BHP Mitsubishi Alliance

Hay Point Coal Terminal
Brake Render Testing Guidelines

Contents

1. Using these Guidelines

These guidelines outline Hay Point Coal Terminal's (Hay Point or the Terminal) requirements and rationale for brake render testing.

The guideline provides examples for calculating and performing a brake render test. Different types of vessels will have different requirements – some of these include:

- Vessels with conventional drum design winches.
- Vessels with split drum design winches.
- Vessels with mooring winches with max brake holding capacity between 30-40t.
- Vessels with mooring winches with max brake holding capacity between 40-50t

Please ensure you are referring to the specific section that applies to your vessel.

2. Introduction

A ship's mooring system is designed to keep vessels safely alongside during mooring operations. One component of a ship's mooring system is the ability for the winch brakes to be set at a pre-determined level to allow the brakes to 'render' or pay out line.

Brake rendering is a critical safety tool for several reasons, some of which include:

- Ships experience various environmental forces while alongside - these forces are absorbed by the mooring system and can cause damage to the mooring equipment or result in mooring lines parting if they exceed certain parameters. A render point allows the mooring system to shed the tension associated with environmental forces thereby reducing the risk to the mooring system.
- Similarly, a render point should not be set too low to ensure the mooring winch does not continuously render allowing the vessel to move off the berth.
- When ship's replace mooring lines, it is common for the line design breaking force (LDBF) of the new lines to exceed the original design. A brake render set point ensures the load absorbed by the mooring system does not exceed any of the individual components.

These concepts are discussed further below.

Hay Point has specific brake render requirements based on metocean conditions experienced at the Terminal. All ship's calling Hay Point must adhere to these requirements.

3. The Rationale for Performing Mooring Winch Brake Render Tests

3.1 Metocean Conditions at Hay Point

Hay Point is an open water port that experiences upper metocean conditions (e.g. wave, current and wind). Modelling of each of the berths at the Terminal indicates the mooring systems of visiting bulk carriers are frequently subjected to environmental loads of at least 22 tons. In the lightship condition in upper metocean conditions, these loads can exceed 40 tons for Panamax and 60 tons for Cape Size vessels.

In addition to the ship's primary mechanism for controlling tension in their mooring systems (e.g. the constant tendering of mooring lines by the ship's crew), mooring winch brakes should be set to render at a pre-determined point.

The mooring winch brake render point is required to be greater than expected loads generated from the moored ship's interaction with the external environment and concurrently lower than the mooring line LDBF and safe working loads (SWL) of the ship's mooring equipment and furniture.

3.2 Mooring line LDBF

BHP has noted a trend in recent years where Ship Operators increase the LDBF of mooring lines with respect to the mooring lines originally supplied to the ship. It is assumed this forms part of the Ship Operators risk mitigation strategies to reduce the likelihood of mooring lines parting during mooring operations.

In an ideal configuration the mooring line LDBF does not exceed the SWL of the mooring furniture and/or the mooring winches. In cases where the mooring line LDBF does exceed the SWL of mooring equipment and/or mooring furniture, the potential does arise for the structural failure of the ship's mooring equipment which can endanger the lives of the ship's crew, shore and tug personal.

The primary objective of setting the mooring winch brakes is to render or automatically pay out line at a pre-determined mooring system tension. The release of the mooring line ensures the tension in the mooring system remains significantly less than the mooring line LDBF and the mooring systems SWL. Mooring systems that render at the correct pre-set tension significantly reduce the likelihood of mooring lines parting or damage occurring to the mooring winches and/or mooring furniture.

3.3 Setting the render point as a % of the max BHC of the mooring winch

As the brake render point is designed to act as the 'control point' in the mooring system, thereby protecting all components of the mooring system, it is critical all parameters should be considered when setting the render point – mooring line LDBF, Sd MBL, SWL of mooring equipment and the max brake holding capacity (max BHC) of the mooring winch.

In cases where greater strength lines (i.e larger LDBF) are used than what was originally installed/designed, the mooring line LDBF can be higher than the Sd MBL.

In Hay Point's experience, mooring system design parameters are not assessed when performing brake render testing. Instead, it is somewhat common practice for the brake render set point to be calculated as a % of the mooring line LDBF. This can result in the render point exceeding the max BHC of the mooring winch and SWL of mooring equipment, thereby not protecting the mooring system as it is no longer the 'weakest point'. In addition, the max BHC of the mooring winch is not designed to be exceeded. Doing so creates risk of equipment failure and crew injury.

Based on the above, Hay Point requires the brake render point be set as a % of the max BHC of the mooring winch as this piece of equipment often has the lowest strength rating in the mooring system.

