REPORT

Stannards Marine Pty Ltd v North Sydney Council

Navigation Issues Response

Client:	Noakes Pty Ltd
Reference:	PA2987WMRP220211
Status:	Final/03
Date:	11 February 2022

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Enhancing Society Together

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Table of Contents

Appendices

1 Background

The report herein outlines Royal HaskoningDHV's (RHDHV's) response to North Sydney Council's experts and Colville Marine Pty Ltd. The response herein is specifically in regard to matters relating to navigation and stability to the extent that it influences navigation. This report should be read in conjunction with the Noakes Boat and Shipyard Floating Dry Dock Navigation Impact Assessment (RHDHV, 2019) (refer **Appendix A**). Matters relating to navigation from Council's experts and Colville Marine include the following:

- Applicant to provide additional cross-sectional detail of the maximum-sized vessels that can be loaded onto the FDD based on hydrographic survey.
- Applicant to prepare agreed list of operational procedures for the FDD dealing with matters of timing of operation and stability assessment.
- Applicant to provide details of berthing, lifting and unloading sequences including timing of each stage and FDD draft at each stage.
- Applicant to provide analysis of annual tidal data identifying monthly loading and unloading dates to assess operational requirements to delivery monthly cycle.

These matters are addressed in **Section 2** to **Section 5** herein.

In addition to the above, the report herein also provides, at **Section 6,** a response to the Review of the Noakes Proposal to use the Floating Dry Dock in Berrys Bay (Colville Marine Pty Ltd, 2021).

2 Maximum vessel size and cross section detail

Additional hydrographic survey information was collected by Port Authority of NSW on the 20th October 2021. The hydrographic survey is provided in **Appendix B**. The survey complies with Ports Australia Class A standards.

An overlay of the FDD in the berthing pocket and loading pocket is provided in **Appendix C** along with cross-sections at the critical location/s. The minimum water depth is as follows:

- Berthing pocket: -4.5m CD; and,
- Loading pocket: -3.0m CD.

An assessment of water depths and UKC, based on the revised survey, is provided herein.

The depth of the FDD main deck, as per the Stability Booklet (John Butler Design, 2022b) is:

- 2.896m at midship centreline; and,
- 2.810m at midship sides.

There is a camber on the deck from side to side. There is no camber fore and aft. The depth of the FDD to main deck was previously adopted at 2.743m, based on drawings provided with the FDD.

2.1 Wave Climate and Seakeeping Assessment

The adopted wave climate for the site is:

- 50 year ARI wind wave - 0.4m with a period of 1.7 seconds;
- Powerboat / cruiser (passing the site at slow speed or traversing Sydney Harbour at high speed) – 0.4m with a period of 4 seconds; and,
- High speed catamaran ferry (traversing Sydney Harbour at high speed) – 0.2m with a period of 2 seconds.

The adopted wave climate is considered conservative. Due to the complexities of wave attenuation, reflection, refraction, diffraction and shoaling, further assessment through desktop methods is not considered appropriate. If required, to refine the design wave height, data collection in the field would be required. However, a visual observation of the site indicates that it is protected and additional data collection is deemed surplus to requirements.

A seakeeping assessment to estimate vertical motion of the FDD and the potential for wave overtopping has been undertaken by John Butler Design (JBD, 2022a) for a wave height of 0.4m (4 second period) and a wave height of 0.2m (8 second period). The 50 year ARI wind wave has not been considered. The period corresponds to a Deepwater wavelength of 4.5m. The FDD would span multiple wave crests and this this wave field would have minimal impact on FDD motions.

The Seakeeping Assessment (JBD, 2022a) is provided in **Appendix D**.

2.1.1 Vertical Motions

Within the berthing pocket, the predicted absolute maximum vertical motion of the FDD is 0.226m and 0.378m for a wave height of 0.2m (8 second period) and 0.4m (4 second period) respectively (JBD, 2022a).

The waterplane of the FDD, when submerged, is relatively small (wingwalls only). As such, minimal movement of the FDD due to wave action is expected. Due to difficulties in modelling the wingwalls, JBD considered two (2) models for the submerged FDD and adopted the worst case scenarios from the 2 models. The predicted absolute maximum vertical motion of the FDD in the loading pocket is 0.391m and 0.305m for a wave height of 0.2m (8 second period) and 0.4m (4 second period) respectively (JBD, 2022a).

The Harbour Master Directions Sydney Harbour and Port Botany (15 February 2021) note that in a berth box, Under Keel Clearance (UKC) must be a minimum of 0.5m unless otherwise directed.

The maximum vertical motions in the berthing pocket and lifting pocket are less than the required UKC. The FDD would not touch the seabed during normal operations.

2.1.2 Wave Overtopping

In order to prevent green water washing onto the working deck, the freeboard must be greater than the sum of half the wave height and the absolute vertical motion relative to still water. This assumes an occurrence where a particular key point is in its lowest possible position in the oscillatory motion cycle of the vessel in the seaway, which is then met with a peak of an incoming wave (JBD, 2022a).

The freeboard of the FDD, with 1000t payload (maximum) and 397t ballast in the holding tank is 0.631m. Only the FDD motions in the lifting pocket are considered.

The sum of the absolute vertical motion from still water and half the respective wave height is 0.326m and 0.464m for a wave height of 0.2m (8 second period) and 0.4m (4 second period) respectively (JBD, 2022a). Green water washing onto the deck is therefore unlikely.

Overtopping (splash and spray) of the working deck may still occur in certain conditions. However, the extent of overtopping is difficult to quantify as the FDD is floating and moves in response to the waves.

2.2 Berth Pocket

The Harbour Master Directions note that in a berth box, UKC must be a minimum of 0.5m unless otherwise directed. It should be noted that the Harbour Master Directions were updated following the Navigation Impact Assessment (RHDHV, 2019). As such, UKC of 0.5m would be adopted herein.

Based on the maximum bed level of -3.0m CD and UKC of 0.5m at Lowest Astronomical Tide, the draft of the FDD shall be less than 2.5m and the freeboard shall be more than 0.31m.

The draft of the FDD with maximum payload (1000t) and 397t ballast in the holding tank is 2.179m (0.631m freeboard) (JBD, 2022a). The draft is less than 2.5m required to maintain UKC of 0.5m.

The minimum freeboard for a FDD, in accordance with the Department of Defense Standard Practice Safety Certificate Program for Drydocking Facilities and Shipbuilding Ways for U.S. Navy Ships (MIL-STD), is 0.3m. It should be noted that the above load and ballast conditions also satisfy this requirement.

2.3 Lifting Pocket and Updated Assessment of Vessel Draft

Noakes intends to use concrete keel blocks (keel line to deck) varying in thickness from 300mm to 1200mm.

The water level adopted for submergence of the FDD is 1.3m CD, which is the water level 2 hours either side of MHWS (1.57m CD) in accordance with the Navigation Impact Assessment (RHDHV, 2019). The maximum water depth available for submergence of the FDD is 5.8m (water depth at CD [-4.5m CD] plus tide [1.3m CD]). Since 5.8m is less than the maximum draft of the FDD (8.68m), the FDD could not be fully submerged and the vessel draught for loading onto the FDD would be limited by the available water depth.

Assuming the following dimensions, the maximum vessel draught that could be loaded onto the FDD is approximately 1.8m:

- Water depth of 5.8m;
- FDD UKC (from seabed to the bottom of the FDD) of 500mm;
- FDD main deck height of 2.896m at centreline;
- Keel block height of 300mm (above the deck of the FDD pontoon. Note that this is the minimum keel block thickness and maximum vessel draught would decrease if keel block thickness increases); and,
- Vessel under keel clearance (from vessel to keel blocks) of 300mm. Note that this assumes calm conditions for loading the vessel.

(Equation: Maximum vessel draft = 5.8m – 0.5m – 2.896m – 0.3m – 0.3m = 1.8m)

The FDD does not need to be submerged to the maximum draught when loading and unloading shallower draught vessels. Loading of shallow draft vessels could be undertaken at lower water levels.

3 List of operational procedures for the FDD dealing with matters of timing of operation and stability assessment.

The MIL-STD and Design of Marine Facilities Engineering for Port and Harbor Structures (Gaythwaite, 2016) both specify 5 phases of operation of an FDD as follows:

- Phase 1 — Dock at full submergence without vessel. The vessel is floating independently and the dry dock is in the submerged condition before the vessel bears on the blocks.
- Phase 2 — Partial liftoff. Vessel starts bearing on the blocks and one-half of the vessel's weight is supported by the floating dock.
- Phase 3 — External waterline at the top of the keel blocks (i.e. vessel keel at water level).
- Phase 4 — Top of pontoon at water level. The water level between the wingwalls is just above the top of the pontoon.
- Phase 5 — Dock at normal operating draft. Top of pontoon is at or above the minimum freeboard.

A stability assessment has been undertaken by Shearforce Maritime Services Pty Ltd (November, 2016), in accordance with MIL-STD. Buoyancy and intact stability requirements were satisfied. The damaged stability calculations indicate that in both the fully ballasted and deballasted conditions, the angle of heel due to the shell damage does not comply. It should be noted that the stability assessment assumed damage at the location of a bulkhead with flooding of 2 tanks (note: the pontoon comprises 12 tanks). To comply with the damage stability requirements, additional watertight bulkheads would need to be added to reduce the size of individual tanks.

The FDD has been modified following completion of the stability assessment undertaken by Shearforce Maritime Services Pty Ltd (November, 2016). The modifications included removal of generators, walkway and redundant upper deck machinery, including a crane. An inclining experiment was completed by John Butler Design, which indicated that the lightship mass and vertical centre of gravity has been reduced by approximately 400 tonnes and 1.5m respectively, which improve stability. There has been no change to the structural assessment completed by Shearforce Maritime Services Pty Ltd (November, 2016) and this assessment remains applicable (JBD, 2022c) (refer **Appendix F**).

A subsequent stability assessment has been completed by John Butler Design (2022b), in accordance with the National Standard for Commercial Vessels (NSCV) issued by the Australian Maritime Safety Authority. The stability assessment is documented in the Stability Booklet (refer **Appendix E**)**.** The stability assessment considered loading scenarios (vessels) including:

- STS Young Endeavour
- Paluma Class Vessel
- Minehunter (Huon Class Vessel)
- 1000t Harbour Tug

The stability assessment was based on keel blocks 1.2m high and it considered the five (5) Phases of operation.

The intact operating loading conditions satisfies the required stability criteria for each scenario. Separate calculations are necessary for all other conditions of loading. However, lighter vessels and/or vessels with a lower vertical centre of gravity would be more stable and would be expected to satisfy the stability requirements.

The FDD is deemed to be compliant with NSCV damage stability requirements as it has three (3) watertight bulkheads through the length of the vessel.

4 Details of berthing, lifting and unloading sequences including timing of each stage and FDD draft at each stage.

An assessment of the timing of operation was included in the Navigation Impact Assessment (RHDHV, 2019). The time required to complete slewing and loading operations is discussed as follows:

- Slewing of the FDD out into the loading pocket would be completed in approximately 30 minutes.
- Submerging the FDD would be completed in approximately 45 minutes.
- Loading a vessel onto the FDD would be completed in approximately 90 minutes. It is noted that the time required to unload a vessel would be less than the time required to load a vessel.
- Floating the FDD would be completed in approximately 120 minutes.
- Slewing the FDD back into the berthing pocket would be completed in approximately 30 minutes.
- Total 5.25 hours.

In the above assessment, the FDD would be submerged on a flooding tide and floated on an ebbing tide (i.e. operations timed around high tide). The total ballast in Phase 1 is 2,849 tonnes (JBD, 2022a), which equates to ~2,778m^3 (2,78,000L) of seawater (JBD, 2022a). Note that this assumes a draft of 5.3m (based on 0.5m UKC and water depth of 5.8m measured 2 hours either side of MHWS, refer **Section 2.3**). Noakes has advised that the time required to float the FDD from a 5m draft to a 1.8m draft is approximately 1.5 hours. However, this would be dependent on the displacement of the vessel to be docked.

The FDD draft in each Phase of operation is outlined below:

- Phase 1 – limited by water depth and requirement for UKC of 500mm. In accordance with the assessment in **Section 2.3**, draft would be 5.3m.
- Phase 2 – draft is approximately equal to Phase 1 less half of the vessel draft (approximately 4.2m).
- Phase 3 – draft equal to the depth of the pontoon (2.896m) plus thickness of keel blocks (300mm), which is approximately 3.196m.
- Phase 4 – draft is equal to depth of the pontoon (2.896m).
- Phase 5 – draft to maintain at least 300mm freeboard in accordance with MIL-STD is 2.51m. At maximum lift of 1000t, and 397 tonnes of water, the draft would be 2.179m (0.631m freeboard). Depending on the weight of the vessel and ballast, and stability of the FDD, draft could be reduced and freeboard could be increased. Further assessment by a naval architect would be required.

5 Analysis of annual tidal data identifying monthly loading and unloading

An analysis of tidal data has been undertaken based on the forecast high and low tides from 1st January 2021 to 31st December 2024 (4 years of data). The forecast high and low tides have been obtained from NSW Department of Planning Industry and Environment. The forecast high tides have been filtered to include forecasted water levels above 1.57m CD (Mean High Water Springs [MHWS]) occurring Monday to Friday and between 9:30am and 3:30pm. This restricts operation of the FDD to standard working hours (7am to 6pm) and caters for 2.5 hours either side of MHWS to slew/warp and ballast (of float and slew/warp) the FDD. It should be noted that:

- the water level adopted in the analysis of maximum vessel draft in **Section 2** is based on the water level two hours either side of MHWS and is therefore consistent with the analysis herein and includes time to slew the FDD within working hours; and,
- loading of shallow draft vessels does not require full submergence of the FDD and could be undertaken at lower water levels.

An analysis of the data presenting high tides exceeding 1.57m CD and occurring on a weekday between 9:30am and 3:30pm is provided in **Figure 1**. In total, there are 158 days where this criteria is satisfied (average of 39.5 days per year). However, water levels exceeding MHWS are skewed with higher tides occurring between November and April. There is a period of 3-5 month each year, typically between May/June and August/September, when a water level exceeding MHWS is not forecast at a suitable time of day.

Reducing the target water level for loading vessels to 1.37m CD, as shown in **Figure 2**, greatly increases the number of days with suitable water level. In total, there are 342 days where this criteria is satisfied (average of 85.5 days per year). The maximum vessel draft that could be docked would decrease by 200mm from 1.80m to 1.60m.

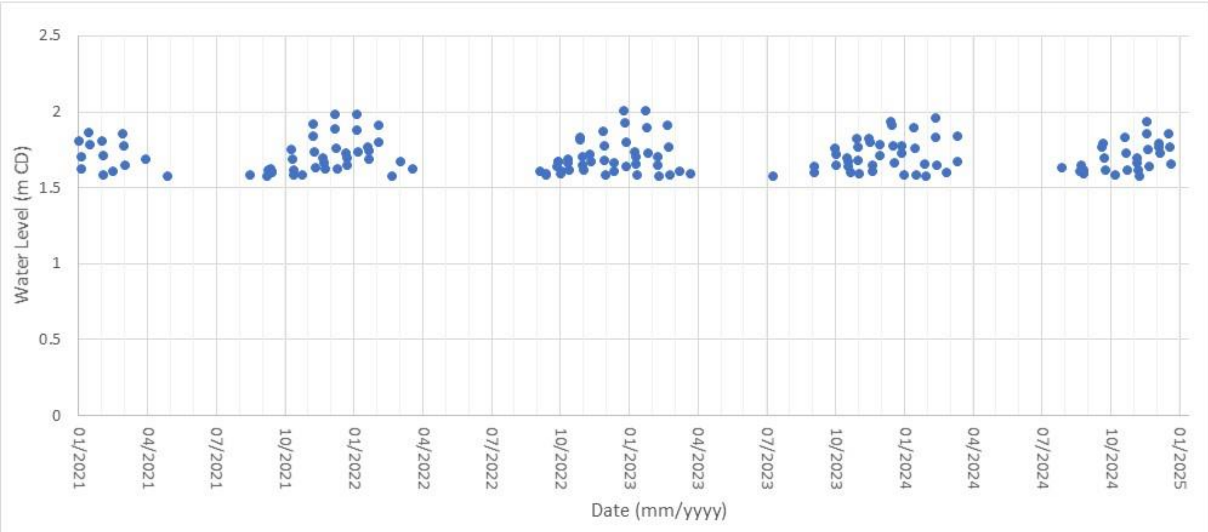

Figure 1: High tides exceeding 1.57m CD and occurring on a weekday between 9:30am and 3:30pm.

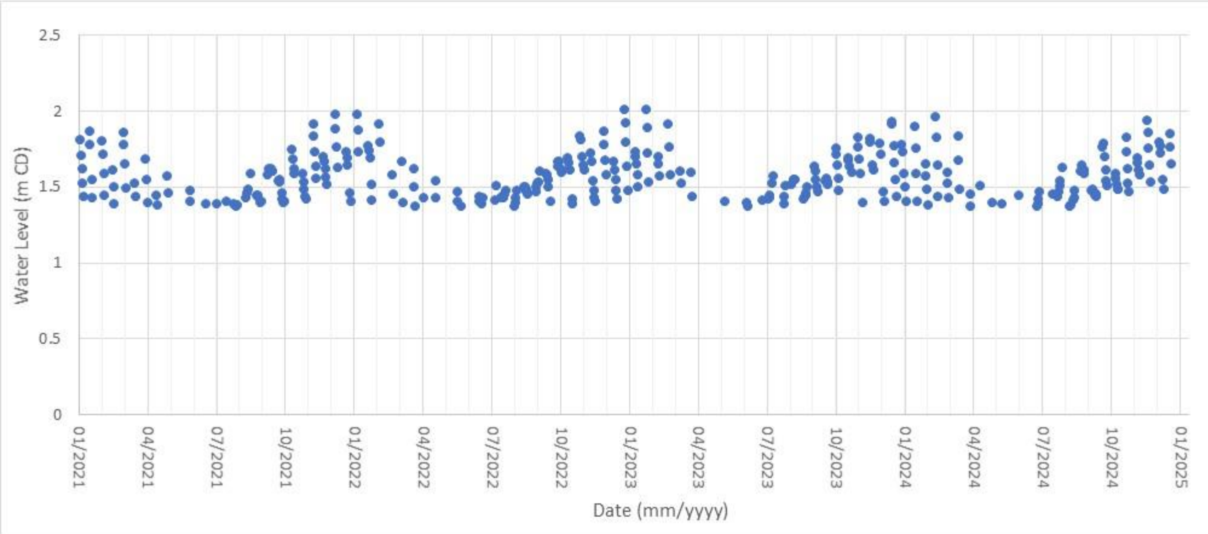

Figure 2: High tides exceeding 1.37m CD and occurring on a weekday between 9:30am and 3:30pm.

6 Response to the Review of the Noakes Proposal to use the Floating Dry Dock in Berrys Bay (Colville Marine Pty Ltd, 2021).

Colville Marine Pty Ltd, 2021 undertook a review of the Noakes proposal to use the FDD in Berrys Bay. The review by Colville Marina includes the following main headings:

1. Executive Summary
2. Market forces and the typical docking
3. Seamanship and navigational issues
    - (a) COLREGS
    - (b) Slewing, warping and berthing lines
    - (c) Safe Distances
    - (d) Wash, waves and wave action
    - (e) Lines of approach
    - (f) Restrictions imposed by the swing basin and lines of approach
    - (g) Entering the dock
4. Dock Stability
    - (a) Ballast and deballast operations
    - (b) The Docking Plan
    - (c) Analysis of the ballast and deballast operation
5. Under Keel Clearance
    - (a) Identifying the correct UKC standard
    - (b) Wave action and the UKC
    - (c) Identifying the UKC through risk assessment
    - (d) A Cross Section of the FDD operations
6. Maritime Lease and Consent to Lodge
7. Other Environmental issues
    - (a) Jacobs Waste Management EIS
    - (b) Jacobs Water Quality EIS
    - (c) Jacobs Noise and Vibration Assessment

Royal HaskoningDHV

   (d) Jacobs Contamination Reports
   (e) Historical Woodleys Contamination Reports
8. Documents Reviewed and References
9. Conclusions

Commentary on each of the headings is provided where applicable. One of the main critiques from Colville Marine is the guidelines adopted for the navigation assessment. The navigation assessment in the Navigation Impact Assessment (RHDHV, 2019) was based on:

- AS3962-2001 Guideline for design of marinas; and,
- Harbour Approach Channel Design Guidelines (PIANC, 2014).

The Navigation Impact Assessment (2019) notes the limitation of both guidelines. However, in lieu of more suitable guideline documentation, these documents have been used as a reference. Alternate guidelines could be considered including:

1. PIANC Design and Operational Guidelines for Superyacht Facilities (2013);
2. PIANC Guidelines for Marina Design (2016); and,
3. PIANC Design Guidelines for Inland Waterway Dimensions (2019).

These guidelines would not substantially change the navigation impact assessment as the various guidelines include similar requirements. Indeed, more recent PIANC guidelines specify reduced navigation widths, which reflects on the improved manoeuvrability of modern vessels.

6.1 Market forces and the typical docking

The response by Colville Marine speculates on market forces and makes a number of assumptions. The Navigation Impact Assessment (RHDHV, 2019) notes constraints around water depths for operation of the FDD, which limits the maximum vessel draft that could be docked on the FDD. This limits the economic benefit of the FDD. However, it does not preclude use of the FDD.

6.2 Seamanship and navigational issues

6.2.1 COLREGS

The assessment and critique of the interpretation of COLREGS is somewhat irrelevant. The Navigation Impact Assessment (RHDHV, 2019) correctly identifies that:

> *The NSW Marine Safety (General) Regulation 2016 and Marine Safety Act 1998 adopts the COLREGS and includes minor modifications and additional special rules applicable to NSW waterways.*
>
> *The RMS produced the NSW Boating Handbook (RMS, 2016), which is an interpretation of the law and legislation.*

Two key rules in the COLREGS were highlighted in the Navigation Impact Assessment (RHDHV, 2019). As correctly identified by Colville Marine, all of the COLREGs Part B – Steering and Sailing Rules (Rules 4 to 19) are key to preventing collisions between vessels in sight of one another. However, the NSW Boating Handbook (RMS, 2016) provide an interpretation of the law and legislation, including the COLREGs, in layman terms. For the purpose of a document prepared for public exhibition, it is deemed preferable to provide a simple explanation of laws and legislation where practical, which the NSW Boating Handbook (RMS, 2016) and the Navigation Impact Assessment (RHDHV, 2019) provides.

6.2.2 Slewing, warping and berthing lines

Cold move slew is defined in the Navigation Impact Assessment. It means that the FDD is relocated by moorings lines with the assistance of hand operated capstans (winches). Warping means to move a vessel by hauling on a rope fixed so a stationary object. Either terminology is acceptable, provided that the terminology in the Environmental Impact Statement is consistent.

As noted in the Navigation Impact Assessment (RHDHV, 2019), the provided mooring line arrangement is indicative only and may be altered to suit floating dock winch locations and hardstand bollard locations. It is understood that additional bollards, leads and capstans may be required. The use of ‘bow’ and ‘stern’ when referring to the FDD has been avoided as the bow and stern of the FDD is not clearly defined. The term ‘athwartship’ meaning across a vessel was used as a suitable description. Colville Marine does correctly identify that the Navigation Impact Assessment (RHDHV, 2019) should refer to ‘spring’ line rather than ‘springer’ line.

The cold move slew and mooring line arrangement has been developed in consultation with Noakes. It is our opinion that the FDD could be readily modified to achieve the cold move slew as proposed. It is noted that high mooring line loads would be encountered during slewing of the FDD to the lifting location, particularly at the southern end of the FDD. Infrastructure would need to be designed accordingly.

6.2.3 Safe Distances

Colville Marine highlights Marine Safety Regulation (NSW) 2016 Clause 40, which outlines the safe distance for ‘towing equipment’ and ‘person being towed’. It is our understanding that the intent of this clause relates to tow sports such as waterskiing and wakeboarding and ‘towing equipment’ relates to ski tubes and inflatables. However, ‘towing equipment’ is not clearly defined in the *Marine Safety Act 1998* or Regulation. Regardless, the assertion by Colville Marine that the proposed tow operation/s contravenes the Regulation because the 60m is not complied with is incorrect as the Regulation states:

1. *The operator of any vessel must ensure that the vessel and any towing equipment and any person being towed by the vessel maintains—*
    a. *a distance of not less than 60 metres from any persons in the water or,* ***if that is not practicable, a safe distance and speed.***

It is noted that recreational swimming facilities are not provided in the vicinity of Noakes Shipyard and any person in the water would likely be a diver assisting with the docking operations, who would be trained and aware of the vessel movement.

Colville Marine notes that the, ‘COLREGS Rule 6 also acts to limit safe distances and speed limits close to persons in the water or on small craft such as kayaks. There is no discussion in the Navigation Assessment about how Noakes intend to manage this restriction on the activities of the FDD if or when the public wharf is constructed?’

The above statement is partially correct in that the COLREGS Rule 6 – Safe Speed specifies that, ‘*a vessel must operate at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.*’ The Navigation Impact Assessment was developed under the assumption that construction vessels and vessels navigating to and from the FDD would meet all navigation safety requirements, and:

- operate under the control of licensed and experienced Masters;
- operate under the supervision of experienced Noakes Group personnel or representatives from Noakes Group;
- comply with the requirements of the COLREGS and NSW Marine Safety (General) Regulation 2016 including PANSW Harbour Master directions; and,
- operate in accordance with the Safety Management System prepared for the FDD.

The Navigation Impact Assessment (RHDHV, 2019) notes that there are no passive recreation craft launching facilities or public jetties at the head of the Bay. Numerous dinghies and kayaks are stored along the foreshore of Berrys Bay and it is assumed that these craft are primarily used for accessing moorings. While dinghy or kayak movements in the vicinity of the FDD operations would not be expected, if it so happened that a boater was too close, the operation/s could be suspended until the boater had moved away a safe distance.

In regard to the impact on DA Condition 51 – Jetty, Section 5.3 of the Navigation Impact Assessment (RHDHV, 2019) addresses this. The FDD would be operated within the Lease Boundary at all times and there are not expected to be any impacts on the operation of the proposed jetty at the end of John Street.

6.2.4 Wash, waves and wave action

Colville Marine notes that, ‘the most likely damaging wave action that will affect the FDD is the case of a 15m vessel entering the bay at high speed and passing down through the point of plane where the wave propagated will be greatest and where the bow waves directly approach the shoaling ground under the proposed FDD berthing box.’

The edge of the mooring field is some 400-450m from the proposed location of the FDD.

As noted in the Navigation Impact Assessment (RHDHV, 2019), the clear width between the defined mooring areas in Berrys Bay is measured to be 45 to 65m. Further and as noted, the NSW Marine Safety Regulation 2016 states the operator of a power-driven vessel that is travelling at a speed of **6 knots** or more must ensure that the vessel, and any towing equipment and any person being towed by the vessel, maintain a distance of not less than **30 metres** from any vessel, land, structures and other things or, if that is not practicable, a safe distance and speed. From a distance of 450m from the site, all vessels are legally required to be travelling at a speed of 6 knots or less. The wave height assessment in the Navigation Impact Assessment (RHDHV, 2019) considers the wave height from a cruiser transiting past the site at a speed of less than 6 knots.

Further to the above, Clause 11 of the NSW Marine Safety Regulation 2016 notes:

> *(2) The operator of a vessel must not cause wash that damages or impacts unreasonably on—*
> > *(a) any dredge or floating plant, or*
> > *(b) any construction or other works in progress, or*
> > *(c) any bank, shore or waterside structure, or*
> > *(d) any other vessel, including a vessel that is moored.*

Operating a vessel in a manner that produces excessive wash near Noakes would violate the regulation. However, the definition of ‘wash that damages or impacts unreasonably’ is ambiguous. The adopted wave height and period reflects a boat generated wave height that could be readily achieved by all operators.

The adopted wave height of 0.4m with a period of 4 seconds and 0.2m with a period of 8 seconds is considered conservative. Due to the complexities of wave attenuation, reflection, refraction, diffraction and shoaling, further assessment through desktop methods is not considered appropriate. If required to refine the design wave height, data collection in the field would be required. However, a visual observation of the site indicates that it is protected and additional data collection is deemed surplus to requirements.

John Butler Design have been engaged to undertake a dynamic vessel analysis based on the nominated wave height (refer **Section 2.1**).

6.2.5 Lines of approach

Colville Marine contests the assessment of the lines of approach and highlights limitations of the adopted guidelines, which is noted in the Navigation Impact Assessment (2019) and discussed in **Section 6**. It should be noted that AS3962-2001 Guideline for design of marinas has been superseded by AS3962-2020 Marina Design. There are some subtle differences. However, in general, the guidelines are largely the same.

Section 4.3.1 and Section 5.1.2 of the Navigation Impact Assessment (2019) note that power assisted move (assistance form a workboat or similar) would be required for navigation of some vessels, which is not considered by Colville Marine.

Further, adopting an ‘entrance channel’ width on the approach to the swing basin in accordance with AS3962, rather than an ‘interior channel’, is deemed acceptable. The ‘interior channel’ caters for manoeuvring into fairways and berths, which is not required on the approach to the swing basin at Noakes.

The response by Colville Marine does not provide substantiated guidelines or evidence to support the conclusions.

6.2.6 Restrictions imposed by the swing basin and lines of approach

Colville Marine notes that size of the proposed swing basin shown in Map 2 of the Navigation Impact Assessment (RHDHV, 2019) should not include any waters in the berthing box alongside the oil terminal. The swing basin is clear of the marine lease boundary, adjacent to the former oil terminal wharf, which ensured the swing basin does not encroach on the berth box.

Colville Marine notes that the commercial mooring operated by Noakes would need to be relocated; this is recognised in Section 5.1.2 of the Navigation Impact Assessment (RHDHV, 2019).

6.2.7 Entering the dock

There are a number of incorrect statements from Colville Marine. These are outlined below:

- Colville Marine notes that an interior channel of 75m provides 37.5m abeam of a vessel on either side. This is incorrect as it does not consider the vessel beam. Further, the intent of the navigation channel is to provide space to manoeuvre. Therefore, the space abeam of a vessel navigating within an interior channel in a marina could reasonably be expected to be less than 5m during manoeuvring or touching a fender for alongside berthing. The assessment to maintain 37.5m abeam of a vessel is excessive.

- Colville Marine notes that the wharf used to cold move slew the FDD presents a danger. This is consistent with Section 4.3.1 and Section 5.1.3 of the Navigation Impact Assessment (RHDHV, 2019), which notes that fenders would be installed at this location. Notwithstanding, the risk of navigating past the wharf is similar to manoeuvring into a marina berth.
- Conclusion 3 notes that the lines of approach and the swing basin impose restrictions on free movement in Berrys Bay. If anything, the swing basin and navigation channel provide space for the movement of vessels and improves navigability of other vessels. It is recognised that the swing basin and navigation channel impacts on mooring grounds. However, the only mooring impacted is a commercial mooring operated by Noakes.

6.3 Dock Stability

The issue of dock stability is indirectly related to the navigation impact. A separate stability assessment has been completed by Shearforce Maritime Services Pty Ltd (2016) (**Appendix F**) and a Stability Booklet has been prepared by John Butler Design (2022b) (**Appendix E**). Further, a seakeeping assessment has also been undertaken by John Butler Design (2022a) (**Appendix D**).

Provided the FDD is maintained and operated within the limiting conditions identified in the stability assessments, the risk of a ‘stability incident’ is extremely low. An analogy to this would be the risk of building collapse or bridge failure provided the structure is not overloaded. Notwithstanding, the risk of a ‘stability incident’ should be included in the Safety Management System. Other risks that could impact instability and the ability to operate the FDD as planned, such as generator or pump failure, should also be included in the Safety Management System.

The analysis of ballast and deballast operations provided by Colville Marine does not reflect the water depth assessment in Section 5.1.5 of the Navigation Impact Assessment (RHDHV, 2020).

6.4 Under Keel Clearance

Colville Marine contends that the adopted guidelines for the Navigation Impact Assessment (RHDHV, 2019) are not applicable. However, alternate guidelines are not suggested or recommended. The Harbour Master Directions (2021) noted by Colville Marina supersede the Harbour Master Directions in the Navigation Impact Assessment (RHDHV, 2019). The assessment should consider the guidelines currently in force and the requirements for UKC in the Harbour Master Directions (2021) are adopted herein.

Colville Marine makes an incomplete reference to Section 2.1.2.7 of the Harbour Approach Channel Design Guidelines (PIANC, 2014), noting that an UKC of 1000mm is recommended where the consequence of touching the bottom is large. This is clarified later in Section 2.1.2.7 of the Harbour Approach Channel Design Guidelines (PIANC, 2014), where it states, “UKC should be at least 0.5 m, but could be increased to 1.0 m where the consequence of touching the bottom is large (e.g. for channels with rocky bottoms)”.

Colville Marine notes that if the FDD touched the bottom during a ballasting or deballasting operation or as a result of wave action, ‘the consequences of disturbing the contaminated sediment should be categorised as large’. Compared to say a fuel tanker running aground on a rocky reef, the consequence of the FDD locally disturbing seabed sediment would be considered low. Nevertheless, as demonstrated in **Sections 2.3** and **5**, this is not expected to be an operational outcome.

Colville Marine notes that there is insufficient water depth to operate the FDD to the maximum capacity. This is not disputed and it is spelt out in Section 5.1.5 of the Navigation Impact Assessment (RHDHV, 2019) and **Sections 2.3** herein.

Colville Marine incorrectly assumes that keel blocks have not been included in the Navigation Impact Assessment (RHDHV, 2019). Section 5.1.5 and Section 5.4 of the Navigation Impact Assessment (RHDHV, 2019) calculates the maximum vessel draft that could be docked at the proposed location and includes an allowance for keel blocks of 300mm as advised by the Naval Architect.

Colville Marine quotes Section 2.16 of the Harbour Masters Directions, which note that, 'a person disturbing the seabed, pursuant to section 67ZN of the Ports and Maritime Administration Regulation 2012 (NSW), must seek permission from the Harbour Master via the application form on the Port Authority website.' It should be noted that the Ports and Maritime Administration Regulation 2012 has been superseded by the Ports and Maritime Administration Regulation 2021. Clause 110 - Disturbance of bed of port states that:

> *A person must not use drags, grapplings or other apparatus for lifting an object or material from the bed, or otherwise disturb the bed, of a port specified in Schedule 4 except—*
> *(a) with the written permission of the relevant harbour master, and*
> *(b) in accordance with the conditions of the permission.*

Approval for disturbance of the seabed would be required from PANSW for removal of piles and the like. No other bed disturbance of any significance is expected with the FDD proposal.

6.5 Maritime Lease and Consent to Lodge

There are a number of items highlighted by Colville Marine that would appear to be misleading. However, a planner would be in a better position to respond. In regard to the Navigation Impact Assessment (2019), it should be noted that:

- The FDD is not intended to operate beyond the lease boundary;
- The FDD is designed to safely operate with passing traffic; and,
- No dredging is proposed as part of the development.

6.6 Other Environmental Issues

A number of issues raised by Colville Marine relate to other environmental considerations, which should be addressed accordingly.

6.7 Conclusions

Response to the conclusions from Colville Marine are provided in red below.

1. The proposed market for the FDD is to dock ASD tugs and vessels between 35m and 50m in length. The proposed market identified by Colville Marine is speculative commentary relating to economics rather than operation. The Navigation Impact Assessment (2019) correctly identifies a maximum vessel draft for operation.

2. The proposed warping operation of the FDD from the alongside position to the docking and submergence position will not work. A fair view, given the location and configuration of the equipment and the difficulties presented, would be that operator intends to move the FDD using

the assistance of a tug and that the primary use of the capstans will be to handle the vessels being docked. An indicative mooring line plan is provided in the Navigation Impact Assessment (2019) demonstrating that the FDD can be slewed. The proponent is aware that additional bollards, leads and capstans may be required to undertake the cold move slew operation.

3. The safe channel widths, lines of approach and swing basin are not correct. The lines of approach and the swing basin impose restrictions on free movement in the bay and the ability to add moorings in the future. The commercial mooring operated by Noakes will need to be permanently removed. The swing basins and approach channels required for operation of the FDD are as per existing with the exception of the commercial mooring operated by Noakes. Free movement would not be restricted in Berrys Bay. The proposed navigation arrangements including the swing basin would potentially improve free movement.

4. Any vessel over 30m entering the dock in a moderate breeze (15kts) from the south or west would require one or two tugs to complete the manoeuvre safely. The requirement for power assisted move (assistance form a workboat or similar) is highly dependent on the type and propulsion of the vessel to be docked. A vessel fitted with suitable bow and stern thrusters would not require assistance. Section 5.1.2 of the Navigation Impact Assessment (2019) correctly identifies that certain vessels would require assistance.

5. The Navigation Assessment does not assess the risk of a stability incident occurring on the boundary of the maritime lease that would block the channel or endanger the public. If operated in accordance with the design conditions, the risk of a stability incident is low. An analogy is the risk of building collapse or bridge failure if the design load is not exceeded.

6. Phase 3 of the FDD 4 phases of operation (Table 4) was omitted as it shows the unfavourable condition of the FDD at the submergence required for a 1000 tonne vessel with a deep draught where the draught of the FDD at this loading should be around 8.0m. Phase 3 relates to the external waterline at the top of the keel blocks (i.e. vessel keel at water level). The draft would be approximately 3m. John Butler Design have undertaken a stability assessment and seakeeping assessment, which considered Phase 3 and Phase 4.

7. The theoretical UKC clearance of 300mm is insufficient to prevent the disturbance of the contaminated sediment on the seabed. A safe UKC should be determined by assessment of the actual risk of wave action or a miscalculation in the Docking Plan and using 500mm UKC as the starting point. The agreed assessed UKC should be referred to the Harbourmaster for consent according to Harbourmasters Directions 2.16 and 3.2. The Harbour Masters Directions (2021) supersede the Navigation Impact Assessment (2019). The revised assessment herein adopts 500mm UKC in accordance with the Harbour Masters Directions (2021).

8. There is insufficient depth to operate the FDD safely without disturbing the contaminated sediments in the seabed in either the alongside position or in the submerged position. The operator intends to operate the FDD in the deeper water beyond the boundary of the maritime lease using a tug for assistance to position and hold the FFD in place during the docking. The FDD is proposed to remain within the lease boundary. There is sufficient water depth to operate the FDD. However, the maximum vessel draft for docking is limited. This is highlighted in Section 5.1.5 of the Navigation Impact Assessment (RHDHV, 2019).

Overall, the review by Colville Marine has misunderstood the proposed development. This is reflected in their assessment and review of the Navigation Impact Assessment (RHDHV, 2019). In particular, the following is noted:

- The FDD is not intended to operate beyond the lease boundary;
- The FDD is designed to safely operate with passing traffic; and,
- No dredging is proposed as part of the development.

7 Expert Witness Qualifications

This report has been prepared by Rick Plain of Royal HaskoningDHV. His qualifications and experience which justifies his ability to provide expert witness is set out in his curriculum vitae in **Appendix G**.

I have read Division 2, Part 31 of the Uniform Civil Procedure Rules 2005 and the Expert witness code of conduct in Schedule 7. This report is prepared in accordance with the Uniform Civil Procedure Rules 2005 and I agree to be bound by their terms. My evidence in this report is within my area of expertise, except where I stated that I have relied upon the evidence of another person.

8 References

- Colville Marine Pty Ltd (2021), Review of the Noakes Proposal to use the Floating Dry Dock in Berrys Bay.
- Department of Defense Standard Practice Safety Certificate Program for Drydocking Facilities and Shipbuilding Ways for U.S. Navy Ships (MIL-STD).
- Gaythwaite (2016), *Design of Marine Facilities Engineering for Port and Harbor Structures.*
- John Butler Design (2022a), *Seakeeping Assessment Floating Dock 'FDD1N' Revision 1*
- John Butler Design (2022b), *'FDD1N' STABILITY BOOKLET UVI No: 455344*
- John Butler Design (2022c), *Letter Reference: L2151-01*
- Port Authority of NSW (PANSW, 2021), *The Harbour Master Directions Sydney Harbour and Port Botany (15 February 2021).*
- Royal HaskoningDHV (RHDHV, 2019), *Noakes Boat and Shipyard Floating Dry Dock Navigation Impact Assessment.*
- Shearforce Maritime Services Pty Ltd (2016), *Structural and Stability Assessment – Final Report Floating Dock AFD 1002.*
- World Association for Waterborne Transport Infrastructure (PIANC, 2014), *Harbour Approach Channel Design Guidelines.*
- World Association for Waterborne Transport Infrastructure (PIANC, 2013), *Design and Operational Guidelines for Superyacht Facilities.*
- World Association for Waterborne Transport Infrastructure (PIANC, 2016), *Guidelines for Marina Design.*
- World Association for Waterborne Transport Infrastructure (PIANC, 2019), *Design Guidelines for Inland Waterway Dimensions.*

Appendix A – Noakes Boat and Shipyard Floating Dry Dock Navigation Impact Assessment (RHDHV, 2019)

REPORT

Noakes Boat and Shipyard Floating Dry Dock

Navigation Impact Assessment

Client: Noakes Group / Hamptons Property Services

Reference: M&APA1718-R01F6.1_NIA

Status: 6.1/Final

Date: 21 February 2019

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Document title:	Noakes Boat and Shipyard Floating Dry Dock
Document short title:	Noakes FDD Navigation Impact Assessment
Reference:	M&APA1718-R01F6.1_NIA
Status:	6.1/Final
Date:	21 February 2019
Project name:	Noakes Navigation Impact Assessment
Project number:	PA1718
Author(s):	Rick Plain

Drafted by:	Rick Plain
Checked by:	Gary Blumberg
Date / initials:	5/7/18
Approved by:	Gary Blumberg
Date / initials:	23/11/18

Classification
Project related

Royal HaskoningDHV

Table of Contents

Appendices

1 Introduction

Noakes Boat and Shipyards (Noakes) are located at 6 John Street, McMahons Point, in the local government area of North Sydney. The Shipyard is located on the eastern side of Berrys Bay and near the head of the eastern arm of the Bay. Berrys Bay is flanked by McMahons Point/Blues Point to the east and Balls Head to the west.

The proponent is proposing to install a floating dry dock (FDD) facility for berthing of vessels to undertake maintenance of the vessels. Hamptons Property Services Pty Ltd (Hamptons) in conjunction with William Loader Architectural & Marine Design (AMD) have been retained to coordinate a development application for installation of the FDD.

Hamptons have advised that the proposed works are classified as designated development in accordance with Section 77A of the Environmental Planning & Assessment Act 1979 (the Act). Further to the relevant requirements, the Secretary Environmental Assessment Requirements (SEARs) have been obtained. A requirement of the SEARS addressed by the report herein is to assess marine safety and navigation including:

- an assessment of the impacts on water based traffic and the existing users of Sydney Harbour in the vicinity of the proposed FDD; and,
- details of private boat moorings surrounding the site and an assessment of the impact of the construction and operation of the FDD on these moorings.

Noakes Group has engaged Royal HaskoningDHV (RHDHV) to undertake the marine safety and navigation Impact Assessment. The scope of this study involves:

- review of background information including nearby recent development applications;
- establish existing waterway navigation and usage;
- assessment of potential marine safety and navigation impacts and proposed mitigation measures; and,
- preparation of a Safety and Navigation Impact Assessment Report.

The report herein assesses marine safety and navigation requirements for inclusion in the EIS.

Appendix A contains maps displaying relevant spatial data and comprise:

- Map 1 – Site layout including features from:
  - Port Jackson (Central Sheet) Sydney Harbour 1:7500 Hydrographic Chart (Aus 202);
  - NSW Roads and Maritime Services (RMS) Boating Map of Port Jackson – Western Area Lower Parramatta and Lane Cove Rivers;
  - RMS Mooring Plan; and,
  - Altis Architecture Proposed FDD (SK4000).

- Map 2 – Detailed site layout including features from:
  - Detailed Hydrographic Survey by Harvey Hydrographic Surveys (2017);
  - RMS Mooring Plan; and,
  - Altis Architecture Proposed FDD (SK4000).

- Map 3 – Hydrographic Contour Map including features from:
  - Detailed Hydrographic Survey by Harvey Hydrographic Surveys (2017);
  - RMS Mooring Plan; and,
  - Altis Architecture Proposed FDD (SK4000).

Appendix B contains details on the proposed FDD including dimensions.

2 Foreshore Occupation

Noakes Shipyard is located between John Street and Munro Street as indicated in **Figure 1** (note, Noakes Shipyard is labelled as North Sydney Marine Centre in the Figure).

North of Noakes Shipyard, the foreshore is relatively steep. Steps carved into sandstone rock lead to a small beach, immediately north of Noakes Shipyard property boundary. This area was the site of a former public baths (swimming enclosure).

The head of Berrys Bay has been reclaimed to form Waverton Park, a sports field. Waverton Park is flanked by a seawall and access to the water is not accommodated. The mudflats were reclaimed to form the playing fields between 1960 and 1963 (North Sydney Council).

The western side of Berrys Bay is the site of the former British Petroleum (BP) oil and gas terminal. The storage tanks have been removed and the site has been reclaimed as public space (Carradah Park). Some of the overwater infrastructure, including a disused wharf for berthing tankers has been retained. There is no public access to the foreshore from Carradah Park.

South of Noakes Shipyard, the foreshore has been retained as public open space. The Boatbuilders Walk, a concrete and timber boardwalk, provides a footpath for pedestrians linking Munro Street to Sawmillers Reserve. A small private marina is located near the middle of the Boatbuilders Walk, and a dinghy skid is located at the southern end of the concrete footpath (immediately south of the private marina). With the exception of the dinghy skid, no public access to the foreshore is provided along the Boatbuilders Walk. Sandy beaches are accessible from Sawmillers Reserve.

Figure 1: Map of Berrys Bay including foreshore reserves (SIX Maps, 2018).

Figure 2 provides historical aerials from 1943. A couple of noteworthy observations include:

1. The baths north of Noakes Shipyard are clearly visible near the foreshore;
2. Waverton Park had not been reclaimed. There is a shipwreck visibly in the centre of the mudflats at the head of the bay;
3. The former BP Terminal is in operation. A floating boom is located across the entrance to Berrys Bay; and

4. A number of slipways are located along the foreshore, south of Noakes Shipyard.

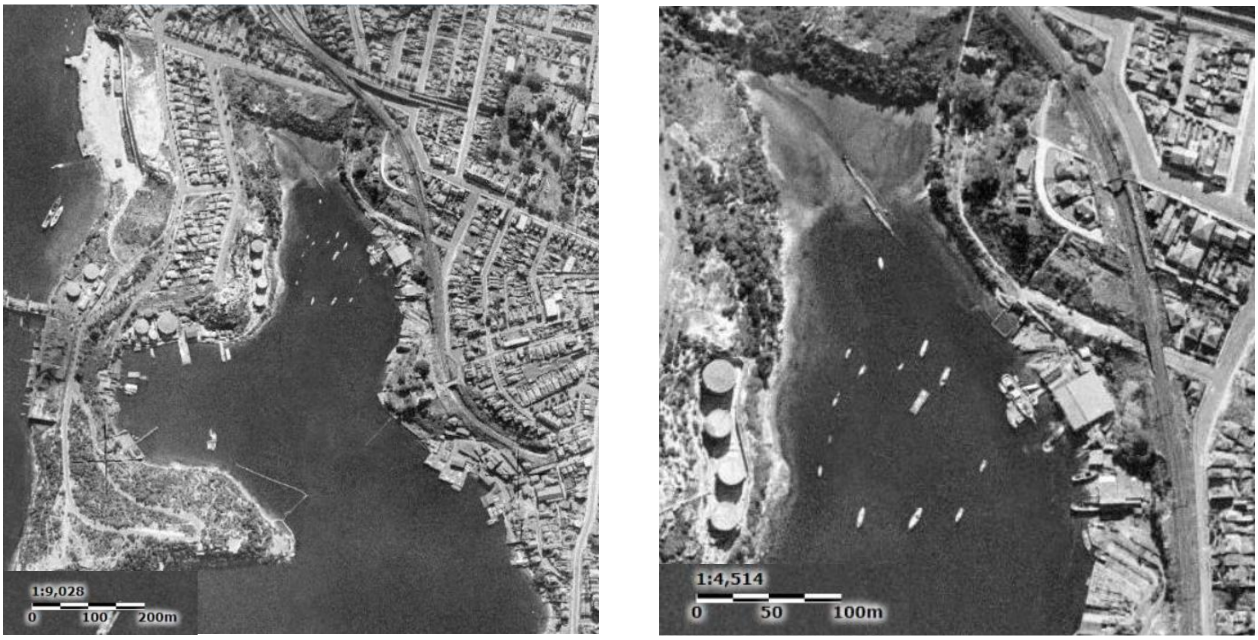

Figure 2: Historical aerials of Berrys Bay from 1943 (SIX Maps, 2018).

3 Existing Waterway Navigation and Usage

3.1 Navigation Rules

The Convention on the International Regulations for Preventing Collisions at Sea 1972 (COLREGS) applies to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels. It is an international document that defines the navigation rules to be followed to prevent collisions between two or more vessels.

Two key rules in the COLREGS are:

- Rule 5 – Look-Out
  Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

- Rule 6 – Safe Speed
  Every vessel shall at all times proceed at a safe speed so that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

  In determining a safe speed, the following factors shall be among those considered:
  a) the state of visibility;
  b) the traffic density including concentrations of fishing vessels or any other vessels;
  c) the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions;
  d) at night, the presence of background light such as from shore lights or from back scatter of her own lights;
  e) the state of wind, sea and current, and the proximity of navigational hazards;
  f) the draught in relation to the available depth of water.

The NSW Marine Safety (General) Regulation 2016 and Marine Safety Act 1998 adopts the COLREGS and includes minor modifications and additional special rules applicable to NSW waterways.

3.2 Regulatory Authority

The NSW Roads and Maritime Services (RMS) is the NSW Government authority with responsibility for marine safety and regulation of commercial and recreational boating, including enforcement of the Marine Safety Act 1998 and Marine Safety Regulation 2016.

The RMS produced the NSW Boating Handbook (RMS, 2016), which is an interpretation of the law and legislation. The basic navigation rules in the handbook dictate:

- vessels must always be navigated on the starboard (right) side of a river or channel.
- when two power driven vessels meet head on, each must alter course to starboard (to the right) and pass at a safe distance.
- in a crossing situation, vessel must give way to the right and in doing so, alter course to starboard.
- a skipper may overtake another vessel on either side but only when it is safe and the overtaking boat must stay well clear.

In addition to the authority granted to RMS, within the Sydney Harbour Port Limits, the Harbour Master who is an employee of the Port Authority of NSW (PANSW) has the authority to issue directions to vessel operators under Part 7 of the Marine Safety Act 1998 and the Master of any vessel shall comply with direction given by the Harbour Master. Sydney Harbour Port Limits incorporates Berrys Bay and is defined as:

> *the waters of Sydney Harbour and of all tidal bays, rivers and their tributaries connected or leading to Sydney Harbour bounded by mean high water mark together with that part of the Tasman Sea below mean high water mark enclosed by the arc of a circle of radius four nautical miles having as its centre the navigation light at Hornby Lighthouse* (South Head) (PANSW, 2016).

Additional rules and regulations apply to the operation of commercial vessels as outlined in the *Marine Safety (Domestic Commercial Vessel) National Law Act 2012*. The act is regulated by the Australian Maritime Safety Authority (AMSA). The objective of the act is to provide a framework for ensuring the safe operation, design, construction and equipping of domestic commercial vessels.

3.3 Harbour Master Directions

Supplementary to the navigation rules identified above, the Harbour Master, under Part 7 of the Marine Safety Act 1998, directs that:

- All vessels of length overall (LOA) 30m or over are required to participate in the Vessel Traffic Service (VTS). The Sydney Harbour Vessel Traffic Service area is defined as:

  From Port limits to Longnose Point (commonly referred to as Yurulbin Point) (PANSW, 2016).

- Pilotage is compulsory for vessels of length overall (LOA) 30m or over unless the vessel is exempt under the Marine Safety Act 1998. Exemptions include:
  - *a vessel whose master is the holder of a marine pilotage exemption certificate under this Act that applies to that port and vessel; and,*
  - *a recreational vessel.*

- Tug assistance from one or more tugs is required for all vessels greater than 30m in length (increased to 75m if a bow thruster is fitted).

- All seagoing ships navigating within port limits are required to maintain the following under keel clearance unless approved:
  - 10% of the vessels deepest draught for the harbour transit to the seaward limit of the berth box; and,
  - 0.5 metres to sail or berth in the berth box and at all times whilst alongside.

Participation in the VTS includes limitations on anchoring and a requirement to seek clearance prior to moving within the VTS area. The Sydney Ports VTS is responsible for monitoring the movement of participating vessels to improve safety and efficiency and protects the port's environment and infrastructure from possible adverse effects.

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3.4 Navigation Restrictions

Navigation restrictions are shown on RMS Boating Map 9G – Port Jackson Western Area, Lower Parramatta and Lane Cove Rivers (dated April 2016), which is reproduced below on **Figure 3**. Navigation restrictions are also shown in Map 1 (refer **Appendix A**).

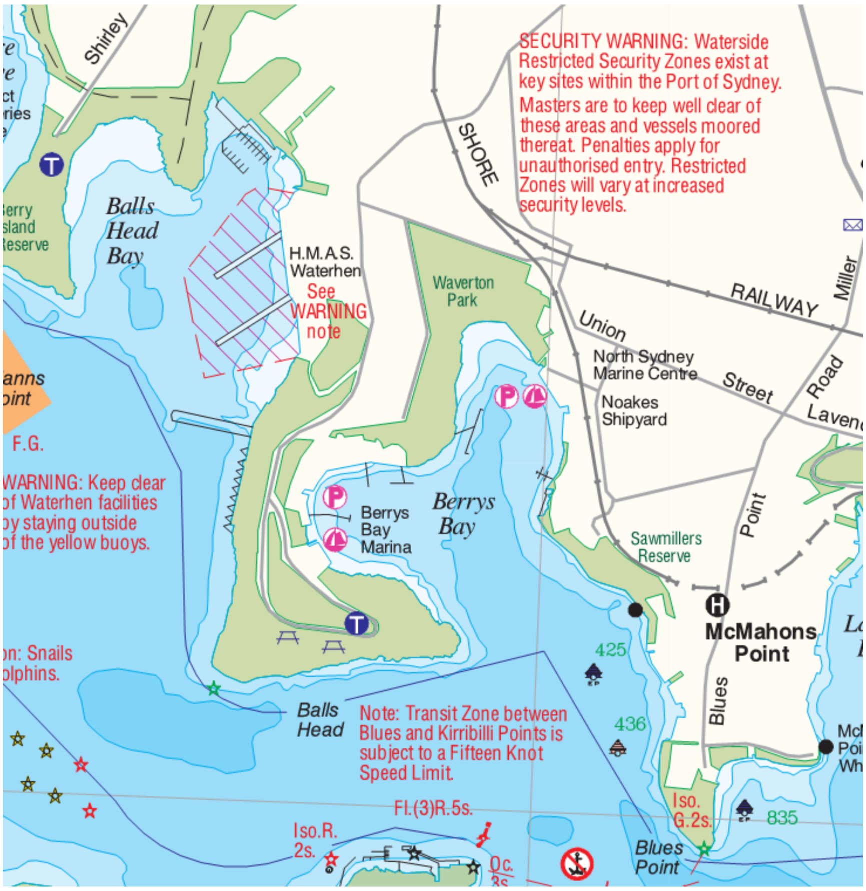

Figure 3: Extract from RMS Boating Map 9G - Port Jackson Western Area Lower Parramatta and Lane Cove Rivers.

The following observations are made from the Boating Map:

- Berrys Bay lies outside of the main shipping channel (indicated by dark blue line near the entrance to Berrys Bay).
- One Public Mooring (no. 436) and one emergency police mooring (no. 425) are located on the western side of Blues Point at the entrance to Berrys Bay.
- Two Marina Boatsheds are located in Berrys Bay, one of which is Noakes.
- Two Private Vessel Pump out facilities are located in Berrys Bay, one of which is at Noakes.

No navigation restrictions are marked on the RMS Boating Map in regards to Berrys Bay. However, Clause 40 of the NSW Marine Safety Regulation 2016 states,

> *'the operator of a power-driven vessel that is travelling at a speed of 6 knots or more must ensure that the vessel, and any towing equipment and any person being towed by the vessel, maintain a distance of not less than 30 metres from any vessel, land, structures and other things or, if that is not practicable, a safe distance and speed.'*

This distance off and speed restriction applies to moorings within Berrys Bay. The mooring plan for Berry's Bay provided by NSW Roads and Maritime Services is reproduced below on **Figure 4**. The clear width for navigating to and from Berrys Bay between the defined mooring areas is measured to be 45 to 65 m. However, it is noted that some of the private moorings are outside of the defined mooring area. Thus in accordance with Clause 40 of the Marine Safety Regulation, it follows that the speed limit in Berrys Bay is 6 knots. This does not preclude vessels from abiding to Rule 5 and Rule 6 of the COLREGS (refer **Section 3.1**).

A 'no anchoring' zone is located at the mouth of Berrys Bay due to submarine cables (TfNSW, 2014). Further, Rule 9 of the COLREGS dictates that any vessel shall, if the circumstances of the case permit, avoid anchoring in a narrow channel. The navigation channel and entrance to Berrys Bay should therefore remain open and unimpeded.

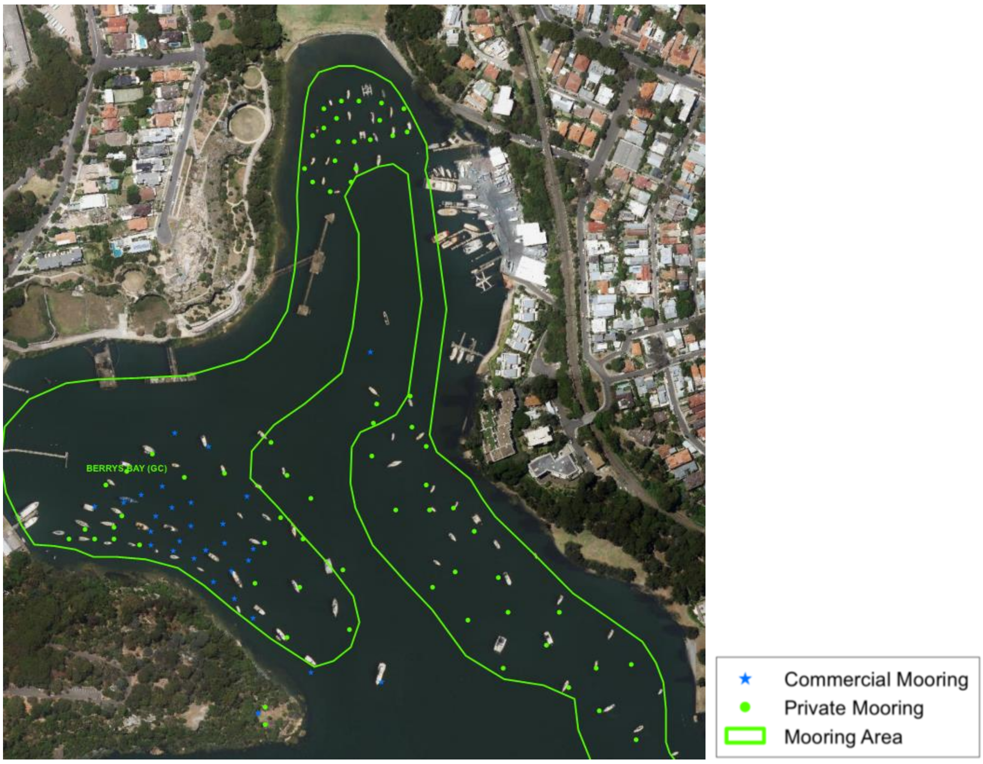

Figure 4: Mooring plan for Berrys Bay provided by NSW RMS (green line indicates mooring area).

3.5 Tidal Water Levels

Tidal water levels in Sydney Harbour are represented by tidal planes at the Fort Denison tide gauge, and are summarised in **Table 1**.

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Table 1: Sydney Harbour Tidal Planes (MHL, 2012).

Tidal Plane	Chart Datum (metres)	Australian Height Datum (metres)
Highest Astronomical Tide, HAT	2.1	1.18
Mean High Water Springs, MHWS	1.57	0.65
Mean High Water, MHW	1.45	0.53
Mean High Water Neaps, MHWN	1.33	0.41
Mean Sea Level, MSL	0.95	0.03
Mean Low Water Neaps, MLWN	0.56	-0.37
Mean Low Water, MLW	0.44	-0.49
Mean Low Water Springs, MLWS	0.32	-0.61
Lowest Astronomical Tide, LAT	0	-0.93

3.6 Water Depths

Water depths in Berrys Bay, in metres below Chart Datum (CD), are shown in **Map 1** (refer **Appendix A**). The water depths are derived from the hydrographic chart AUS 202 and a detailed hydrographic survey near Noakes completed by Harvey Hydrographic Surveys (2017). Chart Datum is zero on the Fort Denison Tide Gauge and is approximately 0.925 m below Australian Height Datum (AHD). Zero metres AHD is approximately equal to Mean Sea Level at present.

Water depths at the entrance to Berrys Bay are up to approximately 13 m below CD. The map indicates water depths in the vicinity of the former BP Terminal are in excess of 10 m below CD. The seabed in the vicinity of Noakes are somewhat shallower at approximately 3 m below CD near the hardstand and increasing to approximately 7 m below CD near the end of the finger wharves.

3.7 Wave Climate

The wave climate at the site is contributed to by wind waves and boat-generated waves. The site is beyond the extent of ocean swell penetration. Wind waves and boat-generated waves combine to generate the incident wave conditions in Berrys Bay.

3.7.1 Wind Waves

Wind waves are generated when the wind blows across a body of water. The size and period of these waves depends on the wind speed, the distance over which the wind blows (fetch) and the water depth. Design wind velocities for the site were obtained from *Australian Standard Structural Design Action Part 2: Wind Actions (AS/NZS1170.2:2011)*. Wind wave hindcast procedures set out in the Coastal Engineering Manual (USACE, 2008) were used to predict the incident wind wave climate at the site, which is summarised in **Table 2**. The wind waves have been calculated in the proximity of Noakes.

Wind waves are defined at primary directions separated by 45 degrees. The fetch is defined as the average length eight radials separated by 3 degrees, centred on the primary direction (SPM, 1984).

Table 2: Incident wind wave height at Noakes.

Direction	South			South-West		
Fetch	1.0 km			0.4 km		
Average Return Period	H_s (m)	T (s)	Power (W/m)	H_s (m)	T (s)	Power (W/m)
1 year	0.3	1.5	132	0.2	1.1	43
50 year	0.4	1.7	267	0.3	1.3	115
Notes (1)	Significant wave height Hs is the average of the highest 1/3 of waves in a wave train. H max ~ 1.5Hs					

3.7.2 Boat Waves

Boat generated waves are governed by the submerged shape of the boat hull, the boat speed and the water depth. Typically boat waves exhibit a diverging component which emanates at the bow, and a transverse component that follows behind the stern. The boat speed relative to the water depth can affect the form of the waves. Typical maximum boat wave height and period approximately 50 to 100 m from the vessels sailing line is recorded in **Table 3**.

Table 3: Maximum boat wave height and period 50 to 100 m from the sailing line.

Vessel Type	Average H_{max}	T (sec)	Power (W/m)
Power Boat	0.5	2 to 3	736
High Speed Catamaran Ferries	0.3	5 to 7	618
15 m Motor Cruiser	0.7	3 to 4	1923

Note: Unshoaled waves based on RHDHV Database.

Berrys Bay is a 6 knot zone due to the proximity of moorings to the navigable channel. A vessel travelling at 6 knots would produce less wash than that noted in **Table 3**. The wave heights in **Table 3** are considered to be far ‘field waves’ at the entrance to Berrys Bay.

Boat waves attenuate with distance from the sailing line. It is noted that there is no reduction in wave period from the sailing line. NSW Maritime (2005) note that the wash height from a high speed catamaran ferries in deep water and at a distance from the sailing line of 400 to 450 m is approximately 0.15 m representing a decrease of approximately 50%. It is assumed the attenuation of power boat and motor cruiser wash would be similar.

Further, the effects of wave reflection, refraction, diffraction and shoaling as the waves propagate into Berrys Bay also need to be considered. Wave reflection refers to the reflection seaward of wave energy at a boundary or surface. Refraction refers to the bending of wave crests (or change in wave direction) because of changes in bed level. Diffraction is the spreading of wave energy into a sheltered region behind a barrier such as a breakwater or moored vessel, and shoaling refers to the change in the form of waves (usually increase in wave height and reduction in wave length) as they pass from deeper to shallower water.

The maximum wave height, in the vicinity of Noakes due to far field boat waves propagating into Berrys Bay would be approximately 0.4 m with a period of 4 seconds (power = 628 W/m). This wave height would be similar to that generated by a cruiser travelling at 6 knots (i.e. not planning) closer to the site. This wave height could occur on a daily basis.

3.8 Existing Vessel Use

3.8.1 Recreational Power Boats Mooring and Berths

With the exception of the private moorings and a small private marina south of Noakes, there is currently minimal amenity for recreational boating in Berrys Bay. The Berrys Bay mooring plan (**Figure 4**) indicates the following moorings are located in Berrys Bay:

- North of Noakes, at the head of Berrys Bay:
  - 20 private moorings.

- Vicinity of Noakes:
  - 1 commercial mooring operated by Noakes.

- Eastern side of Berrys Bay:
  - 29 private moorings;
  - 1 public mooring; and,
  - 1 emergency mooring.

- Western side of Berrys Bay:
  - 23 private moorings; and,
  - 27 commercial moorings.

Some of the moorings on the western side of Berrys Bay are fore and aft moorings. These are typically found in higher use waterway areas as they occupy less space than traditional swing moorings.

At the time of preparing this report, there were no public wharves available for recreational boaters. However, in addition to the above numbers of moorings, there are:

- two short jetties on the western side of Berrys Bay, suitable for berthing two vessels each; and,
- one marina facility on the eastern side of Berrys Bay and south of Noakes suitable for 8 vessels.

The total number of moorings and berths in Berrys Bay is therefore 114. The vessels moored and berthed in Berrys Bay are typically up to 15 m in length.

3.8.2 Passive Recreation Craft and Trailerable Vessels

Formal boat launching facilities for passive recreation craft (canoes and kayaks) or trailerable vessels are not provided along the shoreline of Berrys Bay.

Numerous dinghies and kayaks are stored at the following locations:

- Northern end of Sawmillers Reserve (south of Noakes). Informal launching is provided from small sandy beaches.
- Southern end of Boatbuilders Walk (south of Noakes). A timber dinghy skid is located along Boatbuilders Walk for hand launching the vessels stored at this location.
- End of John Street (north of Noakes Shipyard). Informal launching is provided from a small beach at this location.

It is assumed that these craft are primarily used for accessing moorings.

In addition, there appears to be a tender service operated from 1 Balls Head Drive, Waverton for accessing commercial moorings in Berrys Bay. Details on the tender service could not be identified.

3.8.3 Commercial Vessels

The primary commercial facility in Berrys Bay is Noakes. STS Young Endeavour and the historic Rosmans Ferry Fleet are berthed at Noakes. The Ferry Fleet is not currently in service but are available for functions and they are currently used as spectator vessels for the world renowned NSW 18 Foot Skiff League at Double Bay.

The disused BP Terminal on the western side of Berrys Bay has been used as a berth for superyachts and other large vessels in recent years. There are no shore based facilities at this location. At the time of the site visit, SS South Steyne was berthed at the wharf. The SS South Steyne is 70 m long and operated on the Manly Run from Darling Harbour to Manly Wharf for 36 years. It was retired from service in 1974. It is unclear how frequently vessels access this facility.

