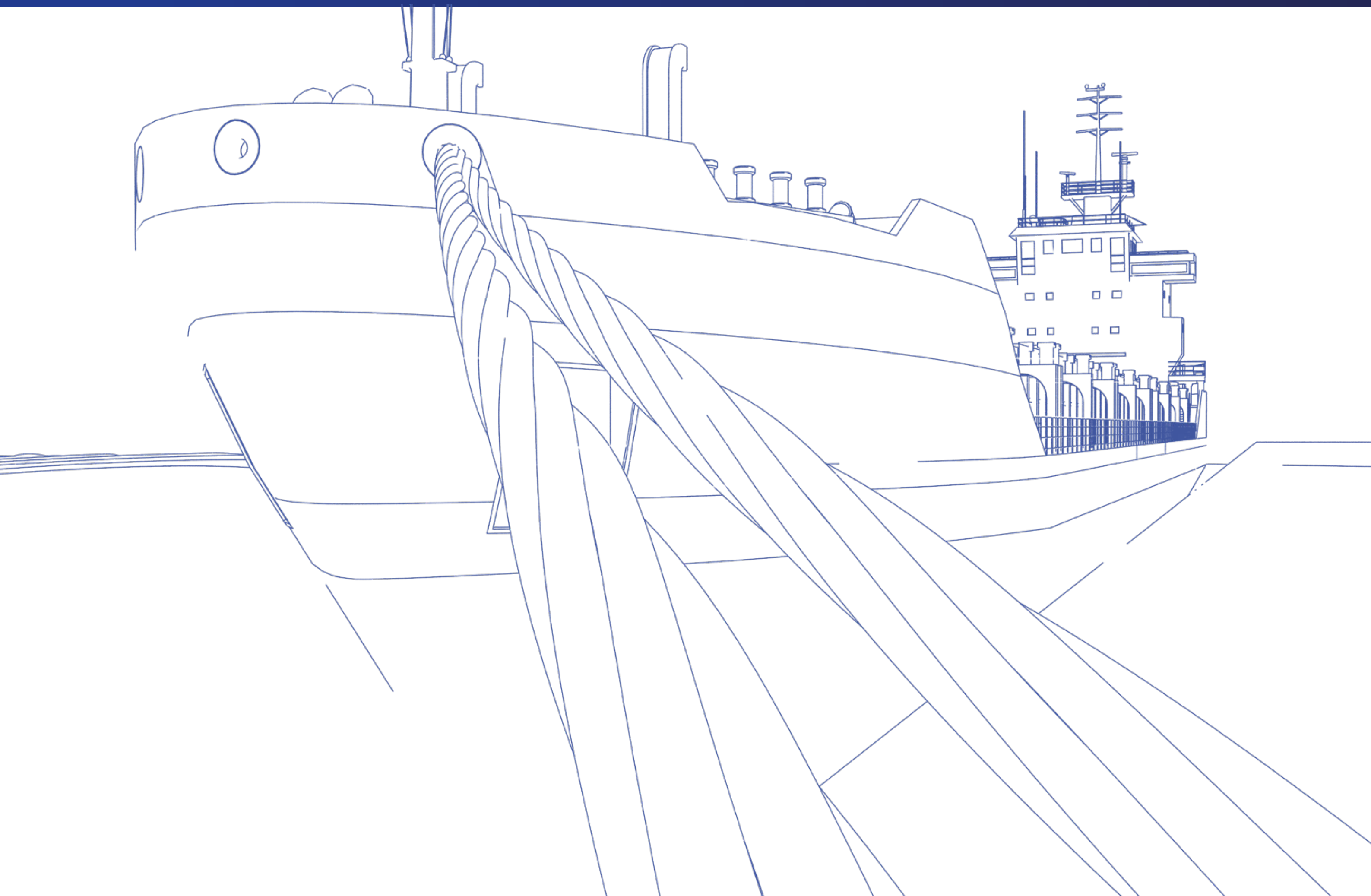
Standard Club

By your side

A Master's Guide to:

Berthing



About this Guide

This is the third edition of Standard Club's guide to Berthing, first produced in 2004. This new version includes further content on berthing aids, snap-back zones and bow thrusters. The guide also provides guidance on electronic berthing aids and detailed tug assistance.

This guide sets out to promote best practice and raise awareness of the risks of berthing.

Ship handling is an art rather than a science. However, a ship handler who knows more of the science will be better at his art. Knowledge of the science will enable easy identification of a ship's manoeuvring characteristics and quick evaluation of the skills needed for control. A ship handler needs to be able to understand what is happening to their ship and anticipate potential issues to prepare for the situation. This knowledge is essential in a port environment when a ship encounters close quarters situations, narrow channels and the effects of cross-winds and currents.

The culmination of any voyage is the controlled mating of the ship with a solid, stationary berth. Berthing requires precise and gentle control if the former is not to demolish the latter. Such fine and precise control is demonstrated everyday by ship handlers in ports all over the world. Most ships dock safely, most of the time – a testament to pilots' skill and ability – but the outcome of a manoeuvre is not always successful.

Ships can, and do, run aground, demolish jetties, hit the berth and collide with other ships at an alarming frequency, giving rise to loss of life, environmental pollution and property damage.

The purpose of this guide is to provide some insight into what can go wrong and why, why ships are designed the way they are, why ships handle the way they do and how to berth them. In the final chapter, there is advice on pilotage. On its own, the guide will not teach you how to become a ship handler, but it does provide background material to help a good ship handler become a better one.

Throughout the berthing examples, it has been assumed that the ship has a single right-handed propeller and that bulk carriers and tankers have their accommodation aft.

The guide is unable to cover all the different ship types. Masters must become acquainted with their own ship configurations.

Captain Yves Vandenborn, Director of Loss Prevention

Contents

01. Golden rules of berthing

There are certain actions that a Master should always take before and during berthing. These are listed below:

Passage planning

- Always passage plan from berth to berth. Pay careful attention to the dangers that are likely to be encountered during the pilotage.
- Always fully brief the pilot, making sure that he understands the ship's speed and manoeuvring characteristics.
- Always ask the pilot to discuss the passage and berthing plan. Ask questions if anything is unclear.

Working with tugs

- Consider the use of tug assistance, where wind and current or the ship's handling characteristics create difficult berthing conditions.
- Always estimate windage and use this estimate to determine the number of tugs required.
- When berthing with a bow thruster, a large ship may need a tug to control the ship's stern.

Manoeuvring

- Avoid high forward speed when:
  - working with tugs
  - using a bow thruster
  - under-keel clearance is small
  - sailing in a narrow channel or when close to other ships.
- Test astern movement and wait until the ship moves positively astern before stopping.
- Remember that a 'kick ahead' can be used to initiate and maintain a turn when speed is low.
- Remember that the ship's pivot point is forward of amidships when steaming ahead.
- Remember that a ship will want to settle with the pivot point to the windward of, and in alignment with, the point of influence of wind.

Figure 1: Stern lines

- Remember that the point of influence of wind changes with wind direction and the ship's heading.
- Remember that at low speed, current and wind have a greater effect on manoeuvrability and that high-sided ships will experience a pronounced effect from leeway.

Finally

- Never ring 'finished with engines' until every mooring line has been made fast.
- Always anticipate well ahead and expect the unexpected to occur.

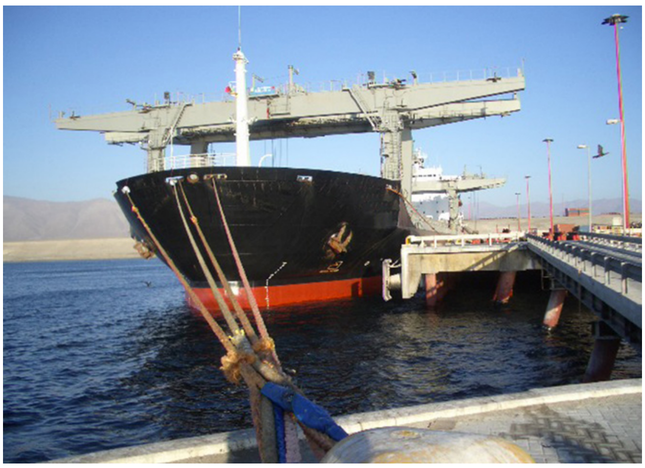


Figure 2: Head lines

02. Ship factors that affect manoeuvring

Handling characteristics will vary from ship type to ship type and from ship to ship. Handling qualities are determined by ship design, which in turn depends on the ship's intended function. Typically, design ratios, such as a ship's length to its beam, determine its willingness to turn. However, desirable handling qualities are achieved only when there is a balance between directional stability and directional instability.

Underwater hull geometry

Length to beam (L/B), beam to draught (B/T), block co-efficient, prismatic co-efficient (ratios of the ship's volume of displacement against the volume of a rectangular block or a prism) and location of longitudinal centre of buoyancy all give an indication of how a ship will handle.

High values of L/B are associated with good course directional stability. Container ships are likely to have an L/B ratio of approximately 8, while harbour tugs, which need to be able to turn quickly and where course stability is not required, have a value of 2.5 to 3.

High values of B/T increase leeway and the tendency for a ship in a beam wind to 'skate across the sea surface'. A B/T ratio of over 4 is large. Most merchant ships have a B/T ratio in the range of 2.75 to 3.75. A 22-metre fast motor yacht will have a B/T ratio of about 5.75.

Ships with large block and prismatic co-efficients have poor course stability and a readiness to turn. When turning, they will do so easily. Large tankers have these characteristics. Ships with a large protruding bulbous bow are likely to have their longitudinal centre of buoyancy far forward. As a result, the ship will show a tendency to turn.

The pivot point

A ship rotates about a point situated along its length, called the 'pivot point'. When a force is applied to a ship that has the result of causing the ship to turn (eg the rudder), the ship will turn around a vertical axis that is conveniently referred to as the pivot point. The position of the pivot point depends on a number of influences. With headway, the pivot point lies between 1/4 and 1/3 of the ship's length from the bow, and with sternway, it lies a corresponding distance from the stern. In the case of a ship without headway through the water but that is turning, its position will depend on the magnitude and position of the applied force(s), whether resulting from the rudder, thrusters, tug, wind or other influence. The pivot point traces the path that the ship follows.

Lateral motion

Ships move laterally when turning because the pivot point is not located at the ship's centre. When moving forward and turning to starboard, the ship's lateral movement is to port. When moving astern and turning to starboard, lateral movement is to starboard. It is important to understand where the pivot point lies and how lateral movement can cause sideways drift, knowledge which is essential when manoeuvring close to hazards.

Propeller and rudder

The rudder acts as a hydrofoil. By itself, it is a passive instrument and relies on water passing over it to give it 'lift'. Rudders are placed at the stern of a ship for this reason and to take advantage of the forward pivot point, which enhances the effect. Water flow is provided by the ship passing through the water and by the propeller forcing water over the rudder in the process of driving the ship. The optimum steerage force is provided by water flow generated by a turning propeller. Water flow is vital in maintaining control of the ship. While water flow provided by the ship's motion alone can be effective, the effect will diminish as speed is reduced. Obstacles that deflect flow, such as a stopped propeller in front of the rudder, particularly when the propeller is large, can reduce rudder effectiveness. Reduced or disturbed flow will result in a poor response to rudder movements.

Conventional rudders are described as 'balanced', as part of the rudder area is forward of the pintles to help the rudder turn and to ease the load on the steering motor. This arrangement provides for better hydrodynamic loading. A flap (Becker rudder) can be fitted to the rudder's trailing edge. The flap works to increase the effective camber of the rudder and to increase lift.

