JOINT ETA-EMPA GUIDELINES

ON DESIGN AND LAYOUT OF HARBOUR

TOWAGE EQUIPMENT

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JOINT ETA-EMPA GUIDELINES ON DESIGN AND LAYOUT OF HARBOUR TOWAGE EQUIPMENT

1 PREAMBLE

Over the last decade European pilots and tug operators have increasingly experienced operational problems when handling ever-larger ships. The problems are mainly related to the type and / or strength and / or positioning of deck equipment on board of ships.

This document is intended to raise the awareness of owners, insurers, naval architects, new-building superintendents, classification societies and shipyards about specific areas of concern to the towage industry, in order to encourage them to take these into account when ordering or designing vessels.

The purpose is to assist the parties involved to ensure that the deck layout will result in safer operations for both ships and tug crews, yet deliver rapid and more efficient harbour towage operations.

Accordingly, Guidelines have been formulated in this paper.

The main areas of concern are:

- **Strength and design of bitts, chocks and fairleads**
- **Positioning of bitts and chocks**
- **Deck arrangement and organisation of the operations**
- **Marks on ship hulls**
- **High "dead slow" of ships**

The sequence in which the topics are listed above does not imply an order of importance; all are equally relevant.

2 INDEX

3 GLOSSARY OF TERMS

The terminology for the equipment used varies around the world. In order to avoid confusion, we will use the terminology as used in OCIMF Mooring Equipment Guidelines, *third edition.*
Throughout this document we will use the following terms and meanings

- Bollard = 1 single post for rope connection
- Bitt = a pair of 2 bollards, in 1 unit
- Chock = a reinforced construction in a bulwark or railing *without* moving parts, used for passing a rope or line.
- Fairlead = a reinforced construction in a bulwark or railing, having moving parts, used for passing a rope or line.
- Roller = a cylindrical part revolving around an axis. The axis may be supported on one or both sides.
- Pedestal fairlead = “dead man” roller = a pillar construction with a roller on top, used for altering the direction of a rope or line.
- BP = (Static) Bollard Pull (maximum continuous pull of the tug on a fixed object)
- Stopping device = any equipment that is used for temporarily taking the weight of the line or rope, while the crew transfers the line from winch to bitt or vice versa.

4 STRENGTH AND DESIGN OF BITTS, CHOCKS AND FAIRLEADS

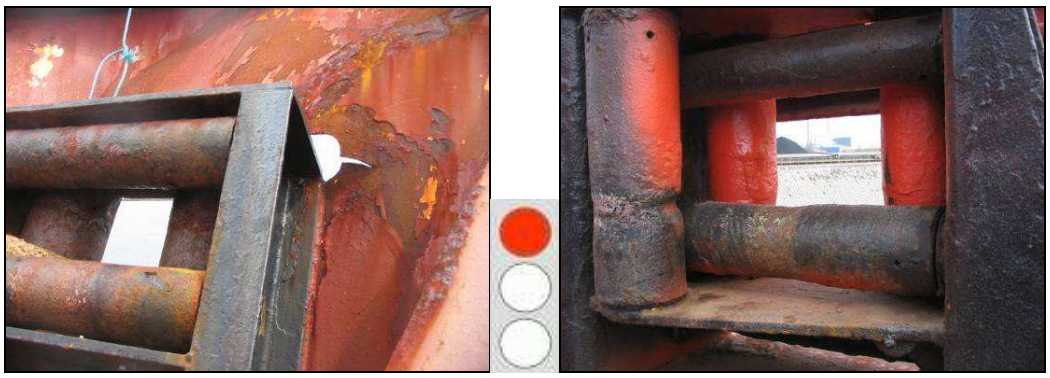
4.1 Fairleads

Open fairleads with rollers for mooring ropes are potentially lethal. The rollers are often only kept down by means of a light steel disk, held in position by one or two light bolts. Rollers have consequently been known to transform into cannon balls shooting through the air.
The picture below shows rollers of very sturdy construction, but nevertheless the missing roller reportedly killed an unfortunate sailor.

The missing roller reportedly killed a man…

Even when rollers of this type are heavily built, the fact remains that the axis of the roller is supported only on one side and thus the base of the axis is much more subject to bending than one supported from both sides. Especially the base will be heavily stressed and very difficult to access for maintenance. When the vessel gets older, it may be expected that corrosion and/or fatigue will occur with possibly lethal consequences.

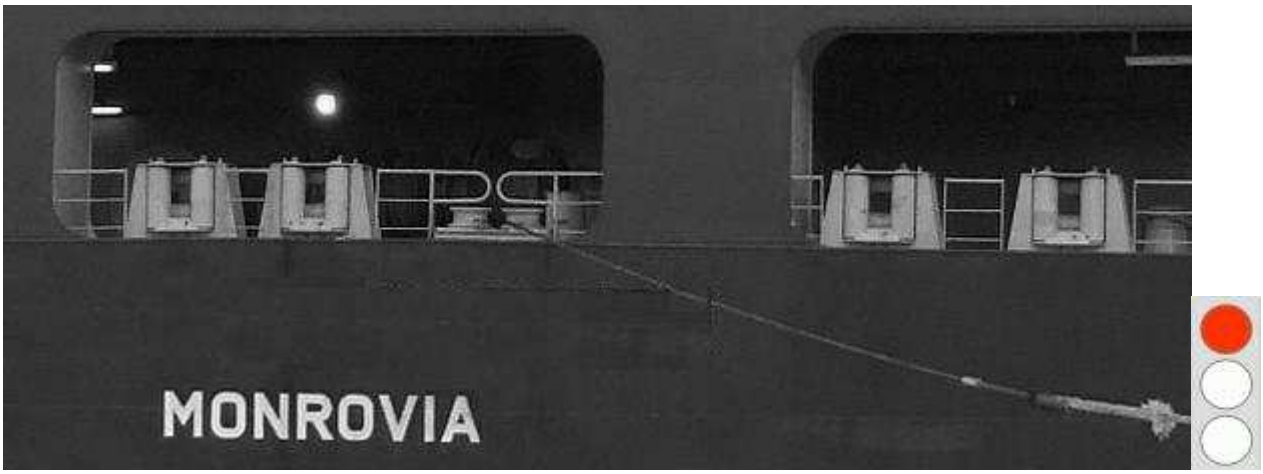
Another type of fairlead that has become common, together with the introduction of mooring winches, is the "square" type with rollers on all four sides. These rollers are, however, much longer than the traditional rollers, and their bearings therefore should be extremely heavy in order to withstand the forces. This is usually not the case.



