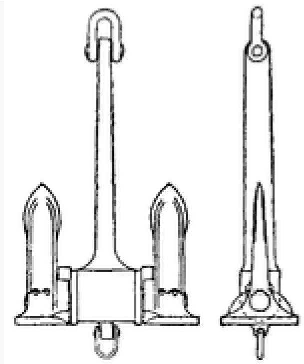
SUMMARY

This work analyzes the procedures that should be followed while a ship is about to anchor or heave up her anchor and the preparations that must be done before operating. It reports in detail all procedures, safety measures and precautions that should be considered prior anchoring. It also mentions the factors that allow a ship to drop her anchor safely without any risks of losing the anchor or cause an accident. The second chapter analyzes the procedure of berthing a ship, the machinery needed, the dangers during berthing, how to properly berth a ship with assistance from tugs or bow thrusters, the proper way to use warping drums and many more for a safe and reliable berthing. In addition, describes how the mooring lines should be used within their safe working load limits. At the third and final chapter the unberthing of the ship is described and presented and information is given about the factors that should be under consideration.

CHAPTER ONE: ANCHORING

The History of the anchor dates back millennia. The most ancient anchors were probably rocks and many rock anchors have been found dating from at least the Bronze age. Many modern moorings still rely on a large rock as the primary element of their design. However, using pure mass to resist the forces of a storm only works well as a permanent mooring; trying to move a large enough rock to another bay is nearly impossible.

The ancient Greeks used baskets of stones, large sacks filled with sand, and wooden logs filled with lead, which, according to Apollonius Rhodius and Stephen of Byzantium, were formed of stone and Athenaeus states that they were sometimes made of wood. Such anchors held the vessel merely by their weight and by their friction along the bottom. Lashing tree branches to the stone formed teeth or "flukes", to fasten themselves into the bottom. Advances in woodworking and metallurgy encouraged development of improved shapes for more compact, durable, and efficient anchors. During the centuries anchor changed a lot of shapes trying to get efficient towards seamen and more reliable. As technology progressed and the quality of iron became better people started figuring out the right pattern of the anchor. At the beginning of the 20th century, the stockless anchors principally in use in the British navy were Hall's improved, Byer's, and Wasteneys Smith's. In Hall's improved anchor, the arms and crown of cast steel are in one piece, and the shank of forged steel passes up through an aperture in the crown to which it is secured by two cross bolts. Two trunnions or lugs are forged to the lower end of the shank. In W.L. Byer's plan, the flukes and crown consist of a steel-casting secured to a forged shank by a through bolt of mild steel, the axis of which is parallel to the points of the flukes; one end of the bolt has a head, but the other is screwed and fitted with a phosphor bronze nut to allow the bolt to be withdrawn for examination. A palm is cast on each side of the crown to trip the flukes when the anchor is on the ground, and for bringing them snug against the ship's side when weighing.



Wasteneys Smith's stockless anchor

Wasteneys Smith's anchor is composed of three main parts, the shank and crown which form one forging, and the two flukes or arms which are separate castings. A bolt passes through the crown of the anchor, connecting the flukes to it; to prevent the flukes working off the connecting through bolt, two smaller bolts pass through the flukes at right angles to the through bolt and are recessed half their diameter into it.

SAFE ANCHORING PROCEDURES

Prior to anchoring, the condition of the windlass, cable stopper and anchor cable, where possible, shall be visually examined.The windlass brake shall be visually inspected to ensure that no damage has occurred especially after periods of heavy weather.Prior to anchoring the Master shall fully advise the officer in charge forward of his intentions and on proceeding forward he shall advise the Master when he has prepared all equipment. The Officer of the Watch shall a checklist prior to anchoring and a respective entry shall be made also in vessel’s Log Book.

When determining the amount of cable to anchor to the Master shall consider:

- Expected winds and weather
- Tidal/current strength and direction
- Nature of the holding ground
- Proximity of other vessels

In order to prevent the loss of the vessels’ anchors during anchoring operations, the Master shall pay particular attention to the speed of the vessel and depth of water, and shall determine the best method to be used for anchoring.

In the event of loss of power, it should still be possible to lower the anchor and pay out the necessary chain under controlled conditions.

The safe release of the anchor should be possible under all conditions, including total loss of vessel power, and the windlass brake system has to be designed accordingly. The main purpose of the windlass brake is to stop the anchor safely during a normal free drop of the anchor and chain. To facilitate dropping the anchor at any time, the stowage should be arranged in such a way that the anchor will start falling by its own weight when the brake is released.

The windlass is not designed to break out the anchor from the seabed and may not be designed to lift chain lengths in excess of Class minimum requirements which typically are between 82.5 and 100 meters.

Mariners should be aware that windlasses are typically designed to lift a maximum weight of an anchor and three free-hanging shackles (shots) of cable.

It should also be noted that existing Classification Society rules are based on anchoring in sheltered waters. While wind and current forces are considered, dynamic forces associated with waves and swell are not.

The weakest component in most anchoring systems is the windlass motor. When walking-out the anchor by means of the windlass motor, it is important that the vessel's speed over the ground is less than the walking-out speed, which is typically 9 meters/min, equivalent to less than 0.3 knot. Higher speeds over the ground may cause the motor to render.

Chain stoppers foundation act as guide to the chain into the hawse pipe and the stopper when closed transfers the chain forces into the ship's structure. The design criteria specified by Class is to withstand a force equal to 80% of the Minimum Breaking Load (MBL) of the chain cable. Chain anchors which are not properly engaged have caused loss of anchors and chains.

A more typical problem is a bend or even lost hinge pin for the chain stopper.

The windlass brake system is essential to secure the controlled drop of the chain. The band brake provides good service as a static brake. However, it is less effective as a dynamic brake and may suffer from brake fade due to heat build-up. A band brake is sensitive to wear of the brake lining and needs frequent adjustment in accordance with the maker’s instructions. Lack of adjustment for brake lining wear is the most frequent cause of failure in the brake system, with subsequent potential loss of anchor and chain.

Many anchors are lost due to the uncontrolled run-out of the chain.

Due to the risks to the crew involved in these operations, regular risk assessments should be held with focus on personal safety.

Technical issues account for a significant portion of anchor losses. The most critical detail is the D-Shackle connecting the anchor to the chain. The D-Shackle bolt is locked in place by a tapered pin which is secured by a lead pellet. Without the securing pellet, the pin will fall-out and the anchor will be lost. The D-Shackle should be inspected each time the anchor is to be used.

There have also been some cases of failure of the Kenter shackle if not properly assembled. Kenter shackles are used to connect the anchor shackles.

The swivel pin is crucial for avoiding too much twisting of the anchor chain. There have been some cases were the anchor has been lost due to detachment of the swivel pin from the link. Wear and tear weakens the connection between the securing knot and eyelid pin, so look for excessive slack at the swivel pin.

The most typical defect in anchor chain is wastage due to wear and tear.

The chain studs may also come loose and fall out which result in significant weakening of the anchor chain.

If studs are lost or dislocated, the office must be informed and special precautions should be taken during anchoring to reduce the load on the chain until the chain is replaced or repaired.

SHIP ANCHORING METHODS

Anchorage is one of the most frequent operations on board ships. The duration and location of anchoring is influenced by a number of variables and external factors. Although the type of seabed is of paramount importance for anchoring, a soft muddy bottom or muddy bottom is preferred. Care should be taken to ensure that there are no power lines, submarine cables, pipelines or rocks at the bottom of the anchorage. Various anchorage methods include wind direction and strength, current and tidal current. Often a good knowledge of local conditions helps the seafarer to determine the necessary maneuvers and actions to be taken when anchored.

The most common anchoring methods are:

1. **Let Go on the brake**

This method is used on a wide variety of vessels including small craft and pleasure yachts as well as larger vessels up to 100,000 GT. The principle used in this method is for the anchor to slide with the cable under its own weight from the hawse tube. Line weight, windlass holding force and boat inertia are factors that must be controlled by the boat to ensure that the anchor is buried and the line is subsequently stowed to pull back. When approaching the place of anchoring, the speed of the vessel relative to the ground is reduced to zero with the help of the engines and the rudder, and at the same point the anchor together with the cable can jump out under its own weight.

Pay attention to the preferred turning direction and which side to use the anchor. Care should also be taken to ensure that the entire cable is not damaged and does not allow cable accumulation, which can lead to kinks or kinks in the cable. When approaching the anchorage, the captains of the ships usually lower the anchor to the water level so that when the brakes are released, the cables can be freely extended. Sometimes, after a long sea voyage, the anchor could get stuck in the hauz pipe and not jump off it under its own weight. As a preemptive and good maritime practice, always check the condition of the winch brake pad prior to use.

On a few occasions, often on older ships, repeated use of the brake pads was found to be completely worn out or less than the required thickness, resulting in a significant reduction in braking power, resulting in the cable completely failing under its own weight, resulting in the loss of anchor and cable both.

- Approach the anchor position heading into the wind/ tide

- stop the ship over the ground

- walk-out the anchor and cable until the anchor is about half a shackle off the bottom

- hold the cable on the brake

- take the windlass out of gear

- when in position, drop the anchor by releasing the brake (releasing and control of the brake should be done by an experienced seaman and supervised by the Officer in charge of anchoring)

- control the speed of cable by the brake, noting the following cautions:

- if the cable is paid out too fast, it can result in the anchor and cable piling up on the bottom and lead to poor holding.

- if the brake fades or fails there is a risk that the cable will run out to the bitter end, with consequent damage.

With smaller ships, the piling of cable on the bottom may be avoided by allowing the vessel to move astern to stretch the cable as it is paid out. If necessary, the main engines may be used to initiate or check the motion over the ground.

An advantage of using this method of anchoring is that the brake will render before critical stresses are reached.

2. Anchor walked out

Most companies have their own rules for anchoring large ships such as VLCC'S or ULCC'S, which must be followed without fail. The reverse anchorage method is recommended and is used primarily on vessels over 1,00,000 GT. The principle of operation is the same, but the cable is spread by a winch at a fixed speed. When approaching the anchorage, the speed of the vessel on the ground gradually decreases to zero, and the anchor is lowered into the water.

- Approach the anchor position heading into the wind/ tide

- stop the ship over the ground

- when in position, walk the anchor and cable out under power until the complete length of cable required is paid out on the seabed, noting the following cautions:

- This method produces a controlled cable flow, but an accurate estimation of the vessel's movement over the ground is essential to avoid damage to the vessel's windlass

- Under no circumstances must the windlass be allowed to operate at a rate in excess of the manufacturer's recommendation

The design maximum speed for the windlass to walk-out the cable is typically 9 meters/ minute, which equates to less than 0.3 knots.

- The windlass motor is the weakest link in the system and, if the windlass over-speeds, there is a risk that the motor will be damaged.

• Under no circumstances should the weight on the cable be such as to cause the windlass to over-speed.

- If this is suspected, aggressive use of the main engine may be required.

- In extreme cases, the windlass brake may be used to assist in controlling the speed of the windlass.

The lead and weight of the cable should be closely monitored as there will be no pre-warning of windlass damage if the system is over-stressed. Damage may not be evident until the windlass is next used to heave up the anchor.

After completed length is paid out, start heave up short length of cable to check windlass condition.

Attention: The anchor should be let go over the target position just as the ship starts to make sternway so that its astern movement draws the cable out from the chain locker whilst also ensuring that it does not pile up on top of the anchor, which will prevent the anchor from digging properly.

The ship’s astern movement will continue to pull the cable out and lay it on the seabed, though pay out must be temporarily checked whenever the cable lead approaches being up and down.

3. Dredging Anchor

Ship anchors can be used not only for mooring, but also when maneuvering along canals and other similar areas with traffic restrictions. Dredging anchors are a technique used to assist a vessel in maneuvering during the absence or inability of tugs to provide assistance as needed.

The dredging anchor sniffing the bottom of the ship will hold the bow, allowing the ship to move forward and backward, this moves the ship's pivot point forward. Then, to overcome the resistance of the armature, a propulsion system is used to provide good steering at low speed.

Today's ships have bow thrusters to steer the bow when moving forward or backward. When piloting in tight confines, in confined waters, or when maneuvering vessels in somewhat confined spaces, bow thrusters or tugs can be helpful.

Sometimes ships have to first cross aft (i.e. move backward) through a limited channel between ships or buoys using thrusters and bow thrusters. Now, since the stern tilts (moves sideways) while the boat is stern due to lateral thrust, in this case a tug is used at the stern and the engine is used sparingly only to correct any deviation in the desired direction of travel.

