CHAPTER 22

Mooring and Berthing

This chapter addresses the preparations and procedures necessary to ensure a tanker berths and remains safely moored at a jetty or buoy mooring. Chapter 21 covers communications between the tanker and terminal on mooring arrangements.

For more information on mooring equipment and training, see OCIMF's *Mooring Equipment Guidelines* and *Marine Terminal Operator Competence and Training Guide (MTOCT)*. For descriptions of good operational practice for mooring, see OCIMF's *Effective Mooring*. Particular types of mooring are covered in OCIMF/CDI/ICS/SIGTTO's *Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases* and OCIMF's *Guidelines for the Design, Operation and Maintenance of Multi Buoy Moorings and Guide to Offshore Tanker Operations*.

Tanker, terminal and berth operators are strongly recommended to bring this information to the attention of their workforce to ensure that mooring and berthing are done safely.

22.1 Mooring safety

Mooring, unmooring and maintaining the effectiveness of the mooring arrangements are among the most routine and critical operations undertaken by tanker and marine terminal personnel. They are some of the highest risk activities that personnel perform.

During mooring and unmooring, tanker and terminal personnel are at increased risk. Potential hazards include lines under tension, winches in operation, towing lines and lines handled by mooring boats and tugs.

While the tanker is alongside and undertaking transfer operations the risks are different, but the risk to personnel remains. Ensuring the tanker remains safely moored to the berth is critical. It should be carried out diligently by competent personnel to ensure they remain safe. The security of the tanker, transfer operations and equipment should not be compromised.

It is imperative that there is an effective tanker/terminal interface to ensure that every mooring operation, no matter how frequently undertaken, remains safe. This includes effective communications before arrival, rigorous planning, good procedures, well maintained equipment and trained and competent personnel who are fully aware of the hazards and risks. A failure in

this area can cause harm to both tanker and terminal personnel, as well as damage to the tanker, the terminal equipment and to the environment.

22.1.1 Snap-back

There are multiple sources of risk to personnel operating in or around the mooring system. One direct cause of injuries to many tanker and terminal personnel is mooring line failure along with the phenomena of snap-back.

This topic is covered more fully in OCIMF's *Mooring Equipment Guidelines* and *Effective Mooring*. Line failures can occur anytime and the following points should be noted.

As a line comes under tension, it stretches and stores energy. Snap-back is the tendency of the broken ends of a tensioned line to draw back rapidly on failure when that energy is released suddenly.

Snap-back is possible in all types of line, but it is strongest in some synthetic lines that have more inherent elasticity and are less stiff than others. Wires and High Modulus Synthetic Fibre (HMSF) lines, which have low stretch capability, can also suffer snap-back but it may be less pronounced. Wires and HMSF are more likely to experience major snap-back events when they are connected to synthetic tails, which have higher inherent elasticity and stored energy.

The force of the snap-back is as great as the energy stored in the line when it breaks. It presents a significant risk to all personnel working in the mooring area of a tanker, tug or berth. Measures should be put in place to remove these risks or to remove personnel from exposure to these risks. This can be done through ship design and good operating procedures and practices.

Training, proper supervision and good communications are the first means of defence. Other measures to be considered include the following:

- Providing safe access to winch controls.
- Positioning supervisors and tanker and terminal personnel with unobstructed views of the operation.
- Providing operating and personnel management procedures.
- Providing adequate lines of sight for the entire mooring deck workspace.
- Using lines with the most direct leads possible from winch to tanker side fairlead.
- Minimising the crossing of the deck area by lines.
- Minimising the use of pedestal rollers.
- Avoiding sharp angled leads.
- Using personnel trained in mooring operations.
- Briefing tanker and terminal personnel on the planned mooring operation, including:
  - Intended mooring layout.
  - Winches and lines to be used.
  - Shore mooring hooks and bollards to be used.

Due to the confines of the mooring deck, the number of personnel involved in mooring and unmooring and their closeness to mooring lines under tension, snap-back is usually considered a higher risk for tanker personnel. However, shore personnel can also be at risk when lines fail. The above measures should be considered in the design and operation of shore facilities.

Some tankers and terminals mark danger zones where snap-back may be a hazard. This practice is not recommended as it is not possible to accurately determine the whole range of zones in which snap-back is a danger. Also, marking off danger zones may create a false sense of safety outside of these areas.

The entire mooring deck and jetty mooring area should be considered an area of elevated risk. Signage should be used to alert personnel that they are entering a risk area.

22.2 Security of moorings

Any excessive movement of a tanker, or its breaking away from the berth, could cause injury to personnel and damage to the jetty installations and the tanker.