It can be seen here that not only the construction of the rollers is obviously weak, the surrounding construction seems not to have been up to the job either.

Another problem that arises with this type of fairlead, when the vessel gets older, is that the rollers commonly become stuck due to poor maintenance. The results can be seen above.

Rollers of this type are usually only suitable for mooring, not towing, unless confirmed by the mooring arrangement plan.



Sufficient PANAMA-type chocks available .

4.2 Chocks.

Closed chocks (also often referred to as "PANAMA" chocks) are the preferred chocks for towing. The round shape and big radius will avoid bending the towing gear too much which will otherwise cause damage to the towing line/wire with the possible danger of parting.

Where fairleads were traditionally made of cast iron, the type that is made of shaped steel plate has become common nowadays. Quite often, these fairleads are not properly reinforced from the outside and the tow wire can easily cut right through.

No reinforcement at all!

Chock reinforced by stiffeners

Below, the method of securing the equipment to the deck and / or foundation was clearly insufficient.

4.3 Bitts

For bitts, the same considerations apply as for chocks. The entire structure of the bitt, the deck reinforcements as well as the welds must be sufficiently strong.

This was a 65t SWL bollard!

Another type of damage that arises is where bitt posts become squeezed by towlines.

Bitts are basically intended for a totally different type of use. When used with mooring ropes, the power is divided over two posts and several tiers of rope, belayed in a “figure of eight” fashion.

With a tow wire, the force is concentrated in one tier of a hard line, applying its pressure on the bitt over a very small surface area and over only half of the circumference of the bitt post. This creates a high concentrated line load on the post, which the steel plate of the bollard may not be able to withstand without purpose made reinforcements.

Bitt post crushed due to concentrated load

5 POSITIONING OF BITTS AND CHOCKS

5.1 Chock for working with one stern tug

Sometimes there is no centre line fairlead, but only two fairleads or chocks that are suitable for towing, at a considerable distance from the vessel's centre line. This has considerable consequences for the tug as well as for the pilot, if the vessel has to work with one tug only.

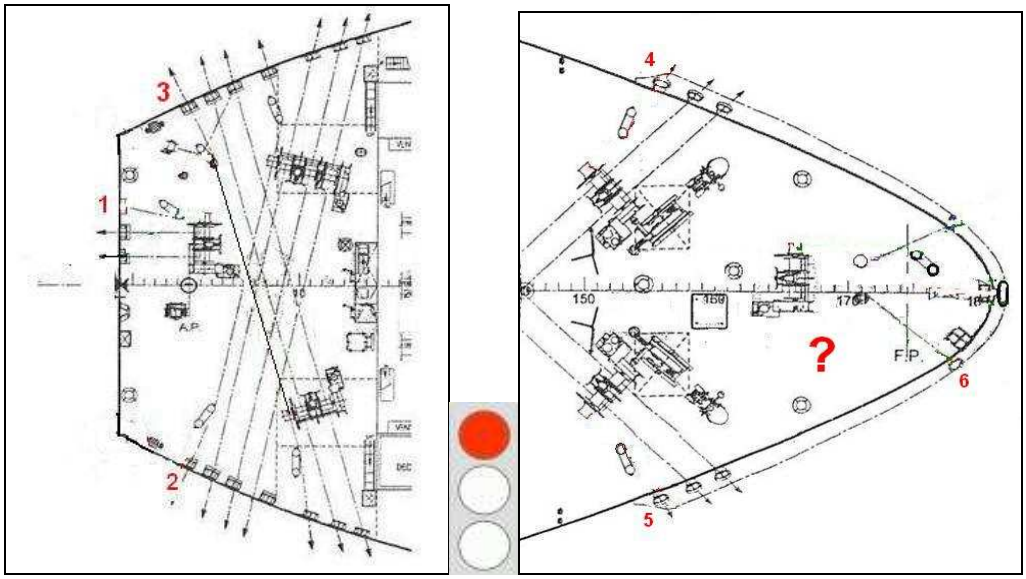
When pulling straight astern to bring down the speed, a swinging moment, proportionate to the distance of the fairlead from the centre line of the vessel, will exist and may cause the vessel's bow to move to the opposite side and hit a lock wall or quay.

Ideally, when working with one stern tug, the chock should be positioned near to the centreline.

There are even extreme cases where there is a bitt /chock on the transom stern (or the forecastle deck) on one side of the centre line only. This is highly undesirable.

