BMA
BHP Mitsubishi Alliance

Hay Point Coal Terminal Mooring Guidelines

April 2022 – Version 1.0

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1. Introduction

The Met Ocean and subsequent mooring loads generated on the ships and terminal infrastructure from visiting Bulk Carriers visiting BMA's coal offtake facility at Hay Point historically has been challenging for ships and terminal staff alike. As part of BMA commitment to people and the environment, all vessel's that have been nominated to undertake cargo operations are vetted via the terminals vessel questionnaire (TVQ). Since the implementation of the TVQ the terminal has seen a large reduction in the mooring related incidents at the terminal. The BMA Hay Point Mooring Terminal Guidelines has been developed to offer further guidance to the requirements of the TVQ and utilised as a supplement to the TVQ and the visiting vessel's mooring and line management plans that are utilised to facilitate mooring operations on board visiting Bulk Carriers.

2. BMA Hay Point Terminal Location and Met Ocean Factors

BMA Hay Point terminal is located forty kilometres (40km) south of Mackay, Queensland and is located within the Great Barrier Reef. The terminal consists of three (3) offshore berths that can moor a range of bulk carriers from Handymax (59k dwt) up to Cape size (180k dwt plus).

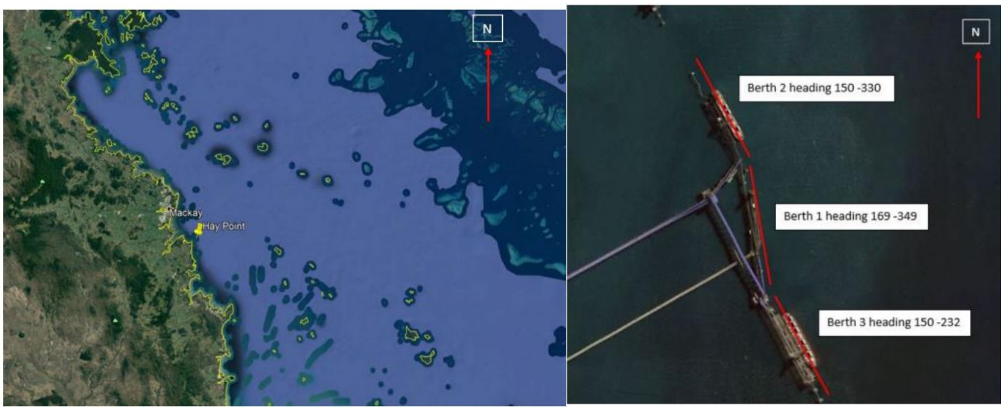


Fig 1: Hay Point Berth Locations

The berths at Port of Hay Point are located up to four (4) kilometres offshore and are exposed to the South East trade winds that blow for most of the year. The winds produce a short sharp sea with wave heights of approximately two (2) meters being experienced at the berth. Longer period waves of approximately one (1) meter in height are generated from the long fetch seventy-five kilometres (75km) due to the berth's alignment to the Capricorn Channel. In addition, the area experiences a large tidal range with king tides reaching heights of seven meters (7 m) above LAT. With this large tidal range comes currents of approximately one (1) knot with the Ebb tide setting to the NNW and the flood tide to the SSE on about 150º.

The upper Met Ocean conditions experienced at the terminal do provide challenging mooring conditions at the berth. Modelling and mooring hook load cell data has indicated loads for light ship Panamax vessels exceed forty (40) tons and for Cape sized vessel sixty (60) tons are exceeded. Under normal weather conditions loads range between twenty (20) and thirty (30) tons. In more severe conditions, ships do move whilst alongside the berth placing large mooring loads on the vessels and terminal mooring infrastructure. The movement can lead to broken mooring lines, uncontrolled ship excursion, hull damage and damage to wharf infrastructure (fenders).

Therefore, ships' Masters, crews and terminal staff need to be particularly vigilant when undertaking cargo operations at the facility.

3. Guidelines for Mooring Equipment Design & Terminal Operational Philosophy

The type of mooring lines, their management whilst in service, the size and type of mooring equipment on board vessels and the relationship of the vessel's mooring lines and mooring equipment to the ship's design MBL are critical to operational and safety performance of ships undertaking cargo operations. More specifically the mooring line design breaking force, the mooring brake holding capacity, mooring winch pulling force as well as the terminals and vessel mooring furniture safe working loads (SWL) and their relationship to the ship design MBL are critical components of a vessel's safe mooring operations philosophy. Therefore, all ships undertaking cargo operations at Hay Point must have a clear understanding of the mooring equipment and mooring lines that are in use on their vessel's and their relationship to the vessel's ship design MBL and how it has been derived. The ship design MBL must be declared via the terminal vessel inspection questionnaire (TVQ).

3.1. Defining Ship Design Minimum Breaking Load

The ship design Minimum Breaking Load (MBL) should be calculated based on either the class society rules requirement which is linked to the ship equipment number or via the guidelines outlined in the Oil Companies International Marine Forum (OCIMF) Mooring Equipment Guidelines (MEG) 4. The ship design MBL OCIMF MEG 4 guidelines due to the Met Ocean requirement are generally larger. Therefore, for Bulk Carriers, the correct ship design MBL should be derived from the class approved Equipment Number calculation.

For older vessels or cases where the ship design MBL is unknown or when Equipment Number (EN) calculation is missing or unknown, the ship design MBL can be estimated and used for the purpose of mooring system management by:

1. The ship design MBL can be assumed to be the same as the size of the original mooring lines which were placed on board has part of the vessel's compliance to class and subsequently flag state requirements.
2. The ship design MBL can be calculated and assumed to be 125% of the maximum brake holding capacity which can be found from mooring winch certificate.
3. The ship design MBL can be assumed to be the same as the safe working loads of the mooring furniture which is used for mooring operations found on board the vessel.

In cases were the original mooring lines and/or the 125% of the maximum brake holding capacity are greater than safe working loads (SWL) of the mooring furniture, the ship design MBL should be taken as the mooring furniture.

As a guide the ship design MBL for Panamax vessels ranges between 55t-63 tons, while for Cape sized vessels the ship design MBL range between 72-80 tonnes.

3.2. Optimum Mooring Configuration and Mooring Philosophy

It is appreciated that most vessels do have in place via the Operator's mooring management plans, standard mooring configurations which are focussed on symmetrically and evenly distributing mooring loads to each mooring line.

However, for each of the three (3) berths at Hay Point depending on vessel size and whether the ship is required to berth port or starboard side, there is a recommended mooring configuration which will be communicated and discussed during the terminal vessel questionnaire process (TVQ) and confirmed with the vessel by the Pilot before mooring operations.

Specific mooring configurations for specific ship types are available if requested.

Typically for handy sized ships a minimum of eight (8) powered mooring winches is required.

For Panamax sized vessels a minimum of ten (10) powered mooring winches is required.

For Mini Cape and Cape sized vessels a minimum of twelve (12) powered mooring winches is required.

The guidelines for mooring arrangements on ships undertaking cargo operations at the terminal can be summarised as follows:

1. As far as possible, all lines should be run from mooring winches.
2. Lines must lead from winch drums to shore via fairleads with minimum a deflection / turns between the mooring winch and the shore hooks.
3. Only one mooring fairlead or mooring fitting must be used per mooring line. Multiple lines must not be passed over a single fitting.
4. On vessels constructed with split drums and single layer of mooring line is required on the split drum.
5. There must be sufficient deck crew to monitor the forward and aft mooring lines simultaneously. The mooring lines must be monitored at all times.
6. The Operators mooring management philosophy outlined through the on-board procedures should comply with the terminal's inspection, maintenance and service life guidelines as outlined in the terminal vessel questionnaire and as outlined in section four (4), five (5) and six(6)

3.3. Design and Safety Factors of Fixed Mooring Equipment

The guidelines around the design and construction of the vessel's mooring equipment and furniture are to ensure the equipment installed are large enough to ensure that there is adequate force at hand to hold the vessel and to heave against the environmental forces generated by the vessel's interaction with the environment but not large enough to overstress the moorings lines, mooring winches and furniture.

More detailed information can be found in BMA Technical Notes titled "Hay Point Mooring Winch Operations Guidelines" and "Mooring Winch Design and In Service Analysis"

The guidelines for mooring equipment design and operations on ships undertaking cargo operations at the terminal can be summarised as follows:

1. Where possible all mooring winches as a minimum should comply with ISO 3730.
2. The minimum ship design MBL for any vessel visiting the terminal should be equal to or greater than 1.25 times the maximum brake holding capacity of the mooring winch. The SWL of the winch should be equal to or greater than the ship design MBL.
3. The mooring winches brakes should be set to render between 60%-80% of the ship design MBL. On vessel's constructed with conventional divided mooring drums a minimum of thirty (30) tons is required at the third layer. On vessels constructed with a split drums a minimum of thirty (30) tons is required at the first layer. Tests should be undertaken at twelve (12) month intervals.
4. All fairleads and mooring rollers for mooring must be equal to or greater than the ship design MBL.
5. All mooring fairleads need to be smooth. All mooring rollers should be free to move.