Mooring restraint guidelines for tankers intended for worldwide trade are detailed in OCIMF's *Mooring Equipment Guidelines*. The principle for this guidance is that mooring is considered an integrated system, from mooring hook to winch or bitts, and that all equipment should be operated and maintained so that the tanker remains securely moored according to the design. The condition of mooring lines should be monitored to ensure they are replaced before they can fail. Mooring system design parameters include a well defined hierarchy of failure to protect human life and the assets.

The requirements for tankers above 16,000 tonnes DWT are based on the standard environmental criteria, outlined in OCIMF's *Mooring Equipment Guidelines*, that are used as the basis for the recommendations on mooring systems in this section. These criteria provide the base conditions for restraint in 60 knots of wind and various current directions. They are not adequate for extreme combinations of environmental conditions at every terminal. Most terminals cannot operate in extreme conditions and tankers may, at a minimum, be required to stop operations, e.g. to allow for MLAs to be disconnected, and may also be required to leave the berth based on their Terminal Operating Limits (TOLs). More information on setting environmental operating limits is available in OCIMF's *Mooring Equipment Guidelines*.

At exposed terminals, or those where the criteria are likely to be exceeded, if the tanker is not removed from its berth its moorings should be supplemented with shore based equipment and/or standby tugs.

For tankers below 16,000 tonnes DWT and tankers operating only on a dedicated route and using terminals whose environmental data is available, a risk assessment may be made and the recommended criteria may be changed to suit local conditions or trading patterns.

Tanker and terminal representatives should work closely to ensure that the mooring system is fully functioning and meets design and operating requirements. This assessment should include the tanker mooring equipment and berth mooring facilities, including the fendering. This ensures that the systems are adequate to keep the tanker at the berth and allow for safe transfer operations, while minimising the risk to personnel, facilities, equipment and environment.

Although responsibility for the mooring of a tanker rests with the Master, the terminal should also ensure that tankers are securely and safely moored. Terminal management should have engineering studies and mooring analyses to determine operating parameters for individual berths. This information should be made available in pre-arrival communications. No cargo hoses or MLAs should be connected until both the Terminal Representative and the Master are satisfied that the tanker is safely moored.

This mutual agreement on the tanker's mooring should be achieved before operations begin. It should be among the first duties of the tanker and terminal representatives at the pre-transfer conference (see chapter 21).

22.3 Preparations for arrival

A successful interaction begins before the tanker arrives at the terminal, with an exchange of information between tanker and terminal personnel. It should cover equipment and facilities along with their capabilities and limitations, as described in the TIB.

Only through the rigorous planning, execution and management of the jointly owned tanker/terminal interface will the tanker's mooring, cargo operations and unmooring be safely conducted.

22.3.1 Tanker's mooring equipment

Once a tanker has been nominated to visit a terminal, the tanker operator should provide technical data and information about the mooring equipment to the terminal. Some of this data may be found in the tanker's Ship Inspection Report Programme (SIRE) Programme Vessel Particulars Questionnaire (VPQ). This information may be accessed by tanker and terminal representatives through the tanker owner's direct or (where available) vetting departments. It is, therefore, important this data is kept up to date.

Terminals or charterers may need other information for tanker/berth compatibility studies. This can be provided in industry recognised formats.

Details of the information that should be exchanged are included in chapter 21.

Before arrival at a port or berth, all necessary mooring equipment should be tested and ready for use. Anchors should be ready for use, if required, unless anchoring is prohibited.

The use of emergency tow-off pennants is not recommended by OCIMF. However, some locations require them to satisfy local rules and regulations. More information is available in OCIMF's *Lloyd's Register Risk Assessment of Emergency Tow-off Pennant Systems (ETOPS) Onboard Tank Vessels.*

An adequate number of trained and competent personnel should be available to handle the moorings.

The tanker operator and Master should ask the terminal for the information necessary for a review of ship compatibility and the development of a detailed mooring plan before arrival. Terminal data may come from various sources (see section 21.3.2).

Mooring plans should be discussed with the tanker personnel who will be involved in mooring, to make sure they have a thorough understanding of what is required. A discussion may also be held with the terminal, particularly if any risks or concerns have been identified.

This forward planning will ensure that all required mooring equipment is identified, tested and available. Defective equipment on the tanker or at the terminal may be assessed and risk assessments undertaken to overcome equipment shortcomings in the plan. This may include developing temporary Management of Change (MOC) measures that might affect the safety of the tanker while alongside.