A control tug is also located in the bow of the vessel, which monitors it and prevents deviations from the course. The control tug also helps to stop the ship's inertia so that its engine does not fire in time.

What happens when there is no bow thruster or bow check tug? A towing tug is necessary as the vessel will invariably deflect with every second the engine is operated astern due to lateral thrust. In such an emergency, the anchor becomes the lifeguard.

The anchor is lowered for a short time when the cable is lowered almost vertically down to the anchor and is taught. The anchor is hardly buried when the ship is put at the stern and the anchor is dragged along the seabed. The axle is offset to the bow next to the waterway, which makes it easier for the towing tug aft to apply more torque as the distance from the axle increases. Bow yawing is also prevented.

The purpose of this operation is to drag the anchor through soft silt (such as the head of a suction dredger) rather than bury the anchor deep in the silt. Otherwise, the cable will be heavily loaded and may break when the engine is in reverse or the towing tug is towing it. Mechanisms that use an anchor on the tank, such as windlass, nose piece or brakes, can also be damaged.

Ideally, the cable length should not be one and a half to two times the depth of the water. Moreover, it is usually advisable to have a good understanding of the sea or river bed before performing this operation. Recent survey maps can be extremely useful in this case.

SAFE ANCHORING AND PLANNING

When an anchorage position has been selected a planned approach can be made. Often, the best direction of approach to the anchorage will be determined by noting the direction in which other vessels of similar type, size and draught are heading. By approaching the anchorage on the same heading, maneuvering in a confined area can be minimized.

Due consideration should be given to identifying an escape route in the event the anchoring operation has to be aborted.

It is recommended that a certificated/ licensed deck officer supervises anchoring operations and that only experienced crew members are assigned to anchor work.

Careful consideration should be given to the maximum depth of water from which the anchor can be recovered.

It is recommended that below information is readily available. Prior to the anchoring party going forward, the officer in charge of the anchoring party should be aware of:

- The approximate anchoring position
- environmental conditions, e.g. wind, current and tide
- the method of approach
- which anchor is to be used
- the depth of water
- the method of anchoring
- the final length of cable to be used.

The officer in charge should also ensure that suitable PPE is available and being worn by all participants in anchoring operations, including goggles, to protect the eyes from rust and/or dust particles.

It is recommended that, prior to entering the anchorage area, the anchoring party are on standby forward.

It is important that sufficient time is allowed for hydraulic systems to `warm up' before use, particularly in cold weather. When engaging dog clutches, the pins or other locking arrangements should always be used.

A secondary means of communication should be available and tested prior to operations.It has been concluded that the following areas of concern should be addressed when shipmaster and navigation officer select an anchorage position:

- Anchorage dedicated for tanker vessels
- Underkeel clearance requirements
- Quality of bottom (holding ground)
- Hazards to surface navigation

- Underwater pipelines
- Protection from the weather
- Room to manoeuvre the vessel
- Warnings in force
- Traffic and congestion in the area

Anchoring is a critical shipboard operation.There are a number of reasons why a vessel may wish to anchor, for example:

1) the berth or cargo is not available

2) an amendment to the passage plan

3) the pilot is not available / boarding delayed

4) machinery breakdown

5) awaiting good weather / adverse weather

6) voyage orders not available.

Anchoring operations are planning consists of information, instructions, and actions that contribute to a procedure for maneuvering the vessel to the designated anchor position and successfully anchoring in a safe, seamanlike manner taking the prevailing weather conditions and sea state into consideration. Improper anchoring has a consequence. The ship may get into colliding with other vessels, or she may run aground and cause damage to property and environment. It is, therefore, for the best interest of all concerned anchoring should be done safely. Proper planning and teamwork are the basis for a safe anchoring operation. The Master should brief the personnel involved with the planned anchoring operation and update the engine room accordingly.

Maintaining a safe operation All checks, inspections, and calculations as per the Arrival Checklist must be completed in a timely fashion to avoid interfering with a smooth, planned approach. A suitable risk management system must comply. Keep the engine room fully advised of the vessel's progress, especially when entering: shallow water, high-risk areas, restricted or confined waters.

As far as circumstances permit, maintain excellent communication with the Port Authority and Vessel Traffic Services (VTS). Request any information regarding shipping movements that could affect the vessel's safe progress to the anchor position. The vessel will now proceed to the designated anchor position and anchor as per planned method.

Clearing the anchor(s) for arrival

1) Ensure power is on to forward windlass

2) Ensure the break is applied and windlass is in gear

3) Remove the guillotine bar or bow stopper and anchor lashings release the brake

4) Lower anchor(s) clear of the hawse pipe

5) Report to the bridge "Anchor(s) clear of hawse pipe and ready for letting go"

6) Await further instructions from the bridge.

During an anchoring operation the following factors should be considered:

1) General safety procedures and precautions including PPE

2) Identify a safe anchorage with good holding ground

3) Identify a safe anchorage that lies within the Territorial

4) Waters of the Port State Authority

5) Local weather and forecasts

6) Good seamanship

7) The direction of the current or tidal stream

8) Sufficient depth of water

9) Anchor to be used

10) Amount of cable to use / payout

11) Anticipated final maneuvering prior to letting go or walking back

12) Method of letting go or walking back

13) Communications

14) Escape / abort route should circumstances dictate.

Preparing and lowering the anchor: When the anchor party has been briefed, the Officer in charge will first establish communication with the Bridge before proceeding forward.
Before arrival at or off the port, both anchors are to be cleared ready for use. Anchors should only be cleared when the water depth will allow recovery of the anchor and cable if they are accidentally let go. An anchor marking buoy is to be available and ready for use.

Visual Inspection: Before clearing the anchors, a visual inspection, as far as possible, should be conducted of the anchoring system. The visual inspection may include:

- confirming power to the windlass
- windlass brake assembly
- clutch / gear mechanism including securing pins
- general appearance of visible components such as D Shackle,
- Crown Shackle, Swivel , Kenter link and short chain
- ensure “D” and crown shackle pins in place and tight.

Under the direct supervision of the Officer in charge, the procedure for preparing and lowering the anchors can be completed. Particular care must be taken when the weight of the cable is secured by the windlass brake only. The anchor party must be alert to any changing circumstances.

Arriving at the anchoring position: Before anchoring, the direction and speed of the current or tidal stream and wind must be confirmed. Attempts should not, whenever possible, be made to anchor across the current, tidal stream or wind. When all the way has been taken off the vessel, the vessel's head should be close to the direction of the tidal flow or wind, and the bow should not be swinging excessively.

Planning for Anchoring:

Master Should identify a suitable anchoring position before entering the anchorage area. Conduct a planned approach including speed reduction in ample time and orienting the ship's head before anchoring to (a) Same as similar sized vessels around or (b) Stem the tide or wind whichever is stronger

A decision on the method of anchoring and the number of shackles to use depends upon the depth of water, expected weather, and holding ground. A simple rule in determining length of cable to use:

Standard condition:
Length of cable = [(Depth of water in meters * 2) + 90] / 27.5
When good holding power can not be expected e.g. strong wind, strong current, harder sea bottom etc. then the length of cable = [(Depth of water in meters * 3) + 140] / 27.5

It is suggested that the use of a radar parallel indexing technique is a useful tool in maneuvering approach to anchoring position. A fixed reference point is necessary for establishing the intended anchoring position relative to this fixed point.

Preparation for Anchoring

The Chief Officer (or another experienced officer in lieu) must supervise letting go or weighing the anchors and should only assign experienced crew members to anchor work. Prior to Anchoring, the Chief Officer should be aware of:

1. Approximate anchoring position
2. Method of approach
3. Which anchor to use
4. Depth of water
5. Method of Anchoring
6. Final amount of Cables

Procedure of the Introduction to Anchoring

1. At the Forecastle: Check brakes are on and clear the voyage securing devices. (Anchor Lashings, Bow Compressed Bar etc.)
2. Start Hydraulic(Source of) Power of Windlasses
3. Check Anchor Shape / Light
4. Check Communication with the Bridge
5. Check Lighting on Forecastle including torch , at night time
6. Ensure all personnel are wearing Safety Helmets, Safety Shoes and Goggles.

Before Letting Go Anchor :

The Chief Officer should confirm that there is no craft or any obstacle under the bow and inform to the Bridge. The Master should ensure that the vessel's GPS speed at the time of anchoring is near-zero or indicates a slight sternway. The speed should be verified by visual transits and Radar ranges of Landmarks if available or other fixed conspicuous targets. Whereby means of communication between Bridge and the Anchoring party is Portable radio, the identification of the ship should be clear to avoid misinterpretation of instructions from other users of such equipment in the vicinity.

Routine Anchoring Operation

There are 2 methods for Anchoring according to depth of the water:

Method 1 (Preferable for Container Ships / Depths up to 50m)

1. Walk out the anchor to Half a shackle above the sea bottom
2. Hold the cable on the brake and take the windlass out of gear

3. Stop the vessel over ground
4. Drop the anchor
5. Control the speed of cable flow by the brake , while not allowing pile-up
6. Bring anchor cable direction forward and confirmed anchor holds its position.

Disadvantages:

If the brake fails, or there is too much speed over the ground, the cable will run out to the bitter end with consequent damage. The brake lining could also be damaged due to this Dynamic load (the Static load on brakes to restrain movement of an anchored vessel is much less).

Method 2 (Suggested for Tankers / Depths over 50m)

1. Stop the vessel over ground
2. Walk out the anchor under power until the complete length of required cable is paid out, and the anchor holds its position on the seabed.
3. Bring anchor cable direction forward and confirmed anchor holds its position.

Disadvantages: A vessel must be completely stopped to avoid significant damage to Windlass.

Particular Caution for VLCCs
VLCCs, because of their inertia, requires excellent caution while anchoring. They can suffer equipment failure if attempting to anchor while moving at speeds as low as half a knot over the ground. Hence, the vessel must be nearly stopped not only in the linear direction but axial, too, meaning the bow should not be swinging much either while anchoring. The depth at which the vessel can safely anchor is about 110m or less, beyond which the Windlass may have extreme difficulty in recovering the anchor. Refer further Practice of anchoring / VLCC in deep water for more details.

Emergency Anchoring
Anchors should be ready for letting go on arrival and departure port, when in anchoring depths. At least, any wire lashings are to be removed, and the anchors held on the brake. In critical situations, to arrest the movement of the vessel, after stopping/reversing the main engine, it is preferable to let go both anchors simultaneously instead of one.

Anchor retrieval
For weighing in the anchors, to reduce the load on the Windlass, and keep the cable near vertical, as required, short movements to be given on the main engine (and Bow Thruster used, where is applicable). The stay and direction of the cable and the residual shackles are continuously reported to the Bridge. Anchor Wash to be run to clean the chain and the anchor. When the anchor is fully hove, the brake is to be applied, and the Windlass is taken out of gear. The bow stopper is to be put when it is deemed safe to do so. Note: If it does not engage properly on the chain, then it is to be lowered across the chain as far as possible and

lashed down in this position in such a manner, that if the cable does slip, the bar will fall into place across the chain.

HEAVING UP THE ANCHOR

Hazards related to anchoring operations may be technical due to the size, weight of anchor, the type and condition of anchor chain and the condition of equipment which supports anchors (winches, links, stoppers etc.), or they may be operational depending on the use of anchors and the procedures supporting the operations.

Careful monitoring of the anchor cable load and lead is important as there will not be any pre-warning of windlass damage if the system is overstressed (unless a cable tension monitor is fitted). Any damage may not be evident until the windlass is next used to heave up the anchor.

During heaving up the anchor the following must be implemented to mitigate any potential hazard due to material failure or operational mistake:

•The anchor lashings and bow stopper are removed prior commencing the operations.

•The pumps of hydraulic windlass are started and tested prior operation.

•The working condition of windlass and its controls have been checked.

•The anchor and its chain have been visually checked prior and during the operation.

•Minimize the tension in the chain and keep the chain as vertical as possible during the operation.

•In windy weather conditions or strong current, the rudder and engine must be fine-tuned to prevent too high tension in the chain and overload of the windlass motor. This will also prevent dragging of anchor and breaking out the anchor. The heaving up speed is typically nine meters/min so speed over ground must be less than this e.g., 0.3 knots.

•Maintain close communication between bridge and anchor party on deck to prevent any hazard.

•The anchor party must know vessel's windlass capacity to heave up max free-hanging shackles.