3.4. Initial and in Service Mooring Lines

When ships are delivered, they are typically constructed with mooring lines with line design breaking forces (LDBF) approximately equal to the ship design MBL. A review of the data does indicate that both the Panamax and Cape Sized Bulk Carriers seem to have mooring line LDBF's an average of 130% above the ship design MBL.

The reason for the increase in LDBF is thought to be due to some Ships Operators and Terminals being of the belief that the increased mooring line breaking strains increases the overall mooring system safety. This is not necessarily the case especially where vessels experience elevated Met Ocean conditions.

More detailed information can be found in BHP Technical Notes titled "Hay Point Mooring Lines and Operations Guidelines"

The guidelines for mooring lines on board ships undertaking cargo operations at the terminal can be summarised as follows:

1. Mooring lines as minimum should comply with ISO 3730. If possible, the original and in service lines design breaking force (LDBF) should be between 100-105% the ship design MBL.
2. In cases where greater strength lines (i.e larger LDBF) are used than what was originally installed, the mooring line LDBF can be higher than the ship design MBL but should always be less or equal to the safe working load values of mooring equipment and where possible SWL of the mooring winches. In situations where this is not possible the correct setting of the mooring winch brake rendering points is critical to ensure the safety of ship/terminal staff.
3. Mooring lines that are constructed of synthetic material should not be a greater diameter to eighty millimetres (80mm).
4. Mooring lines cannot be constructed of wire.
5. Mooring lines constructed of high modulus material must be fitted with synthetic mooring tails.
6. Mooring tails should be attached via cow hitching as shown below.

7. Mooring lines should be of the same type, length, and diameter of lines on the same leads.
8. Mooring lines that make contact with fairleads or mooring rollers should be fitted with chafe protection.
9. The mooring lines should be kept under tension and monitored by ships staff at all times.
10. Mooring lines and mooring tails should comply with the terminal's inspection, maintenance and service life guidelines as outlined in the terminal vessel questionnaire and as outlined in section four (4), five (5) and six(6).

4. Mooring Equipment, Mooring Line Management and Life Cycle Management

The Operator via the mooring management and line management plans should have in place a clear documentation which includes plans detailing the mooring equipment and mooring furniture fitted to the vessel. The mooring and line management plans should also include the life cycle plan for mooring lines. The process should commence with the selection of the mooring lines for specific environments and include the monitoring of the physical condition and residual strength of the mooring line throughout its service life.

4.1 Mooring Equipment Plan

The Operator should have on board a mooring management plan or a detailed list of mooring equipment.

The terminal will review the information via the terminal vessel questionnaire process. The information required by the terminal will take the form of:

1. A summary of permanent fittings and machinery installations.
2. A general arrangement or plans indicating the locations of mooring machinery and permanent fittings.
3. Details of machinery specifications or operating manuals of the mooring machinery.
4. Details of deck strengthening in the areas of mooring equipment and furniture.
5. Details of mooring equipment and furniture safe working loads which include geometric factors of applied mooring loads.

4.2 Mooring Line Strength Criteria.

The mooring line strength can be described by the mooring line design breaking force (LDBF) and Working load limit (WLL). The strength criteria should be used with Operators mooring and line management plans to outline the mooring lines tested and rated line performance, operational loads, and calculated safety margins.

The strength criteria can be defined as follows:

LDBF: The minimum force a new dry spliced mooring synthetic and high modulus lines line will break under load. For nylon lines, the value is measured wet. The values should be outlined on the mooring line certificates.

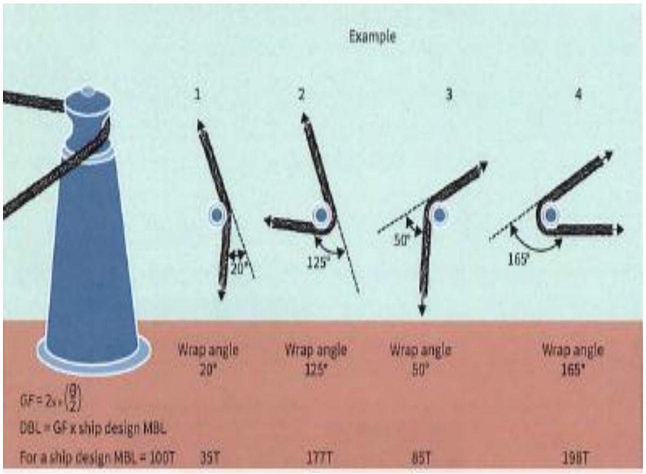
WLL: The maximum load a mooring line should be subjected to during operational service. The WLL for high modulus, synthetic and nylon lines should not exceed 50% of the LDBF.

4.3 Factors Affecting Mooring Loads Mooring Line and Equipment Strength Criteria

The Mooring equipment Design Basis Load (DBL) is to be taken into consideration when planning mooring operations.

The strength criteria can be defined as follows:

DBL: The design load on a fitting calculated by applying a geometric factor. It should be noted that DBL will change when load is applied from mooring lines at different angles. This may exceed the safe working load of a fitting particularly in cases where changes of angles of more than 90 degree occur. Applied loads rapidly increase as the angle of the load applied by the mooring line increases reaching a maximum at 180 degrees



Angle of deflection of Mooring line over the fitting	Load on the line	Actual load on the fitting at various angle of deflection
0	100ts	0ts
10	100ts	17ts
30	100ts	50ts
50	100ts	84ts
70	100ts	**114ts**
100	100ts	**152ts**
150	100ts	**182ts**
180	100ts	**200ts**

Fig 2: Mooring line load increases with angle

The maximum angle over which a line can be turned over a fitting is given in the ships mooring arrangement plan. This value should be known by all ships staff involved in mooring operations.

The angle must not be exceeded. Mooring lines must pass from winch drum to the shore via fairleads in as straight line as possible without undue deflections around fittings.

4.4 The Use of Loose Mooring Lines

The use of loose mooring lines should be avoided, where possible lines should be deployed using the powered drums. In cases where loose mooring lines are required, the Pilot and Terminal should be consulted.

In the case where loose lines are required for service, they should be secured by the ships mooring bitts. Methods for securing, creating, maintaining and relaxing tension need to be agreed with the terminal.

The maintained mooring efficiency and mooring line strength characteristics mooring bit diameter should be fifteen times greater than mooring line diameter. The D/d ratio should be fifteen (15) or above and kept as large as possible to maximise mooring strength and working life.

Mooring lines should not be secured using cruciform bollards and secured to the ships mooring bits using a figure of eight (8).

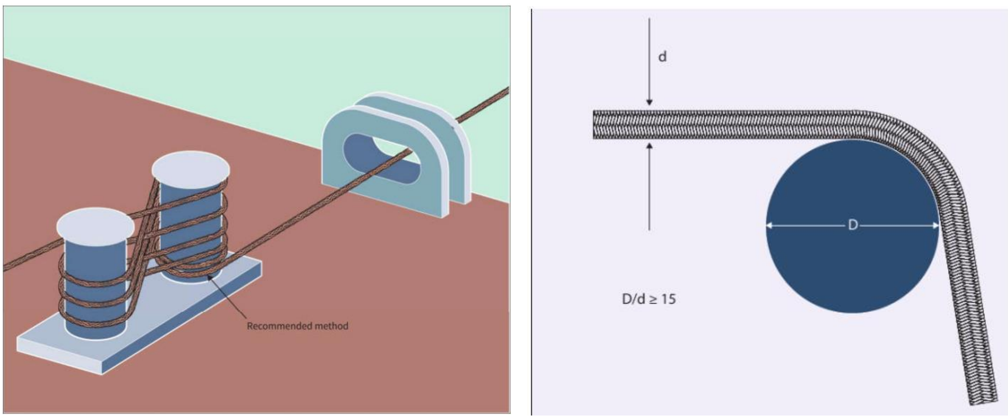


Fig 3: Loose Line Mooring Operations.

4.5 Mooring Line Stiffness

The stiffness of a mooring line is its ability to stretch under load, mooring lines with low stiffness absorb higher dynamic loads. Wire and HMSF lines have high stiffness and synthetic lines have low stiffness. Mooring lines made of extremely low stiffness materials such as Nylon will mean the ship will move more in the berth which cause problems with the terminals operating envelop particularly in upper Met Ocean condition.

In cases were mooring lines of different stiffness are used in the same service, the lines with higher stiffness will take greater load.

If possible, nylon mooring lines should not be used as mooring lines except when used as mooring tails. Nylon lines have very low stiffness and can cause vessel to surge at berth.