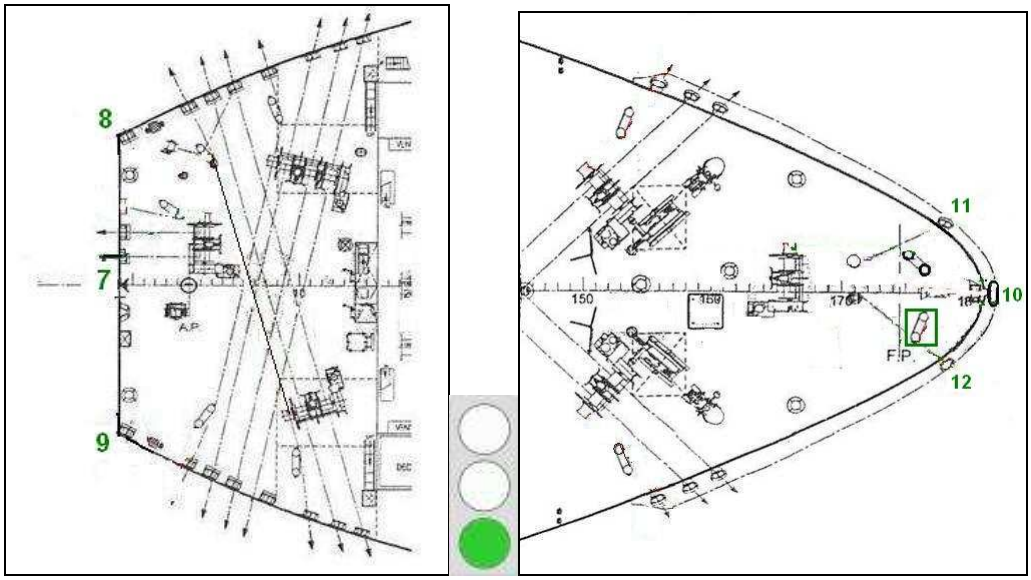
On the following plans we give comments on each individual chock.

The red numbers indicate undesirable positions for chocks, for the following reasons:



- Position N° 1 on the port side of the transom stern allows the tug only to work on the stern of the vessel, up to 90° to the ship's centre line but no further. Moving further forward would damage the tow wire with risk of parting. This setup effectively limits the tug's usefulness, e.g. during swinging. It is also too far off centre and will induce unwanted turning moments in the vessel when bringing down the speed.
- Position N° 2 on the quarter allows the tug only to work on the starboard side of the vessel, up to straight astern but almost no further to port. Moving further to the port side would damage the tow wire with risk of parting. This setup amplifies the limitations pointed out above.
- Position N° 3; as for position N° 2 above but for starboard read port
- Positions N° 4 and N° 5 on the forecastle deck are located too far aft, thereby considerably reducing the operational lever on which the tugs act (distance to pivot point). They also limit the tugs efficiency to almost straight ahead but do not allow working over to the other side. Chock N° 6 would be more suitable, however, in this plan there is no bitt to secure the tow line on the starboard side. (hence the red question mark). When working with two tugs, this will considerably complicate tug operations.

The green numbers indicate favourable positions for chocks, for the following reasons:



- Position N° 7 is most suitable for working with one stern tug in order to control the speed of the vessel and allowing operations up to 90° on either side.
- Positions N° 8 and N° 9 are ideally positioned for working with two stern tugs, however subject to a setup as discussed in 5.2.1 below.
- Position N° 10 is ideal for working with one tug, allowing it freedom of movement to either side.
- Position N° 11 and N° 12 are ideal for working with two tugs. For working with one tug (if no centreline chock would be available) they restrict the tug's operational range to the opposite side, furthermore subject to possible hampering factors such as discussed in 5.2.2 below.
- Position N° 12 is similar to Position N° 11 when provided with a suitable bitt for securing a tow line.

5.2 Operational sector of chocks

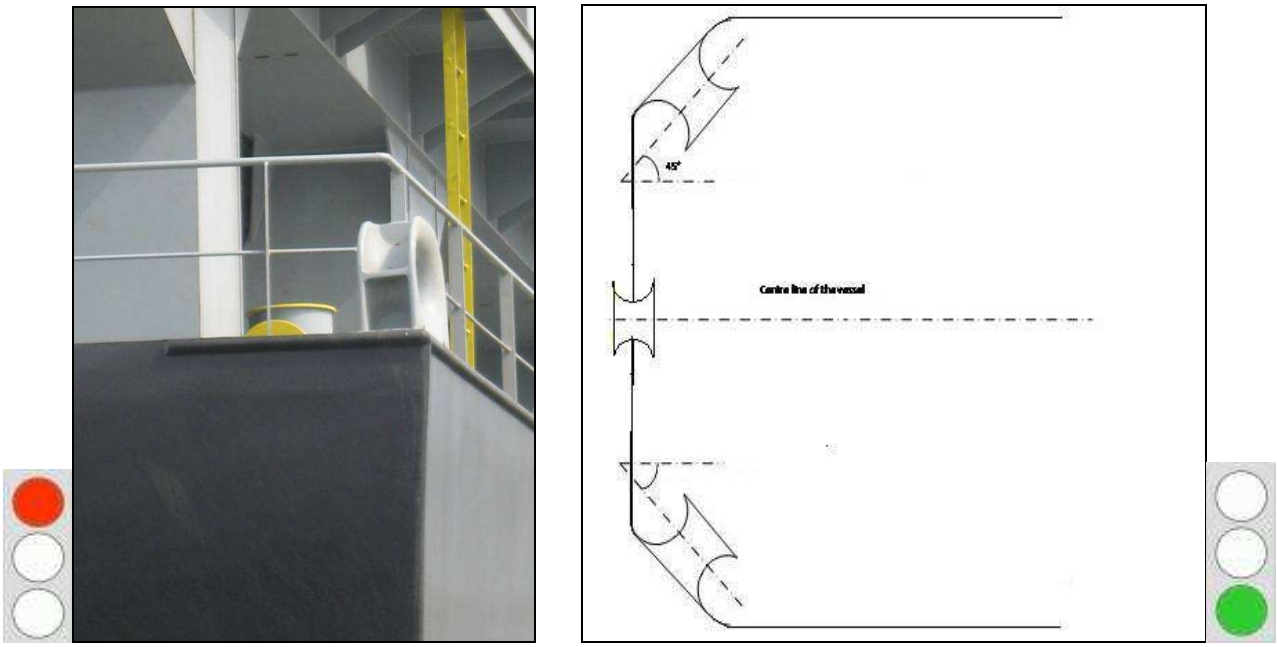
A final aspect of the positioning of chocks is the range of operation they offer to the tug.