•Vessel to prevent the overloading of high-pressure windlasses which can result in their catastrophic failure, the 'heaving in' must be stopped as soon as any significant tensioning is observed, or difficulty is experienced.

•All present crew members must wear proper PPE.

Recovery of Anchor/Preventing Anchor loss

In case the vessel is dragging anchor, keep vessel’s head into the wind and ease the tension on the cable by using the main engine and rudder while heaving up the anchor.

Shifting anchorage or drifting offshore or paying out more cable could be considered depending on the prevailing circumstances. If the weather conditions are likely to deteriorate, it is imperative to heave up and proceed to an open, safe area well in time.

If the vessel is in shallow water and the fully operational windlass is unable to heave up the cable, then the fouling of the anchor must be considered. The vessel can consider steaming around the anchor position or lower and heave the anchor again until it is finally free. In such situations, if there is a suitable work boat available then consideration must be given to using this to help clear the fouled cable.

The last resort is to slip the anchor from the bitter end after tying up an anchor buoy to assist in recovery later utilizing external assistance.

ANCHOR WATCH

When a vessel is at anchor a continuous navigational watch shall be maintained. During the anchoring watch the responsible Officer shall complete a checklist and a relevant entry shall be made in vessel’s Log Book.

The Officer of the Watch shall plot and monitor the ships position. A suitable scale of ENC shall be used by, the Officer of the Watch who shall on first anchoring plot the position at which the anchor lies and inscribe a swinging circle centred on that point. The position shall be checked at regular intervals taking into consideration tides, current and wind strengths. Any possible yaw movement of the vessel shall also be monitored. It is recommended that the watch keeper determines the position of the vessel and anchor and plots the position on the chart using all available navigational methods (visual and electronic).

The Officer of the Watch shall ensure that all appropriate lights, shapes and signals required by the International Regulations for Preventing Collisions at Sea are correctly and clearly displayed.

The Officer of the Watch shall maintain a proper lookout, listen on appropriate VHF channel(s) and shall ensure that rounds of the vessel are made at appropriate intervals and that they include checks forward of the anchor system. He shall also monitor the vessels position in relation to other traffic anchored or passing by, being prepared to take appropriate avoiding action.

Although the vessel at anchor has a very limited capability to avoid collision with an approaching craft, there are actions that can be taken that can, possibly, prevent a collision or mitigate its effects should one occur. External warnings, such as use of the VHF, whistle or signalling lamp, should be considered to alert the approaching vessel of the danger. Consideration should also be given to using the engines and rudder to swing the anchored vessel away from the approaching vessel. It is necessary for the personnel onboard the anchored vessel to do all that they can do to prevent a collision, or mitigate its effects, so that their liability for damage incurred can be avoided.

The Officer of the Watch shall monitor the existing and forecasted meteorological conditions and shall immediately inform the Master of any deterioration in the weather conditions including visibility and shall keep the Engine Room advised of any change in the required state of readiness.

The Officer of the Watch shall, as appropriate, advise the port authorities of the anchored position, confirm that the appropriate status is selected on AIS, monitor compliance with environmental protection requirements and comply with any additional regional or local requirements and, in appropriate circumstances, maintain anti-piracy precautions as laid down in the Master's Standing Orders

ACTIONS IN CASE OF DRAGGING ANCHOR

In the event that the Officer of the Watch establishes that the vessel is not maintaining the desired position and is dragging the anchor he shall immediately call the Master, place the Main Engine on Stand By and summon additional crewmembers to stations on the Navigating Bridge and Forecastle.The decision to recover the anchor and get underway must be taken before the point at which the vessel is endangeredShipmaster, Chief Engineer and the anchor party are informed immediately.

Main engine is prepared and power to the windlass is arranged. The OOW has to make the vessel ready to manoeuvre.The Vessel Traffic System (VTS) is informed as well as the other vessels nearby about the current condition and about the actions taken. The OOW prepares the vessel for the open sea and/or seeks permission for re-anchoring. As soon as the Shipmaster is on the bridge the condition is evaluated and either the vessel re-anchors or proceeds to the open sea. If the conditions permit, the vessel re-anchors and more cable is deployed. The main engine and the rudder are used to manoeuvre the vessel in order to facilitate the heaving up of the anchor. It becomes more difficult to weigh anchor when the vessel is pressed more to the leeward side and takes considerable amount of time. During manoeuvre it is very important not to override the anchor, particularly in shallow waters as the vessel may impact on the anchor during pitching.In case the weighing of the anchor is not possible, Shipmaster should consider release the bitter end. This action is taken in consultation with the head office. Yet, during the decision making process, the fact that a ship without minimum of two (2) anchors is not considered to be sea worthy shall be considered.

SECURING OF ANCHORS

Both anchors shall remain properly secured at all times, except when the anchors have been cleared for stand by following a direct order of the Master. Under no circumstances shall the securing wires be removed from the anchors whilst the vessel is at sea, especially when maintenance is being performed on the windlass units.There are two methods of securing the cable when lying at anchor, as per below:

OPTION 1- CABLE SECURED ON THE BRAKE WITH THE CHAIN STOPPER

It is strongly recommended that a chain stopper is to be always used.

The stopper is designed to withstand 80% of the MBL of anchor chain, whereas a properly adjusted windlass brake is designed to render at 45% MBL. However, it should be noted that it may not be possible to release the chain stopper without using the windlass to relieve the force on the chain stopper.

In deteriorating environmental conditions, cable tension will increase to the point at which the anchor drags or the weakest point in the anchor system fails. This could be physical damage to the anchor, failure of cable or damage to the stopper. When subjected to extreme forces, the stopper may deform and jam in place, hampering quick recovery of the anchor.

OPTION 2- CABLE SECURED ON THE WINDLASS BRAKE

In deteriorating environmental conditions, cable tension will increase to the point at which the anchor drags, or to the point at which the windlass brake's holding capability is overcome and the brake slips, whichever is lower.Detection of the brake slipping by a watch keeper stationed on the bridge is not easy, particularly on larger vessels. Where no stopper is fitted and the vessel secures the anchor cable using the brake, consideration should be given to the provision of an effective means of monitoring cable movement. A traditional method is to mark the cable so that it is visible from the bridge, for example, by a flag tied to the cable on the cable lifter/ gypsy. Some vessels may be fitted with remote reading cable counters or other devices that detect any movement of the cable lifter/ gypsy wheel.

Whichever method is used to secure the cable, it is important to get underway before the tension in the cable increases to the point where it risks a failure of the anchor system. However, this should not be considered the limiting factor. Even before environmental conditions approach a force at which anchor system failure may occur, other undesirable effects may be encountered as a result of waiting too long, including the exposure of personnel to hazardous conditions on the forecastle.

CHAPTER TWO: BERTHING

The berth is the term used in ports and harbors for a specific location at a port where a vessel may be moored, usually for the purposes of loading and unloading. Berths are designated by the management of a facility like port authority or harbormaster. Vessels are assigned to berths by these authorities. A ship's maneuvering capabilities at slow speed are perhaps the biggest factor in determining how the ship's approach onto a berth should be made. Some ships, such as oil rig supply vessels, are normally fitted with banks of powerful lateral thrusters at the bow and stern so the ship can be often simply moved-sideways onto a berth and held there by the thrusters whilst the crew make fast fore and aft. Many ocean-going cargo ships, however, are only built with a single screw and rudder.

Single screw ships are usually slowed down and stopped by making short astern movements on tl1e screw but a rudder's control over the steering decreases as the ship's speed through the water is reduced whilst steering control is lost altogether when the screw is going astern. The rudder 's performance is in sharp contrast to that of bow and stern thrusters, which actually are most effective at generating sideways thrust when the ship is stopped in the water but become less so as the ship picks up speed. Consequently, a ship with only a single screw and rudder has very limited ability to maneuver once it is stopped alongside the berth and so it must be made fast as soon as possible unless there are tugs to keep pushing it onto the berth. There is considerable variation in maneuverability at slow speed even amongst ships with just a single screw and rudder as the stopping ability depends on the screw's astern thrust, relative to the ship's displacement, and the ship's propulsion system.

APPROACHING BERTH WITH A SINGLE SCREW VESSEL

Ships and the situations in which they are berthed vary with the size of vessel, its propulsion power, the nature of the jetty or wharf and the prevailing environmental conditions at the berth. However, most single screw ships are put alongside a jetty or wharf by broadly using one of the two following methods.

No1 Driving the ship onto the berth.

The approach in this method is made either at slack water or against any current that may be flowing. The ship is steered onto the berth at a shallow angle. and stopped with its bow over the quay for the forward spring to be sent ashore as the first line. The stern can be swung alongside by putting the rudder hard over and then giving a short kick of slow ahead on the engine to drive against the spring. Alternatively, the offshore anchor can be dropped when the ship is still off the berth, then paid out and held to check the ship's al1ead motion whilst the rudder is used to swing the stern alongside. Driving a ship directly onto a berth is usually the quickest way of putting smaller ships up to about 12,000 tonnes but it requires the following conditions.

i) There must be no current coming from astern otherwise the stern will swing off the berth
ii) There must be sufficient room downstream of the berth for the ship to make its approach.
iii) The ship must have adequate stopping capability or a tug made fast at the stern should be used to ensure that the vessel does not ram the wharf.

If the ship has a fixed pitch screw, then the final kick astern on the engine to stop the ship at the berth may also generate enough transverse thrust to swing the stern alongside. This, of course, will not occur if the ship is berthing the other side to and in any case transverse thrust is a weak force and cannot always be relied on. The stern of smaller ships in this size range can be swung into the berd1 by putting the rudder hard over and then giving the propeller a brief kick of slow ahead against the forward spring once it has been made fast. The spring must be long enough for its lead to be almost parallel to the wharf, otherwise there will be a significant tendency for the spring to pull the bow into the berth as it tightens up to stop the ship's ahead movement.

The force on the rudder has far more leverage than any lateral component of the spring line's tension so according to the previous paragraph it should be able to bring the stern alongside the wharf. However, there are several other points to keep in mind.

- i) Any headlines that have been run ashore with the spring must be kept slack, otherwise they will hold the bow into the berth and so prevent the stern from swinging alongside.
- ii) The spring line must be in good condition and strong enough to restrain the ship's ahead movement.
- iii) The spring's lead from the bitts or winch onboard to ballard ashore ideally should be as direct as possible to minimize the deviation angle at the overside fairlead to reduce the risk of the line parting at the fairlead.
- iv) The forecastle crew should stand well clear of the spring once they have made it fast.

Stern lines and the aft spring can be run ashore as soon as possible though care must be taken to keep them out of the water and so clear of the propeller. The Lines are then heaved tight and made fast fore and aft when the ship is alongside and in position

The alternative method of swinging the stern alongside is to drop the offshore anchor when the ship is still off the berth on its approach and again use the rudder whilst giving the engine a kick ahead but this time the restraining force is provided by the anchor. Using the anchor may seem to be an extra com plication but the method has the following advantages:

- i) Going ahead against the offshore anchor creates a 'bow out, stern in' yawing moment that tends to swing the stern on its own so less ahead thrust and rudder action will be required
- ii) If the anchor is put on the seabed when the ship is still about half its length off the berth, then the ahead motion can be controlled more precisely by paying out or holding on to the anchor cable as necessary before the ship is at risk of hitting the wharf
- iii) The anchor cable is far less likely to part than a spring line and so it is safer for the crew
- iv) The force acting at any point of contact with the wharf will be considerably reduced

Using an anchor requires good co-ordination between the bridge and the crew on the forecastle and it can prolong the berthing procedure but the extra control is impressive. I once watched a small cargo ship of about 6,000 tonnes displacement being wriggled alongside a tight corner berth in a Hong Kong dockyard using just the anchor, engine and rudder.

One problem with using the anchor to assist putting the ship alongside is that the seabed must allow the anchor to drag smoothly for part of the operation, particularly when it is first put on the seabed (it is also usual to recover the anchor after sh ip is secu red). The ideal seabed would be a flat mud or silt bottom and free of any obstructions. There can also be a tendency for the anchor to pick up rubbish, such as lengths of scrap wire, near some berths (particularly repair berths in shipyards) and these must be cleared from the anchor when it is recovered.

No2 Hauling or pushing the ship sideways onto the berth.

Driving a ship directly onto a berth becomes increasingly difficult as the size of the ship increases, as even an impact at very low speeds with the wharf can cause damage to either the ship or the berth or both. Consequently, ships larger than about 30,000 tonnes displacement are usually stopped some distance off the berth roughly parallel to the wharf and then moved sideways into position, normally by tugs pushing against the offshore side. Even smaller ships may be berthed in this way if there are other vessels already tied up alongside adjacent berths.