22.3.2 Terminal mooring equipment

Terminals should be designed for the safe mooring and management of the tanker types that may pass through them during their working lives. Once this range of tankers has been identified, studies can be undertaken to assess the requirements for safe operations. Terminal designers should be aware that mooring equipment and physical parameters will vary from tanker to tanker, so berth facilities will need to be flexible to cover the anticipated range. They may need to take some or all of the following items into consideration:

- TOL (see section 16.1).
- Minimum distance needed between moored ships. See the World Association for Waterborne Transport Infrastructure's (PIANC) MarCom WG 153 *Recommendations for the Design and Assessment of Marine Oil and Petrochemical Terminals (2016)* for more information.
- Whether the berth will be affected by passing tankers, narrow channel effects, limited Under Keel Clearance (UKC), tidal bores or other hydrodynamic effects.
- Response times and measures for events such as berth breakouts, including the availability of emergency support services, e.g. tugs.
- Rise and fall of the tide and the impact on mooring restraint of freeboard changes and angles of mooring lines.
- Less than optimal alignment of tankers' mooring equipment to berth facilities and any backup provisions.

This information may be found in sources such as the Marine Terminal Particulars Questionnaire (MTPQ) and the TIB. More details of these are given in chapter 15 and OCIMF's *Marine Terminal Information Booklet: Guidelines and Recommendations*.

While the tanker's Master remains accountable for the safety of the tanker, the terminal operator is in the best position to give advice on the operating environment at its site and its own mooring system. It can advise the Master about operating limits that may affect mooring configurations. The terminal operator should provide this information early in the exchange of information to ensure both parties can agree on a mooring plan ahead of the tanker's arrival. Limits to be considered will include, at least, the following:

- Local operating equipment, e.g. availability, SWL and location of mooring hooks or bollards, fender and gangways and MLA range limits.
- Operational events that may cause a special action, e.g. ESD.
- Environmental conditions, e.g. weather, current, tide, sea and swell.

22.3.3 Use of tugs

The use of tugs in port remains a common occurrence despite increasing numbers of tankers with propulsion machinery that gives them self-sufficiency via controllable pitch propellers, propulsion drives or high-powered bow and stern thrusters.

Every port and terminal should consider its tug capabilities and requirements as part of the port risk assessment. These capabilities should be matched to the projected demands of the port, the maximum local environmental operating conditions of wind, waves and current and possible emergency scenarios. The number and specification of tugs required should be confirmed through mission and suitability studies. These studies should not only consider the routine tasks of assisting in berthing and unberthing, but also the following:

- Tug bollard pull to provide a restraining force when manoeuvring on or off a berth and through the approach channel in passive or active escort modes.
- Additional duties that may have to be performed, e.g. standby, firefighting, anti-pollution, pull back and escort towage.
- Whether duties will extend from the relative calm of harbour waters to open seas.

Details on the development of tug capabilities and uses can be found in PIANC MarCom WG 116 *Aspects Affecting the Berthing Operations of Tankers to Oil and Gas Terminals (2012)*.

Before tugs come alongside to assist a tanker, all cargo and ballast tank lids and ullage ports should be closed. This is required no matter what grade of oil is being or has been carried, unless all the cargo tanks have been tested and proven free of hydrocarbon vapour. Tugs and other craft should not be permitted to come alongside before the Master is satisfied that it is safe for them to do so.

Tugs should be adequately fendered to avoid causing damage to the tanker's hull. They should push the tanker at designated push points, which should be clearly marked on the tanker's hull.

When approaching a tanker, tugs should ensure all watertight openings have been secured and should switch off their radar systems without compromising safety of navigation.

Except in an emergency, tugs should not be allowed to come alongside or remain alongside a tanker while it is loading or discharging volatile petroleum or ballasting tanks containing hydrocarbon vapour. Intent by the Master or request from the shore for tugs to remain alongside during any such cargo or ballast activities should be treated as non-routine. It should only be undertaken with full agreement of all parties concerned, after a risk assessment has been carried out and under the following conditions:

- Communications should be maintained between tanker and tugboat or mooring launches on agreed channels during the entire period of assistance.
- The agreed tanker/tugboat communication system is working.

- The tugboat is fully functional and ready to operate under its own power in normal conditions, with full power available for immediate use.
- The tugboat's steering gear, rudder and auxiliary manoeuvring systems, e.g. thruster drives, are fully operational.
- All doors and hatches should be kept closed during the assistance period.
- Enough crew are on board to fulfil the requirements of the maritime/port authority to perform all designated tasks and to deal with an emergency.
- The emergency signal to be used by the tanker and tugboat has been well explained and understood.
- The parties have agreed on an ESD (towline release) procedure.

22.3.4 Emergency use of tugs

Severe weather may place excessive strain on moorings, which may increase the risk of mooring line failure and the movement of the tanker on or off the berth. In such circumstances, tugs can be useful in holding the tanker against the berth to reduce strain on the moorings.

It is critical, in these situations, that cargo operations are immediately suspended, hoses or MLAs are disconnected and engines placed on standby.