Traditionally, the cheeks of the fairlead will open up to an angle of 180 degrees, thus limiting the tug's effective range of operation without damaging the tow line to somewhat less than that.

5.2.1 Aft

Thus, fairleads mounted athwart ships on the transom stern will not allow the tug to apply power forward of the transverse direction. Fairleads in the ship's side will allow no, or only very limited, freedom of movement behind the vessel, the tow line probably resting on the edge of the transom stern when the tug should move behind the vessel. The wire will get damaged by the sharp edge, giving rise to a risk of parting.

If the ship's construction allows, we recommend a layout as illustrated below on the right hand side. This allows single or two tugs to work at the ship's stern and side over a range of 270 degrees.

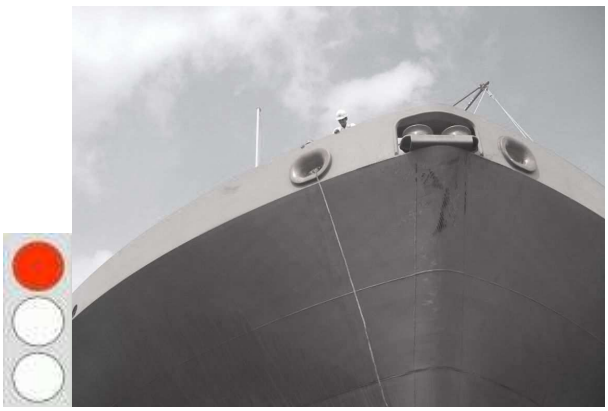


This problem is even more relevant for certain types of ships, such as Ro-Ro vessels with stern ramps, where bitts for towage are often only found in the sides.

5.2.2 Forward

In the picture on the left hand side below, even though the chocks seem well positioned, the deck line will in this case hamper the tug when it needs to work to both sides at a short distance from the bow; the towline may be damaged by the sharp edge of the deck line which increases the risk of the towline parting.

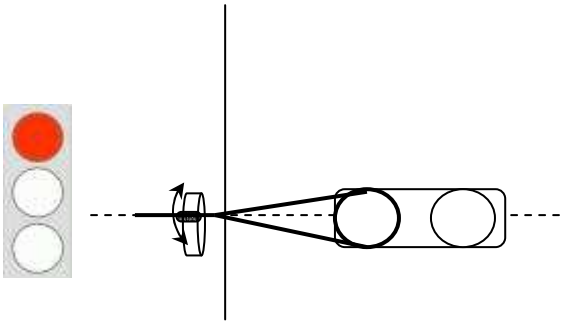
In the picture on the right hand side below, there is no centre line chock and the fairleads on each side are of the roller-type. If to be used for towing, they must be designed suitably strong. A closed (Panama-type) chock however remains the preferred type of equipment.

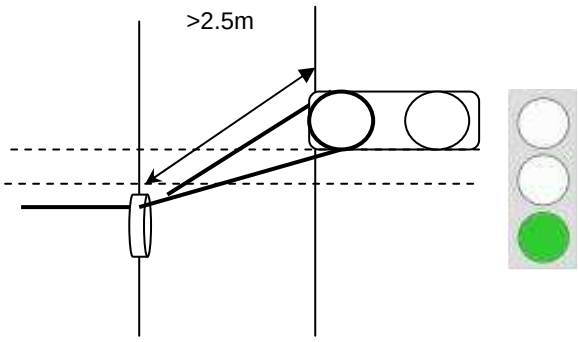


5.3 Angle Of Tow Line And Distance Between Chock And Bitt

At the transom stern, it is often found that the bitt serving a chock is situated right in front of it. When the aft tug is working straight astern, this will result in chafing in way of the chock due to the unavoidable motions of the tug line in the chock. If the bitt is situated slightly out of line, the towline will be kept almost continuously in position on one side of the chock, resulting in less strain in way and thereby reducing the risk of the wire parting.

The distance from the chock to the bitt should be not less than 2m, in order to ensure that the entire tow line loop including clamp or line splice stays clear of the chock during the operations. This also importantly reduces the risk of the line parting.





6 DECK ARRANGEMENT AND ORGANISATION OF THE OPERATIONS

6.1 Deck Lighting

Floodlights located high up in the mast or against the superstructure can blind the tug master, who would be looking directly into them.

In the dark, the tug master will be completely blinded by this light. His eyes will be adjusted to night vision when he arrives and such lights will impair his ability to judge distances in the horizontal plane, thus endangering his manoeuvres.

It is therefore recommended that sufficient floodlights are installed, projecting in different directions. They should be capable of being operated individually, so that the one(s) directed away from the tug can be selected according to the circumstances.

6.2 Mooring Plan And Strength Markings On Bitts

On this subject we would like to quote OCIMF Mooring Equipment Guidelines 3rd edition