4 Proposed Development

A FDD is a type of pontoon comprising floodable ballast tanks and a “U” shaped cross section. When the ballast tanks are flooded (with seawater), the FDD becomes partially submerged. This allows vessels to be floated in. As the ballast tanks are pumped out, the FDD floats and the vessel comes to rest on a dry platform. The FDD would be used for maintenance and repairs of ships, boats and other watercraft at Noakes. The dimensions of the FDD are provided in **Appendix B**.

The FDD proposed for installation was reportedly constructed in Balmain (NSW) in the 1940’s. It was operated by the Australian Defence Force for a number of years and was moored at Cockatoo Island or Garden Island.

The FDD was purchased by Noakes Group around 2014 and spent approximately 12 months moored at the former BP Terminal in Berrys Bay. The floating dry dock was refurbished by Harwood Marine in Yamba in 2017. At the time of preparation of this report, it is understood the FDD is moored at the Snails Bay dolphins in Sydney Harbour, awaiting approval for commissioning at Noakes Shipyard.

The tug “Warren” was purchased by Noakes primarily to assist in transporting and sea towing the FDD. The overall length of the tug is 23 m and the breadth is 7.8 m. It is understood the tug would assist with delivering the FDD to site. However, it would not be required to assist in slewing the FDD to facilitate loading and unloading. The tug may be used to assist in positioning vessels to be loaded on the FDD. However, it is likely that a smaller, and more manoeuvrable, vessel would be used for this operation.

4.1 FDD Dimensions

The external dimension of the FDD is 59.24 m long, 19.81 m wide and 10.51 m high. The design drawings for the FDD are attached in **Appendix B**. The height of the pontoon is 2.743 m.

4.2 Maximum Vessel Size for Docking

The parameters of the maximum vessel that could be docked on the FDD are:

- Displacement 1,000 t
- Length overall 60 m
- Beam 12.5 m

The length overall corresponds to the length of the FDD and the beam corresponds to the internal dimension between the adjacent walls of the FDD as shown in **Appendix B**. The displacement corresponds to the maximum lift of the FDD.

If sufficient water depths are available, the maximum theoretical vessel draught could be up to 5.64 m corresponding to Phase 1 ballasting/deballasting operations (refer **Section 4.3.2**). Achievable vessel draughts for docking are considered later in this report in **Section 5.1.5**.

The dimensions and displacement of a typical vessel that would be docked on the FDD are likely to be less that the maximum vessel parameters noted above. The assessment herein will conservatively adopt the maximum vessel dimensions.

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4.3 Operation of the FDD

4.3.1 Berthing/Loading and Deberthing/Unloading Operations

The FDD would be berthed adjacent to the hardstand at Noakes Shipyard. This location is referred to as the berthing pocket. Fenders would be installed along the seaward face of the hardstand to prevent damage to the FDD and/or hardstand when the FDD is berthed alongside.

The FDD would be cold move slewed to the seaward extent of Noakes Shipyard seabed boundary for loading and unloading vessels. This location is referred to as the loading pocket. **The FDD would remain within Noakes water lease boundary during all phases of operation**. A cold move slew means that the FDD is relocated by moorings lines with the assistance of hand operated capstans (winches). Capstans are positioned on each corner of the FDD, on the upper wall. Auxiliary motors or tug assistance **is not** required for slewing the FDD.

A gangway positioned at either end of the FDD would provide access to the FDD when it is berthed alongside the hardstand. The gangway would be removed when the FDD is slewed into the loading pocket and submerged.

Sequence diagrams for slewing the FDD are provided in **Figure 6** to **Figure 10**. A Safety Management System has been prepared for the operation and slewing of the FDD in accordance with requirements outlined in the *Marine Safety (Domestic Commercial Vessel) National Law Act 2012* and guidelines provided by AMSA. The FDD would only be slewed when favourable (calm) weather conditions are forecast and prevailing as outlined in the Safety Management System. The stages for slewing the FDD and loading a vessel are:

- Stage 1 – Relocated mooring lines. During this stage, the athwartship mooring lines and springers would be retained. Supplementary mooring lines would be cast off and/or relocated to slew the FDD. The supplementary mooring lines are required in severe weather but would not be required in favourable (calm) weather conditions. The gangways would be removed in this stage.
- Stage 2 – Slew southern end of the FDD. This would involve releasing the southern athwartship mooring line and springer while using the hand operated capstan on the FDD to take up and pull in the relocated line for slewing the FDD. The maximum length of the athwartship mooring line would be such that the FDD is physically contained within the lease area.
- Stage 3 – Slew northern end of the FDD. This would involve releasing the northern athwartship mooring line and springer while using the hand operated capstans on the FDD to take up and pull in the relocated lines for slewing the FDD. (Note, depending on the vessel draught to be docked, Stage 3 may not be required).
- Stage 4 – Lower/submerge the FDD and align vessel. The keel blocks would be positioned prior to this Stage of operation. The FDD would be submerged by flooding the ballast tanks. The vessel would be aligned with the assistance of the ships engines. Where necessary, a tug may be used to assist in positioning the vessel.
- Stage 5 – Dock vessel (float in) and float the FDD. The vessel would be manoeuvred into the FDD with the assistance of the ships engines and docking lines. A tug may be required at the stern of the vessel to assist in loading of the vessel. Following docking and positioning of the vessel, the FDD ballast tanks would be pumped out to float the FDD.

Vessels would only be loaded from the southern end of the FDD. The intake and pump out to submerge and float the FDD would be located on the western side of the FDD (i.e. away from the shoreline) and approximately 1.5m above the bottom of the pontoon.

Unloading a vessel would be undertaken in a similar manner. Berthing of the FDD adjacent to the hardstand would be as described above in Stages 1, 2 and 3. However, the sequence would be in the reverse order.

The time required to complete slewing and loading operations is discussed as follows:

- Slewing of the FDD (Stages 1, 2 and 3) out into the loading pocket would be completed in approximately 30 minutes.
- Submerging the FDD (Stage 4) would be completed in approximately 45 minutes.
- Loading a vessel onto the FDD would be completed in approximately 90 minutes. It is noted that the time required to unload a vessel would be less than the time required to load a vessel.
- Floating the FDD would be completed in approximately 120 minutes.
- Slewing the FDD back into the berthing pocket would be completed in approximately 30 minutes.

The total time required to slew the FDD and load a vessel onto the FDD would be approximately 5 to 6 hours. Submerging the FDD and loading a vessel would be undertaken on a flood tide and as close as practical to high tide. Floating the FDD would be undertaken on an ebb tide, immediately after loading a vessel. Slewing the floated FDD out into the loading pocket or back into the berthing pocket is not tidally dependant.

Approximately 12 dockings per year (one per month) would be undertaken. Vessels would remain on the FDD for approximately 4 weeks while repair and maintenance works are carried out.

Following unloading of a vessel, the FDD would be floated to reposition the keel blocks. The keel blocks require positioning to suit a particular vessel. Following repositioning of the keel blocks, the FDD would be submerged to load the next vessel. Loading and unloading of vessels would be undertaken as near to high tide as possible to maximise the available water depth at the site. Sydney experiences semidiurnal tides meaning that there are approximately two high and two low tides every day (i.e. one high tide approximately every 12 hours). Due to the restricted working hours, it is unlikely that unloading and loading of vessels would occur on the same day.

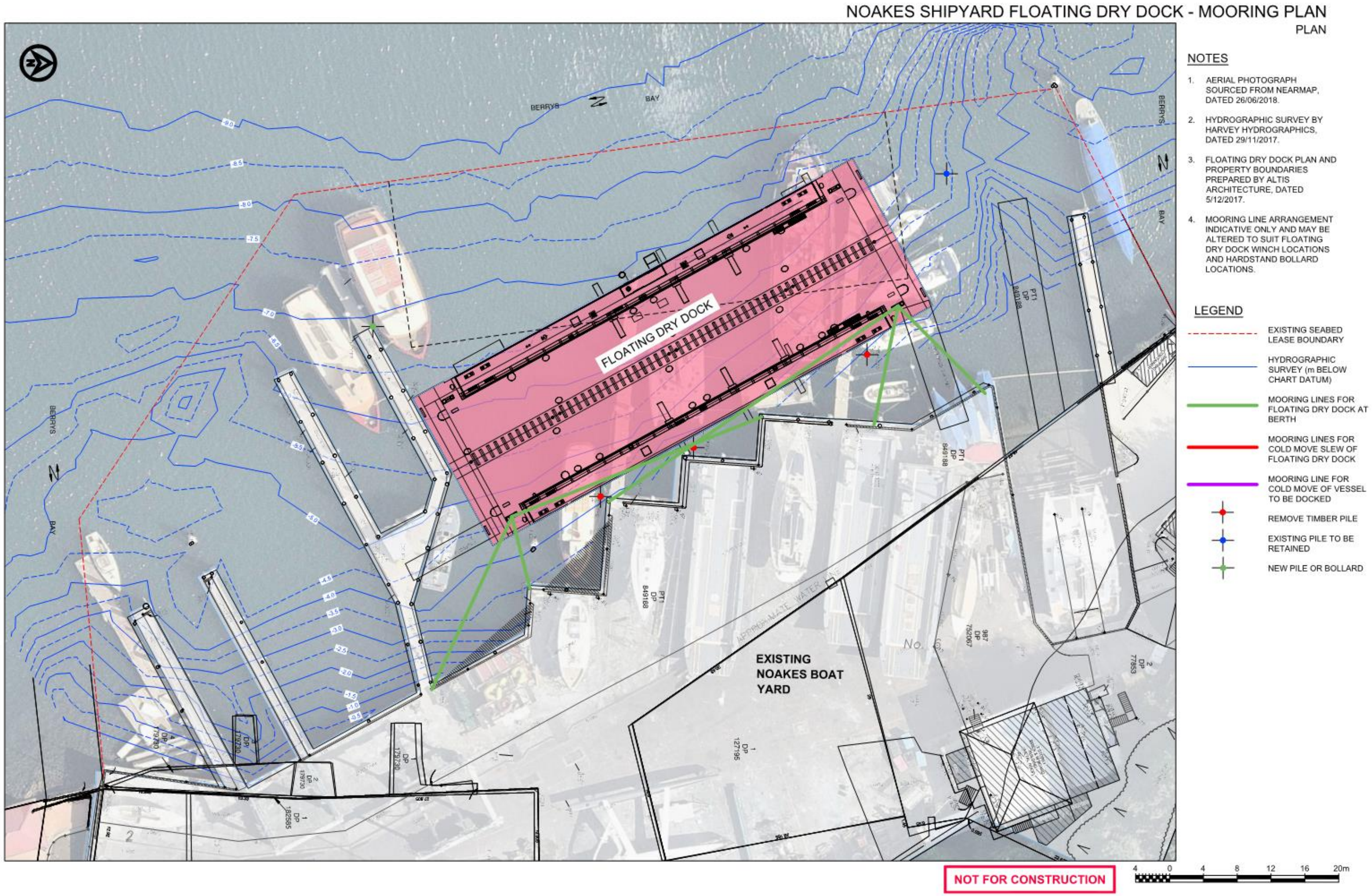

Figure 5: Floating dry dock mooring plan.

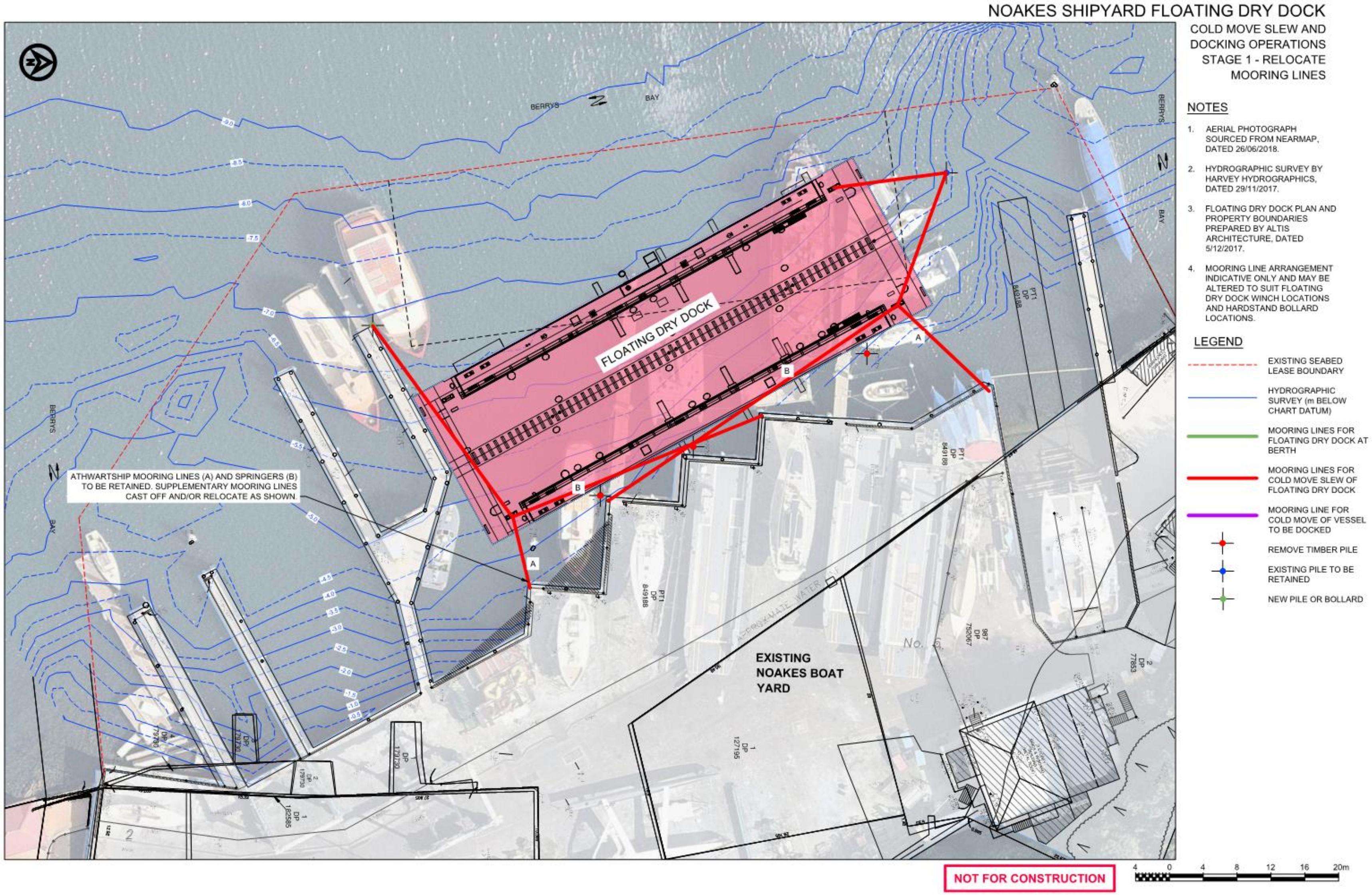

Figure 6: Stage 1 cold move slew and docking operations – relocate mooring lines.

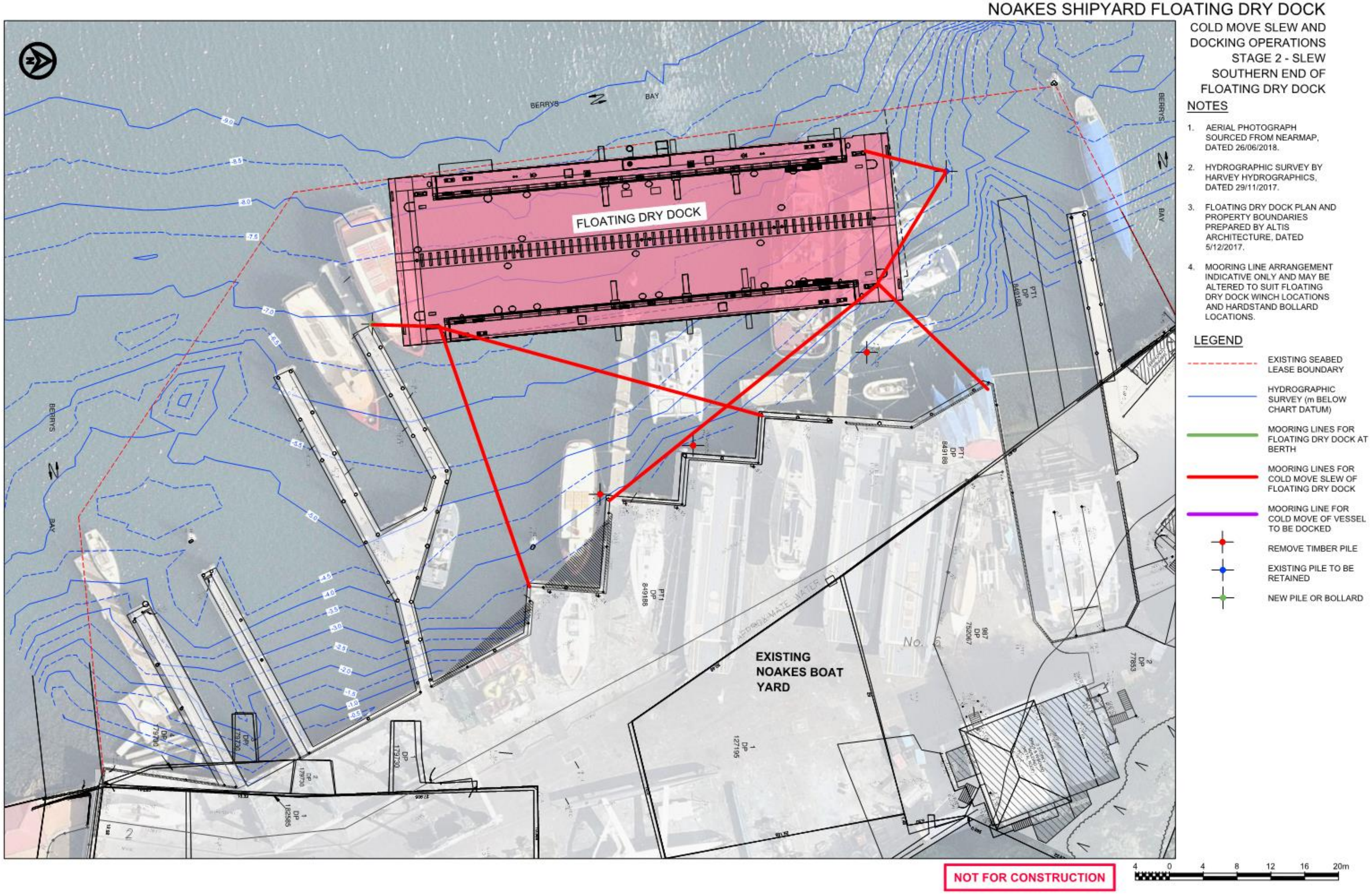

Figure 7: Stage 2 cold move slew and docking operations – slew southern end of floating dry dock.

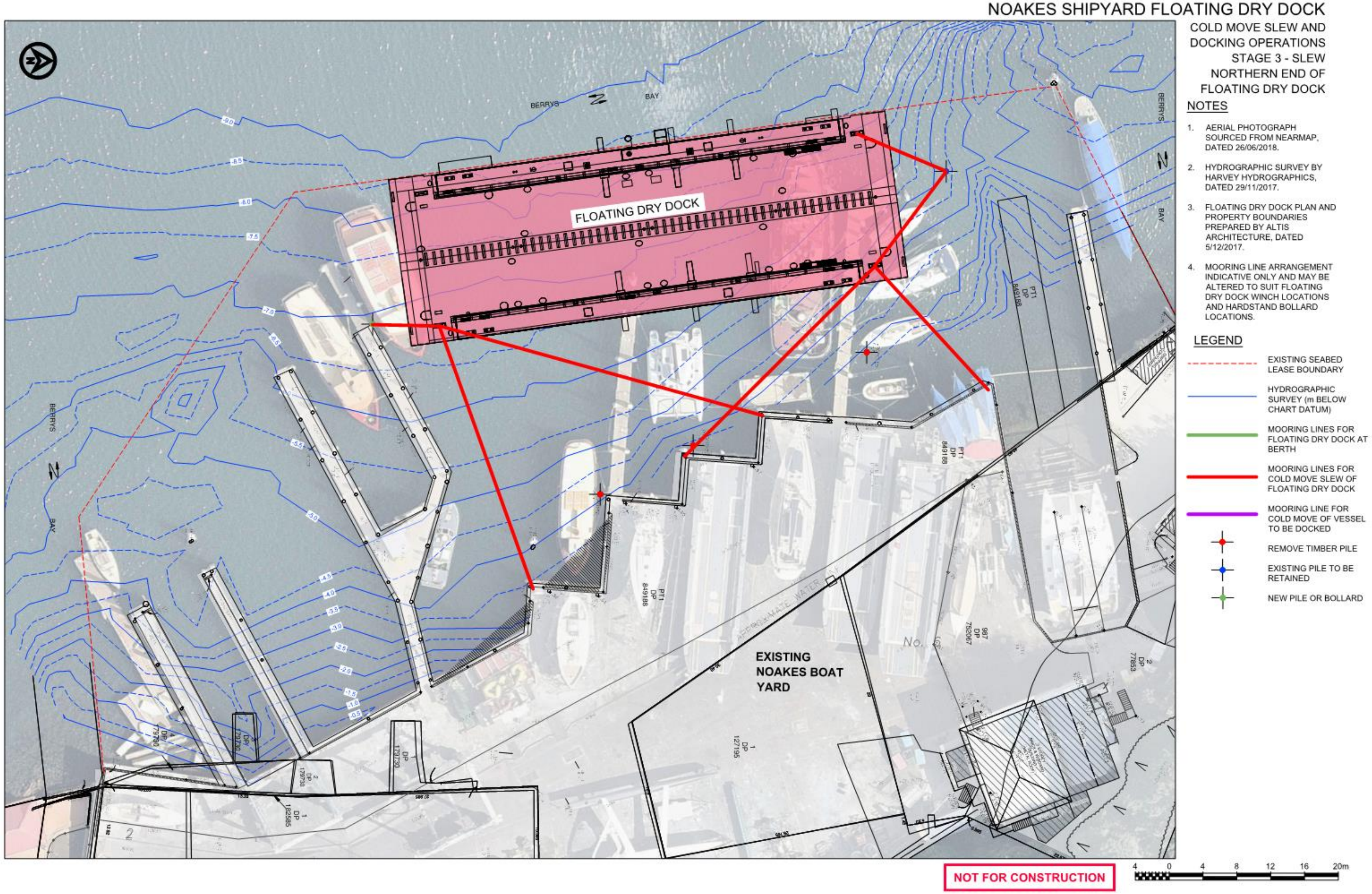

Figure 8: Stage 3 cold move slew and docking operations – slew northern end of floating dry dock.

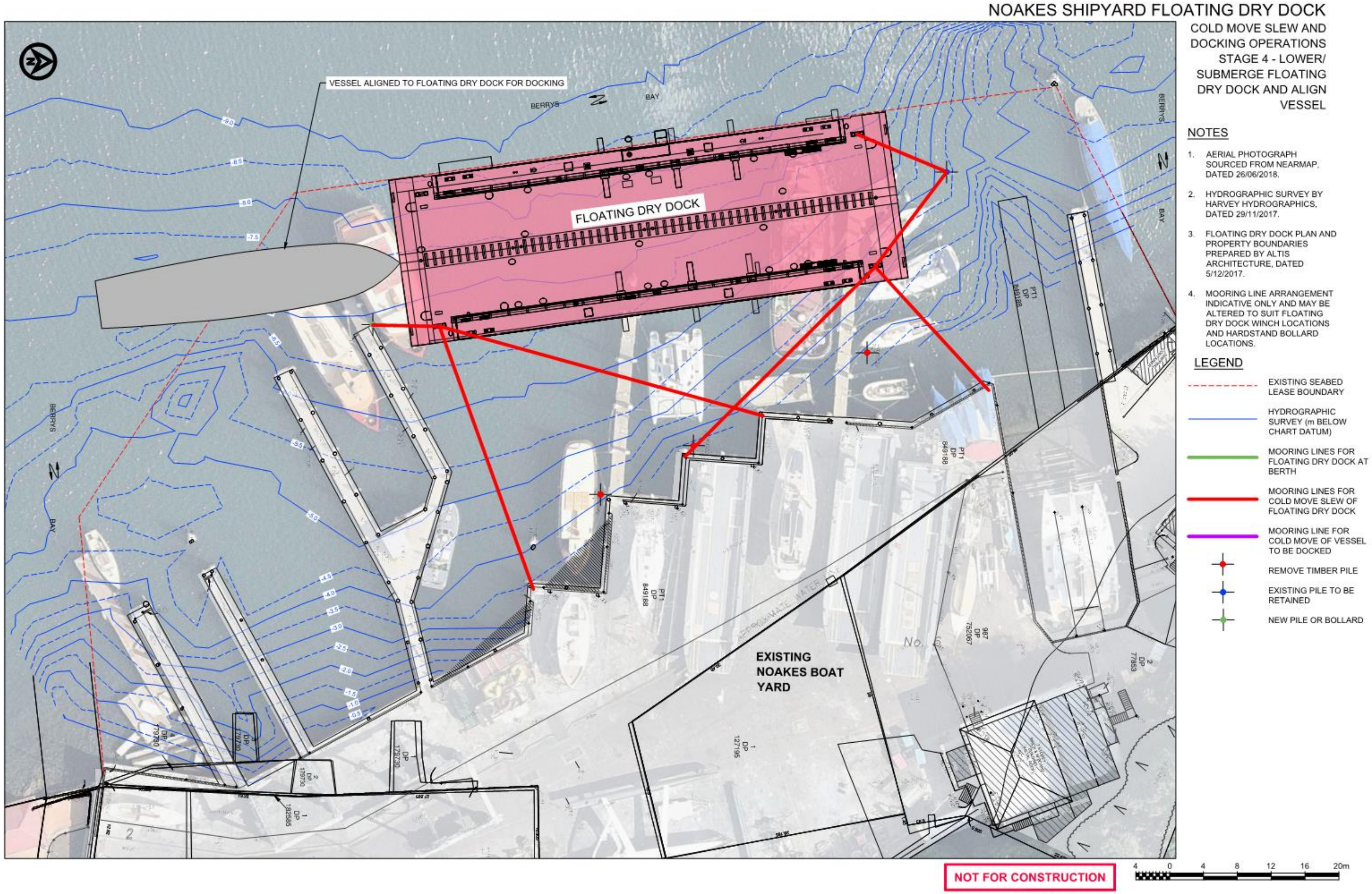

Figure 9: Stage 4 cold move slew and docking operations – lower/submerge floating dry dock and submerge vessel.

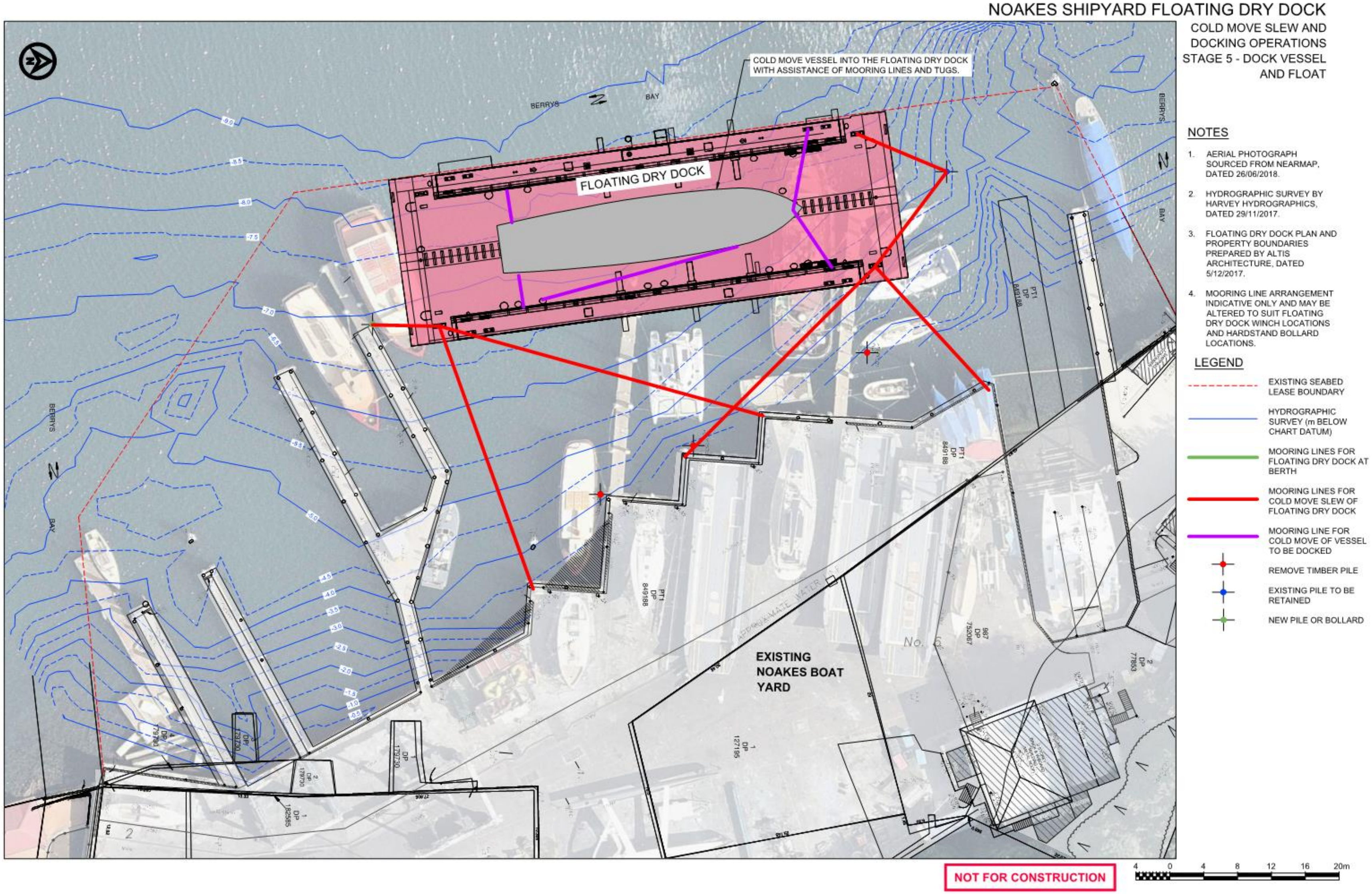

Figure 10: Stage 5 cold move slew and docking operations – dock vessel and float dry dock.

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4.3.2 Ballasting/Deballasting Operation

Noakes has advised that there are four phases for ballasting/deballasting the FDD. The ballast tonnage and draught for each phase of operation is outlined in **Table 4**.

Phase 1 represents the maximum draught of the FDD, which occurs when the ballast tanks are completely flooded for the purpose of floating vessels onto the FDD. Assuming an under keel clearance of 300 mm (depth from seabed to bottom of FDD), the minimum water depth required for operation of the FDD in Phase 1 is 8.98 m.

The under keel clearance has been adopted from AS3962 (Guidelines for design of marinas) for a seabed comprising of soft material. The guidelines are applicable for ‘recreational marinas and small commercial vessels up to 50 m in length’. The Harbour Master’s Directions – Sydney Harbour and Port Botany (PANSW, 2016) specifies a minimum under keel clearance for seagoing vessels in the berthing box of 500 mm at all tides. However, the FDD is not considered a seagoing vessel, which is defined as ‘a vessel of more than 45.72 metres in length that is used or intended to be used to carry cargo or passengers for hire or reward and that normally operates on voyages between ports’.

The maximum water depth above the keel blocks (top of pontoon) in Phase 1 is approximately 5.94 m. Assuming a clearance of 300 mm between the keel blocks and vessel to be floated in, the maximum draught of the vessel for docking on the FDD is 5.64 m.

The FDD does not need to be submerged to the maximum draught when loading and unloading shallower draught vessels. The FDD would need to be submerged so that the keel blocks are 300 mm below the deepest point of the vessel to be floated in for docking. Further, loading and unloading could be undertaken at high tide to ensure increased water depth is available.

Phase 4 and 5 operations correspond to scenarios when a design vessel is docked on the FDD and the FDD is floated. The maximum lift of the FDD is 1000 t on a draught of 2.3 m. An under keel clearance of at least 300 mm would need to be maintained at all tides. The minimum required water depth at Indian Spring Low Water (approximated by 0 m Chart Datum) is therefore 2.6 m.

Table 4: FDD in four phases of operation.

	Phase Description	Ship (Tonne)	Ballast (Tonne)	Total (Tonne)	Draught (m)
Phase 1	Maximum depth of submersion with no vessel load.	-	3314	4763	8.68
Phase 2	Vessel load of 500 tonne and partial ballast.	500	2222	4179	6.1
Phase 4	Maximum vessel lift and partial ballast for stability.	1000	839	3304	2.9
Phase 5	Maximum lift and minimum ballast required for stability.	1000	308	2773	2.3

4.4 Working Hours

The working hours for operation of the FDD are proposed to be the standard hours of operation of Noakes Shipyard, which are 7am to 6pm, Monday to Saturday. No work would be undertaken on Sundays or Public Holidays.

Emergency lifts may be completed outside of the agreed working hours at the request of Water Police or similar emergency response organisation. Emergency lifts may be required where a vessels hull is compromised, taking on water and at risk of sinking.

4.5 Public Jetty

It is understood that a requirement of a previous Development Application (Condition D51) at 6 John Street (Noakes) was to install a public jetty. It is understood that the jetty was to be sited at the location of the former public baths at the end of John Street. The jetty was not previously constructed. It is understood that the condition would apply to the current Development Application to install the FDD.

The location, width and length of the jetty have not been provided by Council. Further, the intended use of the jetty has not been identified in the conditions provided by Council.

4.6 Nearby Proposed Developments

The second Marina Boatshed and Private Vessel Pump out Facility noted on the RMS Boating Map in **Figure 3** is the Berrys Bay Marina/Woodleys Shipyard facility. This site ceased operations in 2011. It is understood that NSW Roads and Maritime and Government Property NSW entered into a lease agreement with Berrys Bay Marina Company (formerly known as Meridian Marinas) to develop a maritime precinct at this site. Berrys Bay Marina Company submitted a Development Application (DA) to North Sydney Council in July 2015. The DA was rejected by the Joint Regional Planning Panel (RMS, 2017).

The NSW government is proposing to construct the Western Harbour Tunnel, a new tunnel from Rozelle interchange to Warringah Freeway, crossing under Sydney Harbour between Birchgrove and Waverton. At the time of preparing this report, the environmental assessment was not publicly available and planning approval had not been granted. However, a Community Update was provided by the NSW Government in July 2018. The Community Update provided limited information regarding a temporary construction site proposed at Berrys Bay, shown in **Figure 11**. Key activities at this site are proposed to include:

- Entry site for road header machines tunnelling north and south;
- Fit-out of Western Harbour Tunnel; and,
- Water-based transport of tunnel spoil back to Glebe Island.

Figure 11: Proposed temporary construction site in Berrys Bay to facilitate construction of the Western Harbour Tunnel (NSW Government, 2018).

The Community Update notes that the temporary construction site will require the temporary relocation of a number of swing moorings. Temporary moorings would be provided in Berrys Bay. However, the exact location of temporary moorings was not nominated.

Details regarding the size of vessels accessing the temporary construction site at Berrys Bay, or the frequency of vessel movements, have not been provided.

As there are no clear plans or Development Applications currently submitted for either of the above mentioned projects, they will not be considered herein. However, it is noted that both developments are likely to be sited on the western side of Berrys Bay and within the mooring area (refer **Figure 4**). The impact on navigation to and from Noakes would therefore be minimal, unless the proposed temporary moorings impede the navigation channel.

5 Assessment of Impacts

The assessment of impacts herein have been developed under the assumption that construction vessels and vessels navigating to and from the FDD would meet all navigation safety requirements, and:

- operate under the control of licensed and experienced Masters;
- operate under the supervision of experienced Noakes Group personnel or representatives from Noakes Group;
- comply with the requirements of the COLREGS and NSW Marine Safety (General) Regulation 2016 including PANSW Harbour Master directions; and,
- operate in accordance with the Safety Management System prepared for the FDD.

The assessment of navigation impacts is often subjective. Industry guidelines are available to assess suitability of impact. The following guidelines are referred to herein:

1. AS3962-2001 Guidelines for design of marinas (Standards Australia, 2001); and,
2. Harbour Approach Channel Design Guidelines (PIANC, 2014).

AS3962-2001 is extensively used for the design of marinas and vessel berthing facilities in Australia. However, the guidelines have been established for vessels up to 50 m in length, which is less than the design vessel length of 60 m. Care is required when applying these guidelines to larger craft.

The Harbour Approach Channel Design Guidelines (PIANC, 2014) have been prepared for large vessels between say 200 m and 400 m in length (e.g. container ships and tankers). Care is required when applying these guidelines to smaller craft.

All navigation safety requirements and these guidelines, along with our extensive experience in the maritime industry, have been adopted to assess impacts herein.

5.1 Operation of the FDD

5.1.1 Navigation Widths

The navigation channel on the approach to and from the FDD and through the mooring field in Berrys Bay must be suitable for the design vessel.

AS3962-2001 specifies the preferred width of an entrance channel to a marina should be the minimum of 30 m or 6 times the maximum vessel beam. Widening of the channel is required where the channel changes direction. The Harbour Approach Channel Design Guidelines (PIANC, 2014) recommends the required channel width for vessels with moderate manoeuvrability of approximately 1.8 times the maximum vessel beam. This assumes a number of favourable site characteristics including a one-way channel, vessel speed less than 8 knots, cross wind less than 15 knots and negligible current.

The maximum design vessel width for vessels accessing the proposed FDD is 12.5 m.

The clear width between the defined mooring areas in Berrys Bay is measured to be 45 to 65 m as indicated in **Map 1** of **Appendix A**. This clear width between moorings is considered ample as it complies with the Australian Standards (minimum 30m) and PIANC Guidelines (1.8 x vessel beam ~ 22.5 m). This too is evident by the size of vessels that currently access Berrys Bay including SS South Steyne at 70 m in length with a beam of 11 m and the FDD which was berthed at the former BP Terminal in 2014 and 2015.

5.1.2 Swing Basin

To ensure safe access to the FDD, a swing basin/turning basin of sufficient diameter is required in the vicinity of the FDD. This is to enable vessels to manoeuvre during loading and unloading of the FDD. The majority of larger modern vessels are fitted with bow and/or stern thrusters or a twin-screw propulsion system, which provide excellent manoeuvrability and enable the vessels to be turned around in a space not much larger than their length. However, older vessels may need more space to manoeuvre and in some circumstances, may require assistance from a tug or work boat.

AS3962-2001 specifies the preferred width of interior channels and fairways in marinas is 1.75 times the maximum vessel beam. The interior channels are used for manoeuvring vessels into a marina berth and serve a similar purpose as a swing basin.

The Harbour Approach Channel Design Guidelines (PIANC, 2014) recommends a swing basing should be 2 times the maximum vessel beam.

A swing basin with a diameter of 2 times the largest vessel is considered appropriate. This would result in a swing basin of 120 m.

The swing basin is marked on the **Map 1** and **Map 2** in **Appendix A**. The clearance between the former BP Terminal maritime lease and private marina south of Noakes is 3.5 m. No private moorings would need to be relocated to facilitate the swing basin. However, it would be desirable for Noakes Group to relocate their single commercial mooring currently located in the channel southwest of the shipyard or vacate the mooring during turning of large vessels.

There would need to be some co-operation between private vessels and Noakes when a vessel is manoeuvred in the swing basin. It would be the responsibility of all vessel operators to maintain a proper look-out and maintain a safe speed in accordance with the COLREGS.

The assessment above demonstrates that available space for manoeuvring vessels in Berrys Bay is ample. This is evident by the size of vessels that currently access the area including SS South Steyne at 70 m in length, which was berthed at the former BP Terminal.

5.1.3 Loading a Vessel

Vessels would be loaded and unloaded from the southern end of the FDD. Loading of vessels is not possible from the northern end of the FDD due to the design of the dock and limited manoeuvring area.

The jetty to the south of the FDD loading pocket is proposed to be partially removed so that it does not impede on vessel loading operations.

A new bollard is required at the end of the jetty, immediately south of the FDD loading pocket, following partial removal. The bollard is required to secured mooring lines for the slewing operations. Fenders would be installed at the end of the jetty to ensure the vessel loaded onto the FDD is not damaged by this structure.

Adequate space and water depths would be available to align and float vessels onto the FDD.

5.1.4 Wave Climate

The anticipated increase in vessels operating in Berrys Bay would be minimal. The FDD is slated for 12 dockings per year, which would result in one additional inbound vessel movement and one additional outbound vessel movement per month. It is noted that these vessels would be larger than the average size of vessels that currently operate in Berrys Bay or are slipped and lifted to the Noakes hardstand. However, they are smaller than the largest vessels currently moored in the bay including the South Steyne at 70 m in length.

The anticipated increase in vessels operating in Berrys Bay is minimal. Further, a vessel speed restriction of 6 knots applies to vessels operating within 30 m of moored vessels, land of fixed structures. The additional vessel movement would have no material impact on the wave climate. Further, it is the responsibility of vessel operators to maintain a safe distance and speed and minimise the wash caused by their boat.

The FDD would lead to wave reflection in the immediate vicinity of Noakes. The wave reflection would be similar to that of any other long vessel moored next to a wharf, including SS South Steyne moored at the former BP Terminal. The wave reflection caused by the FDD is considered inconsequential due to the minimal number of vessel movements past Noakes Shipyard. Further, it would not significantly alter the wave patterns or wave climate in Berrys Bay.

5.1.5 Water Depths and Under Keel Clearance

As discussed in **Section 4.3.2**, the minimum under keel clearance would be 300 mm at all tides. No dredging is proposed for operation of the FDD.

The water depth in the channel between the moorings in Berrys Bay and within the proposed swing basin (refer **Section 5.1.2**) is in excess of 6.0 m CD. There is sufficient water depth for design vessels (draught 5.64 m) accessing the facility at all tides.

The minimum water depth in the proposed berthing pocket depicted in **Appendix A** is 3.0 m CD. The draught of the floated FDD at maximum lift is 2.3m (Phase 5 operation in **Table 4**). This water depth is therefore sufficient for berthing the FDD at all tide levels.

The minimum water depth in the loading pocket depicted in **Appendix A** is approximately -4 m CD. No dredging is proposed. This water depth is less than the draught of the FDD at maximum depth of submersion (refer Phase 1 ballasting/deballasting operation in **Table 4**). The FDD could not be fully submerged and the vessel draught for loading onto the FDD would be limited by the available water depth.

Submersion of the FDD and loading of a vessel would be undertaken on a flood tide and immediately prior to a spring tide (Mean High Water Spring [MHWS] = 1.57m CD) to maximise the available water depth. The acceptable tide level for loading the FDD would be 2 hours prior to MHWS, which allows sufficient time to load a vessel, prior to high tide, as outlined in **Section 4.3.1** and includes an allowance of 30 minutes for contingency. Standard tidal curves are provided in **Figure 12**. The tidal range for a spring tide is approximately 1.25 m (refer **Section 3.5**). The tide level 2 hours prior to MHWS is therefore 1.3 m CD (height of Mean Low Water Springs [0.32 m] plus the height to be added to the height of low water in **Figure 12**). The maximum available water depth is therefore 5.3 m.

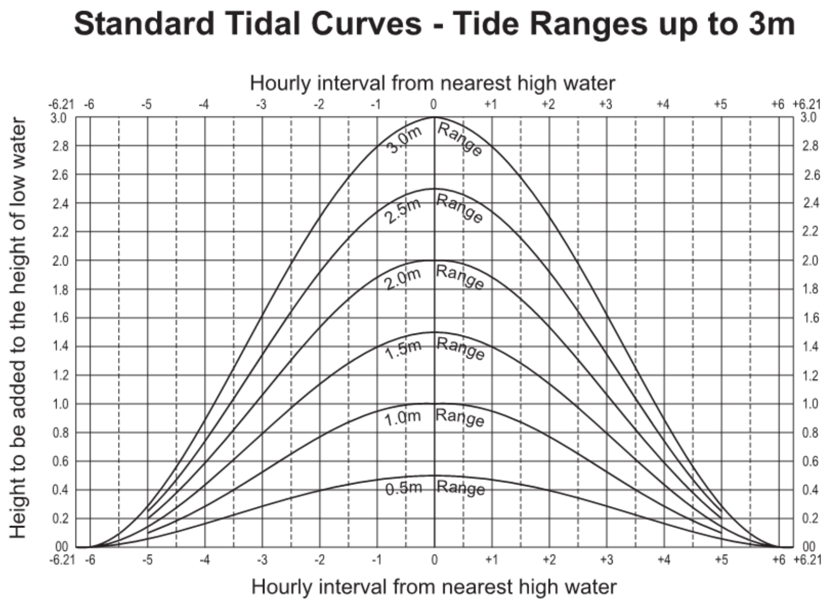


Figure 12: Standard tidal curves (Maritime Safety Queensland, 2018).

Assuming the following dimensions, the maximum vessel draught that could be loaded onto the FDD is approximately 1.7 m:

- FDD under keel clearance (from seabed to the bottom of the FDD) of 300 mm;
- FDD pontoon height of 2.74 m;
- Keel block height of 300 mm (above the deck of the FDD pontoon); and,
- Vessel under keel clearance (from vessel to keel blocks) of 300mm.

While this draught would preclude a number of sailing yachts, large recreational cruisers and superyachts, which typically have a draught less than 1.5m, could be docked on the FDD.

5.1.6 Currents

High currents can impact on the navigation of vessels. The impacts can be mitigated by providing wider navigation channels. Propeller wash can produce a high localised current, depending on the engine capacity and size of the propeller. Pump out of water from the FDD ballast tanks would also produce localised currents.

The discharge point for the pump out of water from the FDD is approximately 1.5 m above the bottom of the pontoon and on the western side of the FDD. The discharge point would always be below water. The jet of water discharged from the FDD would dissipate in a relatively short distance. It would have negligible impact on currents within Berrys Bay or the navigation of vessels.

Tug and/or work boats may be required to assist in loading vessels. Propeller wash from these vessels would dissipate relatively quickly and would have negligible impact on currents within Berrys Bay or the navigation of vessels.

5.1.7 Waterway Encroachment and Navigation Sight Line

As noted in **Section 4**, the proposed footprint of the FDD during berthing and loading operations remains within the current seabed lease boundary. The encroachment into the waterway is in accordance with

Noakes current approved operations. Jetties and mooring piles are to be removed to enable berthing of the FDD parallel to the hardstand. The encroachment of the FDD on the waterway area is less than existing jetties, piles and berths.

The height of the FDD walls above the water surface during Phase 5 operations would be approximately 8.2 m. However, due to the positioning and orientation of the FDD, which is adjacent to the hardstand, within the seabed lease area and parallel to the hardstand and other foreshore structures, the impact on navigation sight lines would be negligible. It would be the responsibility of all vessel operators to maintain a proper look-out and maintain a safe speed in the vicinity of the FDD in accordance with the COLREGS.

5.2 Construction of the FDD

The details of demolition and construction works methodology including proposed land based and water based equipment are subject to detailed design and consultation with potential Contractors. As such, the assessment of impacts herein is high level. Dredging and installation of piles is **not** proposed.

5.2.1 Removal of Piles and Jetties

It is envisaged that demolition works would be required to remove jetties and piles. Some of the demolition work could be undertaken from land. However, a portion of the work would need to be undertaken from the water.

The size of the barge required to remove the jetties and piles would be say 35 m by 17 m (for example PM Melbourne operated by Polaris Marine). This vessel is shorter and wider than the design vessel for docking on the FDD and the draught is significantly less. The assessment of Navigation Width, Swing Basin and Wave Climate would therefore be similar to that for operation of the FDD discussed in **Section 5.1.1** to **5.1.4**.

Demolition of the jetties and piles would need to ensure that the structures are either completely removed or cut off level with the seabed to ensure the demolished structures do not present a navigation hazard and do not decrease the available water depth in the vicinity of the berthing pocket and loading pocket.

It is envisaged that the work barges required for demolition could be positioned alongside the jetties and within Noakes' seabed lease area. As such, the encroachment on the waterway and impact on navigation sight lines would be minimal during the demolition process.

5.2.2 Supply of FDD

The FDD is an existing floating unit that is currently moored at the Snails Bay dolphins in Sydney Harbour. The FDD would be towed to site by a tug, floated into position and secured alongside the existing hardstand with mooring lines. The gangways would be fitted to the FDD once it is alongside the hardstand in Berrys Bay. The FDD was berthed at the former BP Terminal in Berrys Bay for some 12 months prior to repair works been undertaken by Harwood Marine in Yamba. It is understood that moving the FDD in or out of Berrys Bay did not pose any significant issues or constraints in the past. Standard protocols would apply including participating in the Sydney Harbour Vessel Traffic Service (refer **Section 3.3**).

The FDD is wider than the design vessel for docking on the FDD discussed in **Section 4.** The length is identical to the design vessel and the draught (when floated for transport) is significantly less. The assessment of Navigation Width, Swing Basin, Wave Climate and Water Depths for manoeuvring the FDD during installation would therefore be similar to that for operation of the FDD discussed in **Section 5.1.1** to **5.1.5**. Waterway encroachment is not a concern as the FDD would be floated into place within Noakes seabed lease area.

Sight lines past the FDD while it is in transit may cause some issues for vessels operating near the FDD. However, provided vessel operators maintain a proper look-out and maintain a safe speed and distance in accordance with the COLREGS, the impact of sight lines would be mitigated. The NSW Boating Handbook (RMS, 2017) specifies a minimum distance of 30 metres from any other vessel, land, structures (including jetties, bridges and navigation markers), moored or anchored vessels when travelling at more than 6 knots, or if that it is not possible, a safe distance and safe speed. This speed restriction would mitigate any issues in respect of limited sight lines.

5.3 Impact of DA Condition 51 – Jetty

The design, location and intended purpose of the timber jetty has not been provided. It is understood that the jetty would be located at the site of the former public baths at the end of John Street, immediately north of Noakes Shipyard. The FDD would not preclude or impede on navigation to or from this proposed jetty location, if the jetty is installed.

The water depths at the proposed location of the jetty are relatively shallow. This would limit the size and draught of vessels that could dock at the jetty.

A handful of passive craft and dinghies are stored at the location of the proposed jetty. These craft are launched from a small beach at the site. Depending on the design and alignment of the jetty, launching and retrieval of these craft may not be feasible.

5.4 Summary of Impacts

Based on the above assessment the following conclusions are made:

- the navigation channel between moorings in Berrys Bay is 45 to 65 m and is considered suitable for navigation of vessels to be loaded onto the FDD. Further, the channel width is sufficient for delivery of the FDD and other demolition and construction activities;
- a swing basin with a diameter of 120 m is available near the proposed FDD with a clear distance of 3.5 m to nearby structures of seabed lease areas. This is sufficient for manoeuvring vessels during the construction, installation and operational phases of the FDD;
- the wave climate in Berrys Bay would not be significantly altered as a result of increased traffic associated with operation of the FDD. Due to the proximity of moorings, the speed limit in Berrys Bay is 6 knots;
- the wave climate as a result of wave reflection from the FDD would not have a significant impact on the wave climate in Berrys Bay;
- the water depths in the navigation channel and swing basin for design vessels accessing the FDD is sufficient;
- the water depth in the FDD berthing pocket, alongside the existing hardstand, is sufficient at all tides and when the design vessel is docked on the FDD;
- the water depths in the proposed area of operation of the FDD (for loading and unloading vessels), which is located within Noakes seabed lease area is insufficient for the maximum FDD draught. Thus, the FDD cannot be submerged for Phase 1 operations (refer **Section 4.3**). This limits the maximum draught of vessels that could be docked.

- the waterway encroachment is less than existing jetties and berths when the FDD is docked alongside the hardstand as proposed. Encroachment of the FDD in the loading pocket is within Noakes' existing seabed lease boundary;
- due to the alignment and location of the FDD, the impact on navigation sight line of vessels operating in Berrys Bay is minimal; and,
- installation and operation of the FDD would not require the relocation of any moorings. For convenience, it may be preferable to relocate the commercial mooring owned and operated by Noakes Group.

6 Conclusion

The SEARS required a report to address marine safety and navigation including:

- an assessment of the impacts on water based traffic and the existing users of Sydney Harbour in the vicinity of the proposed FDD; and,
- details of private boat moorings surrounding the site and an assessment of the impact of the construction and operation of the FDD on these moorings.

The report herein concludes that 20 private moorings are located at the head of Berrys Bay, north of Noakes. Further, there are no passive recreation craft launching facilities or public jetties at the head of the Bay. It is anticipated that 12 vessel dockings would occur at the FDD per year. Due to the number of vessel movements, the impact on water based traffic and the existing users (i.e. moorings at the head of the bay) would be negligible. Co-operation may be needed while vessels are manoeuvring to access the FDD. However, this would be managed by Noakes.

The vessel berthed at the former BP Terminal at the time of the site inspection was the SS South Steyne. This vessel is longer than the FDD or any design vessel intended to access the FDD. Further, the FDD was berthed at the former BP Terminal in 2014 and 2015. Existing navigations widths and turning areas in Berrys Bay are adequate. The FDD would not impact nearby moorings. For convenience, it may be preferable to relocate the commercial mooring owned and operated by Noakes Group or vacate the mooring while vessels are accessing the FDD.

7 References

Australian Standard (AS3962-2001), *Guidelines for the design of Marinas.*

Australian Standard (AS/NZS1170.2:2011), *Structural Design Action Part 2: Wind Actions*

Manly Hydraulic Laboratory [MHL] (2012), *OEH NSW Tidal Planes Analysis: 1990-2010 Harmonic Analysis*, Report MHL2053, prepared for NSW Office of Environment and Heritage, October.

NSW Government (2018), *Community Update, Western Harbour Tunnel, Temporary construction site: Berrys Bay, Waverton,* July 2018.

NSW Maritime Authority (2005), *Design Guidelines for Waterside Works Subject to Rivercat and Harbourcat Ferry Wash (Sydney Harbour and Parramatta River) Issue No. 4*, Prepared by Patterson Britton & Partners.

NSW Roads and Maritime Services (RMS, 2016), Boating *Handbook*, prepared by Roads and Maritime Services, NSW Transport Maritime, October 2016.

NSW Roads and Maritime Services (RMS, 2017), *Berrys Bay proposed maritime precinct*, www.rms.nsw.gov.au/projects/sydney-north/berrys-bay, accessed 1/12/17.

PIANC (2014), *Harbour Approach Channels Design Guidelines,* Report no. 121-2014.

Port Authority of NSW (2016), *Harbour Master's Directions Sydney Harbour and Botany Bay*, July.

Transport for NSW (2014), *Boating Safety Plan: Sydney Harbour and its tributaries*, prepared by Maritime Management Centre, July.

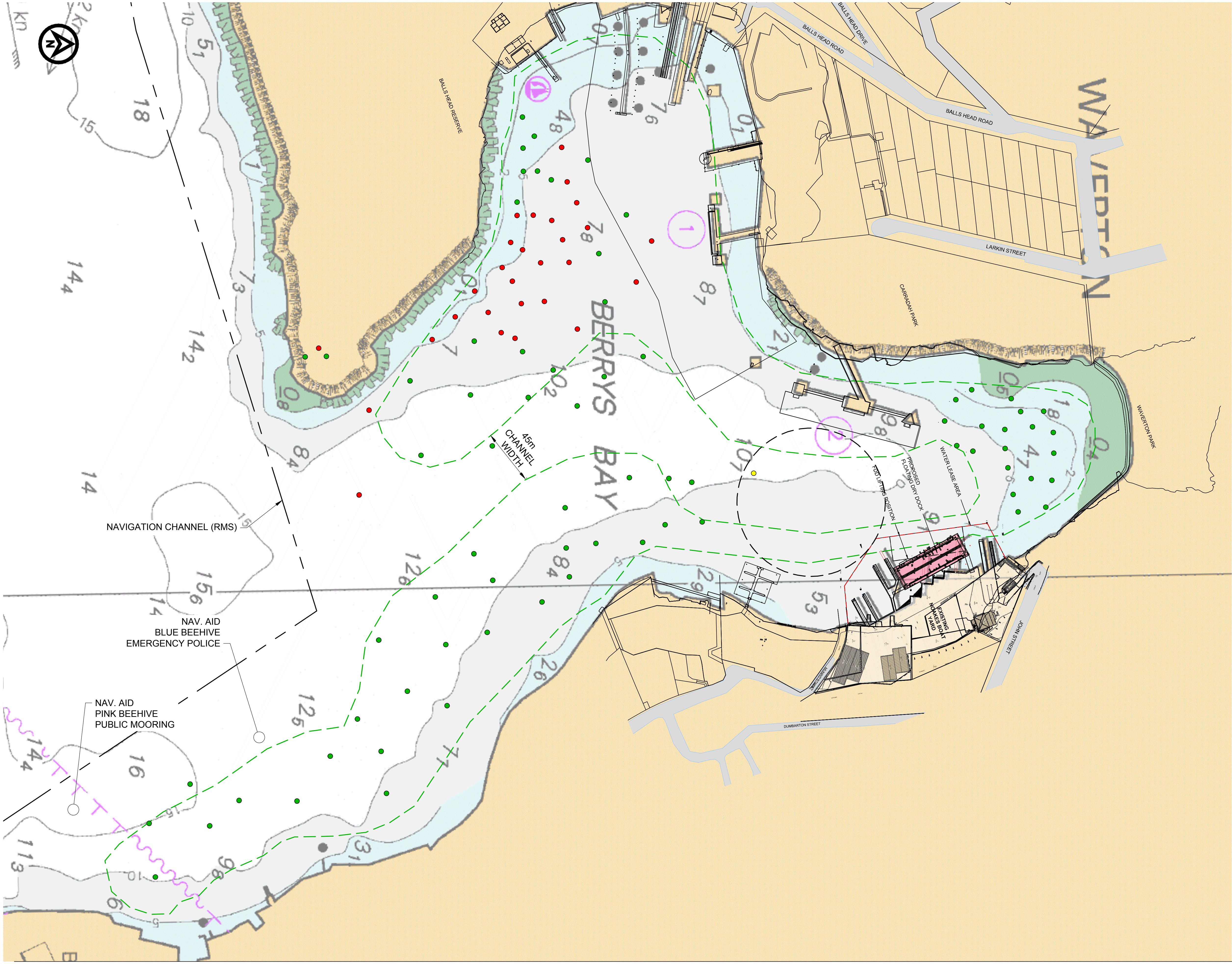
US Army Corps of Engineers (USACE, 2008), *Coastal Engineering Manual*, publication EM 1110-2-1100.

Watson P.J and D.B Lord (2009). “Goat Island Sea Level Rise Vulnerability Study”, a report prepared by the Coastal Unit, NSW Department of Environment and Climate Change (DECC, 2009), January.

Appendix A: Maps

NOAKES SHIPYARD FLOATING DRY DOCK NIA

MAP 1



NOTES

1. AERIAL PHOTOGRAPH SOURCED FROM NEARMAP, DATED 19.10.2017.

LEGEND

- COMMERCIAL MOORING
- COMMERCIAL MOORING OWNED BY NOAKES GROUP
- PRIVATE MOORING
- RMS MOORING AREA

NOT FOR CONSTRUCTION

30 0 30 60 90 120 150m

1:3000 (A3) 1:1500 (A1)

SAVED: 12-Dec-17

Royal HaskoningDHV
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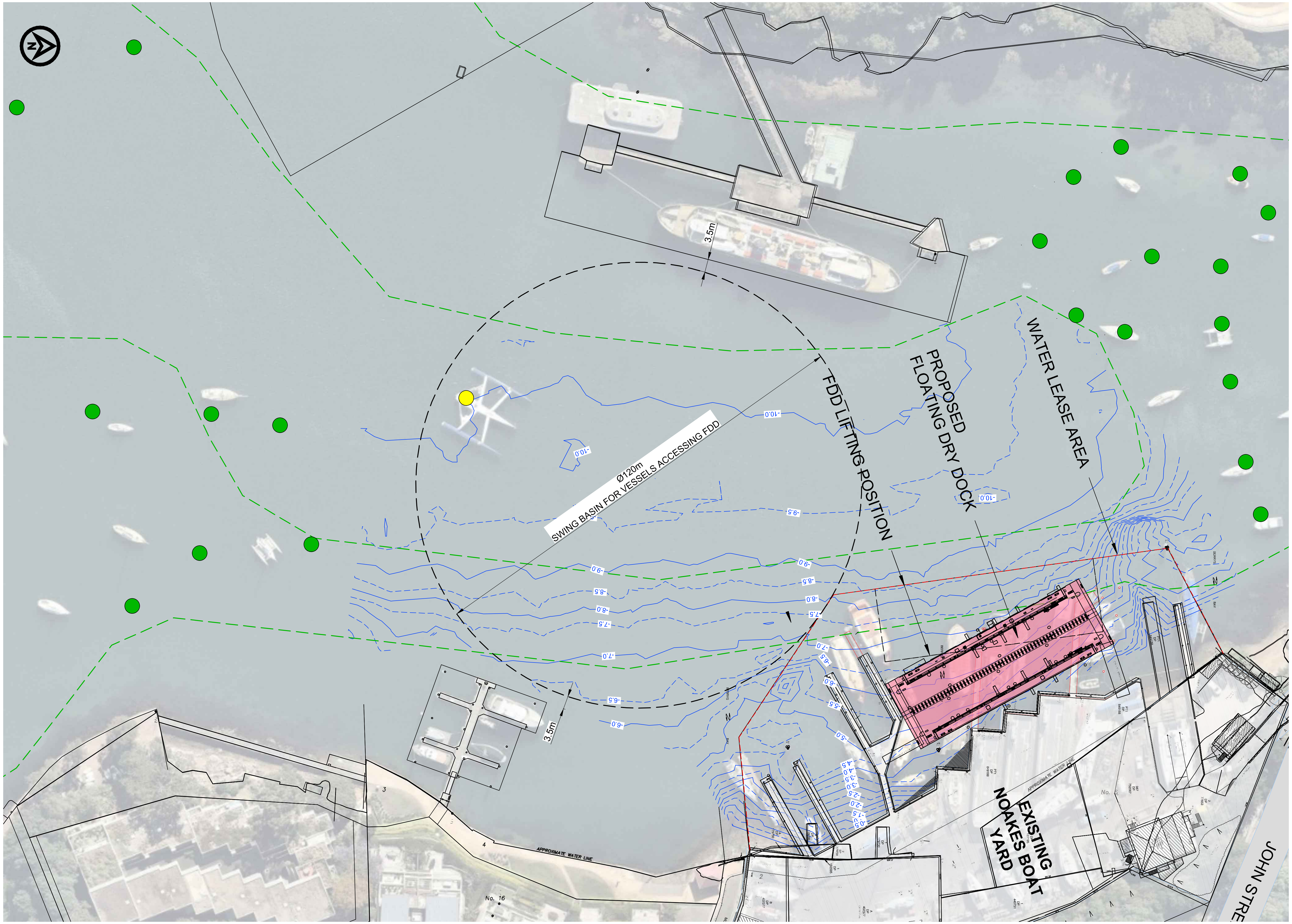
NOAKES SHIPYARD FLOATING DRY DOCK NIA

MAP 2



NOTES

1. AERIAL PHOTOGRAPH SOURCED FROM NEARMAP, DATED 19.10.2017.

LEGEND

- COMMERCIAL MOORING
- COMMERCIAL MOORING OWNED BY NOAKES GROUP
- PRIVATE MOORING
- RMS MOORING AREA

AUSTRALIAN HEIGHT DATUM

NOT FOR CONSTRUCTION

10 0 10 20 30 40 50m

1:1000 (A3) 1:500 (A1)

G:\RHDHV\JOBS\~PA1718 - Noakes Shipyard Floating Dry Dock\E02 Working Drawings\PA1718-MA-Civil Model.dwg

SAVED: 12-Dec-17

Royal HaskoningDHV
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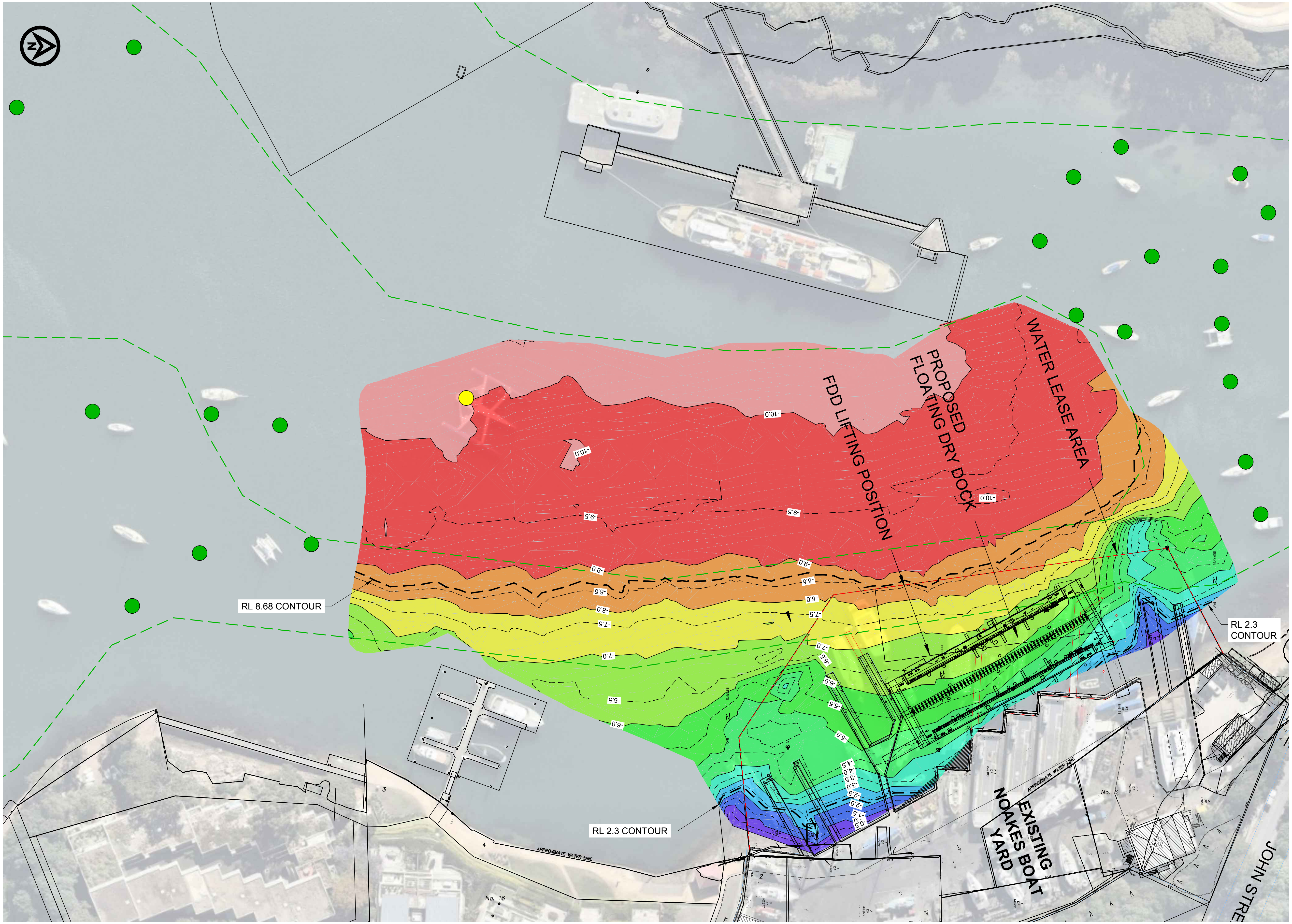
NOAKES SHIPYARD FLOATING DRY DOCK NIA

MAP 3



NOTES

1. AERIAL PHOTOGRAPH SOURCED FROM NEARMAP, DATED 19.10.2017.

LEGEND

- COMMERCIAL MOORING
- COMMERCIAL MOORING OWNED BY NOAKES GROUP
- PRIVATE MOORING
- RMS MOORING AREA

ELEVATIONS TABLE				
No.	MIN. (m)	MAX. (m)	AREA	COLOUR
1	-11.00	-10.00	2783.29	
2	-10.00	-9.00	8738.42	
3	-9.00	-8.00	2551.09	
4	-8.00	-7.00	2175.17	
5	-7.00	-6.00	2201.02	
6	-6.00	-5.00	1406.46	
7	-5.00	-4.00	1462.44	
8	-4.00	-3.00	755.89	
9	-3.00	-2.00	372.80	
10	-2.00	-1.00	274.92	
11	-1.00	0.00	153.60	
12	0.00	1.00	1.70	

AUSTRALIAN HEIGHT DATUM

NOT FOR CONSTRUCTION

10 0 10 20 30 40 50m

1:1000 (A3) 1:500 (A1)

G:\RHDHV\JOBS\~PA1718 - Noakes Shipyard Floating Dry Dock\E02 Working Drawings\PA1718-MA-Civil Model.dwg

SAVED: 12-Dec-17

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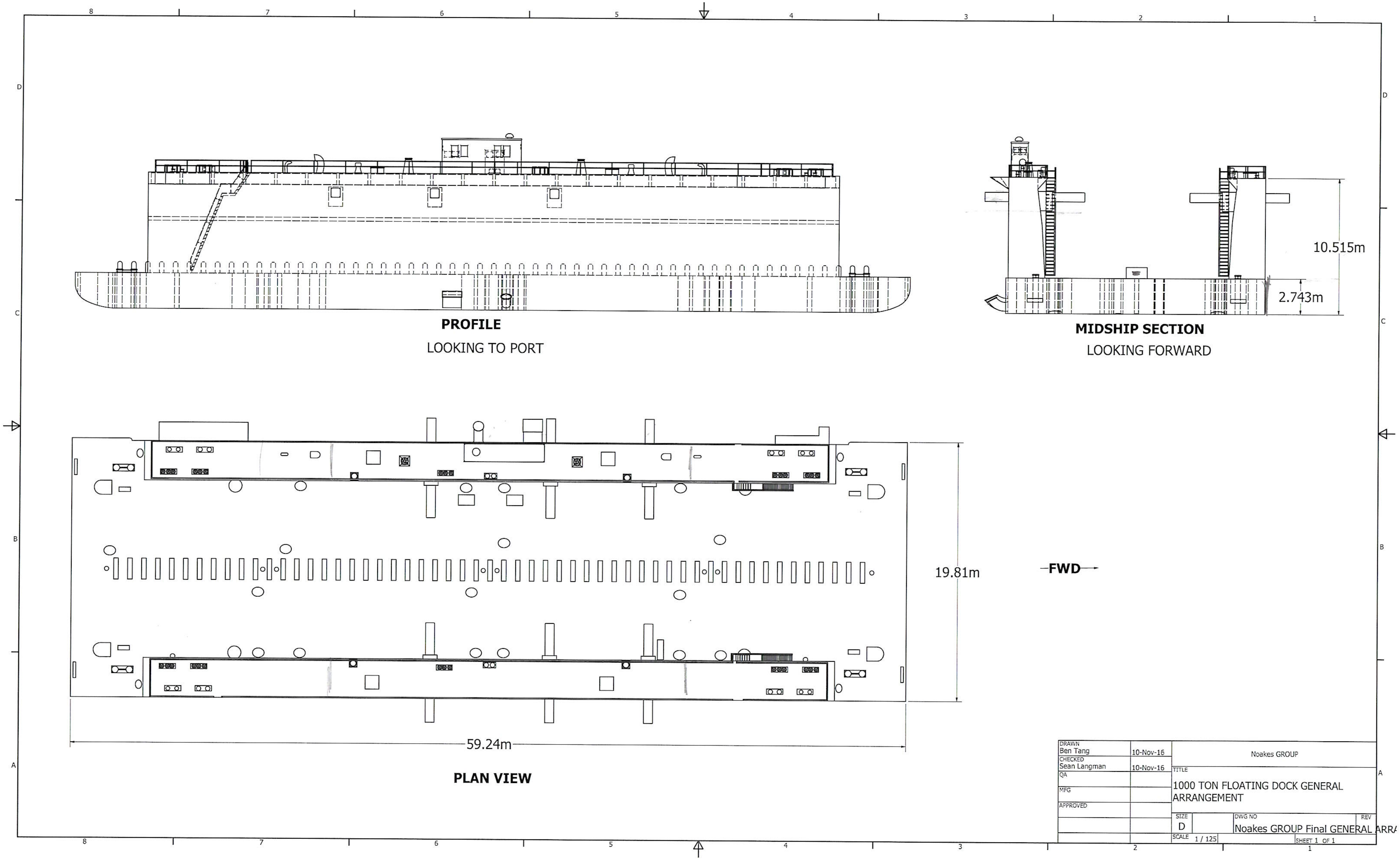
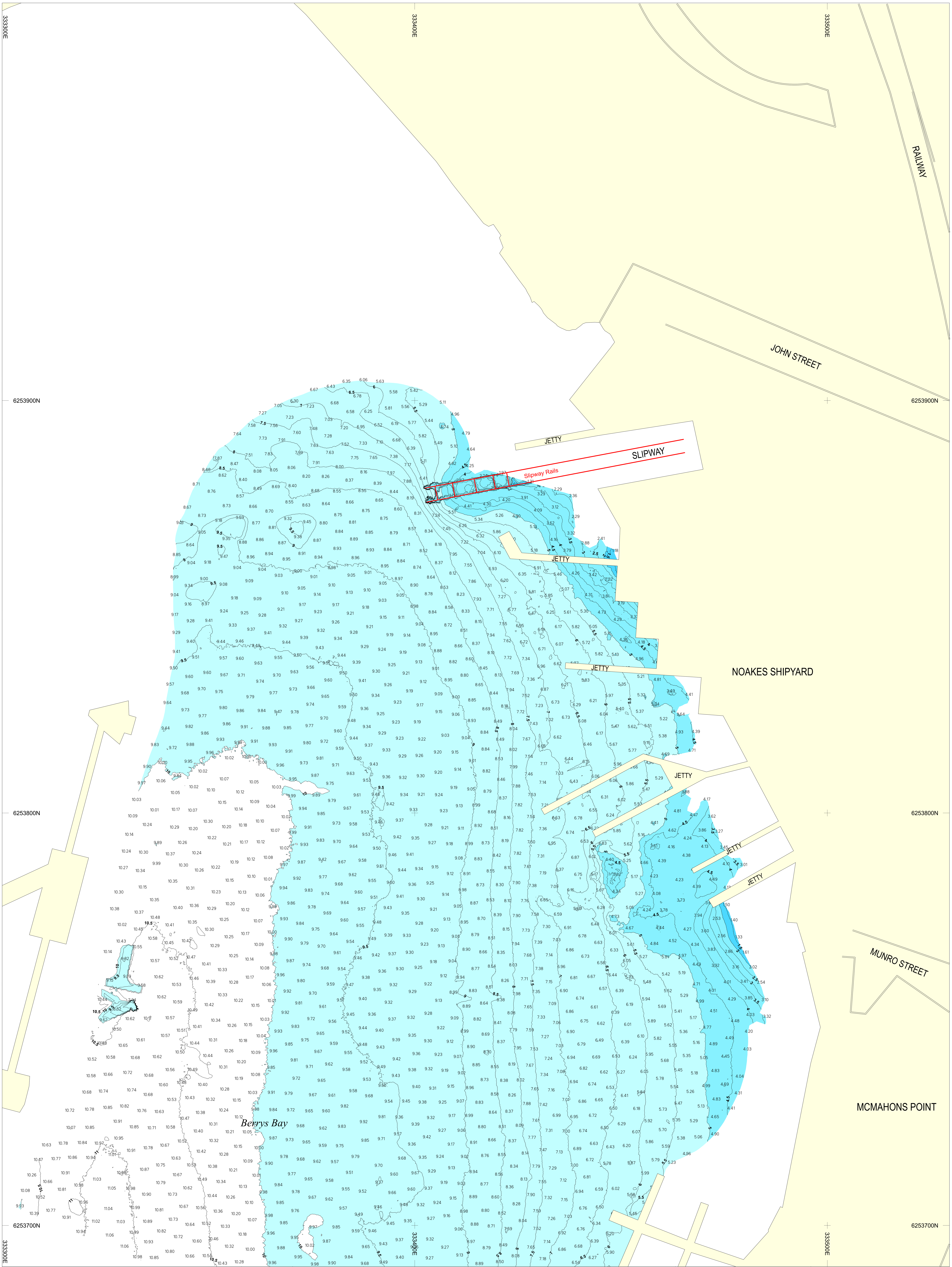
Appendix B: Floating Dry Dock Dimensions


PROFILE
LOOKING TO PORT
MIDSHIP SECTION
LOOKING FORWARD
10.515m
2.743m
19.81m
FWD
59.24m
PLAN VIEW
DRAWN
Ben Tang
10-Nov-16
CHECKED
Sean Langman
10-Nov-16
QA
MFG
APPROVED
Noakes GROUP
TITLE
1000 TON FLOATING DOCK GENERAL ARRANGEMENT
SIZE
D
DWG NO
Noakes GROUP Final GENERAL ARRA
REV
SCALE 1 / 125
SHEET 1 OF 1

Appendix B – Hydrographic Survey (PANSW, 2021)



1. PLAN LIMITATION STATEMENT
This plan has been prepared in accordance with accepted practice for the use only of Port Authority of New South Wales and Noakes Group Pty Ltd for a specific purpose. No warranty or representation, expressed or implied, is made to any other party regarding this survey and plan. This plan should not be relied upon for any other purpose or use by any party including Port Authority of New South Wales.