Tugs helping the tanker to maintain its position should only use the tanker's recognised push points. The tug operators should know the maximum load forces permitted at each push point to ensure no damage is caused to the tanker's hull, to the jetty fendering system or to the berth structure.

22.4 Berthing at jetty berths

Effective tanker mooring management requires knowledge of mooring principles, information about the tanker and terminal mooring equipment, proper maintenance of this equipment and regular tending of mooring lines. All personnel should use OCIMF's *Mooring Equipment Guidelines* and *Effective Mooring* publications for the fullest understanding of the technical, operational and safety considerations involved in berthing. See PIANC MarCom WG 116 *Aspects Affecting the Berthing Operations of Tankers to Oil and Gas Terminals (2012).*

The Master is accountable for the safety of the tanker and its proper mooring. However, the terminal has local knowledge of the operating environment and knows the capabilities of shore equipment, e.g. mooring hooks and fenders, and is responsible for making sure they are available. The terminal operator should advise the Master of the equipment status, mooring line layout and operating limits. See section 22.3.2 for more information.

22.4.1 Fendering

Fendering systems at each berth should be engineered to suit the range of tanker sizes and types that use the berth. They should be capable of withstanding expected loads without causing damage to the tanker or berth. The design should consider the methods of operating the berth, in particular as to whether tugs are used.

The fenders should be spaced on the parallel sides of the tanker to allow the tanker to lie alongside at ballast and loaded draughts and at all expected heights of the tide.

At a jetty, the spacing between outer breasting dolphins should be between 0.25 and 0.40 LOA of the largest ship expected to call. The spacing between the inner breasting dolphins should be approximately 0.25 to 0.40 LOA of the smallest ship expected to call.

For continuous quays, fender spacing should not exceed a maximum of 0.15 LOA of the smallest tanker. More information is available in BS 6349-4: *Maritime works – Code of practice for design of fendering and mooring systems*.

Many different types of fendering systems exist. Studies should be done to help choose the correct system for the various tanker types that will use the berths.

Fendering systems are important in preventing damage to tankers and berth. The system should, therefore, be included in the terminal's inspection and maintenance plans as described in OCIMF/SIGTTO's *Jetty Inspection and Maintenance Guide*. Fenders should be checked as part of berth operator rounds, at a minimum before each tanker berthing. The design should also take into consideration requirements for regular inspection and maintenance (e.g. access) and the anticipated life of the system. More information is available in PIANC MarCom WG 33 *Guidelines for the Design of Fender Systems (2002–2004)* section 5.1.

It is imperative that tankers are not berthed against damaged or inoperable fenders. This may lead to structural damage to the berth or to the tanker's hull. The design should take into consideration the need for repairs and maintenance, so that they may be undertaken in a way that minimises downtime for the berth.

The fendering system should be able to absorb a tanker's berthing energy. The most significant factor is the speed at which the tanker closes with the berth. This should be determined through analysis.

The terminal should tell the tanker's Master, local pilots and berth operating personnel of the maximum permissible closing speed and angle of approach for each berth. This is often difficult to estimate. If the berth has speed of approach equipment, it is strongly recommended that allowable approach speeds for each general size of tanker are included in the operating procedures. Berthing aids can be invaluable in helping the Master and Pilot land the tanker squarely on the fender surface and at a speed that does not damage the tanker or berth.

Unconventional fender systems should be assessed by a qualified marine terminal engineer before use and should be risk assessed, taking into account operational issues, for safe berthing.

More details on the design of fenders can be found in PIANC MarCom WG 33 *Guidelines for the Design of Fender Systems (2002–2004)*.

22.4.2 Type and quality of mooring lines

OCIMF's *Mooring Equipment Guidelines* sets out guidelines and recommendations for an optimum mooring system that can be safely deployed and operated from the tanker.

Mooring lines should, preferably, all be of the same material and construction. Ropes of different stiffnesses, i.e. mixed moorings, should never be used in a single mooring pattern, as low stiffness lines tend to carry almost no load and high stiffness lines tend to be heavily loaded.

The stiffness of lines is important to the type and effectiveness of the mooring system. Mooring lines with high stiffness (or low elastic elongation) are recommended for larger tankers or tankers operating within strict berth movement limits, e.g. where MLAs are connected. This is because they limit the tanker's movement at the berth. Lines with these stiffness properties include winch mounted steel wires or HMSF ropes.

Moorings made entirely of low stiffness lines, e.g. polyester, polypropylene (PP) or polyamide, can absorb higher dynamic loads. For this reason, they are better suited to berths where some movement is expected, such as where there may be swell, waves or passing tanker forces.