4. Hay Point's Brake Render Requirements

Hay Point requires the brake render point be set between 60-80% of the max BHC of the mooring winch. In addition, the render point should be at least 30t to align with metocean conditions at the Terminal.

We note certain vessels are unable to achieve this requirement – specifically some vessels with max BHC between 30-43t. These scenarios are addressed further below.

In all situations, the brake render set point must not exceed the max BHC of the mooring winch at the first layer of rope on the drum.

4.1 Frequency of testing

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

Brake render tests should also be undertaken after major maintenance of the mooring winches, changing mooring lines where the diameter of the mooring lines has significantly changed (e.g. change from synthetic to HMPE mooring lines) or after a mooring rendering incident.

The below photos show examples of brake lining / bands in poor condition. This can lead to unreliable brake performance even if a brake render test has been performed properly.




4.2 Brake render test report

A brake render test report should be produced for each test. The test report should include, at a minimum:

- Each winch should be identified separately.

- The diameter of each mooring winch drum.

  Hay Point will verify the drum diameter/s to technical documents during the review of the TVQ. An example of a suitable document is noted below.

It is critical the documents address all mooring winch drums on the vessel so any difference in diameter is identified and included in the brake render calculation.

B2-a	SPECIFICATION OF HYDRAULIC DRIVEN DECK MACHINERY	[redacted]

2. Windlass and mooring winch

1) Particular		DM No.	Cable lifter	Mooring winch
Quantity per ship	right type	DM 1	1 set(s)	1 set(s)
	left type	DM 2	1 set(s)	1 set(s)
Type ------------------------------------			J-18CU	NS160HW
Hauling load (1st. layer) ---------------		kN	312.0	127.6
Max. hauling load (at no specified speed)		kN	468	-
Nominal hauling speed (1st. layer) ------		m/min.	9	15
Max. hauling speed (at light load) ------		m/min.	28.1	-
Hydraulic motor -------------------------			-	HMC125
Speed ratio of hydr. motor (high/low) ---			-	3.12
Gear ratio ------------------------------			43.923	7.389
Required differential pressure ----------		MPa	15.9	17.9
Required oil flow -----------------------		L/min.	266	131
Chain dia. (Kenter shackle) -------------		mm	φ81 Q3	-
Drum size (dia. × length) --------------		mm×mm	-	φ508×900L
No. of drum -----------------------------			-	2
Storage capa. of drum (rope dia.×length)		mm×m	-	φ82×200L (within 7 layers)
Slack chain / rope speed (1st. layer) ---		m/min.	15	46.8
Brake holding power (1st. layer) --------		kN	2169	364
Warping drum pull load ------------------		kN	-	127.6
Warping drum size (dia. × length) ------		mm×mm	-	φ500×800L

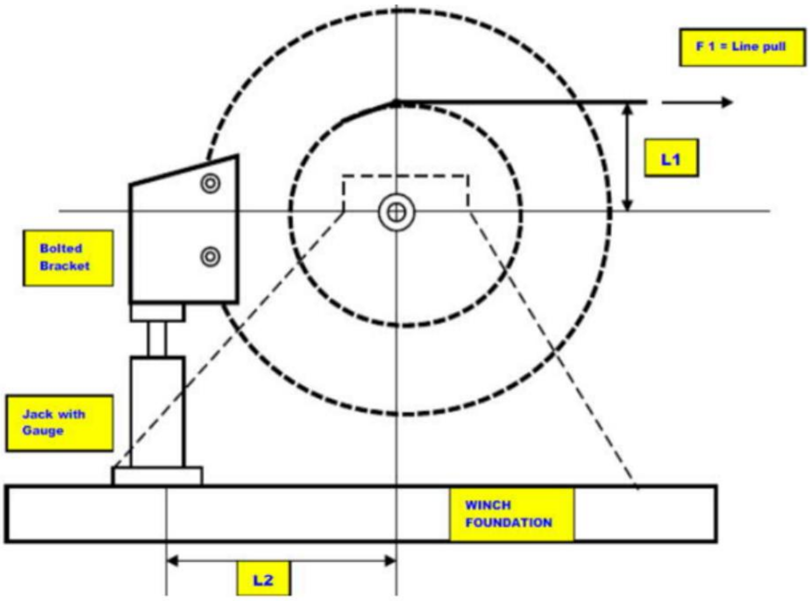
- The diameter of each mooring line installed on the mooring winch drum.

- The calculation for L1 – the distance from the centre of the drum to the centre point of line pull.

  This parameter considers the drum diameter, winch design (conventional or split drum) and mooring line diameter.

  The below picture illustrates L1.

  Winch drum design is discussed further below.