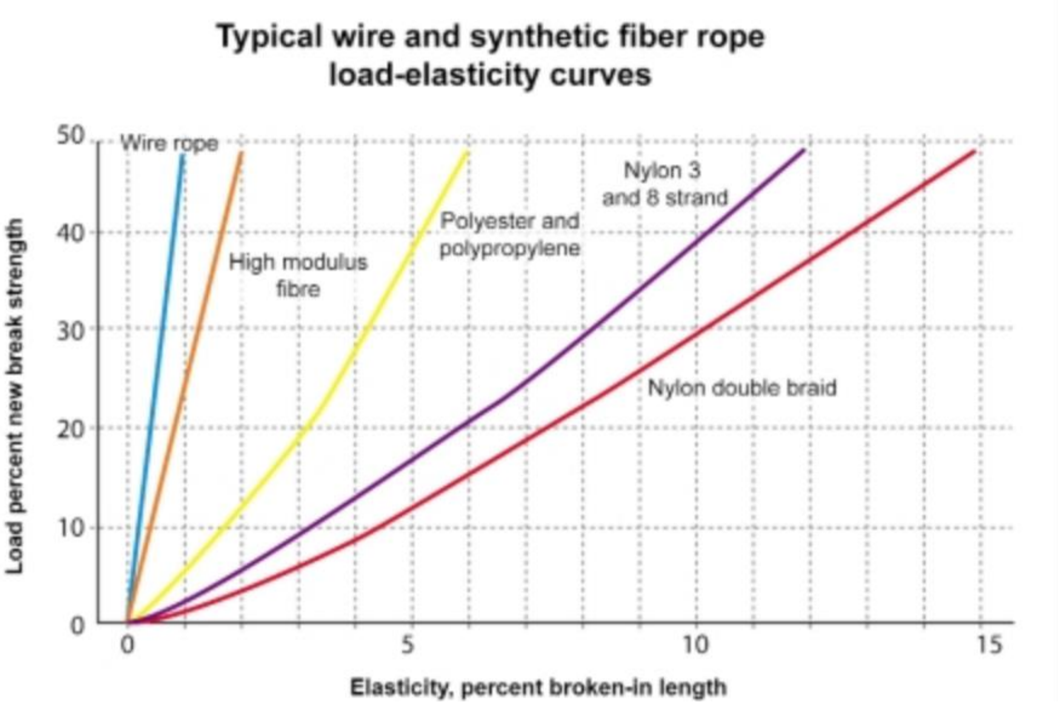


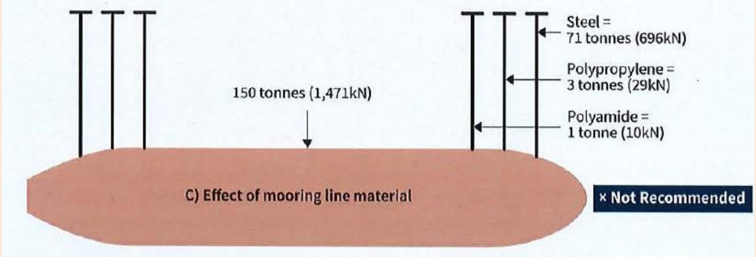
Fig 4: Typical wire and synthetic fibre rope load-elasticity curves.

4.6 Mixed Mooring Line Usage

The Mooring lines of the same size and type should always be used for all leads used in the same service, i.e. breast lines, spring lines, headlines and stern lines.

The mooring lines should be arranged so that all lines in the same service are approximately the same length between the ship and shore bollards

When mooring tails are used, they must be of same size and material.



Different type of lines/ Different material/ Same direction/ Same service/ same lengths

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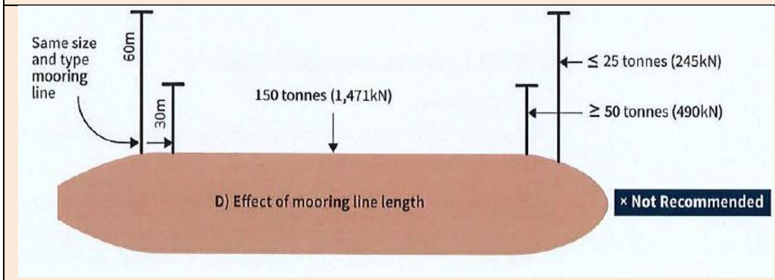
<tr><td>
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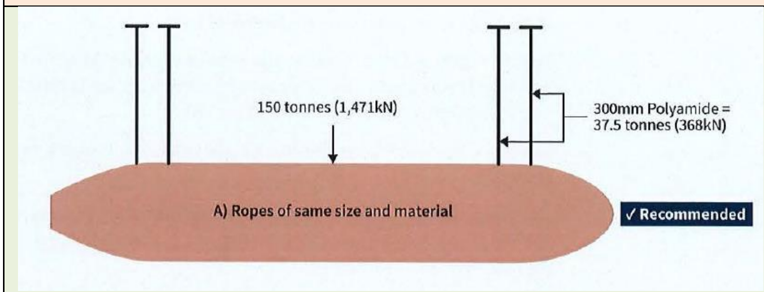
<tr><td>
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Fig 5: Loose Line Mooring Operations (source Anglo Eastern)

4.7 Mooring Tail Service Requirements

The Terminal does require that Operators who undertake mooring operations utilising high modulus synthetic fibre (HMSF) lines to utilise mooring tails. The mooring tails must be a synthetic material that is less stiff than the HMSF.

The difference in stiffness of multiple line materials in the mooring system affect how the mooring loads are distributed in the mooring systems. There is empirical evidence indicating that the use of mooring tails dampens and reduces load on the mooring system.

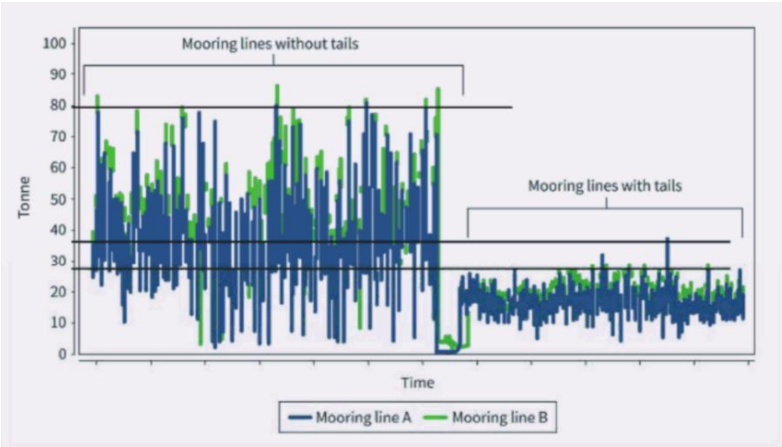


Fig 6: Mooring Tail dampening (MEG 4)

The requirements of mooring tail usage at the terminal can be summarised as follows.

1. The mooring tails material must be a synthetic material which is less stiff than the mooring line in use.
2. The mooring tails must be between 11 meters and 22 meters. Hay Point is an open water port in upper met ocean conditions the terminal has a preference for 22-meter mooring tails.
3. The LDBF of the mooring tails must be 125%-130% high than the LDBF of the mooring lines.
4. Mooring tails must be attached to mooring lines via cow hitch.

4.8 Mooring Line and Tail Service Life

The Operators Mooring and Line Management plans must have defined procedures for the retirement of mooring lines and tails.

For simplicity, the Terminals' preference is to retire mooring lines and tails when they reach a defined service life or when their physical condition does not allow further service.

However, the retirement procedures may take the form of:

1. For mooring lines, an inspection of the mooring lines based on the Cordage Institute 2001E inspection for synthetic lines. When any retirement criteria are met, it is assumed that the strength of the line is less than 75% of SDMBL and line is to be retired from service. Mooring tails do not form part of inspections and residual strength assessments.

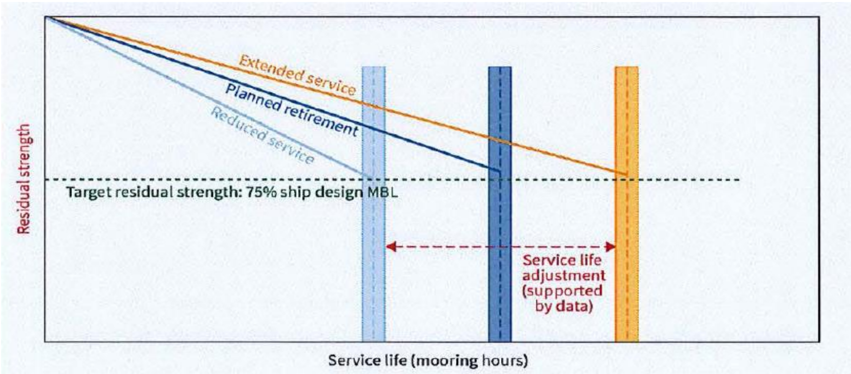


Fig 7: Mooring line residual strength (source MEG 4)

2. In service condition-based monitoring. The Vessel inspection results that indicate that the condition of the mooring lines or tails have been damaged or there has been evidence of mooring lines or tails being overloaded past their WLL.