Rudders can be defined by what is known as the 'rudder area ratio', which is a ratio of the surface area of the rudder divided by the ship's length and draught. The rudder area ratio gives an indication of the likely effectiveness of a rudder. Merchant ship ratios range from 0.016 to 0.035. The larger the ratio, the greater the effect the rudder will have.

Rudder response

The time it takes for the rudder to respond to a helm order will determine how rapidly a ship gets into a turn. The quicker the rudder responds, the sooner the ship will begin to turn.

Single rudders and twin screw ships

Manoeuvring characteristics at low speeds will generally be poor on twin screw ships fitted with a single centre line rudder. This is because the single centre line rudder may have to be moved to large angles before any part of it becomes immersed in the slipstream of one of the propellers. When not immersed, the lift produced by the rudder at low speeds will be very small, resulting in large turning circles and poor response to helm.

Transverse thrust

Transverse thrust is the tendency for a forward or astern running propeller to move the stern to starboard or port. Transverse thrust is caused by interaction between the hull, propeller and rudder. The effect of transverse thrust is a slight tendency for the bow to swing to port on a ship with a right-handed propeller turning ahead.

Transverse thrust is more pronounced when propellers are moving astern. When moving astern, transverse thrust is caused by water passing through the astern-moving propeller and creating high pressure on the starboard quarter of the hull, which produces a force that pushes the ship's stern to port. Rudder angle can influence the magnitude of this force.

Masters should be aware of the variable effect of transverse thrust. As water flow over a ship's hull changes, so does transverse thrust. The difference is most noticeable in shallow water. For example, a ship that turns to starboard in deep water may well turn to port in shallow water. Also, the magnitude of the force will change and, by implication, there will be a range of water depths for which the bias may be difficult to predict, something that is especially true when a ship is stopping in water of reducing depth.

Transverse thrust is often used to help bring the ship's stern alongside during berthing. When a propeller is put astern on a ship moving forward at speed, the initial effect of transverse thrust is slight. However, as the ship's forward motion decreases, the effect of transverse thrust increases.

It is essential for a master to understand just how much effect transverse thrust has on his particular ship.

Approach speed

Many berthing accidents occur because the speed of approach is too high. The master should advise the pilot of the ship's stopping distance and general manoeuvring characteristics, giving particular emphasis to speed, corresponding engine revolutions and to the critical range. When close to a dock, speed should be the minimum necessary to maintain control.

Control while slowing

It can be difficult to reduce speed and maintain control. This is because reduction in propeller speed reduces water flow over the rudder and the rudder becomes less effective. The normal procedure for stopping is to put engines astern. However, when a propeller rotates astern, water flow over the rudder is broken and the ship will be less responsive to helm. In addition, there is the disruptive effect of transverse thrust.

For this reason, it is essential to plan a stop by reducing speed in good time. Also, it should be appreciated that putting engines to full astern during an emergency could result in a loss of steerage.

Kick ahead

The 'kick ahead' is used when a ship is moving forward at very slow speed due to minimal water flow over the rudder and the ship is not responding to helm. It is also used to initiate a turn. Engines are put ahead for a short burst with the objective of increasing water flow over the rudder, but without increasing the ship's speed. Engine power is reduced before the ship's longitudinal inertia is overcome and she begins to accelerate. When using the kick ahead, it should be borne in mind that prolonged and frequent kicks ahead will increase the ship's speed. Apply full rudder to provide maximum steering force. Anything less than hard over during turning will allow a greater proportion of the power to drive the ship ahead. It is important to reduce engine power before reducing helm.

Figure 3: Stern configuration

03. Berthing in wind

Wind and its effect

Wind has a significant effect on a ship. It causes heading changes and leeway. Failure to compensate correctly for wind during berthing is a significant cause of berthing accidents. The difficulty in allowing for wind arises from the variable effect that wind can have on a ship because of changes in a ship's heading and speed.

Wind has special significance in the handling of high-sided vessels such as car carriers. The effect will vary with the relative wind direction and the speed of the ship. Although wind force and direction can be estimated from information obtained from a variety of sources, such as weather forecasts, VTS information, the ship's own wind instrumentation and personal observation, local conditions can change rapidly and with little warning. Control of a ship can be easily lost during the passage of a squall. There is an obvious need to understand how wind will affect your ship and how this effect can be difficult to predict. For example, it might appear logical that the effect of wind on a tanker stopped in the water would cause the bow to swing towards the wind. However, experience shows that a tanker stopped in the water will usually lie with the wind forward of the beam rather than fine on the bow. It is especially difficult to predict the effect of wind on a partially loaded container ship.

The centre of lateral resistance

The force of the wind causes the ship to drift and, by doing so, hydrodynamic forces act on the underwater hull to resist the effect of the wind. The point of influence of these underwater forces is known as the centre of lateral resistance (CLR) and is the point on the underwater hull at which the whole hydrodynamic force can be considered to act. Similarly, there is a point of influence of wind (W), which has an important relationship with the CLR. W is likely to alter frequently as it will change in relation to the wind direction and the ship's heading. To anticipate the effect wind will have on a ship's heading, W must be viewed in relation to CLR.

Ship handlers prefer to refer to pivot point (P) rather than CLR when discussing the effects of wind on a ship with headway or sternway. However, a stopped ship does not have a pivot point and, for this reason, CLR should always be used. In the discussion that follows, CLR is used for a stopped ship and P is used for a ship with motion.

The point of influence of wind

The point of influence of wind (W) is that point on the ship's above-water structure upon which the whole force of the wind can be considered to act.

Unlike a ship's centre of gravity, the point of influence of wind moves depending on the profile of the ship presented to the wind. When a ship's beam is facing to the wind, W will be fairly close to the mid-length point, ie slightly aft in the case of ships with aft accommodation and slightly forward if the accommodation is forward. A ship will always want to settle into a position where the pivot point and point of influence of wind are in alignment.

Ship stopped – ship with accommodation block aft

On a stopped ship with the wind on her beam, W will be close to the ship's mid-length. When stopped in the water, the CLR will also be at its mid-length. The difference in location between the two points will produce a small couple and the ship will turn with its head towards the wind. As the ship turns, W will move until it is close to the CLR, where the couple is reduced to zero. The ship will settle on this heading, usually with the wind slightly forward of the beam.

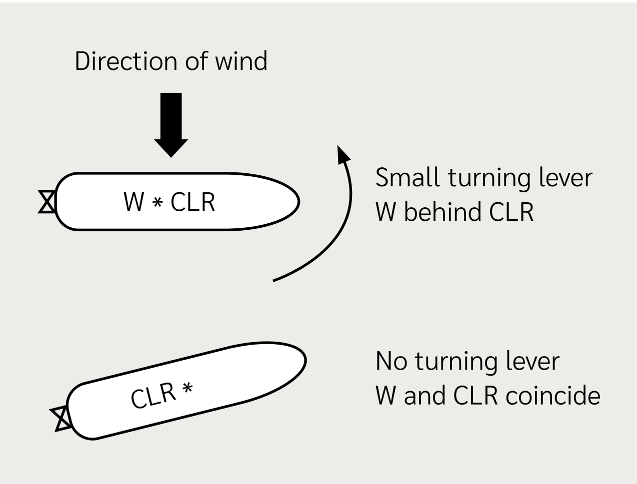


Figure 4: Ship stopped – accommodation block aft

Ship with headway – ship with accommodation block aft

If a ship has headway, P will be forward and the lever between W and P will be large. The resultant force will cause the ship's head to turn to the wind.

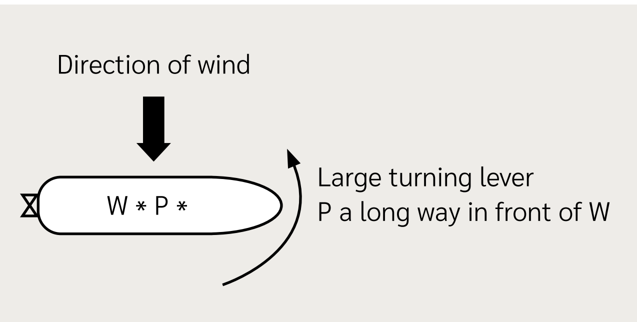


Figure 5: Ship with headway – ship with accommodation block aft

Ship with sternway – ship with accommodation block aft

If a ship has sternway, P will be aft of W and the ship's stern will seek the wind. However, and for the majority of ships, the complexity of the aft-end accommodation structure can cause W to move further aft as the ship turns. Eventually, the ship may settle with the wind broad on the quarter rather than the stern.

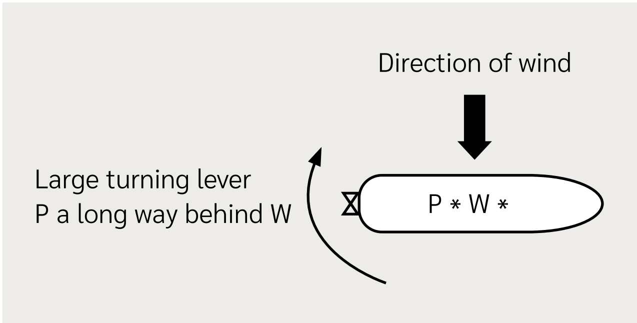


Figure 6: Ship with sternway – ship with accommodation block aft

Force of the wind

Wind force can be estimated by the formula:

F = (V2/18,000) x windage area

Where F is the wind force in tonnes per square metre, V is the wind speed in m/s (metres/second) and windage area is the area of ship exposed to the wind in square metres. Estimate windage area for a beam wind can be calculated by multiplying length by freeboard and adding the profile area of the accommodation housing. For a head wind, multiply beam by freeboard and add the area of the bridge front.

This calculation will give an estimate of the total force of wind on a ship's side. For an indication of the total power that tugs need to overcome this force, double the figure obtained for F and order one or more tugs with the nearest bollard pull.

It should be remembered that a ship will always want to settle on a heading where the ship's pivot point is in alignment with the position of the wind's point of influence. When navigating on such a course, a ship will show good course-keeping properties. As a result, it is preferable to berth with head to wind with headway and to berth with stern to wind with sternway. In addition, knowledge of the location of W, compared with P, makes it possible to predict whether the ship's head or stern will 'go to wind' as the ship is stopped. The ship will want to settle with P in alignment with and to windward of W.

High-sided ships may suffer more from leeway than from heading change.

Berthing in wind

A ship is most vulnerable when presenting its broadside, the area of greatest windage, to the wind. In strong winds, it may be difficult to counteract the effect without tug assistance or the use of a thruster.

If close to a berth, it is essential that mooring lines are set as quickly as possible. Ideally, plan the manoeuvring so as to present the minimum profile to the wind, ie head to wind, or at least reduce to a minimum the time the wind is at a broad angle to the ship.