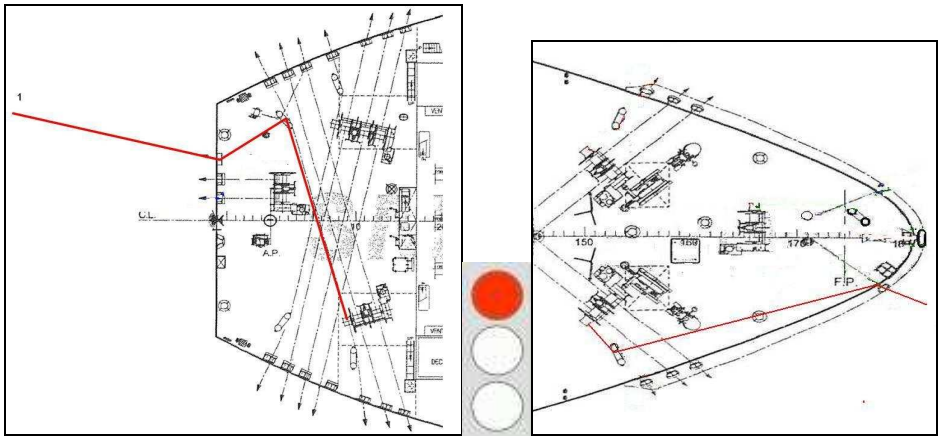
"The mooring plan is produced by Classification Societies to inform Master and Pilot about the load of the relevant parts for towing and mooring on board the ship.
Since about 10 years the rules require marking of bollards, fairleads and winches with the SWL (Safe Working Load) limits. ….. A practical problem in use is, that the SWL in the plan is stated technically correct in Kilo Newton (kN) and the ship's equipment is marked in the common metric tons, which is only 10% of the kNfigure (230 kN = 23t). This could lead to serious misunderstanding regarding the strength."

Therefore, we recommend that the SWL should also be indicated in metric Tons, besides the technical notation in kN.

6.3 Location Of Winches, Warping Drums And Pedestal Fairleads

Especially on large ships it is quite common to find the total distance from the chock to the winch, leading around one or more pedestal fairleads and the bitt, to be more than the length of the tug's messenger line. It must be taken into account that sufficient length of line must be left to take (minimum 3) turns on the warping drum. Warping drums should therefore preferably be positioned at not more than 20m away from the chock, measured along the path of the line. In any case it is always advisable to have an extra messenger line available.

Furthermore, proper attention should be given to positioning of the equipment in order to prevent situations where the mooring lines and towing lines create a complex situation and crossing of lines, which invariably increases the risk to the crew of becoming trapped in line bends.



The increase in tug power has inevitably led to an increase in towing line size, whether steel or synthetic. Crews are often seen to be struggling to secure the eye over the bollard post while the weight of the line is still on the messenger line / warping drum. This operation poses a considerable risk of personal injury.

If the distance is too great, the ships crew cannot manage to let the tug gear go in a controlled manner when releasing the tug. Aft, when the towing gear is dropped instead of lowered in a controlled manner, there is a high likelihood of the towing gear getting caught in the tug's propeller(s), resulting in disablement of the tug.

Therefore, owners should consider in which way the problem can be reduced or overcome. It may be considered to provide easy to use stopping devices at least on the bitts that may be used for harbour towage.

For various types of stopping devices, we refer to the OCIMF Mooring Equipment Guidelines, Third edition; page 172.

6.4 Accessibility of Bitts, Fairleads And Chocks

6.4.1 Bitts

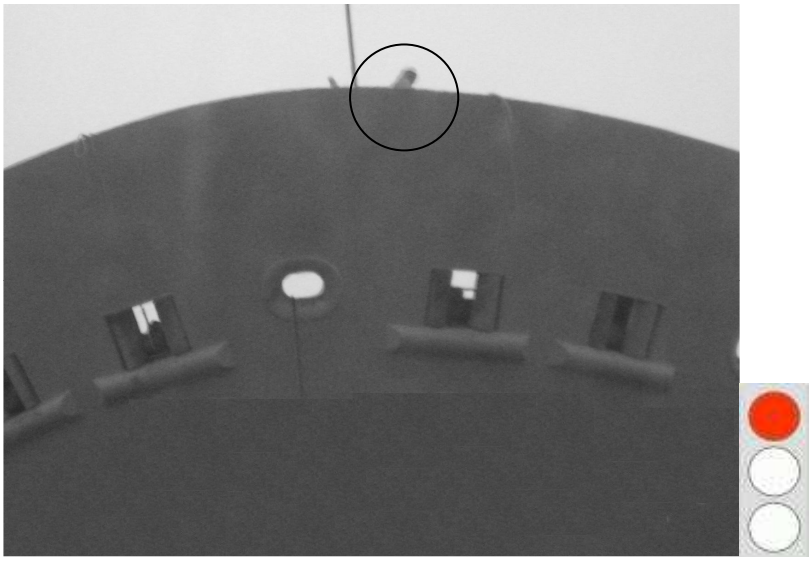
Difficult access to a bitt can be a nightmare for the crew or even result in the bollard never being used, thus turning it onto a waste of resources.

When the crew has no other option than to use a bitt as shown below, this will almost inevitably lead to delays in securing a tug (or during mooring, for that matter) which then could jeopardise the entire manoeuvre. The risk of personal injury also increases considerably.

6.4.2 Fairleads and chocks

Fairleads are often not easily accessed by the ship's crew in order to pass a heaving line easily through the fairlead.

The picture below illustrates the point very well.



When the crew lowers the heaving line from the top in order to pull it in through the fairlead again, they have to try to manoeuvre it just in front of the fairlead and grab it with a hook to pull it back in, in order to lead it to the appropriate position for passing to the tug in the ship's side/shoulder. In windy conditions, this may become almost impossible.

Access from the side will be equally difficult.

There are ways of bypassing the problem by means of endless lines taken through the chock; however, crews are often struggling with this type of problem. We therefore strongly recommend taking this aspect into account at the design stage.

6.4.3 Bulwarks

It also often occurs that the ship's officers and crew at the mooring stations are hampered in their operations by the fact that they cannot easily and readily see the tug, or have insufficient room for throwing a heaving line.