3. The mooring lines or tails have a defined time or have reached the manufactures lifecycle limits as per the below table.

Type	Retirement	Condition for Extension in Service
Mooring Ropes	5 years from date in use	Extension on case-to-case basis after thorough evaluation of condition and consultation or inspection by line manufacturer or third party. A mooring line test must be undertaken and a certified certificate supplied as part of an extension to the mooring lines service life. **Service life cannot be extended to more than 8 years.**
HMSF ropes	The terminal will advise on HMSF lines above five (5) years.	Case-to-case basis after thorough evaluation of condition and consultation or inspection by line manufacturer or third party. A mooring line test must be undertaken and a certified certificate supplied as part of an extension to the mooring lines service life. **Service life cannot be extended to more than 10 years**
Mooring Wires	Not permitted at terminal	No extension permitted

Mooring tails	18 months from date in use	Can be extended to 24months basis evaluation of the service and condition. A mooring line test must be undertaken and a certified certificate supplied as part of an extension to the mooring lines service life No extension permitted beyond 24months

Table 1: Mooring Line and Tail Service Lives

5. Terminal Mooring and Mooring Line Inspection Guidelines

BMA Hay Point does undertake assessments of individual bulk carriers visiting the terminal by using the terminal vessel questionnaire (TVQ). The TVQ is the terminal's primary assessment tool for vessel suitability.

In addition to the guidelines outlined in the preceding sections the Operators mooring and line management plan should contain specific guidance on the following which are reviewed as part of the TVQ review process.

5.1 Mooring Line Certificate File

Each mooring line is issued with a manufacturer's certificate which specifies the construction, material and MBL of the line. These certificates must be received on the vessel when the line is delivered, otherwise the line cannot be used on the vessel. Once the line is put into use, the certificate must be placed into a file to allow the certificate to be matched to the individual mooring winches. All the certificates should be in one file, clearly stating when the line was put into use and identifying the winch that the line is on.

Mooring line certificates will be requested by BMA upon vessel nomination to Hay Point for verification.

5.2 Mooring Line Age and End for End Dates

BMA require synthetic mooring lines are end for ended after 2.5 years, and then replaced after five (5) years.

5.3 Minimum Mooring Line Length

New mooring lines are 220 meters in length and vessels should look to maintain a minimum length of 200 meters on each mooring winch. The 20m between new and when the line should be discarded is for testing the line when required.

The 200m length allows enough line for the line to be run to the hook, including manoeuvring by the lines boat. The vessel should be able to confirm, prior to arriving at the port, that all mooring lines meet the minimum requirement of 200m.

5.4 Management of Snap Back Zones

Vessel movement caused from upper Met Ocean conditions at Hay Point creates additional energy in the mooring system. If the energy is released on a sudden failure of a mooring line that can occur for untended mooring lines or when mooring lines that exceed their LDBF the sudden release of energy will cause mooring lines to snap back unpredictably.

The size of the energy produced from a snap back event is proportional to the sea state, the length of mooring line deployed and the stiffness of the line.

The Haypoint terminal particularly due to distance from terminals mooring hooks and sea state does have greater potential for snap back therefore Operators of vessels are required to have a comprehensive snap back zone management plan.

Operators should not mark individual snap zones around winches. The whole mooring area at the bow and stern as well areas surrounding mooring spring winches should be marked as a snap back zone.

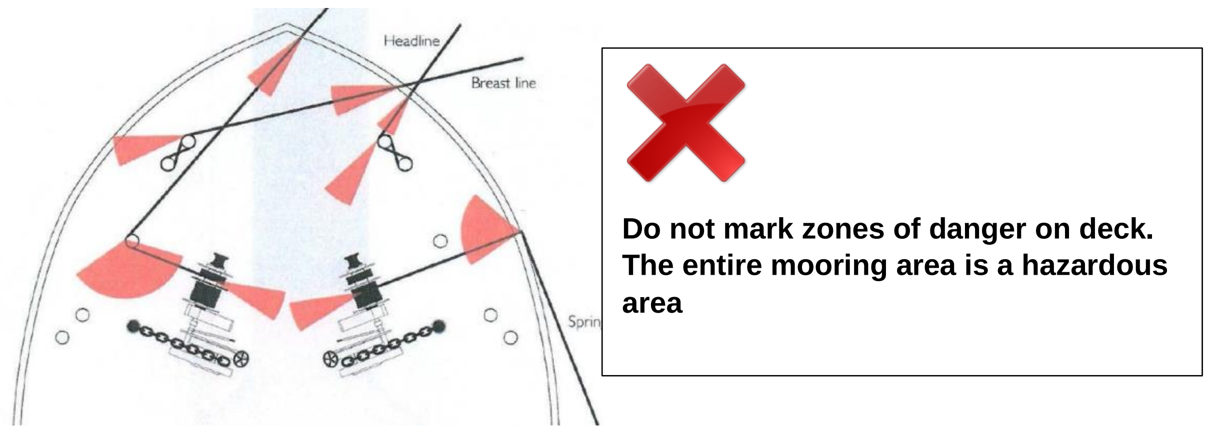


Fig 8: Snap Back Zone Markings (source Anglo Eastern)

5.5 Spares of Mooring Lines

The following spares shall be maintained as a minimum on board:

Type	Spare required
Mooring Ropes	2 Coils
Mooring Wires	Not permitted
HMSF ropes	2 Coils
Mooring tails	10% or 4 Nos whichever is higher
Mooring shackle	Not permitted at the terminal

Inspection Intervals of Mooring Lines and Tails

The terminal does require that mooring lines and tails should be inspected at regular intervals. The inspection intervals of mooring lines and tails depend on the service interval of the lines.

As guide the terminal does require the following:

1. The inspection of mooring lines and tails must be undertaken by the vessel's Senior Officers. The inspection process and guidelines should be clearly outline in the Operator's Line Management plan.

2. HMSF mooring lines must undertake a detailed inspection by the makers' representative at five (5) year intervals. Copies of the makers' reports may be requested by the terminal.

3. Mooring Lines, tails must undertake a routine inspection at a minimum of six (6) month intervals.

4. An inspection of the mooring line high wear or contact areas must be undertaken before undertaking cargo operations.

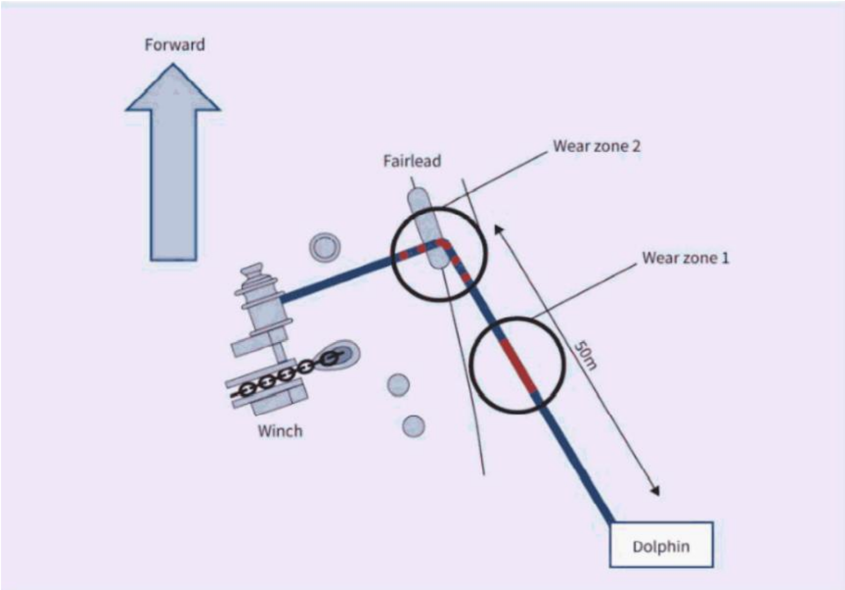


Fig 9: Mooring Line and tail High Wear Zones (MEG 4)

A mooring line and mooring tail summary document should be in place. The document should outline the key mooring line, mooring tail and inspection information.