Berthing by this method should again be car ried out at slack water or with the ship stemming any tide or current as this makes it easier to control the ship's fore and aft positioning. Two tugs will normally be needed to push the ship in and keep it parallel with the berth so officers should ensure that the tugs only push against the positions on the hull that have been specially strengthened to withstand these forces. Additional tugs at the bow and stern are used to check the movement and yaw of large ships. Lines are normally sent ashore by mooring boats when the vessel is still some way off the berth, so there are long run outs to be picked up slack as the ship closes with the berth. Spring lines from both ends of the ship are often the first lines sent ashore from smaller ships, as these can be useful in assisting the ship's fore and aft positioning as it comes alongside, particularly if the aft tug's maneuverability is restricted near the berth. However, tl1e lines of very large ships are not strong enough to withstand the dynamic forces necessary to pull such ships around, so they are picked up slack whilst the tugs push the ship onto the berth. Once the ship is on the berth, the tugs should continue to keep it alongside and in position until the lines have been heaved tight and made fast. The forward tug may not be required if a ship is fitted with a reliable bow thruster of sufficient power to thrust the bow onto the berth but this depends by the opinion of the pilot because many pilots don’t rely on bow thrusters as bow thrusters may fail during berthing operations.

Interaction and shallow water effects close to the berth

The force of water flowing past a ship's hull varies with the direction at which it strikes the hull, the speed of the flow and the depth of water, relative to the ship's draft. This force, as we might expect, is greatest when the flow is athwartships and it is also increased by reducing the ship's underkeel clearance, relative ro the depth of water. just as a ship moving ahead creates a bow wave, so a ship moving sideways through the water pushes a wave i n front of it that grows in height as the flow of water around to the other side of the ship is restricted by narrowing the gap between the seabed and the keel. The build up of water is further increased if it is confined to the ever decreasing space between the wharf and the ship as it comes alongside, so it provides a 'cushion ' that can be surprisingly effective at lessening the impact with the wharf, though it is less evident on open trestle or pile jetties.

The cushioning effect only occurs when water is resisting a ship that is moving predominantly sideways, as other interaction effects take over when the water flow is mainly fore and aft. If the ship is full-bodied with a blunt round ed bow and bulb (as most large bulk carriers and tankers are), then water flowing at this angle can create a force that yaws the bow into the berth. The same situation can occur if the propeller wash from a tug too close to the ship's offshore bow strikes the bow at similar angles.

The behavior of a ship moving astern through the water.

The helm is usually put amidships when going astern and attempting to steer a ship with only a single screw and rudder whilst it is making sternway through the water is normally avoided, as the effects of the rudder and transverse thrust are difficult to control. Steering astern can be controlled, however, if one of the anchors is put down on a short scope so that the ship's swing and bodily movements are constrained by the force of the anchor dragging on the seabed.

The length of anchor cable is an important factor in determining how controllable the steering is when a ship is making sternway through the water. If the cable is too short, then the force on the anchor will be insufficient to adequately constrain the swing and so more cable should be paid out. If the cable is too long, then the anchor may dig in too deeply and stop the ship from moving astern at all. Putting a ship onto a berth stern first is not a normal method of going alongside, as it puts the rudder and propeller at risk if the ship hits the wharf, but situations can arise when the ability to steer a ship effectively whilst going astern would be very useful.

Ships that regularly go stern onto a berth, such as the ro-ro ferry are fitted with either a bow rudd er or a bow thruster for con trolling the steering when going astern. The tendency nowadays is probably to favour the bow thruster but, to some extent, this depends on where the ship is turned around to back up onto the berth. Rudder effectiveness increases with the square of the ship's speed through the water, whereas a tunnel thruster is most effective when the ship is stopped in the water and declines with the ship's increasing speed. Although bow rudders are more effective at steering a ship moving astern at some speed than bow thrusters, they are less effective as rudders than the normal stern rudder when the ship is going ahead. This is because the bow rudder does not have the benefit of being placed directly downstream of the propeller 's thrust.

Arrangements for improving a ship's slow speed maneuverability

A ship's slow speed maneuverability can be improved with numerous other devices that range from high-performance rudders which can divert the main propeller's thrust through angles much greater than 35°.

Twin screw ships

Many older fast merchant ships were built with twin screws to allow these vessels to be fitted with powerful engines that generated too much thrust for a single propeller and shaft. These ships, however, were usually only fitted with a single rudder on the centerline, which is in the relatively stagnant water between the screw races of both propellers and, as such, is far less effective than it would be if it were sited directly in line with a propeller. Consequently, any increase in maneuverability gained by the twin screws was lost by the relatively ineffectual rudder. Building a ship with twin screws can greatly improve its slow speed maneuverability but only if the ship is also fitted with twin rudders that ideally can be opera ted independently

A twin screw, twin rudder ship can be turned short round in about its own length if one screw is thrusting ahead whilst the other is turning astern with both rudders turned inwards. T11e ship's head will then turn to the side of the astern thrusting propeller. The effectiveness of the astern thrusting propeller will be less than that of the propeller turning ahead so the levels of thrust must be adjusted if the ship is not to creep ahead (or astern) during the maneuver.

Twin screw arrangements always consist of a right-handed and left-handed propeller to allow any transverse thrust on the astern thrusting propeller to assist the ship's swing when turning short round. This means that propellers are 'outward turning' from the top for ships with fixed pitch propellers that must be reversed to provide astern thrust. 'Inward turning' propellers are fitted to ships with controllable pitch propellers that always turn in the same direction. A twin screw, twin rudder ship with a bow thruster can be 'walked' sideways by using the bow thruster to counter the turning moment created by one screw thrusting ahead whilst the other thrusts astern. The ship will move bodily sideways and maintain a constant heading.

Thruster power and control arrangements

Pushing a ship bodily sideways requires a considerable amount of power, half of which must be provided by the thrust at the bow. A bow thruster unit must always remain submerged to be effective, so its size is limited by the ship's lightest forward draft and, consequently, many oil supply and offshore support vessels have a line of at least two and often three bow thrusters.

The job of putting a ship alongside and making it fast

A ship's mooring stations must be prepared for berthing alongside before the vessel arrives at the port. The first thing to do on arrival off the port is to clear the anchors ready for letting go. The ship may have to anchor to wait for a pilot or a berth but, more importantly the anchors should always be ready for letting go in case of an engine failure when the ship is in confined waters. The anchors should be held in the hawse pipes by just the windlass brakes whilst the seals and covers on the Spurling pipes are cleared so that the cables are free to run out from the chain lockers.

When the pilot comes onboard, he should discuss the proposed berthing arrangements with the master, who should inform the pilot of any defects or limitations in the ship's maneuverability. These discussions are often quite brief but the master and pilot should agree on the following

1) The berth and which side of the ship is to go alongside

2) The speeds and courses to follow from the pilot station to a position just off the berth

3) How the ship is to be put alongside in the prevailing tide and wind conditions on the berth

4) The number of tugs to be taken and how they are to be used

5) The number of lines to be used in mooring the ship and which ones are to go ashore first

The mooring lines must be ready for running ashore when the ship arrives off the berth, as the time that a ship spends alongside before it is properly made fast fore and aft is often a critical period. Controlling tbe pay out speed is vital for ensuring the lines are sent ashore promptly and without problems, such as:

1) Paying out excessive slack into the water near the propeller and so either restricting the use of the ship's engines or running the risk of the line being drawn into the turning screw.

2) Paying out excessive slack onto a mooring boat, which creates handling problems for the boat's crew and can also foul the mooring boat's propeller.

3) Paying out excessive slack close to the quayside so that the li ne sags and gets caught under a quayside fitting, such as a fender or a ladder, and so it cannot be effectively heaved tight.

4) Initially paying out too fast so that the increasing weight of line suspended over the ship's side overcomes any restraint on the pay out speed and the line runs out of control with the risk of entangling with the ship's fittings or one of the ship's crew. (It's not unknown for an entire mooring line to have been lost overboard in this way.)

5) The payout being abruptly and prematurely stopped when tl1e line either snags on a ship's fitting or comes against a buried turn on a mooring winch. This will delay gelling the line ashore and it can also upset a mooring boat's crew if they are taking the line ashore.

Working mooring lines with warping drums

Preparing fibre lines for running ashore

Most fibre mooring lines worked by warping drums are stored underdeck when the ship is at sea and so they must be brought up on deck ready for going alongside. The ropes are usually coiled down on wooden pallets with both eyes accessible and then sufficient lengths of rope for sending ashore are Oaked up and down on deck so that they can run freely There may only be enough space on deck at each end of the ship to pre pare the first two or three lines in this way and as the first lines ashore can involve long run-outs, it is normally better to send these out as single lines that are simple to get ashore quickly.Any bights required in the mooring pattern are easier to make fast after the ship is alongside and in position.

Mooring rope eyes should be kept inboard until they are ready to be pulled ashore to avoid the ropes slipping overboard prematurely and then being pulled out by the ship's movement. It is particularly important that ropes are kept clear of the ship's propeller and officers in charge of mooring gangs must report to the bridge when lines are being run ashore so that the master is aware of lines in the water. The spring lines are usually run out first when the ship is still off the berth, as these can be used to adjust the ship's fore and aft position as it comes alongside. (The forward spring is particularly important for restraining the ship's ahead movement.) The next lines to go ashore will then be the offshore head and stern lines to provide the best leads for holding the ship alongside and in position whilst the remaining lines are being made fast

Heaving lines

Mooring lines that are run out directly ashore from the ship are pulled ashore tied to heaving lines thrown from the ship. Heaving lines are about 50 metres in length and made of light buoyant fibre rope, usually between 8 and 10 mm in diameter. If the rope is too thin, then the turns in the coil thrown ashore tend to tangle as they fly through the air but, if the rope is too thick, then it is too cumbersome for throwing a coil of sufficient length. A monkey fist knot is tied in the throwing end of the line to give it extra weight, though the practice of enclosing the odd scrap steel nut or bolt is frowned upon.

Techniques for throwing a heaving line vary but most involve splitting the line into two coils that can be easily held in each hand and then throwing the coil with the monkey fist knot. The range of the throw that can be expected varies with the wind conditions and the heigh t of the mooring deck above the wharf, but 25 metres is usually a good throw. It is advisable to have two or three heaving lines available at each mooring station as the ship approaches the berth, otherwise valuable time is lost recovering a line from the water if the first throw misses.

Onboard communications

Communications between the ship's bridge and the mooring stations should be checked before the ship arrives off the berth. These often rely on short-range hand held UHF radios with fixed channels that are shared not only by other ships but frequently by local taxi cabs ashore. The bridge team should select the channel that gives the least interference from other users at the time of berthing and then ensure that the mooring parties fore and aft can receive and transmit clearly on the chosen channel. However, the risk of interference cannot be totally avoided so it is important that all communications between the bridge and the mooring parties are prefixed with the ship’s name. There has been the occasional disaster in which the forecastle party on one ship has let go an anchor in response to an order that was given for another vessel.

Running ashore the first fibre lines

Once the heaving line is being pulled i n by the linesmen ashore or passed down to a mooting boat, the officers in charge of mooring parties must report ·running out lines to the bridge so that the master is aware of lines in the water. The pay out of a.fibre line can be qu i te safely controlled on smaller sh ips by pressing down on i t with a foot at the fairlead, p·rouided that:-

1) The line's overboard tension remains quite small. Ropes that float, such as polypropylene, are particularly suited to this way of handling, as the weight of rope in suspension is never much greater than that of the length of rope between the mooring deck and the waterline.

2) The overside fairlead is set low quite close to decк level. This is usually the case with the open 'button' type of fairlead, but the method cannot be used on ships which are fitted with fairleads and sets of bitts that are all raised to the height of the bulwark top (or 'gunwale').

3) Control is applied right from the beginning of the pay out. It ca n be downright dangerous to try to stamp on the rope if it has started to run out of control under its own weight. (If this does occu r, then the best action to take is to stand clear and throw the eye at the other end of the rope over a set of bitts to prevent losing the entire mooring line over the side.)

4) The crewman controlling the rope pay out should stand in a position where he can easily step back clear of the line if it suddenly starts to be pulled out violently. This should not happen but ropes occasionally get drawn into the propeller of either the ship or one of the attending tugs, so there should be an escape rou te readily at hand.

5) The crewman must press down on the rope with suitable footwear.