- The calculation for L2 – the distance from the centre of the drum to the centre of the jack.

  The above picture illustrates L2.

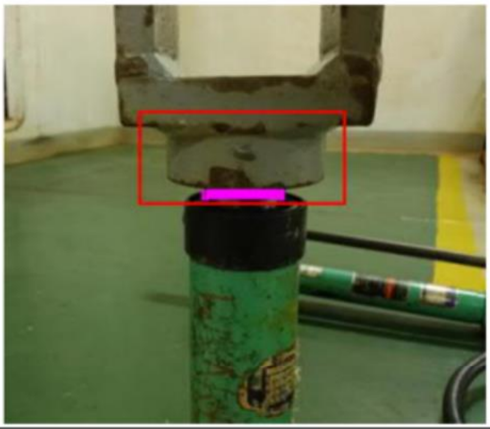
  Often drums installed in conjunction with the windlass will have a larger drum and flange diameter. It is critical that brake render calculations use the correct drum diameter and flange measurements for each individual winch drum.

- The diameter and area of the jack piston.

  This must be the part of the jack where pressure is applied. We have experienced cases where the area of the jack was measured as the area of the brake testing kit resting pad or external surface area of the piston. The correct surface area is the area of the piston receiving the pressure from the jack up kit.

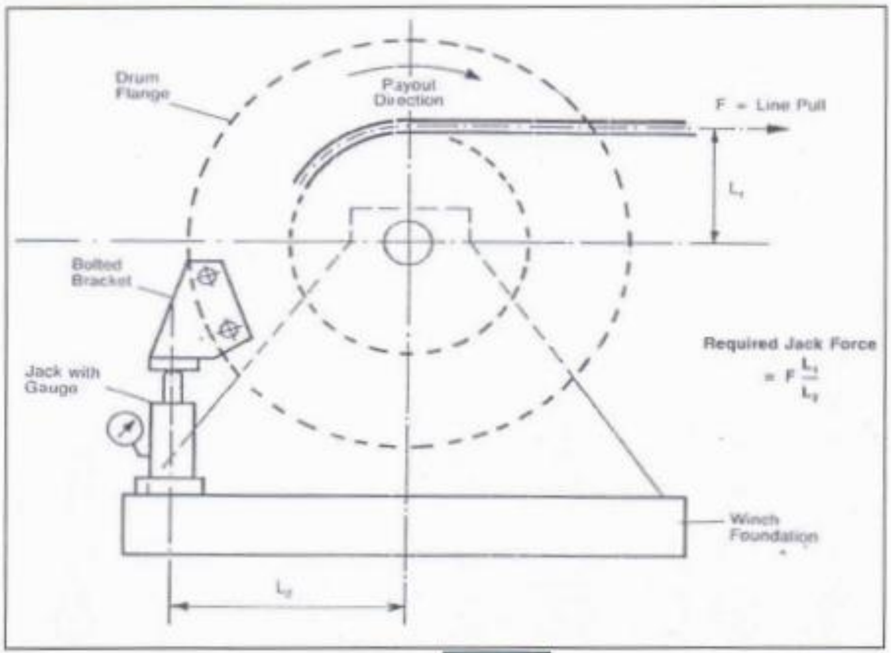
  If the diameter of the jack surface is not correct, the wrong pressure will be used in the calculation and test. A smaller surface area will result in a higher calculated pressure which will lead to the incorrect setting of the brake render set point and vice versa.

  Examples of the correct jack diameter measurement are noted below.



- The calculated test pressure to achieve the pre-determined render point.
- The actual pressure achieved in the test when the brake rendered.
- The test report should be dated and signed by the relevant personal.

An example of a brake render test report is shown below:



Jack's piston Diameter (cm) d=	6.48
Jack's piston Area (cm2) A=	32.979

Winch ID #	Split type (Y or N)	Drum DIA (m)	Max brake capacity (MT)	Rope DIA (m)	SDMBL (MT)	Min F (MT)	L_1 (m)	L_2 (m)	P (bar)	F (MT)	Comments
1	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd stbd (inner)
2	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd stbd (outer)
3	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd port (inner)
4	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd port (outer)
5	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd center (stbd)
6	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd center (port)
7	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd spring (fwd)
8	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Fwd spring (aft)
9	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft spring (fwd)
10	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft spring (aft)
11	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft center (fwd)
12	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft center (aft)
13	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft stbd (inner)
14	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft stbd (outer)
15	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft port (inner)
16	N	0.508	45	0.064	66	39.6	0.414	1.200	370	36.0	Aft port (outer)
						0.0	0.000				
						0.0	0.000				

4.3 Photos of brake render test

Photos of the test should be taken and included with the test report. As a minimum, the following photos should be taken:

- The test being performed – e.g. photo of the winch, jack, lever arm and gauge all set in position.