2. GRIDDED DATASET
Raw soundings have been processed and validated on a shoal bias and gridded at 0.25m x 0.25m resolution.

3. FILTERED SOUNDINGS STATEMENT
In producing this plan some soundings have been intentionally filtered to improve ease of interpretation. Filtering of the "gridded dataset" has been carried out to preserve soundings on a shoal bias. The filtering interval is 10mm at plan scale. Soundings shown are in true horizontal location. Contours have been produced from a TIN model based on a dataset at four times the plotted sounding density.

4. TIDE DATUM INFORMATION
Soundings are in metres reduced to Zero Fort Denison Tide Gauge.
This zero is 0.925 metres below Australian Height Datum. Soundings above zero are shown thus 0.2.

REV	DESCRIPTION	DATE

Grid North

0 5 10 15 20 25
Metres

SCALE 1:400 @ A1
CONTOUR INTERVAL: 0.5m
DECLARED DEPTH: N/A

SURVEY CLASS
This survey and the estimates for horizontal and depth TPU comply with the requirements set out by Ports Australia Class A standards

Average Depth TPU(m) = 0.08m
Average Position TPU(m) = 0.1m

EQUIPMENT
SURVEY VESSEL: Port Explorer
ACQUISITION SOFTWARE: Teledyne PDS
PROCESSING SOFTWARE: CARIS HIPS & SIPS
MULTIBEAM SONAR: Teledyne RESON T50P
SONAR FREQUENCY: 400kHz
GNSS BASE STATION: CORS Network FTDN
POSITION/ORIENTATION: POSMV OceanMaster

NOTES
-SOUNDINGS IN METRES ROUNDED TO 2 DECIMAL PLACES
-POSITION OF LAND FEATURES & MARINE STRUCTURES ARE APPROXIMATE ONLY

SURVEY INFORMATION
REDUCED DATA: J:\SurveyDbase\bkupoutports External Work\2021\2021_Noakes Berrys Bay
FIELD DATA: MicrosoftAzure\Hydrographic Survey Data\2021\ Sydney\202110_Noakes Berrys Bay
FILE NO: Content Manager M17/18
HORIZONTAL DATUM: GDA2020
PROJECTION: MGA zone 56
VERTICAL DATUM: Zero Fort Denison Tide Gauge
RUNLINES: N/A CROSSLINES: N/A
DATE STARTED: 20-October-2021 Date Completed: 20-October-2021

CHARGE SURVEYOR: Tim Connor
Certified Professional (CPHS1)
CHECKING SURVEYOR: Venessa O'Connell
Certified Professional (CPHS1)

PORT AUTHORITY OF NEW SOUTH WALES

Noakes GROUP

Group Survey Manager

HYDROGRAPHIC SURVEY
BERRYS BAY
NOAKES SHIPYARD

Charge Surveyor

This Plan replaces: N/A

DWG No: BB-RHDHV 001

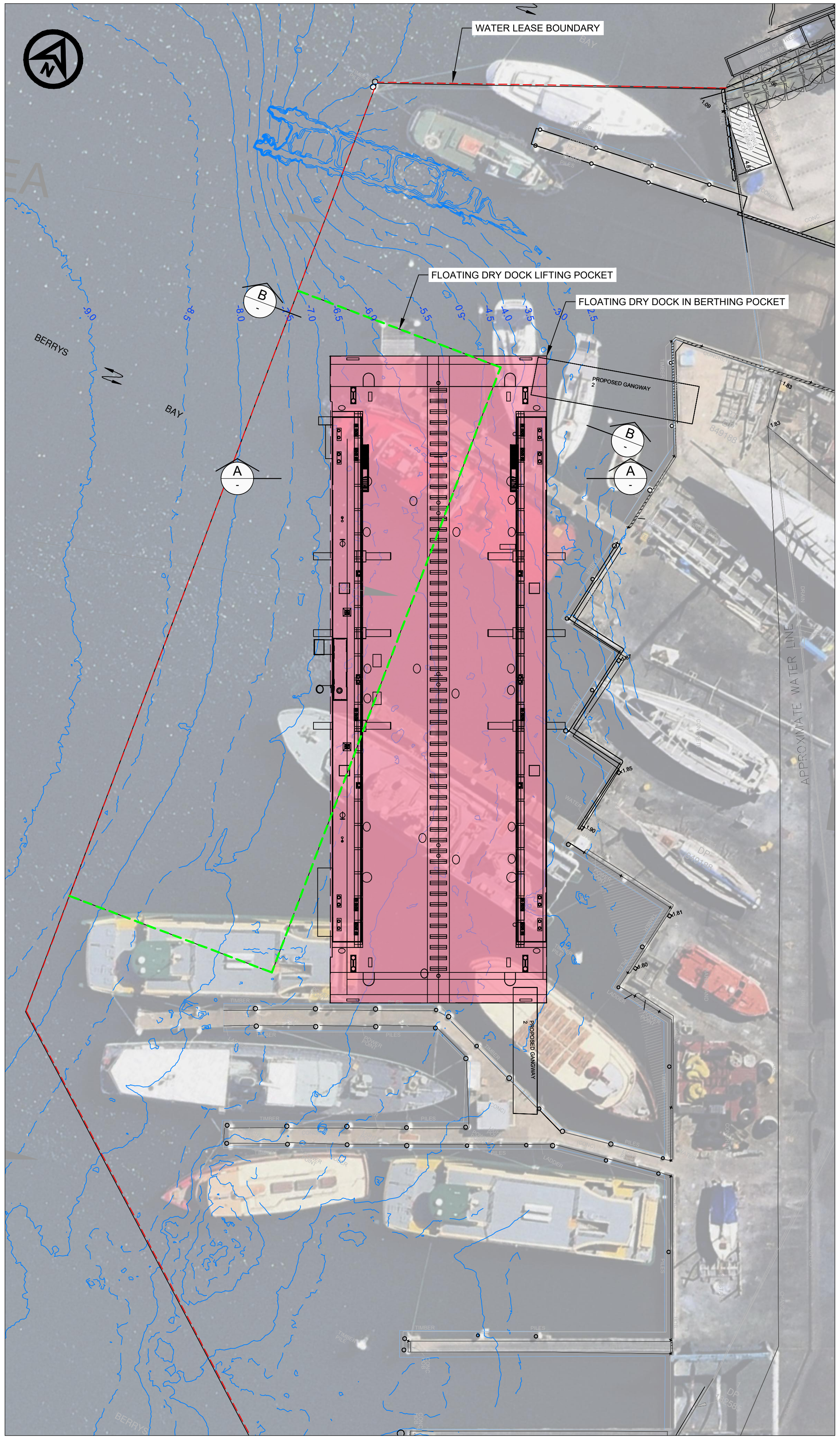
Appendix C – FDD Section

NOAKES SHIPYARD FLOATING DRY DOCK

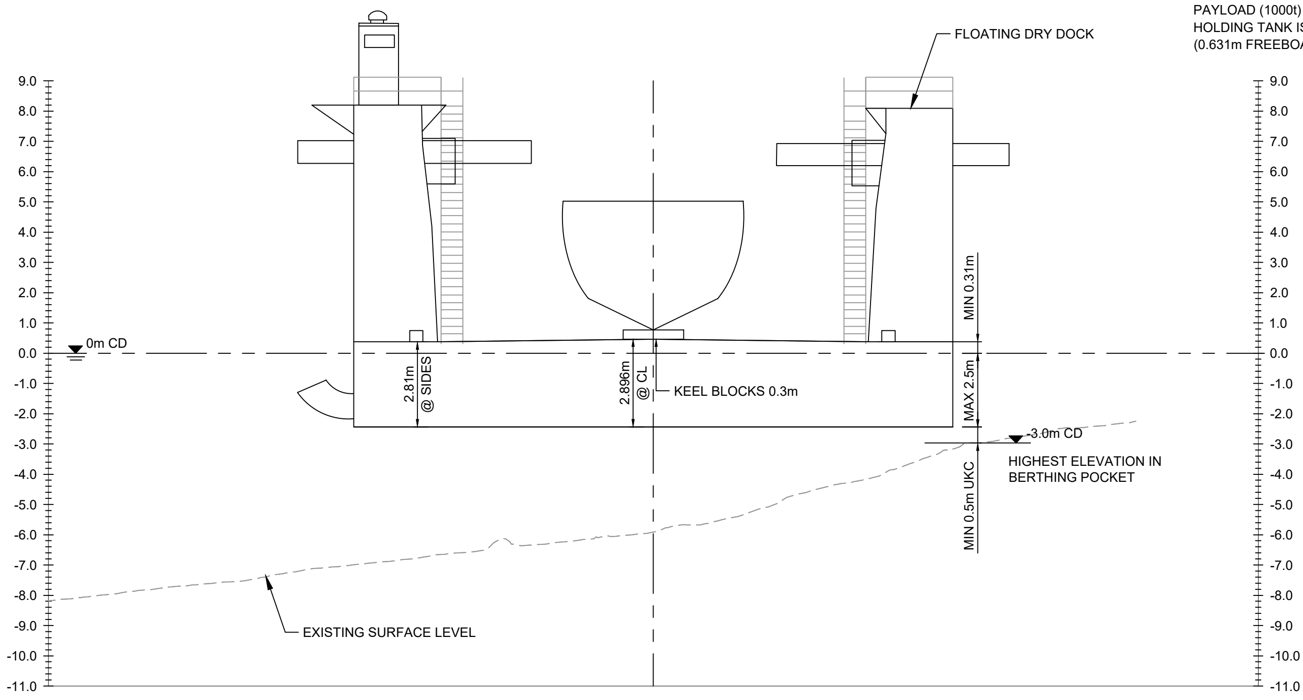
SK001

NOTES

1. AERIAL PHOTOGRAPH SOURCED FROM NEARMAP, DATED 10/2021.
2. HYDROGRAPHIC SURVEY BY PORT AUTHORITY OF NSW, DATED 20/10/2021
3. THE DRAFT OF THE FDD WITH MAXIMUM PAYLOAD (1000t) AND 397t BALLAST IN THE HOLDING TANK IS 2.179m (0.631m FREEBOARD) (JBD, 2022B).

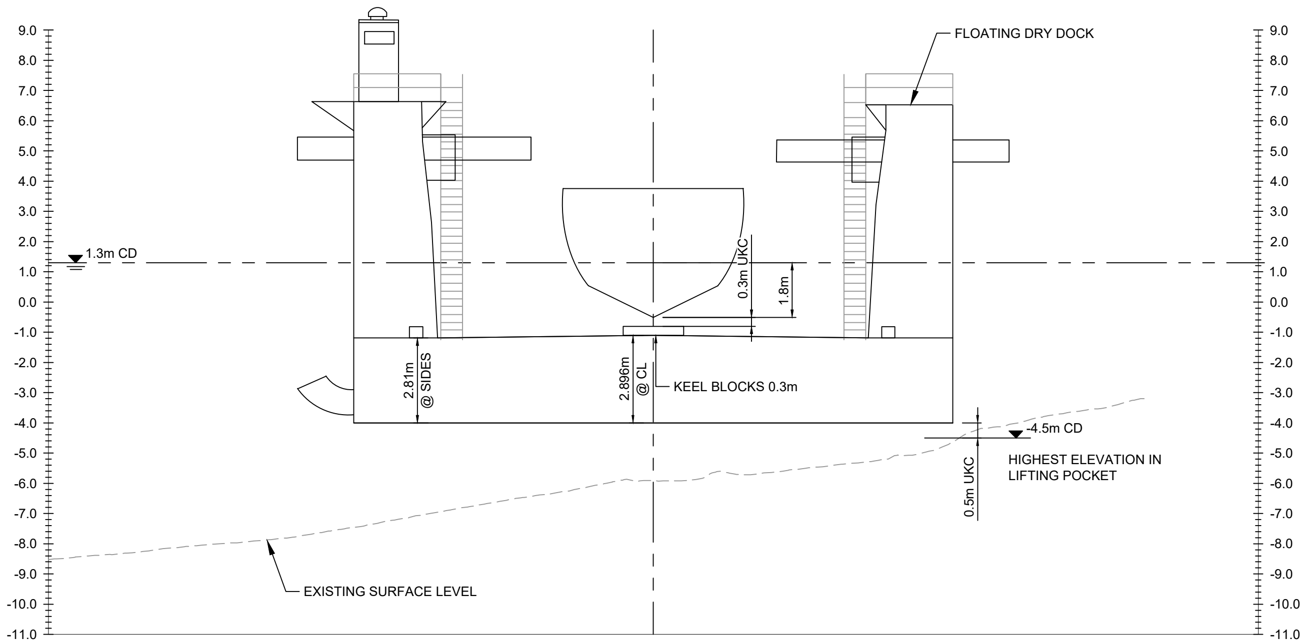


PLAN 01
1:250



SECTION A
1:125

PHASE 5 - NORMAL OPERATING CONDITION IN BERTHING POCKET



SECTION B
1:125

PHASE 1 - BALLASTED DOWN CONDITION IN LIFTING POCKET

C:\Users\220076\Box\PA2987 Noakes FDD\PA2987 Noakes FDD Team\PA2987 Technical Data\Working Drawings\PA2987 Civil Model.dwg

CHART DATUM

NOT FOR CONSTRUCTION

S2 FOR INFORMATION

SAVED: 9-Feb-22

5 0 5 10 15 20 25m

1:500 (A3) 1:250 (A1)

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Appendix D – Seakeeping Assessment (JBD, 2020a)

NOAKES GROUP

SEAKEEPING ASSESSMENT
FLOATING DOCK ‘FDD1N’

REVISION 2

REPORT No.:	EA-2151-006	**CLIENT:**	Noakes Group
REV No:	2		
TITLE:	Seakeeping Assessment – Floating Dock ‘FDD1N’		

DESIGNER APPROVAL		**STABILITY PARAMETERS**	
Signature	J. W. Butler	Vessel Class	2D
		Number of Crew	0
Full Name	John Butler	Number of Passengers	0
Title / Rank	Principal Naval Architect	Number of Special Personnel	12
Organisation	John Butler Design		
Date	10/02/2022	Total No. Persons	12

ENDORSEMENTS & REVISION HISTORY

The document is cleared by:

	Name	Department/Group	Date
Prepared By	Nichola Buchanan	HULL	01/02/2022
Checked By	Jordan Banks	HULL	01/02/2022
Approved By	John Butler	HULL	01/02/2022

RECORD OF AMENDMENTS

Rev No	Date	Description	Prepared By	Checked By	Approved By
1	01/02/2022	Original Issue	Jordan Banks	Nichola Buchanan	John Butler
2	10/02/2022	Analysed conditions renamed for clarity. Ballasted draft condition increased to 5.3m. Discussion expanded for clarity.	Nichola Buchanan	Jordan Banks	John Butler

TABLE OF CONTENTS

1 BACKGROUND

JBD has been engaged by Noakes Group to review the design documentation of the Floating Dry Dock for the purpose of obtaining certification to enable the docking of Australian Defence Force vessels as well as commercial and privately owned vessels at the Noakes Group facility in McMahons Point, NSW. A preliminary strength and stability assessment was undertaken by Shearforce Maritime Services, Ref (b). An inclining experiment has since been undertaken on the floating dock to determine its lightship particulars, Ref (i). These particulars have been used for this assessment.

2 PURPOSE

The purpose of this report is to present a seakeeping analysis to establish the likelihood of green water on the working deck and the proximity of the keel to the sea floor in a particular sea state.

3 REFERENCES

a) NSCV Code

b) Shear force Maritime Services Pty Ltd, “Structural and Stability Assessment – Final Report, Floating Dock AFD 1002”, SYD/2015/19, 16/11/2016

c) Email from Rick Plain “FW: Stannargs Marine Pty Ltd v North Sydney Council – Priority response required [SEC=OFFICIAL]”, dated 29/11/2021

d) Seakeeper User Manual, Version 16. Copywrite 1998-2011 Formation Design Systems Pty Ltd.

e) Website: Navionics Chart Viewer, Accessed 02/12/2021, URL: https://webapp.navionics.com/?lang=en#boating@14&key=p_qmEkszy%5B

f) Bhattacharyya, R., Dynamics of Marine Vehicles, John Wiley and Sons, New York, 1982

g) Noakes Autodesk Inventor Model ‘Noakes FDD Final 3D Model Ben Tang 091116’

h) Email from Rick Plain “Noakes FDD”, dated 02/12/2021

i) JBD Report: EA-2134-005 Inclining Experiment Report

j) JBD 3D Model: 2151_FDD Complete Stability Model_01.3dm

4 GENERAL PARTICULARS OF FLOATING DOCK

Length Overall:	57.912	metres
Breadth (moulded):	19.812	metres
Depth of Pontoon at side:	2.810	meters
Depth of Sides:	7.772	metres
Depth Overall:	10.582	meters
Designed Lift Capacity:	1000	tonnes
Builders:	Morts Dock	
Place and date of building:	Sydney, 1942	

5 ABBREVIATIONS ACRONYMS AND DEFINITIONS

EA	Engineering Assessment
FWD	Forward
GM	Metacentric Height
Heel	Variation in draft between port and starboard sides of vessel
LCG	Longitudinal Centre of Gravity
TCG	Transverse Centre of Gravity
Trim	Variation in draft between Aft Perpendicular and Fwd Perpendicular
VCG	Vertical Centre of Gravity Measured Above Baseline
h	Water Depth
Lw	Wavelength
CL	Centre Line
MS	Midships
BL	Baseline
MD	Main deck
FDD	Floating Dry Dock

6 OPERATION SUMMARY

As detailed in the previous structural and stability assessment, Ref (b), the floating dock 'FDD1N' is to be used by the Noakes Group Shipyard Sydney to dock various vessels including 35m harbour tugs, the Huon Class Minehunters, and the Paluma Class Surveying Ships. These vessels provide a range of displacements and lengths to assess the capability of the floating dock. The general particulars of these vessels have been taken from Ref (b) and are shown below in Table 5.1. The FDD1N has a design load capacity of 1000t.

Vessel Type	**35m Harbour Tug**	**Huon Class Minehunters**	**Paluma Class Surveying Ship**
LOA (m)	34.0	52.5	36.6
Beam (m)	11.0	9.9	12.8
Draft (m)	4.0	3.0	2.7
Displacement (tonnes)	960	732	325
Supporting Block Length (m)	22	42	24

Table 6.1 – Floating Dock Typical Ship Particulars

A recent stability assessment in way of an inclining experiment and lightship survey was conducted on the FDD and is shown in Ref (i). The findings of this report show the current VCG is 4.259 m. This has been taken as the nominal VCG across this seakeeping assessment.

Loading conditions specific to this seakeeping assessment were created based on the proposed operations at the Noakes dry dock facility. A 3D model of the FDD was developed by JBD, Ref (j), which was then imported into Maxsurf Stability. An assessment was undertaken to find the displacement of the FDD at different drafts. These drafts correspond with the varying phases of ballasting and de-ballasting the FDD when docking a vessel. These conditions are shown below in Table 6.2 and have been used for the seakeeping assessment, with the LCG and TCG assumed to be at the zero point (CL and MS). The assessment also used the derived lightship mass of 1101 tonnes and lightship VCG of 4.259m (Ref (i)).

Two vessel displacements were analysed; the maximum rated lift (1000 tonnes) and a vessel that provides a 1.0 m freeboard (566 tonnes) with the ballast tanks de-ballasted. The 1000 t vessel was assessed for three stages of ballasting: half the mass on the keel blocks, total mass on keel blocks with waterline at the top of the blocks and in the free-floating state. The 566t vessel was analysed in the free-floating condition only as the 1000 t vessel provides the worst-case draft conditions.

	Payload (Tonne)	Ballast (%)	Ballast (tonne)	Displacement (Tonne)	Draft (m)	Freeboard to working deck (m)
LC1 - Ballasted	-	83	2849	3950	5.300	-2.490
LC2 – 1000t Half Mass	500	60	2057	3658	4.203	-1.393
LC3 – 1000t Full Load	1000	36	1244	3345	3.061	-0.251
LC4 – 1000t Free-floating	1000	9	397	2498	2.179	0.631
LC5 – 566t Free-floating	566	9	397	2064	1.810	1.000

Table 6.2 – Floating Dock Particulars at Varying Displacements

7 PROPOSED OPERATING ENVIRONMENT

The Noakes facility is located on the north end of Berry's Bay. The bay itself faces in a South-South Easterly direction into the main harbour. A hydrographical map of the bay is shown in Figure 7.1, Ref (e). In accordance with this map, adjacent to the yard there is a nominal water depth of 4m to 9m. A separate hydrographic survey was undertaken by the client which determined the nominal minimum water depth inside the lease area is approximately 5.8m, Ref (h). This water depth is the sum of the 4.5m chart datum, and a tide water level of approximately 1.3m which is 2 hours either side of mean high-water spring.

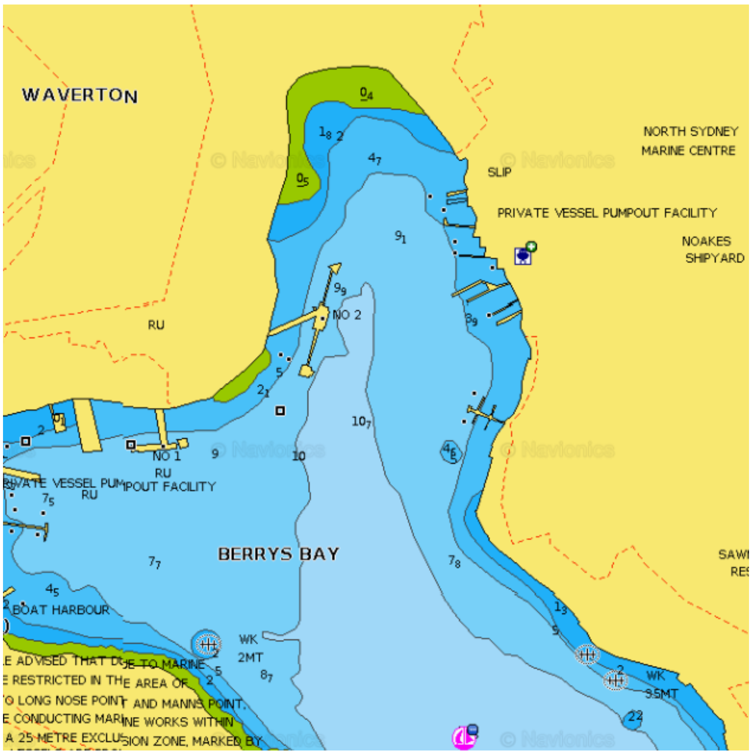


Figure 7.1 – Berrys Bay Hydrographical Map (Ref (e))

7.1 PROPOSED WAVE DATA

In accordance with Ref (c), the floating dock has been assessed for the following wave conditions:

- 0.4m significant wave height and a 4 second peak period, to represent the wash from a large pleasure cruiser on the harbour.
- 0.2m significant wave height and an 8 second peak period, to represent the wash from a typical ferry on the harbour.

The deep-water wavelength has been calculated using the following equation, Ref (f):

$$L_w = \frac{g{T_w}^2}{2\pi}$$

For the proposed wave conditions, the wavelengths are calculated to be:

- 0.4m wave height: 24.98 m
- 0.2m wave height: 99.92 m

Figures 7.2 and 7.3 show the FDD in its proposed location for the lifting pocket within Berrys Bay.

Figure 7.2 illustrates the probable headings of the 0.4m waves relative to the FDD. As these waves will be generated by recreational vessels, the waves will enter the Noakes facility from the south-west at a maximum angle of 60°.

Figure 7.3 illustrates the probable headings of the 0.2m waves relative to the FDD. As these waves will be generated by ferries operating in Balls Head Bay, the waves will enter the Noakes facility from the south at a maximum angle of 13° relative to the FDD.

Figures 7.4 and 7.5 show the FDD in its proposed berthing pocket, when the FDD is alongside the wharf, with or without docked vessels.

Figure 7.4 illustrates the probable headings of the 0.4m waves relative to the FDD. As these waves will be generated by recreational vessels, the waves will enter the Noakes facility from the south-west at a maximum angle of 74°.

Figure 7.5 illustrates the probable headings of the 0.2m waves relative to the FDD. As these waves will be generated by ferries operating in Balls Head Bay, the waves will enter the Noakes facility from the south at a maximum angle of 38° relative to the FDD.

Figure 7.2: FDD in Lifting pocket – 0.4m Wave Direction

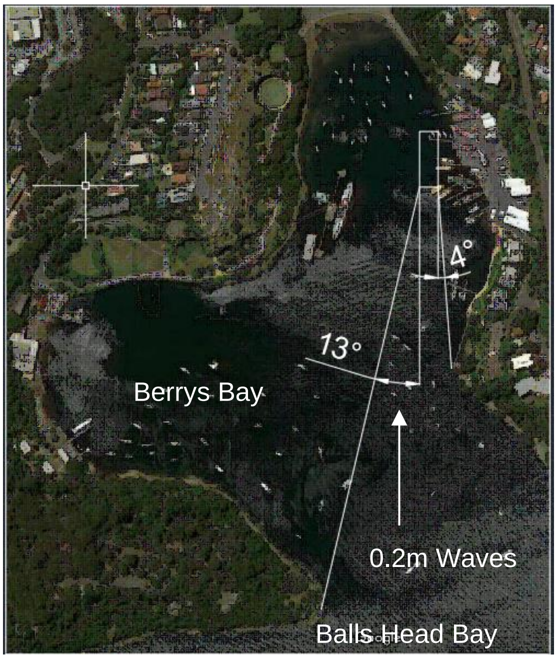


Figure 7.3: FDD in Lifting Pocket – 0.2m Wave Direction

Figure 7.4: FDD in Berthing Pocket – 0.4m Wave Direction

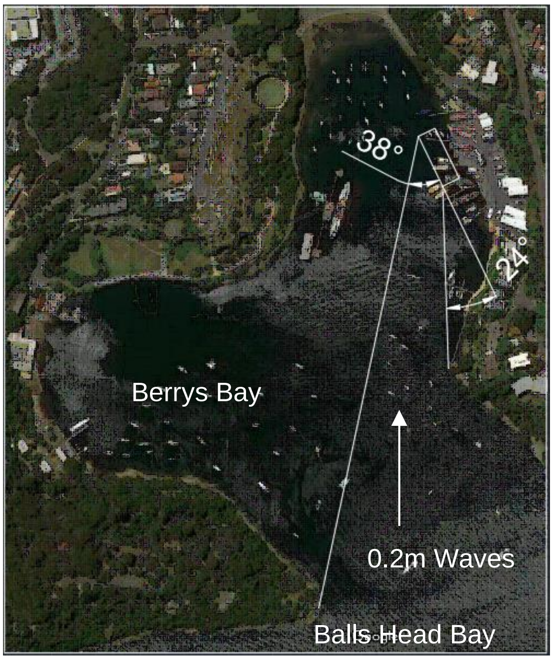


Figure 7.5: FDD in Berthing Pocket – 0.2m Wave Direction

8 SEAKEEPING ASSESSMENT METHODOLOGY

8.1 MODEL AXES

Translation:	Rotation:
dX - longitudinal, +ve FWD of the aft perpendicular	Φx - Roll
dY - transverse, +ve starboard of the centreline	Φy - Pitch
dZ - vertical, +ve above the baseline (Bottom of Hull)	Φz - Yaw

Trim is positive by the stern. Heel is positive to starboard.

8.2 SEAKEEPING MODELS

Due to limitations within the software, see Section 8.6, three Seakeeping models were created to estimate the vessel motions at various drafts. All models were created using Maxsurf Modeller Advanced Version 18.02 defining the design waterline and frame of reference. These were then imported into Maxsurf Motions and, due to the consistent transverse profile of the dock, the number of mapped sections was set to 30, while the maximum number of mapping terms was increased to 15 to accurately capture the hard chined barge hull form. Some aspects such as appendages were also simplified to limit the complexity of the model as these would not have a large effect on the overall results.

Model 1 (Figure 8.1) is an accurate replication of the floating dock, taken from an amended 3D model created by JBD after the stability assessment Ref (j). This model was analysed with the de-ballasted water depths (Phase 4 and Phase 5).

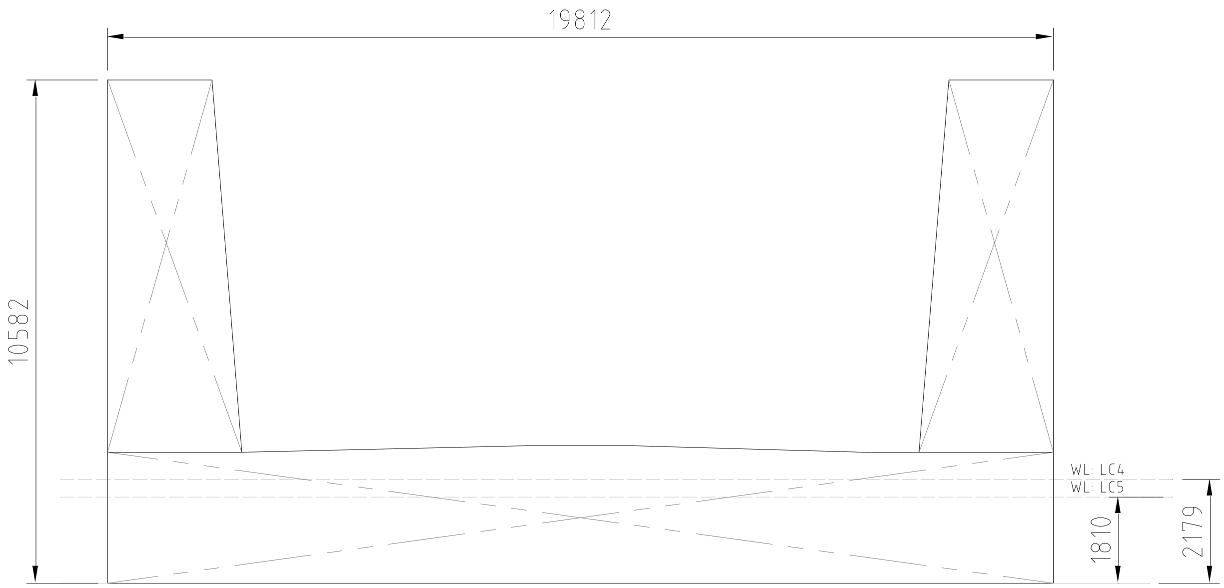


Figure 8.1: Model 1, Cross Section

To account for a changing water plane area between the floating and ballasted conditions (phases 1-3) two additional models were created and assessed. Model 2 (Figure 8.2) is a simplified model of the port and starboard floatation towers and a portion of the main hull, to represent the water plane area of the dock in a ballasted condition. This model does not account for the submerged volume below the main deck between the floatation towers, and therefore, the total displacement of the floating dry dock. As such, the underwater inertia is less than the actual inertia and the ship motions will be overestimated.

To account for the additional below water volume, a third model was created. Model 3 (Figure 8.3) is a simplistic block model representing the floatation towers as well as the area in between them. This model overestimates the submerged volume and waterplane area of the dock. As such, the underwater inertia is greater than the actual value and the ship motions will be underestimated.

Models 2 and 3 provide an upper and lower motion limit, with the actual motion of the floating dock in between these values. The maximum predicted values for each model in each condition have been taken as a conservative approach.

Figure 8.2: Model 2, Cross Section

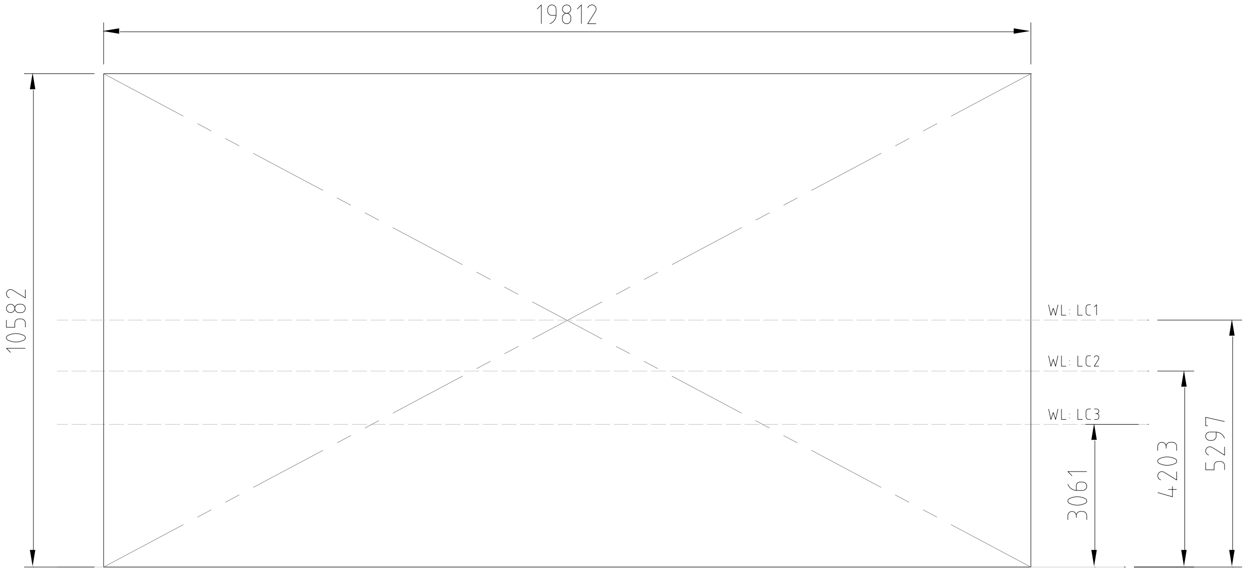


Figure 8.3: Model 3, Cross Section

8.3 SIMULATION CONDITIONS

The simulation was conducted using a speed over water of 0 knots. Due to the symmetry of the model, about the centre line and midships, only headings ranging from 0 to 90 degrees at 15-degree increments were analysed.

8.4 ASSUMPTIONS

The dock is operating in sea water with a density of 1.025 t/m^3.

Irregular wave patterns created by wind fetch, additional harbour traffic or wash in the bay have not been considered. Breaking waves have also not been considered.

The ballasted motions of the floating dock will be not greater than Model 2 or 3.

8.5 KEY POINTS

The key points are used to determine the motions at individual locations of the dry dock. The nature of this preliminary seakeeping assessment is to assess if the dock will be subjected to green water on the working deck, and the under-keel clearance in a particular wave condition. The key points have been placed on the lowest extremities of the hull as well as the extremities of the main deck. Considering this, the key points for this barge were as follows:

Key Point Name	Longitudinal Position	Transverse Position	Vertical Position
	m	m	m
Zero Point	0.000	0.000	0.000
BL, FWD, Pt Side	25.920	-9.910	0.000
BL, FWD, STBD Side	25.920	9.910	0.000
BL, AFT, Pt Side	-25.920	-9.910	0.000
BL, AFT, STBD Side	-25.920	9.910	0.000
MD, FWD, Pt Side	28.960	-9.910	2.740
MD, FWD, Pt Side	28.960	9.910	2.740
MD, AFT, Pt Side	-28.960	-9.910	2.740
MD, AFT, STBD Side	-28.960	9.910	2.740

8.6 MAXSURF MOTIONS SEAKEEPING LIMITATIONS

The seakeeping assessment method uses Maxsurf Motions to assess the relative motions of the vessel in the seaway. Maxsurf Motions uses Linear Strip Theory to compute the coupled heave and pitch motions of the vessel, this method is dependent on several major assumptions (Ref d)):

- Slender ship: length is much greater than beam or draft and beam is much less then wavelength
- Hull is rigid
- Speed is moderate with no lift from forward speed
- Motions are small and linear with respect to wave amplitude
- Hull sections are wall sided (small changes in waterplane area)
- Water depth is much greater than wavelength so that deep-water wave approximations may be applied
- The hull has no effect on the incident waves (so called Froude-Kriloff Hypothesis)

As calculated in Section 7.1, the deep-water wavelength for the proposed wave group is 24.98 m and 99.92 m respectively, while the vessel breadth is 19.81 m. The ratio of wavelength to beam for the 0.2 m wave is 5.04. The ratio for the 0.4 m wave is 1.26. These ratios are greater than 1 and have been considered acceptable.

The sides of the floating dock are wall sided. However, due to its unique shape, the waterplane area changes dramatically once the working deck is submerged. Due to the equations required, Maxsurf Motions is unable to calculate the shape of the floating dock when the deck is submerged. Therefore, two other hull forms were modelled to estimate the extremes of motion the floating dock is likely to encounter at submerged water depths, see Section 8.2.

Oscillatory waves may be classified by the water depth in which they travel where a deep-water wave is one that satisfies $\frac{h}{L_w} > \frac{1}{2}$ (Ref (f)). In accordance with Ref (h), the maximum water depth in the lease area is 5.8 m. The ratio of h/Lw for the given waves is not greater than 0.5 (0.06 for 0.2 m wave and 0.23 for 0.4 m wave). Therefore, these conditions would be considered transitional / shallow water wave conditions. Due to the complexity of shallow water analysis, it is not possible to analyse the motion of the floating dock without undertaking physical model testing or computational fluid dynamics. Deep water waves have a larger wavelength than shallow water waves which increases the likelihood of resonance and increased vessel motions. Therefore, the deep-water analysis has been considered a conservative assessment of the floating docks motions.

9 SEAKEEPING RESULTS

The results from the seakeeping analysis are focused on the absolute vertical motion of the key points from the static waterline. This data will assist the client with predicting the relative operable water depths to prevent sea floor disturbance as well as the likelihood of green water on the deck. Annex A shows the complete result data for all conditions across all operating drafts and wave conditions.

9.1 MODEL 1

Table 9.1 and Table 9.2 show the maximum vertical motions at each key point for each encounter angle, over both displacements within the floating condition (Loading Conditions 4 and 5).

0.4m, 4s	Encounter Angle (°)						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.056	0.106	0.190	0.271	0.331	0.351	0.335
BL, FWD, STBD Side	0.056	0.108	0.174	0.229	0.276	0.325	0.368
BL, AFT, PT Side	0.057	0.117	0.185	0.238	0.277	0.313	0.347
BL, AFT, STBD Side	0.057	0.099	0.184	0.270	0.341	0.374	0.362
MD, FWD, PT Side	0.063	0.110	0.193	0.275	0.335	0.354	0.334
MD, FWD, STBD Side	0.063	0.112	0.176	0.228	0.273	0.323	0.368
MD, AFT, PT Side	0.064	0.121	0.188	0.238	0.275	0.311	0.348
MD, AFT, STBD Side	0.064	0.103	0.187	0.274	0.346	**0.378**	0.362

Table 9.1: Model 1, Maximum Absolute Vertical Motion from Still Water (m), 0.4m significant wave height, 4 second peak period – Maximum Encounter Angle of 74°

0.2m, 8s	Encounter Angle (°)						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.117	0.135	0.152	0.164	0.166	0.161	0.147
BL, FWD, STBD Side	0.117	0.117	0.120	0.123	0.124	0.130	0.141
BL, AFT, PT Side	0.160	0.160	0.169	0.178	0.186	0.190	0.190
BL, AFT, STBD Side	0.160	0.177	0.196	0.212	0.217	0.208	0.184
MD, FWD, PT Side	0.133	0.151	0.167	0.177	0.175	0.165	0.147
MD, FWD, STBD Side	0.133	0.132	0.134	0.133	0.131	0.133	0.143
MD, AFT, PT Side	0.176	0.175	0.183	0.190	0.195	0.197	0.195
MD, AFT, STBD Side	0.176	0.193	0.212	**0.226**	0.229	0.217	0.189

Table 9.2: Model 1, Maximum Absolute Vertical Motion from Still Water (m), 0.2m significant wave height, 8 second peak period – Maximum Encounter Angle of 38°

9.2 MODEL 2

Table 9.3 and Table 9.4 show the maximum vertical motions at each key point for each encounter angle, over all displacements within the ballasted conditions (Loading Conditions 1, 2 and 3).

0.4m, 4s	Encounter Angle						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.136	0.143	0.151	0.147	0.146	0.226	0.283
BL, FWD, STBD Side	0.136	0.147	0.161	0.179	0.279	0.490	0.618
BL, AFT, PT Side	0.144	0.151	0.169	0.199	0.246	0.301	0.303
BL, AFT, STBD Side	0.144	0.157	0.171	0.186	0.298	0.505	0.601
MD, FWD, PT Side	0.152	0.160	0.169	0.167	0.160	0.225	0.282
MD, FWD, STBD Side	0.152	0.163	0.178	0.198	0.290	0.493	0.620
MD, AFT, PT Side	0.160	0.168	0.188	0.218	0.263	0.311	0.305
MD, AFT, STBD Side	0.160	0.174	0.189	0.205	**0.305**	0.509	0.600

Table 9.3: Model 2, Maximum Absolute Vertical Motion from Still Water (m), 0.4m significant wave height, 4 second peak period – Maximum Encounter Angle of 60°

0.2m, 8s	Encounter Angle (°)						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.303	0.311	0.304	0.277	0.230	0.168	0.112
BL, FWD, STBD Side	0.303	0.315	0.314	0.297	0.265	0.227	0.190
BL, AFT, PT Side	0.343	0.352	0.351	0.333	0.295	0.238	0.169
BL, AFT, STBD Side	0.343	0.349	0.343	0.321	0.286	0.238	0.182
MD, FWD, PT Side	0.341	0.350	0.342	0.313	0.259	0.187	0.120
MD, FWD, STBD Side	0.341	0.353	0.352	0.331	0.293	0.245	0.197
MD, AFT, PT Side	0.381	**0.391**	0.389	0.368	0.325	0.259	0.179
MD, AFT, STBD Side	0.381	0.388	0.381	0.356	0.314	0.256	0.189

Table 9.4: Model 2, Maximum Absolute Vertical Motion from Still Water (m), 0.2m significant wave height, 8 second peak period – Maximum Encounter Angle of 13°

9.3 MODEL 3

Table 9.5 and Table 9.6 show the maximum vertical motions at each key point for each encounter angle, over all displacements within the ballasted conditions (Loading Conditions 1, 2 and 3).

0.4m, 4s	Encounter Angle (°)						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.036	0.049	0.068	0.088	0.102	0.104	0.094
BL, FWD, STBD Side	0.036	0.043	0.055	0.066	0.080	0.102	0.124
BL, AFT, PT Side	0.037	0.046	0.059	0.069	0.076	0.087	0.100
BL, AFT, STBD Side	0.037	0.050	0.074	0.103	0.130	0.142	0.135
MD, FWD, PT Side	0.041	0.053	0.072	0.092	0.105	0.106	0.094
MD, FWD, STBD Side	0.041	0.047	0.057	0.067	0.079	0.101	0.124
MD, AFT, PT Side	0.041	0.050	0.062	0.071	0.077	0.088	0.101
MD, AFT, STBD Side	0.041	0.054	0.078	0.107	**0.134**	0.145	0.136

Table 9.5: Model 3, Maximum Absolute Vertical Motion from Still Water (m), 0.4m significant wave height, 4 second peak period – Maximum Encounter Angle of 60°

0.2m, 8s	Encounter Angle (°)						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.293	0.301	0.297	0.275	0.228	0.168	0.141
BL, FWD, STBD Side	0.293	0.299	0.295	0.275	0.240	0.201	0.170
BL, AFT, PT Side	0.327	0.334	0.334	0.319	0.283	0.227	0.161
BL, AFT, STBD Side	0.327	0.337	0.337	0.321	0.286	0.253	0.229
MD, FWD, PT Side	0.329	0.338	0.334	0.309	0.256	0.180	0.147
MD, FWD, STBD Side	0.329	0.336	0.331	0.309	0.268	0.218	0.175
MD, AFT, PT Side	0.363	0.371	0.371	0.353	0.312	0.247	0.171
MD, AFT, STBD Side	0.363	**0.374**	0.373	0.355	0.314	0.263	0.235

Table 9.6: Model 3, Maximum Absolute Vertical Motion from Still Water (m), 0.2m significant wave height, 8 second peak period – Maximum Encounter Angle of 13°

9.4 BALLASTED RESULTS SUMMARY (MODEL 2 & MODEL 3)

Table 9.7 and Table 9.8 show the combined maximum vertical motions at each key point for each encounter angle, over the entire displacement and draft ranges for Models 2 and 3. This implies a conservative approach, where the largest possible motions over the two approximate models have been used.

0.4m, 4s	Encounter Angle (°)						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.136	0.143	0.151	0.147	0.146	0.226	0.283
BL, FWD, STBD Side	0.136	0.147	0.161	0.179	0.279	0.490	0.618
BL, AFT, PT Side	0.144	0.151	0.169	0.199	0.246	0.301	0.303
BL, AFT, STBD Side	0.144	0.157	0.171	0.186	0.298	0.505	0.601
MD, FWD, PT Side	0.152	0.160	0.169	0.167	0.160	0.225	0.282
MD, FWD, STBD Side	0.152	0.163	0.178	0.198	0.290	0.493	0.620
MD, AFT, PT Side	0.160	0.168	0.188	0.218	0.263	0.311	0.305
MD, AFT, STBD Side	0.160	0.174	0.189	0.205	**0.305**	0.509	0.600

Table 9.7: Maximum Absolute Vertical Motion from Still Water (m) Models 2 & 3, 0.4m significant wave height, 4 second peak period – Maximum Encounter Angle of 60°

0.2m, 8s	Encounter Angle (°)						
	0	15	30	45	60	75	90
BL, FWD, PT Side	0.303	0.311	0.304	0.277	0.230	0.168	0.141
BL, FWD, STBD Side	0.303	0.315	0.314	0.297	0.265	0.227	0.190
BL, AFT, PT Side	0.343	0.352	0.351	0.333	0.295	0.238	0.169
BL, AFT, STBD Side	0.343	0.349	0.343	0.321	0.286	0.253	0.229
MD, FWD, PT Side	0.341	0.350	0.342	0.313	0.259	0.187	0.147
MD, FWD, STBD Side	0.341	0.353	0.352	0.331	0.293	0.245	0.197
MD, AFT, PT Side	0.381	**0.391**	0.389	0.368	0.325	0.259	0.179
MD, AFT, STBD Side	0.381	0.388	0.381	0.356	0.314	0.263	0.235

Table 9.8: Maximum Absolute Vertical Motion from Still Water (m) Models 2 & 3, 0.2m significant wave height, 8 second peak period – Maximum Encounter Angle of 13°

10 DISCUSSION

10.1 0.4M SIGNIFICANT WAVE HEIGHT, 4 SECOND PEAK PERIOD

The 0.4m significant wave height and 4 second peak period wave packet represents a large pleasure cruiser operating in Berrys Bay. The results of the seakeeping analysis show a clear correlation between absolute vertical motion and encounter angle, where the largest motions are typically seen between 45 to 90 degrees across all models

The proposed location of the berthing pocket within the lease area relative to the entrance to the bay limits the encounter angle of these waves that the FDD will be exposed to, no greater than 74° is possible, see Figure 7.4. The largest vertical motion value is predicted to be 0.378m on the aft starboard corner of the main deck as shown for model 1 in Table 9.1.

The proposed location of the lifting pocket within the lease area relative to the entrance to the bay limits the encounter angle of these waves that the FDD will be exposed to, no greater than 60° is possible, see Figure 7.2. The largest vertical motion value in the floating condition is predicted to be 0.346m on the aft starboard corner of the main deck as shown for model 1 in Table 9.1. The largest vertical motion value in the ballasted condition is predicted to be 0.305m on the aft stbd corner of the main deck as shown for model 2 in Table 9.3.

10.2 0.2M SIGNIFICANT WAVE HEIGHT, 8 SECOND PEAK PERIOD

The 0.2m significant wave height and 8 second peak period wave packet represents a typical harbour ferry passing the entrance to Berrys Bay.

For the ballasted condition (Model 2 & 3), the results for show a clear correlation with higher absolute vertical motion to approaching head seas, between 0 to 45 degrees. The largest value is predicted to be 0.391m on the aft port corner of the main deck. Conversely, if only a beam sea is considered, i.e. 75-90 degrees, the maximum recorded motion is predicted to be 0.263m on the aft starboard corner of the main deck.

For the floating condition (Model 1), the correlation favours a quartering sea, with the highest values falling between 30 and 60 degrees. The largest predicted vertical motion is 0.229m, at the aft starboard corner of the main deck. Conversely, if only a head sea is considered, i.e. 0-15 degrees, the maximum recorded motion is predicted to be 0.176m on the aft starboard corner of the main deck.

The proposed location of the berthing pocket within the lease area relative to the entrance to the bay limits the encounter angle of these waves that the FDD will be exposed to, no greater than 38° is possible, see Figure 7.5. The largest vertical motion value is predicted to be 0.226m on the aft starboard corner of the main deck as shown for model 1 in Table 9.2.

The proposed location of the lifting pocket within the lease area relative to the entrance to the bay limits the encounter angle of these waves that the FDD will be exposed to, no greater than 15° is possible, see Figure 7.3. The largest vertical motion value in the floating condition is predicted to be 0.176m on the aft starboard corner of the main deck as shown for model 1 in Table 9.2. The largest vertical motion value in the ballasted condition is predicted to be 0.391m on the aft port corner of the main deck as shown for model 2 in Table 9.8.

10.3 WAVE OVERTOPPING

In order to prevent green water washing onto the working deck the freeboard must be greater than the sum of half the wave height and the absolute vertical motion relative to still water. This assumes an occurrence where a particular key point is in its lowest possible position in the oscillatory motion cycle of the vessel in the seaway, which is then met with a peak of an incoming wave.

The still water freeboard in the Phase 5 and Phase 4 Conditions is 1.000m and 0.631m, respectively. Table 10.1 and Table 10.2 show the sum of the absolute vertical motion from still water and half the respective wave height for the Phase 4 and Phase 5 loading conditions.

All of the predicted wave actions were predicted to be below the estimated freeboard and are acceptable.

0.4m, 4s	Encounter Angle						
	0	15	30	45	60	75	90
MD, FWD, PT Side	0.263	0.310	0.393	0.475	0.535	0.554	0.534
MD, FWD, STBD Side	0.263	0.312	0.376	0.428	0.473	0.523	0.568
MD, AFT, PT Side	0.264	0.321	0.388	0.438	0.475	0.511	0.548
MD, AFT, STBD Side	0.264	0.303	0.387	0.474	0.546	**0.578**	0.562

0.2m, 8s	Encounter Angle						
	0	15	30	45	60	75	90
MD, FWD, PT Side	0.231	0.243	0.257	0.269	0.272	0.265	0.247
MD, FWD, STBD Side	0.231	0.232	0.234	0.233	0.231	0.233	0.243
MD, AFT, PT Side	0.272	0.275	0.283	0.290	0.295	0.297	0.295
MD, AFT, STBD Side	0.272	0.284	0.298	**0.309**	0.312	0.300	0.273

*Table 10.1: Sum of Half Wave Height and Maximum Absolute Vertical Motion (m), Phase 5 Condition (**1.000m** freeboard)*

0.4m, 4s	Encounter Angle						
	0	15	30	45	60	75	90
MD, FWD, PT Side	0.256	0.287	0.335	0.383	0.415	0.419	0.396
MD, FWD, STBD Side	0.256	0.272	0.304	0.332	0.362	0.402	0.440
MD, AFT, PT Side	0.257	0.277	0.309	0.331	0.346	0.368	0.397
MD, AFT, STBD Side	0.257	0.286	0.338	0.395	0.443	**0.464**	0.449

0.2m, 8s	Encounter Angle						
	0	15	30	45	60	75	90
MD, FWD, PT Side	0.233	0.251	0.267	0.277	0.275	0.261	0.236
MD, FWD, STBD Side	0.233	0.228	0.223	0.218	0.216	0.224	0.241
MD, AFT, PT Side	0.276	0.273	0.273	0.275	0.276	0.275	0.274
MD, AFT, STBD Side	0.276	0.293	0.312	**0.326**	0.329	0.317	0.289

*Table 10.2: Sum of Half Wave Height and Maximum Absolute Vertical Motion (m), Phase 4 Condition (**0.631m** freeboard)*

10.4 SEAFLOOR DISTURBANCE

An assessment of the likelihood of seafloor disturbance has been based on a minimum nominal water depth of 5.8m in the lifting pocket, Section 7. This provides an acceptable operating draft of 5.3m with 0.5m of under keel clearance to the sea floor. Table 10.3 below shows the maximum vertical motions for Models 2 and 3 when the dry dock is ballasted to a 5.297m draft. The 0.4m data above 60° and the 0.2m data above 15° have been greyed out as the proposed location of the lifting pocket within the lease area relative to the entrance to the bay limits the encounter angle of waves that the FDD will be exposed to.

In the conditions analysed, there are no absolute vertical motions greater than 0.503m, indicating that there is sufficient under keel clearance to prevent the FDD colliding with the seafloor. The maximum vertical motion predicted in the 0.4m wave conditions is 0.219m as shown in Table 10.3. The maximum estimated vertical motion in the 0.2m wave conditions is 0.352m as shown in Table 10.3.

As per Section 10.1 and 10.2, the maximum estimated motion for the floating condition is predicted to be 0.378m and 0.229m for the 0.4m and 0.2m wave conditions respectively. There are no predicted vertical motions greater than 0.5m in the berthing pocket.

	Encounter Angle						
0.4m, 4s	0	15	30	45	60	75	90
BL, FWD, PT Side	0.039	0.033	0.031	0.058	0.120	0.190	0.222
BL, FWD, STBD Side	0.039	0.039	0.045	0.093	0.189	0.294	0.348
BL, AFT, PT Side	0.035	0.035	0.047	0.082	0.141	0.205	0.231
BL, AFT, STBD Side	0.035	0.032	0.051	0.116	**0.219**	0.319	0.355

	Encounter Angle						
0.2m, 8s	0	15	30	45	60	75	90
BL, FWD, PT Side	0.303	0.311	0.304	0.277	0.230	0.168	0.112
BL, FWD, STBD Side	0.303	0.315	0.314	0.297	0.265	0.227	0.190
BL, AFT, PT Side	0.343	**0.352**	0.351	0.333	0.295	0.238	0.169
BL, AFT, STBD Side	0.343	0.349	0.343	0.321	0.283	0.234	0.180

Table 10.3: Maximum Absolute Vertical Motion (m), Phase 1 Condition (5.297m Draft)

11 CONCLUSION

A seakeeping assessment has been undertaken on the floating dry dock “FFD1N” over a range of drafts and displacements. The assessment was conducted using two separate wave packets representing wash from typical harbour traffic. These wave packets had a significant wave height of 0.4m and 0.2m, and peak periods of 4s and 8s respectively. The assessment focused on the absolute vertical motion of key points on the deck and bottom hull of the vessel. To remain within the assumptions and limitations of the sea keeping software, a deep-water wave condition was assumed, which was considered to be a conservative approach.

For all 0.4m wave height conditions, barge motions were reduced with head seas, namely wave encounter angles between 0 and 15 degrees. For all 0.2m wave height conditions, barge motions were reduced with beam sea’s, namely encounter angles between 75 and 90 degrees. Given the relative motions of the 0.2m wave are much less than those of the 0.4m wave, it is recommended to orientate the vessel into head seas (0-15 degrees) where possible to reduce absolute vertical motions for the key points discussed.

Wave overtopping onto the working deck was not found to occur in either the Phase 4 or Phase 5 conditions.

Seafloor disturbance was not predicted to occur for any of the conditions analysed when the vessel is ballasted to a 5.297m draft within the lifting pocket.