Figure 7: Coming alongside

Points to remember:

- Ensure that conditions are safe and suitable for the envisaged manoeuvre. It will be cheaper to delay the ship until the wind moderates than to deal with the aftermath of an accident.
- Wind force acting on a ship increases with the square of the wind speed. Doubling the wind speed gives four times the force. Gusts of wind are dangerous.
- If berthing in high winds, take evasive/corrective action early. Attach tugs early and before they are needed.
- Tugs should be of sufficient strength not only to counteract the effects of wind but to get the ship to the required destination.
- The berthing plan should be devised to minimise the adverse effect of wind and to maximise its assistance.
- A ship is more vulnerable to wind at slow speed. As speed reduces, hydrodynamic forces reduce, and the effect of wind on heading and leeway increases.
- Take corrective action as soon as it becomes obvious that it is needed. The earlier that action is taken, the less that needs to be done. The longer things are left, the more drastic the action needed to correct the situation.
- Kicks ahead are effective in controlling a ship in windy conditions.
- Consider any special circumstances where wind may affect ship handling. Trim, freeboard and deck cargo can vary the position of W and the force of the wind on the ship and change the ship's natural tendency in wind. For example, significant trim by the stern can cause W to move ahead of P. In these circumstances, the bow will have increased windage. Consequently, if the ship is heading into wind, the bow may show a tendency to blow downwind, even if the ship has headway.
- Enclosed bridges can lead to a false impression of wind strength, as opposed to open bridge wings where the wind strength will be obvious.
- The windage area, and hence the force of the wind on the ship, will vary with the heading relative to the wind. The maximum force on the ship is when the ship is broadside to the wind.
- Good control is easy to achieve when the ship's head is to wind and the ship has headway. Control is difficult when wind is following and strong turning forces are created. High freeboard ships are more difficult to berth. When berthing high freeboard ships such as car carriers, it is essential to pay extra attention in windy conditions.
- Apply large passing distances when it is windy. Always pass any obstructions well upwind. Gusts and squalls can arrive very rapidly and with little warning. When wind has caused a ship to move rapidly to leeward, it can be difficult to overcome the motion and return to a position of safety.
- Allow plenty of distance from the berth when wind is onshore. If berthing in an onshore wind, it is best practice to stop half a ship's length from the berth and then come alongside in a controlled manner. An uncontrolled landing on a downwind berth can result in damage to both the ship and the berth.

04. Effect of current

Current and its effect

A feature of any river berth is the current. It is common for a river berth to lie in the same direction as the prevailing current so that the current can assist with berthing. In this case, a berth can be approached bow into the current in order to give the advantage of relatively high speed through the water with a reduced speed over the ground. Consequently, steerage at low ground speed is improved by the good water flow over the rudder. The ship will be easier to stop.

Another advantage of berthing into a current is that it can be used to push a ship alongside. Position the ship off the intended berth but at a slight angle towards it. Then allow the current to produce a sideways movement of the ship towards the berth.

Masters should note that currents are usually complex, with varying rates and directions that can change hourly. For safe navigation, local knowledge is essential. A ship making headway into a current, but stopped over the ground, will have a forward pivot point.

Berthing in a current

Berthing with a following current is difficult, since the ship must develop sternway through the water in order to be stopped over the ground. In these circumstances, control of a single screw ship will not be easy. Use a tug to hold the stern against the current.

Care is needed when berthing into a current, because too large an angle between the berth and the direction of the current will cause the ship to move rapidly sideways. Unless corrected, contact with the berth may be unavoidable. If a controlled approach is not possible, the assistance of tugs should be considered.

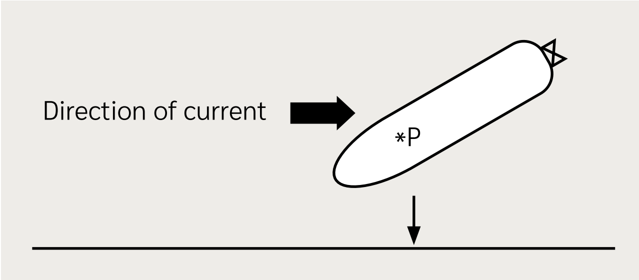


Figure 8: Berthing – starboard side current

If during berthing the bow's angle to the berth is over-corrected, then the ship could move away from the berth as the wedge of water between ship and berth becomes established. This may cause the ship's stern to strike the berth. A controlled and slow speed approach to the berth allows time to assess if the angle of approach is correct. Consideration should also be given to the effect of currents on solid quays/berths or open quays. Masters should be prepared to abort an approach if the ship is incorrectly aligned.

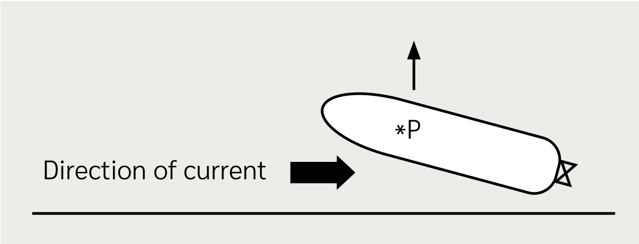


Figure 9: Berthing – port side current

Once alongside, care must be taken to prevent the ship from dropping astern before back springs and head lines are set.

Points to remember:

- In many places, a counter current flows in opposition to the main current close to the bank. Only local knowledge will provide this information.
- Current can vary with depth of water and large, deep-draught ships can experience different current effects at differing parts of the hull. Therefore, caution is needed.
- When close to the berth in a head current, there is a danger that flow inshore of the ship will become restricted and the ship will be subject to interactive forces. These forces can cause the ship to either be sucked towards or pushed away from the berth. Local knowledge will help anticipate this phenomenon.

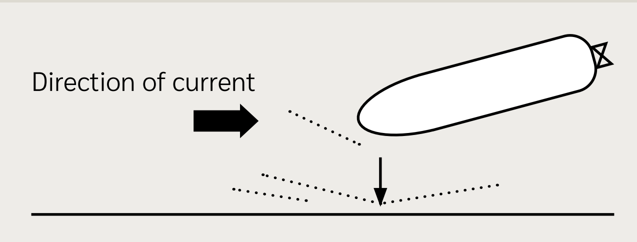


Figure 10: Berthing in challenging current

- As speed is reduced, take care that the increased proportion of the ship's vector that is attributable to current does not set the ship close to obstructions.

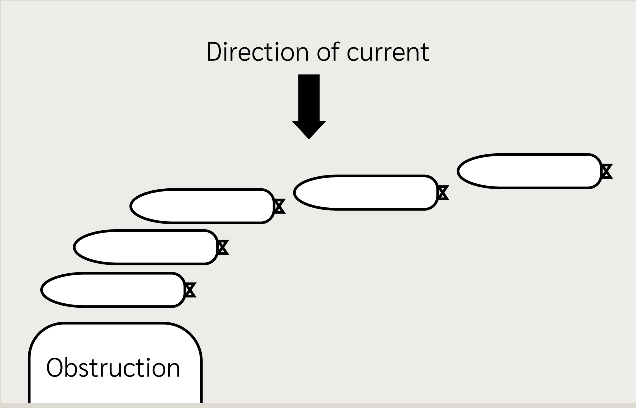


Figure 11: Reducing speed impact on current variant and positioning

- Always make a generous allowance for current. Its effect on the ship increases as the ship's speed reduces. A mistake made during berthing is often impossible to correct. Remember that current predictions are just predictions and meteorological conditions may result in a greater or lesser rate than forecast. Local VTS information will normally advise of any significant anomalies.

05. Hydrodynamic effects

Water depth

Water depth has a profound effect on manoeuvring. In a harbour, water depth may vary from deep to shallow conditions in which there is danger of touching bottom. The behaviour of the ship changes with differences in water depth. A ship's resistance increases as water depth reduces. The increase becomes significant when the water depth is less than twice the mean draught. The effect of this increased resistance is a reduction in speed, unless engine revolutions are increased.

As well as speed, water depth affects manoeuvring, and as depth and under-keel clearance reduce, turning ability deteriorates, virtual mass increases (increase in a ship's mass resulting from water being dragged along with the ship) and the effect of the propeller transverse thrust on yaw alters. As a result, a ship can become difficult, if not impossible, to control during a stopping manoeuvre, as the rudder loses the beneficial effects of the propeller slipstream and the bias off-course may become more pronounced.

The increase in virtual mass is most noticeable when a ship is breasting onto a quay or jetty. Virtual mass in sway motion is invariably large, increasing as under-keel clearance reduces. Consequently, any impact with a quay wall, jetty or fender will be much more severe if under-keel clearance is small. Similarly, when a large ship moored in shallow water is allowed to move, the momentum can be considerable.

Fortunately, the situation is alleviated by the considerably increased damping of any movement that is a consequence of shallow water and small under-keel clearance.

Water depth limits a ship's speed. There is a maximum speed that a conventional displacement ship can achieve in shallow water, which can be less than the normal service speed. This is called the 'limiting speed'. Limiting speed needs to be considered during passage planning. Knowledge of areas where ship's speed is limited by water depth is important, because any increase in engine power to overcome the limiting speed will greatly increase wash. In simple terms, the limiting speed can be calculated using the formula:

$$V_{lim} = 4.5 \sqrt{h}$$

where h is the water depth in metres and Vlim is speed in knots.

In shallow water, and because of insufficient engine power, a conventional ship may be unable to overcome the limiting speed. However, some powerful ships such as fast ferries can overcome limiting speed but, in doing so, produce dangerous wash.

Squat

Squat is the increase in draught and trim that occurs when a ship moves on the surface of the sea. At low speed, a ship sinks bodily and trims by the head. At high speed, a ship bodily lifts and trims by the stern. At especially high speed, the ship can plane. However, squat is greatest in shallow water where the resulting increase in draught and trim can cause grounding.

This, of course, provides a further limit on speed in shallow water, with consideration of grounding due to squat being especially important if the under-keel clearance is 10% or less of the draught and the speed is 70% or more of the limiting speed. In shallow water, squat can be estimated by adding 10% to the draught or 0.3 metres for every 5 knots of speed.

Waterway width

If the waterway is restricted in width as well as depth, this can also have an effect on performance. If the underwater midship area of the ship is significant compared to that of the waterway (say, over 20%), then this 'blockage' will further increase resistance and squat, and create a 'backflow' of water between the ship and the waterway. This will cause silt to go into suspension or deposit on the bed of the channel and may erode the waterway. It may also cause bank material to be transferred to the bed of the waterway.

A further effect may also occur. If the banks are high relative to the water depth, the ship may steer away from the bank. This 'bank effect' is due to backflow between the bank and the ship creating a low-pressure region amidships. This causes the ship to be 'sucked' towards the bank, and a pressure wave between the bow and the bank (the 'bow cushion') pushes the bow away from the bank and the stern is drawn in.

Bank effect increases with increases in speed, blockage (ie when the cross-sectioned area of the ship is large relative to the cross-sectioned area of the bank) and low under-keel clearance. If speed is too high, bank effect can be severe and sudden, catching the ship handler unaware. It is advisable to slow down and to steer towards the bank. By so doing, it may be possible to strike a balance, with the ship running parallel to the bank. Bank effect is also felt on bends in a waterway when proximity to the outer bank may 'help the bow round' a tight bend.

Interaction with other ships

Just as ships can interact with banks, they can also interact with other ships. The same basic physical factors are involved – shallow water, speed and distance off. When one ship comes too close to another at high speed, then one or more things can happen. The ship may turn towards or be drawn towards the other ship, or both ships may sheer away from each other, or the ship may turn towards (across) the other's bows.

These hydrodynamic effects are collectively known as 'interaction'. They can and do lead to collisions or contact. Interaction is accentuated by shallow water when a large hydrodynamic effect can render a ship almost impossible to control. To minimise its effect, it is essential that masters anticipate the situation, that speed is reduced before the encounter, if practicable, and that the maximum passing distance is maintained. This is especially true when overtaking.

Figure 12: Berthing with ship astern

Interaction is more of a problem when overtaking than when crossing on a reciprocal course, because the forces have more time to 'take hold' of the other ship. But it should be remembered that both ships are affected by the interaction and both should take care to minimise its effect. Research has shown that mariners accept closer passing distances for overtaking ships than for crossing ships.