  The below photo shows the winch drum, jack stand, jack and connection to the lever arm and the pressure gauge. Although the pressure gauge is not clearly visible in the photo, we will accept an additional photo showing only the pressure gauge. It will only be acceptable if the needle is pointing to the same pressure in both photos. Both photos will also need to be timestamped.

- Close up photo of the pressure gauge. The gauge reading should align to photos taken showing the test in progress.

- Photo of the jack stand, jack and point of attachment to the lever to ensure the jack is set correctly. A photo of the jack's position on the deck should also be taken.

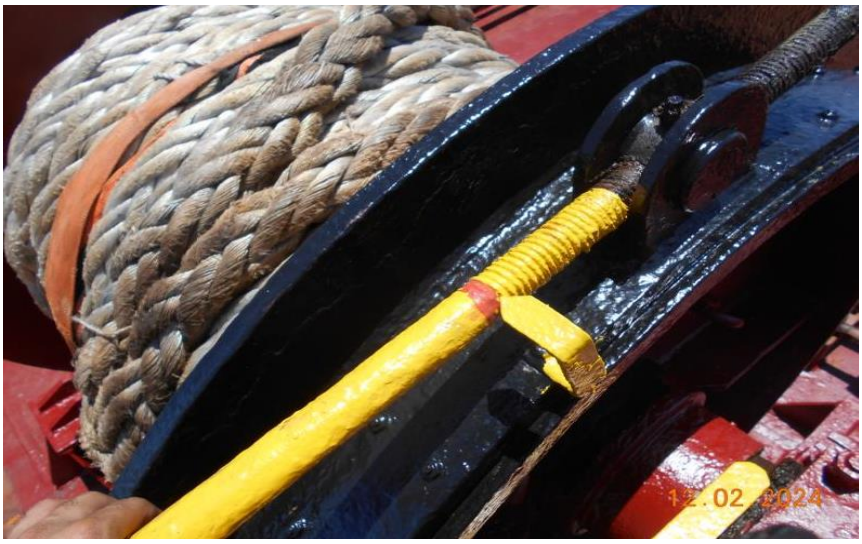
The jack must be centred on the jack stand so the risk of it dislodging under pressure is minimised.

In the below photo, the jack is not centred on the jack stand. The jack stand also appears to be upside down. The photo indicates the jack and lever arm should have been fixed to the other drum flange so the jack stand can be positioned with the base plate on the deck and the jack centred on the stand.

- The render marking on the winch.

Render points must be clearly marked on the brake arm of the winch drum. Hay Point's preference is for the render point to be marked in red or yellow paint.

The below is an example of Hay Point's expectations regarding brake render markings.



The below example is not acceptable to Hay Point as the render point is not clearly identified.

There must be no confusion as to where the crew should set the brake position during mooring operations.

- Photos should be labelled – e.g. winch 1, winch 2 or similar.

- Photos should be timestamped and in high resolution.

5. Guidelines for specific vessel configurations

There are generally two types of mooring winches on bulk carriers:

- Conventional drum design – photo 1.
- Split drum design – photo 2.

The brake render point is calculated differently for each drum type as vessels will moor with different layers of rope on the drum, depending on the drum design. The number of layers of rope on the drum impacts the point of 'line pull'. As the render point is calculated using the point of line pull, it is critical this parameter is considered.

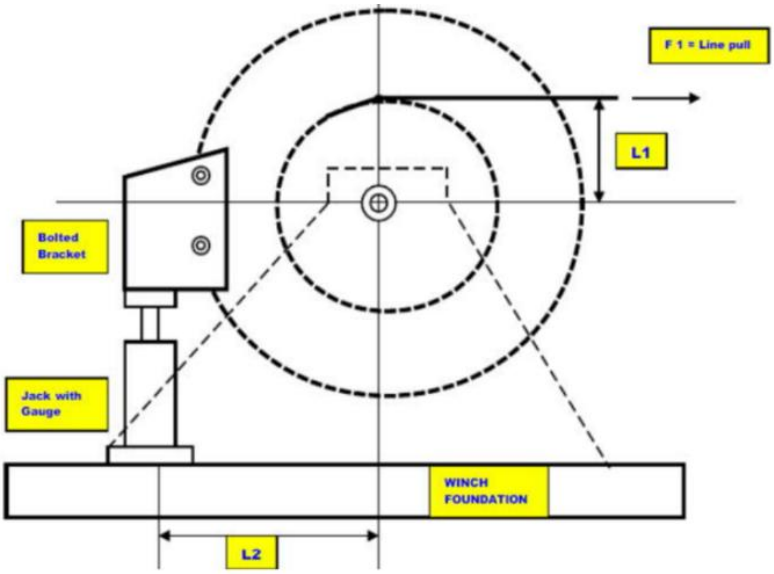
Photo 1: Conventional drum design mooring winch

Photo 2: Split drum design mooring winch

5.1 Vessels with split drum design mooring winches

Split drum mooring winches are designed to only have 1 layer of rope on the working part of the drum while moored. Therefore only 1 layer of rope is used in the brake render calculation.