Vessel	EXAMPLE
IMO	987654321

	Winch no. / line no.	Certificate date	Certificate on board?	Date of installation	n of mooring line	Minimum breaking load	Length	Diameter	mooring line end to ended	Scheduled replacement date	Winch brake rendering capacity	winch brake rendering test	Date of last inspection	Condition of mooring line
	Lines in use:													
Headline Lead	Head line/Fwd in drum 1	12 Jul. 2019	YES	10 Dec. 2016	High Tenacity	104 tons	220 mtrs	80mm	23 Jun. 2019	Dec.2021	09.02.2021	47,1 tons	05 Feb. 2021	Good
	Head line/Fwd in drum 2	13 Jul. 2019	YES	10 Oct.2018	Polypropylene Filament	101 tons	220 mtrs	78mm	N/A	Oct 2023	09.02.2021	47,1 tons		Good
	Head line / Fwd in drum 3	04 May. 2020	YES	10 Dec. 2016	High Tenacity	104 tons	220 mtrs	80mm	22 Jun. 2019	Dec.2021	09.02.2021	47,1 tons	05 Feb. 2021	Good
	Head line / Fwd in drum 4	04 May. 2020	YES	12 Sept.2018	Polypropylene Filament	101 tons	220 mtrs	82mm	N/A	Sept 2023	09.02.2021	47,1 tons	05 Feb. 2021	
FORWARD Springline	Fwd Spring line / MO in drum 5	04 May. 2020	YES	04 Feb. 2021	HMPE	98 tons	220 mtrs	40 mm	N/A	May 2025	09.02.2021	47,1 tons	05 Feb. 2021	
	Fwd Spring line /Loose	04 May. 2020	YES	04.Feb.2021	HMPE	98 tons	220 mtrs	42 mm	N/A	May 2025	09.02.2021	N/A	05 Feb. 2021	Good
FORWARD Breastline Lead	Breast line Fwd/Loose	13 Apr. 2017	YES	30 April. 2017	High Tenacity	85 tons	220 mtrs	76mm	05 Oct. 2020	April 2022	09.02.2021	N/A	05 Feb. 2021	
	Breast Line Fwd/ Loose	13 Apr. 2017	YES	30 April. 2017	High Tenacity	85 tons	220 mtrs	76 mm	05 Oct. 2020	April 2022	09.02.2021	N/A	05 Feb. 2021	Good
STERN Springline Lead	Aft Spring line / MO in drum 6	12 Jul. 2019	YES	07 Feb. 2020	High Tenacity	98 tons	220 mtrs	72 mm	N/A	Feb 2025	09.02.2021	47,1 tons	05 Feb. 2021	
	Aft Spring line / loose	12 Jul. 2019	YES	04 Feb. 2021	High Tenacity	98 tons	220 mtrs	70 mm	N/A	Jul 2025	09.02.2021	N/A	05 Feb. 2021	Good
STERN Breastline Lead	Breast Line aft	14 Mar. 2017	YES	10 Dec. 2017	HMPE	85 tons	220 mtrs	35 mm	05 Feb. 2020	Dec.2022	09.02.2021	N/A	05 Feb. 2021	Good
	Breast line aft	14 Mar. 2017	YES	10 Dec. 2017	HMPE	85 tons	220 mtrs	35 mm	05 Feb. 2020	Dec.2022	09.02.2021	N/A	05 Feb. 2021	Good
STERNLINE LEAD	Stern line / Aft in drum 7	1 Feb. 2021	YES	2 Feb.2021	Polypropylene Filament	118 tons	220 mtrs	80 mm	N/A	Feb 2026	09.02.2021	47,1 tons	05 Feb. 2021	Good
	Stern line / Aft in drum 8	1 Feb. 2021	YES	2 Feb. 2021	Polypropylene Filament	116 tons	220 mtrs	80 mm	N/A	Feb 2026	09.02.2021	47,1 tons	05 Feb. 2021	Good
	Stern line / Aft in drum 9	1 Feb. 2021	YES	2 Feb.2021	Polypropylene Filament	118 tons	220 mtrs	80 mm	N/A	Feb 2026	09.02.2021	47,1 tons	05 Feb. 2021	Good
	Stern line / Aft in drum 10	1 Feb. 2021	YES	2 Feb.2021	Polypropylene Filament	118 tons	220 mtrs	80 mm	N/A	Feb 2026	09.02.2021	47,1 tons	05 Feb. 2021	Good
	Spare lines:													
	Winch no. / line no.	**Certificate date**	**Certificate on board?**	**Date of installation**	**n of mooring line**	**Minimum breaking load**	**Length**	**Diameter**	**mooring line end to ended**	**Scheduled replacement date**	**Winch brake rendering capacity**	**winch brake rendering test**	**Date of last inspection**	**Condition of mooring line**
	SPARE	1 Feb. 2021	YES	2 Feb.2021	Polypropylene Filament	118 tons	220 mtrs	80 mm	N/A	Feb-26			05 Feb. 2021	Good
	SPARE	1 Feb. 2021	YES	2 Feb.2021	Polypropylene Filament	118 tons	220 mtrs	80 mm	N/A	Feb-26			05 Feb. 2021	Good
	SPARE	14-Mar-17	YES	3 Feb.2021	HMPE	85 tons	220 mtrs	35 mm	N/A	Mar-22			6 Feb. 2021	Good
	SPARE	14-Mar-17	YES	4 Feb.2021	HMPE	85 tons	220 mtrs	35 mm	N/A	Mar-22			7 Feb. 2021	Good
	Mooring Line Tails and Spares													
	Fwd Spring line / MO in drum 5	12 Jul. 2019	YES	07 Feb. 2020	Polypropylene Filament	80mm	11	60mm	N/A	12-Dec-20	09.02.2021	N/A	19-Aug-20	Good
	Fwd Spring line /Loose	12 Jul. 2019	YES	07 Feb. 2020	Polypropylene Filament	80mm	11	60mm	N/A	12-Dec-20	09.02.2021	N/A	20-Aug-20	Good
	Breast Line aft	12 Jul. 2019	YES	07 Feb. 2020	Polypropylene Filament	80mm	11	60mm	N/A	12-Dec-20	N/A	N/A	20-Aug-20	Good
	Breast line aft	12 Jul. 2019	YES	07Feb. 2020	Polypropylene Filament	80mm	11	60mm	N/A	12-Dec-20	N/A	N/A	26-Aug-20	Good
	Spare	12 Jul. 2019	YES	07Feb. 2020	Polypropylene Filament	80mm	11	60mm	N/A	12-Dec-20	N/A	N/A	26-Aug-20	Good

Fig 10: Mooring Line and tail Summary Document

6. Guidelines on Mooring Operations

The terminal and its staff are in place to provide guidance and assistance throughout a Bulk Carrier's stay at the terminal however it is the responsibility of the Master and the ship's staff to ensure the vessel remains alongside the terminal.

The Ship Operator’s mooring and line management documentation should guide the Master and Ships staff on safe mooring practices and tendering of mooring lines.

It is thought the ship operators mooring policies and procedures should incorporate the following:

6.1 The Management of Shipboard Activities during Cargo Operations

During cargo operations it is important that the ship staff concentrate on cargo operations and mooring operations. Activities that require the Deck Officers and ratings to divert their attention away from these essential activities are not recommended.

During cargo operations, if the vessel wishes to undertake bunkering operations, load water, dispose of garbage, load provisions and stores the terminal needs to be advised.

It is advised all activities that deflect the ship’s staff attention away from cargo and mooring operations be undertaken before, after or during stops in cargo operations.

6.2 Mooring Equipment and Mooring Line Verifications

To remain securely berthed it highly important that the lines remain correctly tensioned. Lines that are under tensioned will cause additional load to be transferred to the adjacent mooring lines. Mooring lines that are over tensioned can potentially pass their working load limit (WLL) and become overloaded, cause the mooring winch to render or in extreme cases cause the mooring line to part.

The terminal does supply a tablet that does record the tension in the mooring lines however the tablet should be used as guide and is not a substitute for continual monitoring of mooring lines by ships staff.

To ensure that the mooring lines are continually verified, the terminal does require the vessel to have sufficient deck staff to tender the forward and aft mooring lines simultaneously.

A formal system for continually monitoring the tension of the lines and recording the details of the verifications is required.

6.3 Mooring Winch Verifications

The mooring winch brake holding render tests should be undertaken every twelve (12) months.

The mooring winch brakes should be set to render between 60-80% of the ship design MBL or Maximum Brake Holding capacity, whichever is the lesser. At Hay Point, to guard against uncontrolled ship movement the values should correspond to a brake render set point of approximately thirty (30) tons.

For conventional drums, the rendering point must be set at approximately at the 3rd- 4th rope layer and for split drums this must be set at the 1st layer. For both conventional and split drum mooring winches, the maximum render point value if possible, should not exceed the maximum brake holding capacity at the first rope layer.