Approach channels

Approach channels allow a deep-draught ship to enter an otherwise shallow port and may provide many of the external factors that affect manoeuvring.

The width, depth and alignment of many approach channels are now subject to rigorous analysis at the design stage so that they provide the minimum hazard to ships that move along them. They are designed for single or two-way traffic, and their width, depth and alignment are an optimised compromise between acceptable marine risk on the one hand and economic acceptability (with regard to dredging costs) on the other.

06. Berthing without tugs

When berthing without tugs, it is essential that the effects of lateral motion are fully understood. When a ship moving forward turns by use of engines and rudder alone, the effect of centrifugal force is to push the ship laterally away from the direction of the turn. When turning by use of bow thrusters alone, the thruster simply pushes the bow to port or starboard. There is no centrifugal force or lateral motion.

Port-side berthing

The following sequence assumes a fixed-pitch right-handed single screw ship without tug assistance.

Approach the berth at an angle, because astern thrust will be used to stop the ship and swing the bow to starboard and the stern to port. This will parallel the ship to the berth. Once stopped, the ship can be manoeuvred into the final position using astern power, which gives transverse thrust and kicks ahead with appropriate rudder as required. The actual sequence will depend on the available berthing space.

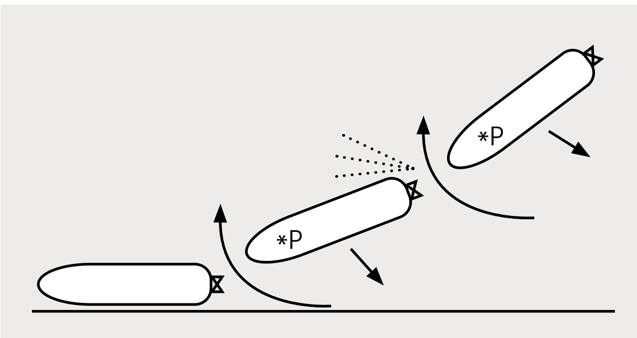


Figure 13: Normal port-side berthing with headway – lateral motion to port

If sternway is developed and transverse thrust causes the stern to swing to port, lateral motion will be to starboard and away from the berth. This may be useful if a new approach is required.

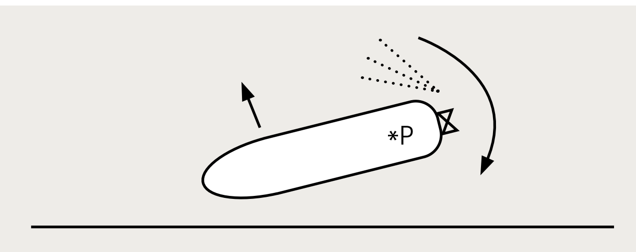


Figure 14: If sternway develops – lateral motion is to starboard

What can go wrong:

- **Approach speed too high**
  The ship can hit the berth with her bow before stopping, or a large astern movement used to stop the ship, and the resulting transverse thrust, can cause the stern to hit the berth.
- **Kicks ahead go wrong**
  If a sharp kick ahead is made close to the berth, then excessive forward motion can result and the ship's bow can strike the berth.
- **Lateral motion ignored**
  When approaching port side to the berth, the ship's lateral motion is to port. Insufficient awareness of lateral motion can cause a ship to land heavily against the berth.
- **Stopping too far from the berth**
  The ship settles off the berth with her bow moving away from the berth, causing a situation that is difficult to remedy. The action of applying port rudder and a kick ahead, and initiating a swing to port, in order to bring the bow towards the berth, is likely to cause lateral motion of the ship, which will drive her away from the berth. Lateral motion is always at right angles to the direction of motion and away from the direction of turn. This apparently logical action may actually make the situation worse.

  If berthing against a knuckle, it is important to land flat against the straight part of the quay, not on the knuckle.

Starboard-side berthing

The following sequence assumes a single screw ship with a fixed-pitch right-handed propeller.

The ideal approach should be to balance forward speed against the astern power needed to stop. The greater the forward speed, the greater the astern power required to stop the ship and, consequently, the greater the effect of transverse thrust, which will bring the bow close to the berth and throw the stern off.

Aim to approach the berth with the ship parallel. The effect of transverse thrust will swing the bow towards the berth.

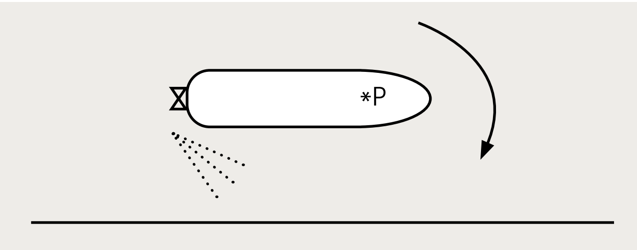


Figure 15: Starboard side berthing – transverse thrusting of bow

To stop the ship, it will be necessary to put the engine astern. Transverse thrust will probably push the stern to port and bow to starboard. To correct the effect of the transverse thrust, initiate a port swing of the bow before applying astern power.

What can go wrong:

- **Approach speed too high**
  The need to use a large astern movement could cause the bow to swing towards the berth and strike the berth.
- **Ship stops close to the berth with her bow towards the berth**
  Forward engine movement could cause the bow to strike the berth if too much power is used. Transverse thrust generated by an astern movement can cause the bow to swing towards the berth and strike the berth.
- **Ship stops some distance from the berth but parallel to it**
  A kick ahead with full starboard rudder could result in the bow striking the berth at almost 90°. The situation can be made more difficult because the stern is driven away from the berth.

Berthing between two other ships

It is normal to berth a ship between two other ships with little more than the ship's length of clear space.

Procedures for berthing between two ships will depend upon local conditions. However, the textbook approach is to stop the ship in the required fore and aft position, but clear of the other two ships, and then work it alongside using thrusters. Alternatively, the bow or stern could be put alongside the berth first.

Although this chapter concerns berthing without tugs, larger ships that are not fitted with a bow thruster will require tug assistance for this manoeuvre.

Points to remember:

- **Current has a greater effect at slow speed**
  As speed is reduced approaching the berth, the current exerts a proportionally greater influence, which may cause the ship to start to drop astern, increasing the danger of contacting the ship astern.

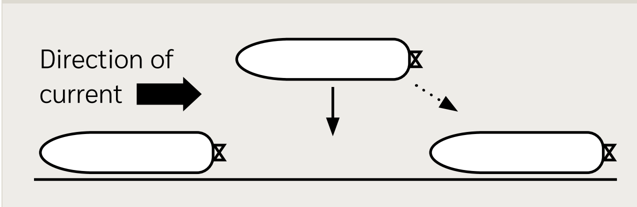


Figure 16: Berthing in current between berthed vessels

- **Other forces can cause a ship to move**
  The ship can pick up headway or sternway when working alongside, either through the effects of wind, current or asymmetrical lead of fore and aft springs.
- **The ship's propeller may not have zero pitch**
  Residual pitch on a controllable pitch propeller ship can cause headway or sternway. This is potentially problematic when berthing in a confined space.
- **Use of bow thrusters may not always help**
  In some ships, and depending on thrust tunnel design, the bow thruster can impart headway.

07. Berthing with tugs

Tugs are usually employed according to the practice of the port after taking into account the capabilities of the available tug types.

Towage has a number of potential hazards, and tug masters will give priority to the safety of their own tugs in dangerous situations. There are several points to remember, not only with regard to safety, but also to ensure that tugs are used in the most effective manner.

Berthing with tugs offers greater flexibility to the ship handler.

Factors to take into account when determining the number of tugs to be employed:

- Port's practice for the particular size of ship and the designated berth
- Under-keel clearance
- Anticipated strength and direction of wind and its likely effect on berthing
- Windage area of the ship
- Stopping power and handling characteristics of the ship.

In general, tugs have difficulty operating at high speed. Interactive forces between the ship and the tug can become very large, particularly at the ends of the ship. High speed increases the possibility of capsizing a conventional tug, and masters should be aware of this danger.

The effectiveness of a tug is proportional to the distance between its point of contact and the ship's pivot point. For instance, when the ship has headway with two tugs attached, one forward and one aft, the aft tug will have more effect than the forward one, because the distance from the aft tug connection to the ship's pivot point is greater. If both tugs are applying the same power, the result will be a swing of the ship in favour of the aft tug.

Points to remember:

- When a tug attached by a line leading forward applies a turning force, there will also be an increase in the ship's speed.
- Anticipate any changes in tug positioning on the ship and allow sufficient time for the tugs to reposition and be ready to assist.
- Be aware of any space or other limitations that may give the tug master difficulty in carrying out the ship's requirements.
- Tugs are most effective when a ship is navigating at slow speed. For berthing purposes, they should not be attached to a ship navigating at a speed of five knots or more.
- It is important for masters to discuss with the pilot the position where the tug will attach before the tug arrives. A tug acting with a long lever from the ship's pivot point will be more effective than a tug with a short lever. The effectiveness of a tug will depend upon the position where it is attached.
- Propeller wash from tugs operating close to a ship, and pulling, could initially cause a ship's bow or stern to move away from the direction in which the tug is pulling.
- Conventional tugs connected by a line can exert an unwanted force on a small ship, which may require corrective action.
- Masters should understand the different performance characteristics of tugs and that conventional tugs are likely to be less manoeuvrable than water tractor tugs. A ship's master can decide on the number of tugs employed but usually has no influence on the tug type.

Port-side berthing

A bow thruster can be used to position the bow with a degree of precision; however, bow thrust will not help to control the stern. Transverse thrust can be used to bring the stern of small ships alongside. However, on a larger ship that is not fitted with a stern thruster, a tug can be secured aft to control the stern while bow thrust is used to control the bow.

The recommended procedure is to stop the ship off the berth and then work her alongside, using bow thrust and a tug to provide lateral power.

Starboard-side berthing

A bow thruster enables the bow to be positioned with a degree of precision. However, without tug assistance, the difficulty of getting the stern alongside remains. Consequently, positioning the stern remains a priority. The use of bow thrust alone to bring the bow alongside, before the stern, is likely to cause the stern to move away from the berth. This situation is difficult to remedy. Once the ship is in position, berthing can be completed using bow thrust until the bow is alongside. When a tug is secured aft, control of the stern is greatly improved.

Types of Tugs

Conventional Tugs

Tugs are still operated in many parts of the world, and the conventional tug is recognisable by the following features:

- Its propulsion unit, which is generally a single screw propeller and a standard rudder. This is similar to the configuration on many merchant ships today, though more recently they may have been replaced by a controllable pitch propeller.
- The location of the towing hook, which is generally fixed amidships, tends to limit the tug's manoeuvrability and leaves it at risk of capsizing (or girting) if it gets into an awkward position, particularly if the vessel she is connected to is turning. The risk to the tug of capsizing is the same, regardless of whether she is connected to the bow or the stern.

Tractor tugs

A tractor tug uses multidirectional propulsion units that consist of controllable pitch rotating blades located below the conning position in the wheelhouse.