Mooring conditions and recommended layouts will differ from port to port. Terminal and port regulations may set their own requirements. It is strongly recommended that tankers and terminals exchange information about mooring equipment and requirements before the tankers' arrivals to make sure they comply with safe mooring expectations.

In some places, swells or the close passing of other ships can cause dynamic (shock) loading on moorings. In such situations, fibre tails on the ends of mooring wires and HMSF mooring ropes can provide enough elasticity to prevent failure. A mooring analysis should be carried out to determine whether tails are required in the system.

Tails are normally provided by the tanker and fitted to the mooring lines before arrival. They can be of various lengths, as specified by the line manufacturer. Shorter, 11m tails can be used on sheltered berths. Longer tails, e.g. 22m, can be used on exposed locations as they can control peak loads more effectively. Longer tails may also cause slightly more tanker movement and they should not be long enough to allow them to come into contact with the tanker's fairlead.

Fibre tails deteriorate faster than the wires or the HMSF ropes to which they are attached. They should, therefore, be at least 25% stronger than the line to which they are attached and receive the same service life tracking as mooring lines. They should be inspected frequently, particularly at the connection point, and replaced if they show signs of damage.

22.4.3 Management of moorings when alongside berth

22.4.3.1 Tending of moorings

Tanker personnel are responsible for the frequent monitoring and tending of the moorings. Qualified terminal personnel should also check the moorings periodically to make sure they are being properly tended. In many terminals, mooring line tension is monitored via remote load cell readouts in a fixed system in the jetty control room.

If moorings become too slack or too taut, the mooring system should be reviewed overall so that the tightening or slackening of individual lines does not allow the tanker to move or place undue loads on other lines. The tanker should maintain contact with the fenders. Moorings should not be slackened if the tanker is lying off the fenders.

If tension monitoring is fitted and can make periodic recordings, berth operators should make the readings or recordings available to ship staff so they can use them to support the Mooring System Management Plan (MSMP). Tension monitoring can also help the berth operator make informed decisions. For more information, see PIANC MarCom WG 153 *Recommendations for the Design and Assessment of Marine Oil and Petrochemical Terminals (2016)*. Tension monitoring is, typically, considered in these circumstances:

- For the mooring of larger tankers.
- For places where environmental conditions or passing ships may pose a risk.

During cold weather, precautions should be taken to make sure the winches are always in a state of readiness. The manufacturer's guidance for cold weather operation should be checked. Steam operated winches and windlasses may have to be rotated slowly when not in use to avoid damage due to freezing. Hydraulic winches may have to go through a warm-up sequence using a circulating line.

22.4.3.2 Tension winches

These winches are fitted with automatic rendering and hauling capability and should not be used in automatic mode when the cargo transfer system is connected.

In automatic mode, these winches may render under load, allowing the ship to move out of position. Equipment connected between ship and shore, e.g. cargo connections and gangways, may suffer damage or failure if the movement exceeds safe operating parameters. Movement of the ship on a berth may also cause damage to mooring lines and berth fenders and could compromise separation distance between ships on adjacent berths.

Before arriving at the terminal, ships fitted with automatic tensioning winches should ensure that agreement is reached as to their conditions of use on the berth. This should subsequently

be noted in the relevant parts of the SSSCL in the pre-arrival information exchange, checks after mooring and (where partial or full use is allowed) in the agreements section during the pre-transfer conference.

When an agreement between ship and shore is not obtained, the default is that they should always be secured with the winch drum held on the manual brake and with the winch drive disengaged, and remain so until such mutual agreement is achieved and documented.

Automatic mode may be considered appropriate for ships not engaged in cargo transfer operations, e.g. on layby or repair berths, and it may not be possible, at these locations, to obtain the agreement.

In all cases where the use of automatic tensioning winches is considered a viable option, a risk assessment should be undertaken to consider the particulars of the specific berth location and confirm its safe use. This should include ship and berth manning, equipment and facilities, any operating parameters or limitations and include consideration of environmental forces, e.g. wind, tide/current, etc. The outcome of the risk assessment should be documented, along with any associated safe operating conditions. The Responsible Officer should ensure that monitoring of the mooring system and ship's position is rigorously adhered to by the crew at all times.

22.4.3.3 Self-stowing mooring winches

Most tankers are now fitted with mooring winches that enable lines to be self-stowed, especially when either wire or HMSF lines are used. Self-stowing mooring winch drums fall into two categories: undivided (a single drum stores and holds the line) and split drum (it is split into a tension or working drum and a storage drum).

In undivided drums, the weight and size of the mooring lines may cause the outer layers to embed themselves into the lower layers, causing damage. For this reason, many mooring winches are of the split drum type.