The picture below clearly illustrates the difficulties for the crew

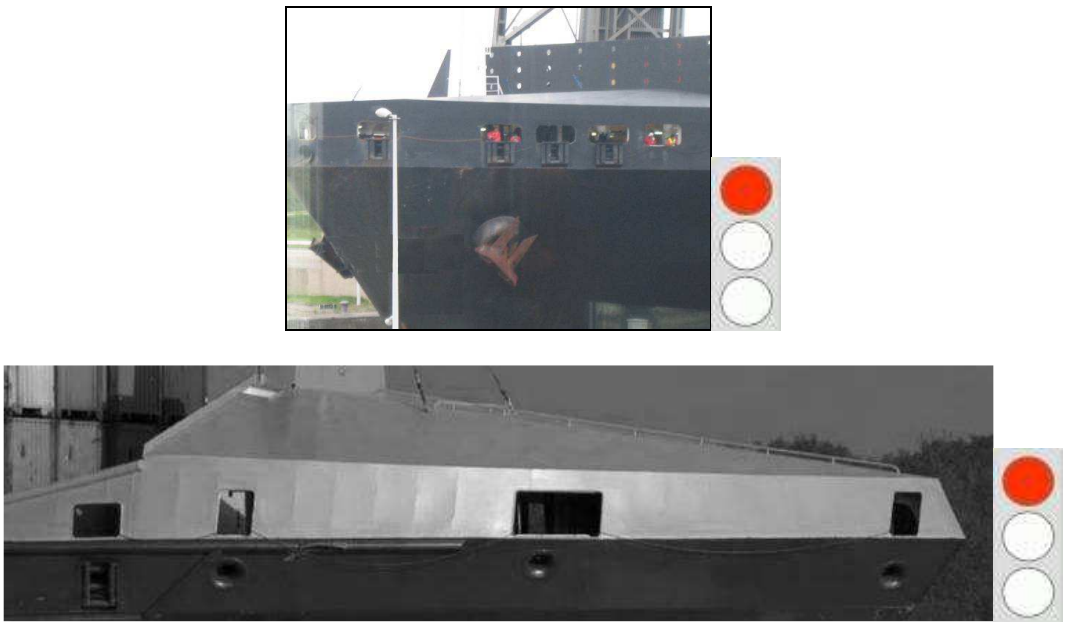
A high and/or heavily inclined bulwark makes it nearly impossible for the crew to look over it and see what is going on below. A person having to throw a heaving line is therefore hampered in his aiming. In a situation as seen above, the railing behind him also hampers throwing a line.

It is highly recommended to ensure that the officer in charge of mooring operations has an elevated position from where he can see the tug when operating ahead of the vessel, as well as when connecting up in the shoulder.

The position for throwing a heaving line should be clear of obstacles and provide sufficient room to swing and throw the line.

6.4.4 Enclosed forecastle decks / canopies

Another development on ship design over the recent years is the introduction of canopies over the ship's forecastle deck. The problem was already quite common on car carriers but has now expanded into container vessels.
The crew may have to try to throw a heaving line through a "window", making it especially difficult to obtain directional accuracy ***and*** get it across with sufficient power in the throw.



Passing a heaving line from the vessel's shoulder is very difficult

It should be ensured that there is a sufficiently large "window" to allow easy aiming and throwing of heaving lines.

6.5 Suggestion For A Dedicated Towing Arrangement

With due regard to the reduced number of crew and increased sizes of towing equipment, it could be considered to install a dedicated towing arrangement, separate from the mooring arrangement.

Even though ETA and EMPA fully understand that additional costs are a serious consideration to shipowners, the advantages of such equipment must also be considered, even though safety is often not quantifiable but for the cases of personal injury that occur.

Additionally, efficient operations will also result in safer and faster operations, avoiding the "spaghetti"-like situations that are frequently seen during mooring and unmooring operations.

Example of a dedicated towing arrangement.

Towing bollard: a dedicated towing bollard can be of very simple but yet sturdy and efficient construction:

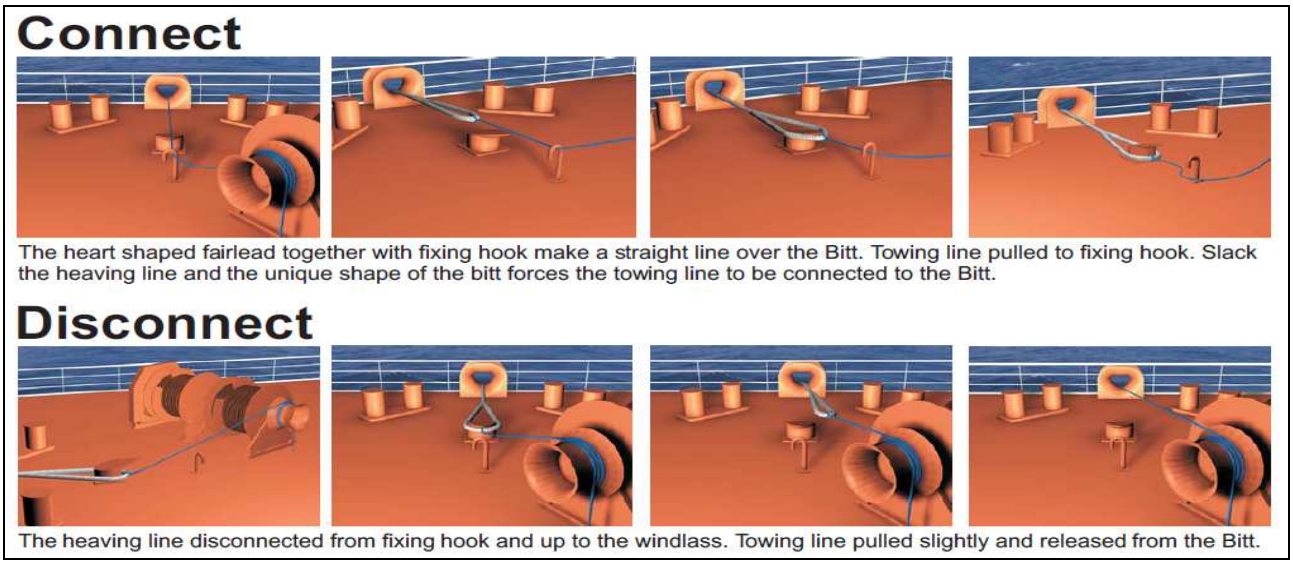
- Smaller (lower) than normal bitt posts
- Single post
- "self- securing" yet without moving parts; i.e. the towline will come into place automatically without the crew having to position it by hand.