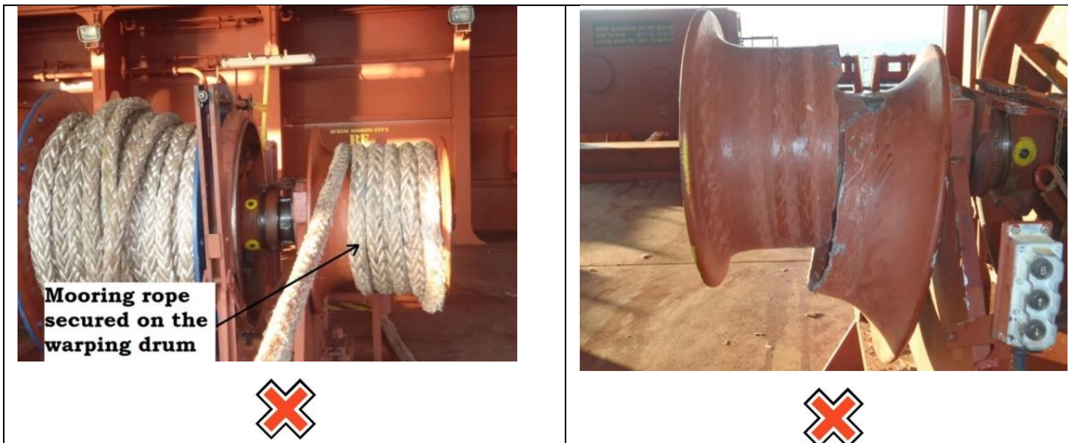
A more detailed explanation of the terminal's requirements on mooring winch brake holding tests can be found in "BHP Technical Note: Mooring Winch Operations and Brake Holding Test Guidelines."

The mooring winch render set points should be clearly marked on the brake spindle and be applied as per the marks when the vessel is conducting cargo operations at the terminal.

Fig 11: Mooring Winch Brake Correct Setting/Alignment.

6.4 Use of Mooring Lines on the Drum End

The terminal does not allow for loose mooring lines to be made fast make fast lines on the warping drum of winches. The warping drums are not designed for making fast the rope.



Mooring Line Secured to a Warping drum can damage the drum or the winch shaft

Fig 12: Mooring Winch Line secured to warping drum. (Source Anglo Eastern)

6.5 The Use of Fairleads

The terminal requires one mooring line passing through one (1) fairlead and one line to pass a single mooring bit. Do not deploy multiple lines from a single fairlead or mooring bitt, it leads to over stressing of fittings.

Fig 13: Overloading Fairleads and mooring bitts (source Anglo Eastern)

6.6 Split Drum Mooring Winches

The Terminal requires only one layer of rope to be maintained on split mooring drums. Variations in the number of layers between mooring drums can cause rendering at different lads and unexpected failure of mooring lines

Fig 14: Multiple layers on a split mooring drum

6.7 Embedded Mooring Lines

An unequal load sharing between the lines can cause brakes to render at different loads and sudden transfer of loads to other lines in the same lead. Such events can cause unexpected failure of lines if the other drums fail to render. This situation may also arise when line embedding issues are encountered at the time of mooring. Operators should pay attention to this problem and where necessary consider using anti embedding devises on their vessels. An example of this as shown below:

Fig 15: Anti mooring Line embedding

6.8 Wear Zone Management

Due to the open water nature of Hay Point Terminal the distance of shore mooring bollard from vessels winch there is the potential for mooring lines to wear at a greater rate than other terminals.

The terminal does require that ship operators manage wear zones to protect mooring line from damage. Pedestal rollers, Roller fairleads and universal roller fairleads must be maintained free to rotate to allow mooring line to move over them.

Fixed deck fittings, mooring bitts, closed fairleads must be maintained free of any sharp edges and burrs. Any such edges and burrs must be evened out. Abrasion resistant jackets or sleeves must be used with synthetic and HMSF lines to prevent damage.

Where possible, stainless steel or synthetic inserts must be used with HMSF and synthetic mooring ropes. Mooring lines must be inspected before use and end for ended as per table one (1).

Fig 16: Mooring Line chafe protection.

7. Mooring Winch Brake Render Testing Procedure

This section serves to offer guidance on undertaking brake holding tests on ships mooring winches. The information has been created to further supplement the guidance notes outlined in BMA's terminal questionnaire.

7.1 The Rationale of Undertaking Mooring Winch Brake Holding Tests

In recent years it has been noted by BHP/BMA that it has been a trend amongst Ship Operators as part of their controls of reducing the likelihood of mooring lines breaking during cargo operations to increase the line design breaking force (LDBF) of mooring lines to what was originally supplied to the vessel upon delivery. In some cases, the replaced mooring lines LDBF have become greater than the maximum winch brake holding capacities or greater than the safe working loads (SWL) of the vessel's bollards, Panama chocks and rollers.

Therefore, to reduce the likelihood of incidents occurring to the vessel's mooring winches, mooring furniture, or mooring lines and therefore endangering the lives of ship and terminal staff, mooring winch brake render tests have now become required for ships planning to undertake cargo operations at BHP/BMA terminals.

The primary objective of setting the mooring winch brakes to render or automatically pay out line is to ensure that the tension in the mooring lines remains less that the mooring line LDBF. When the tension in the mooring lines remains significantly less than the mooring line LDBF the likelihood of mooring lines parting or damage occurring to the mooring winches and/or mooring furniture and therefore potentially endangering the lives of the ships and terminal staff during cargo operations dramatically reduces.

7.2 Establishing the Design Parameters for Mooring Winch Brake Holding Tests

Mooring systems are primarily designed to ensure ships when undertaking cargo operations are safely secured to the terminal to ensure the safety of all personnel and the safe transfer of cargo. Hay Point is an open water port that experiences upper Met Ocean conditions i.e. wave, current and wind. Modelling of each of the berths at Haypoint has indicated that in standard Met Ocean conditions the mooring loads in the ship's mooring lines are typically in order of twenty-two tons (22 tons). In the lightship condition loads can exceed forty tons (40 tons) for Panamax and sixty tons (60 tons) for Cape Size when the vessels experience upper MET Ocean conditions. Therefore, in addition to the ship's staff regularly tendering mooring lines to avoid the uncontrolled ship movement the mooring winch brake holding rendering loads need to be set at values greater than what is expected at the terminal. However, simultaneously the mooring lines must also be set to render at values lower than the mooring line LDBF and SWL of the vessel's mooring equipment and furniture.

7.3 Mooring Winch Brake Holding Render Points using Ship Design MBL and/or Ship Equipment Number.

BMA suggest that mooring winch brake render set points be established taking into consideration the vessel's classification society generated ship equipment number (EN) or by using the ship design minimum breaking load (MBL). The mooring winch brake render set points will vary depending on ship size, Met Ocean conditions applied, and the numbers of powered mooring drums and mooring lines available. When the Met Ocean conditions, and size of a ship are held constant and the numbered of powered mooring lines increases the ship design MBL decreases.

All vessels that are constructed under class guidelines are assigned a ship equipment number (EN). The EN then in turn determines the number, size, minimum breaking loads (MBL)/line design breaking loads, and types of the ship's mooring lines, anchor cables, anchor sizes, mooring and anchoring equipment. The EN is calculated via a classification algorithm concentrating on underwater and above water surface areas. The EN number does not account for all Met Ocean conditions.

As alternative due to the absence of Met Ocean inputs into the EN algorithm the oil company international maritime forum (OCIMF) guidelines require that oil, gas, and chemical tankers determine their ship design MBL (SD MBL) using the Met Ocean guidelines outlined in the mooring equipment guidelines volume four (4) (MEG4). The MEG 4 Met Ocean guidelines calculate the SD MBL using sixty knot (60kn) wind around the vessel and three to half a knot (3.0kn-0.5kn) of current at prescribed locations around the vessel. The OCIMF guidelines do not provision for waves which are prevalent at Hay Point and depending on if the vessel is in the loaded or ballast condition can generate a large percentage of the of mooring loads for vessels moored at the terminal.

The mooring winches placed on board vessels typically comply with either the International Standard (ISO) 3730 or OCIMF mooring equipment guidelines. To comply with the minimum ISO standard the mooring winches brake holding capacities typically rated at values of eighty percent (80%) of the mooring line breaking force (LDBF). On Bulk Carriers this is not always the case. On tankers constructed to OCIMF MEG 4 the maximum break holding capacity is equal to the SD MBL.

In cases where greater strength lines (i.e. larger LDBF) are used than what was originally installed, the mooring line LDBF can be higher than the ship design MBL but should always be less than the safe working load values of mooring equipment i.e. bollards and less than the maximum brake holding capacities of the mooring winches. In situations where this is not possible and powered winches are utilised the correct setting of the mooring winch brake rendering points are critical to ensure the safety of ship/terminal staff.

7.4 Summarising and Interpreting Ship Design MBL using OCIMF and Local Hay Point Guidelines.

The Opitimoor analysis for Bulk Carrier hull forms utilising the Met Ocean data for Hay Point Terminal further confirms the OCIMF guidance with respect to the ship equipment number. It does, as it has done in the case of Tanker vessels seem to indicate that sizing of Bulk Carrier's mooring equipment solely using the ships equipment number (EN) is not adequate. The analysis indicates that the ship design MBLs both for the local Hay Point conditions and for the modified OCIMF guidelines are in some cases significantly larger than the maximum brake holding capacities typically installed on Bulk Carriers.