The following table and calculation illustrate how a vessel with split drum design mooring winches would calculate the brake render set point.



Parameter	Explanation	Example
L1: Diameter from centre of drum to centre of line pull	D = diameter of mooring winch drum, e.g. 500mm d = diameter of mooring line installed on the drum, e.g. 72mm	L1 = (D + d) / 2 L1 = (500 + 72) / 2 L1 = 286mm or 28.6cm

L2: Distance from centre of drum to centre of jack	This parameter should be measured or taken from the brake render test kit technical drawing.	100cm
Diameter of jack piston	This should be the diameter of the jack piston, where pressure is applied.	Diameter = 6.5cm Area = 33.18cm2
Max BHC of mooring winch	49t	
F1: line pull / line tension	Hay Point requires the render point to be set at 60-80% of max BHC AND at least 30t.	F1 = 30t or 30,000kg Is F1 60-80% of max BHC? 30t/49t = 61% which meets Hay Points requirements.
F2: force applied by jack	To be calculated, see below.	

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

F2 x L2 = F1 x L1

F2 x 100cm = 30,000kg x 28.6cm

F2 x 100cm = 858,000kg/cm

F2 = 858,000kg/cm / 100cm

F2 = 8,580kg/cm or 8.58t

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

= 8,580kg/cm / 33.18cm2

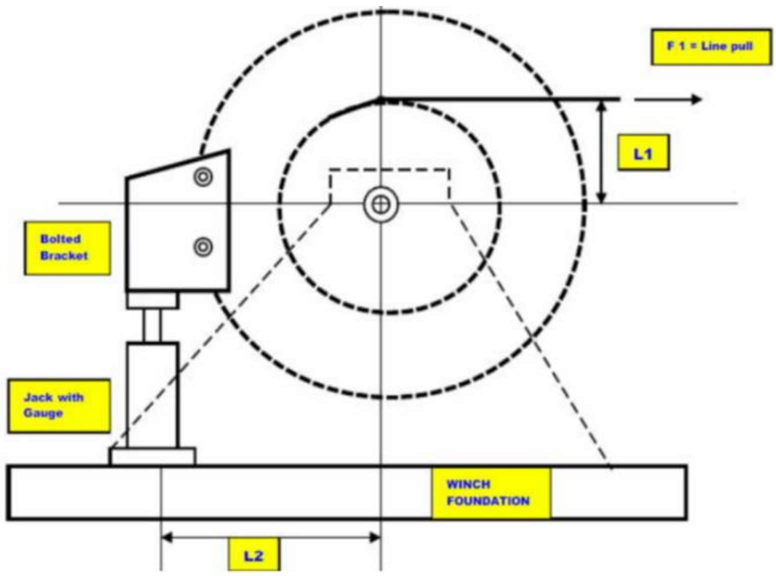
= 258kg/cm2 or 253bar

The vessel should use a test pressure of 253bar to achieve a brake render set point of 30t at the first layer of rope on the drum.

5.2 Vessels with conventional drum design mooring winches

Vessels with conventional drums will generally moor with 3-4 layers of rope on the drum. Hay Point will accept a brake render calculation based on 3 or 4 layers of rope on the drum.

The following table and calculation illustrate how a vessel with conventional drum design mooring winches would calculate the brake render set point. The example is based on 3 layers of rope on the drum.



Parameter	Explanation	Example
L1: Diameter from centre of drum to centre of line pull	D = diameter of mooring winch drum, e.g. 500mm d = diameter of mooring line installed on the drum, e.g. 72mm	L1 = (D / 2) + (d x 2.5) L1 = (500 / 2) + (72 x 2.5) L1 = 250mm + 180mm L1 = 430mm or 43cm
L2: Distance from centre of drum to centre of jack	This parameter should be measured or taken from the brake render test kit technical drawing.	100cm
Diameter of jack piston	This should be the diameter of the jack piston, where pressure is applied.	Diameter = 6.5cm Area = 33.18cm2
Max BHC of mooring winch	49t	
F1: line pull / line tension	Hay Point requires the render point is 60-80% of max BHC AND at least 30t. F1 is the point of line pull – for conventional drum design, the point of line pull is the centre of the third layer of rope on the drum.	F1 = 30t or 30,000kg Is F1 60-80% of max BHC? 30t/49t = 61% which meets Hay Points requirements.
F2: force applied by jack	To be calculated, see below.	