Bollards of the type described below have been encountered in operation and have been noticed to be highly efficient: the images below are reproduced with kind permission of the manufacturers. We refer to the website www.safetybitt.com for further information.

As per reference list provided to us by the manufacturers, already more than 200 tankers and RoRo vessels, operating for various major ship owners /managers such as Wallenius Marine, HoeghAutoliners, Teekay, BP Shipping, Knutsen, V-ships and others, are equipped with this type of towing bitt. (Note: we here use the term towing bitt as used on the manufacturers' website)

ETA and EMPA strongly recommend that a type of towing bollard, equally efficient in use, is introduced on all types of vessels, but especially on (ultra) large container vessels.

PRINCIPLE OF OPERATION (Source: www.safetybitt.com)



7 MARKS ON SHIP'S HULL

7.1 Pushing Points

7.1.1 Marks

A ship may have an entire reinforced belt strengthened for pushing all around, but no specific pushing points are given. Absence of such marks can lead to delays when the tug master tries to clarify with the pilot / Master where he may land when requested to push.

Locations where the tug should ***not*** land or push (e.g. pilot doors, recessed side ramps) should also be clearly indicated ("no tug"). Without such marks, this may not be noticed at night.

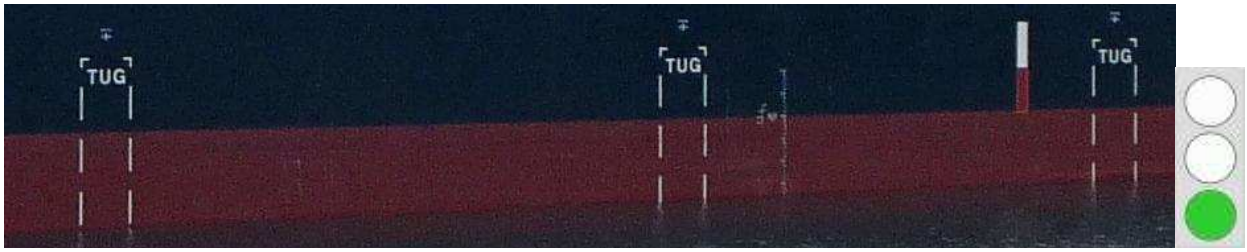
Even when the pushing point is indicated, the tug master does not know what the boundaries of the reinforced area are on either side of the push point. He can only aim for the mark, but when the vessel still has way, it could prove very difficult. A sea or swell would make this even worse.
In the picture below, there are additional indications about the ship's compartments on each side of the tug push point. (Γ , ER / 6)

- Is there danger by pushing just to the left (in this picture: "ER") or to the right (hold or tank 6?)
- Does the angle (Γ) indicate on what side of the arrow the tug may land?
- How wide is the allowed landing area?

It is usually an important question to the tug master how hard he can push. A powerful tug could easily cause deformation of the ship's hull and internals. During mooring / unmooring operations, the ship will react to the force applied and the risk is less. However, when tugs are used to keep a vessel alongside in gale force winds, the vessel cannot move and the applied bollard pull will be brought to bear on the ship's structures!

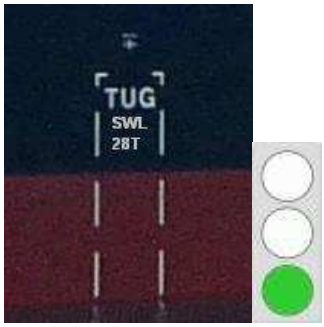
- Can the tug push her full 90 tons of BP on this "TUG"point?

We recommend that a landing area would be clearly indicated to both sides of the "TUG" mark or arrow.



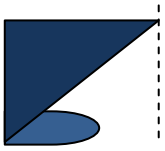
7.1.2 Strength

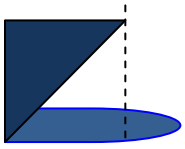
Furthermore, it is recommended to indicate the SWL of that area.



7.2 Bulbous Bows

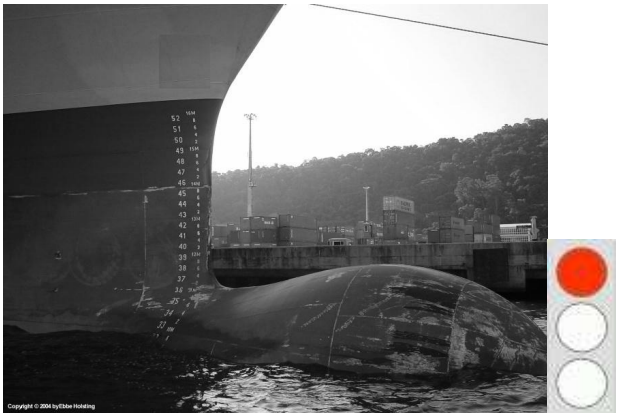
The bulbous bow is specifically designed to counter the ship's bow wave. Bulbous bows, however, differ widely in form and dimensions and will be invisible to the tug master when the ship is at fully laden draft. The tugs operate in and around the bow of the vessel and are affected by the varying pressure areas created by the bow wave and bulb; therefore it is important for the Master to be aware how far the bulb protrudes.