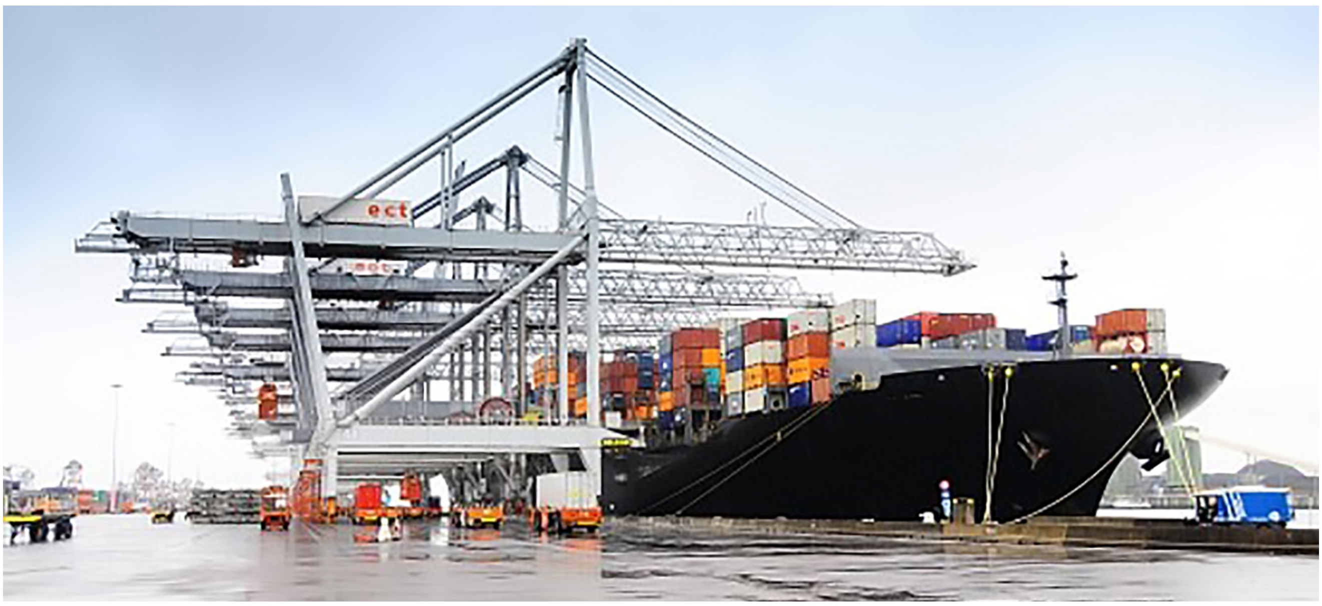


Figure 17: Safely moored

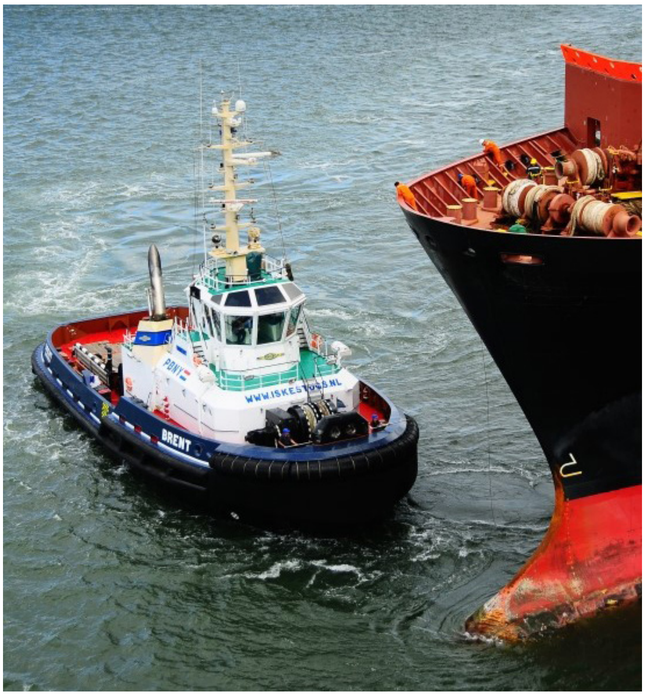


Figure 18: Making tug fast

A leading manufacturer of this type of propulsion unit is Voith Schneider and, in the hands of a skilled tug master, they create a highly manoeuvrable vessel. In addition to the high degree of manoeuvrability that the propulsion unit offers, the towing line is operated from a winch drum, which the tug master can operate remotely from the wheelhouse to increase or decrease the length of towline, as required.

Azimuth stern drive tugs

This type of tug combines the benefits of both conventional tugs and tractor tugs. The main propulsion units are located aft, like a conventional tug, but these units are two rotating azimuth systems, similar to those in use on a tractor tug. The towing position can be either located amidships like a conventional tug or located forward. When secured to the forward winch, this tug can push or pull (tow) and, when pulling, gains a huge lever effect from the distance between the propulsion units and the forward winch position.

Tugs are generally rated by ‘bollard pull’. This is the force produced by a tug, in tonnes, when pulling against a static bollard.

Figure 19: Pilot boarded – tugs in attendance

08. Berthing with anchors

Anchors are an effective berthing aid. Anchors can be used for berthing, without tug assistance, on ships without bow thrusters and in an emergency to stop any ship.

Dredging anchors

A dredging anchor will hold the bow steady while allowing a ship to move forward or aft. A bow anchor can be dredged from a ship going forward or astern. The advantages of dredging an anchor when moving forward are principally that the ship's pivot point moves to the position of the hawse pipe and, to overcome the anchor's drag, propulsive power is used giving good steering at low speed. When going forward, corrective action will be needed to prevent the bow from swinging to port or starboard.

The intention is for the anchor to drag and not to dig in. If the anchor does dig in, it could cause the ship to stop and necessitate breaking the anchor out again. Digging in can also damage the ship, anchor or windlass. It is therefore important to use as little cable as possible, typically a length of cable that is between 1.5 and 2 times the depth of the water.

Local knowledge regarding the nature and condition of the seabed is important to avoid dredging in an area where the bottom is foul. Dredging an anchor can be used to control the bow when manoeuvring into a downwind berth.

Emergency anchoring

In an emergency, anchors can be very effective in stopping a ship, provided the anchor is lowered to the seabed and the cable is progressively paid out. Initially, the anchor should be allowed to dredge and gradually build up its holding power until its braking effect begins to reduce the ship's speed. Care should be taken when trying to stop any ship in this way, especially a large ship, as the anchor and its equipment may 'carry away' causing damage or injury, if the anchor should snag.

Planning

The key to any port approach is planning, and both anchors should be made ready before port approach or river transit. Part of the passage plan and/or pilot exchange should cover the use of anchors and where the dangers are in relation to subsea pipelines and cables. These should be highlighted on the charts. It is too late to check in an emergency.

Figure 20: Proceeding with tug made fast

09. Electronic berthing aids

There are various electronic aids that provide information during a vessel's approach and final berthing manoeuvres. The information that is usually of most value, particularly for very large vessels, is speed over the ground, since to maintain the kinetic energy of such vessels below that which can be absorbed by the berth requires a skilled judgement of velocity.

During the approach to the berth, distance off can be adequately determined from radar, but during the final stages of berthing, it can be of assistance to have independent measurements of distance from the bow and stern, to the berth.

Some noteworthy advantages of using a berthing aid system are:

- Reduced operational costs and damages to the dock, fenders and ships
- Increased safety control and protection over surroundings
- Real-time monitoring, data register, reports, reproductions and records
- Smart analysis of the multiple variables involved in berthing.

There are docking aid systems that are based on the latest laser and LED technology. The laser system can measure the distance from the jetty to the side of the approaching vessel. In addition, on a standard PC, all values can be displayed on a large display, such as distance (bow and aft), speed of approaching and angle. Since the display is based on LED technology, they are able to show other parameters as well, such as wind speed, current, waves or other crucial information, in order to guarantee a safe mooring.

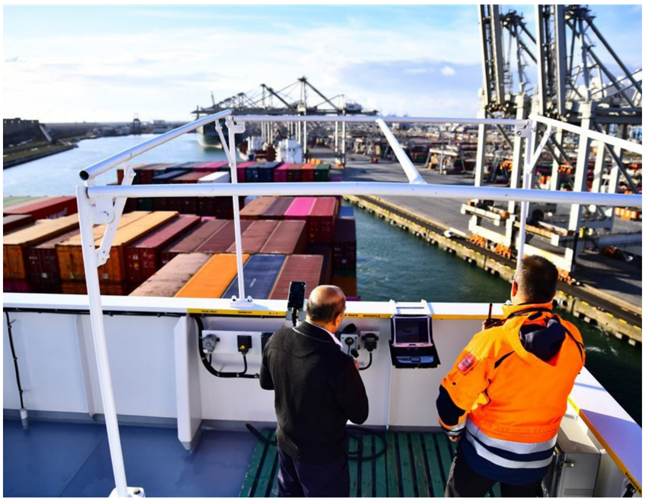


Figure 21: Berthing with pilot assistance

Docking systems feature:

- Real-time display of vessel approach speed and distance
- Reliable, low maintenance design
- Operation is unaffected by weather conditions
- High accuracy, increasing during the critical approach phase
- Simple above-surface installation
- Provides alarms in the event that the vessel moves outside selectable parameters
- Event logging to provide historical data.

10. Thrusters

Thrusters are manoeuvring devices that are designed to deliver side thrust or thrust through 360°. They are used to allow ships to be more independent from tugs, give them more manoeuvrability for special tasks and, in some cases, give them a ‘take home’ capability. There are three general types of thrust devices: the lateral thruster or tunnel thruster, which consists of a propeller installed in an athwartship tunnel; a jet thruster, which consists of a pump taking suction from the keel and discharge to either side; and an azimuthal thruster, which can be rotated through 360°. A cycloidal propulsor can be considered a type of azimuthal thruster.

Thrusters can enhance the manoeuvrability of existing vessels, particularly at low speeds, and provide a high level of redundancy. The main propulsion system based on thrusters can also provide increased speed, or lower installed power and reduction in fuel consumption. The general arrangement and hull form of new builds incorporating thrusters can be modified significantly in order to increase hydrodynamic efficiency. The other key advantage of thrusters is that they tend to suffer less from vibration and noise, and are therefore well suited for use on passenger vessels. Since thrusters are steerable, using them may also eliminate the ship rudder.

Azimuthing thruster – A propeller that can be rotated through 360° in the horizontal plane, thus allowing the thrust to be generated in any desired direction.

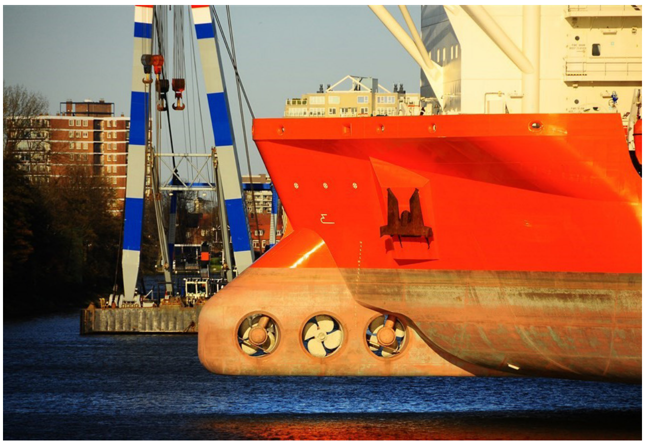


Figure 22: Bow thrusters

Continuous duty thruster – A thruster designed for continuous operation, such as dynamic positioning thrusters, propulsion assistance or main propulsion units.

CRP thruster – An azimuthing thruster equipped with twin contra-rotating propellers.

Intermittent duty thruster – A thruster that is designed for operation at the peak power or rpm levels, or both, for periods not exceeding 1 hour, followed by periods at the continuous rating of less than peak power, with total running time not exceeding 8 hours in 20 hours. Generally, such thrusters are not meant to operate for more than 1,000 hours per year.