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

F2 x L2 = F1 x L1

F2 x 100cm = 30,000kg x 43cm

F2 x 100cm = 1,290,000kg/cm

F2 = 1,290,000kg/cm / 100cm

F2 = 12,900kg/cm or 12.9t

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

= 12,900kg/cm / 33.18cm2

= 388kg/cm2 or 380bar

The vessel should use a test pressure of 380bar to achieve a brake render set point of 30t at the third layer of rope on the drum.

As the render point is calculated at the third layer of rope on the drum, the vessel will also need to verify that the max BHC is not exceeded at the first layer of rope on the drum. An example of this verification is noted below:

Moment generated from the hydraulic jack = Moment generated from the mooring line

F2 x L2 = F1 x L1 (at the first layer of rope on the drum)

12,900kg/cm x 100cm = F1 x (50cm+7.2cm)/2)

1,290,000kg/cm = F1 x 28.6cm

F1 = 1,290,000kg/cm / 28.6cm

F1 = 45,104kg or 45t

As 45t is less than the max BHC of the mooring winch (49t), the max BHC is not exceeded at the first layer of rope on the drum.

5.3 Vessels with 30-40t max brake holding capacity

Vessels with a max BHC of the mooring winch between 30 – 40t may be unable to meet Hay Point's brake render requirements. This is usually because 60-80% of the max BHC is less than the 30t requirement.

Specific examples and how they are managed are detailed below.

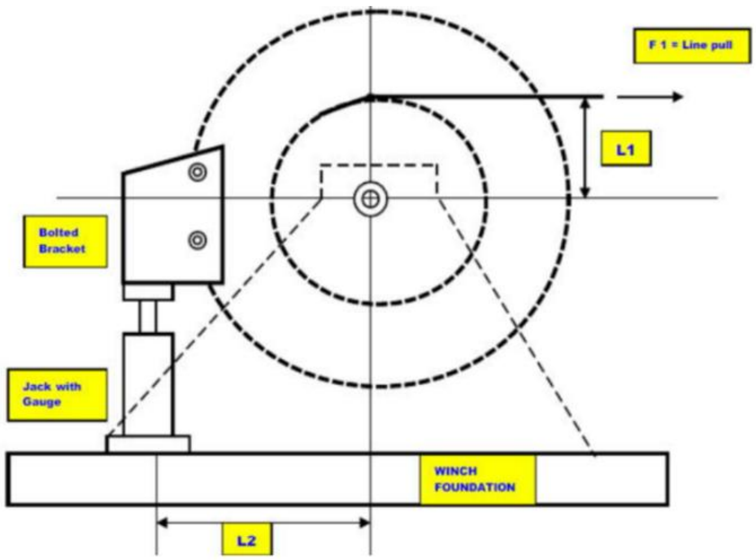
5.3.1 Vessels with 30-40t max BHC and split drum design mooring winches

As previously noted, Hay Point requires a vessel set its render point to 60-80% of max BHC AND at least 30t to align with metocean conditions at the Terminal.

Assuming a vessel has split drum design winches and 35t max BHC:

- 60-80% of the max BHC is only 21-28t. This does not meet Hay Point's requirements of at least 30t to align with metocean conditions at the Terminal.
- 30t is 86% of the max BHC.
- In this situation, Hay Point will accept a render point of 30t at the first layer of rope on the drum. Although it is not within the preferred range (60-80% of max BHC), it is still less than the max BHC and will meet metocean conditions at the Terminal.

An example calculation is shown below:



Parameter	Explanation	Example
L1: Diameter from centre of drum to centre of line pull	D = diameter of mooring winch drum, e.g. 500mm d = diameter of mooring line installed on the drum, e.g. 72mm	L1 = (D + d) / 2 L1 = (500 + 72) / 2 L1 = 286mm or 28.6cm
L2: Distance from centre of drum to centre of jack	This parameter should be measured or taken from the brake render test kit technical drawing.	100cm
Diameter of jack piston	This should be the diameter of the jack piston, where pressure is applied.	Diameter = 6.5cm Area = 33.18cm2
Max BHC of mooring winch	35t	
F1: line pull / line tension	As noted above, Hay Point requires the render point be set to 30t at the first layer of rope on the drum.	F1 = 30t or 30,000kg
F2: force applied by jack	To be calculated, see below.	