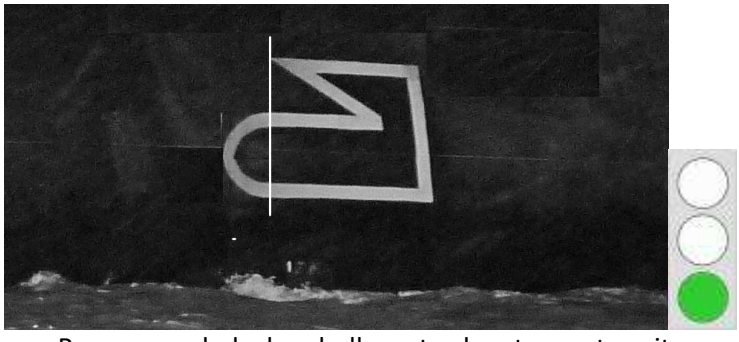
In daylight, the bow wave might give an indication, but in darkness that would not be visible to the tug master anymore.

Bulbs may be deep down below the laden waterline; their presence may be hardly noticeable at the surface.



Absence of any marks

Recommended information



Recommended when bulb protrudes stem extremity

8 HIGH "DEAD SLOW" OF SHIPS

In reefer vessels, container vessels and Ro-Ro ships it frequently happens that the vessel's "dead slow" is 8 knots or even more. This can be a real danger for the tug. Speed has been identified as a key element in most tug accidents.

Even when the pilot stops the engine, a hazardous situation may exist when he needs to give a kick ahead, e.g. in order to correct drift, while the forward tug is in the process of connecting. Speed will build up very rapidly and may result in a disaster.

Also upon leaving a berth or lock, the speed could increase too much before the crew has time to let go the tug and then maybe they will not manage anymore if the vessel should overtake the tug. The only solution would be for the tug to slip its towline, which would then be trailed by the vessel.

We therefore recommend that owners request from their engine manufacturer to ensure that minimum RPM can be set, providing **maximum 6 knots**, is built into their propulsion system for use during tug operations. (Sometimes referred to as "mini" or "baby" dead slow)

9 HISTORY AND BACKGROUND

Recently a working group consisting of EMPA (European Maritime Pilots Association) and ETA (European Tugowners Association) representatives was established. The target of this working group was to define "Best Practice" for both pilotage and harbour towage services and operations in view of the problems that arise with the ever growing ships' sizes and tugboat-strengths, taking into account the various existing rules, regulations and industry guidelines.

Various tug companies from Northwest-European main ports participated in this workgroup and their findings were extensively discussed, whereby existing industry guidelines and/or regulations were considered and evaluated.

Applicable documents:Solas II-1/3-4 and 3-8, IMO MSC circ 1175, 1255 and 84, Solas II-1/3-4 and 3-8, OCIMF Mooring equipment guidelines, third edition,OCIMF Recommendations for ships' fittings for use with tugs

DEVELOPMENT OF SHIPS, TUGS AND HARBOUR TOWAGE

Ships have been assisted by tugs for almost two hundred years. When considering the more recent evolution of tugs since 1980, the following can be noted:

- Tug's maximum power has increased considerably. In addition, there used to be large variations in tug power. The most powerful tugs were used for the large ships and the smaller tugs for the smaller ships. At a certain stage the smaller tugs disappeared and the more powerful tugs had to assist the smaller ships as well. This led to problems with unsuitable bitts, chocks and fairleads.

- Where more power was needed for certain large ships, more tugs used to be ordered. It was not uncommon to have up to 6 tugs assisting a ship. Ship owners, aware of the fact that more tugs meant higher tug charges, put pressure on the tug owners to provide tugs with more power. Over the same period, ship sizes gradually increased, particular those ships with high windage, such as container ships, LNG carriers and car carriers. Tug owners kept pace with the developments in ship size and anticipated the growth in size by building more powerful tugs. During the past two decades the average bollard pull of harbour tugs increased from 30 tons bollard pull (BP) to 60 or even 80 tons BP nowadays, while harbour tugs of 100 tons BP are now coming into service.

  Naval architects and classification societies apparently seem to have overlooked the consequences of stronger tugs. Deck equipment (including deck fittings) on large ships was not upgraded to withstand the high towline forces of new generation tugs. In addition, older and smaller ships were not required to strengthen their fittings to cope with the increasing forces being generated. A new and serious problem developed.

- Strength of deck equipment on ships is related to the minimum breaking strength of the *ship ropes!* See, for instance, the OCIMF publication `Mooring Equipment Guidelines' which tells us: "Although numerous standards, guidelines and recommendations concerning mooring practices exist, …"; furthermore: "Listed `load' variations between two fittings of equal size may be as much as a ratio of 1 to 10, most of which can be due to different definitions of 'load', safety factor and load application."

- Even the most recent publications of IMO and IACS do not refer to the strength of tug towlines. They refer to strength of towlines ships may have on board. Strength requirements for tug towlines are much higher than those mentioned in the above two documents.

- Safe Working loads in use on board ships refer to strength of bitts and fairleads and not to the supporting foundations (even if they are there)! This is an oversight in the requirements, and a cause for many of the present problems!

  The situation now is that container ships have grown in size and tug power has increased considerably, but deck equipment and supporting foundations of such ships lack sufficient strength, so the powerful tugs needed in adverse weather conditions have to limit their power. This results in unsafe conditions! Ironically, to overcome the problem, more tugs might be needed to handle a ship safely and efficiently, so we are back where we were in the old days.

Another factor that cannot be neglected is that it is generally reported by pilots, tug crews and mooring men, that seamanship skills of ships' crews have often not followed the evolution described above.

Where two decades ago most harbour towing operations were carried out by means of ship's lines, and dedicated mooring winches were still rare, seamen routinely handled mooring ropes and belayed them on bitts. The skills of using a stopping device were a basic necessity and common, everyday practice.

Nowadays, mooring ropes are quite often routinely stored on dedicated mooring winches. The only thing the crew has to do is to get them ashore with a heaving line, then operate the winch controls. Consequently, the occurrence of belaying ropes by hand has greatly reduced and the skills are dwindling.