Jet thruster – A pump arranged to take suction from beneath or close to the keel and to discharge to either side, to develop port or starboard thrust, or in many cases through 360°.

Lateral thruster, transverse thruster, tunnel thruster – A propulsion device fitted to certain types of ships to improve manoeuvrability. The thrust unit consists of a propeller mounted in an athwartships tunnel and provided with some type of auxiliary drive, such as an electric or hydraulic motor. During operation, the water is forced through the tunnel to push the ship sideways either to port or starboard, as required. This type of thruster is usually installed at the bow (bow thruster) and sometimes at the stern (stern thruster).

Lateral thrusters are most effective when a ship has neither headway nor sternway. They create a turning effect by providing a side force at their location. Their effectiveness will depend upon the distance between the thruster and ship's pivot point. When berthing a ship that has a single bow thruster and no stern thruster, it is important not to become too focused on the bow, because this can be controlled with the thruster. Plan to get the stern alongside as a priority. Remember that pure rotation can only be induced by two lateral thrusters, one forward and one aft, opposing each other, and that a tug may be needed to control the stern of a large ship.

Bow thrusters are used when it is required to 'breast' onto or off a berth, to move the ship's head from a jetty or to turn the ship in a limited space. Modern ships fitted with a bow thruster will often berth without tug assistance.

However, a bow thruster will lose its effectiveness as a ship's speed increases. Depending on the hull and thrust tunnel design, thrust effectiveness can be lost at between 2 and 5 knots. The reason for this is the merging of the slipstream from the thruster with the general flow around a forward-moving hull. When speed increases above 2 knots, local loss of pressure over the hull, downstream from the thruster, creates a turning moment opposite to the moment produced by the thruster. The thruster may become ineffective.

Thrusting when stopped – When stopped and thrusting, a ship's pivot point is likely to be aft. If a bow thruster is put to starboard on a stopped ship, the ship will turn to starboard.

Thrusting with headway – The pivot point will be forward, so thrusting will be ineffective, especially at high speeds.

Thrusting with sternway – The pivot point is aft and when the bow thruster is put to starboard, the ship's bow will swing to starboard. The thruster will be effective and will act as a form of 'rudder'.

Outboard thruster – In operation, the stern-mounted outboard thruster is similar to an outboard engine on a speedboat and is capable of being lifted out of the water for easy maintenance and to reduce drag while underway.

Retractable thruster –A thruster that can be pulled up or in to reduce drag when a vessel is in a transit mode, or to reduce depth of vessel when transiting or operating in shallow water.

Rim drive thruster – A revolutionary compact lateral thruster developed by two partnerships: Rolls-Royce with Smartmotor from Trondheim, and Van der Velden® Marine Systems with Combimac (The Netherlands). The electric motor has the form of a thin ring. Its stator is incorporated in the tunnel and its rotor carries propeller blades. Waterflow through the unit is unobstructed since there is no gearbox in the tunnel and no struts are needed to support a hub. Together, these factors give a high total efficiency and reduced noise and vibration.

Swing-up azimuth thruster – A dual-function unit, supplementing an azimuthing function with a tunnel thruster role when the unit is in the raised position and recessed within the hull. The transverse tunnel-shaped recess is oversized to allow the thruster to rotate through 180° to provide thrust to port or to starboard. In this way, the propeller thrust is always in the same direction and, therefore, the propeller blades can be designed with optimum camber and radial pitch distribution.

Titled thruster – Wärtsilä has developed a new type of steerable thruster with a downward tilted propeller shaft. The 82° gearbox deflects the jet sufficiently downward to minimise hull interaction effects, thus improving thruster efficiency.

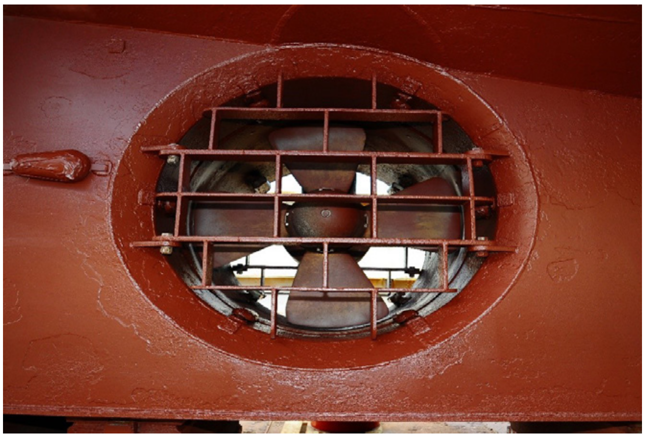


Figure 23: Tunnel thruster

11. Mooring stations forward and aft

In order to achieve the most effective mooring pattern, headlines and springs should be positioned so that they are as close to the fore and aft line of the vessel and as close to horizontal as possible. The mooring line efficiency reduces considerably as the angle to the quay increases. Lines should also be long enough to allow some movement in the vessel without overloading the system and potentially breaking a line.

Breast lines should be positioned as close as possible to 90° to the fore and aft line of the vessel. While tanker berths will usually allow long breast lines to be run, this may not be possible on a normal cargo berth, due to the positioning of bollards.

When a vessel is not fitted with dedicated mooring winches, it should not be made fast with lines on the windlass drum end, capstan or, where practicable, running around pedestal rollers. Once the vessel is in position, these lines should be stoppered off and transferred onto bitts, and the remaining mooring line should be coiled neatly and placed where it will not hinder tending to the lines.

Throughout the course of the vessel's stay in port, all mooring lines must be regularly tended to, to ensure that required line tensions are being maintained at all stages of the tides and/or loading/discharge. When moorings are to be adjusted during the stay, this should be done in a controlled manner, with the appropriate mooring winch clutched-in.

The size, type and condition of the mooring lines in use play a significant role in the effectiveness of the mooring system as a whole. The ideal situation would be to have all lines on board of identical material, size, type and construction, as this will ensure that line properties are consistent, will make planning the mooring operation easier and will allow standardisation of spare lines.

Figure 24: Mooring forward

Care should be taken to ensure that all mooring lines are suitably protected from potential sources of damage when not in use. This may include protection from direct sunlight or contact with chemicals.

12. Snap-back zones

Guidance and a review of the hazards associated with snap-backs are featured in industry publications such as the UK Maritime and Coastguard Agency's *Code of Safe Working Practices for Merchant Seamen (COSWP)*. Until recently, this guidance recommended the marking of snap-back zones on the mooring deck around the critical points, such as the warping drum, roller fairleads and pedestal rollers. The aim of these markings was to warn the seafarers to avoid standing in these zones when mooring lines were under tension.

Figure 25: Correct marking for snap-back hazard zone

However, recent studies have shown that the nature of snap-backs is more complex than initially perceived.

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.

Therefore, the latest version of the COSWP (2015 edition) has revised its guidance on snap-back zones and now dissuades the marking of snap-back zones on the deck. It recommends that the entire mooring deck should be considered as a potential snap-back zone and clear visible signage must be displayed to warn crew. It is also recommended that a bird's eye view of the mooring deck is produced to identify potentially dangerous areas.

13. Fenders

Fenders are bumpers designed to absorb the kinetic energy of a vessel berthing against a jetty, a quay or another vessel. They prevent damage to the ship's shell plating and berthing structures.

Well-designed docking fender systems absorb the ship's impact at docking, transforming ship's berthing energies into reactions, transmitting to both ship and berth structures. There are different types and ranges of fenders, depending on many variables, including dimension and displacement of boats, maximum allowable stand-off, specific berthing structure, tidal variations and other conditions.

Figure 26: Fender configuration

Fender damage can be attributable to two distinct causes:

1. the vessel's approach to the berth being incorrect, resulting in damage
2. the fenders being of poor material and quality or incorrect type, resulting in damage when the vessel comes alongside or during its time at the berth.

The former occurs even when there is a pilot on board (whose orders/actions are frequently not monitored by the master and bridge team).

Instances of the latter are often spurious; however, it is a cause for port attempts to claim for previous damage to fenders or where the fenders used were inadequate and were predictably damaged when a vessel came alongside.

Figure 27: Well-fendered berth

If the master believes that the fenders on the berth are inadequate, they should consider seriously whether to berth the ship. In such cases, the master should seek immediate advice from their owners/operators and the club's correspondent.

Figure 28: Yokohama fender

How does a master determine whether the fendering is adequate for a particular vessel?

This is not an exact science. Fender types and effectiveness vary dramatically, especially when one also takes into account the age and condition of the particular fender. What could be deemed adequate for one vessel could be inadequate for another. Because of these ambiguities, the master will need to make a reasoned assessment on approach to the jetty. The following considerations should be included in the assessment:

1. Nature of the berthing assistance, such as tugs etc, that will be available during berthing
2. Size of the fender
3. Number of fenders
4. Type of fender and positioning on the berth
5. State of repair of fender (as much as can be ascertained)
6. The size of their own vessel
7. Berth exposure to the local weather/sea conditions
8. The mooring arrangements and whether they will be adequate to keep the vessel securely alongside, minimising movement.

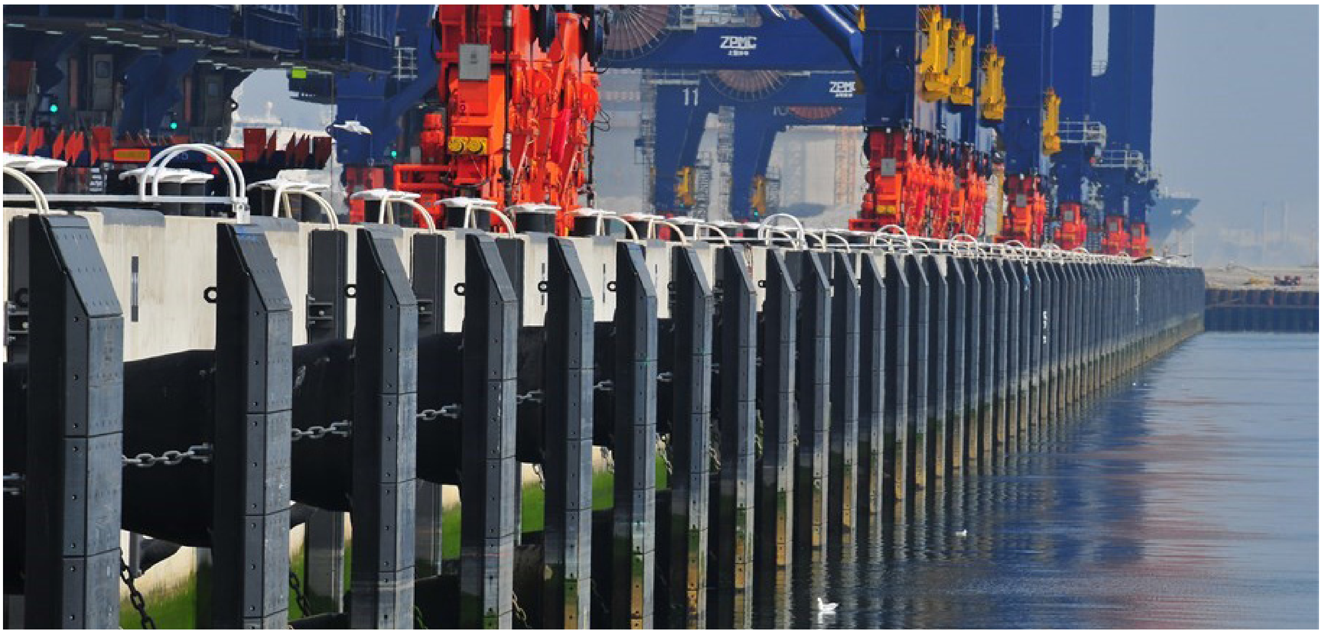


Figure 29: Berth fendered over entire length

14. Tugs and pilots – legal issues

It is evident from the other chapters of this guide dealing with the technical aspects of ship berthing that the effective use of pilotage and towage services is crucial in avoiding accidents. It is therefore important to reflect briefly on the legal responsibilities of pilots, those engaged in towage services and the ships that they assist.