ANNEX A
SEAKEEPING RESULTS

0.4m, 4s	Encounter Angle						
Phase 4	0	15	30	45	60	75	90
BL, FWD, PT Side	0.050	0.083	0.131	0.178	0.210	0.215	0.196
BL, FWD, STBD Side	0.050	0.068	0.102	0.133	0.165	0.205	0.240
BL, AFT, PT Side	0.051	0.073	0.107	0.132	0.148	0.170	0.196
BL, AFT, STBD Side	0.051	0.081	0.134	0.190	0.238	0.261	0.249
MD, FWD, PT Side	0.056	0.087	0.135	0.183	0.215	0.219	0.196
MD, FWD, STBD Side	0.056	0.072	0.104	0.132	0.162	0.202	0.240
MD, AFT, PT Side	0.057	0.077	0.109	0.131	0.146	0.168	0.197
MD, AFT, STBD Side	0.057	0.086	0.138	0.195	0.243	0.264	0.249
	Encounter Angle						
Phase 5	0	15	30	45	60	75	90
BL, FWD, PT Side	0.056	0.106	0.190	0.271	0.331	0.351	0.335
BL, FWD, STBD Side	0.056	0.108	0.174	0.229	0.276	0.325	0.368
BL, AFT, PT Side	0.057	0.117	0.185	0.238	0.277	0.313	0.347
BL, AFT, STBD Side	0.057	0.099	0.184	0.270	0.341	0.374	0.362
MD, FWD, PT Side	0.063	0.110	0.193	0.275	0.335	0.354	0.334
MD, FWD, STBD Side	0.063	0.112	0.176	0.228	0.273	0.323	0.368
MD, AFT, PT Side	0.064	0.121	0.188	0.238	0.275	0.311	0.348
MD, AFT, STBD Side	0.064	0.103	0.187	0.274	0.346	0.378	0.362
0.2m, 8s	Encounter Angle						
Phase 4	0	15	30	45	60	75	90
BL, FWD, PT Side	0.117	0.135	0.152	0.164	0.166	0.155	0.135
BL, FWD, STBD Side	0.117	0.112	0.109	0.108	0.111	0.123	0.140
BL, AFT, PT Side	0.160	0.157	0.159	0.163	0.166	0.168	0.169
BL, AFT, STBD Side	0.160	0.177	0.196	0.212	0.217	0.208	0.184
MD, FWD, PT Side	0.133	0.151	0.167	0.177	0.175	0.161	0.136
MD, FWD, STBD Side	0.133	0.128	0.123	0.118	0.116	0.124	0.141
MD, AFT, PT Side	0.176	0.173	0.173	0.175	0.176	0.175	0.174
MD, AFT, STBD Side	0.176	0.193	0.212	0.226	0.229	0.217	0.189
	Encounter Angle						
Phase 5	0	15	30	45	60	75	90
BL, FWD, PT Side	0.115	0.128	0.143	0.158	0.165	0.161	0.147
BL, FWD, STBD Side	0.115	0.117	0.120	0.123	0.124	0.130	0.141
BL, AFT, PT Side	0.156	0.160	0.169	0.178	0.186	0.190	0.190
BL, AFT, STBD Side	0.156	0.168	0.183	0.196	0.201	0.192	0.169
MD, FWD, PT Side	0.131	0.143	0.157	0.169	0.172	0.165	0.147
MD, FWD, STBD Side	0.131	0.132	0.134	0.133	0.131	0.133	0.143
MD, AFT, PT Side	0.172	0.175	0.183	0.190	0.195	0.197	0.195
MD, AFT, STBD Side	0.172	0.184	0.198	0.209	0.212	0.200	0.173

Table A1: Model 1 Results, Absolute Vertical Motion from still water (m)

0.4m, 4s	Encounter Angle						
Phase 1	0	15	30	45	60	75	90
BL, FWD, PT Side	0.039	0.033	0.031	0.058	0.120	0.190	0.222
BL, FWD, STBD Side	0.039	0.039	0.045	0.093	0.189	0.294	0.348
BL, AFT, PT Side	0.035	0.035	0.047	0.082	0.141	0.205	0.231
BL, AFT, STBD Side	0.035	0.032	0.051	0.116	0.219	0.319	0.355
MD, FWD, PT Side	0.042	0.037	0.034	0.059	0.120	0.189	0.221
MD, FWD, STBD Side	0.042	0.042	0.048	0.094	0.188	0.293	0.348
MD, AFT, PT Side	0.037	0.038	0.050	0.085	0.144	0.206	0.232
MD, AFT, STBD Side	0.037	0.035	0.054	0.119	0.221	0.321	0.355
	Encounter Angle						
Phase 2	0	15	30	45	60	75	90
BL, FWD, PT Side	0.074	0.068	0.062	0.066	0.126	0.226	0.283
BL, FWD, STBD Side	0.074	0.076	0.076	0.117	0.262	0.453	0.555
BL, AFT, PT Side	0.074	0.072	0.079	0.107	0.174	0.260	0.293
BL, AFT, STBD Side	0.074	0.072	0.072	0.136	0.298	0.482	0.552
MD, FWD, PT Side	0.079	0.074	0.070	0.072	0.127	0.225	0.282
MD, FWD, STBD Side	0.079	0.082	0.083	0.121	0.262	0.452	0.555
MD, AFT, PT Side	0.079	0.079	0.087	0.114	0.180	0.263	0.294
MD, AFT, STBD Side	0.079	0.078	0.080	0.141	0.302	0.484	0.552
	Encounter Angle						
Phase 3	0	15	30	45	60	75	90
BL, FWD, PT Side	0.136	0.143	0.151	0.147	0.146	0.208	0.277
BL, FWD, STBD Side	0.136	0.147	0.161	0.179	0.279	0.490	0.618
BL, AFT, PT Side	0.144	0.151	0.169	0.199	0.246	0.301	0.303
BL, AFT, STBD Side	0.144	0.157	0.171	0.186	0.294	0.505	0.601
MD, FWD, PT Side	0.152	0.160	0.169	0.167	0.160	0.210	0.277
MD, FWD, STBD Side	0.152	0.163	0.178	0.198	0.290	0.493	0.620
MD, AFT, PT Side	0.160	0.168	0.188	0.218	0.263	0.311	0.305
MD, AFT, STBD Side	0.160	0.174	0.189	0.205	0.305	0.509	0.600

Table A2: Model 2 Results, Absolute Vertical Motion from still water (m), 0.4m significant wave height, 4 second wave period

0.2m, 8s	Encounter Angle						
Phase 1	0	15	30	45	60	75	90
BL, FWD, PT Side	0.303	0.311	0.304	0.277	0.230	0.168	0.112
BL, FWD, STBD Side	0.303	0.315	0.314	0.297	0.265	0.227	0.190
BL, AFT, PT Side	0.343	0.352	0.351	0.333	0.295	0.238	0.169
BL, AFT, STBD Side	0.343	0.349	0.343	0.321	0.283	0.234	0.180
MD, FWD, PT Side	0.341	0.350	0.342	0.313	0.259	0.187	0.120
MD, FWD, STBD Side	0.341	0.353	0.352	0.331	0.293	0.245	0.197
MD, AFT, PT Side	0.381	0.391	0.389	0.368	0.325	0.259	0.179
MD, AFT, STBD Side	0.381	0.388	0.381	0.356	0.311	0.252	0.187
	Encounter Angle						
Phase 2	0	15	30	45	60	75	90
BL, FWD, PT Side	0.293	0.301	0.297	0.275	0.228	0.162	0.098
BL, FWD, STBD Side	0.293	0.299	0.295	0.275	0.240	0.201	0.170
BL, AFT, PT Side	0.327	0.334	0.334	0.319	0.283	0.227	0.161
BL, AFT, STBD Side	0.327	0.337	0.337	0.321	0.286	0.238	0.182
MD, FWD, PT Side	0.329	0.338	0.334	0.309	0.256	0.180	0.105
MD, FWD, STBD Side	0.329	0.336	0.331	0.309	0.268	0.218	0.175
MD, AFT, PT Side	0.363	0.371	0.371	0.353	0.312	0.247	0.171
MD, AFT, STBD Side	0.363	0.374	0.373	0.355	0.314	0.256	0.189
	Encounter Angle						
Phase 3	0	15	30	45	60	75	90
BL, FWD, PT Side	0.208	0.216	0.219	0.210	0.178	0.127	0.080
BL, FWD, STBD Side	0.208	0.210	0.209	0.197	0.172	0.144	0.131
BL, AFT, PT Side	0.229	0.233	0.237	0.233	0.214	0.176	0.129
BL, AFT, STBD Side	0.229	0.239	0.247	0.245	0.225	0.193	0.151
MD, FWD, PT Side	0.233	0.242	0.246	0.235	0.200	0.141	0.082
MD, FWD, STBD Side	0.233	0.236	0.235	0.222	0.193	0.156	0.133
MD, AFT, PT Side	0.254	0.259	0.263	0.258	0.235	0.191	0.135
MD, AFT, STBD Side	0.254	0.265	0.273	0.270	0.247	0.206	0.155

Table A3: Model 2 Results, Absolute Vertical Motion from still water (m), 0.2m significant wave height, 8 second wave period

0.4m, 4s	Encounter Angle						
Phase 1	0	15	30	45	60	75	90
BL, FWD, PT Side	0.016	0.021	0.030	0.040	0.049	0.053	0.051
BL, FWD, STBD Side	0.016	0.020	0.027	0.033	0.040	0.048	0.056
BL, AFT, PT Side	0.017	0.022	0.030	0.038	0.045	0.052	0.058
BL, AFT, STBD Side	0.017	0.023	0.034	0.047	0.058	0.064	0.062
MD, FWD, PT Side	0.017	0.023	0.032	0.042	0.050	0.054	0.051
MD, FWD, STBD Side	0.017	0.022	0.028	0.034	0.040	0.048	0.056
MD, AFT, PT Side	0.019	0.024	0.032	0.039	0.046	0.053	0.058
MD, AFT, STBD Side	0.019	0.025	0.036	0.049	0.060	0.066	0.063
	Encounter Angle						
Phase 2	0	15	30	45	60	75	90
BL, FWD, PT Side	0.023	0.030	0.041	0.053	0.064	0.068	0.064
BL, FWD, STBD Side	0.023	0.028	0.036	0.043	0.051	0.064	0.077
BL, AFT, PT Side	0.025	0.031	0.040	0.049	0.057	0.066	0.073
BL, AFT, STBD Side	0.025	0.032	0.046	0.064	0.081	0.089	0.085
MD, FWD, PT Side	0.026	0.033	0.044	0.056	0.066	0.069	0.064
MD, FWD, STBD Side	0.026	0.031	0.038	0.044	0.051	0.064	0.077
MD, AFT, PT Side	0.027	0.034	0.043	0.051	0.058	0.067	0.074
MD, AFT, STBD Side	0.027	0.034	0.049	0.067	0.084	0.091	0.086
	Encounter Angle						
Phase 3	0	15	30	45	60	75	90
BL, FWD, PT Side	0.036	0.049	0.068	0.088	0.102	0.104	0.094
BL, FWD, STBD Side	0.036	0.043	0.055	0.066	0.080	0.102	0.124
BL, AFT, PT Side	0.037	0.046	0.059	0.069	0.076	0.087	0.100
BL, AFT, STBD Side	0.037	0.050	0.074	0.103	0.130	0.142	0.135
MD, FWD, PT Side	0.041	0.053	0.072	0.092	0.105	0.106	0.094
MD, FWD, STBD Side	0.041	0.047	0.057	0.067	0.079	0.101	0.124
MD, AFT, PT Side	0.041	0.050	0.062	0.071	0.077	0.088	0.101
MD, AFT, STBD Side	0.041	0.054	0.078	0.107	0.134	0.145	0.136

Table A4: Model 3 Results, Absolute Vertical Motion from still water (m), 0.4m significant wave height, 4 second wave period

	Encounter Angle						
Phase 1	0	15	30	45	60	75	90
BL, FWD, PT Side	0.085	0.102	0.110	0.110	0.103	0.091	0.077
BL, FWD, STBD Side	0.085	0.079	0.067	0.050	0.036	0.039	0.055
BL, AFT, PT Side	0.131	0.123	0.115	0.106	0.095	0.080	0.061
BL, AFT, STBD Side	0.131	0.145	0.157	0.166	0.168	0.161	0.143
MD, FWD, PT Side	0.097	0.114	0.123	0.122	0.113	0.099	0.083
MD, FWD, STBD Side	0.097	0.092	0.079	0.061	0.043	0.039	0.053
MD, AFT, PT Side	0.143	0.136	0.127	0.118	0.105	0.088	0.066
MD, AFT, STBD Side	0.143	0.157	0.170	0.178	0.179	0.169	0.149
	Encounter Angle						
Phase 2	0	15	30	45	60	75	90
BL, FWD, PT Side	0.293	0.301	0.297	0.275	0.228	0.162	0.098
BL, FWD, STBD Side	0.293	0.299	0.295	0.275	0.240	0.201	0.170
BL, AFT, PT Side	0.327	0.334	0.334	0.319	0.283	0.227	0.161
BL, AFT, STBD Side	0.327	0.337	0.337	0.321	0.286	0.238	0.182
MD, FWD, PT Side	0.329	0.338	0.334	0.309	0.256	0.180	0.105
MD, FWD, STBD Side	0.329	0.336	0.331	0.309	0.268	0.218	0.175
MD, AFT, PT Side	0.363	0.371	0.371	0.353	0.312	0.247	0.171
MD, AFT, STBD Side	0.363	0.374	0.373	0.355	0.314	0.256	0.189
	Encounter Angle						
Phase 3	0	15	30	45	60	75	90
BL, FWD, PT Side	0.118	0.151	0.175	0.187	0.185	0.168	0.141
BL, FWD, STBD Side	0.118	0.094	0.071	0.059	0.071	0.102	0.134
BL, AFT, PT Side	0.163	0.141	0.123	0.109	0.102	0.101	0.107
BL, AFT, STBD Side	0.163	0.197	0.227	0.250	0.260	0.253	0.229
MD, FWD, PT Side	0.135	0.168	0.191	0.202	0.198	0.178	0.147
MD, FWD, STBD Side	0.135	0.111	0.086	0.067	0.070	0.097	0.130
MD, AFT, PT Side	0.180	0.158	0.139	0.123	0.111	0.107	0.110
MD, AFT, STBD Side	0.180	0.213	0.243	0.265	0.273	0.263	0.235

Table A5: Model 3 Results, Absolute Vertical Motion from still water (m), 0.2m significant wave height, 8 second wave period

Apepndix E – Stability Booklet (JBD, 2020b)

JOHN BUTLER DESIGN

MARITIME CONSULTANTS - NAVAL ARCHITECTS
AMSA ACCREDITED SURVEYORS

'FDD1N'

STABILITY BOOKLET

UVI No: 455344

REPORT No.:	EA-2151-007	**CLIENT:**	NOAKES GROUP
TITLE:	FDD1N - STABILITY BOOKLET		

DESIGNER APPROVAL		**STABILITY PARAMETERS**	
Signature	J W Butler	Applied Standard	NSCV, Part C, Section 6, Subsection 6A, 6B
Full Name	John Butler	Vessel Class	2D
Title / Rank	Principal Naval Architect	Number of Crew	0
Organisation	John Butler Design	Number of Passengers	0
Date	08/02/2022	Number of Special Personnel	12

ENDORSEMENTS & REVISION HISTORY

The document is cleared by:

	Name	Department/Group	Date
Prepared By	Nichola Buchanan	HULL	08/02/2022
Checked By	Jordan Banks	HULL	08/02/2022
Approved By	John Butler	HULL	08/02/2022

RECORD OF AMENDMENTS

Rev No	Date	Description	Prepared By	Checked By	Approved By
1	08/02/2022	Original Issue	Nichola Buchanan	Jordan Banks	John Butler

TABLE OF CONTENTS

1 BACKGROUND

An inclining experiment was undertaken on the floating dry dock, ‘FDD1N, to establish the lightship particulars following remediation work carried out at Harwood Marine.

2 PURPOSE

The purpose of this report is to present the results of a stability analysis performed on the vessel outlined in Section 5. The analysis detailed in this report considers both intact and flooded stability after damage has occurred to the vessel as per Ref (e) over a range of practical loading conditions.

A copy of this report is to be kept on-board at all times.

3 REFERENCES

a) NSCV Code

b) IACS (International Association of Classification Societies) Inclining Test Unified Procedure

c) John Butler Design Report EA-2151-005 – Noakes FDD Inclining Experiment Report

d) Shearforce Maritime Services Report SYD/2015/19 – Structural and Stability Assessment – Final Report Floating Dock AFD 1002, 16th November 2016

e) Floating Dock Structural Drawing 162/5/1 – 1000 Tons Floating Dock Transverse WT Bulkheads

f) Floating Dock General Arrangement 285/55 – 1000 Ton Floating Dock 1002 General Arrangement

4 ABBREVIATIONS ACRONYMS AND DEFINITIONS

Crew	NSCV, Part B: Individuals employed or engaged in any capacity on board the vessel on the business of the vessel, including the master and a pilot
EA	Engineering Assessment
FWD	Forward
GM	Metacentric Height
Heel	Variation in draft between port and starboard sides of vessel
JBD	John Butler Design
LCG	Longitudinal Centre of Gravity
NSCV	National Standard for Commercial Vessels
Passenger	NSCV, Part B: Any person other than: a) The master or a member of the crew; or b) Special personnel; or c) A child not more than 1 year old; or d) A person on board the vessel because of the master’s obligation to carry shipwrecked or distressed persons or because of circumstances the master or owner could not prevent.
STBD	Starboard
TCG	Transverse Centre of Gravity
Trim	Variation in draft between Aft Perpendicular and Fwd Perpendicular
USK	Underside of Keel
VCG	Vertical Centre of Gravity Measured Above Baseline

5 PARTICULARS OF VESSEL

Name of Vessel	FDD1N	
UVI Number	455344	
Owner of Vessel	Noakes Group	
Length Overall (hull)	57.912	metres
Length Between Perpendiculars	57.912	metres
Length Extreme	57.912	meters
Breadth Moulded	19.812	metres
Depth (to main deck at midships - CL)	2.896	metres
Depth (to main deck at midships - side)	2.810	metres
Height of Wing Deck (above BL)	10.582	metres
Lightship Draft (Amidships)	0.984	metres
Lightship Displacement	1100.6	tonnes
Speed	0	knots
Class of Service	2D	
No. of Passengers	0	
No. of Crew	0	
No. of Special Personnel	0	
Rake of Keel	0.00	metres

5.1 DERIVED LIGHTSHIP CONDITION JANUARY 2022

An inclining experiment was undertaken on the floating dock to determine its current lightship particulars. These particulars are shown in Table 5.1. The inclining experiment report is provided in Annex G. These lightship particulars are to be used as the comparison values in future lightship surveys as required by the NSCV.

FDD1N				
Item	Mass (T)	LCG (m)	TCG (m)	VCG (m)
As-Inclined Particulars 17/01/2022	1618.40	-0.008	-0.011	3.124
Personnel	-0.45	1.193	2.641	3.684
Weights Off (Solid State Survey)	-2.58	0.354	0.321	3.556
Weights Off (Inclining Equipment)	-0.12	1.427	0.166	3.234
Weights to Move*	0.00	-	-	-
Weights On	0.00	-	-	-
Tank Contents (Liquid State Survey)	-509.42	-0.093	-0.015	0.673
Fluids in Voids	-5.23	5.805	8.024	2.854
Lightship Particulars – January 2022	**1100.59**	**0.003**	**-0.050**	**4.259**
Approved Lightship Particulars – 1974	1499.00	0.000	0.000	5.585
Growth	-398.41	0.003	-0.050	-1.326
% Difference (% of LBP, Breadth moulded, VCG)	-26.58%	0.01%	-0.25%	-23.75%

*Mass not included in Displacement Calculation

Table 5.1 – Lightship Particulars Summary

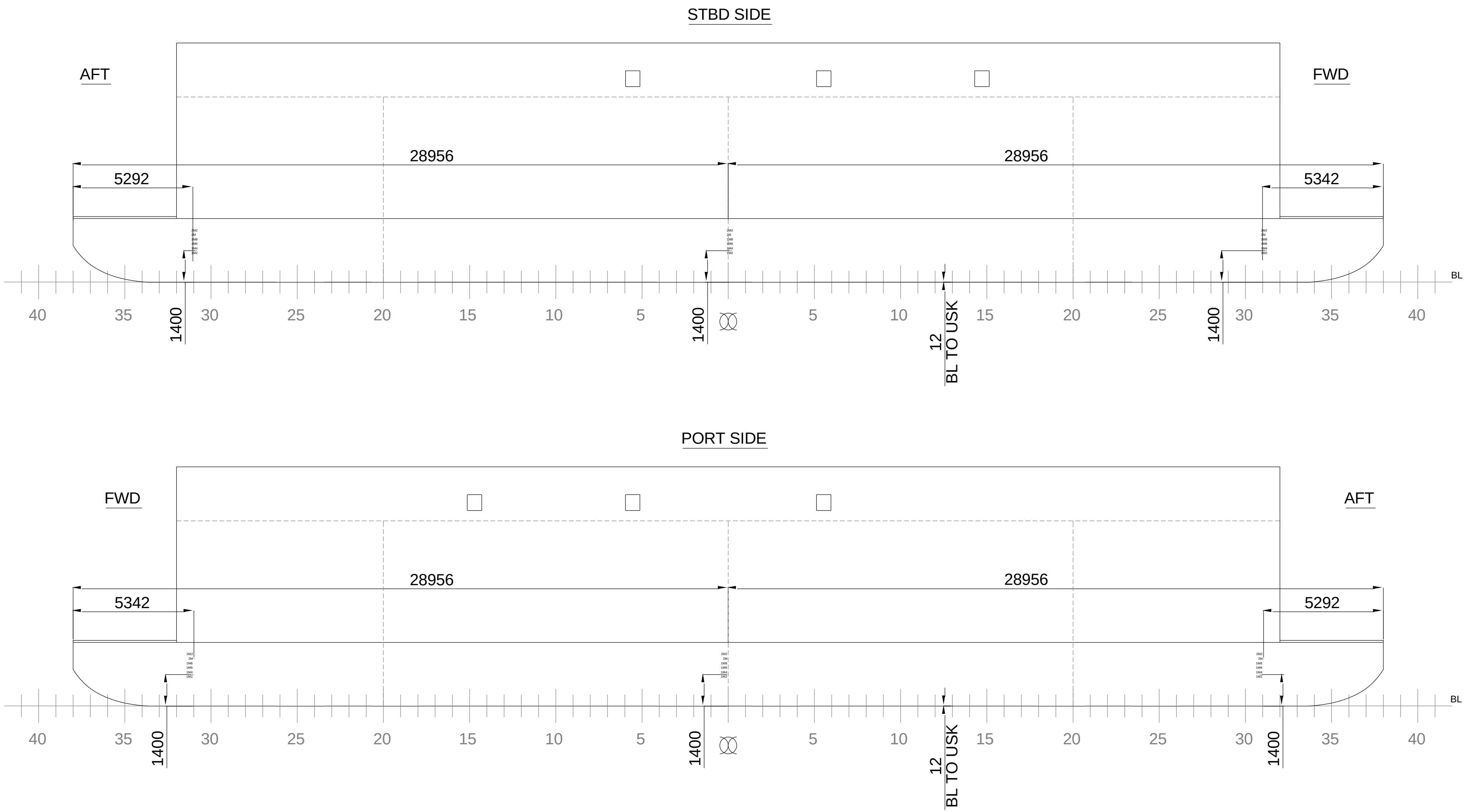


Figure 5.1 – Starboard and Port Side Draft Marks

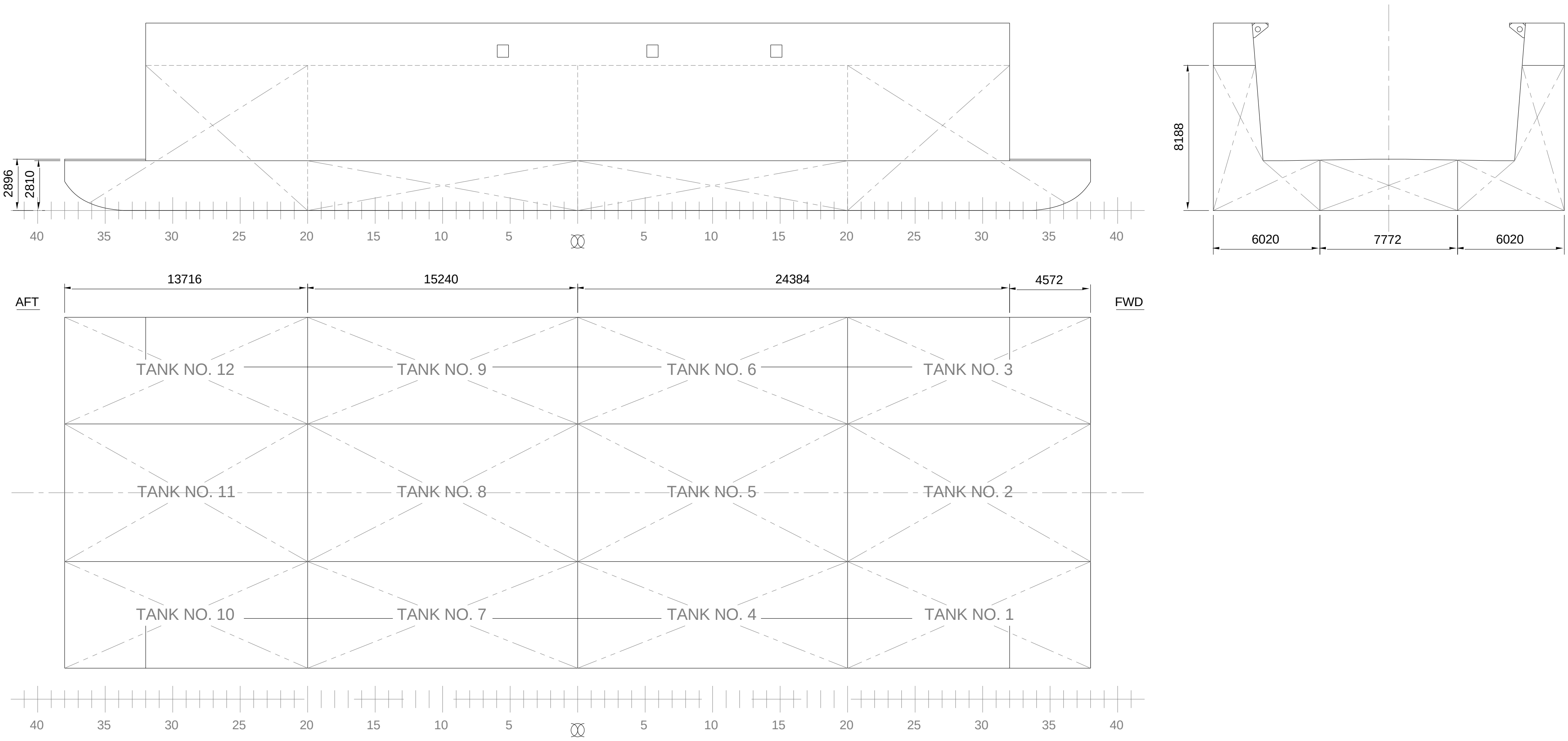


Figure 5.2 – Tank Plan

6 NOTES TO THE MASTER

6.1 STABILITY BOOK TO BE KEPT ON THE VESSEL

A complete and legible approved copy of this stability book must be kept on board the vessel at all times. If this book should be lost, or become illegible, a replacement copy must be obtained immediately.

6.2 LOAD CASES

The loading conditions shown in this book are typical for the intended service of the vessel demonstrating the general capability of the floating dock. Separate stability assessments will be required other vessels to be docked to ensure stability compliance.

Compliance with the stability criteria does not ensure immunity against capsizing, regardless of the circumstances, nor absolve the master from his or her responsibility with the safety of the vessel, crew and passengers. The master must exercise and use good seamanship, having regard to the weather and navigational zone.

The trim of the floating dock has been assumed to be level or close to level for all load cases. In practice this may be achieved by placing the LCG of the docked vessel as close to the longitudinal centre of buoyancy (midships) as possible, alternatively the trim can be corrected using the ballast tanks. Additional stability analysis will be required where ballast tanks are used to correct heel or trim to account for the additional free surface moment.

6.3 ENVIRONMENTAL CONDITIONS

The floating dock is to be able to operate in Operational Area D conditions – partially smooth waters.

The floating dock is to be loaded and operated within the limits of weight, centre of gravity and heel and trim angles, as shown in the Loading Condition Sheets. All other loading conditions are to be assessed separately. The heel (transverse inclination) and trim (longitudinal inclination) are not to exceed **5 degrees** at any time.

When a vessel is docked or being loaded/unloaded, wind speed is to be less than 25 knots. Current velocity is to be less than 2 knots with a significant wave height of 0.5 m. Continual monitoring of the wind and current speeds and wave height is to be undertaken. If the conditions are considered unsafe by the Dock Master, operations of the floating dock are to be suspended until such time that the conditions improve.

6.4 ASPECTS OF LOADING

The following matters have been considered when establishing the load cases:

6.4.1 Keel Blocks

It has been assumed that the keel blocks used for all dockings are 1.2 x 1.2 x 1.2 m concrete blocks. For the purposes of this analysis, they have been assumed to be centred around midships. The number of dock blocks for each vessel is indicative only and a separate loading condition will be required where deviations occur.

The crushing timbers have been assumed to provide an overall height above the main deck of no more than 2 m. The VCG's for all vessels have also been assumed as these will be vessel dependent. The following table provides the assumed VCG for each vessel and the resulting height above baseline.

Vessel	VCG above Vessel BL (m)	VCG above FDD1N BL (m)
STS Young Endeavour	4.438	8.818
Paluma Class Vessel	4.700*	9.100
Minehunter (Huon Class Vessel)	5.000*	9.400
1000t Harbour Tug	5.300*	9.700

*Assumed VCG

Table 6.2 – Vessel VCGs

6.4.2 Person Particulars

For the purpose of load case calculations, the following person particulars have been used in accordance with the NSCV, Part C, Section 6A, Annex A:

- The standard mass of a person shall be taken as 80 kg.
- A baggage allowance of 15 kg per person shall be taken for overnight voyages.
- The vertical centre of gravity of a standing person shall be taken as 1.0 metres above the deck.
- The vertical centre of gravity of a seated person shall be 0.30 metres above the seat.

6.4.3 Ballast Tank Usage

When the floating dock is being re-floated, the ballast tanks are to be emptied as much as practically possible to achieve a level of 10% or less.

6.5 EXCESS TRIM

Some conditions of loading can give rise to excessive trim which can lead to difficulties in handling and poor seakeeping. The vessel trim should be kept as level as practically possible for all loading conditions.

- Excess trim by the stern is detrimental to stability.
- Excess trim by the bow results in poor handling and sea keeping.

6.6 REDUCTION OF STABILITY DUE TO A STEADY ANGLE OF HEEL

A steady angle of heel (a list), however caused, reduces the stability of the vessel to below that calculated for that load case. Thus, it is essential to strive to keep the vessel upright at all times.

6.7 HYDROSTATIC DATA

The hydrostatic particulars for the Load Cases presented in this report have been directly calculated by Maxsurf.

If the trim of the vessel varies from the trim as calculated for that Load Case, the hydrostatic particulars will vary from those presented in this report and the stability of the vessel will be overestimated. When operating the vessel, it is essential to keep the vessel as close to her design level trim as possible.

6.8 WATERTIGHT INTEGRITY AND ANGLE OF DOWN FLOODING

The KN values for the vessel have been calculated assuming that the vessel is entirely watertight up to the main deck.

7 STABILITY ASSESSMENT METHODOLOGY

7.1 PREPARING STABILITY MODEL

The hull model was created in Rhinoceros and imported into Maxsurf Stability Advanced v18.02 with 200 stations on high precision.

7.2 VESSEL DATUM

The following convention was used for the stability model:

Longitudinal Datum:	Midships
Transverse Datum:	Centreline (+ve STBD, -ve Port)
Vertical Datum:	Baseline

Trim is positive by the stern.
Heel is positive to starboard.

7.3 ASSUMPTIONS

The vessel is operating in sea water with a density of 1.025 t/m^3. A change in density will affect the displacement of the vessel and may affect its overall stability. When calculating any loading conditions, a correction should be made to account for any variations in density.

7.4 KEY POINTS

Key points are used to determine the freeboards for the immersion of the deck edge and the downflooding points in each loading condition. The following key points have been used in this analysis.

Key Point	Longitudinal Position (m)	Transverse Position (m)	Vertical Position (m)
Deck Edge Forward Port	28.956	-9.906	2.810
Deck Edge Forward Stbd	28.956	9.906	2.810
Deck Edge Aft Port	-28.956	-9.906	2.810
Deck Edge Aft Stbd	-28.956	9.906	2.810
Bottom Edge Forward Port	25.654	-9.906	0.000
Bottom Edge Forward Stbd	25.654	9.906	0.000
Bottom Edge Aft Port	-25.654	-9.906	0.000
Bottom Edge Aft Stbd	-25.654	9.906	0.000
WW Deck Edge Forward Port	24.384	-9.906	10.582
WW Deck Edge Forward Stbd	24.384	9.906	10.582
WW Deck Edge AftPort	-24.384	-9.906	10.582
WW Deck Edge AftStbd	-24.384	9.906	10.582

Table 7.1 – Floating Dock Key Points

7.5 COMPARTMENT SPECIFICATION

The floating dock hull model was created in Rhinoceros using the original drawings, Refs (e) and (f). This was then imported into Maxsurf Stability Advanced v18.02 with 200 stations using the high precision. The ballast tanks were defined as per Refs (e) and (f).

Tank Name	Permeability (%)	Aft (m)	Fore (m)	Port (m)	Stbd (m)	Top (m)	Bottom (m)
Tank No. 1	90.0	15.240	28.955	3.886	9.906	8.188	0.000
Tank No. 2	90.0	15.240	28.955	-3.886	3.886	2.896	0.000
Tank No. 3	90.0	15.240	28.955	-9.906	-3.886	8.188	0.000
Tank No. 4	90.0	0.000	15.240	3.886	9.906	2.845	0.000
Tank No. 5	90.0	0.000	15.240	-3.886	3.886	2.896	0.000
Tank No. 6	90.0	0.000	15.240	-9.906	-3.886	2.845	0.000
Tank No. 7	90.0	-15.240	0.000	3.886	9.906	2.845	0.000
Tank No. 8	90.0	-15.240	0.000	-3.886	3.886	2.896	0.000
Tank No. 9	90.0	-15.240	0.000	-9.906	-3.886	2.845	0.000
Tank No. 10	90.0	-28.955	-15.240	3.886	9.906	8.188	0.000
Tank No. 11	90.0	-28.955	-15.240	-3.886	3.886	2.896	0.000
Tank No. 12	90.0	-28.955	-15.240	-9.906	-3.886	8.188	0.000

Table 7.2 – Tank Extents

7.6 SIMULATION AND ANALYSIS OF LOAD CASES

The load cases analysed in this booklet were derived using the updated lightship displacement. These loading cases are as follows:

Number	Operational Area	Load Case	Type
1	-	Lightship	Intact
2	2D	Docking Phase 1 - Fully Ballasted	
3	2D	Docking Phase 2: STS Young Endeavour – Half Mass on Blocks	
4	2D	Docking Phase 3: STS Young Endeavour – Full Mass on Blocks, Water Level at vessel keel	
5	2D	Docking Phase 4: STS Young Endeavour – Full Mass on Blocks, Water Level at deck level	
6	2D	Docking Phase 5: STS Young Endeavour – Full Mass on Blocks, Water Level at floating level (unballasted)	
7	2D	Docking Phase 2: Paluma – Half Mass on Blocks	
8	2D	Docking Phase 3: Paluma – Full Mass on Blocks, Water Level at vessel keel	
9	2D	Docking Phase 4: Paluma – Full Mass on Blocks, Water Level at deck level	
10	2D	Docking Phase 5: Paluma – Full Mass on Blocks, Water Level at floating level (unballasted)	
11	2D	Docking Phase 2: Minehunter – Half Mass on Blocks	
12	2D	Docking Phase 3: Minehunter – Full Mass on Blocks, Water Level at vessel keel	
13	2D	Docking Phase 4: Minehunter – Full Mass on Blocks, Water Level at deck level	
14	2D	Docking Phase 5: Minehunter – Full Mass on Blocks, Water Level at floating level (unballasted)	
15	2D	Docking Phase 2: 1000T Tug – Half Mass on Blocks	
16	2D	Docking Phase 3: 1000T Tug– Full Mass on Blocks, Water Level at vessel keel	
17	2D	Docking Phase 4: 1000T Tug – Full Mass on Blocks, Water Level at deck level	
18	2D	Docking Phase 5: 1000T Tug – Full Mass on Blocks, Water Level at floating level (unballasted)	

Table 7.3 – Loading Conditions

The lightship particulars, determined from the inclining experiment, Ref (c), presented in Annex F, were entered into each load case.

The weights and centres of gravity for items that are considered deadweight were then determined and added as required to load cases.

The vessel was then assessed for each of the load cases for the following:

Equilibrium Condition – To determine the angle of heel, angle of trim and the remaining freeboard.

Large Angle Stability – To determine the GZ parameters, angles of heel when wind, turning and passenger heel arms are applied and angles of heel at which deck edge immersion occurs.

These results were then compared with the stability criteria outlined in Section 8 to determine the stability compliance of the vessel arrangement in each condition.

8 INTACT STABILITY CRITERIA

The floating dock must comply with the relevant intact stability criteria pertaining to a domestic commercial vessel, Ref (a).

8.1 INTACT STABILITY CRITERIA – NSCV PART C, SECTION 6A

The vessel is classed as a non-passenger dumb barge to be operated in partially-smooth water (Class 2D). The following details the applicable intact stability criteria in accordance with the NSCV. The applicable criteria for this vessel are highlighted grey:

Chapter 3.8 Criteria for Maximum Allowable Angle of Heel due to Heeling Moments

Table 4 – Maximum allowable angles of static heel

Heel consequence Level	Allowable maximum angle of static heel for heeling moment(s)		Conditions of application
	Single θ_s degrees	Combined θ_c(A) degrees	
1. High	5	5	No specified conditions of application – applicable to any vessel that is unsuited to the application of large angles of heel.
2. Moderate	10	15	θ_s or θ_c (if combined lever criteria are applied) may exceed 5 degrees where – 1. If the vessel is fitted with a slewing crane that is subject to the lifting criteria, the crane is capable of safe operation at angles of heel up to at least θ_s; and 2. If the vessel is carrying unsecured deck cargo, the deck cargo shall either – a. Comprise vehicles having rubber tyres; or b. Have a maximum potential moment from cargo shifting that does not exceed 20 percent of the greatest value of M_P, M_W or M_T.
3. Low	14	18	θ_s may exceed 10 degrees or θ_c (if combined lever criteria are applied) may exceed 15 degrees where – 1. All cargo including deck cargo is secured against shifting; 2. Seating is provided for all persons; 3. Furniture is fixed when in use and/or when stowed; 4. Sufficient grab rails are provided in spaces that normally contain persons; and 5. Decks and deck surfaces are arranged to reduce slipping hazards.

Chapter 5C - Alternative Comprehensive Criteria of general application to vessels in operational areas D and E.

C.5.6.2

A vessel that complies with the criteria listed in Table 12 over the range of normal operating conditions shall be deemed to satisfy the Chapter 5C Criteria.

Table 12 – Chapter 5C Criteria

Criterion No.	Limits to Application	Description
5C.1	All vessels	The angle of heel θ_h shall not exceed θ_s degrees (see Table 4) when any of the individual heeling moments due to person crowding, wind or turning is applied.
5C.2	Vessels carrying 50 or more passengers	The angle of heel θ_h shall not exceed θ_c degrees (see Table 4) when the combined effect of the two greatest heeling moments resulting from person crowding, the effect of wind or the effect of turn are applied simultaneously.
5C.3	All vessels	The righting lever G_FZ at the intersection of the *righting lever curve* and the heeling lever curve due to the effects of person crowding, wind heeling or turning, shall not exceed 60 per cent of the maximum righting lever G_FZ_{max}.
5C.4	Vessels having either of the following: The angle of maximum righting lever θ_{max} < 25 degrees, or The maximum allowable angle θ_s > 10 degrees and the angle of heel θ_h from a single heeling moment > 10 degrees (see criterion 5C.1)	The area under the curve of righting levers above the largest single heeling lever curve up to 40° (or the angle of flooding θ_f if this angle is less than 40°), shall not be less than $A_{RS} = 1.03 + 0.2\,A_{40/\theta f}$ Where A_{RS} = minimum residual area under the curve of righting above the single heeling lever curve up to 40° (or the angle of flooding θ_f if this angle is less than 40°), in metre-degrees. $A_{40/\theta f}$ = total area under curve of righting levers up to 40° (or the angle of flooding θ_f if this angle is less than 40°), in metre-degrees.
5C.5	Vessels carrying 50 or more passengers	The area under the *righting lever curve* above the heeling lever arising from the combined effects of the largest two wind heel, person crowding or turning lever curve (A_{RC}), taken up to the angle of flooding (θ_f) or the second intercept with the *righting lever curve* (whichever is less), shall be not less than 25 per cent of the total area (A_T) under the *righting lever curve* up to the angle of flooding θ_f or the second intercept whichever is less (see Figure 9).

9 DAMAGE STABILITY CRITERIA

The floating dock must comply with the relevant damage stability criteria pertaining to a domestic commercial vessel, Ref (a).

9.1 DAMAGE STABILITY CRITERIA – NSCV PART C, SECTION 6B

With 12 Special Personnel and operating in Sydney Harbour (Area D – partially smooth waters), the floating dock has a Flooding Risk Category of I. As per Table 9 of NSCV, Part C Section 6B, Arrangement 1 has been chosen as the deemed-to-satisfy solution the vessel. This requires that the vessel has a minimum of two (2) watertight bulkheads. The vessel is deemed to be compliant with this requirement as it has three (3) watertight bulkheads.

10 APPLICABLE HEELING ARMS

10.1 WIND AREA AND HEELING ARM

The floating dock hull has been modelled to the top of the Wing Wall Deck. All buoyant volumes have been included in the model. However, appendages have not been included. The handrails and cabins on the Wing Wall Deck have not been modelled and is considered additional windage area. As the floating dock is capable of docking a variety of vessels with differing heights, the amount of additional windage area required can change. Therefore, conservatively, a height above the dock blocks of 15 m was chosen and the additional windage area was assumed to incorporate the entire length of the wing walls, see Figure 10.1.

The software will automatically calculate the windage area of the hull using the calculated draft.

$$M_w = \frac{P_w A_w h}{1000g} \cos\theta$$

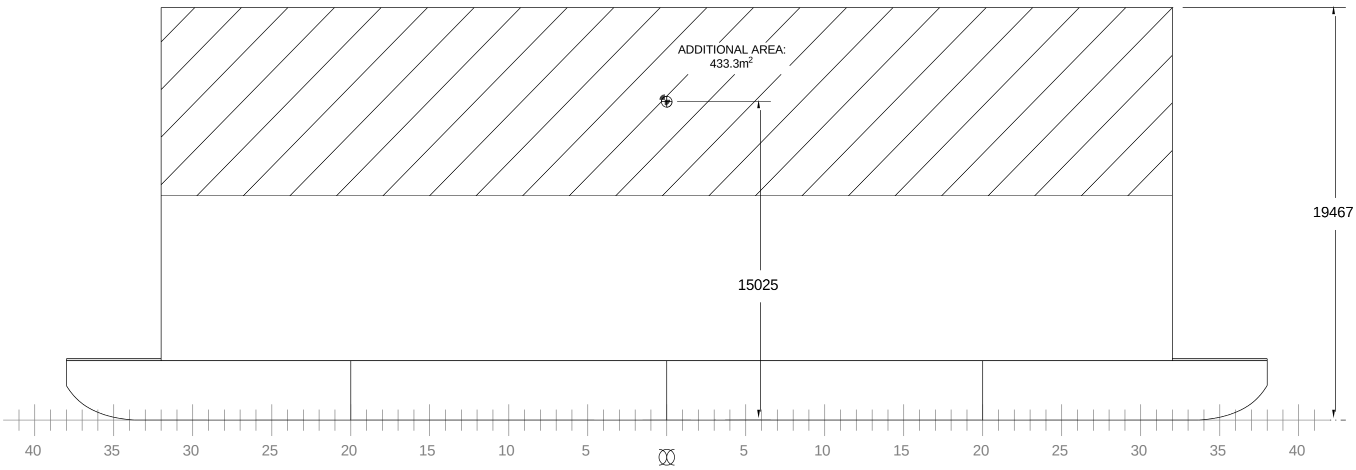


Figure 10.1 – Wind Area

Additional Windage Area = 433.3 m^2
Heeling Lever = 15.025 metres (abv BL)

10.2 PASSENGER CROWDING AND HEELING ARM

All Passengers and Special Personnel are to be included in the Passenger Heeling Arm.

The passenger heeling moment has been calculated in accordance with NSCV Part C, Section 6A, Annex A:

$$M_p = \frac{Nwb}{1000} \cos\theta$$

Each person is assumed to weigh 80 kg and cover an area of 625mm x 400mm.

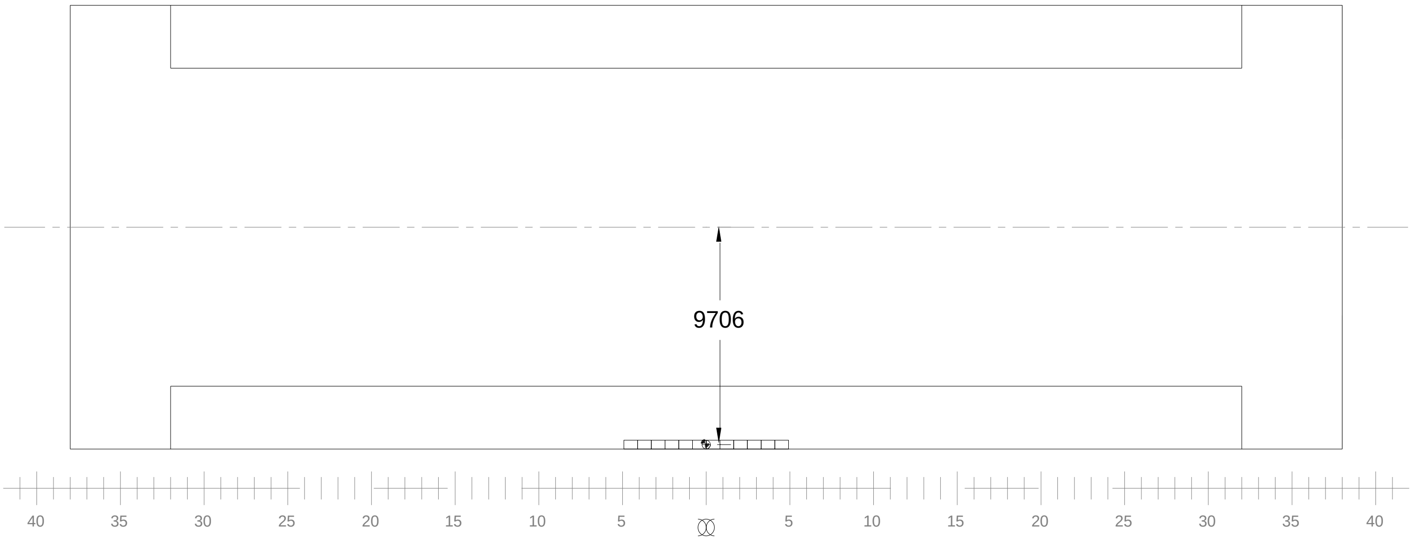


Figure 10.2 – Passengers Crowded on Wing Wall Deck

With 12 persons on the Wing Wall Deck the resultant heeling lever is 9.706m.

10.3 TURNING HEELING ARM

The vessel has no propulsion system and will be towed when required to be moved. No turning heeling moment has been applied in this analysis. A separate towing analysis will be required to be undertaken prior to any towing operations.

11 INTACT STABILITY RESULTS SUMMARY

Cond. No.	Displ't (Tonnes)	Draft @ midships (m)	Heel (°) (+ve stbd)	Trim Angle (°) (+ve stern)	5C Criteria: 5C.1 Max Allowable Heel Angle (deg)			5C.3 Max Allowable Ratio of GZ at phi1 and phi2 (%)			5C.4 Min Allowable area A_{RS} (m.deg)			Pass / Fail?
					Required	Pax Heel	Wind Heel	Required	Pax Heel	Wind Heel	Required	Pax Heel	Wind Heel	
1	1100.6	0.984	-0.1	0.0	*5.0*	0.1	0.6	*60.0*	0.0	5.8	*34.478*	167.242	156.543	PASS
2	4733.2	8.459	-0.1	0.0	*5.0*	0.2	0.8	*60.0*	0.2	4.5	*6.742*	28.487	27.064	PASS
3	4205.8	6.294	-0.2	0.0	*5.0*	0.3	1.3	*60.0*	0.2	4.3	*7.952*	34.528	32.617	PASS
4	3712.1	4.402	-0.2	0.0	*5.0*	0.3	1.5	*60.0*	0.1	3.1	*11.349*	51.502	49.036	PASS
5	3299.1	2.897	-0.2	0.0	*5.0*	0.3	1.4	*60.0*	0.1	3.1	*14.375*	66.620	63.573	PASS
6	1816.8	1.599	-0.1	0.0	*5.0*	0.1	0.7	*60.0*	0.2	5.3	*21.696*	103.139	97.081	PASS
7	4067.0	5.751	-0.2	0.0	*5.0*	0.3	1.4	*60.0*	0.2	3.8	*8.845*	38.991	36.935	PASS
8	3712.1	4.402	-0.2	0.0	*5.0*	0.3	1.6	*60.0*	0.1	3.3	*10.844*	48.977	46.515	PASS
9	3299.1	2.897	-0.3	0.0	*5.0*	0.3	1.4	*60.0*	0.1	3.3	*13.781*	63.650	60.607	PASS
10	1888.3	1.660	-0.1	0.0	*5.0*	0.1	0.8	*60.0*	0.2	5.3	*20.479*	97.065	91.259	PASS
11	4104.9	5.898	-0.2	0.0	*5.0*	0.3	1.5	*60.0*	0.2	4.5	*7.607*	32.804	30.794	PASS
12	3711.9	4.401	-0.3	0.0	*5.0*	0.5	2.3	*60.0*	0.2	4.2	*8.448*	37.000	34.566	PASS
13	3298.9	2.897	-0.4	0.0	*5.0*	0.4	1.9	*60.0*	0.1	4.2	*10.921*	49.353	46.333	PASS
14	2385.6	2.083	-0.1	0.0	*5.0*	0.2	0.9	*60.0*	0.2	5.8	*14.917*	69.295	64.824	PASS

Cond. No.	Displ't (Tonnes)	Draft @ midships (m)	Heel (°) (+ve stbd)	Trim Angle (°) (+ve stern)	5C Criteria									
					5C.1 Max Allowable Heel Angle (deg)			5C.3 Max Allowable Ratio of GZ at phi1 and phi2 (%)			5C.4 Min Allowable area A_{RS} (m.deg)			Pass / Fail?
					Required	Pax Heel	Wind Heel	Required	Pax Heel	Wind Heel	Required	Pax Heel	Wind Heel	
15	4232.9	6.401	-0.2	0.0	*5.0*	0.4	1.6	*60.0*	0.2	5.6	*6.123*	25.382	23.508	PASS
16	3712.2	4.402	-0.4	0.0	*5.0*	0.7	3.2	*60.0*	0.2	5.1	*6.848*	28.999	26.603	PASS
17	3299.1	2.898	-0.5	0.0	*5.0*	0.5	2.3	*60.0*	0.2	5.2	*9.059*	40.043	37.050	PASS
18	2569.6	2.240	-0.1	0.0	*5.0*	0.2	0.9	*60.0*	0.2	6.7	*12.034*	54.884	50.778	PASS

12 CONCLUSION

All intact operating loading conditions satisfy the required stability criteria and are considered acceptable.

The vessel is deemed to be compliant with NSCV Part C, Section 6B damage stability requirements as it has three (3) watertight bulkheads through the length of the vessel.

The loading conditions presented in this book are indicative for the intended service of the floating dock. Separate calculations are necessary for all other conditions of loading.

ANNEX A
INTACT STABILITY RESULTS

A-1 CONDITION No.1 – LIGHTSHIP CONDITION

A-1.1 LIGHTSHIP CONDITION WITH 0 SPECIAL PERSONNEL AND 0% TANKS

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	0	0.000	0.000	0.000	3.896	0.000
Equipment	0	0.000	0.000	0.000	3.896	0.000
Vessel to be Docked	0	0.000	0.000	0.000	0.000	0.000
Dock Blocks - Keel	0	0.000	0.000	0.000	0.000	0.000
Dock Block - Side	0	0.000	0.000	0.000	0.000	0.000
Crushing Timbers	0	0.000	0.000	0.000	0.000	0.000
Tank No. 1	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 2	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 3	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 4	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 5	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 6	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 7	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 8	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 9	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 10	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 11	0%	0.000	0.000	0.000	0.000	0.000
Tank No. 12	0%	0.000	0.000	0.000	0.000	0.000
Total Loadcase		**1100.590**	**0.003**	**-0.050**	**4.259**	**0.000**
FS correction					**0.000**	
VCG fluid					**4.259**	

A-1.2 EQUILIBRIUM CONDITION

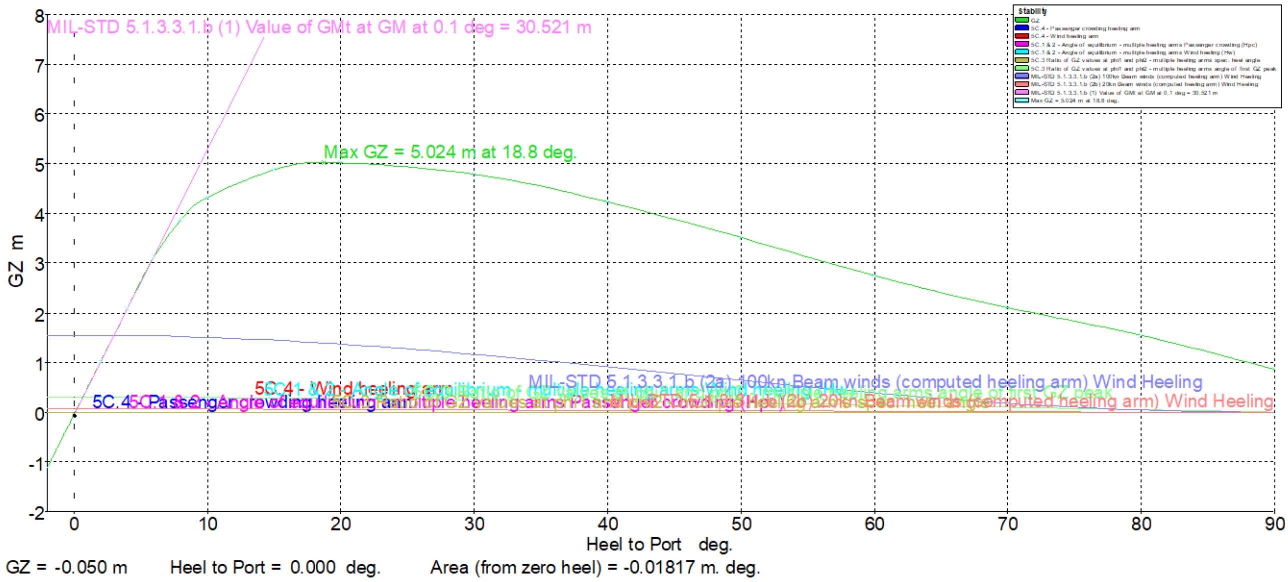
Draft Amidships m	0.984
Displacement t	1101
Heel deg	-0.1
Draft at FP m	0.984
Draft at AP m	0.984
Draft at LCF m	0.984
Trim (+ve by stern) m	0.000
WL Length m	56.896
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	0.499
KG fluid m	4.259
GMt corrected m	30.540
KMt m	34.799
Immersion (TPc) tonne/cm	11.543
MTc tonne.m	53.000
Max deck inclination deg	0.095
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
Margin Line	Immersion Point	1.733	11.1
Deck Edge Forward Port	Immersion Point	1.809	11.7
Deck Edge Forward Stbd	Immersion Point	1.842	Not immersed in positive range
Deck Edge Aft Port	Immersion Point	1.809	11.7
Deck Edge Aft Stbd	Immersion Point	1.842	Not immersed in positive range
WW Deck Edge Forward Port	Immersion Point	9.581	69.9
WW Deck Edge Forward Stbd	Immersion Point	9.614	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	9.581	69.9
WW Deck Edge AftStbd	Immersion Point	9.614	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Bottom Edge Forward Port	Emersion Point	1.001	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	0.968	5.6
Bottom Edge Aft Port	Emersion Point	1.001	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	0.968	5.6

A-1.3 STABILITY RESULTS



Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.050	1.015	2.080	3.130	3.865	4.322	4.876	5.017	4.788	4.230	3.514	2.749
Displacement (t)	1101	1101	1101	1101	1101	1101	1101	1101	1101	1101	1101	1101

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	0.499	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	919.447	
	Total windage area centroid (from zero point)		m	10.065	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	0			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.293	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.1	**Pass**
	Wind heeling (Hw)	5.0	deg	0.6	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.00	**Pass**
	Wind heeling (Hw)	60.00	%	5.84	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	34.478	m.deg	167.242	**Pass**
	Wind heeling (Hw)	34.478	m.deg	156.543	**Pass**

A-2 CONDITION No.2 – DOCKING PHASE 1: FULLY BALLASTED

A-2.1 DOCKING CONDITION WITH 12 SPECIAL PERSONNEL AND 100% TANKS

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass (t)	Long. Arm (m)	Trans. Arm (m)	Vert. Arm (m)	Total FSM (t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Vessel to be Docked	0	0.000	0.000	0.000	9.400	0.000
Dock Blocks - Keel	21	88.200	0.000	0.000	3.722	0.000
Dock Block - Side	24	100.800	0.000	0.000	3.943	0.000
Crushing Timbers	54	18.900	0.000	0.000	5.407	0.000
Tank No. 1	100%	324.292	21.108	7.518	2.901	0.000
Tank No. 2	100%	271.707	21.849	0.000	1.479	0.000
Tank No. 3	100%	324.292	21.108	-7.518	2.901	0.000
Tank No. 4	100%	238.332	7.620	6.891	1.408	0.000
Tank No. 5	100%	314.311	7.620	0.000	1.438	0.000
Tank No. 6	100%	237.943	7.632	-6.891	1.408	0.000
Tank No. 7	100%	237.956	-7.630	6.891	1.408	0.000
Tank No. 8	100%	314.311	-7.620	0.000	1.438	0.000
Tank No. 9	100%	238.332	-7.620	-6.891	1.408	0.000
Tank No. 10	100%	324.292	-21.108	7.518	2.901	0.000
Tank No. 11	100%	271.707	-21.849	0.000	1.479	0.000
Tank No. 12	100%	324.292	-21.108	-7.518	2.901	0.000
Total Loadcase		**4733.218**	**0.001**	**-0.012**	**2.608**	**0.000**
FS correction					**0.000**	
VCG fluid					**2.608**	

A-2.2 EQUILIBRIUM CONDITION

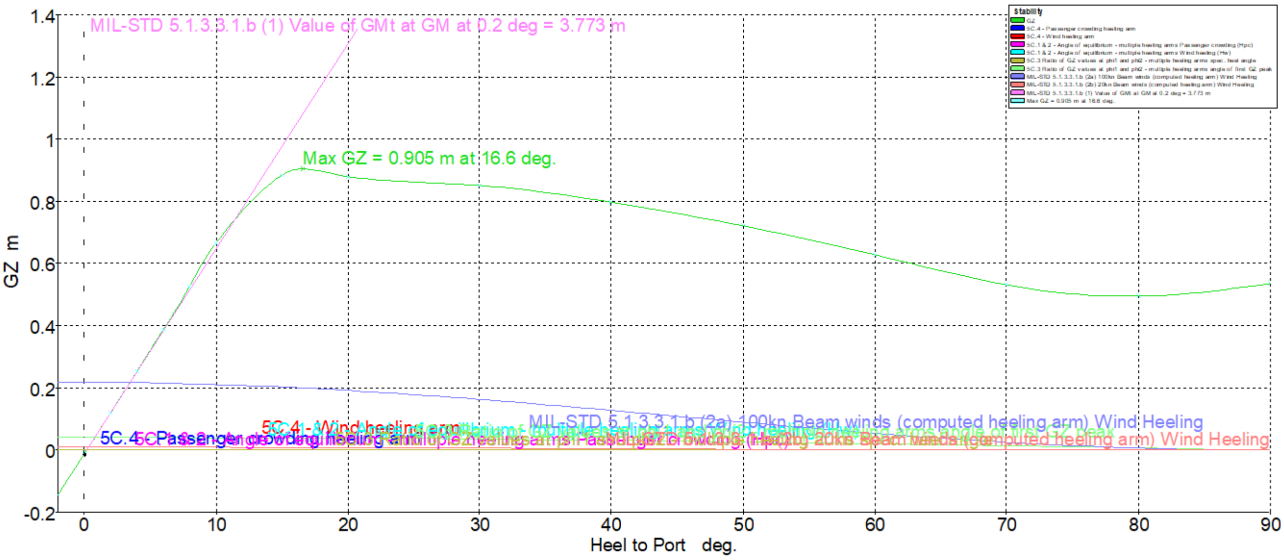
Draft Amidships m	8.459
Displacement t	4733
Heel deg	-0.1
Draft at FP m	8.459
Draft at AP m	8.459
Draft at LCF m	8.459
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	-0.002

LCF from zero pt. (+ve fwd) m	-0.152
KB m	2.705
KG fluid m	2.608
GMt corrected m	3.772
KMt m	6.380
Immersion (TPc) tonne/cm	2.263
MTc tonne.m	8.048
Max deck inclination deg	0.134
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	2.100	11.3
WW Deck Edge Forward Stbd	Immersion Point	2.146	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	2.100	11.4
WW Deck Edge AftStbd	Immersion Point	2.146	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	5.748	NA
Deck Edge Forward Port	Emersion Point	5.672	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	5.626	72.8
Deck Edge Aft Port	Emersion Point	5.672	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	5.626	72.3
Bottom Edge Forward Port	Emersion Point	8.482	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	8.436	80.6
Bottom Edge Aft Port	Emersion Point	8.482	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	8.436	80.4

A-2.3 STABILITY RESULTS



GZ = -0.012 m   Heel to Port = 0.000 deg.   Area (from zero heel) = -0.004224 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.012	0.120	0.253	0.388	0.526	0.666	0.885	0.880	0.851	0.797	0.721	0.628
Displacement (t)	4733	4733	4733	4733	4733	4733	4733	4733	4733	4733	4733	4733

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	4.087	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	537.054	
	Total windage area centroid (from zero point)		m	13.961	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.002	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.2	**Pass**
	Wind heeling (Hw)	5.0	deg	0.8	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.22	**Pass**
	Wind heeling (Hw)	60.00	%	4.54	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	6.742	m.deg	28.487	**Pass**
	Wind heeling (Hw)	6.742	m.deg	27.064	**Pass**

A-3 CONDITION No.3 – DOCKING PHASE 2: STS YOUNG ENDEAVOUR

A-3.1 DOCKING CONDITION WITH HALF SHIP MASS ON BLOCKS, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass (t)	Long. Arm (m)	Trans. Arm (m)	Vert. Arm (m)	Total FSM (t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
STS Young Endeavour	0.5	107.128	0.000	0.000	8.818	0.000
Dock Blocks - Keel	19	79.800	0.000	0.000	3.722	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	28	9.800	0.000	0.000	5.407	0.000
Tank No. 1	82.95%	269.000	21.367	7.284	2.091	255.533
Tank No. 2	82.95%	225.381	21.798	0.000	1.240	549.967
Tank No. 3	82.95%	269.000	21.367	-7.284	2.091	255.533
Tank No. 4	82.95%	197.696	7.620	6.896	1.168	283.999
Tank No. 5	82.95%	260.721	7.620	0.000	1.193	611.119
Tank No. 6	82.95%	197.374	7.632	-6.896	1.168	283.993
Tank No. 7	82.95%	197.385	-7.630	6.896	1.168	283.993
Tank No. 8	82.95%	260.721	-7.620	0.000	1.193	611.119
Tank No. 9	82.95%	197.696	-7.620	-6.896	1.168	283.999
Tank No. 10	82.95%	269.000	-21.367	7.284	2.091	255.533
Tank No. 11	82.95%	225.381	-21.798	0.000	1.240	549.967
Tank No. 12	82.95%	269.000	-21.367	-7.284	2.091	255.533
Total Loadcase		**4205.834**	**0.001**	**-0.013**	**2.525**	**4480.290**
FS correction					**1.065**	
VCG fluid					**3.590**	

A-3.2 EQUILIBRIUM CONDITION

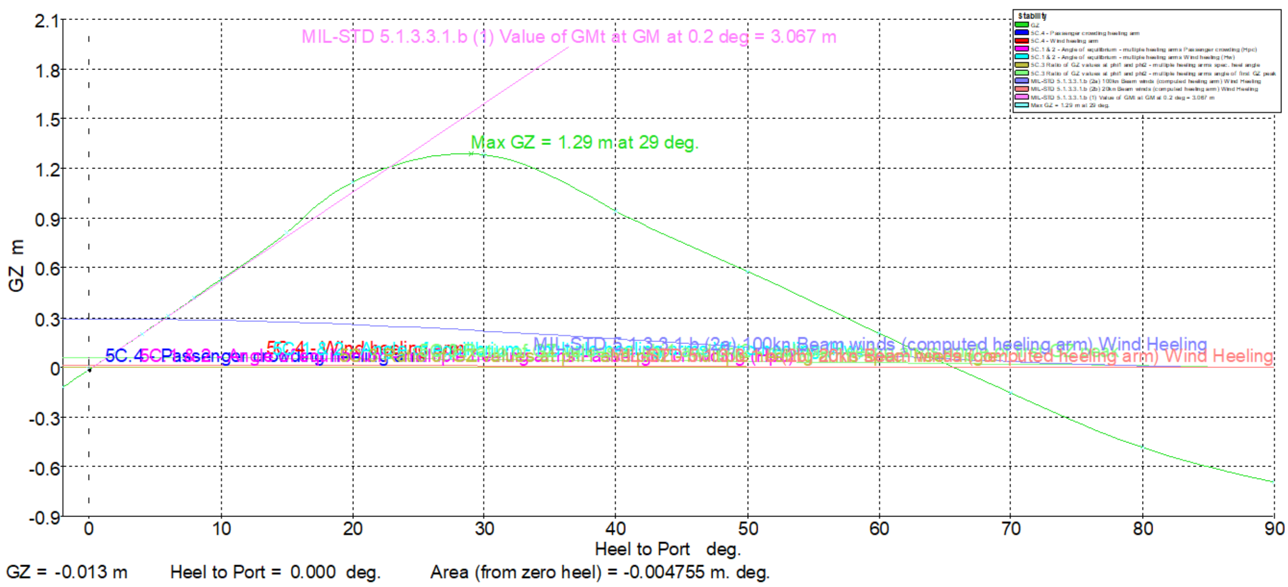
Draft Amidships m	6.294
Displacement t	4206
Heel deg	-0.2
Draft at FP m	6.294
Draft at AP m	6.294
Draft at LCF m	6.294
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	2.121
KG fluid m	3.590
GMt corrected m	3.066
KMt m	6.656
Immersion (TPc) tonne/cm	2.536
MTc tonne.m	7.667
Max deck inclination deg	0.187
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	4.255	21.7
WW Deck Edge Forward Stbd	Immersion Point	4.320	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	4.255	21.9
WW Deck Edge AftStbd	Immersion Point	4.320	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	3.593	NA
Deck Edge Forward Port	Emersion Point	3.517	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	3.452	20.4
Deck Edge Aft Port	Emersion Point	3.517	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	3.452	20.0
Bottom Edge Forward Port	Emersion Point	6.327	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	6.262	63.4
Bottom Edge Aft Port	Emersion Point	6.327	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	6.262	62.9

A-3.3 STABILITY RESULTS



Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.013	0.094	0.201	0.310	0.419	0.530	0.814	1.116	1.284	0.944	0.579	0.205
Displacement (t)	4205	4205	4205	4205	4205	4205	4205	4205	4205	4205	4205	4205

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	3.037	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	642.930	
	Total windage area centroid (from zero point)		m	12.876	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.002	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.3	**Pass**
	Wind heeling (Hw)	5.0	deg	1.3	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.17	**Pass**
	Wind heeling (Hw)	60.00	%	4.28	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	7.952	m.deg	34.528	**Pass**
	Wind heeling (Hw)	7.952	m.deg	32.617	**Pass**

A-4 CONDITION No.4 – DOCKING PHASE 3: STS YOUNG ENDEAVOUR

A-4.1 DOCKING CONDITION WITH WATER LEVEL AT SHIP KEEL, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass (t)	Long. Arm (m)	Trans. Arm (m)	Vert. Arm (m)	Total FSM (t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
STS Young Endeavour	1	214.256	0.000	0.000	8.818	0.000
Dock Blocks - Keel	19	79.800	0.000	0.000	3.722	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	28	9.800	0.000	0.000	5.407	0.000
Tank No. 1	65.39%	212.055	21.776	6.941	1.494	255.533
Tank No. 2	65.39%	177.669	21.718	0.000	0.992	549.967
Tank No. 3	65.39%	212.055	21.776	-6.941	1.494	255.533
Tank No. 4	65.39%	155.845	7.620	6.896	0.921	283.999
Tank No. 5	65.39%	205.528	7.620	0.000	0.940	611.119
Tank No. 6	65.39%	155.591	7.632	-6.896	0.921	283.993
Tank No. 7	65.39%	155.600	-7.630	6.896	0.921	283.993
Tank No. 8	65.39%	205.528	-7.620	0.000	0.940	611.119
Tank No. 9	65.39%	155.845	-7.620	-6.896	0.921	283.999
Tank No. 10	65.39%	212.055	-21.776	6.941	1.494	255.533
Tank No. 11	65.39%	177.669	-21.718	0.000	0.992	549.967
Tank No. 12	65.39%	212.055	-21.776	-6.941	1.494	255.533
Total Loadcase		**3712.100**	**0.001**	**-0.015**	**2.637**	**4480.290**
FS correction					**1.207**	
VCG fluid					**3.844**	