Fibre ropes are sometimes stored on reels fixed to the deck that can be turned freely by hand unless they are secured by a locking pin. It is not advisable to run a rope ashore directly off a reel because it will tend to spin faster and faster with the pay out, due to the increasing weight of line over the side and the hauling in by the linesmen ashore. Pressing down on a fibre mooring line with a foot is a very effective way of controlling its run ashore from ships up to about 30,0000 tonnes displacement, provided the crewman controlling the pay out is experienced and aware of what is going on around him. He is in a position to see what is occurring on deck and over the ship's side, so he can co-ordinate the pay out with the linesmen ashore or a mooring boat.

Securing the mooring line on the quayside Ballard

When the linesmen pull the eye of the first line ashore, they will throw it over a ballard on the quay that should provide an appropriate lead for the line, which can be checked by the marker showing the position for the ship's bridge when the vessel is in position. If the line is a spring, then it will usually be put on an empty ballard, but if it is a head (or even a stern) line, then the ballard may already have lines on it leading in a very different direction to a ship alongside an ad jacent berth. Dipping the eye in this situation can just push i t under the eyes already on the ballard) but the linesmen may still dip the eye, particularly if the other ship is due to sail first, so it is advisable not to argue about it at this critical stage of berthing.

Hauling in the first lines ashore

When the officer in charge of the mooring party is satisfied that the first line is secure on the ballard, he should report this to the bridge and star t picking up slack so that the length of line in the water does not become excessive as the ship closes with the berth. However, no weight should be put on any line unless this is ordered by the master on the bridge, as tension in the line will affect the ship's heading whilst it is being maneuvered onto the berth. Slack line can usually be picked up at the fast speed control setting with only one turn on the drum or capstan.

SNAP BACK ZONES

A snap back is the sudden recoil of a mooring line as a result of its failure under tension. A snap-back zone on a mooring deck is the space where it is anticipated that the failed mooring line could recoil with great velocity, possibly resulting in injury or even death to crew present within this zone.

However, recent studies have shown that the nature of snap backs is more complex than initially perceived. This is due to various factors such as:

• Mooring configurations.

• The nature of the mooring line used with regard to elasticity.

• Breaking strength which may influence the trajectory of a parted mooring line.

Hence the marking of snap-back zones on the deck, although convenient and simple, does not reflect the actual complex snap-back zone and may lead the seafarer into a false sense of security that they are safe as long as they aren’t standing in the highlighted area.

All mooring ropes will stretch to some degree under tension and more so when constructed from synthetic fibre. When a mooring line parts under load, the sudden release of stored energy in the rope will cause it to recover its original length almost instantaneously. The two ends of the line recoil or snap-back towards or past their secured ends with great velocity and anyone standing within the snap-back zone risks serious injury or death. A snap-back zone is thus an area within which it is unsafe for persons to be positioned when ropes are likely to come under tension.

A snap back zone should enclose all the possible positions that a broken end may pass through whilst it recoils back from the point of failure. A zone is defined by two parameters, namely:-

1) The 'snap back distance’ that the broken end can move away from the point of failure 'x') in the previous diagram, but it is more conveniently expressed as a percentage of 'd'. A snap

back distance of 200% means that 'd' = 'x' and the broken end will snap back as far beyond its point of restraint (i.e., the capstan) as the point of failure (i.e. the fairlead) is in front of it. Snap back distances of less than 100% mean that 'x' is negative so the broken ends will not snap back as far as the point of restraint. Snap back distance, as a percentage of 'd’ depends on the breaking tension and strain in the rope, its material and construction.

2) The 'spread angle 8' indicates how much the snap back of a broken end may deviate from the direction of the unbroken rope. The spread angle depends on the flexibility of the rope material and its construction but is not greatly affected by breaking tension or strain.

The extent to which a line snaps back is difficult to predict, as it depends on several factors. A new fibre rope that parts suddenly at full strength can snap back almost 200%, as nearly all the energy released by the break is transformed into kinetic energy as the broken part contracts to reach maximum speed and then back into strain as it approaches the limit of the snap back. If the rope has lost some of its strength through wear, then the breaking stress will be lower and consequently the snap back distance will be less, though it can still be considerable if the rope parts suddenly. If, however, a worn rope parts relatively slowly (i.e., strand by strand) then the snap back is often less than 100% and may not even be any significant distance at all if the rope is in very poor condition. Snap back is often associated with high stretch nylon ropes, but considerable energy is released when any fibre rope parts suddenly at high loads, so it is best to assume a 200% snap back for all fibre lines. Wire lines are much heavier than fibre ropes of similar MBL, so wire snap back distances are likely to be less, but this is difficult to quantify:

When a rope parts, its two broken parts are initially pushed in opposite directions along the line of the intact rope. The rope parts must bend and contract to absorb this push and the more flexible the rope is, the smaller are these local elastic distortions and the closer the broken ends follow the line of the intact rope, so the spread angle can be quite small, particularly. if the rope is torsionally balanced. However, stiffer ropes with built-in twist snap back in a more whip-like motion that can have a spread angle of up to about 20°. Furthermore, the lay of wire ropes tend to unravel as they part so broken strands flail about like a 'cat of nine tails', which is usually fatal to anyone who is struck by it.

It would be unwise to hold onto a forward spring line under high tension as not only are the crew in the danger of being struck by a broken end if the line pans, the extra deviation in its lead as it passes around the pedestal lead also increases the risk of it parting.

Making the ship fast

If once the ship is in position but still not alongside, then it can be heaved onto the berth with head and stern lines working together so as to keep the ship parallel to the wharf. If there is a high load on the lines due to a strong offshore force, then bringing the ship tight up against the fenders is often best achieved by the 'touch touch' method, in which the ship is pulled in by a series of short heaves on the low speed, high torque setting of the winch. The initial heave gets the ship moving but, if the winch continues attempting to haul in at its target speed, then it will be continually trying to accelerate the ship's movement, the line tension will rise and the winch motor will stall. If, however, the heaving is interrupted by short periods of holding, during which the ship's motion towards the berth will ease the line tension, then each successive heave will keep the ship moving without stalling the winch or capstan motor, until the ship is hard up against the fendering.

The mooring lines can be made fast on the bitts once the ship is in position and not moving, as the ship must be stationary when there are crew in the snap back zones stoppering off the lines and transferring them to the bitts. This takes a certain amount of time, so the officers in charge of mooring gangs should check that the ship is not likely to be disturbed by another vessel passing close by whilst the crew are making the lines fast.

When all the remaining lines have been made fast fore and aft, then the unused lengths of li ne should be coiled back down on the pallets, which are kept clear of the windlass and capstan to avoid hindering the crew tending the moorings whilst the ship remains alongside.

Tending the moorings when the ship is alongside

One of the main duties of the watch in port is to keep the ship alongside and maintain a safe access to the ship from ashore (one should never forget the gangway, which has often given me more problems than the moorings themselves). How much effort this involves on the part of the crew depends very much on how much a ship's height is to change, relative to the quay, how much these changes in heigh t effect the mooring line leads and how fast the changes will occur. VLCCs' can load and unload large amounts of oil in a very short time so they are often made fast with long spring and breast lines, which minimizes the effect of such large changes in draft on the moorings (see page 46), although there is still the rise and fall of the tide to take into account. Large bulk carriers also have very fast rates of loading and discharge but usually are on berths that do not allow for long breast lines, so the resulting changes in draft can have an even bigger effect on the moorings than on a large tanker. It is quite common in these ships for crew to be almost continually adjusting the gangway and the moorings. Cargo operations on general cargo ships (including container ships and ro-ro vessels) usually cause smaller and slower changes in d raft, so the moorings can be left alone for longer periods if the ship is on a berth with a small rise and fall of tide or in a locked dock. The shipowner must consider the man-hours needed to keep his particular ships alongside when deciding on the size of crews.

Tending mooring lines made fast on bitts

If the ship is stationary and the conditions are settled, then a slack fibre line made fast on bitts ca n be safely picked up, heaved tight and re-secured by two men, as follows: -

1) The first crewman tests the winch controls to ensure that power is on the winch

2) The first crewman then applies a stopper to the slack line so that the second man can take turns off the bitts to ease the weigh t of the line onto the stopper and transfer the line to the drum end or capstan

3) The first crewman releases the stopper and then checks overside to see whether or not the slack line is clear to be picked up (spring lines, in particular, run nearly parallel to the quay and, as such, can dip under the quayside fendering when they are slack). He should also warn anyone on the quay near to the ballard that load is about come on the line and check that the ship is unlikely to be disturbed by another vessel passing close by

4) The first crewman then drives the motor to heave the line tight whilst the second crewman tails the line off the drum end or capstan

5) When the line is tight, the first crewman puts the control lever to stop so the line is held on the motor's in put brake whilst he re-applies the stopper. The second crewman then eases the line back to transfer the load onto the stopper before throwing the turns off the capstan or drum end and turning them up on the bitts

The process is straight forward but it will take two men some time to pick u p and re-secure all the moori ng lines, if this is what is required. (It is not always necessary to adjust all the lines, as the longer lines are less sensitive to changes in the ship's heigh t than the shorter ones.)

Slacking down fibre lines on bitts that have become too tight through the ship rising with the tide or discharging cargo only needs one man but it must be done with care. Most of the load on the line is taken by the bottom full round turn so there is a risk of the line jumping out of control if the bottom round turn suddenly slips. The trick is to take the upper figure of eight loops off the bitts and then step back from the bitts whilst still holding on to the line. The required slack can be put in to the few turns remaining on the bitts by gently shaking the line from side to side, which allows the slack to pass around the bins in small increments whilst still maintaining sufficient friction on the bitts to control the pay out. Slacking off over-tight mooring lines is easier and safer when it is done before the tension has become too close to line's breaking load.

Tending mooring lines held on winch brakes

One man can pick up slack or pay out excessive high tension in any line held on the brake of a dedicated mooring winch as follows:

1) Test the winch controls with the barrel disengaged from the motor to check the power.

2) Engage the cl u tch to hold the line on the shaft input brake and then release the band brake (see pages 124-126 for the details of the possible different brake arrangements).

3) Check overside to see whether or not there is any problem with picking up or paying out the line. (Disturbances from another ship passing close by are not so important, as stoppers are not involved and the line is always held by the torque output of the winch motor.)

4) Pick up or pay out to the required tension, re-set the brake and then disengage the clutch.

It is better to relieve a very high tension by driving line out (rather than just easing off on the brake handle) to avoid the winch barrel spinning out a bight of slack line when the tension is suddenly released. Driving the line out also ensures that the brake setting is not disturbed.

When to pick up slack or pay out to ease excessive tension

A ship's mooring lines should only be adjusted for changes in the height of the ship, relative to the quay. Mooring lines might be excessively slack or tight for other reasons where adjusting the lines is usually the wrong thing to do. Considering slack lines first, these should not be tightened up in the following circumstances:

1) The force of an onshore wind or current is creating a yawing moment so the lines will go tight at the end of the ship that has been swung off the berth, whilst the lines at the other end will go slack. The ship is pivoting around a point towards the end that has swung into the berth, so picking up the slack increases the tension in the lines at the other end and prevents the ship from re-aligning itself parallel to the berth when the wind or current changes

2) Lines will go slack at both ends of the ship if it lists in towards the berth, usually due to a temporary imbalance of weight distribution between the port and starboard sides occurring during cargo operations. Picking up the slack just prevents the ship returning to the upright when the weight distribution is evened up

3) Lines made fast on bitts are frequently slack because of the tension that is in variably lost du ring the transfer of the lines from the drum end or capstan to the stopper. There is no point in picking up slack on a warping drum if the line ends up just as slack at the end of the procedure. At its best, the operation will simply be a waste of time and may even result in the line being slacker than i t was before being interfered with. A sensible judgement must be made to decide whether or not it is worth trying to reduce the slack of these lines

Slack lines on bitts, however, should be picked up if a current or wind on the bow or stern purrs the entire load on the upstream or upwind mooring lines, which leaves lines at the downstream or downwind end of the ship slack. It is particularly important to pick up this slack when the berth is subjected to tidal currents, otherwise the lines at both ends of the ship will work loose over a full tidal cycle and the ship will gradually range further up and down the quayside with each successive tide.

Similarly, excessive tension in a line should not be eased in the following circumstances:

1) Again, an onshore wind or current may have created a yawing moment so the lines at the end of the ship that has swung off the berth will tighten. Slackening off these lines will simply increase the yaw.