The results also indicate that setting individual vessel's mooring brake render load solely using the ship design MBL or mooring line LDBF is not advised. It is thought a holistic approach considering the specific equipment on board each vessel is required. When establishing a mooring brake render set points a consideration should be given to the OCIMF ship design MBL or the Class Society generated EN ship design MBL. Either of the values need to be balanced against the subsequent mooring loads generated by the vessel's interaction with environment at the terminal. The mooring brake render set point values need to be considered against the mooring line LDBF, the safe working loads of the mooring furniture installed on each vessel and the maximum brake holding capacity of the mooring winches that are installed on individual vessels.

7.5 Mooring Line and Mooring Winch Render Conclusions

Previously in the absence of specific data generated by the Optimoor models BMA did require that Brake Holding Capacity test calculations should have been based on the ship design MBL and not the LDBF of the mooring lines.

The Optimoor modelling data has indicated that both the Hay Point local and modified OCIMF ship design MBL were considerably higher than ship design MBL's generated by using the ships equipment number.

As a result, mooring winch brake rendering loads can be potentially set at 60% of the ship design MBL or between 60-80% of the mooring winch brake at the 3rd-4th layer of rope. However, in either case to guard against uncontrolled ship movement the brake render loads for conventional drums must be set to approximately thirty (30) tons at the 3rd- 4th rope layer which is typically between sixty (60) to eighty (80) percent of the maximum brake holding capacity of the mooring winch.

For split drums the settings at the 1st layer should be approximately thirty (30) tons. For both conventional and split drum mooring winches the maximum render point value should not exceed 100% of the maximum brake holding capacity at the first rope layer.

The vessel's mooring winches should not be set to render at values calculated from the mooring line LDBF. As a guide the mooring line LDBF should be approximately double the mooring winch rendering points.

Mooring brake render tests should be undertaken on an annual basis to allow for wear brake drums and linings.

The mooring winch render set points should be clearly marked on the brake spindle and be applied as per the marks when the vessel is conducting cargo operations at the terminal.

7.6 Calculating and Testing Mooring Winch Brake Holding Tests.

The mooring winch brake holding render tests are undertaken by applying a pressure via a hydraulic jack to the outer spool of the mooring winch. Each mooring winch should have defined procedure which should be followed by ships staff and the Operator.

The equipment used to undertake the tests should be supplied by the winch manufacturer or certified by a qualified individual. Testing using ships manufactured equipment is not advised.

As a guideline each winch test procedure should include.

- Preparing the winch for testing. This include establishing the previous brake test marks located on the winch and ensuring work planning documentation has been completed in line with the operators Safety Management System (SMS).
- Setting up the test gear and ensuring the brake engagement/adjustment can be moved and if required freely adjusted.
- An understanding of loads generated by the hydraulic jack. The loads are transmitted to the deck. The loads transmitted to the deck are large and may exceed localised load requirements if not distributed.
- Establishing and understanding the hydraulic jack test pressure required to test that the mooring winch brake renders/ pays out line at a setting appropriate for the individual vessel. In all cases the render point at the first layer should not exceed the vessels brake holding capacity or the safe working load of the mooring furniture. The mooring line LDBF should be twice the value of the mooring winch rendering point. For Hay Point the value should be approximately set to render at thirty (30) tons at the 3rd-4th layer on conventional drums and thirty (30) tons at the first layer for split drums.
- Applying the hydraulic pressure and ensuring the mooring winch brake renders at the designated hydraulic jack pressure. If the winch fails to render or pay out mooring line the mooring brake should be adjusted accordingly.
- Recording the test results which may include taking photos of the hydraulic jack gauge mooring brake render activation points.
- Ensuring the mooring winch brake engagement points are prominently marked to ensure that the mooring winch brakes can be engaged and set to the test position during the vessels port stay.
- Training the ship’s deck ratings to apply the brakes to the correct setting during the mooring operations.

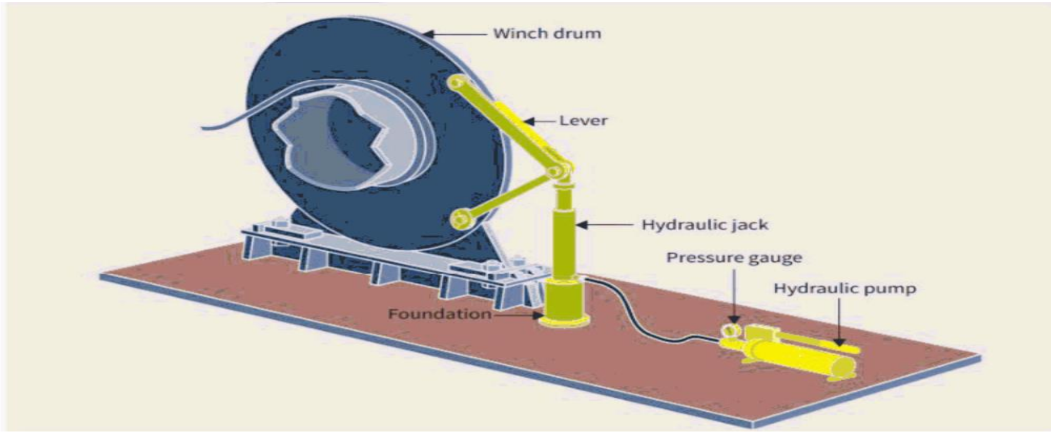


Fig 17: Mooring Winch Brake Test Set Up.

7.7 Calculating and Determining Mooring Brake Render Test Points

There are two different mooring winches generally in use on board most Cape Size, Mini Cape or Panamax vessels. These mooring winches can be described as split drum or conventional/single drums. The two different types of mooring drums do change the calculation for determining the hydraulic jack pressure required to ensure the mooring winch brake renders at the appropriate value.

For conventional drums which by far are the most frequent found on board bulk carriers an allowance must be made for the fact that wraps of mooring line do remain on the drum. Therefore, the drum diameter or three(3)-four(4) layers rope are used in the calculation to allow for the increase in moment arm subsequently the higher load at which the mooring brake will render.

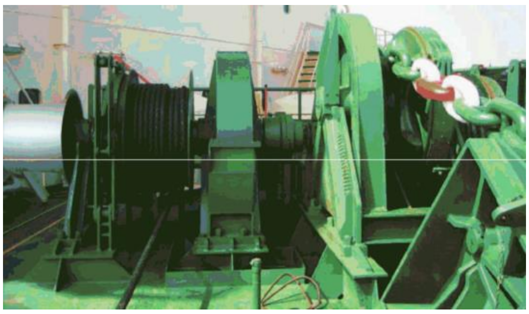


Fig 18: Conventional Drums. (note 4-6 wraps on drum)

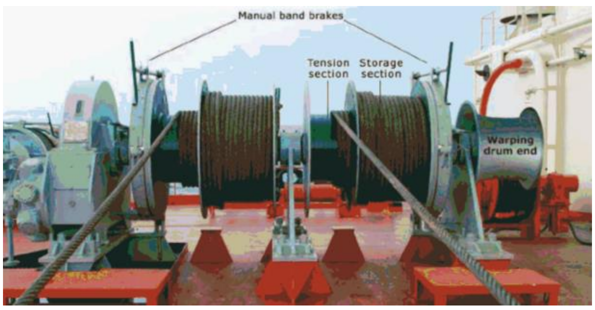


Fig 18a: Split Mooring Drums. (note one wrap on warping drum)

7.8 The Effect of Mooring Rope Layers on Brake Effectiveness

Several incident investigations undertaken has indicated that not considering the remaining layers of rope on the drum when determining the mooring winch brake set points has been a contributing cause to mooring incidents. The effect of having multiple layers of rope on the drum reduces the brakes effectiveness due to an increase on the moment or leverage being applied to the brake band as diagrammatically demonstrated in table one (1). Further analysis does indicate that the original brake setting which was thought to be applied to the brake reduces in conventional calculations or by the principles laid out in the OCIMF MEG 4 guidelines. In either case, there is a reduction in a brakes holding capacity when considering that multiple rope layers do remain on the mooring winch brake drum.