A-4.2 EQUILIBRIUM CONDITION

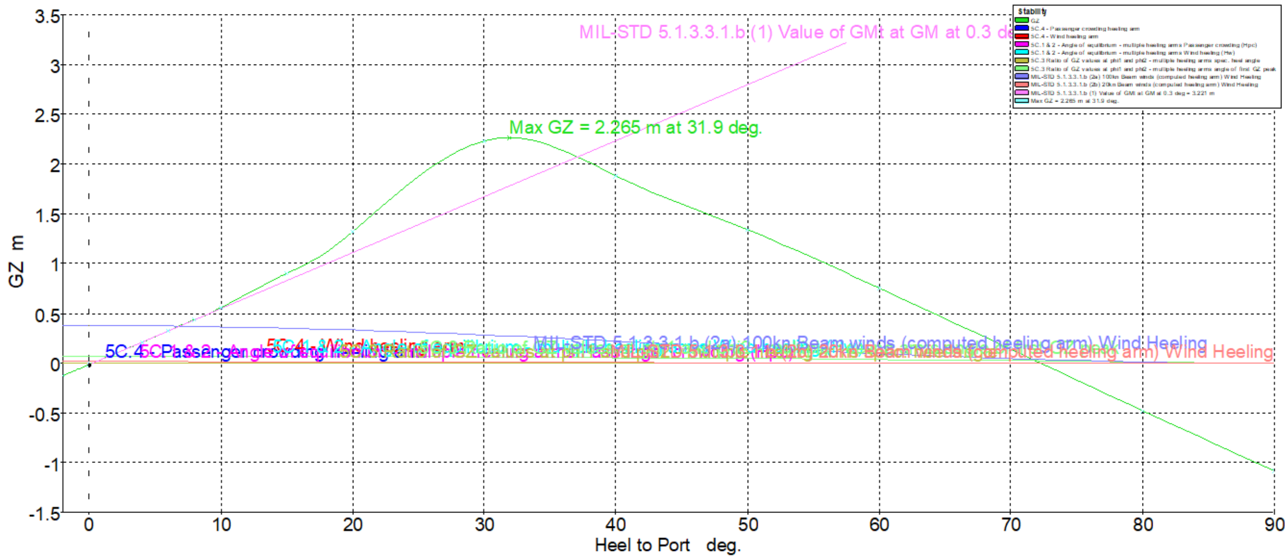
Draft Amidships m	4.402
Displacement t	3712
Heel deg	-0.2
Draft at FP m	4.402
Draft at AP m	4.402
Draft at LCF m	4.402
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.694
KG fluid m	3.844
GMt corrected m	3.220
KMt m	7.064
Immersion (TPc) tonne/cm	2.695
MTc tonne.m	7.958
Max deck inclination deg	0.227
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	6.141	28.2
WW Deck Edge Forward Stbd	Immersion Point	6.219	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	6.141	28.3
WW Deck Edge AftStbd	Immersion Point	6.219	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	1.707	NA
Deck Edge Forward Port	Emersion Point	1.631	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	1.553	9.3
Deck Edge Aft Port	Emersion Point	1.631	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	1.553	9.3
Bottom Edge Forward Port	Emersion Point	4.441	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	4.363	27.9
Bottom Edge Aft Port	Emersion Point	4.441	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	4.363	27.8

A-4.3 STABILITY RESULTS



GZ = -0.015 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.005389 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.015	0.097	0.209	0.323	0.438	0.556	0.902	1.319	2.233	1.882	1.340	0.753
Displacement (t)	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	2.141	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	735.438	
	Total windage area centroid (from zero point)		m	11.928	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.3	**Pass**
	Wind heeling (Hw)	5.0	deg	1.5	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.11	**Pass**
	Wind heeling (Hw)	60.00	%	3.14	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	11.349	m.deg	51.502	**Pass**
	Wind heeling (Hw)	11.349	m.deg	49.036	**Pass**

A-5 CONDITION No.5 – DOCKING PHASE 4: STS YOUNG ENDEAVOUR

A-5.1 DOCKING CONDITION WITH WATER LEVEL AT MAIN DECK, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
STS Young Endeavour	1	214.256	0.000	0.000	8.818	0.000
Dock Blocks - Keel	19	79.800	0.000	0.000	3.722	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	28	9.800	0.000	0.000	5.407	0.000
Tank No. 1	53.32%	172.913	21.789	6.897	1.230	255.533
Tank No. 2	53.32%	144.874	21.632	0.000	0.820	549.967
Tank No. 3	53.32%	172.913	21.789	-6.897	1.230	255.533
Tank No. 4	53.32%	127.079	7.620	6.896	0.751	283.999
Tank No. 5	53.32%	167.591	7.620	0.000	0.767	611.119
Tank No. 6	53.32%	126.871	7.632	-6.896	0.751	283.993
Tank No. 7	53.32%	126.878	-7.630	6.896	0.751	283.993
Tank No. 8	53.32%	167.591	-7.620	0.000	0.767	611.119
Tank No. 9	53.32%	127.079	-7.620	-6.896	0.751	283.999
Tank No. 10	53.32%	172.913	-21.789	6.897	1.230	255.533
Tank No. 11	53.32%	144.874	-21.632	0.000	0.820	549.967
Tank No. 12	53.32%	172.913	-21.789	-6.897	1.230	255.533
Total Loadcase		**3299.093**	**0.001**	**-0.017**	**2.709**	**4480.290**
FS correction					**1.358**	
VCG fluid					**4.067**	

A-5.2 EQUILIBRIUM CONDITION

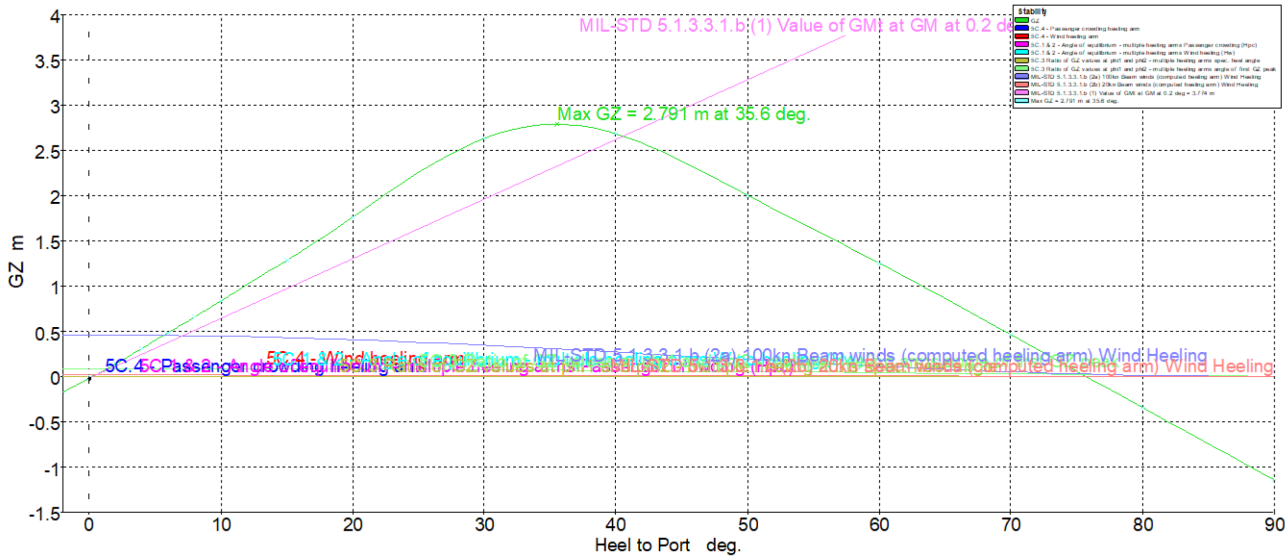
Draft Amidships m	2.897
Displacement t	3299
Heel deg	-0.2
Draft at FP m	2.897
Draft at AP m	2.897
Draft at LCF m	2.897
Trim (+ve by stern) m	0.000
WL Length m	57.912
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.449
KG fluid m	4.067
GMt corrected m	3.598
KMt m	7.665
Immersion (TPc) tonne/cm	3.297
MTc tonne.m	10.531
Max deck inclination deg	0.242
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	7.643	31.9
WW Deck Edge Forward Stbd	Immersion Point	7.727	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	7.643	31.9
WW Deck Edge AftStbd	Immersion Point	7.727	Not immersed in positive range
Deck Edge Forward Stbd	Emersion Point	0.045	0.6
Deck Edge Aft Stbd	Emersion Point	0.045	0.6

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	0.205	NA
Deck Edge Forward Port	Emersion Point	0.129	Not emerged in positive range
Deck Edge Aft Port	Emersion Point	0.129	Not emerged in positive range
Bottom Edge Forward Port	Emersion Point	2.939	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	2.855	21.7
Bottom Edge Aft Port	Emersion Point	2.939	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	2.855	21.7

A-5.3 STABILITY RESULTS



GZ = -0.017 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.006069 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.017	0.140	0.313	0.486	0.660	0.836	1.287	1.763	2.634	2.686	2.004	1.254
Displacement (t)	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	1.468	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	808.978	
	Total windage area centroid (from zero point)		m	11.174	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.3	**Pass**
	Wind heeling (Hw)	5.0	deg	1.4	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.10	**Pass**
	Wind heeling (Hw)	60.00	%	3.13	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	14.375	m.deg	66.620	**Pass**
	Wind heeling (Hw)	14.375	m.deg	63.573	**Pass**

A-6 CONDITION No.6 – DOCKING PHASE 5: STS YOUNG ENDEAVOUR

A-6.1 FLOATING CONDITION WITH 12 SPECIAL PERSONNEL AND 10% TANKS

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Vessel to be Docked	1	214.256	0.000	0.000	8.818	0.000
Dock Blocks - Keel	19	79.800	0.000	0.000	3.722	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	28	9.800	0.000	0.000	5.407	0.000
Tank No. 1	10%	32.429	21.124	6.896	0.255	255.533
Tank No. 2	10%	27.171	20.983	0.000	0.169	549.967
Tank No. 3	10%	32.429	21.124	-6.896	0.255	255.533
Tank No. 4	10%	23.833	7.620	6.896	0.141	283.999
Tank No. 5	10%	31.431	7.620	0.000	0.144	611.119
Tank No. 6	10%	23.794	7.632	-6.896	0.141	283.993
Tank No. 7	10%	23.796	-7.630	6.896	0.141	283.993
Tank No. 8	10%	31.431	-7.620	0.000	0.144	611.119
Tank No. 9	10%	23.833	-7.620	-6.896	0.141	283.999
Tank No. 10	10%	32.429	-21.124	6.896	0.255	255.533
Tank No. 11	10%	27.171	-20.983	0.000	0.169	549.967
Tank No. 12	10%	32.429	-21.124	-6.896	0.255	255.533
Total Loadcase		**1816.783**	**0.002**	**-0.030**	**4.005**	**4480.290**
FS correction					**2.466**	
VCG fluid					**6.471**	

A-6.2 EQUILIBRIUM CONDITION

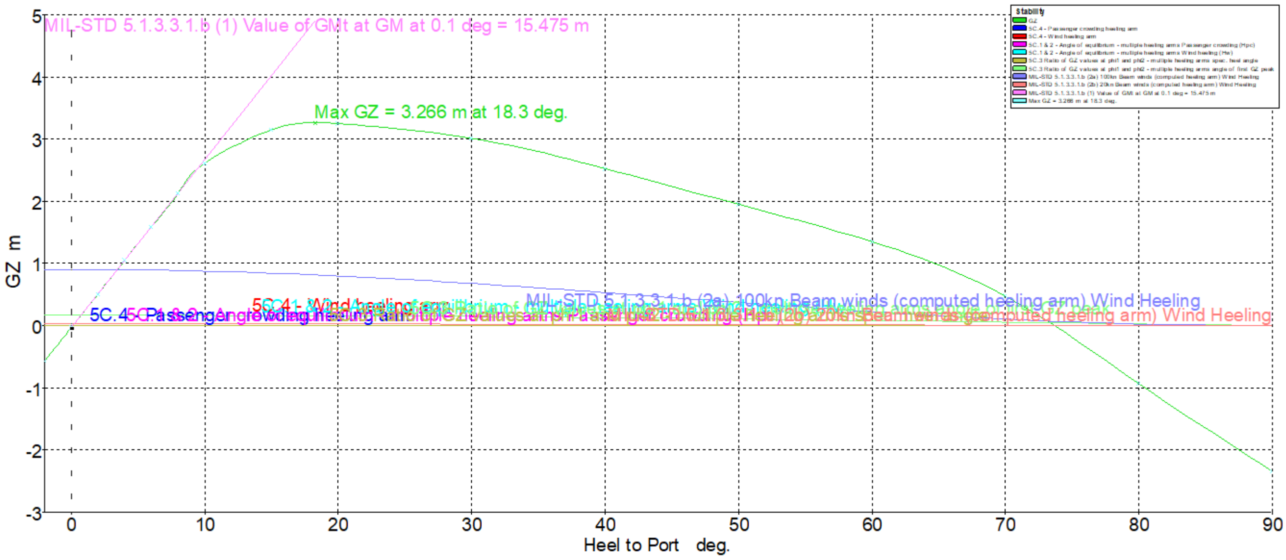
Draft Amidships m	1.599
Displacement t	1817
Heel deg	-0.1
Draft at FP m	1.599
Draft at AP m	1.599
Draft at LCF m	1.599
Trim (+ve by stern) m	0.000
WL Length m	57.892
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	0.812
KG fluid m	6.471
GMt corrected m	15.484
KMt m	21.955
Immersion (TPc) tonne/cm	11.746
MTc tonne.m	54.826
Max deck inclination deg	0.112
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
Margin Line	Immersion Point	1.115	6.6
Deck Edge Forward Port	Immersion Point	1.191	7.0
Deck Edge Forward Stbd	Immersion Point	1.230	Not immersed in positive range
Deck Edge Aft Port	Immersion Point	1.191	7.0
Deck Edge Aft Stbd	Immersion Point	1.230	Not immersed in positive range
WW Deck Edge Forward Port	Immersion Point	8.963	55.3
WW Deck Edge Forward Stbd	Immersion Point	9.002	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	8.963	55.4
WW Deck Edge AftStbd	Immersion Point	9.002	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Bottom Edge Forward Port	Emersion Point	1.619	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	1.580	9.1
Bottom Edge Aft Port	Emersion Point	1.619	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	1.580	9.1

A-6.3 STABILITY RESULTS



Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.030	0.509	1.048	1.588	2.124	2.614	3.150	3.250	3.014	2.530	1.953	1.353
Displacement (t)	1817	1817	1817	1817	1817	1817	1817	1817	1817	1817	1817	1817

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	0.812	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	884.162	
	Total windage area centroid (from zero point)		m	10.415	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.005	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.1	**Pass**
	Wind heeling (Hw)	5.0	deg	0.7	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.16	**Pass**
	Wind heeling (Hw)	60.00	%	5.25	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	21.696	m.deg	103.139	**Pass**
	Wind heeling (Hw)	21.696	m.deg	97.081	**Pass**

A-7 CONDITION No.7 – DOCKING PHASE 2: PALUMA CLASS VESSEL

A-7.1 DOCKING CONDITION WITH HALF SHIP MASS ON BLOCKS, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Paluma Class Vessel	0.5	162.500	0.000	0.000	9.100	0.000
Dock Blocks - Keel	24	100.800	0.000	0.000	3.343	0.000
Dock Block - Side	0	0.000	0.000	0.000	3.943	0.000
Crushing Timbers	48	16.800	0.000	0.000	4.207	0.000
Tank No. 1	78.42%	254.310	21.455	7.208	1.909	255.533
Tank No. 2	78.42%	213.073	21.781	0.000	1.176	549.967
Tank No. 3	78.42%	254.310	21.455	-7.208	1.909	255.533
Tank No. 4	78.42%	186.900	7.620	6.896	1.104	283.999
Tank No. 5	78.42%	246.483	7.620	0.000	1.128	611.119
Tank No. 6	78.42%	186.595	7.632	-6.896	1.104	283.993
Tank No. 7	78.42%	186.606	-7.630	6.896	1.104	283.993
Tank No. 8	78.42%	246.483	-7.620	0.000	1.128	611.119
Tank No. 9	78.42%	186.900	-7.620	-6.896	1.104	283.999
Tank No. 10	78.42%	254.310	-21.455	7.208	1.909	255.533
Tank No. 11	78.42%	213.073	-21.781	0.000	1.176	549.967
Tank No. 12	78.42%	254.310	-21.455	-7.208	1.909	255.533
Total Loadcase		**4067.001**	**0.001**	**-0.014**	**2.561**	**4480.290**
FS correction					**1.102**	
VCG fluid					**3.663**	

A-7.2 EQUILIBRIUM CONDITION

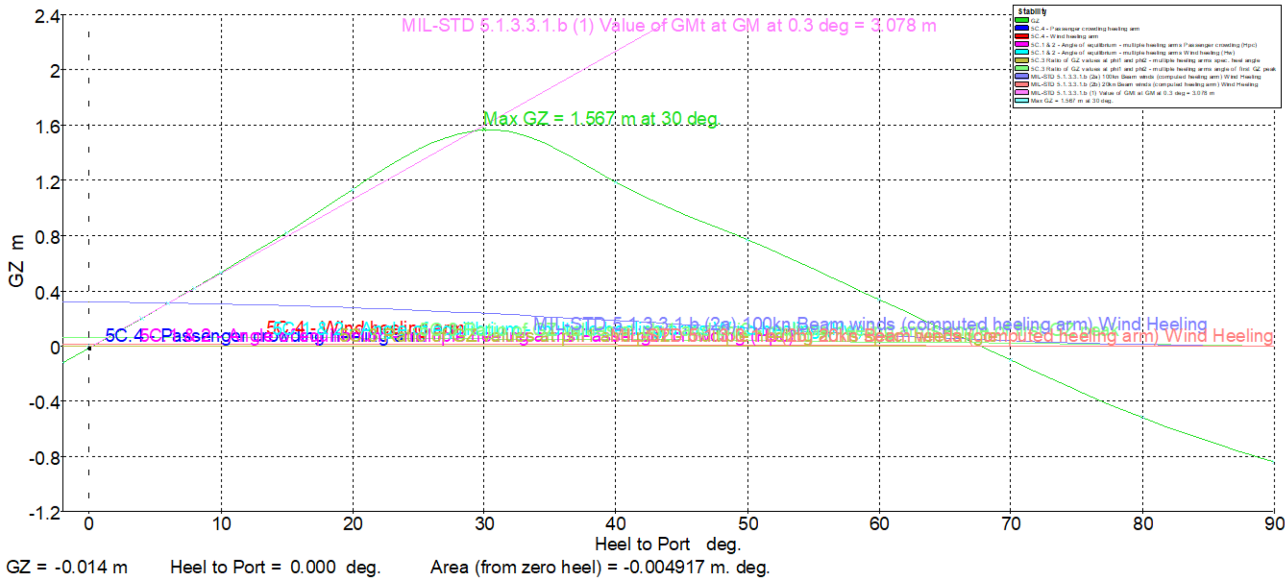
Draft Amidships m	5.751
Displacement t	4067
Heel deg	-0.2
Draft at FP m	5.751
Draft at AP m	5.751
Draft at LCF m	5.751
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.988
KG fluid m	3.663
GMt corrected m	3.077
KMt m	6.740
Immersion (TPc) tonne/cm	2.581
MTc tonne.m	7.730
Max deck inclination deg	0.197
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	4.797	23.9
WW Deck Edge Forward Stbd	Immersion Point	4.865	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	4.797	23.9
WW Deck Edge AftStbd	Immersion Point	4.865	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	3.051	NA
Deck Edge Forward Port	Emersion Point	2.975	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	2.907	17.0
Deck Edge Aft Port	Emersion Point	2.975	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	2.907	17.0
Bottom Edge Forward Port	Emersion Point	5.785	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	5.717	52.1
Bottom Edge Aft Port	Emersion Point	5.785	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	5.717	51.4

A-7.3 STABILITY RESULTS



Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.014	0.094	0.201	0.310	0.420	0.532	0.823	1.134	1.567	1.185	0.769	0.336
Displacement (t)	4067	4067	4067	4067	4067	4067	4067	4067	4067	4067	4067	4067

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	2.776	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	669.557	
	Total windage area centroid (from zero point)		m	12.603	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.002	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.3	**Pass**
	Wind heeling (Hw)	5.0	deg	1.4	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.15	**Pass**
	Wind heeling (Hw)	60.00	%	3.79	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	8.845	m.deg	38.991	**Pass**
	Wind heeling (Hw)	8.845	m.deg	36.935	**Pass**

A-8 CONDITION No.8 – DOCKING PHASE 3: PALUMA CLASS VESSEL

A-8.1 DOCKING CONDITION WITH WATER LEVEL AT SHIP KEEL, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass (t)	Long. Arm (m)	Trans. Arm (m)	Vert. Arm (m)	Total FSM (t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Paluma Class Vessel	1	325.000	0.000	0.000	9.100	0.000
Dock Blocks - Keel	24	100.800	0.000	0.000	3.343	0.000
Dock Block - Side	0	0.000	0.000	0.000	3.943	0.000
Crushing Timbers	48	16.800	0.000	0.000	4.207	0.000
Tank No. 1	63.3%	205.277	21.835	6.896	1.446	255.533
Tank No. 2	63.3%	171.991	21.705	0.000	0.963	549.967
Tank No. 3	63.3%	205.277	21.835	-6.896	1.446	255.533
Tank No. 4	63.3%	150.864	7.620	6.896	0.891	283.999
Tank No. 5	63.3%	198.959	7.620	0.000	0.910	611.119
Tank No. 6	63.3%	150.618	7.632	-6.896	0.891	283.993
Tank No. 7	63.3%	150.626	-7.630	6.896	0.891	283.993
Tank No. 8	63.3%	198.959	-7.620	0.000	0.910	611.119
Tank No. 9	63.3%	150.864	-7.620	-6.896	0.891	283.999
Tank No. 10	63.3%	205.277	-21.835	6.896	1.446	255.533
Tank No. 11	63.3%	171.991	-21.705	0.000	0.963	549.967
Tank No. 12	63.3%	205.277	-21.835	-6.896	1.446	255.533
Total Loadcase		**3712.129**	**0.001**	**-0.015**	**2.826**	**4480.290**
FS correction					**1.207**	
VCG fluid					**4.033**	

A-8.2 EQUILIBRIUM CONDITION

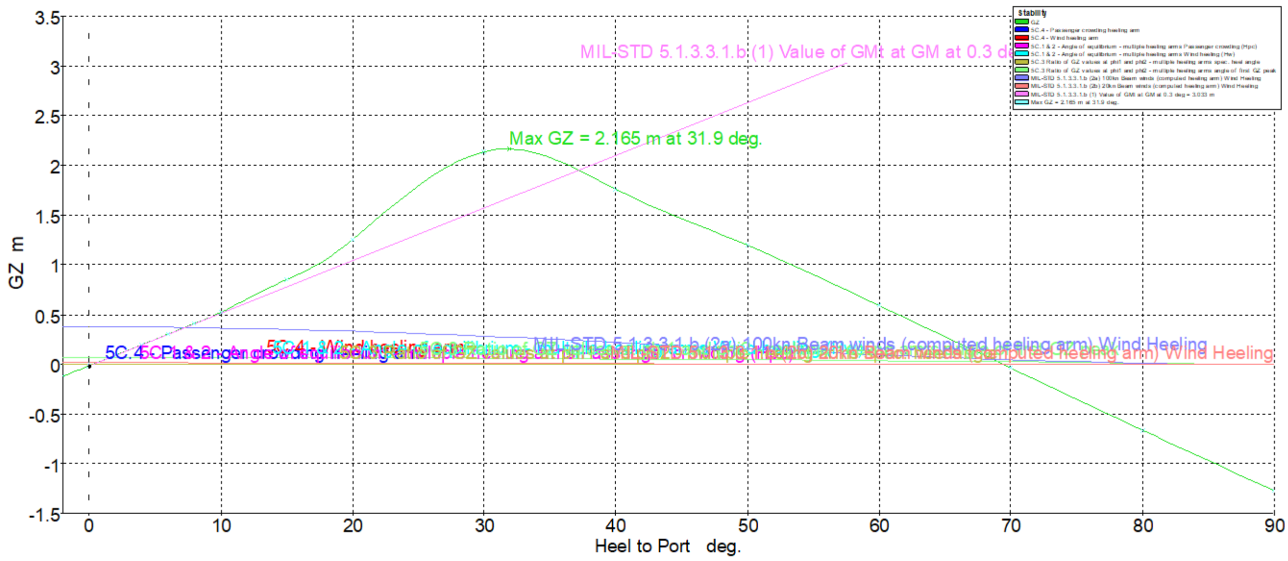
Draft Amidships m	4.402
Displacement t	3712
Heel deg	-0.2
Draft at FP m	4.402
Draft at AP m	4.402
Draft at LCF m	4.402
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.694
KG fluid m	4.033
GMt corrected m	3.032
KMt m	7.064
Immersion (TPc) tonne/cm	2.695
MTc tonne.m	7.837
Max deck inclination deg	0.239
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	6.139	28.2
WW Deck Edge Forward Stbd	Immersion Point	6.221	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	6.139	28.3
WW Deck Edge AftStbd	Immersion Point	6.221	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	1.709	NA
Deck Edge Forward Port	Emersion Point	1.633	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	1.551	9.3
Deck Edge Aft Port	Emersion Point	1.633	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	1.551	9.3
Bottom Edge Forward Port	Emersion Point	4.443	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	4.361	27.9
Bottom Edge Aft Port	Emersion Point	4.443	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	4.361	27.8

A-8.3 STABILITY RESULTS



GZ = -0.015 m   Heel to Port = 0.000 deg.   Area (from zero heel) = -0.005389 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.015	0.090	0.196	0.303	0.412	0.523	0.853	1.255	2.139	1.761	1.196	0.590
Displacement (t)	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	2.141	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	735.432	
	Total windage area centroid (from zero point)		m	11.928	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.3	**Pass**
	Wind heeling (Hw)	5.0	deg	1.6	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.12	**Pass**
	Wind heeling (Hw)	60.00	%	3.29	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	10.844	m.deg	48.977	**Pass**
	Wind heeling (Hw)	10.844	m.deg	46.515	**Pass**

A-9 CONDITION No.9 – DOCKING PHASE 4: PALUMA CLASS VESSEL

A-9.1 DOCKING CONDITION WITH WATER LEVEL AT MAIN DECK, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Paluma Class Vessel	1	325.000	0.000	0.000	9.100	0.000
Dock Blocks - Keel	24	100.800	0.000	0.000	3.343	0.000
Dock Block - Side	0	0.000	0.000	0.000	3.943	0.000
Crushing Timbers	48	16.800	0.000	0.000	4.207	0.000
Tank No. 1	51.23%	166.135	21.777	6.897	1.185	255.537
Tank No. 2	51.23%	139.195	21.615	0.000	0.790	549.967
Tank No. 3	51.23%	166.135	21.777	-6.897	1.185	255.537
Tank No. 4	51.23%	122.097	7.620	6.896	0.721	283.999
Tank No. 5	51.23%	161.022	7.620	0.000	0.737	611.119
Tank No. 6	51.23%	121.898	7.632	-6.896	0.721	283.993
Tank No. 7	51.23%	121.905	-7.630	6.896	0.721	283.993
Tank No. 8	51.23%	161.022	-7.620	0.000	0.737	611.119
Tank No. 9	51.23%	122.097	-7.620	-6.896	0.721	283.999
Tank No. 10	51.23%	166.135	-21.777	6.897	1.185	255.537
Tank No. 11	51.23%	139.195	-21.615	0.000	0.790	549.967
Tank No. 12	51.23%	166.135	-21.777	-6.897	1.185	255.537
Total Loadcase		**3299.122**	**0.001**	**-0.017**	**2.930**	**4480.303**
FS correction					**1.358**	
VCG fluid					**4.288**	

A-9.2 EQUILIBRIUM CONDITION

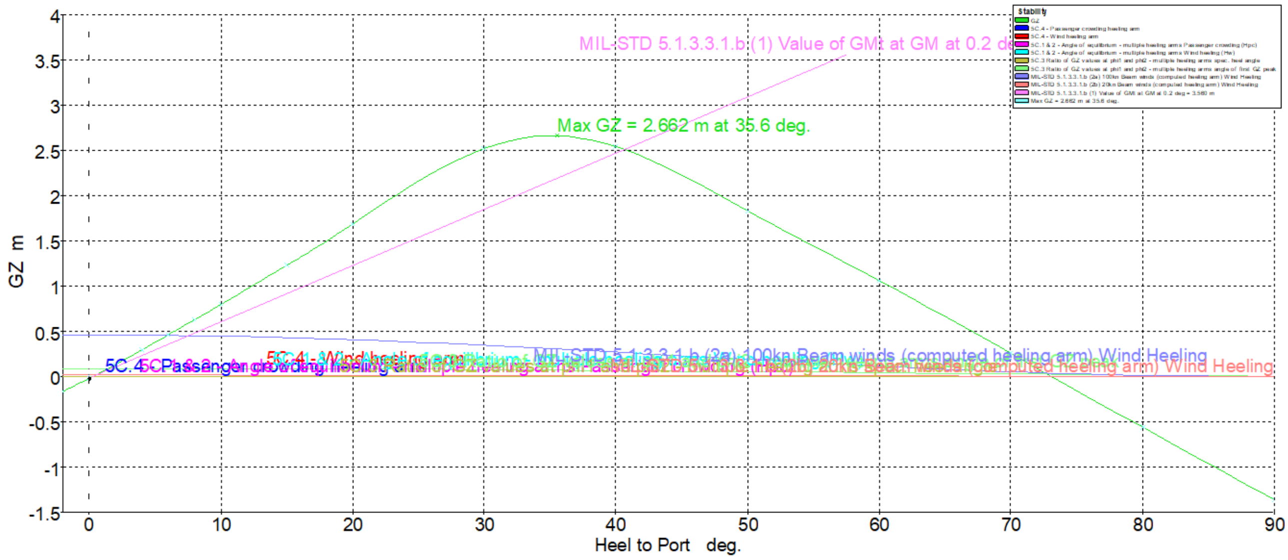
Draft Amidships m	2.897
Displacement t	3299
Heel deg	-0.3
Draft at FP m	2.897
Draft at AP m	2.897
Draft at LCF m	2.897
Trim (+ve by stern) m	0.000
WL Length m	57.912
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.449
KG fluid m	4.288
GMt corrected m	3.377
KMt m	7.666
Immersion (TPc) tonne/cm	3.300
MTc tonne.m	10.421
Max deck inclination deg	0.257
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	7.640	31.9
WW Deck Edge Forward Stbd	Immersion Point	7.729	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	7.640	31.9
WW Deck Edge AftStbd	Immersion Point	7.729	Not immersed in positive range
Deck Edge Forward Stbd	Emersion Point	0.043	0.6
Deck Edge Aft Stbd	Emersion Point	0.043	0.6

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	0.208	NA
Deck Edge Forward Port	Emersion Point	0.132	Not emerged in positive range
Deck Edge Aft Port	Emersion Point	0.132	Not emerged in positive range
Bottom Edge Forward Port	Emersion Point	2.942	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	2.853	21.7
Bottom Edge Aft Port	Emersion Point	2.942	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	2.853	21.7

A-9.3 STABILITY RESULTS



GZ = -0.017 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.00607 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.017	0.132	0.297	0.463	0.629	0.797	1.230	1.688	2.523	2.544	1.834	1.062
Displacement (t)	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	1.468	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	808.973	
	Total windage area centroid (from zero point)		m	11.174	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.3	**Pass**
	Wind heeling (Hw)	5.0	deg	1.4	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.11	**Pass**
	Wind heeling (Hw)	60.00	%	3.28	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	13.781	m.deg	63.650	**Pass**
	Wind heeling (Hw)	13.781	m.deg	60.607	**Pass**

A-10 CONDITION No.10 – DOCKING PHASE 5: PALUMA CLASS VESSEL

A-10.1 FLOATING CONDITION WITH 12 SPECIAL PERSONNEL AND 10% TANKS

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Paluma Class Vessel	1	325.000	0.000	0.000	9.100	0.000
Dock Blocks - Keel	24	100.800	0.000	0.000	3.343	0.000
Dock Block - Side	0	0.000	0.000	0.000	3.943	0.000
Crushing Timbers	48	16.800	0.000	0.000	4.207	0.000
Tank No. 1	10%	32.429	21.124	6.896	0.255	255.533
Tank No. 2	10%	27.171	20.983	0.000	0.169	549.967
Tank No. 3	10%	32.429	21.124	-6.896	0.255	255.533
Tank No. 4	10%	23.833	7.620	6.896	0.141	283.999
Tank No. 5	10%	31.431	7.620	0.000	0.144	611.119
Tank No. 6	10%	23.794	7.632	-6.896	0.141	283.993
Tank No. 7	10%	23.796	-7.630	6.896	0.141	283.993
Tank No. 8	10%	31.431	-7.620	0.000	0.144	611.119
Tank No. 9	10%	23.833	-7.620	-6.896	0.141	283.999
Tank No. 10	10%	32.429	-21.124	6.896	0.255	255.533
Tank No. 11	10%	27.171	-20.983	0.000	0.169	549.967
Tank No. 12	10%	32.429	-21.124	-6.896	0.255	255.533
Total Loadcase		**1888.327**	**0.002**	**-0.029**	**4.309**	**4480.290**
FS correction					**2.373**	
VCG fluid					**6.681**	

A-10.2 EQUILIBRIUM CONDITION

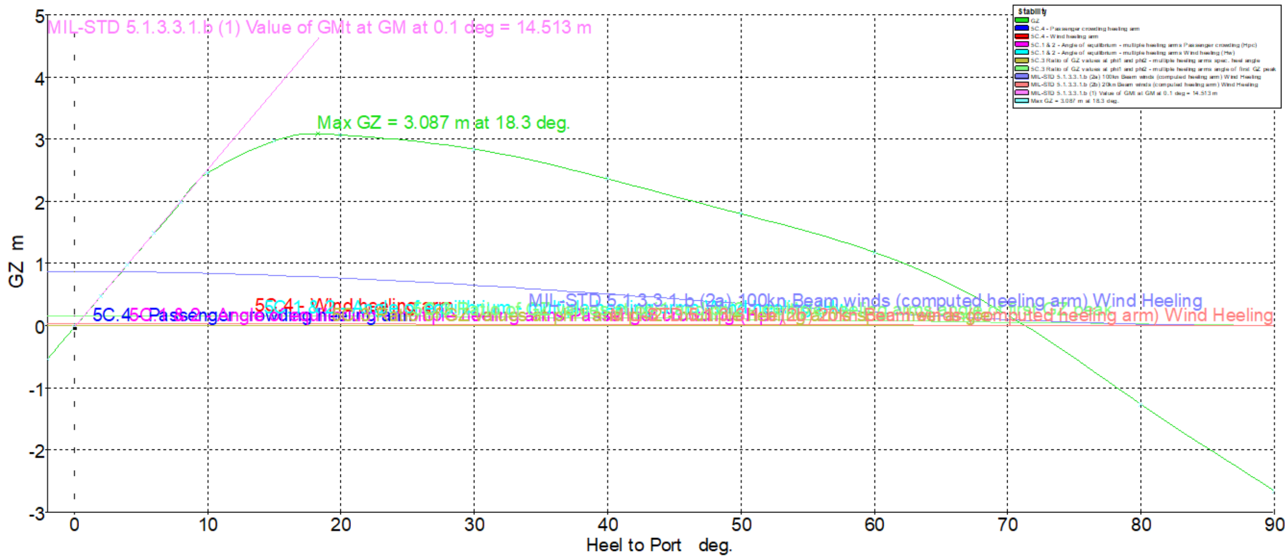
Draft Amidships m	1.660
Displacement t	1888
Heel deg	-0.1
Draft at FP m	1.660
Draft at AP m	1.660
Draft at LCF m	1.660
Trim (+ve by stern) m	0.000
WL Length m	57.912
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	0.843
KG fluid m	6.681
GMt corrected m	14.514
KMt m	21.196
Immersion (TPc) tonne/cm	11.752
MTc tonne.m	54.781
Max deck inclination deg	0.115
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
Margin Line	Immersion Point	1.054	NA
Deck Edge Forward Port	Immersion Point	1.130	6.6
Deck Edge Forward Stbd	Immersion Point	1.170	Not immersed in positive range
Deck Edge Aft Port	Immersion Point	1.130	6.6
Deck Edge Aft Stbd	Immersion Point	1.170	Not immersed in positive range
WW Deck Edge Forward Port	Immersion Point	8.902	53.7
WW Deck Edge Forward Stbd	Immersion Point	8.942	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	8.902	53.8
WW Deck Edge AftStbd	Immersion Point	8.942	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Bottom Edge Forward Port	Emersion Point	1.680	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	1.640	9.5
Bottom Edge Aft Port	Emersion Point	1.680	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	1.640	9.5

A-10.3 STABILITY RESULTS



GZ = -0.029 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.0106 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.029	0.477	0.982	1.489	1.988	2.451	2.974	3.071	2.838	2.363	1.801	1.182
Displacement (t)	1888	1888	1888	1888	1888	1888	1888	1888	1888	1888	1888	1888

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	0.843	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	880.642	
	Total windage area centroid (from zero point)		m	10.450	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.005	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.1	**Pass**
	Wind heeling (Hw)	5.0	deg	0.8	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.16	**Pass**
	Wind heeling (Hw)	60.00	%	5.33	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	20.479	m.deg	97.065	**Pass**
	Wind heeling (Hw)	20.479	m.deg	91.259	**Pass**

A-11 CONDITION No.11 – DOCKING PHASE 2: HUON CLASS VESSEL

A-11.1 DOCKING CONDITION WITH HALF SHIP MASS ON BLOCKS, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Minehunter (Huon Class) Vessel	0.5	366.000	0.000	0.000	9.400	0.000
Dock Blocks - Keel	21	88.200	0.000	0.000	3.343	0.000
Dock Block - Side	24	100.800	0.000	0.000	3.943	0.000
Crushing Timbers	54	18.900	0.000	0.000	4.207	0.000
Tank No. 1	70.94%	230.053	21.625	7.065	1.648	255.533
Tank No. 2	70.94%	192.749	21.748	0.000	1.071	549.967
Tank No. 3	70.94%	230.053	21.625	-7.065	1.648	255.533
Tank No. 4	70.94%	169.073	7.620	6.896	0.999	283.999
Tank No. 5	70.94%	222.972	7.620	0.000	1.020	611.119
Tank No. 6	70.94%	168.797	7.632	-6.896	0.999	283.993
Tank No. 7	70.94%	168.806	-7.630	6.896	0.999	283.993
Tank No. 8	70.94%	222.972	-7.620	0.000	1.020	611.119
Tank No. 9	70.94%	169.073	-7.620	-6.896	0.999	283.999
Tank No. 10	70.94%	230.053	-21.625	7.065	1.648	255.533
Tank No. 11	70.94%	192.749	-21.748	0.000	1.071	549.967
Tank No. 12	70.94%	230.053	-21.625	-7.065	1.648	255.533
Total Loadcase		**4104.852**	**0.001**	**-0.013**	**2.918**	**4480.290**
FS correction					**1.091**	
VCG fluid					**4.009**	

A-11.2 EQUILIBRIUM CONDITION

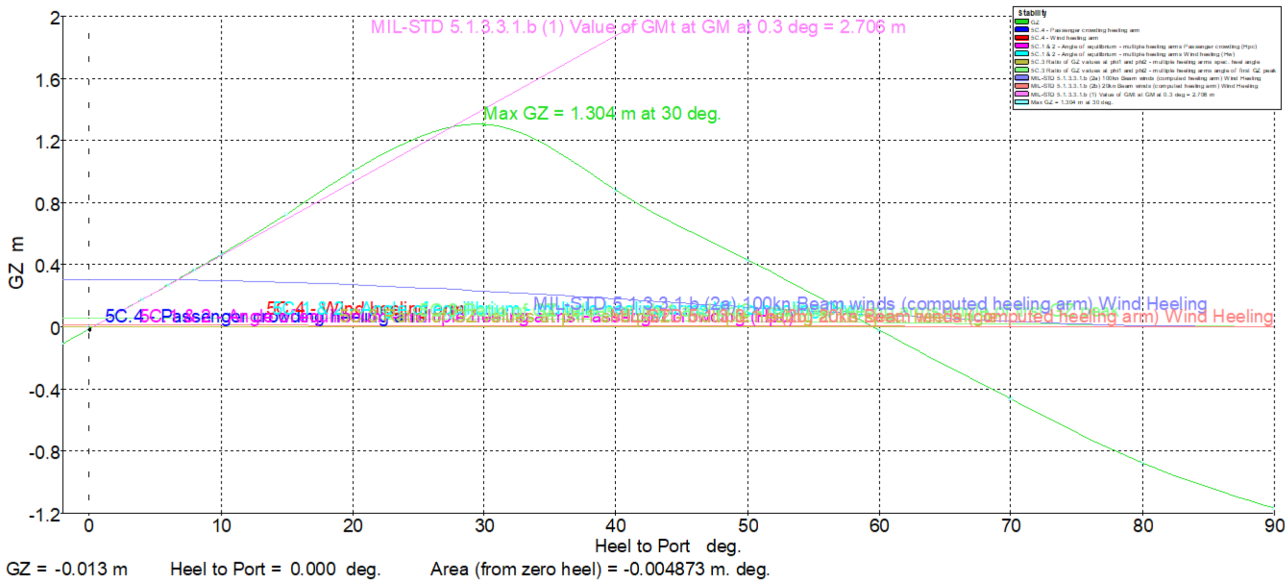
Draft Amidships m	5.898
Displacement t	4105
Heel deg	-0.2
Draft at FP m	5.898
Draft at AP m	5.898
Draft at LCF m	5.898
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	2.024
KG fluid m	4.009
GMt corrected m	2.705
KMt m	6.715
Immersion (TPc) tonne/cm	2.569
MTc tonne.m	7.452
Max deck inclination deg	0.214
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	4.647	23.3
WW Deck Edge Forward Stbd	Immersion Point	4.721	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	4.647	23.3
WW Deck Edge AftStbd	Immersion Point	4.721	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	3.201	NA
Deck Edge Forward Port	Emersion Point	3.125	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	3.051	17.9
Deck Edge Aft Port	Emersion Point	3.125	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	3.051	17.9
Bottom Edge Forward Port	Emersion Point	5.935	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	5.861	55.8
Bottom Edge Aft Port	Emersion Point	5.935	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	5.861	55.1

A-11.3 STABILITY RESULTS



Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.013	0.081	0.176	0.271	0.368	0.467	0.726	1.001	1.304	0.880	0.433	-0.019
Displacement (t)	4105	4105	4105	4105	4105	4105	4105	4105	4105	4105	4105	4105

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	2.847	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	662.294	
	Total windage area centroid (from zero point)		m	12.677	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.002	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.3	**Pass**
	Wind heeling (Hw)	5.0	deg	1.5	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.17	**Pass**
	Wind heeling (Hw)	60.00	%	4.46	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	7.607	m.deg	32.804	**Pass**
	Wind heeling (Hw)	7.607	m.deg	30.794	**Pass**

A-12 CONDITION No.12 – DOCKING PHASE 3: HUON CLASS VESSEL

A-12.1 DOCKING CONDITION WITH WATER LEVEL AT SHIP KEEL, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass (t)	Long. Arm (m)	Trans. Arm (m)	Vert. Arm (m)	Total FSM (t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Minehunter (Huon Class) Vessel	1	732.000	0.000	0.000	9.400	0.000
Dock Blocks - Keel	21	88.200	0.000	0.000	3.343	0.000
Dock Block - Side	24	100.800	0.000	0.000	3.943	0.000
Crushing Timbers	54	18.900	0.000	0.000	4.207	0.000
Tank No. 1	48.76%	158.125	21.761	6.897	1.131	255.546
Tank No. 2	48.76%	132.484	21.595	0.000	0.754	549.967
Tank No. 3	48.76%	158.125	21.761	-6.897	1.131	255.546
Tank No. 4	48.76%	116.211	7.620	6.896	0.687	283.999
Tank No. 5	48.76%	153.258	7.620	0.000	0.701	611.119
Tank No. 6	48.76%	116.021	7.632	-6.896	0.687	283.993
Tank No. 7	48.76%	116.028	-7.630	6.896	0.687	283.993
Tank No. 8	48.76%	153.258	-7.620	0.000	0.701	611.119
Tank No. 9	48.76%	116.211	-7.620	-6.896	0.687	283.999
Tank No. 10	48.76%	158.125	-21.761	6.897	1.131	255.546
Tank No. 11	48.76%	132.484	-21.595	0.000	0.754	549.967
Tank No. 12	48.76%	158.125	-21.761	-6.897	1.131	255.546
Total Loadcase		**3711.904**	**0.001**	**-0.015**	**3.720**	**4480.342**
FS correction					**1.207**	
VCG fluid					**4.927**	

A-12.2 EQUILIBRIUM CONDITION

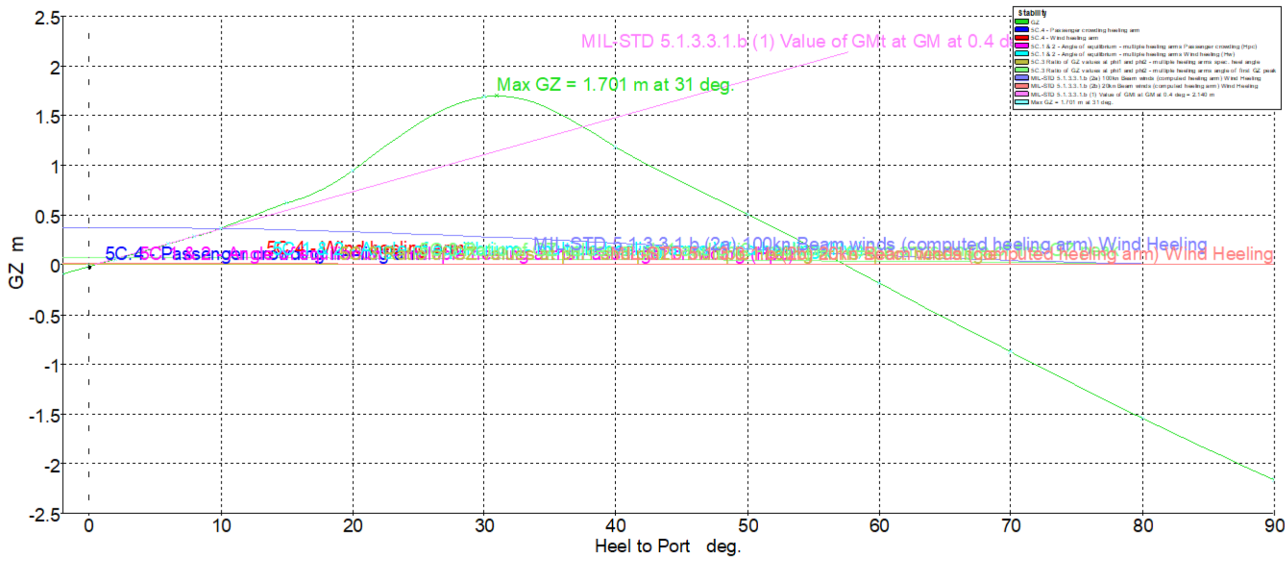
Draft Amidships m	4.401
Displacement t	3712
Heel deg	-0.3
Draft at FP m	4.401
Draft at AP m	4.401
Draft at LCF m	4.401
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.693
KG fluid m	4.927
GMt corrected m	2.138
KMt m	7.065
Immersion (TPc) tonne/cm	2.695
MTc tonne.m	7.264
Max deck inclination deg	0.318
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	6.126	28.2
WW Deck Edge Forward Stbd	Immersion Point	6.236	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	6.126	28.3
WW Deck Edge AftStbd	Immersion Point	6.236	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	1.722	NA
Deck Edge Forward Port	Emersion Point	1.646	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	1.536	9.3
Deck Edge Aft Port	Emersion Point	1.646	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	1.536	9.3
Bottom Edge Forward Port	Emersion Point	4.456	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	4.346	27.9
Bottom Edge Aft Port	Emersion Point	4.456	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	4.346	27.8

A-12.3 STABILITY RESULTS



GZ = -0.015 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.00539 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.015	0.059	0.134	0.210	0.287	0.368	0.622	0.949	1.692	1.186	0.511	-0.184
Displacement (t)	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	2.141	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	735.473	
	Total windage area centroid (from zero point)		m	11.927	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.5	**Pass**
	Wind heeling (Hw)	5.0	deg	2.3	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.15	**Pass**
	Wind heeling (Hw)	60.00	%	4.18	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	8.448	m.deg	37.000	**Pass**
	Wind heeling (Hw)	8.448	m.deg	34.566	**Pass**

A-13 CONDITION No.13 – DOCKING PHASE 4: HUON CLASS VESSEL

A-13.1 DOCKING CONDITION WITH WATER LEVEL AT MAIN DECK, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Minehunter (Huon Class) Vessel	1	732.000	0.000	0.000	9.400	0.000
Dock Blocks - Keel	21	88.200	0.000	0.000	3.343	0.000
Dock Block - Side	24	100.800	0.000	0.000	3.943	0.000
Crushing Timbers	54	18.900	0.000	0.000	4.207	0.000
Tank No. 1	36.69%	118.983	21.653	6.896	0.867	255.547
Tank No. 2	36.69%	99.689	21.472	0.000	0.578	549.967
Tank No. 3	36.69%	118.983	21.653	-6.896	0.867	255.547
Tank No. 4	36.69%	87.444	7.620	6.896	0.517	283.999
Tank No. 5	36.69%	115.321	7.620	0.000	0.528	611.119
Tank No. 6	36.69%	87.301	7.632	-6.896	0.517	283.993
Tank No. 7	36.69%	87.306	-7.630	6.896	0.517	283.993
Tank No. 8	36.69%	115.321	-7.620	0.000	0.528	611.119
Tank No. 9	36.69%	87.444	-7.620	-6.896	0.517	283.999
Tank No. 10	36.69%	118.983	-21.653	6.896	0.867	255.547
Tank No. 11	36.69%	99.689	-21.472	0.000	0.578	549.967
Tank No. 12	36.69%	118.983	-21.653	-6.896	0.867	255.547
Total Loadcase		**3298.897**	**0.001**	**-0.017**	**3.998**	**4480.346**
FS correction					**1.358**	
VCG fluid					**5.356**	

A-13.2 EQUILIBRIUM CONDITION

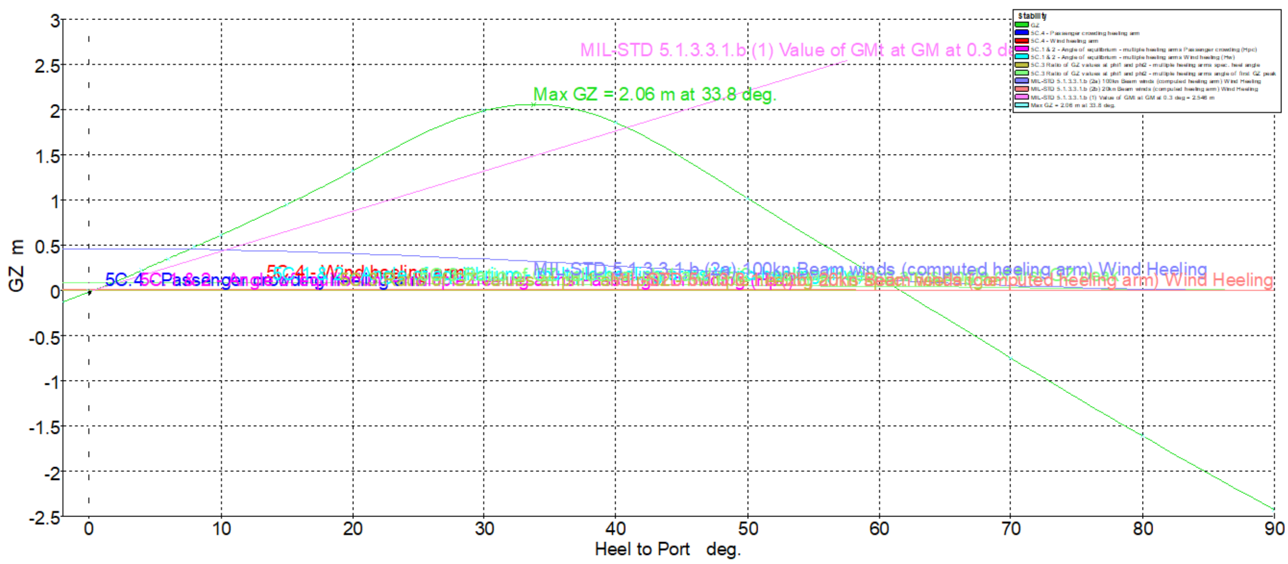
Draft Amidships m	2.897
Displacement t	3299
Heel deg	-0.4
Draft at FP m	2.897
Draft at AP m	2.897
Draft at LCF m	2.897
Trim (+ve by stern) m	0.000
WL Length m	57.912
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.449
KG fluid m	5.356
GMt corrected m	2.315
KMt m	7.671
Immersion (TPc) tonne/cm	3.515
MTc tonne.m	10.851
Max deck inclination deg	0.359
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	7.623	31.9
WW Deck Edge Forward Stbd	Immersion Point	7.747	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	7.623	31.9
WW Deck Edge AftStbd	Immersion Point	7.747	Not immersed in positive range
Deck Edge Forward Stbd	Emersion Point	0.025	0.6
Deck Edge Aft Stbd	Emersion Point	0.025	0.6

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	0.225	NA
Deck Edge Forward Port	Emersion Point	0.149	Not emerged in positive range
Deck Edge Aft Port	Emersion Point	0.149	Not emerged in positive range
Bottom Edge Forward Port	Emersion Point	2.959	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	2.835	21.7
Bottom Edge Aft Port	Emersion Point	2.959	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	2.835	21.7

A-13.3 STABILITY RESULTS



GZ = -0.017 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.006071 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.017	0.095	0.223	0.351	0.481	0.612	0.954	1.323	1.990	1.858	1.017	0.139
Displacement (t)	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	1.468	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	809.012	
	Total windage area centroid (from zero point)		m	11.174	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.4	**Pass**
	Wind heeling (Hw)	5.0	deg	1.9	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.14	**Pass**
	Wind heeling (Hw)	60.00	%	4.24	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	10.921	m.deg	49.353	**Pass**
	Wind heeling (Hw)	10.921	m.deg	46.333	**Pass**

A-14 CONDITION No.14 – DOCKING PHASE 5: HUON CLASS VESSEL

A-14.1 FLOATING CONDITION WITH 12 SPECIAL PERSONNEL AND 10% TANKS

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
Minehunter (Huon Class) Vessel	1	732.000	0.000	0.000	9.400	0.000
Dock Blocks - Keel	21	88.200	0.000	0.000	3.343	0.000
Dock Block - Side	24	100.800	0.000	0.000	3.943	0.000
Crushing Timbers	54	18.900	0.000	0.000	4.207	0.000
Tank No. 1	10%	32.429	21.124	6.896	0.255	255.533
Tank No. 2	10%	27.171	20.983	0.000	0.169	549.967
Tank No. 3	10%	32.429	21.124	-6.896	0.255	255.533
Tank No. 4	10%	23.833	7.620	6.896	0.141	283.999
Tank No. 5	10%	31.431	7.620	0.000	0.144	611.119
Tank No. 6	10%	23.794	7.632	-6.896	0.141	283.993
Tank No. 7	10%	23.796	-7.630	6.896	0.141	283.993
Tank No. 8	10%	31.431	-7.620	0.000	0.144	611.119
Tank No. 9	10%	23.833	-7.620	-6.896	0.141	283.999
Tank No. 10	10%	32.429	-21.124	6.896	0.255	255.533
Tank No. 11	10%	27.171	-20.983	0.000	0.169	549.967
Tank No. 12	10%	32.429	-21.124	-6.896	0.255	255.533
Total Loadcase		**2385.627**	**0.001**	**-0.023**	**5.208**	**4480.290**
FS correction					**1.878**	
VCG fluid					**7.086**	

A-14.2 EQUILIBRIUM CONDITION

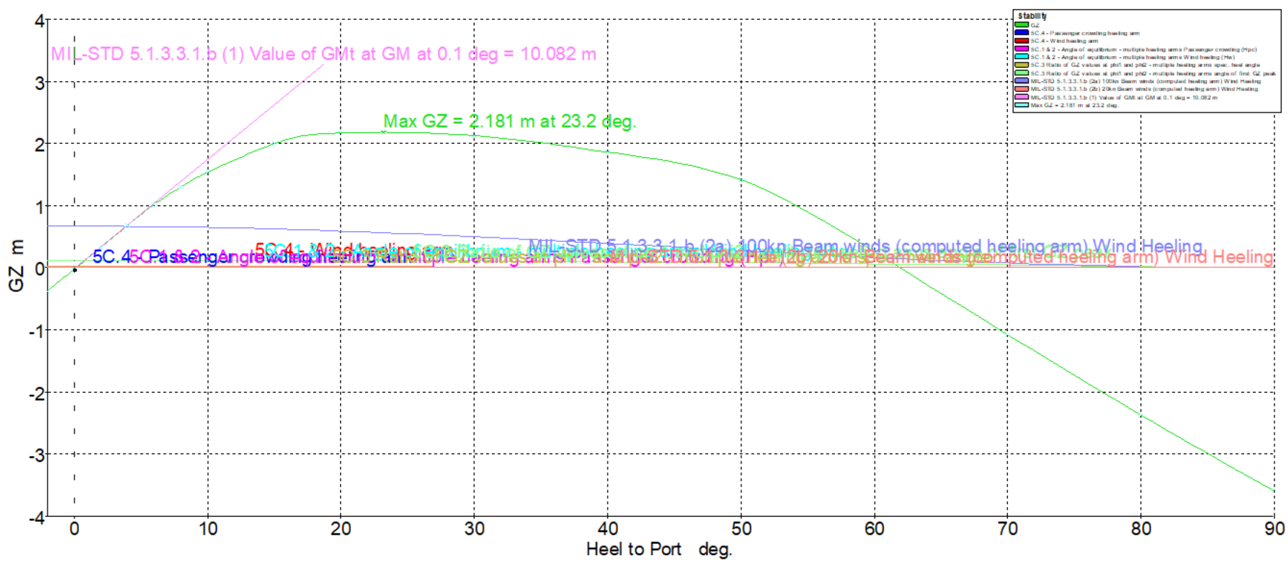
Draft Amidships m	2.083
Displacement t	2386
Heel deg	-0.1
Draft at FP m	2.083
Draft at AP m	2.083
Draft at LCF m	2.083
Trim (+ve by stern) m	0.000
WL Length m	57.912
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.057
KG fluid m	7.086
GMt corrected m	10.081
KMt m	17.166
Immersion (TPc) tonne/cm	11.751
MTc tonne.m	54.194
Max deck inclination deg	0.131
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
Margin Line	Immersion Point	0.628	NA
Deck Edge Forward Port	Immersion Point	0.704	4.2
Deck Edge Forward Stbd	Immersion Point	0.749	Not immersed in positive range
Deck Edge Aft Port	Immersion Point	0.704	4.2
Deck Edge Aft Stbd	Immersion Point	0.749	Not immersed in positive range
WW Deck Edge Forward Port	Immersion Point	8.476	44.2
WW Deck Edge Forward Stbd	Immersion Point	8.521	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	8.476	44.3
WW Deck Edge AftStbd	Immersion Point	8.521	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Bottom Edge Forward Port	Emersion Point	2.106	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	2.061	12.6
Bottom Edge Aft Port	Emersion Point	2.106	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	2.061	12.6

A-14.3 STABILITY RESULTS



GZ = -0.023 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.00839 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.023	0.329	0.683	1.021	1.301	1.536	1.997	2.172	2.130	1.862	1.416	0.258
Displacement (t)	2386	2386	2386	2386	2386	2385	2386	2386	2386	2386	2386	2386

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	1.058	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	856.133	
	Total windage area centroid (from zero point)		m	10.696	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.004	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.2	**Pass**
	Wind heeling (Hw)	5.0	deg	0.9	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.18	**Pass**
	Wind heeling (Hw)	60.00	%	5.82	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	14.917	m.deg	69.295	**Pass**
	Wind heeling (Hw)	14.917	m.deg	64.824	**Pass**

A-15 CONDITION No.15 – DOCKING PHASE 2: 1000T TUG

A-15.1 DOCKING CONDITION WITH HALF SHIP MASS ON BLOCKS, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass (t)	Long. Arm (m)	Trans. Arm (m)	Vert. Arm (m)	Total FSM (t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
35m Tug	0.5	500.000	0.000	0.000	9.700	0.000
Dock Blocks - Keel	11	46.200	0.000	0.000	3.343	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	30	10.500	0.000	0.000	4.207	0.000
Tank No. 1	73.22%	237.447	21.569	7.111	1.721	255.533
Tank No. 2	73.22%	198.944	21.759	0.000	1.103	549.967
Tank No. 3	73.22%	237.447	21.569	-7.111	1.721	255.533
Tank No. 4	73.22%	174.507	7.620	6.896	1.031	283.999
Tank No. 5	73.22%	230.139	7.620	0.000	1.053	611.119
Tank No. 6	73.22%	174.222	7.632	-6.896	1.031	283.993
Tank No. 7	73.22%	174.232	-7.630	6.896	1.031	283.993
Tank No. 8	73.22%	230.139	-7.620	0.000	1.053	611.119
Tank No. 9	73.22%	174.507	-7.620	-6.896	1.031	283.999
Tank No. 10	73.22%	237.447	-21.569	7.111	1.721	255.533
Tank No. 11	73.22%	198.944	-21.759	0.000	1.103	549.967
Tank No. 12	73.22%	237.447	-21.569	-7.111	1.721	255.533
Total Loadcase		**4232.869**	**0.001**	**-0.013**	**3.142**	**4480.290**
FS correction					**1.058**	
VCG fluid					**4.200**	

A-15.2 EQUILIBRIUM CONDITION

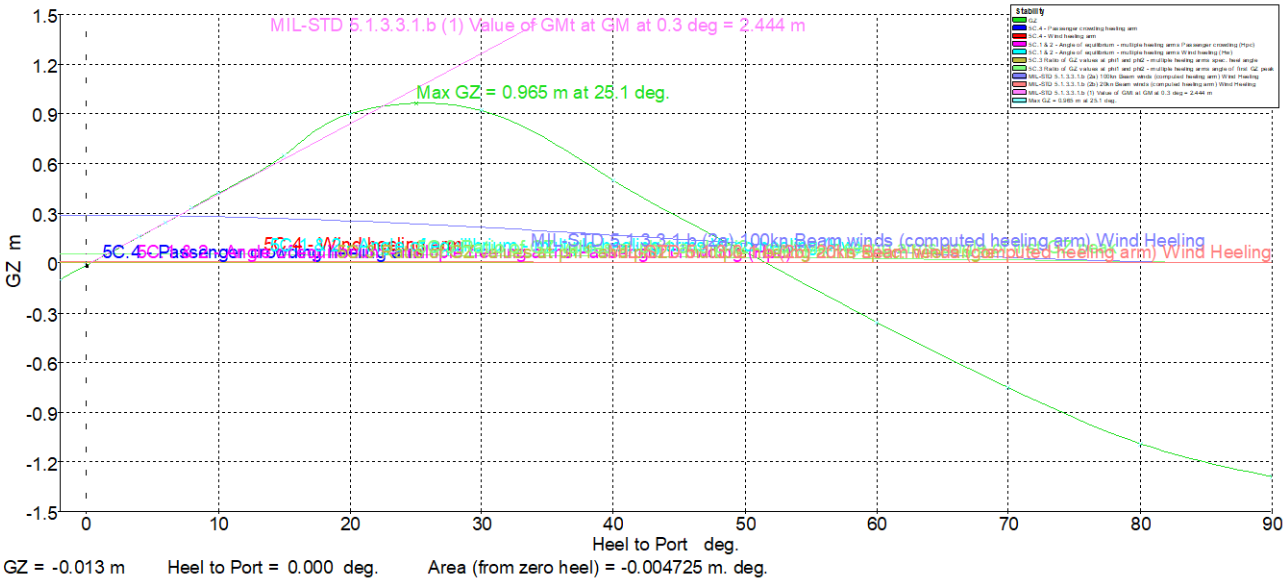
Draft Amidships m	6.401
Displacement t	4233
Heel deg	-0.2
Draft at FP m	6.401
Draft at AP m	6.401
Draft at LCF m	6.401
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	2.148
KG fluid m	4.200
GMt corrected m	2.442
KMt m	6.642
Immersion (TPc) tonne/cm	2.527
MTc tonne.m	7.201
Max deck inclination deg	0.220
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	4.143	21.4
WW Deck Edge Forward Stbd	Immersion Point	4.219	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	4.143	21.5
WW Deck Edge AftStbd	Immersion Point	4.219	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	3.705	NA
Deck Edge Forward Port	Emersion Point	3.629	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	3.553	21.7
Deck Edge Aft Port	Emersion Point	3.629	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	3.553	21.2
Bottom Edge Forward Port	Emersion Point	6.439	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	6.363	65.1
Bottom Edge Aft Port	Emersion Point	6.439	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	6.363	64.5

A-15.3 STABILITY RESULTS



Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.013	0.072	0.158	0.245	0.332	0.422	0.651	0.902	0.920	0.500	0.068	-0.357
Displacement (t)	4233	4233	4233	4233	4233	4233	4233	4233	4233	4233	4233	4233

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	3.088	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	637.704	
	Total windage area centroid (from zero point)		m	12.930	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.002	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.4	**Pass**
	Wind heeling (Hw)	5.0	deg	1.6	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.23	**Pass**
	Wind heeling (Hw)	60.00	%	5.64	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	6.123	m.deg	25.382	**Pass**
	Wind heeling (Hw)	6.123	m.deg	23.508	**Pass**

A-16 CONDITION No.16 – DOCKING PHASE 3: 1000T TUG

A-16.1 DOCKING CONDITION WITH WATER LEVEL AT SHIP KEEL, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass (t)	Long. Arm (m)	Trans. Arm (m)	Vert. Arm (m)	Total FSM (t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
35m Tug	1	1000.000	0.000	0.000	9.700	0.000
Dock Blocks - Keel	11	46.200	0.000	0.000	3.343	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	30	10.500	0.000	0.000	4.207	0.000
Tank No. 1	43.39%	140.710	21.721	6.897	1.014	255.533
Tank No. 2	43.39%	117.894	21.543	0.000	0.676	549.967
Tank No. 3	43.39%	140.710	21.721	-6.897	1.014	255.533
Tank No. 4	43.39%	103.412	7.620	6.896	0.611	283.999
Tank No. 5	43.39%	136.380	7.620	0.000	0.624	611.119
Tank No. 6	43.39%	103.243	7.632	-6.896	0.611	283.993
Tank No. 7	43.39%	103.249	-7.630	6.896	0.611	283.993
Tank No. 8	43.39%	136.380	-7.620	0.000	0.624	611.119
Tank No. 9	43.39%	103.412	-7.620	-6.896	0.611	283.999
Tank No. 10	43.39%	140.710	-21.721	6.897	1.014	255.533
Tank No. 11	43.39%	117.894	-21.543	0.000	0.676	549.967
Tank No. 12	43.39%	140.710	-21.721	-6.897	1.014	255.533
Total Loadcase		**3712.155**	**0.001**	**-0.015**	**4.316**	**4480.290**
FS correction					**1.207**	
VCG fluid					**5.523**	