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

F2 x L2 = F1 x L1

F2 x 100cm = 30,000kg x 28.6cm

F2 x 100cm = 858,000kg/cm

F2 = 858,000kg/cm / 100cm

F2 = 8,580kg/cm or 8.58t

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

= 8,580kg/cm / 33.18cm2

= 258kg/cm2 or 253bar

The vessel should use a test pressure of 253bar to achieve a brake render set point of 30t at the first layer of rope on the drum.

5.3.2 Vessels with 30-40t max BHC and conventional drum design mooring winches

Vessels with conventional drum design winches and 35t max BHC are generally unable to meet Hay Point's requirements.

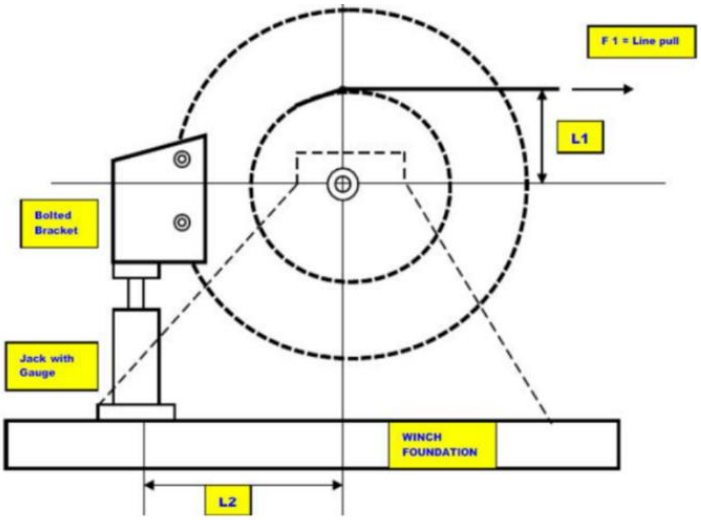
Unlike the split drum example above, the vessel is not able to set the render point at 30t at the 3rd layer of rope on the drum – doing so will exceed the max BHC of the mooring winch. The render point at the first layer of rope on the drum usually calculates to 44t which is 125% of the max BHC (35t). This is not acceptable to Hay Point as it involves operating outside the design limits of the equipment which is not safe or correct practice.

In this example, Hay Point requests the vessel set the render point as high as possible without exceeding the max BHC of the mooring winch at the first layer of rope on the drum. The render point at the 3rd layer of rope on the drum will usually be somewhere between 20-25t (this is an approximate guideline – we expect each vessel to perform a calculation and determine what the render point will be without exceeding the max BHC).

As this is less than the 30t requirement, one of two scenarios will apply:

1. If the vessel has 16 lines on drums: the vessel will be permitted to berth in all normal conditions if the vessel moors with all 16 lines on drums.
2. If the vessel has less than 16 lines on drums: the vessel will only be permitted to berth in calm weather only. Any delays to the berthing schedule will be to the vessel's account with no cost to the Terminal.

An example calculation for this scenario is shown below:



Parameter	Explanation	Example
L1: Diameter from centre of drum to centre of line pull	D = diameter of mooring winch drum, e.g. 500mm d = diameter of mooring line installed on the drum, e.g. 72mm	L1 = (D / 2) + (d x 2.5) L1 = (500 / 2) + (72 x 2.5) L1 = 250mm + 180mm L1 = 430mm or 43cm

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L2: Distance from centre of drum to centre of jack	This parameter should be measured or taken from the brake render test kit technical drawing.	100cm
Diameter of jack piston	This should be the diameter of the jack piston, where pressure is applied.	Diameter = 6.5cm Area = 33.18cm2
Max BHC of mooring winch	35t	
F1: line pull / line tension	F1 is the point of line pull – for conventional drum design, the point of line pull is the centre of the third layer of rope on the drum. As noted above, this will be the highest render point without exceeding the max BHC of the mooring winch at the first layer of rope on the drum. The target render point will usually be 23t at the third layer of rope on the drum.	F1 = 23t or 23,000kg
F2: force applied by jack	To be calculated, see below.	

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

F2 x L2 = F1 x L1

F2 x 100cm = 23,000kg x 43cm

F2 x 100cm = 989,000kg/cm

F2 = 989,000kg/cm / 100cm

F2 = 9,890kg/cm or 9.89t

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

= 9,890kg/cm / 33.18cm2

= 298kg/cm2 or 292bar

The vessel should use a test pressure of 292bar to achieve a brake render set point of 23t at the third layer of rope on the drum.