2) Lines will go tight at both ends of the ship if it lists away from the berth and slackening the lines off will only increase the list

3) The ship is being subjected to a strong offshore force pushing it off the berth

What to do when mooring lines part whilst a ship is alongside

Lines usually start parting on berths exposed to high offshore winds, though the disturbance from a passing vessel or a severe swell can also break lines. Once one line parts, the load on the remaining lines will increase and so they may also part, so the broken lines must be replaced as soon as possible. Ship's crews often resort to tying a knot in a broken end of a fibre rope to make a new eye, as this is undoubtedly the quickest way of replacing a line. A bowline (which is probably the best knot to use) will reduce the strength of the rope to about 60% to 65% of its unbroken MBL, so this is not an ideal solution, but neither is the knot necessarily doomed to fail, as this depends on where the rope parted.

Tying a bowline in a broken end and then pa sing it ashore to be used again a   a temporary measure is better than doing nothing. The knot may well hold if the line broke in the fairlead, as the eye is not subjected to the upward force at the fairlead. Furthermore, the part of the knotted rope that passes through the fairlead will be fresh and not worn by abrasion. However, an even better solution may be to send the parted line out as a bight and turn the broken end up on a set of birrs, as this will be twice as strong as a single unbroken line whilst also passing fresh line through the fairleads. The bight can be sent ashore and heaved tight just as quickly as tying a knot but another free fairlead is needed and the bight may suffer abrasion as it is pulled around the quayside ballard, particularly if it shares the ballard with other ropes.

Tending moorings held on self-tensioning winches

Lines held in self-tensioning control should neither go slack nor become so tight that they could part, unless the self-tension control has developed a fault or a line's strength has been severely reduced by damage through abrasion. However, if an offshore force is strong enough to push the ship off the fenders, then the winches may continue to pay out until the ship is cast off the berth. It is important to monitor and adjust the set tensions as required to keep the ship always against the fenders and approximately parallel to the wharf.

The problems arising from a ship's deck being below the quay

A ship's mooring deck will lie below the level of the wharf when the ship is on a berth used by much larger vessels and/or in a port with a very large tidal range. The ship must be fitted with a sufficient number of closed overside fairleads for the mooring arrangements needed to keep it alongside but it is not always obvious when a ship ties up that the lines will have an upward lead to the wharf. When the moori ng lines are made fast on bitts, there is nearly always a sag in the catenary that, in marginal cases, can obscure the upward straight line leads that the lines will develop if they are pulled tight for any reason. The ship may tie up on a berth using open fairleads many times without anyone realizing the situation until the moorings are subjected to loads high enough to pull the lines straight so that they pop out of the fairleads. The risk may only exist at low water on a spring tide or when the ship is fully loaded with a particular trim and it may be that only the stern lines are affected, as the after deck is usually lower than the fore deck. Furthermore, open fairleads are often mounted with a downward tilt, in which case, even a line leading horizontally ashore will pop out of the fairlead if it is pulled tight enough.

Shifting the ship along the quay with the mooring lines.

Ships are moved along the quay either to make room for another vessel on a long quayside, or for the ship's cargo operations. In either case, the move must be made with the approval of the port authority which provides linesmen to move lines on the quay and arrange for a pilot and tugs if necessary. The ship's engine should be put on standby for the move, though it must be used with caution, if at all, as the move along the quay must be at a very slow speed maintain control. If the ship is to be moved by its moorings, then some lines must be let go and brought onboard whilst the remaining lines are re- arranged to lead mainly fore and aft, which reduces the ability to stop the ship from yawing or moving off the quay during the move.

Keeping a ship approximately parallel to the quay during a move is important, as small yaws, due to a wind or current slightly off the bow or stern, increase rapidly if the ship is allowed to swing the current or wind closer to abeam. The force creating the yawing moment, however, will also push the ship bodily either onto or off the quay, so yaw created by an onshore force is limited by the ship being pushed hard up against the quay How far the ship has swung before this happens depends on the length of the ship's parallel sides, as well as any restrain t from mooring line tensions at the end of the ship that has swung off the quay. Yaw clue to offshore forces is less restricted, as the ship is bodily pushed off the quay and so given more scope to swing, which can result in mooring lines parting

CHAPTER THREE: UNBERTHING

Letting go on departure

A ship is usually ta ken off a berth by reversing the sequence of events followed when putting the ship alongside. If there is no force acting to mainly push the ship bodily off the bench, then the stern must be swung out nest so that the engine can be used as soon as possible. If a ship is to be taken off the berth stern first, then the forward spring (which is usually the first line ashore when going alongside) is the last line to let go, as it can be used to swing the stern out, as shown on the previous page. It also will go slack as the ship moves astern, so it can be easily let go and, unlike the aft lines, there should be no danger of it fouling the screw.

If there is a strong offshore force, then the ship will come off the berth of its own accord but the moorings will be tight. One or two tugs (depending upon onshore wind's yawing moment) will be needed to push the ship alongside whilst the lines are released from the bollards ashore and brough t onboard and the tugs can control any yaw as the ship comes off the berth. There is little control over the ship's steering whilst it is going astern to clear the berth, so a t ug at the stern may be needed to restrain any yaw due to a current either from ahead or astern. Steering control can be regained by putting the engine ahead as soon as there is room to maneuver but the ship may have to be swung with tug assistance to head in the direction for leaving the port.

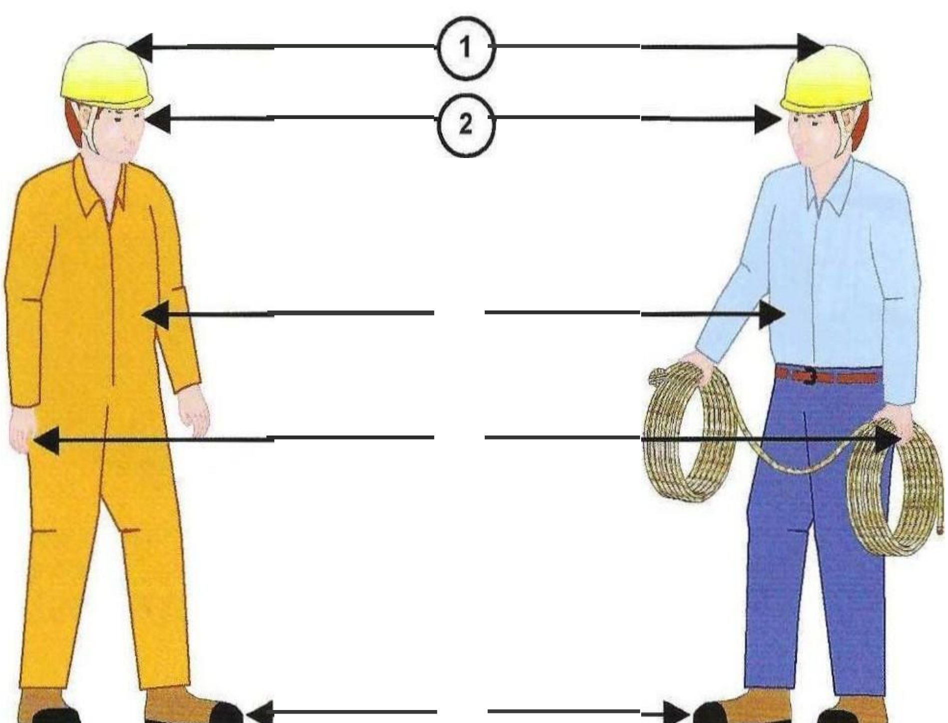
The mooring gangs are called to standby for letting go after the departure checks on the ship's engines, helm and other equipment are completed. The gangway is brought onboard and the ship's moorings are singled up to the minimum number of lines that can safely hold the ship alongside for the prevailing conditions on the berth (this typically might be a head line, stern line and two springs). The officers or supervisors in charge of the mooring gangs should then check on the remaining lines ashore to see if the linesmen might have problems releasing the eyes from the bollards, particularly the head and stern lines that share bollards with lines from ships on adjacent berths. It does not really make any difference whether the eyes of these lines have been clipped or not, they can still jam and require a pull from the winch to jerk them free if there are other lines on the same bollard leading in a different direction. The linesmen can nearly always free an eye but it can sometimes take them a few minutes and the bridge should be warned of the possible delay. The bridge must always be informed of when lines are 'gone' from the wharf and when they are 'clear' of the water.

If a tug is to be used, then only fairleads and bitts that are sufficiently strong for towing must be used for the tug's line. Once the tug is made fast, the crew should stay clear of the snap back zone, as tugs sometimes pull on a towline before a ship is let go. If a tug is to push, then it must only push at the reinforced parts of the hull marked by a letter 'T'

When a tug is to be let go, one or two turns of the messenger rope should be put around a set of bitts in line with the tug's wire so that it can be manually belayed over the ship's side after the eye has been released from the bitts. Very large ships have a winch drum end in line with the towing fairlead and bitts for the messenger rope because the tugs' wires they use are too heavy for manual handling. Very large unwieldy ships, such as VLCCs', must usually be taken off the berth parallel to the quay by tugs, again in the reverse of the berthing sequence.

Appendix I - Personal safety

Ships' crews should wear clothing that is comfortable, practical and suitable for their work, as shown below



1 Hard hat: - Although these are an almost iconic symbol of men at work, they are only capable of protecting the wearer from relatively small objects hitting him or her on the head (such as the end of weighted heaving line) and they offer no real protection from being struck by the end of a parted mooring line. The value of wearing a hard hat during mooring operations is limited but, if it is to be worn, then the chinstrap should also be used, otherwise the wearer will be constantly distracted by trying to keep the hat on his or her head.

2 Eye protection: - This is not really necessary for working with mooring rope, *but it* is *essential*

that the anchoring party do wear proper goggles, as small particles of dust or rust can cause serious damage if they enter the eye after coming off the anchor cable, particularly as it is being run out.

3 Clothing: – Mooring parties should wear clothes that are comfortable and easy to move in but not excessively loose or baggy, otherwise they can snag on wires, get caught in a winch or, even trip the wearer up, in the case of excessively long trouser legs. Many companies provide boiler suits that are highly suitable as work clothes, provided that they are a reasonable fit.

4 Hand protection: - Wearing working gloves reduces sensitivity in the wearer's hands, so they are normally only worn when working with wires.

5 Footwear: - Good footwear is essential for working on deck and modern slip-on rigger boots with steel toe caps are ideal, as they are comfortable, quick and easy to put on and have no laces.

Many shipping companies have rules with regard to wearing proper clothing and safety gear but there can be drawbacks in protective gear that should be weighed against the protection that the gear provides. Approved goggles, for example, are made with wrap-around flexible plastic framing so they tend to become misty with condensation from the wearer 's breath, even though there are small vent holes in the sides of the frame. Consequently, they are only usually worn when risk or damage to the eyes is high, such as working with the anchor.

Safety is to do with a lot more than just wearing the appropriate clothing and most companies have procedures for mooring operations. However, it is difficult to write precise instructions to cover every possible situation and some procedures seem to be written more for complying with legal requirements rather than the safety of the crew.

There are very few hard and fast rules that apply to all mooring operations, but the following dangers should be absolutely avoided in any situation:

1)Never stand in either an open or a closed bight of rope

2)Never heave blindly on a line when no one is watching what is happening at the other end

3)Always be aware of what is going on around you and have an escape route from any likely danger

4) Always put an eye onto a ballard or bitts by holding the eye either on its side or by a messenger l ne to avoid getting fingers trapped against the bollard if the line comes suddenly tight

5) Never try to be heroic by jumping onto a line that is clearly running over the side and out of control, as you are likely to go overboard with it

6) Do not run more than one line around a fairlead sheave, as the lines chafe through quicker and the sheave is really only strong enough to take the load of a single line under tension

7) Do not use any equipment that is obviously faulty. If damage is noticed, then it should be reported and an alternative arrangement for the mooring line used

8) Never let go of a mooring line und er heavy load without determining first why the load is so high and then taking the proper precautions if it must be let go

9) Never check the alignment of the holes for a securing pin, such as for the winch clutch or anchor cable compressor, with your fingers. This may seem a stupid thing to do but it is also quite a natural first response if the pin will not go in properly. However, if there is any slight movement in what you are trying to secure, then it is very likely to slice off your finger. If the holes need to be jiggled into alignment, then use a spike

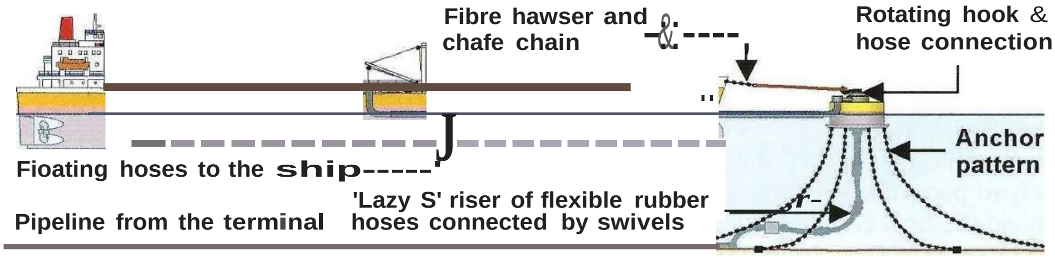
The most important thing that crew can do to keep themselves out of trouble is to understand what is going on around them. Some companies, for example, may decide to have snap back zones for the moori ng lines painted on the deck. This may seem to be a good idea but there are very few areas, if any, on the mooring deck that are not within one or more possible snap back zones, so the result would be confusing. (The snap back zones on the ship's foredeck shown in UK-MCA Marine Guidance Notice MGN 308 are misleading, as they underestimate the distances that many of the lines in the diagram could snap back.)