A-16.2 EQUILIBRIUM CONDITION

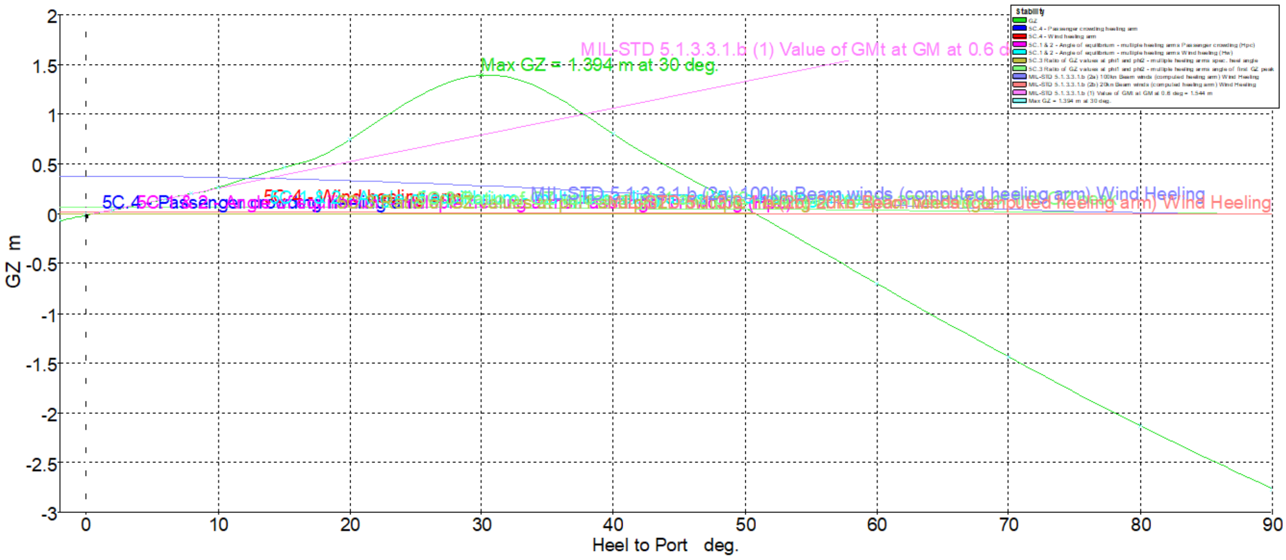
Draft Amidships m	4.402
Displacement t	3712
Heel deg	-0.4
Draft at FP m	4.402
Draft at AP m	4.402
Draft at LCF m	4.402
Trim (+ve by stern) m	0.000
WL Length m	48.768
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.694
KG fluid m	5.523
GMt corrected m	1.542
KMt m	7.065
Immersion (TPc) tonne/cm	2.695
MTc tonne.m	6.882
Max deck inclination deg	0.410
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	6.109	28.2
WW Deck Edge Forward Stbd	Immersion Point	6.250	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	6.109	28.3
WW Deck Edge AftStbd	Immersion Point	6.250	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	1.739	NA
Deck Edge Forward Port	Emersion Point	1.663	Not emerged in positive range
Deck Edge Forward Stbd	Emersion Point	1.521	9.3
Deck Edge Aft Port	Emersion Point	1.663	Not emerged in positive range
Deck Edge Aft Stbd	Emersion Point	1.521	9.3
Bottom Edge Forward Port	Emersion Point	4.473	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	4.331	27.9
Bottom Edge Aft Port	Emersion Point	4.473	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	4.331	27.8

A-16.3 STABILITY RESULTS



GZ = -0.015 m Heel to Port = 0.000 deg. Area (from zero heel) = -0.005391 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.015	0.038	0.092	0.147	0.204	0.264	0.467	0.745	1.394	0.802	0.054	-0.701
Displacement (t)	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712	3712

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	2.141	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	735.428	
	Total windage area centroid (from zero point)		m	11.928	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.7	**Pass**
	Wind heeling (Hw)	5.0	deg	3.2	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.18	**Pass**
	Wind heeling (Hw)	60.00	%	5.10	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	6.848	m.deg	28.999	**Pass**
	Wind heeling (Hw)	6.848	m.deg	26.603	**Pass**

A-17 CONDITION No.17 – DOCKING PHASE 4: 1000T TUG

A-17.1 DOCKING CONDITION WITH WATER LEVEL AT MAIN DECK, 12 SPECIAL PERSONNEL AND TANKS INTERMEDIATELY BALLASTED

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
35m Tug	1	1000.000	0.000	0.000	9.700	0.000
Dock Blocks - Keel	11	46.200	0.000	0.000	3.343	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	30	10.500	0.000	0.000	4.207	0.000
Tank No. 1	31.32%	101.568	21.586	6.896	0.747	255.533
Tank No. 2	31.32%	85.099	21.402	0.000	0.498	549.967
Tank No. 3	31.32%	101.568	21.586	-6.896	0.747	255.533
Tank No. 4	31.32%	74.646	7.620	6.896	0.441	283.999
Tank No. 5	31.32%	98.442	7.620	0.000	0.450	611.119
Tank No. 6	31.32%	74.524	7.632	-6.896	0.441	283.993
Tank No. 7	31.32%	74.528	-7.630	6.896	0.441	283.993
Tank No. 8	31.32%	98.442	-7.620	0.000	0.450	611.119
Tank No. 9	31.32%	74.646	-7.620	-6.896	0.441	283.999
Tank No. 10	31.32%	101.568	-21.586	6.896	0.747	255.533
Tank No. 11	31.32%	85.099	-21.402	0.000	0.498	549.967
Tank No. 12	31.32%	101.568	-21.586	-6.896	0.747	255.533
Total Loadcase		**3299.148**	**0.001**	**-0.017**	**4.692**	**4480.290**
FS correction					**1.358**	
VCG fluid					**6.050**	

A-17.2 EQUILIBRIUM CONDITION

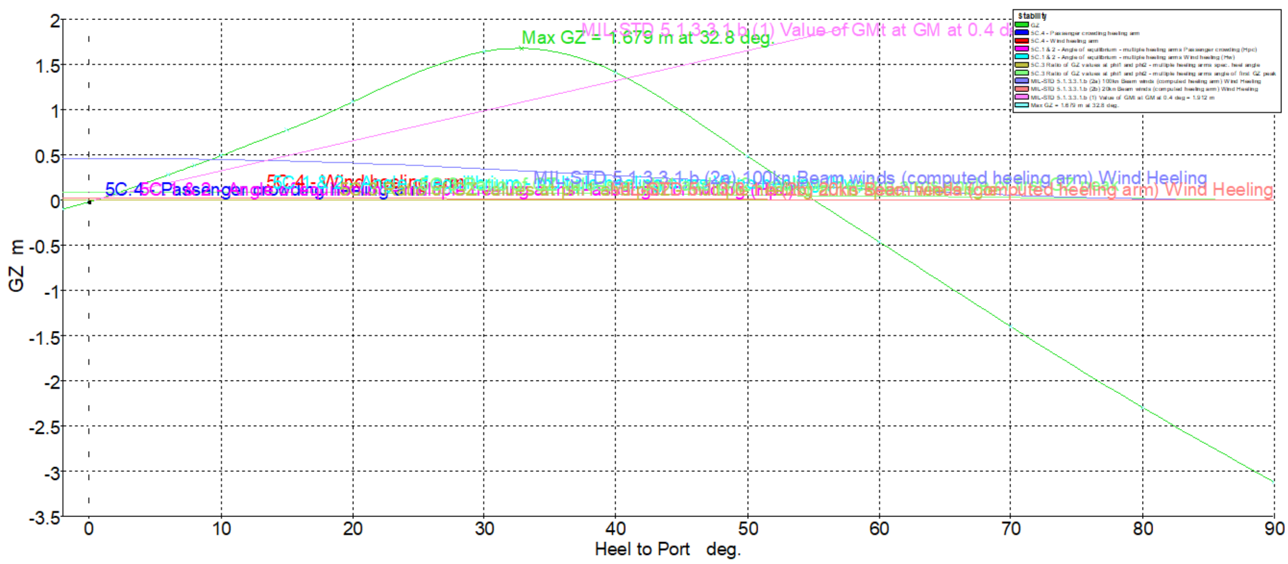
Draft Amidships m	2.898
Displacement t	3299
Heel deg	-0.5
Draft at FP m	2.898
Draft at AP m	2.898
Draft at LCF m	2.898
Trim (+ve by stern) m	0.000
WL Length m	57.912
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.449
KG fluid m	6.050
GMt corrected m	1.628
KMt m	7.677
Immersion (TPc) tonne/cm	3.595
MTc tonne.m	10.839
Max deck inclination deg	0.485
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
WW Deck Edge Forward Port	Immersion Point	7.600	31.9
WW Deck Edge Forward Stbd	Immersion Point	7.768	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	7.600	31.9
WW Deck Edge AftStbd	Immersion Point	7.768	Not immersed in positive range
Deck Edge Forward Stbd	Emersion Point	0.004	0.6
Deck Edge Aft Stbd	Emersion Point	0.004	0.6

Key Point	Type	Draft (m)	Immersion Angle (˚)
Margin Line	Emersion Point	0.248	NA
Deck Edge Forward Port	Emersion Point	0.172	Not emerged in positive range
Deck Edge Aft Port	Emersion Point	0.172	Not emerged in positive range
Bottom Edge Forward Port	Emersion Point	2.982	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	2.814	21.7
Bottom Edge Aft Port	Emersion Point	2.982	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	2.814	21.7

A-17.3 STABILITY RESULTS



GZ = -0.017 m   Heel to Port = 0.000 deg.   Area (from zero heel) = -0.006071 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.017	0.070	0.174	0.279	0.384	0.492	0.774	1.085	1.643	1.411	0.485	-0.463
Displacement (t)	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299	3299

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	1.468	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	808.969	
	Total windage area centroid (from zero point)		m	11.174	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.003	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.5	**Pass**
	Wind heeling (Hw)	5.0	deg	2.3	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.17	**Pass**
	Wind heeling (Hw)	60.00	%	5.20	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	9.059	m.deg	40.043	**Pass**
	Wind heeling (Hw)	9.059	m.deg	37.050	**Pass**

A-18 CONDITION No.18 – DOCKING PHASE 5: 1000T TUG

A-18.1 FLOATING CONDITION WITH 12 SPECIAL PERSONNEL AND 10% TANKS

Specific gravity = 1.025; (Density = 1.025 tonne/m^3)

Item Name	Quantity	Total Mass	Long. Arm	Trans. Arm	Vert. Arm	Total FSM
		(t)	(m)	(m)	(m)	(t-m)
Lightship	1	1100.590	0.003	-0.050	4.259	0.000
Personnel (12)	12	0.960	0.000	0.000	11.582	0.000
Equipment	1	2.000	0.000	0.000	3.896	0.000
35m Tug	1	1000.000	0.000	0.000	9.700	0.000
Dock Blocks - Keel	11	46.200	0.000	0.000	3.343	0.000
Dock Block - Side	16	67.200	0.000	0.000	3.943	0.000
Crushing Timbers	30	10.500	0.000	0.000	4.207	0.000
Tank No. 1	10%	32.429	21.124	6.896	0.255	255.533
Tank No. 2	10%	27.171	20.983	0.000	0.169	549.967
Tank No. 3	10%	32.429	21.124	-6.896	0.255	255.533
Tank No. 4	10%	23.833	7.620	6.896	0.141	283.999
Tank No. 5	10%	31.431	7.620	0.000	0.144	611.119
Tank No. 6	10%	23.794	7.632	-6.896	0.141	283.993
Tank No. 7	10%	23.796	-7.630	6.896	0.141	283.993
Tank No. 8	10%	31.431	-7.620	0.000	0.144	611.119
Tank No. 9	10%	23.833	-7.620	-6.896	0.141	283.999
Tank No. 10	10%	32.429	-21.124	6.896	0.255	255.533
Tank No. 11	10%	27.171	-20.983	0.000	0.169	549.967
Tank No. 12	10%	32.429	-21.124	-6.896	0.255	255.533
Total Loadcase		**2569.627**	**0.001**	**-0.021**	**5.812**	**4480.290**
FS correction					**1.744**	
VCG fluid					**7.556**	

A-18.2 EQUILIBRIUM CONDITION

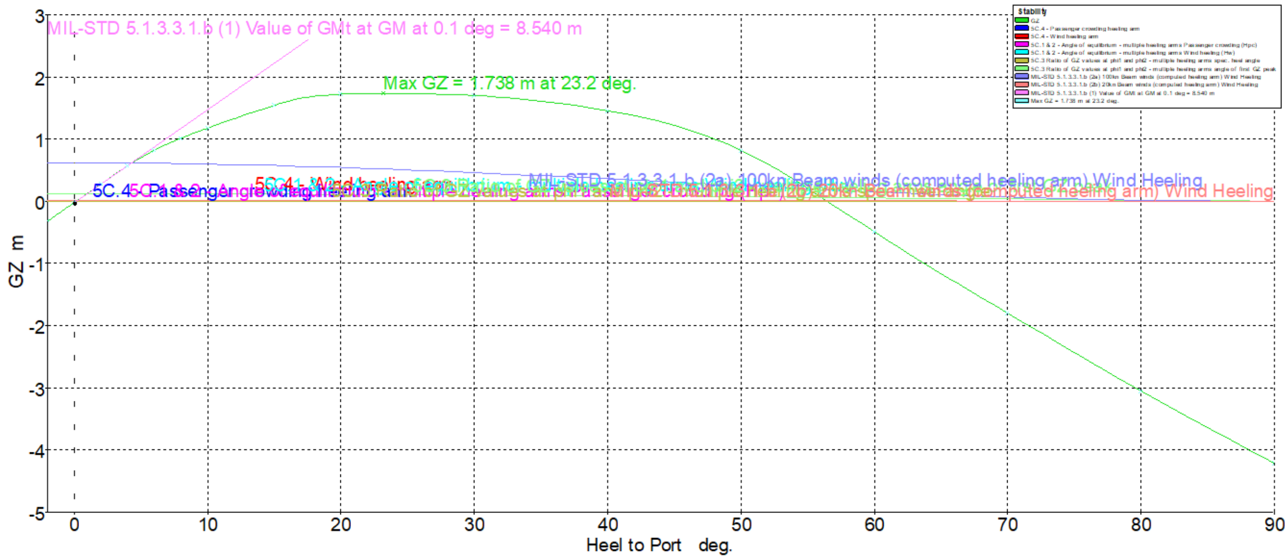
Draft Amidships m	2.240
Displacement t	2570
Heel deg	-0.1
Draft at FP m	2.240
Draft at AP m	2.240
Draft at LCF m	2.240
Trim (+ve by stern) m	0.000
WL Length m	57.912
LCB from zero pt. (+ve fwd) m	0.000

LCF from zero pt. (+ve fwd) m	0.000
KB m	1.136
KG fluid m	7.556
GMt corrected m	8.539
KMt m	16.094
Immersion (TPc) tonne/cm	11.753
MTc tonne.m	53.847
Max deck inclination deg	0.144
Trim angle (+ve by stern) deg	0.000

Key Point	Type	Freeboard (m)	Immersion Angle (˚)
Margin Line	Immersion Point	0.469	2.9
Deck Edge Forward Port	Immersion Point	0.545	3.3
Deck Edge Forward Stbd	Immersion Point	0.595	Not immersed in positive range
Deck Edge Aft Port	Immersion Point	0.545	3.3
Deck Edge Aft Stbd	Immersion Point	0.595	Not immersed in positive range
WW Deck Edge Forward Port	Immersion Point	8.317	41.1
WW Deck Edge Forward Stbd	Immersion Point	8.367	Not immersed in positive range
WW Deck Edge AftPort	Immersion Point	8.317	41.2
WW Deck Edge AftStbd	Immersion Point	8.367	Not immersed in positive range

Key Point	Type	Draft (m)	Immersion Angle (˚)
Bottom Edge Forward Port	Emersion Point	2.265	Not emerged in positive range
Bottom Edge Forward Stbd	Emersion Point	2.215	14.1
Bottom Edge Aft Port	Emersion Point	2.265	Not emerged in positive range
Bottom Edge Aft Stbd	Emersion Point	2.215	14.1

A-18.3 STABILITY RESULTS

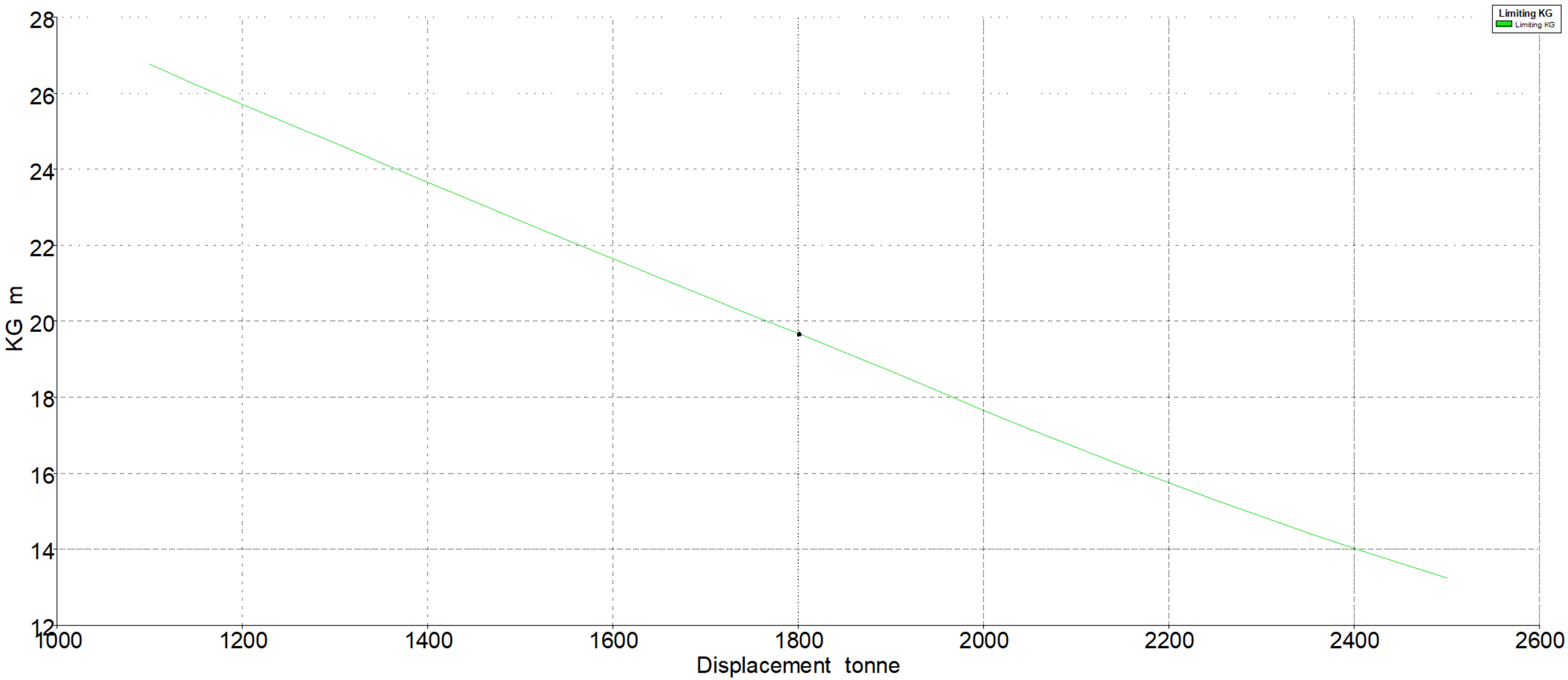


GZ = -0.021 m   Heel to Port = 0.000 deg.   Area (from zero heel) = -0.007791 m. deg.

Heel to PORT (°)	0.0	2.0	4.0	6.0	8.0	10.0	15.0	20.0	30.0	40.0	50.0	60.0
GZ (m)	-0.021	0.277	0.573	0.823	1.014	1.179	1.545	1.724	1.702	1.460	0.824	-0.490
Displacement (t)	2570	2570	2570	2570	2569	2570	2570	2570	2570	2570	2570	2570

Code	Criteria	Value	Units	Actual	Status
NSCV Pt.C, Sec.6,	***Data:***				
Subsection 6A :-	Wind arm: a P A (h - H) / (g disp.) cos^n(phi)				
Chapter 5A Criterion	constant: a =	1.000			
	wind pressure: P =	360.0	Pa		
	area centroid height (from zero point): h =	15.025	m		
	additional area: A =	433.3	m^2		
	H = vert. centre of projected lat. u'water area	1.137	m		
	cosine power: n =	1			
	gust ratio	1			
	Total windage area		m^2	847.068	
	Total windage area centroid (from zero point)		m	10.787	
	Pass. crowding arm = nPass M / disp. D cos^n(phi)				
	number of passengers: nPass =	12			
	passenger mass: M =	0.080	tonne		
	distance from centre line: D =	9.706	m		
	cosine power: n =	1			
	Intermediate values				
	Heel arm amplitude		m	0.004	
	5C.1 – Angle of equilibrium – multiple heeling arms				
	Passenger heeling (Hp)	5.0	deg	0.2	**Pass**
	Wind heeling (Hw)	5.0	deg	0.9	**Pass**
	5C.3 Ratio of GZ values at phi1 and phi2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	60.00	%	0.21	**Pass**
	Wind heeling (Hw)	60.00	%	6.72	**Pass**
	5C.4 - GZ area between limits type 2 - multiple heeling arms				**Pass**
	Passenger heeling (Hp)	12.034	m.deg	54.884	**Pass**
	Wind heeling (Hw)	12.034	m.deg	50.778	**Pass**

ANNEX B
LIMITING KG CURVE



Limiting KG = 19.684 m Displacement = 1800.000 tonne

ANNEX C
TANK TABLES

Tank Name: Ballast Tank No. 1
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	20.425	6.896	0.000	0.000
0.054	1.00	3.160	3.239	20.594	6.896	0.028	204.079
0.500	10.07	31.819	32.615	21.126	6.896	0.257	231.195
1.000	21.11	66.726	68.394	21.419	6.896	0.516	247.419
1.500	32.60	103.016	105.591	21.602	6.896	0.775	252.296
2.000	44.31	140.048	143.549	21.728	6.897	1.033	255.528
2.500	56.05	177.136	181.564	21.803	6.897	1.288	255.533
3.000	64.86	204.986	210.111	21.794	6.926	1.479	17.092
3.500	68.49	216.464	221.876	21.690	7.011	1.573	16.369
4.000	72.07	227.777	233.472	21.599	7.087	1.681	15.668
4.500	75.60	238.925	244.898	21.517	7.155	1.801	14.986
5.000	79.07	249.907	256.155	21.443	7.218	1.931	14.325
5.500	82.50	260.724	267.242	21.377	7.275	2.068	13.683
6.000	85.87	271.376	278.161	21.317	7.328	2.213	13.061
6.500	89.18	281.863	288.909	21.262	7.377	2.363	12.458
7.000	92.45	292.184	299.489	21.212	7.422	2.518	11.874
7.500	95.66	302.341	309.899	21.166	7.465	2.677	11.308
7.853	97.90	309.409	317.144	21.135	7.493	2.791	10.920
7.869	98.00	309.725	317.468	21.134	7.494	2.796	10.903
8.000	98.83	312.332	320.140	21.123	7.504	2.839	10.761
8.188	100.00	316.046	323.947	21.108	7.518	2.901	0.000

Tank Name: Ballast Tank No. 2
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	20.425	0.000	0.000	0.000
0.036	1.00	2.651	2.717	20.538	0.000	0.018	427.475
0.200	5.89	15.624	16.015	20.830	0.000	0.102	474.154
0.400	12.22	32.402	33.212	21.041	0.000	0.205	497.493
0.600	18.82	49.893	51.140	21.199	0.000	0.308	509.163
0.800	25.60	67.847	69.543	21.321	0.000	0.412	520.832
1.000	32.50	86.155	88.309	21.419	0.000	0.516	532.502
1.200	39.51	104.733	107.351	21.501	0.000	0.620	532.502
1.400	46.64	123.619	126.710	21.576	0.000	0.724	543.011
1.600	53.80	142.620	146.186	21.637	0.000	0.827	548.826
1.800	61.04	161.800	165.845	21.691	0.000	0.931	549.967
2.000	68.28	180.987	185.512	21.734	0.000	1.033	549.967
2.200	75.51	200.174	205.178	21.769	0.000	1.136	549.967
2.400	82.75	219.360	224.844	21.798	0.000	1.237	549.967
2.600	89.99	238.547	244.511	21.822	0.000	1.339	549.967
2.800	97.23	257.734	264.177	21.842	0.000	1.440	549.967
2.819	97.90	259.513	266.001	21.844	0.000	1.450	549.967
2.821	98.00	259.778	266.273	21.844	0.000	1.451	549.967
2.896	100.00	265.080	271.707	21.849	0.000	1.479	0.000

Tank Name: Ballast Tank No. 3
Fluid Density: 1.250 T/m³

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	20.425	-6.896	0.000	0.000
0.054	1.00	3.160	3.239	20.594	-6.896	0.028	204.079
0.500	10.07	31.819	32.615	21.126	-6.896	0.257	231.195
1.000	21.11	66.726	68.394	21.419	-6.896	0.516	247.419
1.500	32.60	103.016	105.591	21.602	-6.896	0.775	252.296
2.000	44.31	140.048	143.549	21.728	-6.897	1.033	255.528
2.500	56.05	177.136	181.564	21.803	-6.897	1.288	255.533
3.000	64.86	204.986	210.111	21.794	-6.926	1.479	17.092
3.500	68.49	216.464	221.876	21.690	-7.011	1.573	16.369
4.000	72.07	227.777	233.472	21.599	-7.087	1.681	15.668
4.500	75.60	238.925	244.898	21.517	-7.155	1.801	14.986
5.000	79.07	249.907	256.155	21.443	-7.218	1.931	14.325
5.500	82.50	260.724	267.242	21.377	-7.275	2.068	13.683
6.000	85.87	271.376	278.161	21.317	-7.328	2.213	13.061
6.500	89.18	281.863	288.909	21.262	-7.377	2.363	12.458
7.000	92.45	292.184	299.489	21.212	-7.422	2.518	11.874
7.500	95.66	302.341	309.899	21.166	-7.465	2.677	11.308
7.853	97.90	309.409	317.144	21.135	-7.493	2.791	10.920
7.869	98.00	309.725	317.468	21.134	-7.494	2.796	10.903
8.000	98.83	312.332	320.140	21.123	-7.504	2.839	10.761
8.188	100.00	316.046	323.947	21.108	-7.518	2.901	0.000

Tank Name: Ballast Tank No. 4
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	7.620	6.896	0.000	0.000
0.028	1.00	2.325	2.383	7.620	6.896	0.014	283.999
0.200	7.10	16.514	16.927	7.620	6.896	0.100	283.999
0.400	14.20	33.028	33.854	7.620	6.896	0.200	283.999
0.600	21.31	49.542	50.781	7.620	6.896	0.300	283.999
0.800	28.41	66.056	67.708	7.620	6.896	0.400	283.999
1.000	35.51	82.570	84.635	7.620	6.896	0.500	283.999
1.200	42.61	99.084	101.561	7.620	6.896	0.600	283.999
1.400	49.72	115.598	118.488	7.620	6.896	0.700	283.999
1.600	56.82	132.113	135.415	7.620	6.896	0.800	283.999
1.800	63.92	148.627	152.342	7.620	6.896	0.900	283.999
2.000	71.02	165.141	169.269	7.620	6.896	1.000	283.999
2.200	78.13	181.655	186.196	7.620	6.896	1.100	283.999
2.400	85.23	198.169	203.123	7.620	6.896	1.200	283.999
2.600	92.33	214.683	220.050	7.620	6.896	1.300	283.999
2.757	97.90	227.636	233.327	7.620	6.896	1.378	283.999
2.760	98.00	227.869	233.565	7.620	6.896	1.380	283.999
2.800	99.43	231.197	236.977	7.620	6.896	1.400	283.999
2.845	100.00	232.519	238.332	7.620	6.891	1.408	0.000

Tank Name: Ballast Tank No. 5
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	7.620	0.000	0.000	0.000
0.029	1.00	3.066	3.143	7.620	0.000	0.014	611.119
0.200	6.95	21.320	21.853	7.620	0.000	0.100	611.119
0.400	13.91	42.640	43.706	7.620	0.000	0.200	611.119
0.600	20.86	63.960	65.559	7.620	0.000	0.300	611.119
0.800	27.81	85.281	87.413	7.620	0.000	0.400	611.119
1.000	34.76	106.601	109.266	7.620	0.000	0.500	611.119
1.200	41.72	127.921	131.119	7.620	0.000	0.600	611.119
1.400	48.67	149.241	152.972	7.620	0.000	0.700	611.119
1.600	55.62	170.561	174.825	7.620	0.000	0.800	611.119
1.800	62.57	191.881	196.678	7.620	0.000	0.900	611.119
2.000	69.53	213.201	218.532	7.620	0.000	1.000	611.119
2.200	76.48	234.522	240.385	7.620	0.000	1.100	611.119
2.400	83.43	255.842	262.238	7.620	0.000	1.200	611.119
2.600	90.39	277.162	284.091	7.620	0.000	1.300	611.119
2.800	97.34	298.482	305.944	7.620	0.000	1.400	611.119
2.816	97.90	300.205	307.711	7.620	0.000	1.408	611.119
2.819	98.00	300.512	308.025	7.620	0.000	1.410	611.119
2.896	100.00	306.645	314.311	7.620	0.000	1.438	0.000

Tank Name: Ballast Tank No. 6
Fluid Density: 1.250 T/m³

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	7.632	-6.896	0.000	0.000
0.028	1.00	2.321	2.379	7.632	-6.896	0.014	283.993
0.200	7.10	16.487	16.899	7.632	-6.896	0.100	283.993
0.400	14.20	32.974	33.798	7.632	-6.896	0.200	283.993
0.600	21.31	49.461	50.698	7.632	-6.896	0.300	283.993
0.800	28.41	65.948	67.597	7.632	-6.896	0.400	283.993
1.000	35.51	82.435	84.496	7.632	-6.896	0.500	283.993
1.200	42.61	98.922	101.395	7.632	-6.896	0.600	283.993
1.400	49.72	115.409	118.295	7.632	-6.896	0.700	283.993
1.600	56.82	131.896	135.194	7.632	-6.896	0.800	283.993
1.800	63.92	148.383	152.093	7.632	-6.896	0.900	283.993
2.000	71.02	164.870	168.992	7.632	-6.896	1.000	283.993
2.200	78.12	181.358	185.891	7.632	-6.896	1.100	283.993
2.400	85.23	197.845	202.791	7.632	-6.896	1.200	283.993
2.600	92.33	214.332	219.690	7.632	-6.896	1.300	283.993
2.757	97.90	227.264	232.946	7.632	-6.896	1.378	283.993
2.760	98.00	227.497	233.184	7.632	-6.896	1.380	283.993
2.800	99.43	230.819	236.589	7.632	-6.896	1.400	283.993
2.845	100.00	232.139	237.943	7.632	-6.891	1.408	0.000

Tank Name: Ballast Tank No. 7
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	-7.630	6.896	0.000	0.000
0.028	1.00	2.322	2.380	-7.630	6.896	0.014	283.993
0.200	7.10	16.488	16.900	-7.630	6.896	0.100	283.993
0.400	14.20	32.976	33.800	-7.630	6.896	0.200	283.993
0.600	21.31	49.464	50.701	-7.630	6.896	0.300	283.993
0.800	28.41	65.952	67.601	-7.630	6.896	0.400	283.993
1.000	35.51	82.440	84.501	-7.630	6.896	0.500	283.993
1.200	42.61	98.928	101.401	-7.630	6.896	0.600	283.993
1.400	49.72	115.416	118.301	-7.630	6.896	0.700	283.993
1.600	56.82	131.904	135.202	-7.630	6.896	0.800	283.993
1.800	63.92	148.392	152.102	-7.630	6.896	0.900	283.993
2.000	71.02	164.880	169.002	-7.630	6.896	1.000	283.993
2.200	78.12	181.368	185.902	-7.630	6.896	1.100	283.993
2.400	85.23	197.856	202.802	-7.630	6.896	1.200	283.993
2.600	92.33	214.344	219.703	-7.630	6.896	1.300	283.993
2.757	97.90	227.277	232.959	-7.630	6.896	1.378	283.993
2.760	98.00	227.510	233.197	-7.630	6.896	1.380	283.993
2.800	99.43	230.832	236.603	-7.630	6.896	1.400	283.993
2.845	100.00	232.153	237.956	-7.630	6.891	1.408	0.000

Tank Name: Ballast Tank No. 8
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	-7.620	0.000	0.000	0.000
0.029	1.00	3.066	3.143	-7.620	0.000	0.014	611.119
0.200	6.95	21.320	21.853	-7.620	0.000	0.100	611.119
0.400	13.91	42.640	43.706	-7.620	0.000	0.200	611.119
0.600	20.86	63.960	65.559	-7.620	0.000	0.300	611.119
0.800	27.81	85.281	87.413	-7.620	0.000	0.400	611.119
1.000	34.76	106.601	109.266	-7.620	0.000	0.500	611.119
1.200	41.72	127.921	131.119	-7.620	0.000	0.600	611.119
1.400	48.67	149.241	152.972	-7.620	0.000	0.700	611.119
1.600	55.62	170.561	174.825	-7.620	0.000	0.800	611.119
1.800	62.57	191.881	196.678	-7.620	0.000	0.900	611.119
2.000	69.53	213.201	218.532	-7.620	0.000	1.000	611.119
2.200	76.48	234.522	240.385	-7.620	0.000	1.100	611.119
2.400	83.43	255.842	262.238	-7.620	0.000	1.200	611.119
2.600	90.39	277.162	284.091	-7.620	0.000	1.300	611.119
2.800	97.34	298.482	305.944	-7.620	0.000	1.400	611.119
2.816	97.90	300.205	307.711	-7.620	0.000	1.408	611.119
2.819	98.00	300.512	308.025	-7.620	0.000	1.410	611.119
2.896	100.00	306.645	314.311	-7.620	0.000	1.438	0.000

Tank Name: Ballast Tank No. 9
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	-7.620	-6.896	0.000	0.000
0.028	1.00	2.325	2.383	-7.620	-6.896	0.014	283.999
0.200	7.10	16.514	16.927	-7.620	-6.896	0.100	283.999
0.400	14.20	33.028	33.854	-7.620	-6.896	0.200	283.999
0.600	21.31	49.542	50.781	-7.620	-6.896	0.300	283.999
0.800	28.41	66.056	67.708	-7.620	-6.896	0.400	283.999
1.000	35.51	82.570	84.635	-7.620	-6.896	0.500	283.999
1.200	42.61	99.084	101.561	-7.620	-6.896	0.600	283.999
1.400	49.72	115.598	118.488	-7.620	-6.896	0.700	283.999
1.600	56.82	132.113	135.415	-7.620	-6.896	0.800	283.999
1.800	63.92	148.627	152.342	-7.620	-6.896	0.900	283.999
2.000	71.02	165.141	169.269	-7.620	-6.896	1.000	283.999
2.200	78.13	181.655	186.196	-7.620	-6.896	1.100	283.999
2.400	85.23	198.169	203.123	-7.620	-6.896	1.200	283.999
2.600	92.33	214.683	220.050	-7.620	-6.896	1.300	283.999
2.757	97.90	227.636	233.327	-7.620	-6.896	1.378	283.999
2.760	98.00	227.869	233.565	-7.620	-6.896	1.380	283.999
2.800	99.43	231.197	236.977	-7.620	-6.896	1.400	283.999
2.845	100.00	232.519	238.332	-7.620	-6.891	1.408	0.000

Tank Name: Ballast Tank No. 10
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	-20.425	6.896	0.000	0.000
0.054	1.00	3.160	3.239	-20.594	6.896	0.028	204.079
0.500	10.07	31.819	32.615	-21.126	6.896	0.257	231.195
1.000	21.11	66.726	68.394	-21.419	6.896	0.516	247.419
1.500	32.60	103.016	105.591	-21.602	6.896	0.775	252.296
2.000	44.31	140.048	143.549	-21.728	6.897	1.033	255.528
2.500	56.05	177.136	181.564	-21.803	6.897	1.288	255.533
3.000	64.86	204.986	210.111	-21.794	6.926	1.479	17.092
3.500	68.49	216.464	221.876	-21.690	7.011	1.573	16.369
4.000	72.07	227.777	233.472	-21.599	7.087	1.681	15.668
4.500	75.60	238.925	244.898	-21.517	7.155	1.801	14.986
5.000	79.07	249.907	256.155	-21.443	7.218	1.931	14.325
5.500	82.50	260.724	267.242	-21.377	7.275	2.068	13.683
6.000	85.87	271.376	278.161	-21.317	7.328	2.213	13.061
6.500	89.18	281.863	288.909	-21.262	7.377	2.363	12.458
7.000	92.45	292.184	299.489	-21.212	7.422	2.518	11.874
7.500	95.66	302.341	309.899	-21.166	7.465	2.677	11.308
7.853	97.90	309.409	317.144	-21.135	7.493	2.791	10.920
7.869	98.00	309.725	317.468	-21.134	7.494	2.796	10.903
8.000	98.83	312.332	320.140	-21.123	7.504	2.839	10.761
8.188	100.00	316.046	323.947	-21.108	7.518	2.901	0.000

Tank Name: Ballast Tank No. 11
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	-20.425	0.000	0.000	0.000
0.036	1.00	2.651	2.717	-20.538	0.000	0.018	427.475
0.200	5.89	15.624	16.015	-20.830	0.000	0.102	474.154
0.400	12.22	32.402	33.212	-21.041	0.000	0.205	497.493
0.600	18.82	49.893	51.140	-21.199	0.000	0.308	509.163
0.800	25.60	67.847	69.543	-21.321	0.000	0.412	520.832
1.000	32.50	86.155	88.309	-21.419	0.000	0.516	532.502
1.200	39.51	104.733	107.351	-21.501	0.000	0.620	532.502
1.400	46.64	123.619	126.710	-21.576	0.000	0.724	543.011
1.600	53.80	142.620	146.186	-21.637	0.000	0.827	548.826
1.800	61.04	161.800	165.845	-21.691	0.000	0.931	549.967
2.000	68.28	180.987	185.512	-21.734	0.000	1.033	549.967
2.200	75.51	200.174	205.178	-21.769	0.000	1.136	549.967
2.400	82.75	219.360	224.844	-21.798	0.000	1.237	549.967
2.600	89.99	238.547	244.511	-21.822	0.000	1.339	549.967
2.800	97.23	257.734	264.177	-21.842	0.000	1.440	549.967
2.819	97.90	259.513	266.001	-21.844	0.000	1.450	549.967
2.821	98.00	259.778	266.273	-21.844	0.000	1.451	549.967
2.896	100.00	265.080	271.707	-21.849	0.000	1.479	0.000

Tank Name: Ballast Tank No. 12
Fluid Density: 1.250 T/m^3

Sounding (m)	% Full	Volume (m^3)	Weight (t)	LCG (m)	TCG (m)	VCG (m)	FSM (Tm)
0.000	0.00	0.000	0.000	-20.425	-6.896	0.000	0.000
0.054	1.00	3.160	3.239	-20.594	-6.896	0.028	204.079
0.500	10.07	31.819	32.615	-21.126	-6.896	0.257	231.195
1.000	21.11	66.726	68.394	-21.419	-6.896	0.516	247.419
1.500	32.60	103.016	105.591	-21.602	-6.896	0.775	252.296
2.000	44.31	140.048	143.549	-21.728	-6.897	1.033	255.528
2.500	56.05	177.136	181.564	-21.803	-6.897	1.288	255.533
3.000	64.86	204.986	210.111	-21.794	-6.926	1.479	17.092
3.500	68.49	216.464	221.876	-21.690	-7.011	1.573	16.369
4.000	72.07	227.777	233.472	-21.599	-7.087	1.681	15.668
4.500	75.60	238.925	244.898	-21.517	-7.155	1.801	14.986
5.000	79.07	249.907	256.155	-21.443	-7.218	1.931	14.325
5.500	82.50	260.724	267.242	-21.377	-7.275	2.068	13.683
6.000	85.87	271.376	278.161	-21.317	-7.328	2.213	13.061
6.500	89.18	281.863	288.909	-21.262	-7.377	2.363	12.458
7.000	92.45	292.184	299.489	-21.212	-7.422	2.518	11.874
7.500	95.66	302.341	309.899	-21.166	-7.465	2.677	11.308
7.853	97.90	309.409	317.144	-21.135	-7.493	2.791	10.920
7.869	98.00	309.725	317.468	-21.134	-7.494	2.796	10.903
8.000	98.83	312.332	320.140	-21.123	-7.504	2.839	10.761
8.188	100.00	316.046	323.947	-21.108	-7.518	2.901	0.000

ANNEX D
HYDROSTATIC PARTICULARS

Fixed Trim = -0.750 m
Relative Density = 1.025
Datum for VCB is Baseline

Draft Midships [m]	Displacement [t]	LCB Midships [m]	TCB Centreline [m]	VCB [m]	LCF Midships [m]	KMt [m]	KML [m]	TPcm	MTc [t.m]
0.75	835.200	4.659	0.000	0.412	0.537	44.943	356.631	11.373	51.139
1.00	1121.000	3.586	0.000	0.531	0.403	34.113	275.929	11.516	53.041
1.25	1411.000	2.921	0.000	0.654	0.319	27.593	225.639	11.621	54.474
1.50	1702.000	2.465	0.000	0.778	0.201	23.201	189.673	11.671	55.149
1.75	1994.000	2.124	0.000	0.902	0.094	20.113	163.979	11.716	55.775
2.00	2288.000	1.858	0.000	1.027	0.005	17.822	144.429	11.749	56.256
2.25	2581.000	1.647	0.000	1.152	0.003	16.040	128.334	11.753	56.308
2.50	2873.000	1.463	0.000	1.276	-1.377	13.663	100.411	11.180	48.824
2.75	3119.000	1.003	0.000	1.377	-7.454	11.290	49.035	8.427	25.327
3.00	3294.000	0.456	0.000	1.450	-10.330	9.392	39.160	5.608	21.136
3.25	3397.000	0.211	0.000	1.498	-0.591	7.518	19.215	2.843	10.098
3.50	3466.000	0.205	0.000	1.535	-0.088	7.402	17.620	2.771	9.349
3.75	3535.00	0.200	0.000	1.576	-0.088	7.298	17.216	2.750	9.287
4.00	3603.00	0.195	0.000	1.619	-0.089	7.202	16.834	2.729	9.229
4.25	3671.00	0.190	0.000	1.665	-0.089	7.115	16.472	2.708	9.173
4.50	3738.00	0.185	0.000	1.714	-0.090	7.035	16.130	2.687	9.120
4.75	3805.00	0.180	0.000	1.765	-0.090	6.963	15.807	2.666	9.070
5.00	3871.00	0.176	0.000	1.818	-0.091	6.898	15.500	2.645	9.023
5.25	3937.00	0.172	0.000	1.873	-0.091	6.840	15.210	2.624	8.979
5.50	4002.00	0.168	0.000	1.930	-0.092	6.787	14.934	2.602	8.937
5.75	4067.00	0.164	0.000	1.989	-0.092	6.741	14.673	2.581	8.898
6.00	4131.00	0.160	0.000	2.049	-0.093	6.699	14.425	2.560	8.862
6.25	4194.00	0.156	0.000	2.111	-0.093	6.663	14.190	2.539	8.828
6.50	4258.00	0.153	0.000	2.174	-0.094	6.631	13.966	2.518	8.797
6.75	4320.00	0.149	0.000	2.239	-0.095	6.604	13.754	2.497	8.768
7.00	4383.00	0.146	0.000	2.305	-0.095	6.581	13.552	2.477	8.742
7.25	4444.00	0.143	0.000	2.372	-0.096	6.562	13.361	2.456	8.718
7.50	4505.00	0.140	0.000	2.440	-0.096	6.547	13.179	2.435	8.696
7.75	4566.00	0.137	0.000	2.509	-0.097	6.535	13.006	2.414	8.677
8.00	4626.00	0.133	0.000	2.578	-0.166	6.502	12.806	2.374	8.631
8.25	4685.00	0.129	0.000	2.648	-0.243	6.431	12.598	2.309	8.573
8.50	4742.00	0.125	0.000	2.716	-0.324	6.350	12.400	2.243	8.515
8.75	4798.00	0.120	0.000	2.785	-0.316	6.317	12.257	2.205	8.496
9.00	4853.00	0.115	0.000	2.854	-0.317	6.322	12.127	2.186	8.485
9.25	4907.00	0.110	0.000	2.924	-0.213	6.365	12.057	2.186	8.521
9.50	4963.00	0.108	0.000	2.997	-0.101	6.530	12.021	2.268	8.588
9.75	5020.00	0.106	0.000	3.071	-0.102	6.541	11.905	2.247	8.585
10.00	5076.00	0.104	0.000	3.147	-0.103	6.553	11.795	2.226	8.585
10.25	5132.0	0.102	0.000	3.222	-0.104	6.568	11.691	2.206	8.587
10.50	5177.0	0.066	0.000	3.285	-9.028	5.367	5.376	1.383	3.018

Fixed Trim = -0.500 m
Relative Density = 1.025
Datum for VCB is Baseline

Draft Midships [m]	Displacement [t]	LCB Midships [m]	TCB Centreline [m]	VCB [m]	LCF Midships [m]	KMt [m]	KML [m]	TPcm	MTc [t.m]
0.75	833.10	3.121	0.000	0.394	0.347	45.153	360.181	11.401	51.522
1.00	1120.00	2.396	0.000	0.518	0.260	34.204	277.653	11.534	53.299
1.25	1409.00	1.952	0.000	0.643	0.210	27.623	226.295	11.629	54.587
1.50	1701.00	1.648	0.000	0.769	0.138	23.256	191.044	11.697	55.526
1.75	1994.00	1.419	0.000	0.895	0.048	20.133	164.648	11.731	56.000
2.00	2288.00	1.239	0.000	1.021	0.000	17.822	144.557	11.753	56.310
2.25	2581.00	1.098	0.000	1.146	0.001	16.032	128.281	11.751	56.286
2.50	2875.00	0.986	0.000	1.272	-0.002	14.639	115.460	11.752	56.328
2.75	3145.00	0.724	0.000	1.386	-6.300	11.446	54.471	8.998	28.494
3.00	3317.00	0.223	0.000	1.458	-9.493	8.840	38.004	4.772	20.623
3.25	3397.00	0.141	0.000	1.497	-0.058	7.516	18.046	2.792	9.413
3.50	3467.00	0.137	0.000	1.534	-0.058	7.402	17.618	2.771	9.348
3.75	3535.00	0.133	0.000	1.575	-0.059	7.297	17.213	2.750	9.287
4.00	3603.00	0.130	0.000	1.618	-0.059	7.201	16.831	2.729	9.228
4.25	3671.00	0.126	0.000	1.665	-0.059	7.114	16.470	2.708	9.172
4.50	3738.00	0.123	0.000	1.713	-0.060	7.035	16.128	2.687	9.120
4.75	3805.00	0.120	0.000	1.764	-0.060	6.963	15.805	2.666	9.070
5.00	3871.00	0.117	0.000	1.818	-0.060	6.898	15.498	2.644	9.023
5.25	3937.00	0.114	0.000	1.873	-0.061	6.839	15.208	2.623	8.978
5.50	4002.00	0.112	0.000	1.930	-0.061	6.787	14.932	2.602	8.937
5.75	4067.00	0.109	0.000	1.989	-0.062	6.740	14.671	2.581	8.898
6.00	4131.00	0.107	0.000	2.049	-0.062	6.699	14.423	2.560	8.861
6.25	4195.00	0.104	0.000	2.111	-0.062	6.662	14.188	2.539	8.827
6.50	4258.00	0.102	0.000	2.174	-0.063	6.631	13.965	2.518	8.796
6.75	4320.00	0.099	0.000	2.239	-0.063	6.604	13.752	2.497	8.767
7.00	4383.00	0.097	0.000	2.304	-0.063	6.581	13.551	2.476	8.741
7.25	4444.00	0.095	0.000	2.371	-0.064	6.562	13.359	2.455	8.717
7.50	4505.00	0.093	0.000	2.439	-0.064	6.546	13.177	2.435	8.696
7.75	4566.00	0.091	0.000	2.508	-0.065	6.535	13.005	2.414	8.676
8.00	4626.00	0.089	0.000	2.578	-0.116	6.506	12.813	2.377	8.637
8.25	4685.00	0.086	0.000	2.647	-0.191	6.436	12.605	2.312	8.579
8.50	4742.00	0.082	0.000	2.716	-0.271	6.355	12.407	2.246	8.522
8.75	4798.00	0.078	0.000	2.785	-0.281	6.316	12.256	2.205	8.496
9.00	4853.00	0.074	0.000	2.854	-0.282	6.322	12.126	2.185	8.485
9.25	4907.00	0.070	0.000	2.924	-0.282	6.329	12.003	2.166	8.476
9.50	4963.00	0.069	0.000	2.996	-0.068	6.530	12.020	2.268	8.587
9.75	5020.00	0.067	0.000	3.071	-0.068	6.540	11.904	2.247	8.585
10.00	5076.00	0.066	0.000	3.146	-0.069	6.553	11.794	2.226	8.585
10.25	5132.0	0.064	0.000	3.222	-0.069	6.567	11.690	2.206	8.586
10.50	5183.0	0.047	0.000	3.292	-7.436	5.583	6.092	1.523	3.661

Fixed Trim = -0.250 m
Relative Density = 1.025
Datum for VCB is Baseline

Draft Midships [m]	Displacement [t]	LCB Midships [m]	TCB Centreline [m]	VCB [m]	LCF Midships [m]	KMt [m]	KML [m]	TPcm	MTc [t.m]
0.75	831.80	1.566	0.000	0.383	0.175	45.285	362.477	11.420	51.777
1.00	1119.00	1.200	0.000	0.510	0.122	34.240	278.307	11.540	53.385
1.25	1409.00	0.977	0.000	0.636	0.110	27.644	226.693	11.634	54.654
1.50	1701.00	0.825	0.000	0.763	0.088	23.289	191.897	11.713	55.760
1.75	1994.00	0.711	0.000	0.890	0.004	20.161	165.430	11.749	56.266
2.00	2288.00	0.619	0.000	1.017	0.002	17.816	144.514	11.752	56.294
2.25	2581.00	0.549	0.000	1.143	-0.003	16.030	128.302	11.752	56.298
2.50	2875.00	0.493	0.000	1.269	0.003	14.635	115.434	11.751	56.316
2.75	3165.00	0.417	0.000	1.393	-2.704	12.041	80.648	10.553	42.984
3.00	3328.00	0.074	0.000	1.462	-1.334	7.627	21.482	2.956	11.194
3.25	3397.00	0.070	0.000	1.496	-0.029	7.516	18.044	2.792	9.412
3.50	3467.00	0.068	0.000	1.534	-0.029	7.401	17.616	2.771	9.348
3.75	3535.00	0.067	0.000	1.575	-0.029	7.296	17.212	2.750	9.286
4.00	3603.00	0.065	0.000	1.618	-0.030	7.201	16.830	2.729	9.228
4.25	3671.00	0.063	0.000	1.664	-0.030	7.114	16.469	2.708	9.172
4.50	3738.00	0.062	0.000	1.713	-0.030	7.034	16.127	2.687	9.119
4.75	3805.00	0.060	0.000	1.764	-0.030	6.962	15.804	2.665	9.069
5.00	3871.00	0.059	0.000	1.817	-0.030	6.897	15.497	2.644	9.022
5.25	3937.00	0.057	0.000	1.872	-0.030	6.839	15.207	2.623	8.978
5.50	4002.00	0.056	0.000	1.929	-0.031	6.786	14.931	2.602	8.936
5.75	4067.00	0.055	0.000	1.988	-0.031	6.740	14.670	2.581	8.897
6.00	4131.00	0.053	0.000	2.049	-0.031	6.698	14.422	2.560	8.861
6.25	4195.00	0.052	0.000	2.110	-0.031	6.662	14.187	2.539	8.827
6.50	4258.00	0.051	0.000	2.174	-0.031	6.630	13.964	2.518	8.796
6.75	4320.00	0.050	0.000	2.238	-0.032	6.603	13.751	2.497	8.767
7.00	4383.00	0.049	0.000	2.304	-0.032	6.580	13.550	2.476	8.741
7.25	4444.00	0.048	0.000	2.371	-0.032	6.561	13.359	2.455	8.717
7.50	4506.00	0.047	0.000	2.439	-0.032	6.546	13.177	2.434	8.695
7.75	4566.00	0.046	0.000	2.508	-0.032	6.534	13.004	2.414	8.676
8.00	4626.00	0.045	0.000	2.578	-0.066	6.510	12.820	2.380	8.643
8.25	4685.00	0.043	0.000	2.647	-0.139	6.440	12.613	2.314	8.586
8.50	4742.00	0.040	0.000	2.716	-0.217	6.361	12.415	2.249	8.529
8.75	4798.00	0.037	0.000	2.785	-0.247	6.316	12.255	2.205	8.497
9.00	4853.00	0.034	0.000	2.854	-0.247	6.321	12.126	2.185	8.486
9.25	4908.00	0.031	0.000	2.924	-0.247	6.329	12.003	2.166	8.477
9.50	4963.00	0.029	0.000	2.996	-0.034	6.530	12.019	2.268	8.587
9.75	5020.00	0.029	0.000	3.071	-0.034	6.540	11.904	2.247	8.585
10.00	5076.00	0.028	0.000	3.146	-0.034	6.553	11.794	2.226	8.584
10.25	5132.0	0.027	0.000	3.222	-0.035	6.567	11.689	2.205	8.586
10.50	5187.0	0.025	0.000	3.298	-2.680	6.226	9.163	1.947	6.416

Fixed Trim = 0.000 m
Relative Density = 1.025
Datum for VCB is Baseline

Draft Midships [m]	Displacement [t]	LCB Midships [m]	TCB Centreline [m]	VCB [m]	LCF Midships [m]	KMt [m]	KML [m]	TPcm	MTc [t.m]
0.75	831.4	0.000	0.000	0.380	0.000	45.329	363.214	11.426	51.855
1.00	1119.0	0.000	0.000	0.507	0.000	34.253	278.541	11.543	53.415
1.25	1408.0	0.000	0.000	0.634	0.000	27.664	227.123	11.640	54.747
1.50	1700.0	0.000	0.000	0.761	0.000	23.287	191.885	11.713	55.753
1.75	1994.0	0.000	0.000	0.888	0.000	20.166	165.560	11.753	56.311
2.00	2288.0	0.000	0.000	1.015	0.000	17.812	144.454	11.750	56.271
2.25	2581.0	0.000	0.000	1.141	0.000	16.031	128.335	11.753	56.313
2.50	2875.0	0.000	0.000	1.268	0.000	14.633	115.417	11.751	56.308
2.75	3169.0	0.000	0.000	1.393	0.000	13.520	104.961	11.751	56.341
3.00	3328.0	0.000	0.000	1.462	0.000	7.640	18.498	2.813	9.480
3.25	3397.0	0.000	0.000	1.496	0.000	7.515	18.044	2.792	9.412
3.50	3467.0	0.000	0.000	1.534	0.000	7.401	17.616	2.771	9.348
3.75	3535.0	0.000	0.000	1.574	0.000	7.296	17.212	2.750	9.286
4.00	3603.0	0.000	0.000	1.618	0.000	7.201	16.830	2.729	9.228
4.25	3671.0	0.000	0.000	1.664	0.000	7.113	16.469	2.708	9.172
4.50	3738.0	0.000	0.000	1.713	0.000	7.034	16.127	2.686	9.119
4.75	3805.0	0.000	0.000	1.764	0.000	6.962	15.803	2.665	9.069
5.00	3871.0	0.000	0.000	1.817	0.000	6.897	15.497	2.644	9.022
5.25	3937.0	0.000	0.000	1.872	0.000	6.839	15.206	2.623	8.978
5.50	4002.0	0.000	0.000	1.929	0.000	6.786	14.931	2.602	8.936
5.75	4067.0	0.000	0.000	1.988	0.000	6.740	14.670	2.581	8.897
6.00	4131.0	0.000	0.000	2.048	0.000	6.698	14.422	2.560	8.861
6.25	4195.0	0.000	0.000	2.110	0.000	6.662	14.187	2.539	8.827
6.50	4258.0	0.000	0.000	2.174	0.000	6.630	13.963	2.518	8.796
6.75	4320.0	0.000	0.000	2.238	0.000	6.603	13.751	2.497	8.767
7.00	4383.0	0.000	0.000	2.304	0.000	6.580	13.550	2.476	8.741
7.25	4444.0	0.000	0.000	2.371	0.000	6.561	13.358	2.455	8.717
7.50	4506.0	0.000	0.000	2.439	0.000	6.546	13.176	2.434	8.695
7.75	4566.0	0.000	0.000	2.508	0.000	6.534	13.003	2.414	8.676
8.00	4626.0	0.000	0.000	2.578	-0.016	6.513	12.828	2.383	8.650
8.25	4685.0	-0.001	0.000	2.647	-0.088	6.445	12.621	2.317	8.593
8.50	4743.0	-0.002	0.000	2.716	-0.164	6.367	12.423	2.252	8.536
8.75	4798.0	-0.004	0.000	2.785	-0.212	6.316	12.256	2.205	8.497
9.00	4853.0	-0.007	0.000	2.854	-0.212	6.321	12.126	2.185	8.486
9.25	4908.0	-0.009	0.000	2.924	-0.212	6.329	12.003	2.165	8.477
9.50	4963.0	-0.010	0.000	2.996	0.000	6.530	12.019	2.268	8.587
9.75	5020.0	-0.010	0.000	3.071	0.000	6.540	11.903	2.247	8.585
10.00	5076.0	-0.010	0.000	3.146	0.000	6.553	11.794	2.226	8.584
10.25	5132.0	-0.010	0.000	3.222	0.000	6.567	11.689	2.205	8.586
10.50	5187.0	-0.010	0.000	3.298	0.000	6.584	11.590	2.185	8.590

Fixed Trim = 0.250 m
Relative Density = 1.025
Datum for VCB is Baseline

Draft Midships [m]	Displacement [t]	LCB Midships [m]	TCB Centreline [m]	VCB [m]	LCF Midships [m]	KMt [m]	KML [m]	TPcm	MTc [t.m]
0.75	831.800	-1.565	0.000	0.383	-0.175	45.285	362.478	11.420	51.777
1.00	1119.000	-1.199	0.000	0.510	-0.121	34.240	278.307	11.540	53.385
1.25	1409.000	-0.977	0.000	0.636	-0.110	27.644	226.693	11.634	54.654
1.50	1701.000	-0.825	0.000	0.763	-0.088	23.289	191.897	11.713	55.760
1.75	1994.000	-0.711	0.000	0.890	-0.004	20.161	165.430	11.749	56.266
2.00	2288.000	-0.619	0.000	1.017	-0.002	17.817	144.514	11.752	56.294
2.25	2581.000	-0.549	0.000	1.143	0.003	16.030	128.302	11.752	56.298
2.50	2875.000	-0.493	0.000	1.269	-0.003	14.635	115.434	11.751	56.316
2.75	3165.000	-0.417	0.000	1.393	2.705	12.041	80.648	10.553	42.983
3.00	3328.000	-0.073	0.000	1.462	1.334	7.627	21.482	2.956	11.194
3.25	3397.000	-0.070	0.000	1.496	0.029	7.516	18.044	2.792	9.412
3.50	3467.000	-0.068	0.000	1.534	0.029	7.401	17.616	2.771	9.348
3.75	3535.00	-0.066	0.000	1.575	0.029	7.296	17.212	2.750	9.286
4.00	3603.00	-0.065	0.000	1.618	0.030	7.201	16.830	2.729	9.228
4.25	3671.00	-0.063	0.000	1.664	0.030	7.114	16.469	2.708	9.172
4.50	3738.00	-0.061	0.000	1.713	0.030	7.034	16.127	2.687	9.119
4.75	3805.00	-0.060	0.000	1.764	0.030	6.962	15.804	2.665	9.069
5.00	3871.00	-0.058	0.000	1.817	0.030	6.897	15.497	2.644	9.022
5.25	3937.00	-0.057	0.000	1.872	0.030	6.839	15.207	2.623	8.978
5.50	4002.00	-0.056	0.000	1.929	0.031	6.786	14.931	2.602	8.936
5.75	4067.00	-0.054	0.000	1.988	0.031	6.740	14.670	2.581	8.897
6.00	4131.00	-0.053	0.000	2.049	0.031	6.698	14.422	2.560	8.861
6.25	4195.00	-0.052	0.000	2.110	0.031	6.662	14.187	2.539	8.827
6.50	4258.00	-0.051	0.000	2.174	0.031	6.630	13.964	2.518	8.796
6.75	4320.00	-0.050	0.000	2.238	0.032	6.603	13.751	2.497	8.767
7.00	4383.00	-0.049	0.000	2.304	0.032	6.580	13.550	2.476	8.741
7.25	4444.00	-0.047	0.000	2.371	0.032	6.561	13.359	2.455	8.717
7.50	4506.00	-0.046	0.000	2.439	0.032	6.546	13.177	2.434	8.695
7.75	4566.00	-0.045	0.000	2.508	0.032	6.534	13.004	2.414	8.676
8.00	4626.00	-0.044	0.000	2.578	0.034	6.517	12.836	2.386	8.656
8.25	4685.00	-0.044	0.000	2.647	-0.036	6.449	12.629	2.320	8.599
8.50	4743.00	-0.044	0.000	2.717	-0.111	6.372	12.432	2.255	8.543
8.75	4798.00	-0.046	0.000	2.785	-0.177	6.316	12.256	2.205	8.498
9.00	4854.00	-0.047	0.000	2.854	-0.177	6.321	12.127	2.185	8.487
9.25	4908.00	-0.049	0.000	2.924	-0.177	6.329	12.004	2.165	8.478
9.50	4963.00	-0.050	0.000	2.996	0.034	6.530	12.019	2.268	8.587
9.75	5020.00	-0.049	0.000	3.071	0.034	6.540	11.904	2.247	8.585
10.00	5076.00	-0.048	0.000	3.146	0.034	6.553	11.794	2.226	8.584
10.25	5132.0	-0.047	0.000	3.222	0.035	6.567	11.689	2.205	8.586
10.50	5187.0	-0.045	0.000	3.298	2.677	6.226	9.167	1.947	6.418

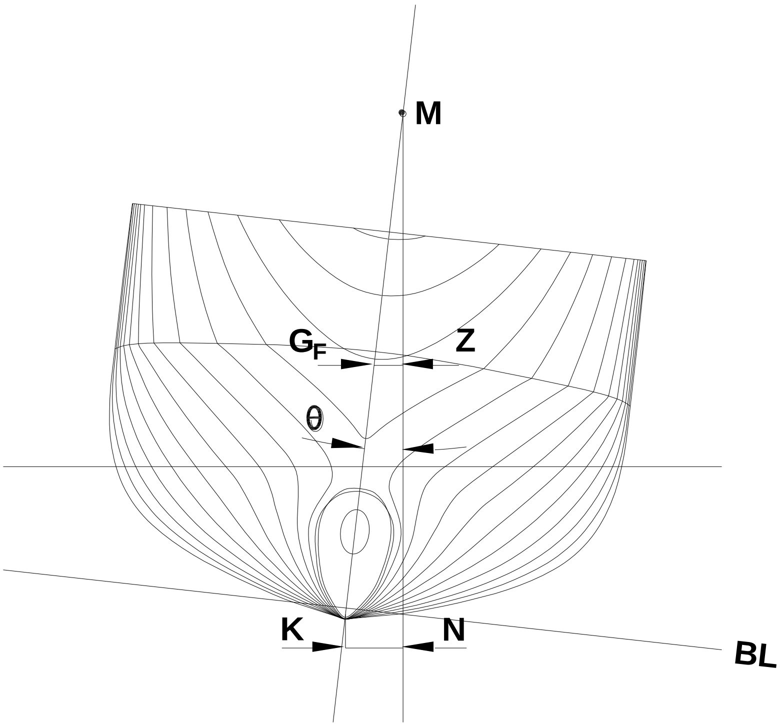
Fixed Trim = 0.500 m
Relative Density = 1.025
Datum for VCB is Baseline

Draft Midships [m]	Displacement [t]	LCB Midships [m]	TCB Centreline [m]	VCB [m]	LCF Midships [m]	KMt [m]	KML [m]	TPcm	MTc [t.m]
0.75	833.100	-3.121	0.000	0.394	-0.347	45.153	360.183	11.401	51.522
1.00	1120.000	-2.396	0.000	0.518	-0.260	34.204	277.654	11.534	53.299
1.25	1409.000	-1.952	0.000	0.643	-0.210	27.623	226.295	11.629	54.587
1.50	1701.000	-1.648	0.000	0.769	-0.138	23.256	191.045	11.697	55.526
1.75	1994.000	-1.419	0.000	0.895	-0.048	20.133	164.649	11.731	56.000
2.00	2288.000	-1.239	0.000	1.021	0.000	17.822	144.557	11.753	56.310
2.25	2581.000	-1.098	0.000	1.146	-0.001	16.032	128.281	11.751	56.286
2.50	2875.000	-0.986	0.000	1.272	0.002	14.639	115.460	11.752	56.328
2.75	3145.000	-0.723	0.000	1.386	6.300	11.446	54.470	8.998	28.494
3.00	3317.000	-0.223	0.000	1.458	9.493	8.840	38.004	4.772	20.623
3.25	3397.000	-0.140	0.000	1.497	0.058	7.516	18.046	2.792	9.413
3.50	3467.000	-0.137	0.000	1.534	0.058	7.402	17.618	2.771	9.348
3.75	3535.00	-0.133	0.000	1.575	0.059	7.297	17.213	2.750	9.287
4.00	3603.00	-0.130	0.000	1.618	0.059	7.201	16.831	2.729	9.228
4.25	3671.00	-0.126	0.000	1.665	0.059	7.114	16.470	2.708	9.172
4.50	3738.00	-0.123	0.000	1.713	0.060	7.035	16.128	2.687	9.120
4.75	3805.00	-0.120	0.000	1.764	0.060	6.963	15.805	2.666	9.070
5.00	3871.00	-0.117	0.000	1.818	0.060	6.898	15.498	2.644	9.023
5.25	3937.00	-0.114	0.000	1.873	0.061	6.839	15.208	2.623	8.978
5.50	4002.00	-0.112	0.000	1.930	0.061	6.787	14.932	2.602	8.937
5.75	4067.00	-0.109	0.000	1.989	0.062	6.740	14.671	2.581	8.898
6.00	4131.00	-0.106	0.000	2.049	0.062	6.699	14.423	2.560	8.861
6.25	4195.00	-0.104	0.000	2.111	0.062	6.662	14.188	2.539	8.827
6.50	4258.00	-0.102	0.000	2.174	0.063	6.631	13.965	2.518	8.796
6.75	4320.00	-0.099	0.000	2.239	0.063	6.604	13.752	2.497	8.767
7.00	4383.00	-0.097	0.000	2.304	0.063	6.581	13.551	2.476	8.741
7.25	4444.00	-0.095	0.000	2.371	0.064	6.562	13.359	2.455	8.717
7.50	4505.00	-0.093	0.000	2.439	0.064	6.546	13.177	2.435	8.696
7.75	4566.00	-0.091	0.000	2.508	0.065	6.535	13.005	2.414	8.676
8.00	4626.00	-0.089	0.000	2.578	0.073	6.518	12.838	2.386	8.657
8.25	4685.00	-0.087	0.000	2.648	0.015	6.454	12.638	2.323	8.606
8.50	4743.00	-0.087	0.000	2.717	-0.059	6.377	12.441	2.258	8.550
8.75	4799.00	-0.087	0.000	2.786	-0.143	6.316	12.257	2.205	8.499
9.00	4854.00	-0.088	0.000	2.855	-0.142	6.322	12.128	2.185	8.488
9.25	4908.00	-0.088	0.000	2.925	-0.142	6.329	12.005	2.165	8.479
9.50	4963.00	-0.089	0.000	2.996	-0.019	6.507	11.976	2.250	8.549
9.75	5020.00	-0.087	0.000	3.071	0.068	6.540	11.904	2.247	8.585
10.00	5076.00	-0.086	0.000	3.146	0.069	6.553	11.794	2.226	8.585
10.25	5132.0	-0.084	0.000	3.222	0.069	6.567	11.690	2.206	8.586
10.50	5183.0	-0.067	0.000	3.292	7.435	5.584	6.092	1.523	3.662