Terminal and tanker personnel need to clearly understand certain features of these winches when reviewing mooring arrangements at the terminal. This is to avoid slipping winch brakes, which can cause tankers to break adrift from berths.

The holding power of the brake is specified by the winch manufacturer. It should be consistent with the ship design MBL. Every tanker officer should know the designed brake holding capacity of the tanker's self-stowing mooring winches. Details of the winch design, operation and maintenance should be entered in the tanker's onboard MSMP, as recommended in OCIMF's *Mooring Equipment Guidelines*.

The physical condition of the winch gearing and brake shoe linings or blocks affects the brake holding capacity while the winch is in service. Mooring winch brakes should be tested at regular intervals, at least every 12 months. Records should be kept on the tanker of both regular maintenance and inspections and of tests. More details on winch brake testing requirements and test kits are found in OCIMF's *Mooring Equipment Guidelines*.

Newer self-stowing mooring winches may be fitted with disc brakes. These are less affected by wear, but they are less common in tankers.

Tanker and terminal personnel should be aware that the holding capacity of winch brakes can be reduced if operations are not correctly carried out. Full technical descriptions of these factors can be found in OCIMF's *Mooring Equipment Guidelines*. These include the following:

- Number of layers on the drum.
- Direction of reeling on the drum.
- Condition of the brake linings and drum.
- Application of the brake.

Each of these is discussed in more detail below.

22.4.3.3.1 The number of layers on the drum

The designed holding capacity of the winch brake is usually calculated for the first layer. For each additional layer, the holding capacity is reduced. The reduction can be substantial, with the second layer reduced to 89% of rated holding capacity and further reduction in each additional layer, down to as little as 69% on the fifth layer.

If the rated brake holding capacity of a split drum winch is not to be reduced, only one layer should be permitted on the working drum.

22.4.3.3.2 The direction of reeling on the winch drum

On both single and split drum winches, the holding power of the brake decreases substantially if the mooring line is reeled in the wrong direction. Before arrival at the berth, it is important to confirm that the mooring line's pull direction matches the manufacturer's recommendation and guidance.

Typically, this will be against the fixed end of the brake strap rather than against the pinned end. Reeling in the wrong direction can seriously reduce the brake holding capacity, in some cases by as much as 50%. The correct reeling direction should be permanently marked on the drum. Reelings are to be drawn in accordance with OCIMF's *Mooring Equipment Guidelines*.

Winches fitted with disc brakes do not have this limitation.

22.4.3.3.3 The condition of the brake linings and drum

Oil, moisture or heavy rust on the brake linings or drum can seriously reduce the brake holding capacity. If a brake lining or drum is found to be affected by any of these things, the Responsible Officer should immediately be notified and action should be taken to return the brake to its normal operating condition.

Moisture may be removed by running the winch with the brake lightly applied. This should be done under supervision and care should be taken not to cause excessive wear. Oil cannot be removed, so oil contaminated brake linings should be replaced.

22.4.3.3.4 The application of the brake

Brakes should be tightened as much as is necessary to achieve the required holding capacity (this is usually 60% of the MBL).

The use of hydraulic brake applicators, or a torque wrench showing the degree of torque applied, is recommended. If brakes are applied manually they should be checked for tightness.

22.4.3.4 Shore moorings

At some terminals, shore moorings are added to supplement the tanker's moorings. Shore personnel who handle shore moorings should be fully aware of the hazards of the operation and should use safe working practices.

If the adjustable ends of the shore mooring are on board the tanker, the moorings should be tended by the tanker's personnel along with the tanker's moorings. If shore based wires with winches are used, shore and tanker personnel should reach an agreement as to who has the responsibility for tending them.

Shore based pulley systems are not commonly used at terminals. However, if one is provided, the tanker should tend the mooring, since both ends of the line are on board.

Before shore based moorings are used on a tanker, the mooring fitting or winch strength capability should be thoroughly reviewed to make sure it does not overload the tanker's equipment. The tanker's management team should do a risk assessment to make sure the risks

and hazards of the non-standard equipment are understood by all of the tanker's crew who will be used in the operation.

The Responsible Officer and the Terminal Representative should clearly agree who will take responsibility for tending moorings provided by the terminal.

22.4.3.5 Anchors

Unless otherwise agreed by the terminal, while the tanker is moored at the terminal, anchors not in use should be secured by brake and stopper bars, but should still be available for immediate use. Chains used to secure anchors during sea passages should be removed at every marine terminal, including conventional berths, SPMs and MBMs.