As the render point is calculated at the third layer of rope on the drum, the vessel will also need to verify that the max BHC is not exceeded at the first layer of rope on the drum. An example of this verification is noted below:

Moment generated from the hydraulic jack = Moment generated from the mooring line

F2 x L2 = F1 x L1 (at the first layer of rope on the drum)

9,890kg/cm x 100cm = F1 x (50cm+7.2cm)/2)

989,000kg/cm = F1 x 28.6cm

F1 = 989,000kg/cm / 28.6cm

F1 = 34,580kg or 34.6t

As 34.6t is less than the max BHC of the mooring winch (35t), the max BHC is not exceeded at the first layer of rope on the drum.

5.4 Vessels with 40-50t max brake holding capacity

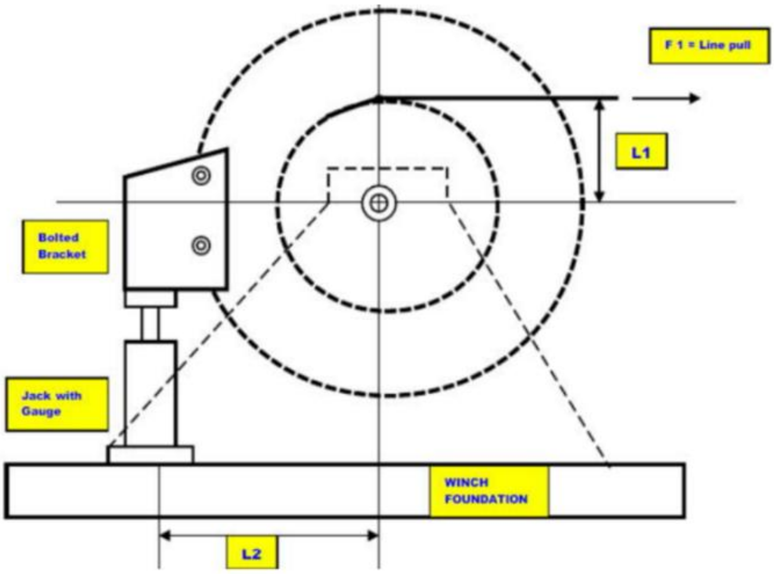
Vessels with a max BHC of the mooring winch between 40–50t are likely to meet Hay Point's requirements.

However, vessels with conventional drums will need to calculate the render point to verify if they can achieve 30t at the third layer of rope on the drum whilst not exceeding the max BHC at the first layer.

An example is provided below of vessel with conventional drums:

5.4.1 Vessels with 40-50t max BHC and conventional drum design mooring winches

An example calculation for this scenario is shown below:



Parameter	Explanation	Example
L1: Diameter from centre of drum to centre of line pull	D = diameter of mooring winch drum, e.g. 500mm d = diameter of mooring line installed on the drum, e.g. 72mm	L1 = (D / 2) + (d x 2.5) L1 = (500 / 2) + (72 x 2.5) L1 = 250mm + 180mm L1 = 430mm or 43cm
L2: Distance from centre of drum to centre of jack	This parameter should be measured or taken from the brake render test kit technical drawing.	100cm
Diameter of jack piston	This should be the diameter of the jack piston, where pressure is applied.	Diameter = 6.5cm Area = 33.18cm2
Max BHC of mooring winch	45t	
F1: line pull / line tension	F1 is the point of line pull – for conventional drum design, the	F1 = 30t or 30,000kg

	point of line pull is the centre of the third layer of rope on the drum. As noted above, this will be the highest render point without exceeding the max BHC of the mooring winch at the first layer of rope on the drum. The target render point should be 30t at the third layer of rope on the drum.	
F2: force applied by jack	To be calculated, see below.	

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

F2 x L2 = F1 x L1

F2 x 100cm = 30,000kg x 43cm

F2 x 100cm = 1,290,000kg/cm

F2 = 1,290,000kg/cm / 100cm

F2 = 12,900kg/cm or 12.9t

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

= 12,900kg/cm / 33.18cm2

= 388kg/cm2 or 380bar

The vessel should use a test pressure of 380bar to achieve a brake render set point of 29t at the third layer of rope on the drum.

As the render point is calculated at the third layer of rope on the drum, the vessel will also need to verify that the max BHC is not exceeded at the first layer of rope on the drum. An example of this verification is noted below:

Moment generated from the hydraulic jack = Moment generated from the mooring line

F2 x L2 = F1 x L1 (at the first layer of rope on the drum)

12,900kg/cm x 100cm = F1 x (50cm+7.2cm)/2)

1,290,000kg/cm = F1 x 28.6cm

F1 = 1,290,000kg/cm / 28.6cm

F1 = 45,105kg or 45t

As 45t does not exceed the max BHC of the mooring winch (45t), the render point is acceptable.