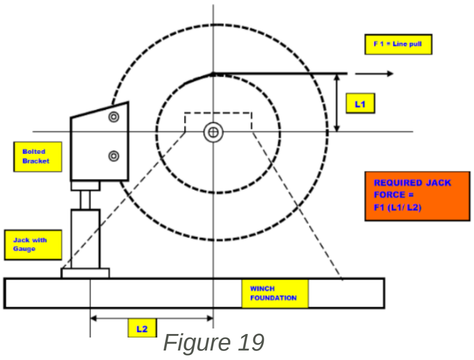


Figure 19

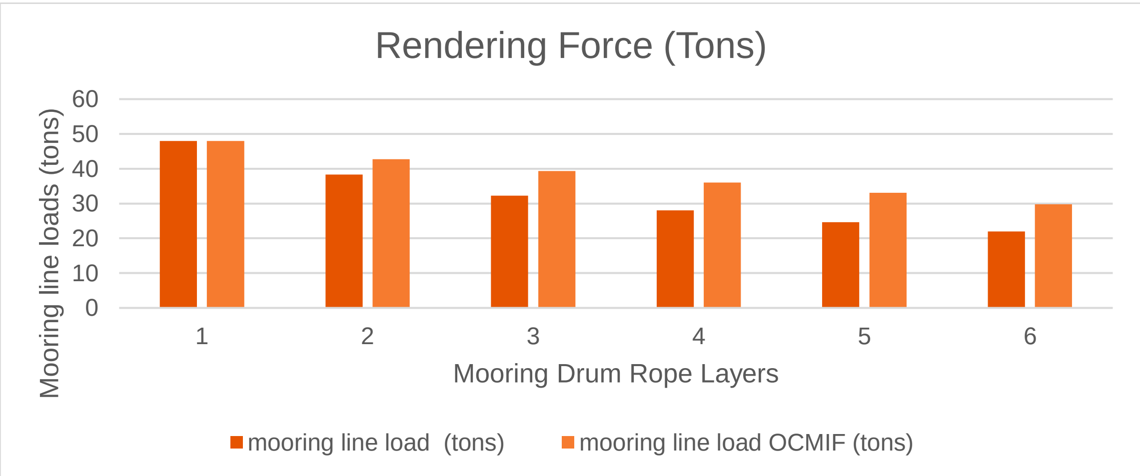


Table 2: Mooring Rope Wraps Remaining on Drum versus Mooring Brake Effectiveness.

7.9 Example Mooring Brake Calculations – Conventional/Single Mooring Winch

Conventional Drum Calculation for Panamax (Allowing for increase of moment arm due to rope on drum)

1. F1 line pull or line tension: 60% SDMBL or 60-80% max BHC (3rd -4th layer) = 33 tons or 33,000kg

2. L1 Drum or split drum diameter: 582mm or 58.2 cm ***(Moment increase due allowing for 4-6 wraps on mooring drum spool)***

3. L2 or Distance between Jack centre and winch centre**:** 690mm or 69.0 cm

4. The diameter and surface area of the of the hydraulic jack: 98mm or 9.8 cm Area = 75.4 cm2

5. Mooring Line Diameter: 72mm or 7.2 cm

Moment Generated from the Hydraulic Jack = Moment Generated from the Mooring Line

Summary of Moments = F2(jack) x L2 = F1(mooring line) x (L1)

= F2 (jack) x 69 cm = 33,000 kg x (58.2)

= F2 (jack) x 69 cm = 1,920,600 kg/cm

F2 (jack) = 1,920,600 kg/cm / 69 cm

Force required to be applied by Jack (F1) = 27,834.78 kg/cm or 27.8 tons.

Hydraulic Jack Pressure = Force Applied by Jack / Area of Jack

= 27, 834.78 kg/cm / 75.4 cm 2

= 369.16 kg/cm2 or 370 bar

7.10 Example Mooring Brake Calculations – Split Mooring Winch

Split Drum Calculation for Panamax.

1. F1 line pull or line tension: 60% SDMBL or 60-80% max BHC = 33 tons or 33,000kg

2. L1 Drum or split drum radius: 291mm or 29.1 cm

3. L2 or Distance between Jack centre and winch centre**:** 690mm or 69.0 cm

4. The diameter and surface area of the of the hydraulic jack: 98mm or 9.8 cm Area = 75.4 cm2

5. Mooring Line Diameter: 72mm or 7.2 cm

Moment Generated from the Hydraulic Jack = Moment Generated from the Mooring Line

Summary of Moments = F2(jack) x L2 = F1(mooring line) x (L1 + line diameter) – *(warping drum radius + line diameter)*

= F2 (jack) x 69 cm = 33,000 kg x (29.1 cm + 7.2 cm)

= F2 (jack) x 69 cm = 1,197,900 kg/cm

F2 (jack) = 1,197,900 kg/cm / 69 cm

Force required to be applied by Jack (F2) = 17,360 kg/cm or 17.4 tons.

Hydraulic Jack Pressure = Force Applied by Jack / Area of Jack

= 17, 839 kg/cm / 75.4 cm 2

= 230. 2 kg/cm2 or 230 bar

8. SABR Mooring Implementation Strategy

8.1 Introduction

Ship Loader and Berth Replacement (SABR) is a project at the port of Hay Point that will replace the current infrastructure at Berth 2.

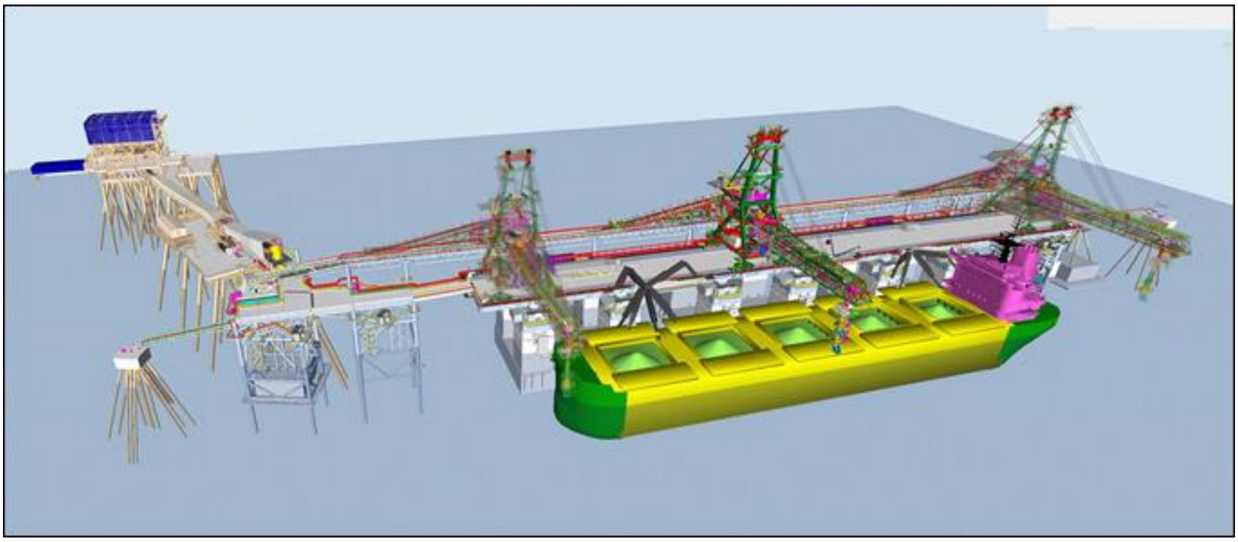
The current Shiploader 2 was commissioned 44 years ago and is approaching the end of its life span. It also carries two significant issues relating to ongoing maintenance and cyclone immunity.

To address these issues BMA have endorsed the Shiploader and Berth Replacement Project (SABR Project) to undertake works to disassemble and replace the existing shiploader and berthing facilities. On completion of the Shiploader and Berth Replacement Project, Shiploader 2 (SL2) is to become Shiploader 2A (SL2A), and Berth 2 is to become Berth 2A.

The replacement Shiploader 2A will have a nominal load rate of 8,000tph with a surge rate of 9,800 Tph. It will carry a structural capacity of 10,000 Tph and with future modifications (to conveyors and transfer chutes), be able load at the full rate.

The focus of Project SABR is as described above for replacement of Shiploader 2 and mitigation of cyclone wave impact risk for Berth 2 topside structures. The intent is to re-use the existing Berth 2 caissons, which are in the final stages of a structural integrity upgrade and cathodic protection installation project (to extend the caisson life).

The new Shiploader SL2A will have an increased loading rate, matched to the capacity of the two existing out loading streams. This will assist in supporting an overall terminal throughput improvement of nameplate capacity, from a nominal 55 Mtpa post-HPX3 to approximately 63 Mtpa (to be determined as this project and other upgrades at HPT are implemented).



As part of the SABR project there is a requirement to increase the utilization of Berth 1 to ensure the throughput of the port is minimally impacted, the risk associated with this is that Bert h1 has more exposure to environmental impacts.

BMA Hay Point have developed a set of guidelines to assist Ships Technical Managers, Ships Masters and their Crews of the mooring requirements in place at the terminal. The Terminal Mooring Guidelines complement the BMA Terminal Vessel Vetting Questionnaire (TVQ) which is hosted on the Rightship platform. The Hay Point TVQ is an additional mechanism used by BMA to identify vessel’s that fit within the risk profile of the terminal.

To further assist the terminal with its management of risk an additional question set has been developed specifically for vessels with fewer than 12 lines on winches who plan to undertake operations Hay Point.

To assist the terminal the vessel’s Technical Operators and Masters are requested to provide short answers to the individual questions using the guidance notes and the Technical Operators on board procedures as part of the responses.