Pilotage

The relationship between the master and the pilot is fraught with potential difficulties and conflict. The pilot directs the navigation of the ship, but the master still retains overall command and control. The freedom that the master gives to the pilot varies from master to master but also depends upon the circumstances in which the pilotage takes place. The master of a large foreign-going ship entering a difficult channel will tend to adopt a more passive attitude to the pilot than a coastal master who knows the area intimately.

The way in which the law interprets the relationship between master and pilot, and the rights and responsibilities of each to the other, and to third parties, obviously differs from country to country and the following is therefore offered as a general overview. In many legal systems, the customary rules and statutory enactments provide a confused and sometimes contradictory picture, which tends to the conclusion that a master, when considering how to operate with a pilot, should be guided more by common sense and self-preservation than by precise legal principles.

The pilot owes a professional duty of care to those whom he serves, which assumes a knowledge and awareness of local conditions. The pilot is therefore generally liable to the shipowner, and to third parties, for a failure to exercise such care. In practice, however, such a responsibility is largely illusory, since the pilot, as an individual, has few assets with which to satisfy any award of damages. Also, the extent of his liability is often restricted at law or limited in amount, although he may also be subject to criminal sanctions under any relevant legislation as a result of his actions.

Where there is injury or damage to the property of a third party caused by the pilot's negligence, the third party will naturally look to the shipowner for compensation. Commonly, the pilot is seen as the servant or agent of the master/shipowner. His faults or errors are therefore taken to be those of the master/shipowner. There may be a possibility of recourse action against the harbour authority, port commission or canal company that employs the negligent pilot. If, however, the relevant body merely acts as a licensing authority, it will not be liable for pilot error. Pilot associations are also generally immune from liability for the actions of their members.

Given the lack of practical accountability of the pilot, it is tempting to ignore any detailed legal analysis of the relationship between the master and the pilot. This would be a mistake, since the principles that have been articulated in various legal jurisdictions provide a well-considered view on the way in which the relationship should operate most effectively. In terms of engagement, the master is only legally bound to employ a pilot in an area of compulsory pilotage. However, the master may be found liable for not employing a pilot where it can be shown that such failure caused or contributed to an accident. Whilst the pilot may assume control of the navigation of the ship, this does not relieve the master of his command of the ship. The master therefore retains both the right and the responsibility to intervene in the actions of the pilot, for example, where he perceives the threat of an imminent danger to the ship or when the pilot is obviously incapacitated in some way.

There is therefore a divided authority, with both the master and the pilot continuing to have active roles that may potentially conflict. The pilot is the servant of the master and is responsible for giving advice on navigation, speed, course, stopping and reversing. The ship's master is responsible for the ship and the entire operation, including managing difficulties, monitoring the pilot's actions and maintaining a proper lookout. The pilot in turn should expect a well-regulated and seaworthy ship with competent bridge personnel who provide him with proper assistance and information.

Towage

Towage has been defined as 'a service rendered by one vessel to aid the propulsion or to expedite the movement of another vessel'. Towage can take place in many different circumstances and can be part of a salvage or wreck removal operation following a casualty. It can also occur when a ship is in distress in order to avoid a casualty occurring. In the vast majority of cases, however, towage is a routine operation, particularly within the confines of a port. This is referred to as customary towage.

An agent of the ship, or the charterer, usually requests the services of a tug for port towage. Once engaged, however, the tug may take its orders from any pilot on board the towed ship and, therefore, the presence of tugs adds to the complexities of the relationship between the master and pilot referred to above. The pilot and the master should be fully aware of each tug's power and handling characteristics, but the responsibility for engaging tug assistance, where required, rests with the ship's master, and the ship's master may be found negligent in not engaging a tug to assist where the circumstances warrant it, and an accident occurs. Every shipowner should leave the question of tug assistance to the discretion of the master, who must make a judgement based on the prevailing circumstances.

The rights and responsibilities of the tug and the towed ship, with regards to each other and in relation to third parties, are generally dealt with in the applicable towage contract. In most cases, the contract will be based on industry standard terms that lay down clearly the division of responsibility between the two entities. Specific port user agreements exist, but standard form contracts, such as the UK Standard Towage Conditions, the Netherlands Towage Conditions or the Scandinavian Conditions, are used in most cases. These all favour the tug, although in the USA, the Supreme Court has held that any clauses in a towage contract purporting to relieve the tug owner of liability for negligence are invalid as being against public policy. In Japan, the tug owner must exercise due diligence to make the tug seaworthy at the time she leaves the port and is liable for any damage to the tow caused by any failure to do so. Generally, in the absence of clear wording to the contrary, a court will apply as an implied term of the towage contract that the tug owner warrants to exercise due diligence to make the tug seaworthy at the commencement of the towage.

Figure 30: Minimal moorings

15. Master/pilot relationship (incorporating the ICS/Intertanko/OCIMF Guide)

Masters have the ultimate responsibility for the safe navigation of their ship. They must be co-operative with the pilot, yet assertive. They must remember that they are in command, not the pilot. They must be confident that the pilot is doing his duties correctly and they must be ready to take over if the pilot is not fulfilling his duties.

On most occasions, pilotage is compulsory. The majority of accidents during berthing occur with a pilot on the bridge. No berthing guide would be complete without reference to the master/pilot relationship. With kind permission of the International Chamber of Shipping, Intertanko and OCIMF, we have reprinted the following text from their guide *'International Best Practices for Maritime Pilotage'*.

International Best Practices for Maritime Pilotage

These recommendations are for the guidance of masters, their supporting personnel and pilots in laying down the minimum standards to be expected of the pilotage service given on board ships in pilotage waters worldwide and aims to clarify the roles of the master and the pilot and the working relationship between them. Such guidance is designed to supplement existing regulations and standard references on pilotage which include, but are not limited to, those listed at the end of this section.

1.0 Principles for the safe conduct of pilotage

1.1 Efficient pilotage is chiefly dependent upon the effectiveness of the communications and information exchanges between the pilot, the master and other bridge personnel and upon the mutual understanding each has for the functions and duties of the others. Ship's personnel, shore based ship management and the relevant port and pilotage authorities should utilise the proven concept of "Bridge Team Management". Establishment of effective co-ordination between the pilot, master and other ship's personnel, taking due account of the ship's systems and the equipment available to the pilot is a prerequisite for the safe conduct of the ship through pilotage waters.

1.2 The presence of a pilot on the ship does not relieve the master or officer in charge of the navigational watch from their duties and obligations for the safe conduct of the ship.

2.0 Provision of information for berth to berth passage planning

2.1 Ships should provide the relevant port or pilotage authority with basic information regarding their arrival intentions and ship characteristics, such as draught and dimensions, as required by the port or other statutory obligations. This should be completed well in advance of the planned arrival and in accordance with local requirements.

2.2 In acknowledging receipt of this information, the appropriate port or pilotage authority should pass relevant information back to the ship (either directly or via agents) as soon as it becomes available. Such information should include as a minimum: the pilot boarding point; reporting and communications procedures; and sufficient details of the prospective berth, anchorage and routing information to enable the master to prepare a provisional passage plan to the berth prior to his arrival. However, masters should recognise that not all of this information may be available in sufficient detail to complete the passage plan until the pilot has boarded the ship.

3.0 Master pilot information exchange

3.1 The pilot and the master should exchange information regarding the pilot's intentions, the ship's characteristics and operational parameters as soon as possible after the pilot has boarded the ship. The ICS

Master / Pilot Exchange Forms (Annexes A1 and A2 of the ICS Bridge Procedures Guide) or the company equivalent format, should be completed by both the master and pilot to help ensure ready availability of the information and that nothing is omitted in error.

3.2 The exchange of information regarding pilotage and the passage plan should include clarification of:

- roles and responsibilities of the master, pilot and other members of the bridge management team
- navigational intentions
- local conditions including navigational or traffic constraints
- tidal and current information
- berthing plan and mooring boat use
- proposed use of tugs
- expected weather conditions

After taking this information into account and comparing the pilot's suggested plan with that initially developed on board, the pilot and master should agree an overall final plan early in the passage before the ship is committed. The master should not commit his ship to the passage until satisfied with the plan. All parties should be aware that elements of the plan may change.

3.3 Contingency plans should also be made which should be followed in the event of a malfunction or a shipboard emergency, identifying possible abort points and safe grounding areas. These should be discussed and agreed between pilot and master.

4.0 Duties and responsibilities

4.1 The pilot, master and bridge personnel share a responsibility for good communications and mutual understanding of the other's role for the safe conduct of the ship in pilotage waters. They should also clarify their respective roles and responsibilities so that the pilot can be easily and successfully integrated into the normal bridge management team.

4.2 The pilot's primary duty is to provide accurate information to ensure the safe navigation of the ship. In practice, the pilot will often con the ship on the master's behalf.

4.3 The master retains the ultimate responsibility for the safety of his ship. He and his bridge personnel have a duty to support the pilot and to monitor his actions. This should include querying any actions or omissions by the pilot (or any other member of the bridge management team) if inconsistent with the passage plan or if the safety of the ship is in any doubt.

5.0 Preparation for pilotage

5.1 The pilot should:

- ensure he is adequately rested prior to an act of pilotage, in good physical and mental fitness and not under the influence of drugs or alcohol
- prepare information for incorporation into the ship's passage plan by keeping up to date with navigational, hydrographic and meteorological information as well as traffic movements within the pilotage area
- establish communication with the ship to make arrangements for boarding

5.2 In supporting the pilot, the master and bridge personnel should:

- ensure they are adequately rested prior to an act of pilotage, in good physical and mental fitness and not under the influence of drugs or alcohol
- draw upon the preliminary information supplied by the relevant port or pilotage authority along with published data (for example, charts, tide tables, light lists, sailing directions and radio lists) in order to develop a provisional passage plan prior to the ship's arrival
- prepare suitable equipment and provide sufficient personnel for embarking the pilot in a safe and expedient manner
- establish communications with the pilot station to confirm boarding details

6.0 Pilot boarding

6.1 The boarding position for pilots should be located, where practicable, at a great enough distance from the port so as to allow sufficient time for a comprehensive face-to-face exchange of information and agreement of the final pilotage passage plan. The position chosen should allow sufficient sea-room to ensure that the ship's safety is not put in danger, before, during or directly after such discussions; neither should it impede the passage of other ships.