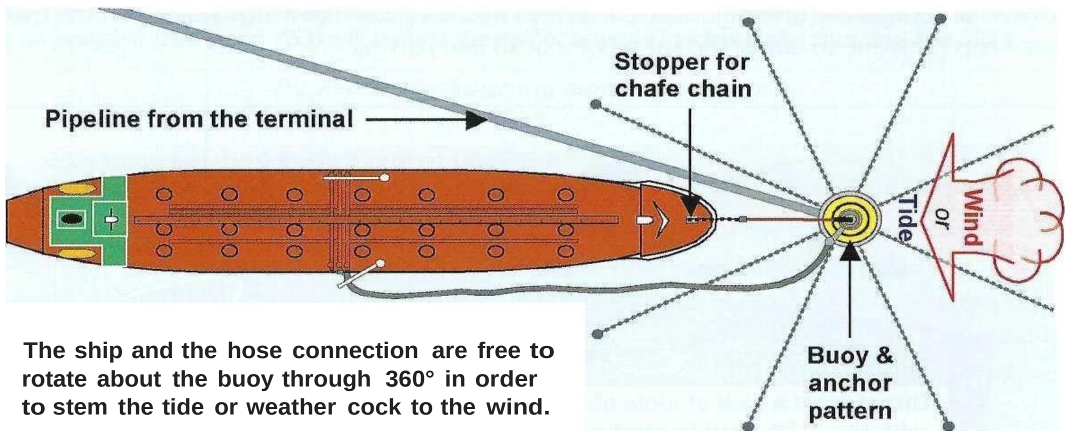
Personal safety and snap back zones

A ship cannot be effectively operated if all the snap back zones are made 'no go' areas when mooring lines are run out. The crew must usually enter snap back zones in order to tie the ship up, so it is important not to do this when there is a high risk of the relevant rope parting. Lines often give no indication that they are about to pan, though this is most likely to occur when a line is being hauled tight or used to arrest the ship's motion. The crew should step clear of the snap back zone of a line being heaved in or when the ship's movement is about to put load on a slack line. (New ropes will fail at higher loads and so snap back more fiercely than old worn ones, which may just flop onto the deck, though there is no guarantee of this.)

Appendix II- Single point moorings for tankers

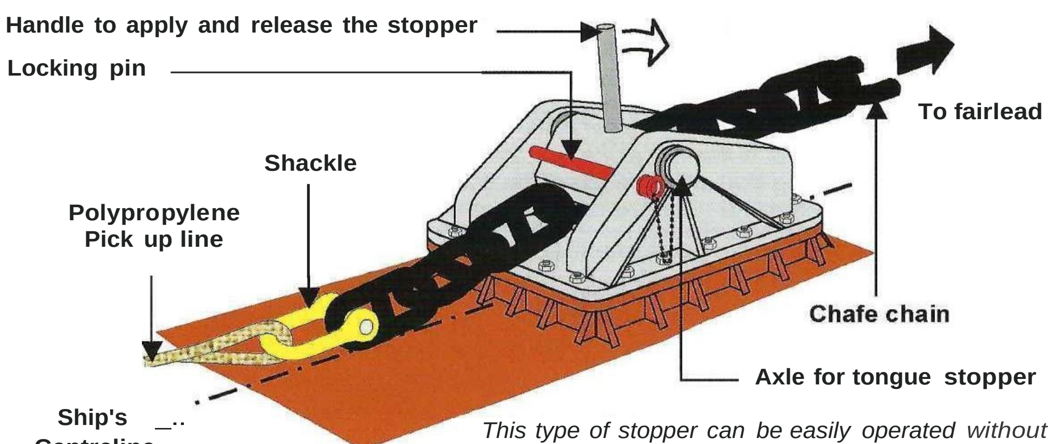
The 'Single Point Mooring', or 'SPM', (sometimes referred to as a 'single buoy mooring', or 'SBM) provides a berth for tankers to load or discharge cargo in sheltered locations as if they were at anchor. The SPM is anchored to the seabed and the tanker moors to it by either one or two strong fibre rope hawsers (depending on the terminal and the vessel's size) shackled to a chafe chain secured to the ship’s foredeck. Guidance for SPM equipment and operations can be found in OCIMF Guidelines for Equipment Employed in the Bow Mooring of Conventional Tankers at Single Point Moorings and OCIMF Single Point Mooring and Maintenance Guide.





The chafe chain and hawser are supplied by the terminal but the tanker must be fitted with a chain stopper and fairlead on the centreline aligned with a winch to bring the chafe chain onboard.

A tongue chain stopper mounted to secure the ship to the buoy with a single hawser



This type of stopper can be easily operated without the risk of crushing fingers against parts of the stopper.

The hawsers provided by the terminal for securing the tanker to the buoy are usually polyester or nylon braided lines with minim um breaking loads of between 300 and 600 tonnes whilst 76 mm chafe chain has been established as the standard size for all tankers. The tanker's foredeck must have for each pickup rope a winch storage drum capable of accommodating 150 metres of 80mm diameter pick up rope and lifting 15 tonnes. Each d r u m should be i n li ne with the bow fairlead and chai n stopper to avoid the need for pedestal fairleads. The ship shou ld have about 90 metres of 75 mm polypropylene messenger rope to bring the pickup rope and chafe chain through a suitable closed 'Panama' type fairlead and chain stopper. The messenger rope should lead directly through the stop per to the bow fairlead so a pedestal lead sited aft of and in line with the stopper and fairlead may be necessary to achieve this. Terminals may use two separate hawsers, depending on the size of ship the terminal is designed to accommodate, and chafe chains that must pass through two fairleads either side of the centerline to be secured to two stoppers. Two hawsers provide extra time to disconnect the cargo hoses safely if one parts but the fairleads should be sited close to the ship's cent reline to avoid the load coming mainly on one hawser at a time when the ship is yawing.

Mooring the tanker to the buoy with a single hawser, as shown on the previous page, requires the following preparations to be completed when the tanker arrives at the buoy:

1) The terminal to lay the hawser and chafe chain appropriate for the tanker on the seabed with one end secured to the buoy and the other end attached to an 80 mm polypropylene pick up rope ready for the tanker as it arrives at the buoy

2) The tanker foredeck crew to have the messenger line ready to pay out through the stopper and fairlead to the terminal 's boat crew for attaching it to the A oating pick up rope

The moori ng operation is carried out under the directions of a pilot, who usual l y stands at the bow with the foredeck crew a nd an experienced ship's officer in good communication with the master on the bridge. Mooring can then proceed as follows:

1) The tanker approaches the buoy with the wind or current on the bow at slow speed and is stopped short of the buoy when directed by the terminal pilot

2) The foredeck crew pass the messenger line to the terminal's boat crew, who attach it to the pick up line for sending the chafe chain up to the tanker

3) The crew heave on the winch to haul in the messenger line, pick up rope and chafe chain, stopping the pick up when the chain is correctly located for applying the stopper

4) The stop per is applied and the pick up rope eased back on the winch to transfer the tension in the linefully onto the stopper

The crew should always have essential items, such as a sledgehammer or axe, and a crow bar available to them when carrying out the mooring operation. If a ship is to be moored with two hawsers, then the messenger rope must be disconnected and passed out through the stopper and fairlead on the other side of the bow to pick up the second chain once the first chafe chai n is stoppered off Some ships are fitted with 'Smit' type towing brackets instead of stoppers, for securing the chafe chains,

i n which case short lengths of mooring chain must be secured to the brackets before the chafe chains are ha u l ed on board. The chafe chains can then be temporarily held by special stoppers provided by the terminal whilst they are shackled to the lengths of moori ng chain. This ensures that the chafe chains can be secured even if their links do not fit the brackets.It is essential that the ship's engine and helm are used cautiously whilst the ship is being made fast so that the load on the messenger and pick up rope is kept to a minimum.

A watch should be posted on the foredeck whilst the tanker is moored to the buoy to warn the duty officer if the ship either drifts too close to the buoy or, conversely, puts excessive strain on the hawsers. If the ship starts to approach the buoy; then the ship's engine should be used to hold it off. If the ship starts to yaw excessively, then the cargo operation should be stopped in readiness to slip the moorings if necessary. (The assistance of a tug pulling at the stern and/or using the ship's helm may resolve this particular problem.)

Unberthing is essentially the mooring process in reverse, so the messenger rope is attached to pick up rope and heaved in to take up the slack in the chafe chain aft of the stopper whilst the ship's engine and helm are used to take the load off the hawser. The stopper is released as soon as the hawser goes slack so that the chafe chain, pick up rope and messenger rope can be paid out until the chain is lying on the seabed with the other end of the pickup rope floating on the surface. The messenger rope can then be disconnected and recovered onboard, either to repeat the process with the other chafe chain, if the tanker is made fast with two hawsers, or to al low the ship to back off from the buoy and proceed on its way.

Mooring to and letting go from a SPM demands deli cate maneuvering of the ship and it helps if the foredeck operations are carried out smoothly and quickly which, in turn, requires careful preparation so everything is close at hand when it is needed. Some tankers are equipped with a controllable pitch main propeller and bow and stern thrusters so that the ship's overall thrust can be controlled by Dynamic Positioning, or DP, control as outlined on page 151. However, the ability of the system to control the ship's position is limited by the power of the thrusters and how fast they can react to the signals from the DP. It will not control a 100,000 tonne tanker as precisely as a 3,000 tonne dive support ship but, provided that the DP is correctly set up for the vessel's characteristics and the ship is predominantly heading into the wind or tide, then the DP should be capable of keeping the ship's fore and aft position within the tolerances required for the mooring operation.

The CALM system is generally used in sheltered sites with water depths of between 20 and 35 metres whilst other SBM arrangements, such as those shown in the diagrams below, are used in deeper water or locations more exposed to waves.

Appendix III - Shore based mooring systems

Some pons offer totally shore based mooring arrangements on some of their berths. There are currently two such systems in use, namely:-

1. Lines from self-tensioning winches on the quay that are a attached to special mooring posts mounted in recesses low down on the ship's hull to provide near horizontal leads so that the lines can be most effective at holding the ship alongside.

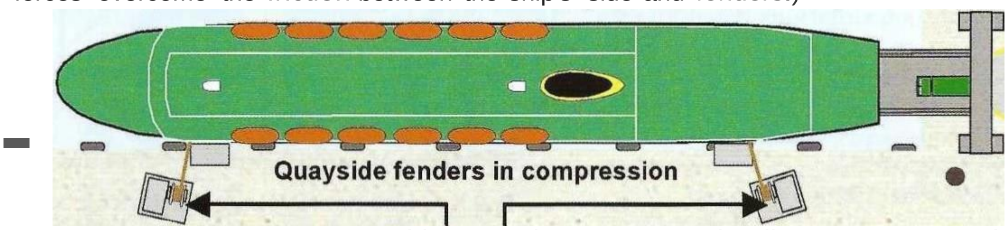
2. Vacuum systems consist of shore mounted mechanical arms supporting a framework that houses suction pads connected to an accumulator held at low pressure by a vacuum pump so that a ship can be held in position after being put alongside the pads. The framework can be extended out towards the ship and incorporates rails to allow for the ship's vertical movements when it is alongside.

The shore based self-tensioning winch system

Shore-based mooring winch systems are designed for particular ships using specific berths, such as the ro-ro ferry shown in the following diagram.