22.5 Berthing at buoy moorings

When berthing at a buoy mooring, tanker personnel should take all the normal precautions for berthing alongside a jetty. Characteristics of the buoy mooring facility should be carefully identified through site-specific studies. Terminal operators at buoy moorings should also review the output from these studies and use risk assessment tools to develop their safety and operations management systems. This should consider, at least, the following factors:

- Mooring and unmooring requirements, including the need to exchange information on berthing and unberthing requirements before a tanker arrives.
- The ability to put a berth in deeper water. This may help serve tankers with larger draughts, but it creates issues with safe access for terminal operations and ancillary support staff.
- The number of tugs necessary to moor and unmoor tankers. Fewer tugs may be needed, but they may also have to operate in exposed open sea conditions with larger swell.
- Weather conditions. Deteriorating conditions may create an increasing sea and swell, which means operations may have to stop earlier and more often. Disconnection from the facility may also have to be done earlier and more often, to allow enough time for unmooring and hose handling. In addition, the operational window for berthing and mooring is usually smaller for offshore facilities.
- Maintenance of terminal equipment. Buoy berth maintenance will almost always require support from specialist contractors, such as divers and support craft for subsea operations.

For detailed guidance on facilities with buoy moorings, see the following OCIMF publications:

- *Guidelines for the Design, Operation and Maintenance of Multi Buoy Moorings.*
- *Single Point Mooring Maintenance and Operations Guide.*
- *Guidelines for Offshore Tanker Operations.*

22.5.1 Mooring Masters

At terminals with buoy moorings for ocean-going tankers, it is recommended that professional advice is obtained on safety issues related to local marine operations. A Mooring Master may be assigned to the terminal, or the terminal may consult with a port or pilotage authority. To further lower risks, Mooring Masters may be required to remain on board tankers throughout their stays, from pre-berthing to unberthing.

Mooring Masters should have the expertise for the full range of duties they will perform, including piloting to and from the berth, manoeuvring and working with tugs and mooring boats during mooring and unmooring and taking part in cargo operations at the buoy berth.

A wide range of skills is required in this critical role. OCIMF's *Competence Assurance Guidelines for Mooring, Loading and Lightering Masters* should be used to provide oversight and guidance for this role, including the following:

- Recommendations for developing and implementing a system to make sure that Mooring Masters are competent.
- Guidance on the competencies required of Mooring Masters.
- Guidance on the knowledge required of Mooring Masters.
- Recommendations on how to assess competence.
- Recommendations on continued verification of competence.
- Advice on record-keeping and documentation for a competence development programme.

22.5.2 Mooring at Multi Buoy Moorings

The two main configurations of MBM are CBM and ABM.

A CBM is an offshore marine berth in which the tanker's bow is held in position by its own anchors and the stern is secured by an array of mooring buoys, typically three to seven of them.

An ABM is an offshore marine berth in which both the tanker's bow and stern are held in position by mooring buoys.

Mooring and unmooring at MBMs is not often carried out by tanker personnel. Given the risks, it is imperative that mooring and unmooring operations are done under a detailed plan developed together with the terminal representatives, e.g. the terminal's Mooring Master. The plan should be communicated to tanker personnel before arrival at the berth.

The tanker's anchors are normally required during the approach. They often are needed in addition to mooring lines as an extra restraint at the berth. For this reason, the plan should consider the extra demands on personnel required for mooring and unmooring stations and the need for supervision, particularly where multiple operations may take place simultaneously.

Mooring personnel should maintain good communication throughout the operation. It is critical that the team handling mooring lines from the poop deck are vigilant to the dangers of mooring lines and mooring boats operating in the water around the tanker's propeller. They should keep these from being caught in the propeller or propeller wash in the event of a sudden engine manoeuvre. Severe loads can develop in mooring lines during mooring. It is essential to use good quality moorings of adequate length and to closely supervise personnel to make sure they remain safe.

At some MBM berths, the tanker's moorings are supplemented by mooring lines provided by the facility, which are run from the buoys or by ground moorings. At some berths these may be wires, which are often heavy. Only experienced personnel should handle them around the warping drum of a winch.

22.5.3 Mooring at Single Point Moorings

Mooring at SPMs presents extra hazards and is not routinely carried out by most tanker personnel. These risks should be managed through planning and the use of tanker and shore personnel. All personnel involved should be trained and competent in operations at this type of terminal.

Mooring and unmooring operations should be done according to a detailed plan developed together with the terminal representatives, e.g. the terminal's Mooring Master. The plan should be communicated to tanker personnel before arrival at the berth.

Mooring personnel should maintain good communication throughout the operation. If any forward mooring winches critical to the operation fail, an abort manoeuvre should immediately be taken until the nature of the winch failure is understood and the equipment is back in working condition.

Complicated and non-standard mooring arrangements at SPMs can lead to dangerous and extended operations. Therefore, both on tankers and on SPMs, the use of standard equipment, fit for purpose and accurately positioned, considerably reduces the risk of injury. The proper fitting of such equipment also provides a more efficient method of securing tankers to SPMs at offshore terminals.