6.2 The pilot should:

- take all necessary personal safety precautions, including using or wearing the appropriate personal protective equipment and ensuring items are properly maintained
- check that boarding equipment appears properly rigged and manned
- liaise with the master so that the ship is positioned and manoeuvred to permit safe boarding

6.3 In supporting the pilot, the master and ship's personnel should:

- ensure that the means of pilot embarkation and disembarkation are properly positioned, rigged, maintained and manned in accordance with IMO recommendations and, where applicable, other port requirements
- the master should liaise with the pilot station/ transfer craft so that the ship is positioned and manoeuvred to ensure safe boarding

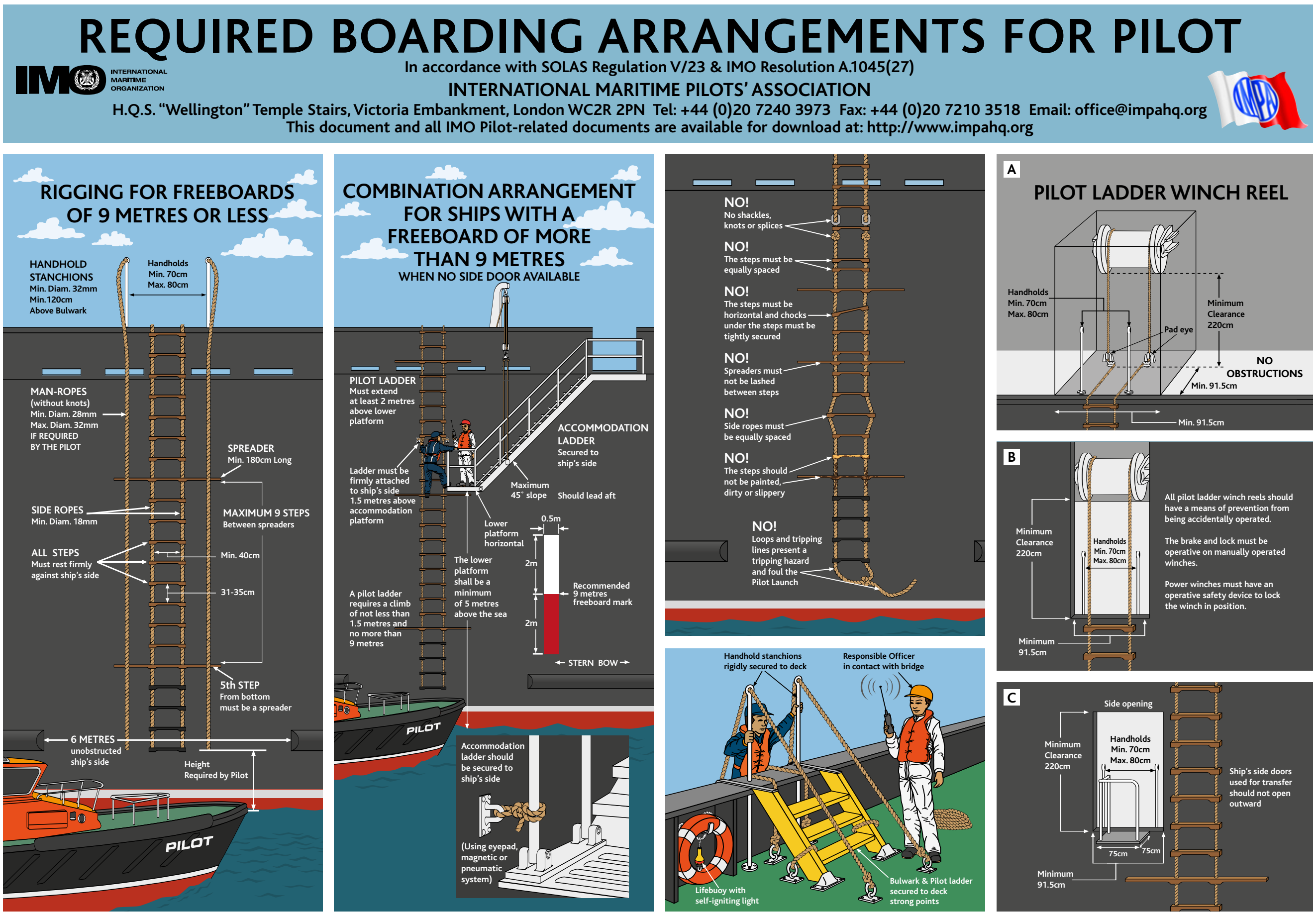


Figure 31: Required boarding arrangements for pilot

7.0 Conduct of passage in pilotage waters

7.1 It is essential that a face-to-face master/pilot exchange (MPX) described in section 3.1 results in clear and effective communication and the willingness of the pilot, master and bridge personnel to work together as part of a bridge management team. English language or a mutually agreed common language or the IMO Standard Marine Communication Phrases should be used, and all members of the team share a responsibility to highlight any perceived errors or omissions by other team members, for clarification.

7.2 The master and bridge personnel should:

- within the bridge management team, interact with the pilot providing confirmation of his directions and feedback when they have been complied with monitor at all times the ship's speed and position as well as dynamic factors affecting the ship (for example, weather conditions, manoeuvring responses and density of traffic)
- confirm on the chart at appropriate intervals the ship's position and the positions of navigational aids, alerting the pilot to any perceived inconsistencies

7.3 The pilot should:

- ensure that the master is able to participate in any discussions when one pilot relinquishes his duty to another pilot
- report to the relevant authority any irregularity within the passage, including deficiencies concerning the operation, manning, or equipment of the ship

8.0 Berthing and unberthing

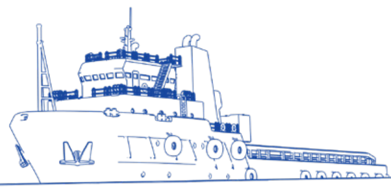
8.1 The necessity of co-operation and a close working relationship between the master and pilot during berthing and unberthing operations is extremely important to the safety of the ship. In particular, both the pilot and the master should discuss and agree which one of them will be responsible for operating key equipment and controls (such as main engine, helm and thrusters).

8.2 The pilot should:

- co-ordinate the efforts of all parties engaged in the berthing or unberthing operation (for example, tug crews, linesmen, ship's crew). His intentions and actions should be explained immediately to the bridge management team, in the previously agreed appropriate language.

8.3 In supporting the pilot, the master and bridge personnel should:

- ensure that the pilot's directions are conveyed to the ship's crew and are correctly implemented
- ensure that the ship's crew provide the bridge management team with relevant feedback information
- advise the pilot once his directions have been complied with, where an omission has occurred or if a potential problem exists



9.0 Other matters

9.1 The pilot should:

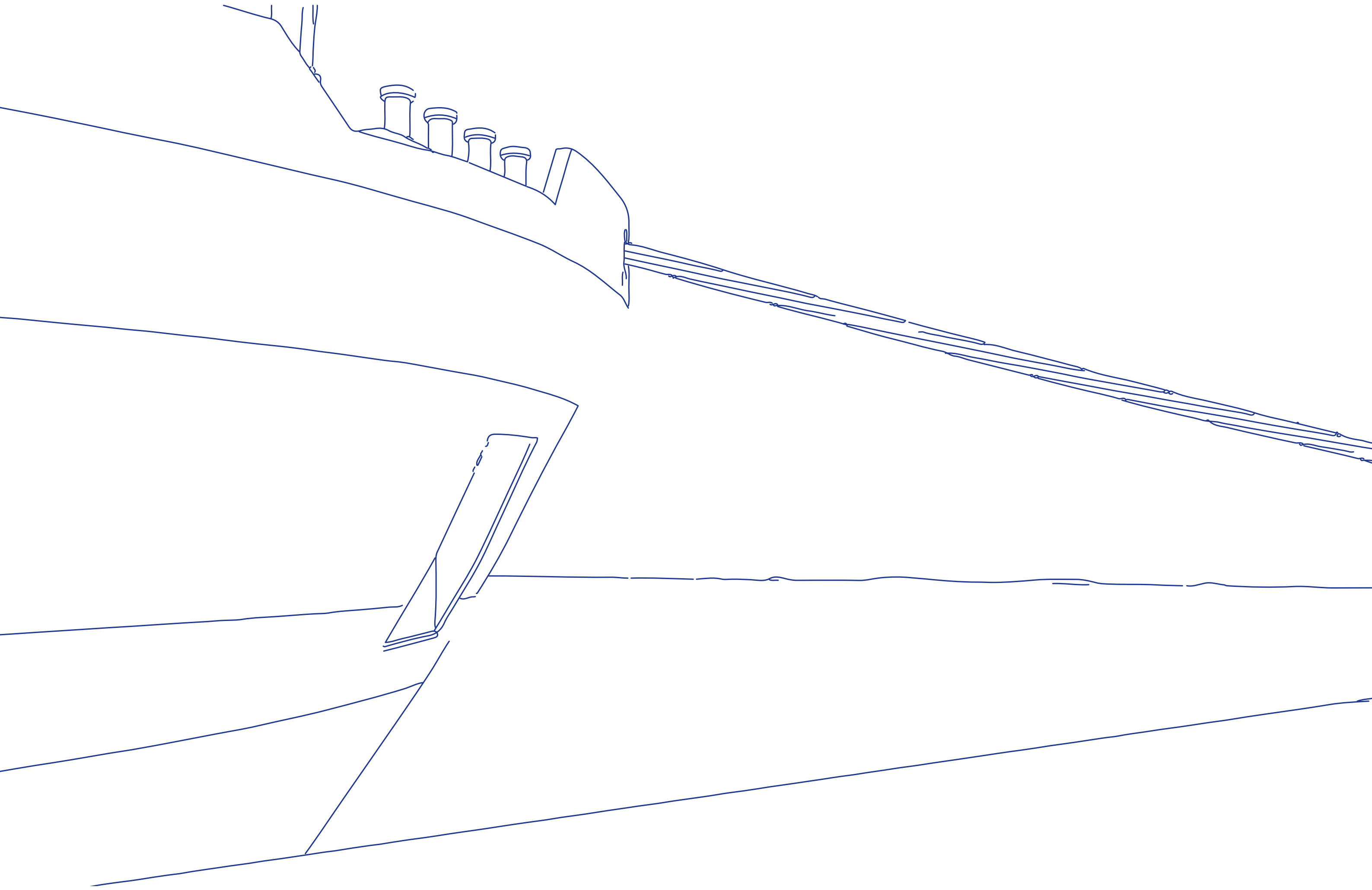
- assist interested parties such as port authorities, national authorities and flag administrations in reporting and investigating incidents involving ships whilst under pilotage, subject to the laws and regulations of the relevant authorities
- in observing the recommendations within this document pilots should meet or exceed the requirements set down in IMO Assembly Resolution A.485(XII) and its annexes
- should report to the appropriate authority anything observed which may affect safety of navigation or pollution prevention, including any incident that may have occurred to the piloted ship
- refuse pilotage when the ship to be piloted is believed to pose a danger to the safety of navigation or to the environment. Any such refusal, together with the reason, should immediately be reported to the appropriate authority for further action.

9.2 The master, having the ultimate responsibility for the safe navigation of the ship, has a responsibility to request replacement of the pilot, should he deem it necessary.

Figure 32: Approaching berth

16. Standard references

- IMO Resolution A.960(23), Annex 1 and Annex 2 “Recommendations on Training, Qualifications and Operational Procedures for Maritime Pilots other than Deep Sea Pilots”
- IMO Resolution A.893(21} “Guidelines for Voyage Planning”
- IMO Resolution A.1045(27} “Pilot Transfer Arrangements”
- SOLAS Chapter V, Regulation 23 “Pilot Transfer Arrangements”
- ICS Bridge Procedures Guide



List of figures

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The authors acknowledge technical contributions from colleagues and associates with particular thanks to:

- Eric Murdoch BSc, MSc, CEng, MRINA, MI MarEST
- Brian Glover BA (Hons), Barrister
- Dr. Ian W. Dand BSc, PhD, FREng, Director of Hydrodynamics, BMT SeaTech Ltd
- Capt. Chris Clarke OBE, Master Mariner Senior Lecturer, Manned Model Ship Handling Facility, Warsash Maritime Centre

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August 2021