Fixed Trim = 0.750 m
Relative Density = 1.025
Datum for VCB is Baseline

Draft Midships [m]	Displacement [t]	LCB Midships [m]	TCB Centreline [m]	VCB [m]	LCF Midships [m]	KMt [m]	KML [m]	TPcm	MTc [t.m]
0.75	835.20	-4.659	0.000	0.412	-0.536	44.943	356.633	11.373	51.139
1.00	1121.00	-3.586	0.000	0.531	-0.403	34.113	275.930	11.516	53.041
1.25	1411.00	-2.921	0.000	0.654	-0.319	27.593	225.640	11.621	54.474
1.50	1702.00	-2.465	0.000	0.778	-0.201	23.201	189.674	11.671	55.149
1.75	1994.00	-2.124	0.000	0.902	-0.093	20.113	163.979	11.716	55.775
2.00	2288.00	-1.858	0.000	1.027	-0.005	17.822	144.429	11.749	56.256
2.25	2581.00	-1.647	0.000	1.152	-0.003	16.040	128.334	11.753	56.308
2.50	2873.00	-1.463	0.000	1.276	1.377	13.663	100.411	11.180	48.824
2.75	3119.00	-1.003	0.000	1.377	7.454	11.290	49.034	8.427	25.327
3.00	3294.00	-0.456	0.000	1.450	10.330	9.392	39.160	5.608	21.136
3.25	3397.00	-0.211	0.000	1.498	0.591	7.518	19.215	2.843	10.098
3.50	3466.00	-0.205	0.000	1.535	0.088	7.402	17.620	2.771	9.349
3.75	3535.00	-0.200	0.000	1.576	0.088	7.298	17.216	2.750	9.288
4.00	3603.00	-0.194	0.000	1.619	0.089	7.202	16.834	2.729	9.229
4.25	3671.00	-0.189	0.000	1.665	0.089	7.115	16.472	2.708	9.173
4.50	3738.00	-0.185	0.000	1.714	0.090	7.035	16.130	2.687	9.120
4.75	3805.00	-0.180	0.000	1.765	0.090	6.963	15.807	2.666	9.070
5.00	3871.00	-0.176	0.000	1.818	0.091	6.898	15.500	2.645	9.023
5.25	3937.00	-0.171	0.000	1.873	0.091	6.840	15.210	2.624	8.979
5.50	4002.00	-0.167	0.000	1.930	0.092	6.787	14.934	2.602	8.937
5.75	4067.00	-0.163	0.000	1.989	0.092	6.741	14.673	2.581	8.898
6.00	4131.00	-0.160	0.000	2.049	0.093	6.699	14.425	2.560	8.862
6.25	4194.00	-0.156	0.000	2.111	0.093	6.663	14.190	2.539	8.828
6.50	4258.00	-0.152	0.000	2.174	0.094	6.631	13.966	2.518	8.797
6.75	4320.00	-0.149	0.000	2.239	0.095	6.604	13.754	2.497	8.768
7.00	4383.00	-0.146	0.000	2.305	0.095	6.581	13.552	2.477	8.742
7.25	4444.00	-0.143	0.000	2.372	0.096	6.562	13.361	2.456	8.718
7.50	4505.00	-0.139	0.000	2.440	0.096	6.547	13.179	2.435	8.696
7.75	4566.00	-0.136	0.000	2.509	0.097	6.535	13.006	2.414	8.677
8.00	4626.00	-0.134	0.000	2.578	0.109	6.518	12.839	2.386	8.658
8.25	4685.00	-0.131	0.000	2.648	0.066	6.458	12.647	2.326	8.613
8.50	4743.00	-0.129	0.000	2.718	-0.006	6.383	12.450	2.261	8.557
8.75	4799.00	-0.128	0.000	2.786	-0.094	6.322	12.266	2.208	8.506
9.00	4854.00	-0.128	0.000	2.856	-0.108	6.322	12.129	2.185	8.489
9.25	4908.00	-0.128	0.000	2.925	-0.107	6.330	12.006	2.165	8.480
9.50	4963.00	-0.128	0.000	2.997	-0.090	6.471	11.924	2.229	8.504
9.75	5020.00	-0.126	0.000	3.071	0.102	6.541	11.905	2.247	8.585
10.00	5076.00	-0.124	0.000	3.147	0.103	6.553	11.795	2.226	8.585
10.25	5132.0	-0.121	0.000	3.222	0.104	6.568	11.691	2.206	8.587
10.50	5177.0	-0.086	0.000	3.285	9.027	5.367	5.377	1.384	3.018

ANNEX E
KN DATA


M
G_F
Z
θ
K
N
BL

Fixed Tim = -0.750 m									
Relative Density = 1.025									
Displacement [t]	KN								
	0.0˚	5.0˚	10.0˚	20.0˚	30.0˚	40.0˚	50.0˚	60.0˚	70.0˚
800.00	0.000	3.859	5.734	6.933	7.222	7.113	6.752	6.237	5.725
910.00	0.000	3.511	5.477	6.769	7.121	7.073	6.773	6.322	5.881
1020.00	0.000	3.206	5.234	6.612	7.023	7.032	6.793	6.405	6.029
1130.00	0.000	2.938	5.002	6.460	6.924	6.991	6.814	6.490	6.167
1240.00	0.000	2.705	4.778	6.308	6.824	6.949	6.835	6.576	6.291
1350.00	0.000	2.503	4.562	6.156	6.721	6.906	6.855	6.662	6.399
1460.00	0.000	2.329	4.354	6.000	6.617	6.861	6.875	6.749	6.489
1570.00	0.000	2.180	4.152	5.841	6.511	6.816	6.894	6.833	6.558
1680.00	0.000	2.050	3.954	5.679	6.404	6.769	6.911	6.907	6.595
1790.00	0.000	1.935	3.759	5.516	6.296	6.721	6.925	6.957	6.577
1900.00	0.000	1.834	3.567	5.350	6.186	6.672	6.938	6.976	6.438
2010.00	0.000	1.741	3.379	5.184	6.075	6.622	6.950	6.956	6.233
2120.00	0.000	1.656	3.195	5.016	5.963	6.569	6.953	6.876	6.036
2230.00	0.000	1.578	3.016	4.846	5.850	6.514	6.934	6.703	5.849
2340.00	0.000	1.504	2.841	4.676	5.735	6.456	6.884	6.491	5.668
2450.00	0.000	1.433	2.674	4.504	5.620	6.396	6.790	6.284	5.494
2560.00	0.000	1.362	2.512	4.332	5.504	6.336	6.635	6.081	5.326
2670.00	0.000	1.289	2.356	4.158	5.386	6.271	6.417	5.881	5.162
2780.00	0.000	1.212	2.206	3.984	5.267	6.191	6.189	5.684	5.003
2890.00	0.000	1.127	2.060	3.809	5.145	6.083	5.963	5.490	4.847
3000.00	0.000	1.036	1.918	3.633	5.020	5.935	5.737	5.298	4.694
3110.00	0.000	0.940	1.781	3.458	4.894	5.736	5.513	5.108	4.544
3220.00	0.000	0.842	1.649	3.288	4.768	5.492	5.290	4.919	4.396
3330.00	0.000	0.748	1.525	3.125	4.643	5.240	5.066	4.732	4.250
3440.00	0.000	0.674	1.412	2.972	4.517	4.988	4.843	4.545	4.106
3550.00	0.000	0.637	1.319	2.832	4.385	4.736	4.621	4.360	3.964
3660.00	0.000	0.621	1.262	2.706	4.237	4.482	4.399	4.176	3.823
3770.00	0.000	0.610	1.228	2.597	4.059	4.229	4.177	3.993	3.684
3880.00	0.000	0.601	1.207	2.506	3.844	3.975	3.955	3.809	3.547
3990.00	0.000	0.593	1.191	2.438	3.593	3.722	3.734	3.632	3.423
4100.00	0.000	0.587	1.178	2.390	3.332	3.479	3.522	3.467	3.314
4210.00	0.000	0.581	1.167	2.357	3.082	3.254	3.332	3.318	3.219
4320.00	0.000	0.577	1.157	2.335	2.852	3.053	3.164	3.187	3.137
4430.00	0.000	0.574	1.145	2.285	2.644	2.873	3.018	3.079	3.071
4540.00	0.000	0.570	1.135	2.122	2.455	2.714	2.895	2.994	3.024
4650.00	0.000	0.563	1.131	1.923	2.283	2.576	2.792	2.930	2.997
4760.00	0.000	0.558	1.130	1.740	2.130	2.456	2.709	2.885	2.990
4870.00	0.000	0.560	1.092	1.572	1.992	2.353	2.644	2.860	3.003
4980.00	0.000	0.565	0.920	1.417	1.870	2.267	2.598	2.853	3.030
5090.00	0.000	0.475	0.748	1.275	1.763	2.198	2.568	2.860	3.067
5200.00	0.000	0.298	0.585	1.144	1.666	2.139	2.546	2.877	3.119

Fixed Tim = -0.500 m									
Relative Density = 1.025									
Displacement [t]	KN								
	0.0˚	5.0˚	10.0˚	20.0˚	30.0˚	40.0˚	50.0˚	60.0˚	70.0˚
800.00	0.000	3.930	5.764	6.947	7.228	7.116	6.752	6.235	5.718
910.00	0.000	3.561	5.505	6.782	7.127	7.075	6.772	6.319	5.875
1020.00	0.000	3.236	5.260	6.624	7.029	7.035	6.793	6.402	6.024
1130.00	0.000	2.953	5.029	6.472	6.930	6.993	6.814	6.488	6.164
1240.00	0.000	2.711	4.806	6.321	6.829	6.951	6.835	6.574	6.290
1350.00	0.000	2.506	4.591	6.168	6.726	6.908	6.855	6.660	6.400
1460.00	0.000	2.332	4.384	6.011	6.622	6.863	6.875	6.747	6.491
1570.00	0.000	2.182	4.182	5.851	6.515	6.818	6.894	6.833	6.561
1680.00	0.000	2.052	3.985	5.689	6.408	6.771	6.911	6.910	6.599
1790.00	0.000	1.937	3.789	5.525	6.299	6.723	6.926	6.961	6.583
1900.00	0.000	1.835	3.594	5.359	6.189	6.674	6.939	6.980	6.439
2010.00	0.000	1.745	3.401	5.192	6.078	6.623	6.951	6.960	6.233
2120.00	0.000	1.662	3.212	5.023	5.966	6.571	6.956	6.881	6.037
2230.00	0.000	1.586	3.028	4.854	5.853	6.515	6.938	6.703	5.849
2340.00	0.000	1.515	2.852	4.683	5.738	6.457	6.888	6.491	5.669
2450.00	0.000	1.447	2.683	4.511	5.623	6.398	6.795	6.284	5.495
2560.00	0.000	1.379	2.520	4.338	5.506	6.337	6.639	6.081	5.326
2670.00	0.000	1.306	2.363	4.165	5.389	6.275	6.418	5.881	5.162
2780.00	0.000	1.227	2.211	3.990	5.270	6.196	6.190	5.685	5.003
2890.00	0.000	1.140	2.064	3.815	5.148	6.088	5.963	5.490	4.847
3000.00	0.000	1.046	1.922	3.638	5.023	5.940	5.738	5.298	4.694
3110.00	0.000	0.947	1.784	3.462	4.897	5.740	5.514	5.108	4.544
3220.00	0.000	0.844	1.650	3.289	4.770	5.493	5.290	4.920	4.396
3330.00	0.000	0.743	1.524	3.125	4.645	5.241	5.067	4.732	4.251
3440.00	0.000	0.666	1.409	2.972	4.519	4.990	4.844	4.546	4.107
3550.00	0.000	0.634	1.314	2.831	4.390	4.737	4.622	4.361	3.965
3660.00	0.000	0.621	1.257	2.704	4.243	4.483	4.400	4.177	3.824
3770.00	0.000	0.610	1.227	2.594	4.065	4.230	4.178	3.993	3.684
3880.00	0.000	0.601	1.207	2.504	3.849	3.976	3.956	3.810	3.547
3990.00	0.000	0.593	1.191	2.437	3.594	3.723	3.734	3.632	3.422
4100.00	0.000	0.586	1.177	2.388	3.332	3.479	3.522	3.467	3.313
4210.00	0.000	0.581	1.166	2.356	3.082	3.254	3.331	3.316	3.219
4320.00	0.000	0.577	1.157	2.336	2.852	3.052	3.163	3.186	3.136
4430.00	0.000	0.574	1.145	2.289	2.644	2.872	3.017	3.078	3.069
4540.00	0.000	0.570	1.135	2.121	2.454	2.714	2.894	2.993	3.021
4650.00	0.000	0.563	1.131	1.923	2.283	2.575	2.792	2.929	2.995
4760.00	0.000	0.558	1.131	1.740	2.130	2.455	2.709	2.885	2.988
4870.00	0.000	0.560	1.097	1.572	1.992	2.353	2.644	2.859	3.002
4980.00	0.000	0.566	0.920	1.417	1.870	2.267	2.597	2.853	3.029
5090.00	0.000	0.475	0.747	1.275	1.763	2.198	2.568	2.860	3.067
5200.00	0.000	0.298	0.585	1.143	1.666	2.139	2.546	2.877	3.119

Fixed Tim = -0.250 m									
Relative Density = 1.025									
Displacement [t]	KN								
	0.0˚	5.0˚	10.0˚	20.0˚	30.0˚	40.0˚	50.0˚	60.0˚	70.0˚
800.00	0.000	3.978	5.781	6.955	7.232	7.117	6.752	6.233	5.715
910.00	0.000	3.596	5.521	6.789	7.130	7.077	6.772	6.318	5.872
1020.00	0.000	3.252	5.276	6.631	7.032	7.036	6.793	6.401	6.021
1130.00	0.000	2.958	5.045	6.479	6.933	6.995	6.814	6.486	6.162
1240.00	0.000	2.713	4.823	6.329	6.832	6.952	6.835	6.573	6.290
1350.00	0.000	2.508	4.610	6.175	6.729	6.909	6.855	6.659	6.400
1460.00	0.000	2.334	4.402	6.017	6.624	6.864	6.875	6.746	6.492
1570.00	0.000	2.183	4.200	5.857	6.518	6.819	6.894	6.833	6.562
1680.00	0.000	2.053	4.003	5.694	6.410	6.772	6.911	6.911	6.602
1790.00	0.000	1.938	3.808	5.530	6.301	6.724	6.926	6.963	6.587
1900.00	0.000	1.836	3.612	5.364	6.192	6.675	6.939	6.982	6.439
2010.00	0.000	1.746	3.414	5.197	6.080	6.624	6.951	6.963	6.233
2120.00	0.000	1.665	3.220	5.028	5.968	6.572	6.958	6.885	6.037
2230.00	0.000	1.590	3.036	4.858	5.855	6.516	6.941	6.704	5.849
2340.00	0.000	1.521	2.858	4.687	5.740	6.458	6.890	6.492	5.669
2450.00	0.000	1.456	2.688	4.515	5.625	6.399	6.798	6.285	5.495
2560.00	0.000	1.390	2.525	4.342	5.508	6.338	6.642	6.081	5.326
2670.00	0.000	1.317	2.367	4.169	5.390	6.277	6.418	5.882	5.163
2780.00	0.000	1.236	2.215	3.994	5.272	6.199	6.190	5.685	5.003
2890.00	0.000	1.147	2.067	3.818	5.150	6.091	5.964	5.491	4.847
3000.00	0.000	1.052	1.924	3.642	5.025	5.943	5.739	5.299	4.694
3110.00	0.000	0.952	1.785	3.465	4.898	5.743	5.514	5.108	4.544
3220.00	0.000	0.847	1.651	3.290	4.772	5.494	5.291	4.920	4.396
3330.00	0.000	0.741	1.524	3.125	4.646	5.242	5.067	4.732	4.251
3440.00	0.000	0.659	1.407	2.971	4.521	4.990	4.845	4.546	4.107
3550.00	0.000	0.634	1.311	2.830	4.393	4.737	4.622	4.361	3.965
3660.00	0.000	0.621	1.255	2.703	4.247	4.484	4.401	4.177	3.824
3770.00	0.000	0.610	1.226	2.593	4.069	4.231	4.178	3.993	3.684
3880.00	0.000	0.601	1.207	2.502	3.852	3.977	3.956	3.810	3.547
3990.00	0.000	0.593	1.191	2.436	3.595	3.723	3.734	3.632	3.422
4100.00	0.000	0.586	1.177	2.387	3.332	3.478	3.522	3.467	3.313
4210.00	0.000	0.581	1.166	2.356	3.081	3.254	3.331	3.315	3.218
4320.00	0.000	0.577	1.157	2.336	2.852	3.052	3.162	3.186	3.135
4430.00	0.000	0.574	1.145	2.292	2.643	2.872	3.017	3.078	3.067
4540.00	0.000	0.570	1.135	2.121	2.454	2.714	2.894	2.992	3.020
4650.00	0.000	0.563	1.131	1.923	2.283	2.575	2.792	2.928	2.993
4760.00	0.000	0.558	1.131	1.740	2.129	2.455	2.709	2.884	2.988
4870.00	0.000	0.560	1.100	1.572	1.992	2.353	2.644	2.859	3.001
4980.00	0.000	0.566	0.920	1.417	1.870	2.267	2.597	2.852	3.029
5090.00	0.000	0.475	0.747	1.275	1.763	2.198	2.568	2.860	3.067
5200.00	0.000	0.299	0.585	1.143	1.666	2.139	2.546	2.877	3.119

Fixed Tim = 0.000 m									
Relative Density = 1.025									
Displacement [t]	KN								
	0.0˚	5.0˚	10.0˚	20.0˚	30.0˚	40.0˚	50.0˚	60.0˚	70.0˚
800.00	0.000	3.994	5.787	6.958	7.233	7.118	6.752	6.233	5.713
910.00	0.000	3.611	5.527	6.792	7.131	7.077	6.772	6.317	5.871
1020.00	0.000	3.255	5.282	6.633	7.034	7.037	6.793	6.400	6.020
1130.00	0.000	2.959	5.050	6.481	6.934	6.995	6.814	6.485	6.162
1240.00	0.000	2.714	4.828	6.331	6.833	6.953	6.835	6.572	6.290
1350.00	0.000	2.509	4.616	6.177	6.730	6.909	6.855	6.659	6.400
1460.00	0.000	2.334	4.409	6.019	6.625	6.865	6.875	6.746	6.493
1570.00	0.000	2.184	4.206	5.859	6.519	6.819	6.894	6.833	6.563
1680.00	0.000	2.053	4.008	5.696	6.411	6.772	6.912	6.912	6.603
1790.00	0.000	1.938	3.815	5.532	6.302	6.724	6.926	6.964	6.588
1900.00	0.000	1.836	3.619	5.366	6.192	6.675	6.939	6.983	6.439
2010.00	0.000	1.746	3.418	5.198	6.081	6.624	6.951	6.963	6.233
2120.00	0.000	1.665	3.223	5.030	5.969	6.572	6.959	6.886	6.037
2230.00	0.000	1.592	3.038	4.860	5.855	6.517	6.942	6.704	5.849
2340.00	0.000	1.524	2.860	4.688	5.741	6.459	6.891	6.492	5.669
2450.00	0.000	1.459	2.690	4.516	5.625	6.399	6.799	6.285	5.495
2560.00	0.000	1.394	2.527	4.343	5.508	6.339	6.644	6.082	5.326
2670.00	0.000	1.321	2.369	4.170	5.391	6.278	6.419	5.882	5.163
2780.00	0.000	1.239	2.216	3.995	5.272	6.200	6.191	5.685	5.003
2890.00	0.000	1.149	2.068	3.819	5.150	6.092	5.964	5.491	4.847
3000.00	0.000	1.054	1.925	3.643	5.026	5.944	5.739	5.299	4.694
3110.00	0.000	0.953	1.785	3.466	4.899	5.745	5.515	5.109	4.544
3220.00	0.000	0.848	1.651	3.290	4.773	5.494	5.291	4.920	4.396
3330.00	0.000	0.741	1.523	3.125	4.647	5.242	5.067	4.733	4.251
3440.00	0.000	0.657	1.406	2.971	4.521	4.990	4.845	4.546	4.107
3550.00	0.000	0.634	1.309	2.830	4.394	4.738	4.622	4.361	3.965
3660.00	0.000	0.621	1.254	2.703	4.248	4.484	4.400	4.177	3.824
3770.00	0.000	0.610	1.226	2.592	4.070	4.231	4.178	3.993	3.684
3880.00	0.000	0.601	1.207	2.502	3.853	3.977	3.956	3.810	3.547
3990.00	0.000	0.593	1.191	2.436	3.595	3.723	3.734	3.632	3.422
4100.00	0.000	0.586	1.177	2.387	3.332	3.478	3.522	3.467	3.313
4210.00	0.000	0.581	1.166	2.355	3.081	3.254	3.331	3.315	3.218
4320.00	0.000	0.577	1.157	2.336	2.852	3.052	3.162	3.185	3.135
4430.00	0.000	0.574	1.145	2.293	2.643	2.872	3.017	3.077	3.067
4540.00	0.000	0.570	1.135	2.121	2.454	2.714	2.894	2.992	3.019
4650.00	0.000	0.564	1.131	1.923	2.283	2.575	2.792	2.928	2.993
4760.00	0.000	0.558	1.131	1.740	2.129	2.455	2.708	2.884	2.987
4870.00	0.000	0.560	1.102	1.572	1.992	2.353	2.644	2.859	3.001
4980.00	0.000	0.565	0.920	1.417	1.870	2.267	2.597	2.852	3.029
5090.00	0.000	0.475	0.747	1.275	1.763	2.198	2.568	2.860	3.067
5200.00	0.000	0.298	0.585	1.143	1.666	2.139	2.546	2.877	3.119

Fixed Tim = 0.250 m									
Relative Density = 1.025									
Displacement [t]	KN								
	0.0˚	5.0˚	10.0˚	20.0˚	30.0˚	40.0˚	50.0˚	60.0˚	70.0˚
800.00	0.000	3.978	5.781	6.955	7.232	7.117	6.752	6.233	5.715
910.00	0.000	3.596	5.521	6.789	7.130	7.077	6.772	6.318	5.872
1020.00	0.000	3.252	5.276	6.631	7.032	7.036	6.793	6.401	6.021
1130.00	0.000	2.958	5.045	6.479	6.933	6.995	6.814	6.486	6.163
1240.00	0.000	2.713	4.823	6.329	6.832	6.952	6.835	6.573	6.290
1350.00	0.000	2.508	4.610	6.175	6.729	6.909	6.855	6.659	6.400
1460.00	0.000	2.334	4.402	6.017	6.624	6.864	6.875	6.746	6.492
1570.00	0.000	2.183	4.200	5.857	6.518	6.819	6.894	6.833	6.563
1680.00	0.000	2.053	4.003	5.694	6.410	6.772	6.912	6.912	6.602
1790.00	0.000	1.938	3.808	5.530	6.301	6.724	6.926	6.963	6.587
1900.00	0.000	1.836	3.612	5.364	6.192	6.675	6.940	6.983	6.439
2010.00	0.000	1.746	3.414	5.197	6.080	6.624	6.952	6.963	6.233
2120.00	0.000	1.665	3.220	5.028	5.968	6.572	6.959	6.885	6.037
2230.00	0.000	1.590	3.036	4.858	5.855	6.517	6.941	6.704	5.849
2340.00	0.000	1.521	2.858	4.687	5.740	6.459	6.890	6.492	5.669
2450.00	0.000	1.456	2.688	4.515	5.625	6.399	6.798	6.285	5.495
2560.00	0.000	1.390	2.525	4.342	5.508	6.339	6.642	6.081	5.326
2670.00	0.000	1.317	2.367	4.169	5.390	6.277	6.418	5.882	5.163
2780.00	0.000	1.236	2.215	3.994	5.272	6.199	6.190	5.685	5.003
2890.00	0.000	1.147	2.067	3.818	5.150	6.091	5.964	5.491	4.847
3000.00	0.000	1.052	1.924	3.642	5.026	5.943	5.739	5.299	4.694
3110.00	0.000	0.952	1.785	3.465	4.899	5.743	5.514	5.108	4.544
3220.00	0.000	0.847	1.651	3.290	4.773	5.494	5.291	4.920	4.396
3330.00	0.000	0.741	1.524	3.125	4.646	5.242	5.067	4.732	4.251
3440.00	0.000	0.659	1.407	2.971	4.521	4.990	4.845	4.546	4.107
3550.00	0.000	0.634	1.311	2.830	4.393	4.737	4.622	4.361	3.965
3660.00	0.000	0.621	1.255	2.703	4.247	4.484	4.401	4.177	3.824
3770.00	0.000	0.610	1.226	2.593	4.069	4.231	4.178	3.993	3.684
3880.00	0.000	0.601	1.207	2.503	3.852	3.977	3.956	3.810	3.547
3990.00	0.000	0.593	1.191	2.437	3.595	3.723	3.734	3.632	3.422
4100.00	0.000	0.586	1.177	2.388	3.332	3.478	3.522	3.467	3.313
4210.00	0.000	0.581	1.166	2.356	3.081	3.254	3.331	3.315	3.218
4320.00	0.000	0.577	1.157	2.336	2.852	3.052	3.162	3.186	3.135
4430.00	0.000	0.574	1.145	2.292	2.643	2.872	3.017	3.078	3.067
4540.00	0.000	0.570	1.135	2.121	2.454	2.714	2.894	2.992	3.020
4650.00	0.000	0.564	1.131	1.923	2.283	2.575	2.792	2.928	2.993
4760.00	0.000	0.558	1.131	1.740	2.129	2.455	2.709	2.884	2.988
4870.00	0.000	0.560	1.100	1.572	1.992	2.353	2.644	2.859	3.001
4980.00	0.000	0.565	0.920	1.417	1.870	2.267	2.597	2.852	3.029
5090.00	0.000	0.475	0.748	1.275	1.763	2.198	2.568	2.860	3.067
5200.00	0.000	0.299	0.585	1.143	1.666	2.139	2.546	2.877	3.119

Fixed Tim = 0.500 m									
Relative Density = 1.025									
Displacement [t]	KN								
	0.0˚	5.0˚	10.0˚	20.0˚	30.0˚	40.0˚	50.0˚	60.0˚	70.0˚
800.00	0.000	3.930	5.764	6.947	7.228	7.116	6.752	6.235	5.719
910.00	0.000	3.561	5.505	6.782	7.127	7.075	6.772	6.319	5.876
1020.00	0.000	3.236	5.260	6.624	7.029	7.035	6.793	6.402	6.025
1130.00	0.000	2.953	5.029	6.472	6.930	6.993	6.814	6.488	6.165
1240.00	0.000	2.711	4.806	6.321	6.829	6.951	6.835	6.574	6.291
1350.00	0.000	2.506	4.591	6.168	6.726	6.908	6.855	6.661	6.400
1460.00	0.000	2.332	4.384	6.011	6.622	6.863	6.875	6.747	6.492
1570.00	0.000	2.182	4.182	5.851	6.515	6.818	6.894	6.834	6.561
1680.00	0.000	2.051	3.985	5.689	6.408	6.771	6.912	6.910	6.600
1790.00	0.000	1.937	3.789	5.525	6.299	6.723	6.926	6.961	6.583
1900.00	0.000	1.835	3.594	5.359	6.189	6.674	6.940	6.981	6.439
2010.00	0.000	1.745	3.401	5.192	6.078	6.623	6.951	6.960	6.233
2120.00	0.000	1.662	3.212	5.023	5.966	6.571	6.957	6.881	6.037
2230.00	0.000	1.586	3.028	4.854	5.853	6.516	6.939	6.703	5.849
2340.00	0.000	1.515	2.852	4.683	5.738	6.458	6.888	6.491	5.669
2450.00	0.000	1.447	2.683	4.511	5.623	6.399	6.795	6.284	5.495
2560.00	0.000	1.379	2.520	4.338	5.506	6.338	6.639	6.081	5.326
2670.00	0.000	1.306	2.363	4.165	5.389	6.275	6.418	5.881	5.162
2780.00	0.000	1.227	2.211	3.990	5.270	6.196	6.190	5.685	5.003
2890.00	0.000	1.140	2.064	3.815	5.149	6.088	5.963	5.490	4.847
3000.00	0.000	1.046	1.922	3.638	5.025	5.940	5.738	5.298	4.694
3110.00	0.000	0.947	1.784	3.462	4.898	5.740	5.514	5.108	4.544
3220.00	0.000	0.844	1.650	3.289	4.772	5.493	5.290	4.920	4.396
3330.00	0.000	0.743	1.524	3.125	4.645	5.241	5.067	4.732	4.251
3440.00	0.000	0.666	1.409	2.972	4.520	4.990	4.844	4.546	4.107
3550.00	0.000	0.634	1.314	2.831	4.390	4.737	4.622	4.361	3.965
3660.00	0.000	0.621	1.257	2.704	4.243	4.483	4.400	4.177	3.824
3770.00	0.000	0.610	1.227	2.594	4.065	4.230	4.178	3.993	3.684
3880.00	0.000	0.601	1.207	2.505	3.849	3.976	3.956	3.810	3.547
3990.00	0.000	0.593	1.191	2.438	3.594	3.723	3.734	3.632	3.422
4100.00	0.000	0.586	1.177	2.389	3.332	3.479	3.522	3.467	3.313
4210.00	0.000	0.581	1.166	2.356	3.082	3.254	3.331	3.316	3.219
4320.00	0.000	0.577	1.157	2.336	2.852	3.052	3.163	3.186	3.136
4430.00	0.000	0.574	1.146	2.289	2.644	2.872	3.017	3.078	3.069
4540.00	0.000	0.570	1.136	2.121	2.454	2.714	2.894	2.993	3.021
4650.00	0.000	0.564	1.131	1.923	2.283	2.575	2.792	2.929	2.995
4760.00	0.000	0.559	1.131	1.740	2.130	2.455	2.709	2.885	2.989
4870.00	0.000	0.560	1.097	1.572	1.992	2.353	2.644	2.859	3.002
4980.00	0.000	0.565	0.920	1.417	1.870	2.267	2.597	2.853	3.029
5090.00	0.000	0.475	0.748	1.275	1.763	2.198	2.568	2.860	3.067
5200.00	0.000	0.298	0.585	1.143	1.666	2.139	2.546	2.877	3.119

Fixed Tim = 0.750 m									
Relative Density = 1.025									
Displacement [t]	KN								
	0.0˚	5.0˚	10.0˚	20.0˚	30.0˚	40.0˚	50.0˚	60.0˚	70.0˚
800.00	0.000	3.859	5.734	6.933	7.222	7.113	6.752	6.237	5.725
910.00	0.000	3.511	5.477	6.769	7.121	7.073	6.773	6.322	5.882
1020.00	0.000	3.206	5.234	6.612	7.023	7.032	6.793	6.405	6.031
1130.00	0.000	2.938	5.002	6.460	6.924	6.991	6.814	6.490	6.168
1240.00	0.000	2.705	4.778	6.308	6.824	6.949	6.835	6.576	6.292
1350.00	0.000	2.503	4.562	6.156	6.721	6.906	6.855	6.663	6.400
1460.00	0.000	2.329	4.354	6.000	6.617	6.861	6.875	6.749	6.490
1570.00	0.000	2.180	4.152	5.841	6.511	6.816	6.894	6.834	6.559
1680.00	0.000	2.050	3.954	5.679	6.404	6.769	6.911	6.908	6.596
1790.00	0.000	1.935	3.759	5.516	6.296	6.721	6.926	6.958	6.577
1900.00	0.000	1.834	3.567	5.350	6.186	6.672	6.939	6.977	6.438
2010.00	0.000	1.741	3.379	5.184	6.075	6.622	6.951	6.956	6.233
2120.00	0.000	1.656	3.195	5.016	5.963	6.570	6.954	6.876	6.036
2230.00	0.000	1.578	3.016	4.846	5.850	6.515	6.935	6.703	5.849
2340.00	0.000	1.504	2.841	4.676	5.735	6.457	6.884	6.491	5.668
2450.00	0.000	1.433	2.674	4.504	5.620	6.398	6.790	6.284	5.494
2560.00	0.000	1.362	2.512	4.332	5.504	6.337	6.635	6.081	5.326
2670.00	0.000	1.289	2.356	4.158	5.386	6.272	6.417	5.881	5.162
2780.00	0.000	1.212	2.206	3.984	5.268	6.192	6.189	5.684	5.003
2890.00	0.000	1.127	2.060	3.809	5.147	6.083	5.963	5.490	4.847
3000.00	0.000	1.036	1.918	3.633	5.022	5.935	5.737	5.298	4.694
3110.00	0.000	0.940	1.781	3.458	4.896	5.736	5.513	5.108	4.544
3220.00	0.000	0.842	1.649	3.288	4.770	5.492	5.290	4.919	4.396
3330.00	0.000	0.748	1.525	3.125	4.644	5.240	5.066	4.732	4.250
3440.00	0.000	0.674	1.412	2.972	4.518	4.988	4.843	4.545	4.106
3550.00	0.000	0.637	1.319	2.832	4.385	4.736	4.621	4.360	3.964
3660.00	0.000	0.621	1.262	2.706	4.237	4.482	4.399	4.176	3.823
3770.00	0.000	0.610	1.228	2.597	4.059	4.229	4.177	3.993	3.684
3880.00	0.000	0.601	1.207	2.508	3.844	3.975	3.955	3.809	3.547
3990.00	0.000	0.593	1.191	2.440	3.593	3.722	3.734	3.632	3.423
4100.00	0.000	0.587	1.178	2.391	3.332	3.479	3.522	3.467	3.314
4210.00	0.000	0.581	1.167	2.358	3.082	3.254	3.332	3.318	3.219
4320.00	0.000	0.577	1.157	2.335	2.852	3.053	3.164	3.187	3.137
4430.00	0.000	0.574	1.146	2.285	2.644	2.873	3.018	3.079	3.071
4540.00	0.000	0.571	1.136	2.122	2.455	2.714	2.895	2.994	3.024
4650.00	0.000	0.564	1.131	1.923	2.283	2.576	2.792	2.930	2.997
4760.00	0.000	0.559	1.130	1.740	2.130	2.456	2.709	2.886	2.990
4870.00	0.000	0.560	1.092	1.572	1.992	2.353	2.645	2.860	3.003
4980.00	0.000	0.564	0.920	1.417	1.870	2.267	2.598	2.853	3.030
5090.00	0.000	0.475	0.748	1.275	1.763	2.198	2.568	2.860	3.067
5200.00	0.000	0.298	0.585	1.143	1.666	2.139	2.546	2.877	3.119

ANNEX F
INCLINING EXPERIMENT

JOHN BUTLER DESIGN

MARITIME CONSULTANTS - NAVAL ARCHITECTS

AMSA ACCREDITED SURVEYORS

NOAKES GROUP

FLOATING DRY DOCK – ‘FDD1N’

INCLINING EXPERIMENT REPORT

REVISION 1

REPORT No.:	EA-2151-004	**CLIENT:**	NOAKES GROUP
PO No:			
TITLE:	FLOATING DRY DOCK INCLINING EXPERIMENT REPORT		

DESIGNER APPROVAL		**CUSTOMER ACCEPTANCE**	
Signature	J Butler	Signature	
Full Name	John Butler	Full Name	
Title / Rank	Principal Naval Architect	Title / Rank	
Organisation	John Butler Design	Organisation	
Date	25/01/2022	Date	

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ENDORSEMENTS & REVISION HISTORY

The document is cleared by:

	Name	Department / Group	Date
Prepared By:	Nichola Buchanan	HULL	25/01/2022
Checked By:	Jordan Banks	HULL	25/01/2022
Approved By:	John Butler	HULL	25/01/2022

RECORD OF AMENDMENTS

Rev No	Date	Description	Prepared By	Checked By	Approved By
1	25/01/2022	Original Issue	Nichola Buchanan	Jordan Banks	John Butler

TABLE OF CONTENTS

1 BACKGROUND

John Butler Design carried out a periodic inclining experiment on the floating dry dock, FDD1N, to determine lightship parameters of the vessel following the remediation work carried out at Harwood Marine.

2 PURPOSE

This report shows the results of the inclining experiment undertaken on the floating dry dock. The experiment was conducted by John Butler Design on the 17th of January 2022 in Snails Bay, Sydney.

The Inclining Program included:

- Preparing the ship to an acceptable condition for the inclining experiment.
- Carrying out a ship check to determine weights to remove, add and move.
- Conducting the Inclining Experiment; and
- Calculating the results for the as-inclined condition and determining the lightship condition.

The inclining experiment was conducted in accordance with Ref (A).

3 REFERENCES

a) DEF(AUST) 5000, MRS Vol 03 “Hull System Requirements” Pt 14, “Inclining Experiments”

b) IACS (International Association of Classification Societies) Inclining Test Unified Procedure

c) National Standard for Commercial Vessels, Part C, Section 6C

d) John Butler Design Report EA-2151-002 – Noakes FDD Inclining Experiment Procedure

e) Shearforce Maritime Services Report SYD/2015/19 – Structural and Stability Assessment – Final Report Floating Dock AFD 1002, 16th November 2016

4 ABBREVIATIONS ACRONYMS AND DEFINITIONS

DNE	Department of Naval Engineering
EA	Engineering Assessment
FDD	Floating Dry Dock
FSC	Free Surface Correction
FSM	Free Surface Moment
FR	Frame
FWD	Forward
GM	Metacentric Height
Heel	Variation in draft between port and starboard sides of vessel
IAW	In Accordance With
JBD	John Butler Design
NSCV	National Standard for Commercial Vessels
LCG	Longitudinal Centre of Gravity
TCG	Transverse Centre of Gravity
Trim	Variation in draft between Aft Perpendicular and Fwd Perpendicular
USK	Underside of Keel
VCG	Vertical Centre of Gravity Measured Above Baseline

5 VESSEL PARTICULARS

Length Extreme	57.912	meters
Length Overall (hull)	57.912	metres
Length B.P.	57.912	metres
Breadth (moulded)	19.810	metres
Depth (to main deck at midships)	2.500	metres
Depth Extreme		
Rake of Keel (between Draft Marks)	0.000	metres
Distance from midships to forward perpendicular	28.956	metres
Distance from midships to aft perpendicular	-28.956	metres

5.1 VESSEL DATUM

Longitudinal:	AP (Frame 0) +ve, Fwd
Transverse:	Centreline +ve, to Port
Vertical:	Baseline +ve, Up

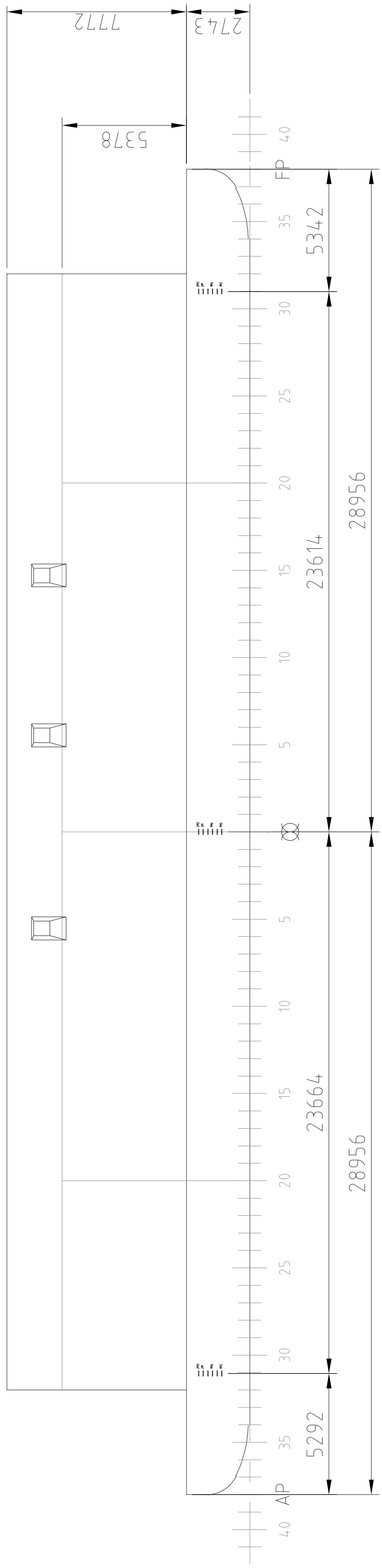


Figure 5.1 – Location of Draft Marks

6 VESSEL LIGHTSHIP CONDITION

6.1 LIGHTSHIP CONDITION SUMMARY

The vessel drafts were measured, and a solid and liquid state survey conducted to determine items to be added, removed and moved as necessary to derive the lightship particulars. These are shown in Table 6.1.

‘FDD1N’				
	Mass (T)	LCG (m)	TCG (m)	VCG (m)
Lightship Particulars – January 2022	1100.6	0.003	-0.050	4.259

Table 6.1 – Lightship Particulars

6.2 AS-INCLINED CONDITION

To define the As-inclined particulars, the mass and location of personnel that were aboard the draft and density measuring vessels during the draft measurement were added to the As-measured displacement and LCG. The hydrostatic tables were utilised to determine the As-measured parameters.

‘FDD1N’				
	Δ (Tonnes)	LCG (m)	TCG (m)	VCG (m)
As-Inclined Particulars	1618.4	-0.008	-0.011	3.124

Table 6.2 – As-Inclined Particulars

6.3 DERIVED LIGHTSHIP CONDITION

The lightship condition is defined by DEF(AUST)5000, Vol 3, Part 10, Section 3.1:

Lightship – Ship complete, ready for service in every respect, including permanent ballast (solid & liquid), and liquids in machinery at operating levels, without any items of variable load, and without aircraft. This condition represents the ship under full wartime conditions with ultimate armament and boat allowance aboard.

All items which fall outside this definition have been deducted from the “As-Inclined” condition to derive the Lightship Particulars. Items to be removed, added or moved to derive the lightship condition are shown in Annex A. For example, ropes, tools and safety gear are considered part of lightship.

‘FDD1N’				
Item	Mass (T)	LCG (m)	TCG (m)	VCG (m)
As-Inclined Particulars, 17/01/2022	1618.40	-0.008	-0.011	3.124
Personnel	-0.45	1.193	2.641	3.684
Weights Off (Solid State Survey)	-2.58	0.354	0.321	3.556
Weights Off (Inclining Equipment)	-0.12	1.427	0.166	3.234
Weights to Move*	0.00	-	-	-
Weights On	0.00	-	-	-
Tank Contents (Liquid State Survey)	-509.42	-0.093	-0.015	0.673
Fluids in Bilges (Liquids State Survey)	-5.23	5.805	8.024	2.854
Lightship Particulars – January 2022	1100.59	0.003	-0.050	4.259
Previous Lightship Particulars – 1974	1499.00	0.000	0.000	5.585
Growth	-398.41	0.003	-0.050	-1.326
% Difference (% of LBP, Breadth moulded, VCG)	-26.58%	0.01%	-0.25%	-23.74%

***Mass of 'Weights to Move' not included in the summation, however moment changes due to moved weight have been included.**

Table 6.3 – Derived Lightship Particulars Summary

7 INCLINING PERSONNEL

The following paragraphs detail the personnel who were involved in the inclining experiment. Mass and location details of personnel that remained on-board during pendulum readings and draft measurements are provided in Annex A.

7.1 JBD PERSONNEL

JBD was requested to conduct the floating dock inclining experiment. The following personnel were involved in the inclining program.

- John Butler — Principal Naval Architect
- Nichola Buchanan — Senior Naval Architect (Fwd Pendulum)
- Jordan Banks — Naval Architect (Aft Pendulum)

7.2 OTHER PERSONNEL

Two personnel from Universal Engineering were onboard during the experiment to run the pump and flow meter.

8 PRE-INCLINING PREPARATION

8.1 VESSEL SHIP CHECK

A ship check of the vessel was carried out prior to conducting the ballast water movements. This check was undertaken to identify and estimate the mass and centre of gravity of items that were required to be removed, added, or moved on-board the vessel in order to derive the correct lightship condition.

The void compartments were inspected for bilge water which could alter the lightship displacement and free surface correction of the inclining. A list of bilge water found is detailed in Annex A. This bilge water was below the line of suction; therefore, it was agreed that the mass of the bilge water would be removed with no correction made to the VCG.

All tank levels were measured using JBD dip tapes to determine their volumes. JBD took fluid samples to determine the accurate fluid density of each tank. A full list of ship tanks and their levels and densities are detailed in Annex A. Due to the ships operational systems several tanks were in use during the pendulum readings. These tank levels were measured before and after pendulum readings and the average reading was used to determine the weights off.

All spaces were inspected in order to determine the quantity of dry items onboard that are not to be included in the vessel's lightship condition.

8.2 INCLINING SET-UP

Prior to the inclining experiment, the vessel was prepared as follows;

1. The vessel was moored midwater heading Northwest, with mooring lines off the bow and stern. A Single tug was used to assist the FDD. All lines were confirmed slack prior to pendulum readings. The wind was continually monitored, and wind speed was confirmed to be less than 12 knots from the Southeast prior to all pendulum readings. Tide and current effects were negligible.
2. The ballast tanks 4, 7, 6 and 9 were approximately 50% filled with sea water (with average density of 1.0195 t/m^3). The tank levels were taken to ensure there was sufficient ballast water in each tank to achieve the desired angle of heel. The level of these tanks was measured after each ballast transfer.
3. All pendulum troughs were filled with seawater water (density of 1.0198 t/m^3) and the pendulums were setup in the locations described in Section 9.7. The forward and aft pendulum bobs are constructed from aluminium angles, with a high resistance to movement in the trough. All pendulum bobs were supported by bricklayer's line, suspended by hanging a flat washer over the shaft of a bolt in an aluminium angle. The aluminium angle was clamped to the dock blocks that were in place from a previous docking. This arrangement allowed the pendulums to rotate freely as required in order to measure the heel of the vessel and provided sufficient pendulum lengths. The forward pendulum was on the starboard side, and the aft pendulum was on the port side of the vessel. Photos of the pendulum arrangements and measurement strips are shown in Annex B: photos B1 through B6.
4. All tank valves were confirmed closed.

9 CONDUCTING THE EXPERIMENT

9.1 LOCATION

The experiment was conducted at Snails Bay, Sydney Harbour, Sydney. An aerial picture of the location is shown below.

9.2 WEATHER CONDITIONS

The weather was clear with minimal cloud cover with an average wind speed of 5-10 knots from the south-east. The sea state was calm and tidal flow was negligible.

9.3 TIME

The experiment commenced at 06:00 am and concluded at 4:00 pm.

9.4 DRAFT / FREEBOARD MEASUREMENTS

Port and Stbd drafts were measured from the forward, mid and aft draft marks prior to the experiment. The draft measurements were as follows (-ve indicates the point is below the specified datum):

Location	Port Side		STBD Side	
	Measurement	Datum	Measurement	Datum
Fwd Mark	-392	1800	-472	1800
Mid Mark	-290	1800	-391	1800
Aft Mark	-375	1800	-485	1800

Table 9.1 – Freeboard Readings prior to experiment

Due to the marine traffic late in the day and the wave fetch from the breeze, it was not possible to measure drafts after the experiment. Alternatively, all spaces were inspected prior to and after the experiment, where no changes in fluids were found excluding the ballast tanks used for the weight movements.

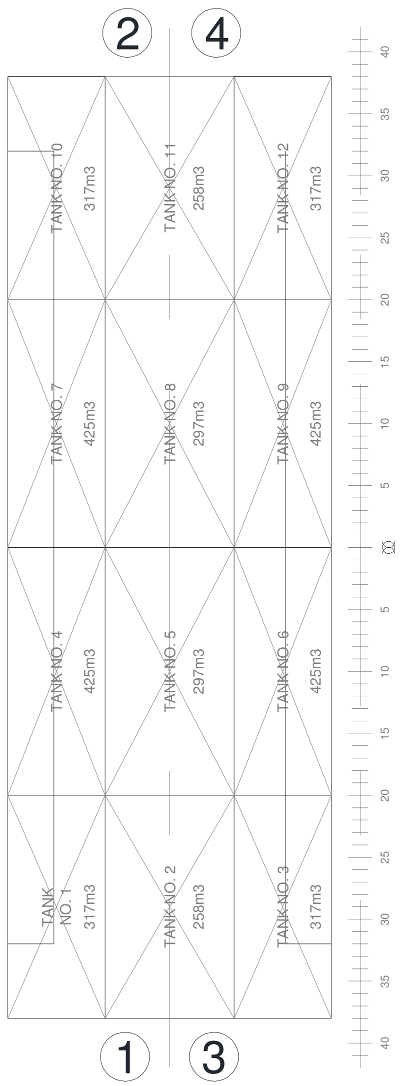
Mean draft, heel and trim measurements were derived as part of this report.

Photos of the draft marks taken before the mass movements can be seen in Annex B photos B7 through B12.

9.5 WATER TEMPERATURE / HYDROMETER READINGS

The water temperature and density were measured before and after the experiment. The first two measurements were taken at 08:00 am before the pendulum readings and the last three measurement were taken at 03:00 pm prior to the final pendulum readings. The locations and results of the readings are recorded below. Photographs of the density can be seen in Annex B, photos B13 and B14.

<table>
<tr><th>Diagram of Location:</th><th>Measured Data:</th></tr>
<tr><td>



</td><td>

1. Density: 1.0200 T/m^3
Temperature: 23.7 °C
Time: 08:00
2. Density: 1.0200 T/m^3
Temperature: 23.8 °C
Time: 08:12
3. Density: 1.0195 T/m^3
Temperature: 25.0 °C
Time: 02:52
4. Density: 1.0195 T/m^3
Temperature: 25.0 °C
Time: 02:56

Readings Taken By: Jordan Banks

Readings Witnessed By: Nichola Buchanan

</td></tr>
</table>

Table 9.2 – Mass and initial centres of gravity for ballast tanks

9.6 INCLINING MASS MOVEMENTS

An average total fluid mass of 477.1 tonnes was used in this experiment to create the heeling moments. This mass was transferred between the forward ballast tanks (Tanks 4 & 6) and the aft ballast tanks (Tanks 7 & 9) in eight movements. Tank soundings of each of these tanks was taken after the completion of each ballast transfer. These soundings are detailed in Table 9.3.

Movement Number	Movement Direction	Tank Soundings (mm)			
		Tank No.4	Tank No.6	Tank No.7	Tank No.9
0	-	1417	1433	1442	1439
1	P→S	1921	931	1433	1446
2	P→S	1913	927	1926	954
3	S→P	1923	920	1443	1436
4	S→P	1403	1445	1440	1436
5	S→P	926	1940	1447	1426
6	S→P	925	1935	980	1895
7	P→S	1385	1460	981	1901
8	P→S	1387	1462	1449	1424

Table 9.3 – Mass and initial centres of gravity for ballast tanks

A 3D model of each tank was used to calculate the volume and centre of mass of the fluid at each sounding. The waterplane used in the 3D model at each mass movement was rotated to match the heel in that condition. The mass and centre of gravity of each ballast tank in their initial position is detailed in Table 9.4. The density of the ballast water was measured to be consistently 1.0195 t/m^3 across all ballast tanks.

Ballast Tank	Initial Tank Sounding (m)	Volume (m^3)	Mass (t)	LCG (m)	TCG (m)	VCG (m)
# 4 (S)	1.417	115.540	117.793	7.631	6.912	0.708
# 6 (P)	1.433	117.301	119.588	7.620	-6.939	0.717
# 7 (S)	1.442	117.765	120.061	7.620	6.912	0.720
# 9 (P)	1.439	117.608	119.901	7.630	-6.939	0.720

Table 9.4 – Mass and initial centres of gravity for ballast tanks

The ballast was transferred in accordance with the sequence shown in Table 9.3. The resulting mass in each tank after the completion of ballast transfer is shown, along with the mass discrepancy in Table 9.5. The largest percentage difference of the mass discrepancy to the total mass moved was 3.28%. The Deflection vs Heeling MMT graph shows that all moves fit within the linear relationship of this graph. Therefore, this error can be considered acceptable in the overall result of the experiment.

Movement Number	Movement Direction	No. 4 Mass (t)	No. 6 Mass (t)	Mass Discrepancy (t)	% Difference	Resultant Transverse CoG (m)
0	-	117.793	119.588	-	-	-0.066
1	P→S	160.341	77.168	0.127	0.30%	2.467
2	P→S	160.015	76.033	-1.460	0.84%	2.564
3	S→P	160.462	76.175	0.588	0.23%	2.514
4	S→P	116.617	120.588	0.568	1.29%	-0.130
5	S→P	76.223	162.330	1.348	3.28%	-2.572
6	S→P	75.380	162.236	-0.936	0.58%	-2.654
7	P→S	114.449	122.299	-0.868	-2.20%	-0.299
8	P→S	115.285	122.005	0.542	0.49%	-0.210

Table 9.5 – Fwd Ballast Tank Weight movements

Movement Number	Movement Direction	No. 7 Mass (t)	No. 9 Mass (t)	Mass Discrepancy (t)	% Difference	Resultant Transverse CoG (m)
0	-	120.061	119.901	-	-	-0.009
1	P→S	119.909	119.913	-0.141	0.07%	0.043
2	P→S	161.349	78.162	-0.311	-0.75%	2.504
3	S→P	120.697	119.005	0.191	0.47%	0.094
4	S→P	119.884	119.651	-0.168	0.61%	-0.007
5	S→P	119.785	119.285	-0.463	0.19%	-0.056
6	S→P	80.088	158.652	-0.330	-0.84%	-2.402
7	P→S	80.943	158.823	1.025	0.59%	-2.320
8	P→S	120.634	118.652	-0.480	-1.20%	0.043

Table 9.6 – Aft Ballast Tank Weight movements

9.7 FORWARD PENDULUM LOCATION / READINGS

The fwd pendulum location was selected to be on the starboard side of the main deck on FR17. The forward dock block that was in place from a previous docking (Emerald Class Ferry) was used to secure and hang the pendulum. A pendulum length of 1.992 m was achieved, which is greater than the minimum length IAW Refs (a) and (c). This location was not sheltered; however, the wind speed was checked close to zero prior to any pendulum readings.

Photos of the pendulum setup, length and measurement strip readings can be seen in Annex B, photos B4 through B6.

The Pendulum reading was carried out with personnel facing aft. A coordinate system of -ve starboard and +ve port was used.

PENDULUM READINGS

Name of Vessel:	FDD1N	Date:	17/01/2022
Pendulum Station:	Forward	Vessel Heading:	Northwest
Location:	Main deck Frame 17	Pendulum Length:	1.992 m
Trough Dimensions:	Length: 430 mm,	Width: 610 mm,	Water Depth: 178 mm
Readings By:	Nichola Buchanan	Witnessed By:	

Number	Pendulum Reading (mm)	Deflection (m)	Time
0	202.5	0.000	7:58
1	161.5	0.041	9:03
2	123.0	0.080	10:05
3	160.0	0.043	11:02
4	203.0	-0.001	11:59
5	242.5	-0.040	12:56
6	279.0	-0.077	13:46
7	242.0	-0.040	14:49
8	203.0	-0.001	15:41

Table 9.7 – Fwd Pendulum Readings

9.8 AFT PENDULUM LOCATION / READINGS

The aft pendulum location was selected to be on the portside of the main deck on FR-12. The aft dock block that was in place from a previous docking (Emerald Class Ferry) was used to secure and hang the pendulum. A pendulum length of 2.121 m was achieved, which is greater than the minimum length IAW Refs (a) and (c). This location was not sheltered; however, the wind speed was checked close to zero prior to any pendulum readings.

Photos of the pendulum setup, length and measurement strip readings can be seen in Annex B, photos B1 through B3.

The Pendulum reading was carried out with personnel facing Aft. A coordinate system of -ve starboard and +ve port was used.

PENDULUM READINGS

Name of Vessel:	FDD1N	Date:	17/01/2022
Pendulum Station:	Aft	Vessel Heading:	Northwest
Location:	Main deck Frame -12	Pendulum Length:	2.121 m
Trough Dimensions:	Length: 430 mm,	Width: 615 mm,	Water Depth: 200 mm
Readings By:	Jordan Banks	Witnessed By:	John Butler

Number	Pendulum Reading (mm)	Deflection (m)	Time
0	207.5	0.000	7:58
1	164.0	0.044	9:03
2	122.5	0.085	10:05
3	163.0	0.045	11:00
4	207.5	0.000	11:57
5	251.5	-0.044	12:55
6	290.0	-0.083	13:47
7	250.5	-0.043	14:47
8	208.0	-0.001	15:40

Table 9.8 – Pendulum Readings

10 RESULTS

10.1 POSITION OF WEIGHTS AND PERSONNEL

The initial position of weights, personnel and pendulum locations are detailed in Section A5.3.1 in Annex A. A summary is shown in Table 10.1 below.

Item	Mass (T)	LCG (m)	TCG (m)	VCG (m)
Personnel	0.451	1.193	2.641	3.684

Table 10.1 – Personnel

10.2 FLUID STATE SURVEY

A detailed list of tank measurements and fluids in bilge spaces can be seen in Section A6.1 and A6.2 in Annex A. Photos of all initial tank soundings can be seen in Annex B, photos B15 through B26. A summary of the items is shown in Table 10.2 below.

Item	Mass (T)	LCG (m)	TCG (m)	VCG (m)
Tanks	509.422	-0.093	-0.015	0.673
Fluids in Bilges	5.230	5.805	8.024	2.854

Table 10.2 – Fluid State

10.3 SOLID STATE SURVEY

During the pre-inclining ship check, items were recorded on-board that constituted as Weights Off and as such need to be removed to derive the lightship particulars, these are detailed in Annex A, section A5.3. The inclining equipment and all personnel were included as Weights Off in Annex A, sections A5.3.1 and A5.3.2.

A summary of Weights On/Off/Move items is shown below (-ve indicates the mass is to be removed):

Item	Mass (T)	LCG (m)	TCG (m)	VCG (m)
Weights On	0.000	0.000	0.000	0.000
Weight Off Items (Solid)	-2.584	0.354	0.321	3.556
Weight Off Items (Inclining Equipment)	-0.120	1.427	0.166	3.234
Weights to Move	0.000	0.000	0.000	0.000

Table 10.3 – Weights On/Off/Move

10.4 CALCULATION OF HEELING MOMENT

The volumes and centres of gravity of ballast tanks 4, 6, 7 and 9 were calculated using the 3D surface model of each tank. Using the sounding taken after each ballast transfer, a waterplane was created and rotated to match the heel measured at that weight movement. The full volume in the tank was determined up to the water level and a 10% reduction was applied to account for the volume of structure and major pipes within each tank. The deck drains within tanks 4 and 9 were included in the 3D model. The resulting mass and centre of gravity were used to derive the heeling moment and resultant VCG at each weight shift.

10.5 ERROR ANALYSIS

Pendulum deflections were measured after each weight movement. An error analysis of these measurements was conducted during the experiment based on the ballast tank soundings and tank table data. The results during the experiment were reviewed by NTB and considered acceptable. The pendulum results were then refined after the experiment using the 3D tank model data.

10.5.1 FORWARD PENDULUM

The largest percentage difference of pendulum deflection calculated for the forward pendulum was 3.3%, which is less than 5% and considered acceptable.

The line of best-fit method was applied after the experiment to plot the heeling moment against the pendulum deflection and the vessel heel. A linear trend line was fitted through all of the points derived from the weight movements. The R^2 value for the two plots was 0.9998781, this value is very close to 1.0 indicating that the inclining experiment was not influenced by tide, wind or mooring arrangements. Therefore, the pendulum readings are considered accurate.

A plot of the Deflection v. Heeling Moment and Heeling Moment v. Heel Angle can be seen in Annex A, page A-5.

10.5.2 AFT PENDULUM

The largest percentage difference of pendulum deflection calculated for the aft pendulum was 6.2%. All other percentage differences of pendulum deflections were calculated to be less than 5%.

The line of best-fit method was applied after the experiment to plot the heeling moment against the pendulum deflection and the vessel heel. A linear trend line was fitted through all of the points derived from the weight movements. The R^2 value for the two plots was 0.9997731, this value is very close to 1.0 indicating that the inclining experiment was not influenced by tide, wind or mooring arrangements. Therefore, the pendulum readings are considered accurate.

A plot of the Deflection v. Heeling Moment and Heeling Moment v. Heel Angle can be seen in Annex A, page A-7.

10.6 AS-INCLINED CONDITION

Annex A provides details of the calculated As-Inclined Condition of the vessel during the experiment. The drafts were measured before and after the ballast transfer (mass movements). Photographs of the draft measurements and density readings have been included in Annex B of this report.

10.7 LIGHTSHIP DERIVATION

The lightship particulars were calculated by deducting the weight of personnel, tanks, fluids in bilges, inclining equipment and items that needed to be added, deducted, and moved to the lightship condition following the lightship survey. A summary of this calculation is shown in section 6.3 of this report.

11 CONCLUSIONS

The ship was in an acceptable state for the inclining experiment to be conducted.

The inclining ship check undertaken by JBD successfully identified weights to add, move and remove, which were used to determine the lightship condition.

The experiment was conducted in reasonable weather and harbour conditions; the pendulum readings and the results were considered acceptable.

The ship's lightship displacement calculated in this inclining report was compared to the ship's previously approved lightship displacement to assess the % difference in displacement, LCG, VCG and TCG. As it is known that large changes were made during the previously completed refit, these percentage differences are for information only: the lightship particulars derived in this report are to be used for ALL future stability calculations.

The lightship displacement of FDD1N was calculated to be 1100.6 tonnes, which is 26.58% *less* than the ship's previous calculated lightship displacement.

It was found that the LCG of FDD1N was 0.004 m Fwd of midships, which is 0.01% *Fwd* of the ship's previous lightship LCG.

The VCG was calculated to be 4.259 m, this is 23.74% *less* than the ship's previous lightship VCG.

The derived TCG of FDD1N is -0.050 m to port, which is 0.25% of the overall breadth further to *Port* of the previous lightship TCG.