The detailed technical and operational guidance in the relevant operational publications (see section 22.5) is recommended. It should be followed by all SPM terminals and the tankers using them to make sure that tanker and terminal mooring equipment is compatible.

Section 22.1.1 highlights the dangers of snap-back following line failure. These risks are also present in the forward section of the main deck during mooring on SPMs. The loads on pick-up ropes during mooring, and on mooring hawsers when moored, can be significant. For this reason, the mooring deck area should be considered an area of high risk and measures to mitigate these risks should be in place to protect the tanker's crew.

In particular, a storage drum should be used to heave in the SPM pick-up rope before connection of the chafing chain to the stopper. The warping end should never be used for this purpose.

22.5.4 Management of moorings at buoy berths

A large variety and type of buoy mooring facilities and operating environments exists. Conventional tankers and their crews are often unfamiliar with the requirements of a specific buoy berth. The terminal should carry out a risk assessment that covers operations, types of tankers, equipment and resources available, e.g. tugs and other support craft, location of support facilities, likely metocean conditions and potential emergency scenarios. These should be used to develop standard operations procedures.

22.5.4.1 Pre-berthing planning

In pre-planning for berthing at a buoy mooring, the Terminal Representative and tanker Master should have a detailed exchange of information that sets out the technical and operational requirements. It should include the exchange of any required pre-arrival checklists and communications. See information on the pre-berthing/pre-arrival information exchange in chapter 21.

This information should be used to create a pre-berthing plan that considers at least the following factors, to ensure the safety and compatibility of the tanker and facility:

- During the tanker's stay at the buoy mooring, terminal regulations should be closely observed:
  - This includes the maintenance of the tanker's propulsion equipment so that it can leave the berth immediately if required.
  - Engine maintenance should not be done while the tanker is at berth if it will affect the tanker's propulsion system and leave it unready to depart.
- Conventional tanker propulsion systems are not normally used to maintain position once the tanker is securely moored to a buoy system. Except in extraordinary circumstances, tankers have limited capability to run the propulsion astern at low revolutions for long periods of time.
- Where a safe position needs to be maintained, e.g. in relation to the SPM, it is often done with the help of a pull-back tug attached by a towline to the stern of the tanker. If in abnormal conditions a pull-back tug is not able to tow as required, the tanker's main engines may be considered for use.
- All tankers at buoy berths should be ready for manoeuvring and navigation:
  - This may be needed if the tanker's Master, with the advice of a Mooring Master or Pilot, decides that tanker propulsion should be used carefully to help maintain or restore position or to ensure that mooring hawsers and other equipment does not receive excessive dynamic loads.
- A detailed emergency unmooring and contingency plan should be established:
  - It should have clear, safe operating limits that allow enough time for an orderly and safe stop to cargo operations, for disconnection of hoses and for unmooring before conditions become too severe for safe operations by the deck crew or terminal personnel, e.g. mooring boats.

22.5.4.2 Manning at buoy berths

Manning requirements vary according to the tanker capability, facility type and location. Demands on tanker personnel include bridge watches, the continuous monitoring of the mooring from the forecastle and cargo transfer operations. These require a careful management of resources. Human factors should be addressed in the overall operations plan to provide the numbers of personnel required and to make sure enough trained, competent and rested personnel are always available.

The relevant operational publications (see section 22.5) offer further guidance, but as a minimum there should be:

- One Mooring Master on watch at all times to monitor the position of the tanker in relation to the buoy system, mooring loads and weather.
- A bow watchkeeper to report on any issues arising from the tanker position in relation to the buoy system and any abnormal conditions, including mooring hawsers that are excessively tensioned or slack.
- A manifold watch to monitor cargo hoses and report any cargo leaks.
- A qualified and experienced deck officer to oversee cargo operations.

The bow and manifold watchkeeper positions can be combined where facilities, e.g. telemetry, and the use of a Mooring Master makes two persons unnecessary.

Further consideration should be given to the manning of the bridge if additional risk factors are identified. These may include the following:

- Local metocean conditions that could affect the loads placed on the bow mooring equipment or the ability of the tanker to safely maintain position in relation to the buoy system.
- Risks arising from close traffic or navigational hazards, e.g. the distance from the grounding line.
- Potential security threats identified from the use of the *International Ship and Port Facility Security (ISPS) Code* or security risk assessment (see chapter 6).

All terminal marine personnel involved in mooring at buoy berths should take part in the terminal's competency programme. As detailed in section 22.5.1, Mooring Masters should have a programme that follows OCIMF's *Competence Assurance Guidelines for Mooring, Loading and Lightering Masters*.