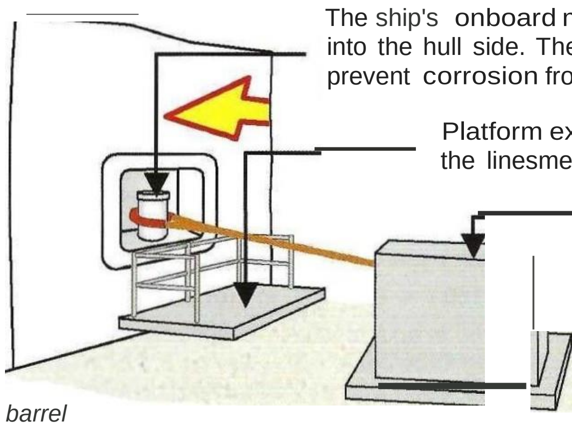
The following diagrams are based on information from 'MacGregor', who make the 'Moorex' system

The ferry is put alongside on the fenders parallelto the quay for linesmen to secure the mooring lines to the posts in the hull recesses fore and aft. (Spring lines held on shipboard winch brakes must be run out if fore and aft forces overcome the friction between the ship's side and fenders.)



Mooring winch units set to provide the optimum leads for holding the ship in position

Winch units are at about the same height as the mooring recesses in the ship's side.



The ship's onboard mooring post is mounted in a recess built into the hull side. The bottom of the recess slopes outboard to prevent corrosion from spray water accumulating in the recess.

Platform extending just beyond the edge of the quay for the linesmen to put the mooring line over the post.

Self-tensioning winch unit

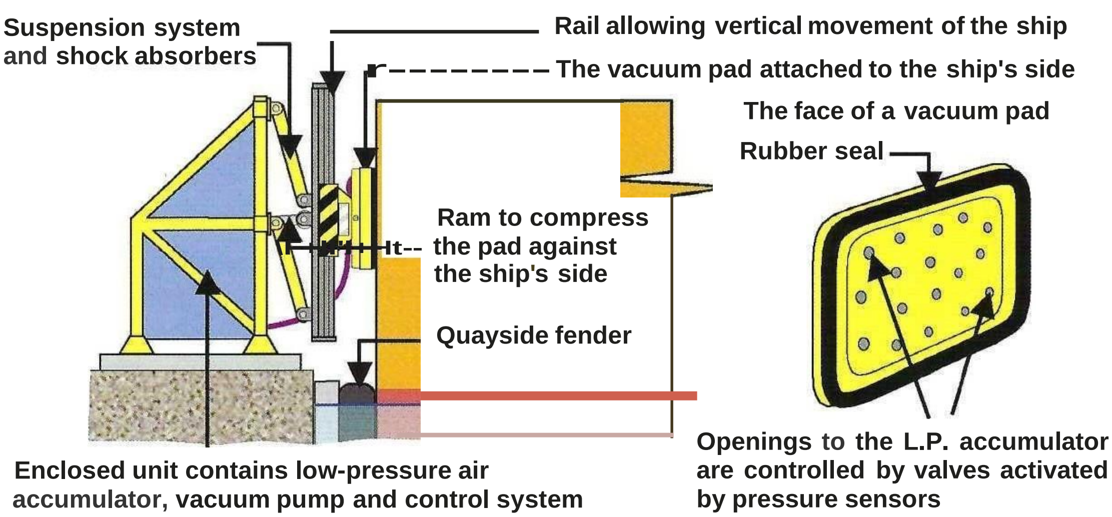
The self-tensioning winch can be set quite close to the edge of the quay, as the length of line under tension to be spooled on and off the winch is very short, so the winch can be fitted with a narrow barrel

The mooring lines from shore-based winches are secured to the ship by linesmen on the quay, so the mooring posts recessed into the ship's hull must be within easy reach from the quayside platforms when the ship is in position. This means that the posts must either be located within the hull's parallel body or that the quay is built to follow the shape of the hull so that a line can be attached to the bow region from the ashore. If lines are secured too far away from the bow and stern, then the mooring pattern will be poor at resisting any yawing moments. Fore and aft movement is resisted by the friction between the fenders and the ship, though spring lines held on winch brakes are necessary on berths exposed to large fore and aft forces. A mooring line's efficiency decreases with the cosine of the lead angle to the horizontal, so the arrangement can only be effective if the ship's height does not change greatly whilst the vessel is alongside.

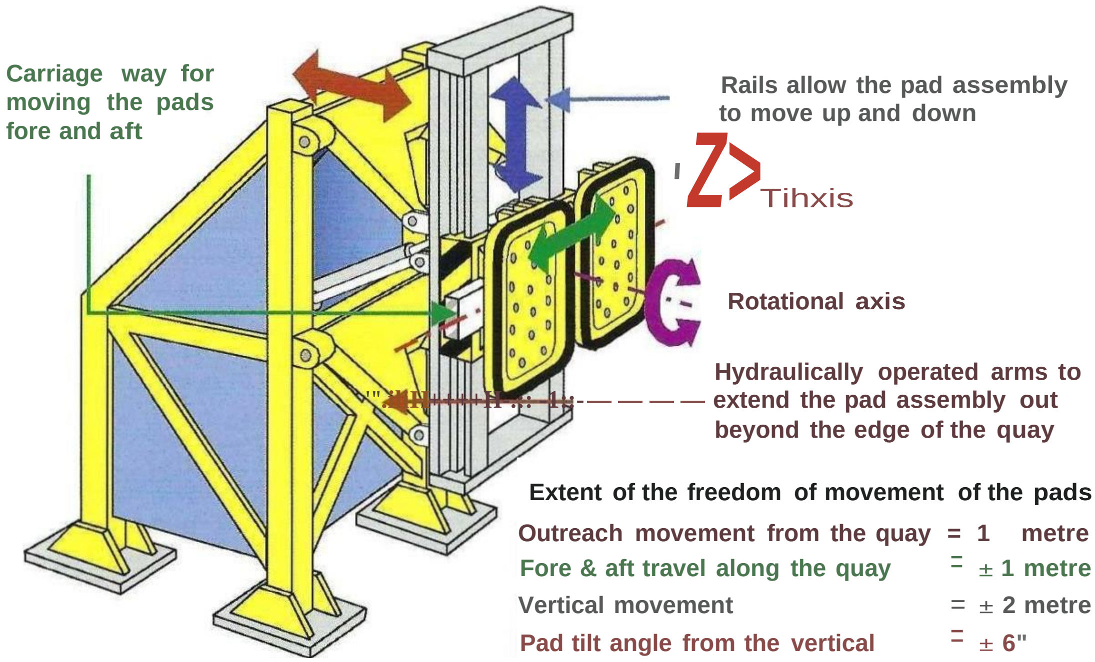
Shore-based mooring systems using winches on the quay are only suited to purposely adapted ships that always use the same berths during short turnaround periods alongside, in which the change in draft is quite small and a t which there is little or no tidal rise and fall. Short haul ro-ro vessels on regular runs are obvious candidates for such systems, particularly when they are fitted wit h bow and stern thrusters so that the vessel can be put and held alongside whilst the lines are secured without the need for tugs.

Shore-based vacuum mooring systems

The vacuum mooring system provides a similar flexibility to conventional mooring lines yet maintains a horizontal pull on the ship's hull to keep the vessel alongside. Ship surge along the quay is resisted by passive clam pers or hydraulic cylinders incorporated into the mounting that holds the pads on the vertical rails whilst allowing limited fore and aft movement. Overload ed pads will slide along the hull, rather than break free, and monitoring sensors within the system will provide ship's staff and port operators with early warning of such situations developing.



Sensors are continually measuring the loads on the pads when they are attached to a ship and the system can be monitored and operated remotely by radio link from a computer with visual display units sited on the ship's bridge and the port control room. The way in which the pads are mounted on the unit allows for normally encountered ship motion even on berths exposed to swell. However, the ship can rise and fall freely with the tide and/or changes in draft due to cargo work without detaching the pads, as these can slide up and down the vertical rails. If the pads reach either the top or bottom of the rail, then the system automatically disconnects the pads, one by one, re-positions them on the rails and then re-connects them to the ship's side in a procedure known as 'stepping up or clown ' the ship's hull. The horizontal carriageway that the pads are mounted on allows some fore and aft movement and can, in some configurations, be used to adjust the ship's position on a berth by moving it in either direction along the quay. The pads can tilt sightly in the vertical plane to allow for normal ship heeling movements and also rotate in the horizontal plane so they can attach to a region of the hull that is not entirely parallel to the quay.



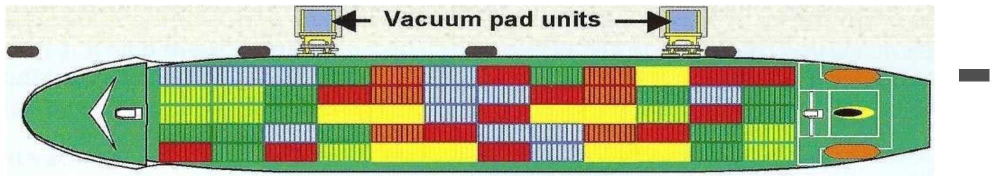
Tugs or bow and stern thrusters are used to put a ship bodily alongside the berth where at least two units are spaced out along the quay. The pads' rubber seals are then compressed against the ship's side by hydraulic cylinders whilst the valves between the low pressure accumulator and the pads are opened to produce the suction that secures the ship to the pads. Applying the near vacuum to the pads to fully secure the ship takes no more than 15 seconds, which is much less time than is needed to make fast conventional mooring lines.

The rubber seals around the pads are very stiff, so slight movements of the ship, relative to the pads, cause large changes in the force of the pads against the hull. Consequently, any variation in an offshore wind force acting on the ship is compensated by imperceptible ship movements against the pads. However, the pads move with a ship when it is subjected to large alternating forces produced by swell waves, though the resulting movement is greatly reduced by the damping effect of the hydraulics in the articulated mounting arrangement, which is supporting the pads and flexed to the quay.

The system will hold the ship without power providing that the pads retain their seals so the ship will not be suddenly cast off without warning.

The manufacturers produce units that range in holding capacity from 20 to 80 tonnes by increasing the number of basic 20 tonne pads incorporated into the units. The diagram below shows a feeder container ship held alongside by two 40 tonne units though larger vessels will require more units with higher capacity.

The following diagram and those on the previous two pages are based on information from 'Cavotec', a leading manufacturer in this technology who produce the 'Moormaster' system.



If the ship is held alongside by two 40 tonne units, as shown on the previous page, then this should be sufficient to withstand the static side load of a 60 knot wind on the beam (see page 7). However, vacuum units can only attach against the flat plating of the ship's midships region of parallel body

The vacuum pads must hold against parts of the hull that:

1) Consists of almost flat plating that is dose to being parallel to the quay.

2) Is free of ice and has no significant bumps, such as rivets or portholes with side scuttles.

3) Is sufficiently strong to withstand the suction force of the pads. A pressure difference of about 9 t/m2 will distort the plating enclosed by the pads, as well as compress the rubber seals and distort the pad's back plates, so any distortion must be within the elastic limits of the hull plating. However, the pressure difference created by the suction with the pads can be reduced if the suction force is likely to cause permanent distortion of the hull of a ship with relatively light scantlings (i.e. one with thin plates and frames).

The vacuum pads are normally restricted to between 25% and 30% of the ship's length either side of amidships, particularly in the case of fast container ships and ro-ro ferries with very fine-lined hulls. This is an advantage when securing a ro-ro ship on a berth where the bow or stern extends well beyond the quay (see page 43), as there is no need for a mooring dol phi n. However, it is less than ideal for opposing yawing moments, as load will be Jess well spread between the pads than would be the case if they could be attached closer to bow and stern.

The vacuum system undoubtedly overcomes most of the problems involved in mooring high-sided ships on low quays by providing a very quick means of both securing a ship alongside and releasing it from the berth (which takes about 5 seconds) when it is ready to sail. The pads are applied and released by one person operating the system remotely, which removes the risk of injury to personnel from snap back of parting lines or failures of fittings and equipment that accompany traditional mooring operations with lines. Although installation and maintenance costs will be much higher than for the bollards that the system replaces, ports should be able to recover this by more effective use of the berths through the quicker turn around times and the closer spacing of ships along the quayside that the system allows. There will also be far less disruption of cargo work due to excessive ship movement on berths exposed to a swell. However, like any other means of securing a ship alongside, the capacity of the system has its limits and users must follow the manufacturer's recommendations and instructions.

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