ANNEX A
INCLINING CALCULATIONS

A1.0 General Particulars

Vessel Name	FDD1N	
UVI Number	455344	
Length Overall (hull)	57.912	metres
Length B.P.	57.912	metres
Breadth (moulded)	19.812	metres
Depth to top of Wing Wall	10.515	metres
Depth to Main Deck	2.743	metres
Rake of Keel (Between Draft Marks)	0.000	metres
Distance from midships to forward perpendicular	28.956	metres
Distance from midships to aft perpendicular	-28.956	metres

A2.0 Inclining Experiment

Name of vessel:	FDD1N
Owner:	Noakes Group
Experiment conducted by:	John Butler (AMSA Surveyor / John Butler Design)
Witnessed by:	Nichola Buchanan (AMSA Surveyor / John Butler Design)
Date & place of experiment:	17/01/2022
State of weather:	Calm, Overcast
Wind Speed and Direction	5-10 knots South East
Sea State	Calm
Tidal Flow	Nil
Vessel's Heading	North West
Vertical datum:	Baseline
Longitudinal datum	Midships
Transverse datum	Centreline, +ve to Port

			Mass (tonnes)	LCG (metres)	TCG (metres)	VCG (metres)	Location
No. persons off vessel during freeboard measure, & their distribution during inclining:	1	John Butler	0.088	-9.609	-2.690	3.869	Aft Pendulum
	2	Nichola Buchanan	0.107	13.266	3.290	3.459	Fwd Pendulum
	3	Jordan Banks	0.072	-8.639	-2.690	3.469	Aft Pendulum
	4	Gary	0.095	10.441	6.900	3.810	Main Deck
	5	Jacob	0.089	-4.561	6.900	3.810	Main Deck

Mooring arrangement: Lines off bow and stern
Equipment: See List
Ballast Tanks and their mass used to induce heel:

No. 4	117.977	tonnes
No. 6	119.588	tonnes
No. 7	120.061	tonnes
No. 9	120.089	tonnes

Location of weights:	FR-20 to FR20	
VCG of No. 4 & 6 (Fwd tanks) above datum	0.713	metres
LCG of No. 4 & 6 (Fwd tanks) Fwd of datum	7.626	metres
VCG of No. 7 & 9 (Aft tanks) above datum	0.720	metres
LCG of No. 7 & 9 (Aft tanks) Fwd of datum	-7.625	metres
Length of pendulum Fwd:	1.992	metres
Location of pendulum Fwd:	12.801	metres Fwd of datum
Length of pendulum Aft:	2.121	metres
Location of pendulum Aft:	-9.099	metres Fwd of datum
Density of water:	1.0198	t/m^3
Weights to go ashore:	See Weights Off list	
Fuel tanks:	None	
Fresh water tanks:	None	
Ballast tanks:	See Tank List	
Cross connections:	Closed	

Table 1: No. 4 and No. 6 Ballast Tank Data

Density: 1.0195 t/m³

No. 4 Volume (m^3)	No. 4 Mass (T)	No. 4 TCG (m)	No. 4 VCG (m)	No. 6 Volume (m^3)	No. 6 Mass (T)	No. 6 TCG (m)	No. 6 VCG (m)	No. 4 change (T)	No. 6 Change (T)	Discrepancy (T)	Discrepancy % Difference	Total Mass (T)	Total TCG (m)	Total VCG (m)
115.540	117.793	6.912	0.708	117.301	119.588	-6.939	0.717					**237.4**	**-0.066**	**0.713**
157.274	160.341	6.964	0.963	75.692	77.168	-6.876	0.462	42.5	-42.4	0.127	0.30%	**237.5**	**2.467**	**0.800**
156.955	160.015	7.009	0.960	74.579	76.033	-6.791	0.454	-0.3	-1.1	-1.460	0.84%	**236.0**	**2.564**	**0.797**
157.393	160.462	6.966	0.964	74.718	76.175	-6.865	0.456	0.4	0.1	0.588	0.23%	**236.6**	**2.514**	**0.800**
114.386	116.617	6.911	0.701	118.281	120.588	-6.939	0.723	-43.8	44.4	0.568	1.29%	**237.2**	**-0.130**	**0.712**
74.765	76.223	6.830	0.716	159.225	162.330	-6.986	0.973	-40.4	41.7	1.348	3.28%	**238.6**	**-2.572**	**0.891**
73.939	75.380	6.757	0.449	159.133	162.236	-7.027	0.971	-0.8	-0.1	-0.936	0.58%	**237.6**	**-2.654**	**0.805**
112.260	114.449	6.853	0.687	119.960	122.299	-6.992	0.733	39.1	-39.9	-0.868	-2.20%	**236.7**	**-0.299**	**0.710**
113.080	115.285	6.911	0.693	119.671	122.005	-6.939	0.732	0.8	-0.3	0.542	0.49%	**237.3**	**-0.210**	**0.713**
	Average	6.902	0.760		Average	-6.928	0.691		Average Deviation	0.808		237.2		

Table 2: No. 7 and No. 9 Ballast Tank Data

Density: 1.0195 t/m³

No. 7 Volume (m^3)	No. 7 Mass (T)	No. 7 TCG (m)	No. 7 VCG (m)	No. 9 Volume (m^3)	No. 9 Mass (T)	No. 9 TCG (m)	No. 9 VCG (m)	No. 7 change (T)	No. 9 Change (T)	Discrepancy (T)	Discrepancy % Difference	Total Mass (T)	Total TCG (m)	Total VCG (m)
117.765	120.061	6.912	0.720	117.608	119.901	-6.939	0.720					**240.0**	**-0.009**	**0.720**
117.615	119.909	6.968	0.719	117.619	119.913	-6.881	0.720	-0.152	0.012	-0.141	0.07%	**239.8**	**0.043**	**0.719**
158.263	161.349	7.009	0.966	76.667	78.162	-6.794	0.467	41.4	-41.8	-0.311	-0.75%	**239.5**	**2.504**	**0.803**
118.388	120.697	6.970	0.724	116.729	119.005	-6.880	0.715	-40.7	40.8	0.191	0.47%	**239.7**	**0.094**	**0.719**
117.591	119.884	6.911	0.719	117.362	119.651	-6.940	0.719	-0.8	0.6	-0.168	0.61%	**239.5**	**-0.007**	**0.719**
117.494	119.785	6.853	0.718	117.004	119.285	-6.994	0.716	-0.1	-0.4	-0.463	0.19%	**239.1**	**-0.056**	**0.717**
78.556	80.088	6.764	0.477	155.618	158.652	-7.028	0.951	-39.7	39.4	-0.330	-0.84%	**238.7**	**-2.402**	**0.792**
79.394	80.943	6.835	0.484	155.785	158.823	-6.986	0.953	0.9	0.2	1.025	0.59%	**239.8**	**-2.320**	**0.795**
118.327	120.634	6.911	0.724	116.382	118.652	-6.940	0.713	39.7	-40.2	-0.480	-1.20%	**239.3**	**0.043**	**0.718**
	Average	6.904	0.695		Average	-6.931	0.742		Average Deviation	0.346		239.2		

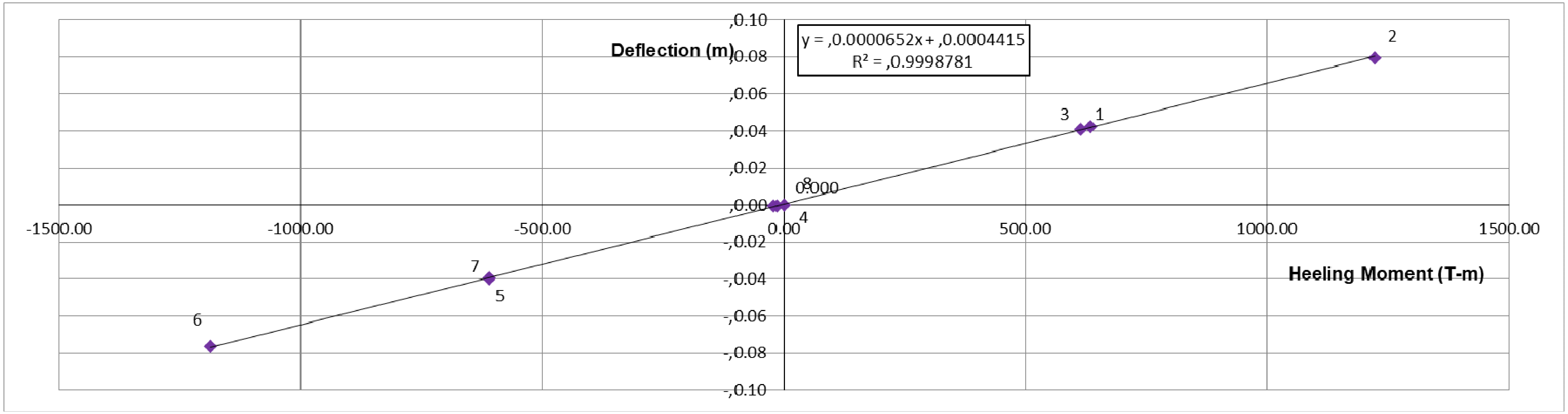
Table 3: Mass Movements and Fwd Pendulum Deflections

Ship Heading: North West

Mass movement number	Direction of mass movement	Combined Ballast Mass (T)	Transverse CoG (d) - m	Resultant moment (wxd) - T.m	Resultant moment² $(wxd)^2$ - $T^2.m^2$	Pendulum reading (mm)	Pendulum deflection (m)	Moment x Deflection ($T.m^2$)	Pendulum shift (m)	(w x d) shift (T.m/m)	Percentage difference of average	Time	Heel Angle (°)	GM_{Ffluid} (m)	GM_{Ffluid} with 9C VCG Correction (m)
Init. Cond.		477.3	-0.037	0.0	0.0	202.5	0.000	0.000	0.000	0.00		7:58	0.00		
1	P(6) → S(4)	477.3	1.250	614.3	377326.1	161.5	0.041	-25.185	-0.041	14962.65	3.1	9:03	1.18	18.441	18.454
2	P(9) → S(7)	475.6	2.534	1222.9	1495460.5	123.0	0.080	-97.220	-0.039	15904.15	-3.0	10:05	2.29	19.458	19.482
3	S(7) → P(9)	476.3	1.296	635.1	403361.8	160.0	0.043	-26.992	0.037	15951.74	-3.3	11:02	1.22	19.553	19.566
4	S(4) → P(6)	476.7	-0.068	-14.8	218.7	203.0	-0.001	-0.007	0.043	15124.96	2.0	11:59	-0.01	18.603	18.603
5	S(4) → P(6)	477.6	-1.313	-609.1	370981.7	242.5	-0.040	-24.363	0.040	15015.11	2.7	12:56	-1.15	18.519	18.544
6	S(7) → P(9)	476.4	-2.528	-1186.3	1407204.0	279.0	-0.077	-90.749	0.037	15870.24	-2.8	13:46	-2.20	19.463	19.488
7	P(6) → S(4)	476.5	-1.316	-609.3	371302.3	242.0	-0.040	-24.069	-0.037	15609.27	-1.1	14:49	-1.14	19.192	19.202
8	P(9) → S(7)	476.6	-0.083	-21.7	471.3	203.0	-0.001	-0.011	-0.039	15073.88	2.4	15:41	-0.01	18.546	18.546
				∑ Moment²	4426326.4		Sum	-288.596	Average	15439.00				Average	18.986

Maximum Angle of heel achieved to stbd. = 2.285 degrees
Maximum Angle of heel achieved to port = 2.199 degrees

Fwd Pendulum Graph - Figure 1



Fwd Pendulum Graph - Figure 2

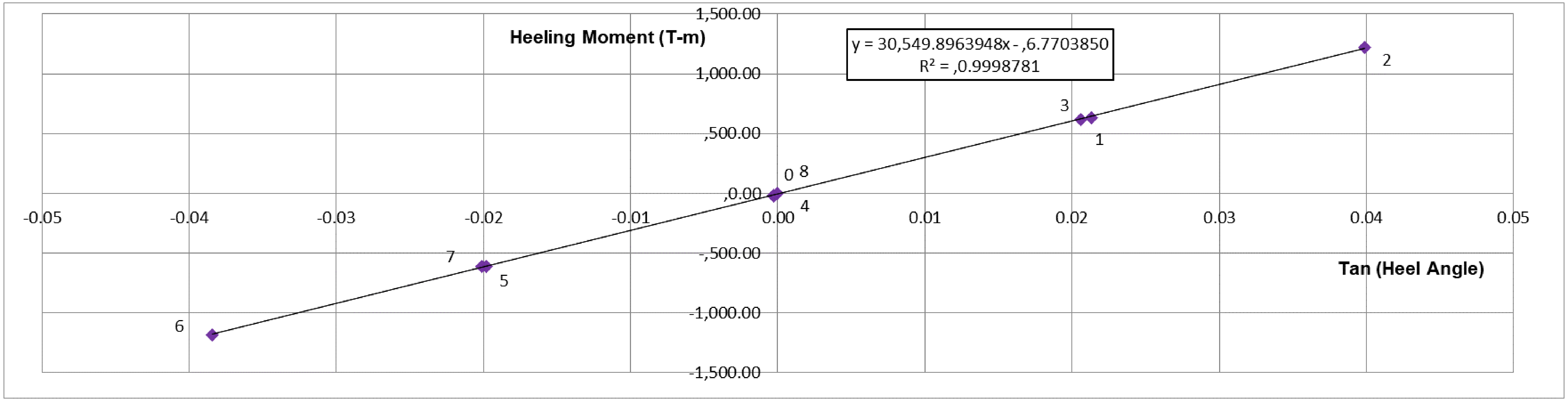


Table 4: Mass Movements and Aft Pendulum Deflections

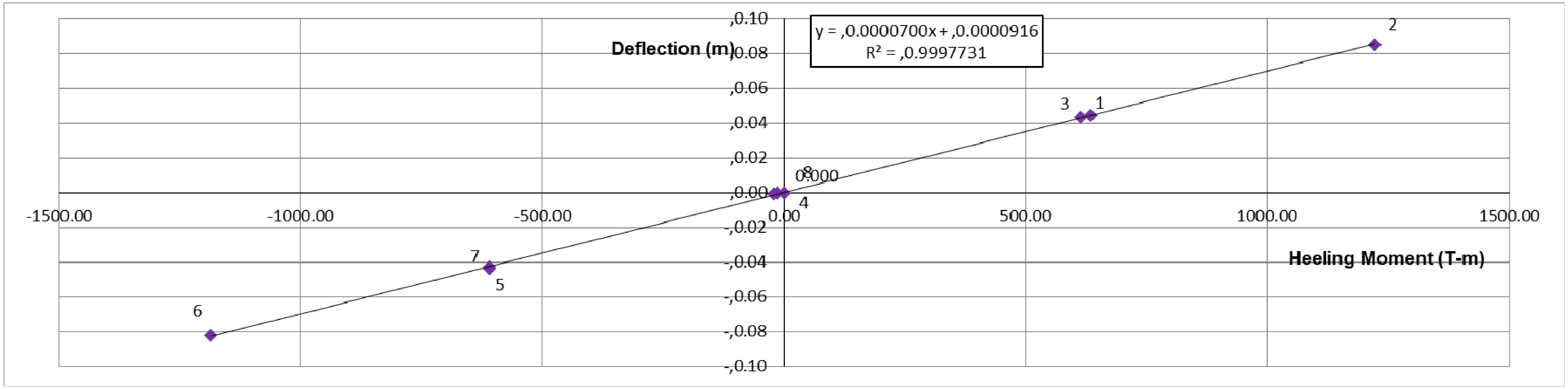
Ship Heading: North West

Mass movement number	Direction of mass movement	Combined Ballast Mass (T)	Transverse CoG (d) - m	Resultant moment (wxd) - T.m	Resultant moment² $(wxd)^2$ - $T^2.m^2$	Pendulum reading (mm)	Pendulum deflection (m)	Moment x Deflection ($T.m^2$)	Pendulum shift (m)	(w x d) shift (T.m/m)	Percentage difference of average	Time	Heel Angle (°)	GM_{Ffluid} (m)	GM_{Ffluid} with 9C VCG Correction (m)
Init. Cond.		477.3	-0.037	0.0	0.0	207.5	0.000	0.000	0.000	0.00		7:58	0.00		
1	P(6) → S(4)	477.3	1.250	614.3	377326.1	164.0	0.044	26.721	-0.044	14102.73	1.9	9:03	1.17	18.507	18.519
2	P(9) → S(7)	475.6	2.534	1222.9	1495460.5	122.5	0.085	103.946	-0.042	14754.46	-2.6	10:05	2.29	19.220	19.245
3	S(7) → P(9)	476.3	1.296	635.1	403361.8	163.0	0.045	28.262	0.041	14573.19	-1.4	11:00	1.20	19.020	19.033
4	S(4) → P(6)	476.7	-0.068	-14.8	218.7	207.5	0.000	0.000	0.045	14615.13	-1.6	11:57	0.00	19.140	19.140
5	S(4) → P(6)	477.6	-1.313	-609.1	370981.7	251.5	-0.044	26.800	0.044	13479.47	6.2	12:55	-1.19	17.701	17.727
6	S(7) → P(9)	476.4	-2.528	-1186.3	1407204.0	290.0	-0.083	97.866	0.039	15045.81	-4.6	13:47	-2.23	19.647	19.671
7	P(6) → S(4)	476.5	-1.316	-609.3	371302.3	250.5	-0.043	26.202	-0.040	14621.34	-1.7	14:45	-1.16	19.141	19.152
8	P(9) → S(7)	476.6	-0.083	-21.7	471.3	208.0	-0.001	0.011	-0.043	13832.50	3.8	15:40	-0.01	18.121	18.120
				∑ Moment²	4426324.4		Sum	309.807	Average	14378.08				Average	18.826

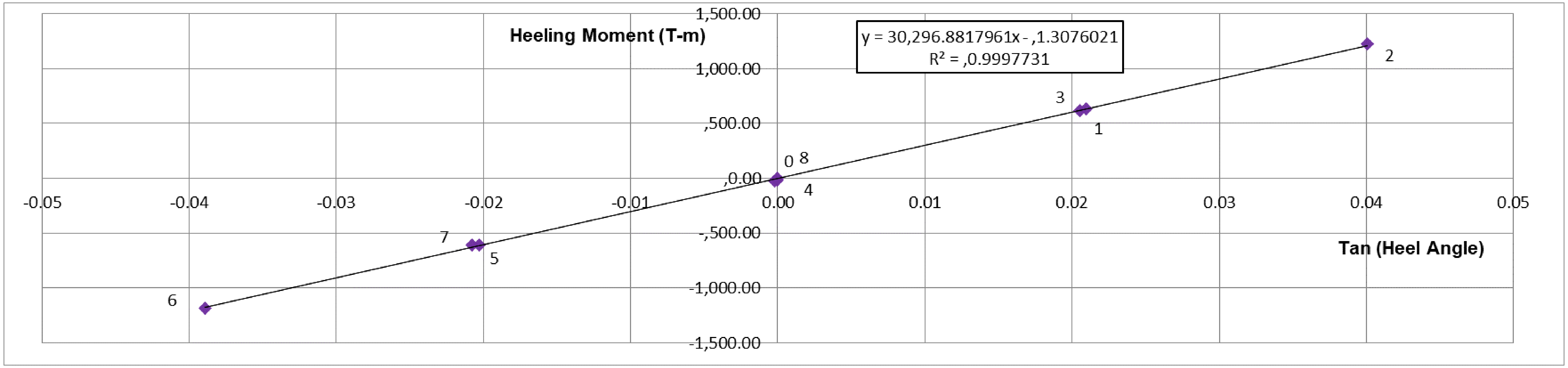
Maximum Angle of heel achieved to stbd. = 2.295 degrees

Maximum Angle of heel achieved to port = 2.227 degrees

Aft Pendulum Graph - Figure 5



Aft Pendulum Graph - Figure 6



A3.0 As-Measured Calculations

A3.1 Draft Measurements

Before Experiment	Port			Stbd.			Mean
	Measure	Datum	Draft (mm)	Measure	Datum	Draft (mm)	Draft (mm)
Fwd Mark	-392	1800	1408	-472	1800	1328	1368
Mid Mark	-290	1800	1510	-391	1800	1409	1460
Aft Mark	-375	1800	1425	-485	1800	1315	1370

Forward Mark Datum Correction to USK at Midships	=	-0.012	m	
Mean Forward Draft Mark Reading	=	1.368	m	
Corrected Mean Forward Draft (DF) to USK at Midships	=	1.356	m	
Midship Mark Datum Correction to USK at Midships	=	-0.012	m	
Mean Midship Draft Mark Reading	=	1.460	m	
Corrected Mean Midship Draft (DD) to USK at Midships	=	1.448	m	
Aft Mark Datum Correction to USK at Midships	=	-0.012	m	
Mean Aft Draft Mark Reading	=	1.370	m	
Corrected Mean Aft Draft (DA) to USK at Midships	=	1.358	m	
Distance of Aft Drafts FWD of AP (P)	=	5.292	m	+ve fwd, -ve aft
Distance from Midship Draft point to midships (R)	=	0.000	m	-ve fwd, +ve aft
Distance of FWD Drafts Aft of FP (Q)	=	5.342	m	-ve fwd, +ve aft
Length between Perpendiculars (LBP)	=	57.912	m	
Length between Fwd & Aft Draft Measurements (L)	=	47.278	m	

Trim of baseline between mean freeboard marks (T_{FM}) = DA - DF

= 0.002 metres, trim by the stern

Calculated Midships draft (D_{MID}) = DD - (R / L) * T_{FM}

= 1.448 m above baseline

Interpolated Midships draft (DM) (from Drafts at FP & AP)	=	$\frac{DA - ((DA-DF)*(LBP/2 - P))}{LBP-P-Q}$
	=	1.357 m above baseline
Hog / Sag Calculation	=	1.448 – 1.357
	=	**0.091 m Sag**
Draft at forward perpendicular, D_{FP}	=	1.356 m
Draft at aft perpendicular, D_{AP}	=	1.358 m
Mean Midships draft from perpendiculars, d_m	=	$\frac{(1.356 + 1.358)}{2}$
	=	1.357 m above baseline
Mean Midships draft of vessel	=	**1.357 m above baseline**
Trim between perpendiculars	=	1.356 – 1.358
	=	**0.002 metres, trim by the stern**
	=	**0.002 ° by the stern**
Heel between Fwd Draft Marks	=	0.080 m to port
Transverse Distance between Draft Marks	=	19.800 metres
Heel of vessel	=	ATAN (0.080 / 19.800)
	=	0.23 **° to port**
Heel between Mid Draft Marks	=	0.101 m to port
Transverse Distance between Draft Marks	=	19.800 metres
Heel of vessel	=	ATAN (0.101 / 19.800)
	=	0.29 **° to port**
Heel between Aft Draft Marks	=	0.110 m to port
Transverse Distance between Draft Marks	=	19.800 metres
Heel of vessel	=	ATAN (0.110 / 19.800)
	=	0.32 ° to port
Mean Heel of vessel	=	**0.28 ° to port**

A3.1 Hydrostatic Particulars at Draft Measurement

As - Measured Hydrostatics (from Hydrostatic Data)

SG = 1.0250 **Trim = 0.477 metres, trim by the stern**

Draft Amidships [m]	Displacement [t]	LCB Midships [m]	LCF Midships [m]	KMT [m]	TPC	MTc [t-m]	VCB [m]	TCB [m]
1.357	1547.000	-0.007	-0.001	25.464	11.720	56.354	0.688	-0.121

Displacement at SG = 1.0198	=	1539.076	tonnes	
LCB = LCG (level trim) =	=	-0.007	metres	Fwd of midships
LCF	=	-0.001	metres	Fwd of midships
KMT	=	25.464	m	
MTcm at SG = 1.0250	=	56.354	t-m	
MTcm at SG = 1.0198	=	56.065	t-m	

As Measured Trim	=	0.002	metres, trim by the stern
Length Between Perpendiculars	=	57.912	m
KB	=	0.688	m
KG	=	3.124	m
BG	=	KG – KB	
	=	3.124 – 0.688	
	=	2.436	m

Correction to LCG for vertical separation $= \dfrac{\text{Trim x BG}}{\text{LBP}}$

$= \dfrac{0.002 \quad \text{x } 2.436}{57.912}$

$=$ 0.0001 m

LCG as measured	=	LCB_{Level} + Correction to LCG	
	=	-0.007 + 0.000	
	=	-0.007	m Fwd of AP
Correction to TCB	=	TCB_o + (KM – KB) x tan(Heel of Vessel)	
	=	-0.121 + (25.464 – 0.688) x tan(0.281)	
	=	0.000	m
Correction to TCG	=	BG x tan(Heel of Vessel)	
	=	2.436 x tan(0.28)	
	=	-0.0119	m (shift toward centreline)
TCG as measured	=	TCB + Correction to TCG	
	=	0.000 - 0.012	
	=	-0.012	m from Centreline
Displacement @ SG = 1.0198	=	1539.076	tonnes
Measured Sag of the Vessel, DHS	=	0.091	m
TPC @ SG = 1.0250	=	11.660	tonnes/cm
Hog / Sag Correction, C_{HS}	=	75 * (D_{HS} * TPC)	
	=	75 * (0.091 * 11.660)	
	=	79.143	tonnes
Displacement @ SG = 1.0250, incl. CHS	=	1539.076 + 79.143	
	=	1618.219	tonnes

A4.0 As-Inclined Particulars
A4.1 Displacement, LCG and TCG of Vessel As-Inclined

Item	Mass	LCG	Moment	TCG	Moment	Dist fr LCF	Moment (T-m)
Displacement as Measured	1618.219	-0.007	-11.161	-0.012	-18.704		
John Butler	0.092	-9.609	-0.846	-2.690	-0.237	-9.608	0.846
Jacob	0.089	-4.561	-0.406	6.900	0.614	-4.560	0.406
Displacement as Inclined	1618.396	-0.008	-12.412	-0.011	-18.326	-7.070	1.251

Displacement as inclined = 1618.396 tonnes

LCG as Inclined = -0.008 m

TCG as Inclined = -0.011 m

Change of trim, t $= \dfrac{\text{Trimming Moment}}{\text{MT1cm}}$

$= \dfrac{1.251}{56.065}$

= 0.0002 m

Trim as inclined = Trim + t

= 0.002 - 0.0002

= **0.002** m

As - Inclined Hydrostatics (from Hydrostatic Data)

SG = 1.0250 **Trim = 0.002 metres, trim by the stern**

Draft Amidships [m]	Displacement [t]	LCB Midships [m]	LCF Midships [m]	KMT [m]	TPC	MTc [t-m]	VCB [m]	TCB [m]
1.425	1618.396	-0.007	-0.001	24.316	11.674	56.277	0.722	-0.115

A4.2 Calculation of Inclined GM_f – Forward Pendulum

METHOD 1: TABULAR DATA – AVERAGE (W x D /SHIFT) – Column 11

Average Shift = 15439.00

$$GM_{Fwd\ fluid} = \frac{\text{Average Shift x Length of pendulum}}{\text{Displacement}} = \frac{15439.00 \times 1.992}{1618.396} = 18.985 \text{ metres}$$

A4.3 Calculation of Inclined GM_f – Aft Pendulum

METHOD 1: TABULAR DATA – AVERAGE (W x D /SHIFT) – Column 11

Average Shift = 14378.08

$$GM_{Aft\ fluid} = \frac{\text{Average Shift x Length of pendulum}}{\text{Displacement}} = \frac{14378.08 \times 2.121}{1618.396} = 18.826 \text{ metres}$$

A4.4 Calculation of Inclined GM_f – Average

GM_{fluid} = Average ($GM_{Fwd\ fluid}$, $GM_{Aft\ fluid}$)
= Average (18.985, 18.826)
= **18.906 metres**

A4.6 Calculation of KG_{Fluid}

Calculation of Free Surface Correction (FSC):

Free Surface Moment (FSM) present during inclining = 3700.018 tonnes metres

$$FSC = \frac{FSM}{Displacement} = \frac{3700.018}{1618.396} = 2.286 \text{ metres}$$

$$GM = GM_{fluid} + FSC = 18.906 + 2.286 = 21.192 \text{ metres}$$

$$KM_t = 24.316 \text{ metres}$$

$$KG = KM_t - GM = 24.316 - 21.192 = \mathbf{3.124\ metres}$$

A4.7 As-Inclined Particulars

Displacement (SG = 1.025)	=	1618.396	t
LCG	=	-0.007	m
TCG	=	-0.011	m
VCG	=	3.124	m

A5.0 Solid State Survey

A5.1 Weights to be Added

Location Description	Item Description	Mass (kg)	LCG (m) AP	TCG (m) fr CL	VCG (m) abv BL
	Total Weight On	**0.0**	**-**	**-**	**-**
	None				

A5.2 Weights to be Moved

Location Description	Item Description	Mass (kg)	LCG (m) AP	TCG (m) fr CL	VCG (m) abv BL
	Total Weight to Move	**0.0**	**-**	**-**	**-**
	None				

A5.3 Weights Off

A5.3.1 Personnel / Crew

Compartment	Personnel	Deck	Mass (kg)	LCG (m) AP	TCG (m) fr CL	VCG (m) abv BL
		Total Weight Off	**451**	**1.193**	**2.641**	**3.684**
Fwd Pendulum	Nichola Buchanan	Main	107	13.266	3.290	3.459
Aft Pendulum	Jordan Banks	Main	88	-9.609	-2.690	3.869
	John Butler	Main	72	-8.639	-2.690	3.469
Main Deck	Gary	Main	95	10.441	6.900	3.810
	Jacob	Main	89	-4.561	6.900	3.810

A5.3.2 Inclining Equipment

Location Description	Item Description	Mass (kg)	LCG (m) Midships	TCG (m) fr CL	VCG (m) abv BL
	Total Weight Off	**119.9**	**1.427**	**0.166**	**3.234**
Main Deck	Fwd Pendulum Trough	47.6	12.801	3.105	2.959
	Fwd Pendulum Support	10.0	12.801	3.433	4.777
	Aft Pendulum Trough	52.3	-9.099	-2.505	2.958
	Aft Pendulum Support	10.0	-9.099	-3.133	4.447

A5.3.3 Items in Ships Compartments

Location Description	Item Description	Mass (kg)	LCG (m) AP	TCG (m) fr CL	VCG (m) abv BL
	Total Weight Off	**2583.6**	**0.354**	**0.321**	**3.556**
Main Deck	JBD Gear	50.0	-12.219	6.900	3.010
	UE Gear	20.0	9.316	6.900	3.010
	Water	15.0	-4.561	5.500	2.910
	Small Hoses (6)	30.0	11.592	1.207	2.885
	Large Hoses (2)	60.0	-0.885	-0.955	2.896
	Transfer Pump Hoses (4)	80.0	-0.656	-0.572	2.996
	Transfer Pump	140.0	2.824	3.350	3.155
	Sumbersible Pump (6)	60.0	5.511	-3.945	2.945
	Diesel Generator	40.0	1.677	0.200	3.085
	Diesel Jerry Can	20.0	3.228	4.511	3.035
	Flow Meter	20.0	0.000	0.000	2.985
Emerald Class Dock Blocks	FR8 Steel Block	377.2	-8.882	0.000	3.664
	Fr10 Steel Block	377.2	-6.482	0.000	3.664
	Fr15 Steel Block	321.2	-0.512	0.000	3.431
	Fr20 Steel Block	335.2	5.496	0.000	3.575
	Fr26 Steel Block	346.2	12.762	0.000	3.712
	FR8 Timber Block	55.4	-8.952	0.000	4.384
	Fr10 Timber Block	40.0	-6.552	0.000	4.344
	Fr15 Timber Block	82.0	-0.552	0.000	3.958
	Fr20 Timber Block	88.2	5.449	0.000	4.077
	Fr26 Timber Block	26.0	12.649	0.000	4.662

A6.0 Liquid State Survey
A6.1 Tank State

Tank Name	Location	Capacity (%)	Sounding (m)	Mass (T)	LCG (m) AP	TCG (m) fr CL	VCG (m) abv BL	FSM (T.m)
Ballast Tanks - SG=1.0205								
Tank No. 1	FR20 - FR38	0.80	0.044	2.566	20.566	6.926	0.022	196.263
Tank No. 2	FR20 - FR38	0.98	0.035	2.691	20.545	0.000	0.018	450.645
Tank No. 3	FR20 - FR38	0.71	0.039	2.269	20.554	-6.926	0.020	194.784
Tank No. 4	FR0 - FR20	50.27	1.417	117.793	7.631	6.912	0.708	274.261
Tank No. 5	FR0 - FR20	3.06	0.088	9.719	7.620	0.000	0.044	455.106
Tank No. 6	FR0 - FR20	50.96	1.433	119.588	7.620	-6.939	0.717	274.261
Tank No. 7	FR-20 - FR0	51.16	1.442	120.061	-7.620	6.912	0.720	274.261
Tank No. 8	FR-20 - FR0	1.18	0.034	3.755	-7.620	0.000	0.017	455.106
Tank No. 9	FR-20 - FR0	51.17	1.439	119.901	-7.630	-6.939	0.720	274.261
Tank No. 10	FR-38 - FR-20	1.33	0.072	4.246	-20.628	6.926	0.036	199.280
Tank No. 11	FR-38 - FR-20	1.38	0.049	3.790	-20.578	0.000	0.025	455.106
Tank No. 12	FR-38 - FR-20	0.95	0.052	3.043	-20.585	-6.926	0.026	196.686
TOTAL TANK STATE				**509.422**	**-0.093**	**-0.015**	**0.673**	**3700.018**

A6.2 Fluid in Bilges

Compartment Name	Density (t/m^3)	Sounding (mm)	Capacity (m^3)	Mass (T)	LCG (m) Midships	TCG (m) fr CL	VCG (m) abv BL (FR30)	FSM (T.m)
Void above Tank No. 4	1.020	117	4.837	4.936	7.620	8.502	2.868	28.359
Green Water Filter	1.021	400	0.288	0.294	-24.684	0.000	2.610	0.088
TOTAL FLUID STATE				**5.230**	**5.805**	**8.024**	**2.854**	**26.771**

ANNEX B
INCLINING EXPERIMENT PHOTOS

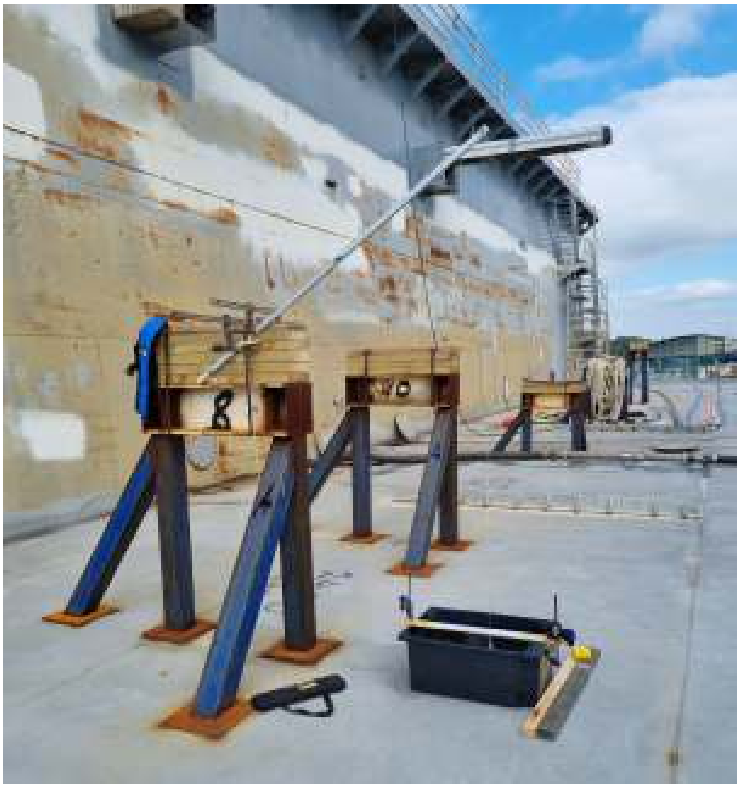


Figure B1: Aft Pendulum set-up

Figure B2: Aft Pendulum length measurement

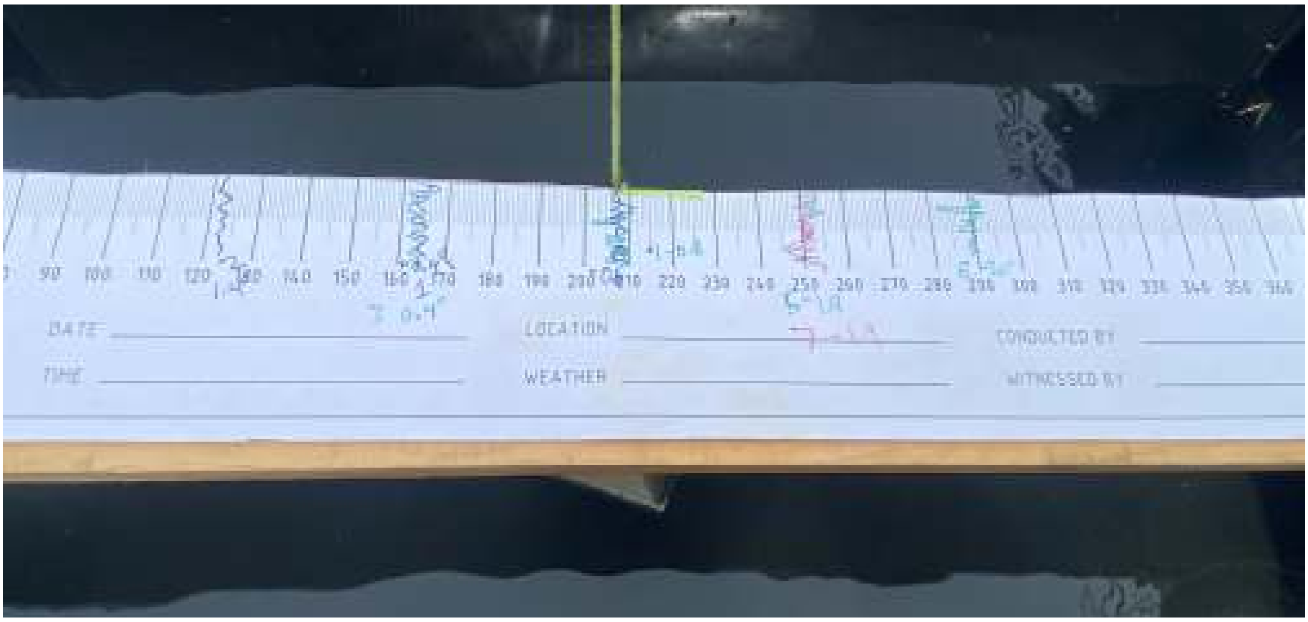


Figure B3: Aft Pendulum measurement strip

Figure B4: Fwd Pendulum set-up

Figure B5: Fwd Pendulum length measurement

Figure B6: Fwd Pendulum measurement strip

Figure B7: Draft measurement Port Aft (1M8 – 375)

Figure B8: Draft measurement Port Mid (1M8 – 290)

Figure B9 Draft measurement Port Fwd (1M8 – 392)

Figure B10: Draft measurement Stbd Fwd (1M8 – 472)

Figure B11: Draft measurement Stbd Mid (1M8 – 391)

Figure B12: Draft measurement Stbd Aft (1M8 – 485)

Figure B13: Typical Ocean Density & Temperature Reading

Figure B14: Typical Tank Density and Temperature Reading

Figure B15: Tank 1 Sounding (44mm)

Figure B16: Tank 2 Sounding (35mm)

Figure B17: Tank 3 Sounding (39mm)

Figure B18: Transfer Tank 4 Sounding, Initial condition (1417mm)

Figure B19: Tank 5 Sounding (88mm)

Figure B20: Transfer Tank 6 Sounding, Initial condition (1433mm)

Figure B21: Transfer Tank 7 Sounding, Initial condition (1442mm)

Figure B22: Tank 8 Sounding (34mm)

Figure B23: Transfer Tank 9 Sounding, Initial condition (1439mm)

Figure B24: Tank 10 Sounding (72mm)

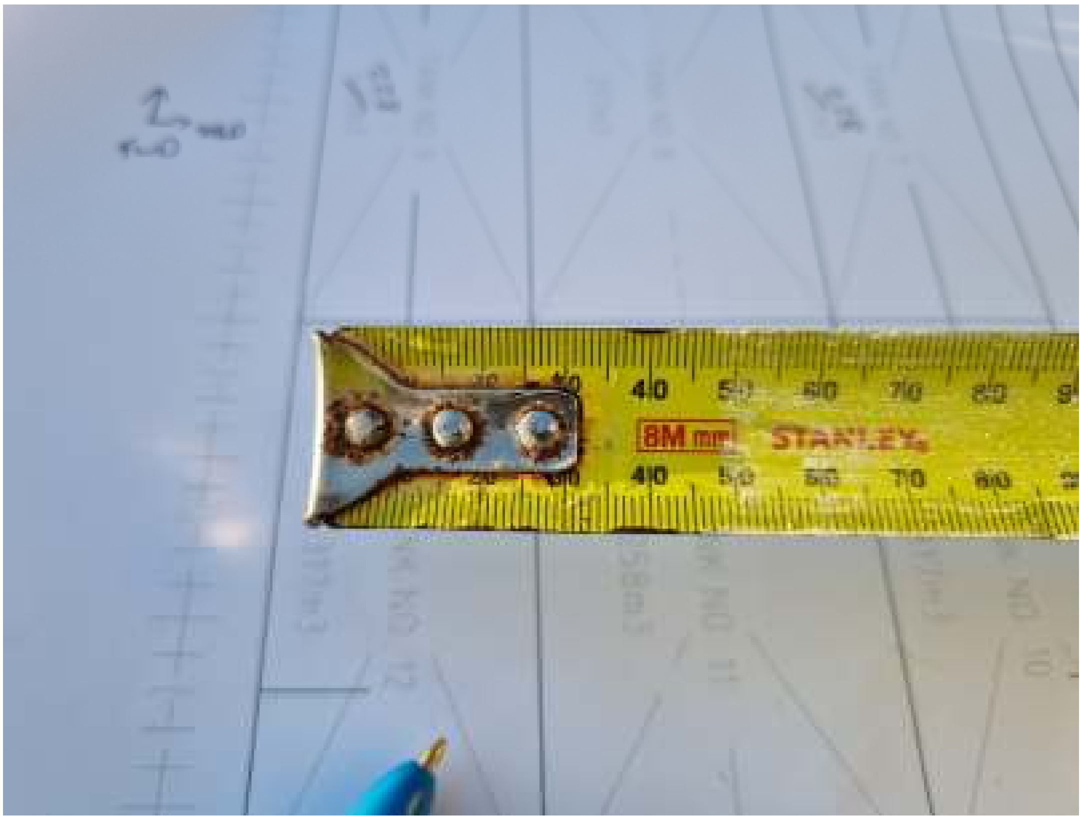


Figure B25: Tank 11 Sounding (49mm)

Figure B26: Tank 12 Sounding (52mm)

ANNEX C
HYDROMETER CALIBRATION CERTIFICATE

CarltonGlass Australia

CERT XDS

Certificate of Conformity

This Draft Survey hydrometer, serial number F5958 has been calibrated against instruments that have been certified by a NATA laboratory. When tested against these instruments, it was found to be accurate to +/- 0.0005 kg/l at 15°C.

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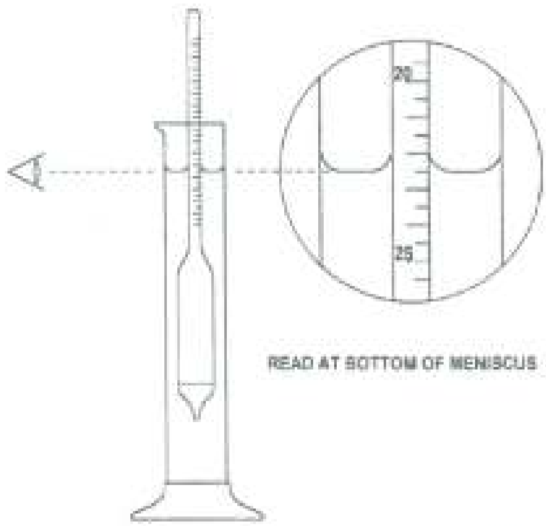
www.carltonglass.com.au



This is a brief and general outline of the method that is recommended to obtain accurate results from your hydrometer. More detailed information is available from the relevant standard. Ensure that the hydrometer, the vessel, and the liquid are clean, and that the liquid is at a stable temperature. Insert the hydrometer into the liquid by holding the top of the stem, and releasing it when it is judged to be in equilibrium with the liquid.

Press the hydrometer down a few millimeters and let it rise to the equilibrium point. Ensure that a good meniscus is formed. The scale should be viewed from below the surface of the liquid, and the observers eye raised until it is as close as possible to the plane of the liquid surface. You should see an ellipse reducing to a line as the eye is raised. Note reading. Apply appropriate corrections.

Insist on Quality. Insist on Carlton.

Figure C1: Hydrometer Calibration Certificate

Appendix F – Structural Assessment (JBD, 2020c and Shearforce, 2016)

Letter Reference: L2151-01
Subject: Report No: SYD/2015/19

The attached report *SYD/2015/19* was prepared by Shearforce Maritime Services in November 2016. It details a structural and preliminary stability analysis undertaken on the floating dry dock, FDD1N.

Due to the age of the floating dock, the length of time since the previous inclining and the remedial works still to be carried out, the stability analysis was preliminary only and was undertaken using the original lightship particulars from 1974. Remediation work on the floating dock has since been undertaken, removing a number of pieces of equipment no longer required.

An inclining experiment was undertaken on the floating dock in January 2022. It was found that this work has reduced the lightship mass and vertical centre of gravity by approximately 400 tonnes and 1.5m respectively. Therefore, the stability analysis provided in the Shearforce Maritime Services report is no longer valid. A separate stability booklet has been prepared and approved by John Butler Design in accordance with AMSA regulations. This stability booklet is to be used for any future analysis and comparisons.

The structural analysis undertaken within the Shearforce Maritime Services report was undertaken after a structural survey was undertaken. Therefore, the material thicknesses and conditions assumed within this report are considered accurate and no further structural analysis has been undertaken. The structure was assessed in accordance with MIL-STD-165D to determine the maximum allowable bending moments and maximum deck loadings. The structural analysis is considered acceptable and complete with no further actions required.

A red-line marked up version of the report is attached to this letter, which details the sections of the report that are now superceded and the new document to refer to for this information.

J M Butler	John Michael Butler	Principal Naval Architect	08/02/2022
Signed on behalf of John Butler Design Pty Ltd	Printed Name	Position	Date

Report No: SYD/2015/19

Date: 16/11/2016

Structural and Stability Assessment – Final Report
Floating Dock AFD 1002

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QUALITY SYSTEM CERTIFICATION DNV·GL ISO 9001

CONTENTS

Appendix I – UGL Strength Analysis of the Docking Cradle

Appendix II – Longitudinal Bending Moment & Deflection Calculation

1 Executive Summary

At the request of Noakes Group Pty Ltd, Shearforce Maritime Services Pty Ltd, has conducted a structural and stability assessment for the floating dock designated FLOATING DOCK AFD 1002.

The assessments have been carried to demonstrate that the floating dock is fit for purpose for use by Royal Australian Navy (RAN) vessels. This particular usage of the floating dock requires that the submission of the documents confirm that the floating dock is in a satisfactory condition and is adequate for its intended purpose.

To demonstrate the suitability of the floating dock for the use of RAN vessels, the United State Department of Defense Standard Practice Safety Certification Program for Dry-docking Facilities and Shipbuilding Ways for U.S. Navy Ships (MIL-STD) was selected for this assessment.

The structural strength of the floating dock has been assessed in several operating conditions, as per the MIL-STD, to identify the limiting loading at different stages of the operation and in different loading configurations.

To assess the longitudinal strength, three different types of docked vessels were used for the assessment. These cases were selected as they are considered to provide the worst loading case scenarios. The calculations were carried out to determine if the floating dock bending moment is within its limit when each of these vessels is in dock. The maximum allowable bending moment and its corresponding deflection at amidships were also calculated.

The loading limits of local structural components comprising of transverse structure, watertight bulkheads, mooring bollard and the keel block stand were calculated. Details of these loading conditions and their results are discussed in ***Section 4*** of this report.

The preliminary stability assessment of the existing floating dock has been carried out to determine the intact and damage stability characteristics and their compliance with the MIL-SPEC requirements.

The intact stability characteristics of the dock were calculated and both the GM and the maximum wind heeling were found compliant.

The maximum lifting capacity versus docked vessel adjusted VCG and the maximum lifting capacity of the dock versus the range of docked vessel longitudinal positions were calculated with the result presented in ***Section 5.5*** of this report.

The damaged stability calculations show that in both the fully ballasted and the de-ballasted conditions, the equilibrium-heeling angle from side shell damage does not comply with the MIL-STD. The large angle of heel was due to the significant loss of the reserve buoyancy from the forward wing compartment and from the side tank at the floating dock end.

The extent of damage required to be survived is considered excessive. It is recommended that the watertight sub-division of the floating dock be either increased by adding watertight bulkheads so that compliance with the MLI-STD can be achieved or that alternate damage stability criteria be applied such as the IMO Damage Stability Requirements. The results from this investigation are included in this report.

This preliminary stability assessment is subject to validation once the actual stability data is obtained through the conduct of an inclining experiment.

2 Floating Dry Dock Particulars

Name of Vessel:	Floating Dock AFD 1002
Classification Society:	Not Classed
Length Overall:	64.00 m
Moulded Breadth:	19.81 m

SEE JOHN BUTLER DESIGN REPORT EA-2151-007 - FDD1N STABILITY REPORT FOR UPDATED GENERAL PARTICULARS

Depth of Sides:	7.77 m
Depth Overall:	10.52 m
Designed Lift Capacity:	1000 tons
Builders:	Morts Dock
Place and Date of building:	Sydney, 1942

3 General Information

3.1 Background

The structural and stability assessments have been carried out to demonstrate that the floating dock is fit for purpose for use by the Australian Defence Force for their vessels. This use of the dry dock requires the submission of documents that verify that the floating dock is in a satisfactory condition and is adequate for its intended purpose.

The Australian Shipbuilding Board originally designed the floating dock in the 1940's for the Royal Australian Navy. The original structural and stability calculations and its design certifications are no longer available. As such, the calculations have been carried out following the United States Department of Defense Standard Practice Safety Certification Program for Drydocking Facilitates and Shipbuilding Ways for U.S. Navy Ships, document no. MIL-STD 1625D(SH) (MIL-STD).

3.2 Structural arrangement

The floating dock consists of a barge shaped steel hull and a wing section at both sides of the dock. These are supported by primary structures which consist of shell plating, longitudinal bulkheads, transverse bulkheads and transverse open frames.

3.3 Watertight and Ballasting arrangement

The floating dock is subdivided into twelve compartments by a combination of longitudinal and transverse watertight bulkheads for ballasting purposes. ***Figure 3.3.1*** shows the tanks arrangement.

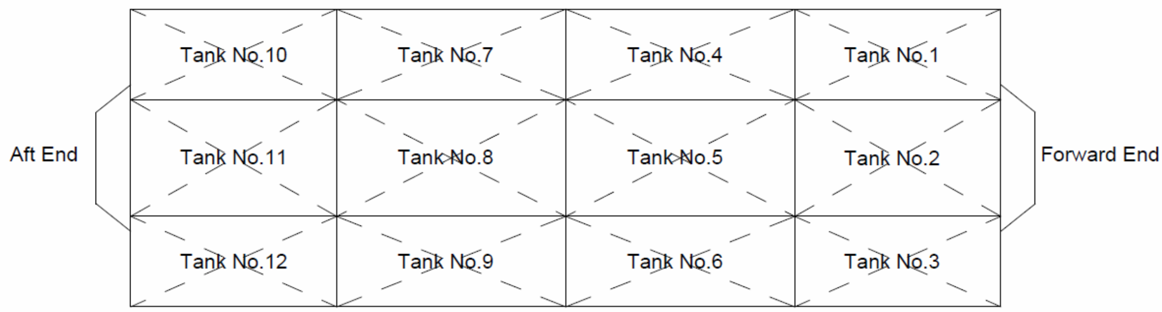

Figure 3.3.1: Ballast tanks arrangement

The pontoon deck bounds all the tank tops, except for tanks No. 1, 3, 10 and 12. Tanks 1, 3, 10 and 12 are bound by the safety deck. These four tanks work by the isothermal compression principle, where the tank's air ventilation pipe is fitted with its intake end below the safety deck and works like a shut off valve. Once the ballast level is above the pipe bottom, the remaining air inside the tank will compress to the point where its pressure will stop any further ballast from entering.

To flood the dock to its deepest allowable draught, tanks No. 1, 3, 10 and 12 are filled up to the bottom of the air vent pipe while the other tanks are filled to the pontoon deck level.

4 Structural Assessments

4.1 Introduction

The structural assessment of the floating dock has been carried out to determine its capacity as defined in the MIL-STD.

The intent of the assessment is to determine the maximum longitudinal strength, transverse strength and the maximum load of local structural components. Detailed requirements from the MIL-STD are listed in ***Section 4.2*** below.

For this assessment, first principle calculations and FEA analysis have been used where it is deemed appropriate.

4.2 Structural Criteria

The section concerning the structural strength assessment of the floating dock is detailed in Section 5.1.3.4 of the MIL-STD and its detail requirements are summarised as follows:

a. Maximum allowable longitudinal bending moment calculation.
b. Transverse strength calculation substantiating the maximum allowable pontoon deck loading in long tons (LT) per linear foot.
c. Longitudinal deflection calculation corresponding to maximum allowable bending moment.
d. Maximum keel block, side block, and hauling block loading calculations including local pontoon deck structure under docking blocks.
e. Maximum pontoon deck loading at other than keel block and side block locations, if different than that of the blocking area.
f. Structural arrangement and scantlings.
g. Longitudinal and transverse watertight bulkhead design calculations.
h. Maximum allowable differential head between adjacent tanks.
i. Maximum allowable differential head between tanks and exterior dry dock draft.
k. Data and calculations substantiating adequacy of mooring attachments on the dock's structure.
l. Maximum allowable differential head between adjacent tanks (or group of adjacent tanks) to produce a bending moment equal to the maximum

allowable value.

The allowable longitudinal and transverse bending stress for steel floating dry docks shall not exceed 0.60 Fy (60% of the structure material yield strength), which is equivalent to a minimum Factor of Safety of 1.66.

4.3 Material Properties

At the time of this assessment, the mechanical properties of the original structural steel used for the floating dock was not known. It has been assumed that mild-steel was used for all of the structural components and ***Table 4.3.1*** lists the mechanical properties.

Table 4.3.1: Mild-Steel Mechanical Properties

Mass Density	7850 kg/m^3
Yield Strength	207 MPa
Ultimate Tensile Strength	345 MPa
Young’s Modulus	220 GPa
Poisson’s Ratio	0.275

From the above mechanical properties, the allowable bending stress of all the floating dock structure components are limited to 124 MPa in exception of the docking block. The mechanical properties of the docking block are to refer to the separate analysis report from UGL in Appendix I.

4.4 Scantling

Throughout the operational life of the floating dock, its structure is subjected to potential corrosion wastage and this must be considered in this assessment. For this, a net scantling approach has been adopted where the net scantling used for the analysis are calculated from deducting the corrosion thickness allowance from the gross scantling of the structure. Corrosion thickness allowance of 25% was adopted in accordance to the MIL-STD.

Table 4.4.1 summarised both the original and net scantling for the floating dock structure components.

Table 4.4.1: Structural Components Scantling Summary

Items	Original Scantling (mm)	Net Scantling (mm)
Bottom Plate	12	9
Side Plate	12	9
Pontoon Deck Plate	12	9
Outer Wing Wall Plate	12	9
Inner Wing Wall Plate	12	9
Top Deck Plate	10	7.5
Safety Deck Plate	10	7.5
Centreline Girder	10	7.5
Side Longitudinal BHD Plate	10	7.5
Transverse Side Frame	12	9
Plate supporting stiffener	10	7.5

4.5 Design Loads

This section identifies the loads that the floating dock encounters during its operations.

4.5.1 Floating Dock Mass

The mass of the floating dock used for this assessment is 1426 tons using the data from inclining experiment carried out on 11th May 1974.

4.5.2 Docked Vessel load

For determining the loads from the docked vessels, we considered three types of vessel, which the floating dock is capable to lift and each of them represents the worst loading scenarios. These are:

- 35m Harbour Tug

  This represents the heaviest vessel that the floating dock is rated to lift on the shortest blocking length.

- Huon Class Minehunter

  This represents the heaviest vessel that the floating dock is rated to lift on the longest blocking length.

- Paluma Class Surveying Ship

  This vessel type represents the heaviest catamaran type vessel that the floating dock is rated to lift on the longest blocking length.

Table 4.5.2.1 summaries the particulars for these vessels, and ***Figures 4.5.2.1*** to ***4.5.2.3*** shows their photos.

Table 4.5.2.1: Particulars of vessels used for structural assessment

Vessel Type	**35m Harbour Tug**	**Huon Class minehunters**	**Paluma Class Surveying ship**
LOA (m)	34.0	52.5	36.6
Beam (m)	11.0	9.9	12.8
Draft (m)	4.0	3.0	2.7
Displacement (tonnes)	960	732	325
Supporting block length (m)	22	42	24

Figure 4.5.2.1: Harbour tug

Figure 4.5.2.2: Huon Class Minehunter

Figure 4.5.2.3: Paluma Class Surveying Ship

To determine the load distributions of these vessels along the longitudinal length of the floating dock, the two weight distribution curves from the DNV-GL Classification Rule for Floating Docks were chosen. These two curves represent typical load distributions for a ‘sagging’ and a ‘hogging’ vessel. ***Figure 4.5.2.4*** and ***4.5.2.5*** shows their weight distribution profile and their calculation details are described in the Classification rules[1].

1. DNV-GL Rules for Classification Floating Dock Edition October 2015, website https://rules.dnvgl.com/docs/pdf/DNVGL/RU-FD/2015-10/DNVGL-RU-FD.pdf

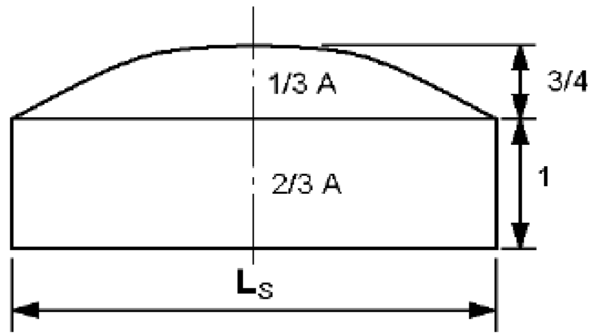

Figure 4.5.2.4: Sagging vessel load distribution profile

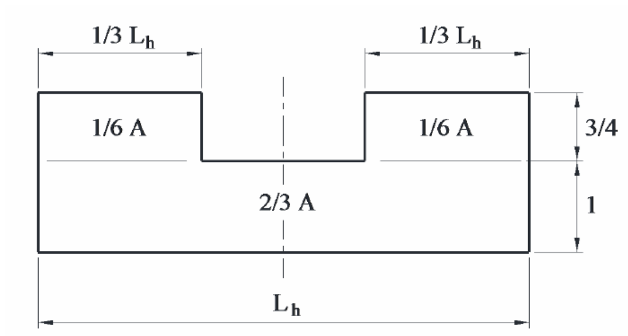

Figure 4.5.2.5: hogging vessel load distribution profile

The sagging vessel load profile was used for the harbour tug and Paluma Class Surveying Ship as this represents the greatest load applied to the midship of the dock. The hogging load profile was used for the Huon Class Minehunter as it represents the greatest load distribution applied the fore and aft ends of the dock.

4.5.3 Hydrostatic & Water ballast load

The typical hydrostatic and corresponding water ballast load for various stages of dock operations have been determined using the condition as described in ***Figure 4.5.3.1***.

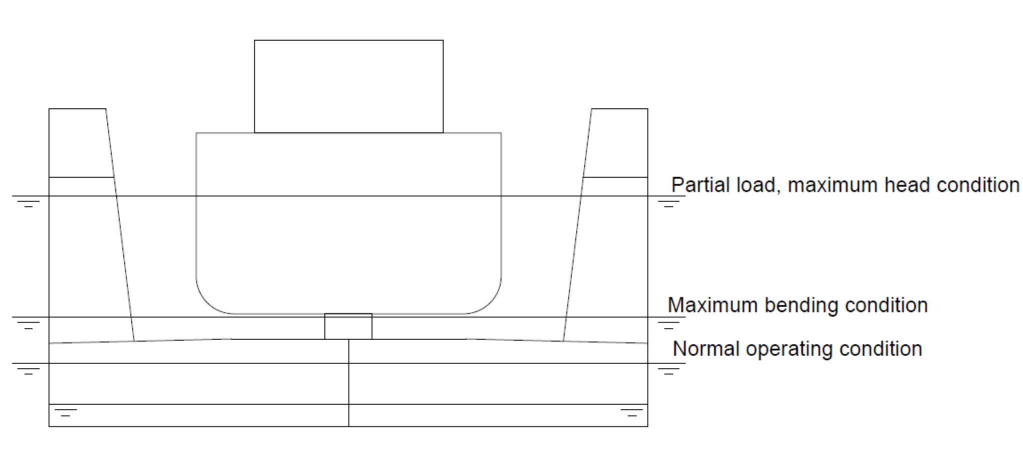

Figure 4.5.3.1: three phase of operation conditions considered for structural assessment

4.6 Assessment Methodology

This section lays out the assessment methodology used for each for the analyses as required by the MIL-STD.

4.6.1 Maximum allowable longitudinal bending moment calculation

The floating docks' longitudinal strength has been assessed by using the quasi-static method, where the bending moments are calculated by first integrating the net load of the dock along its length to obtain the shear force, and then by integrating the shear force to obtain the bending moment.

$$\text{Shearforce}, S = \int (\rho g a - m g) dx$$

Where ρ is seawater density, *m* is the dock weight per unit length, *a* is the immersed cross-section area at point of interested and *g* is gravity.

$$\text{Longitudinal bending moment}, \mathrm{M} = \int S\, dx = \iint (\rho g a - m g) dx\ dx$$

The floating docks' maximum allowable bending moment was calculated by applying the load exerted by a docked vessel on the centreline block of the dock amidships, to represent a worst-case scenario. Load cases from docked vessels were also calculated using the vessels listed in ***Section 4.5.2***.

4.6.2 Transverse strength calculation substantiating the maximum allowable pontoon deck loading in long tons (LT) per linear foot.

The transverse strength assessments were focused on the open frame section i.e. frames that were not supported by either a solid frame or a watertight bulkhead.

The operating conditions of the dock that were assessed are as shown in ***Figure 4.5.3.1*** and as described below:

- **Normal operating conditions (Phase 5)**

  This represents a docked vessel on the floating dock with 1 foot of slack ballast

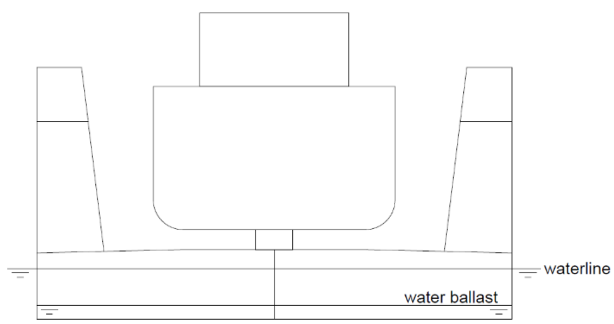

Figure 4.6.2.1: Normal Operating Conditions (Phase 5)

- **Docked vessel keel at water level (Phase 3)**

  This is represented by the maximum load on the pontoon deck from both the docked vessel and seawater.

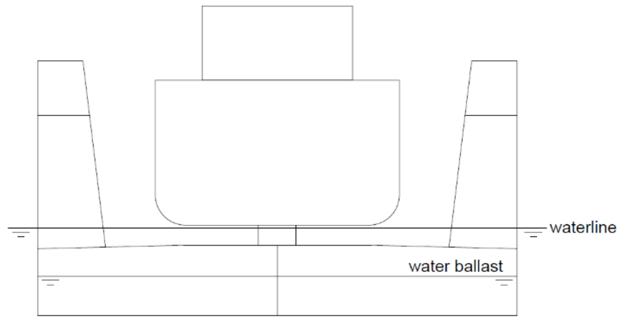

Figure 4.6.2.2: Maximum load (Phase 3)

- **Partial load, Maximum head condition (Phase 2.5)**

  this is when the docked vessel is just about to lift out of the water. At this condition the internal ballast water level is parallel to the pontoon deck and 10% of the vessel weight is supported by the floating docks' block.

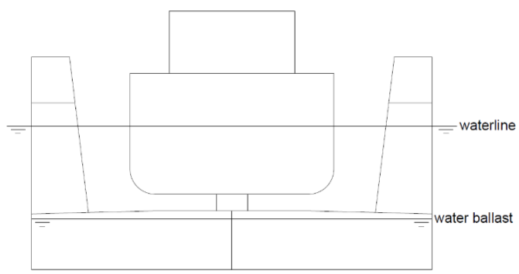

Figure 4.6.2.3: Partial load, maximum head condition (Phase 2.5)

For each of these three conditions, two different block load arrangements were investigated:

- 100% loading on centreline block
- 50% Keel block and 50% load Side Block

This condition represents the docked vessel load on both centreline and side block and are assessed to investigate the load acting on the side of the dock.

A section of the dock model was created with a span of a single centreline block spacing i.e. 0.953 m. ***Figure 4.6.2.4*** shows this model.

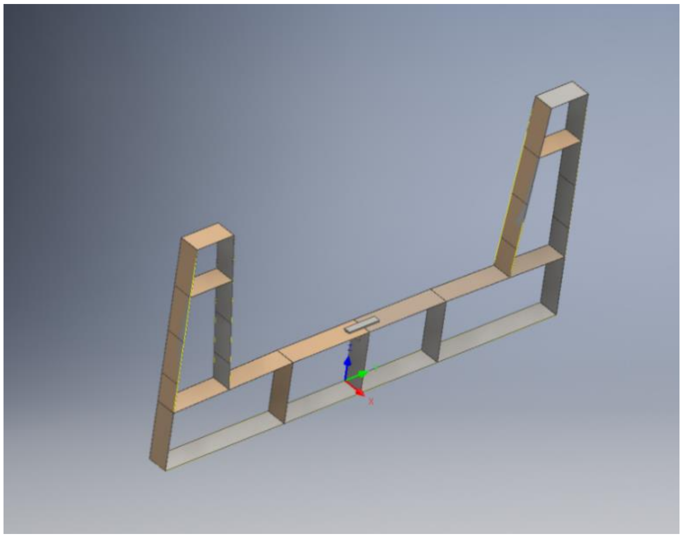

Figure 4.6.2.4 CAD model for transverse strength FEA analysis

4.6.3 Longitudinal deflection calculation corresponding to maximum allowable bending moment.

The deflection is calculated by integrating the bending moment calculated as per ***Section 4.6.1*** along the length of the dock twice.

$$\text{Deflection}, d = \int \frac{M}{EI} dxdx$$

4.6.4 Maximum keel block and side block loading calculations including local pontoon deck structure under docking blocks.

The structural assessment of the Dock keel and side block cradle was independently assessed by UGL in 2015. ***Figure 4.6.4.1*** shows a CAD drawing of the block structural arrangement and the UGL strength analysis was listed in ***Appendix I***.

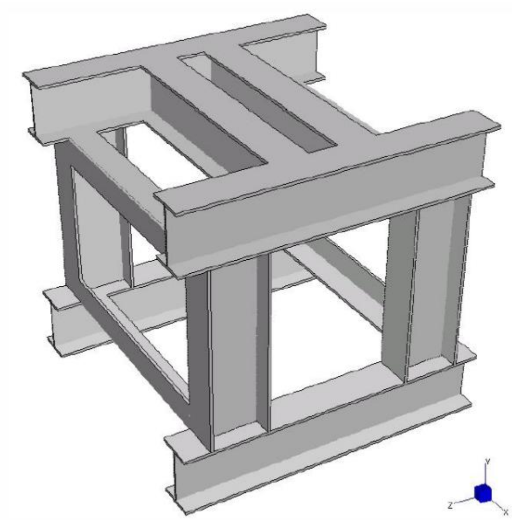

Figure 4.6.4.1: Keel and side block arrangement

4.6.5 Maximum pontoon deck loading at other than keel block and side block locations, if different than that of the blocking area.

The Dock's pontoon deck loading was calculated to access the scenario of the dock is fully submerge with the water level up to its top deck. Partial of deck structure was modelled for FEA assessment and this partial structure are shown in ***Figure 4.6.5.1*** and ***4.6.5.2***.

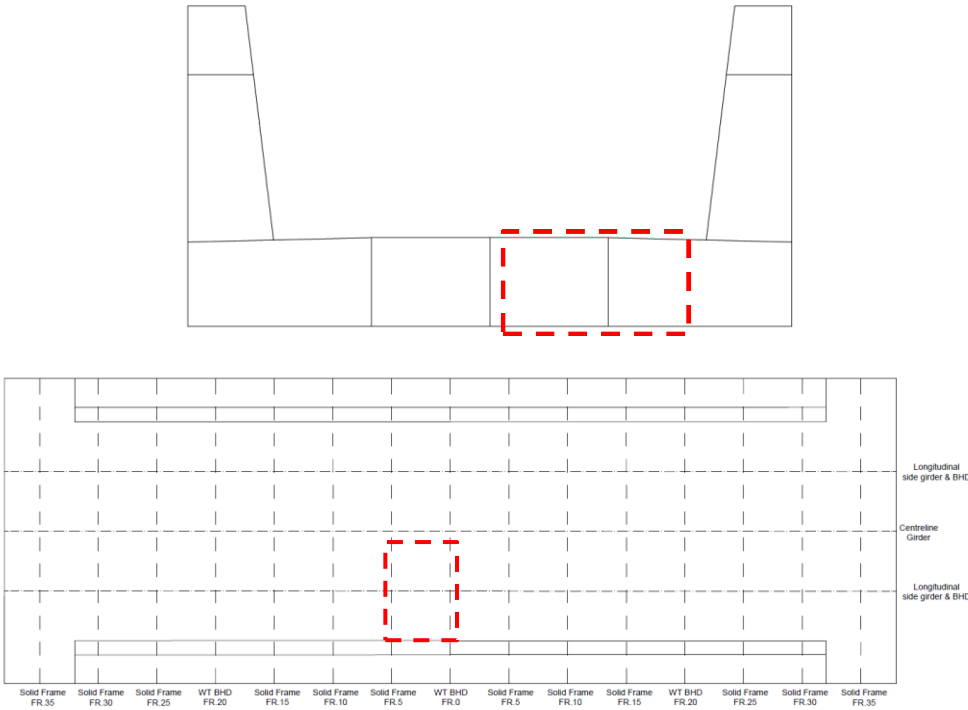

Figure 4.6.5.1: Area of the partial deck structure used for FEA assessment

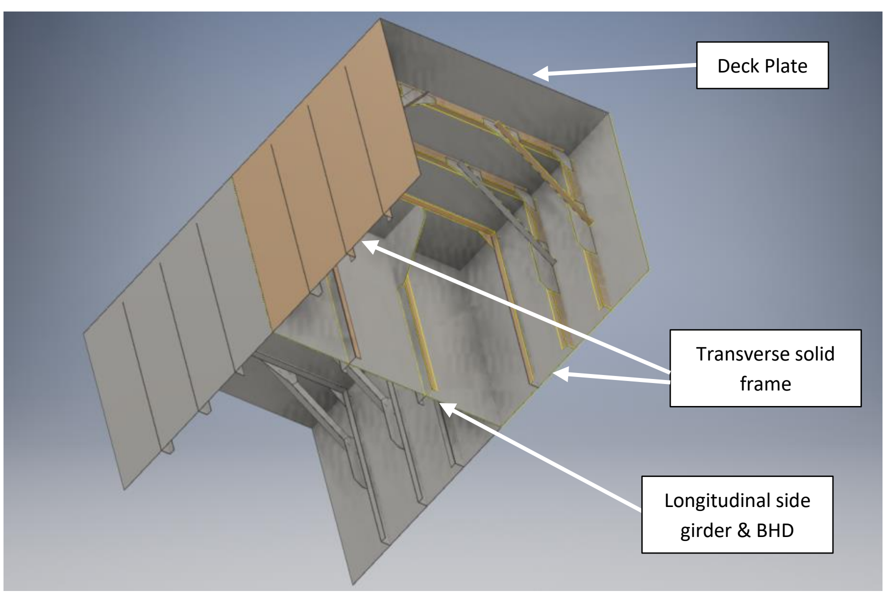

Figure 4.6.5.2: Deck structure CAD Model

4.6.6 Longitudinal and transverse watertight bulkhead design calculations

The strength of longitudinal and transverse watertight bulkheads was calculated whilst subjected to both the hydrostatic and docked vessel load. To assess the combination of these loads acting on the bulkhead FEA was used.

The FEA assessment was carried out using the operating stage as stated in ***Section 4.6.2***, in addition, the worst case scenario was investigated where water ballasts tanks were 100% filled on tank no 1, 2 and 3 while tank no 4, 5 and 6 were emptied. A detail model of the transverse bulkhead at frame No. 20 was created for this assessment and its CAD model is shown in ***Figure 4.5.6.1***.

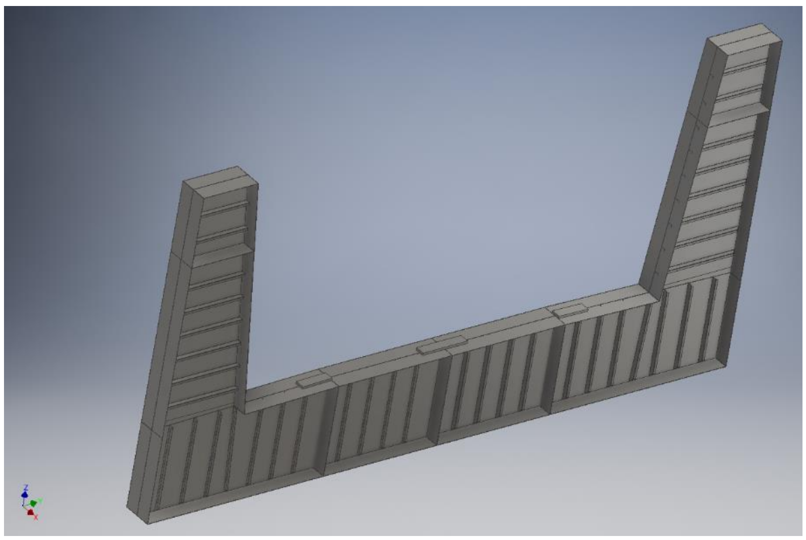

Figure 4.5.6.1: Transverse watertight bulkhead CAD model

4.6.7 Maximum allowable differential head between adjacent tanks

FEA was used to assess the differential head loads between the ballast tanks. A model of the dock forward between midships and end was used to represent the Tank No.1 to No.6. Analysis was carried out with tanks No.1 and No.4 filled separately while the other tanks were empty. The FEA model is shown in ***Figure 4.6.7.2.***

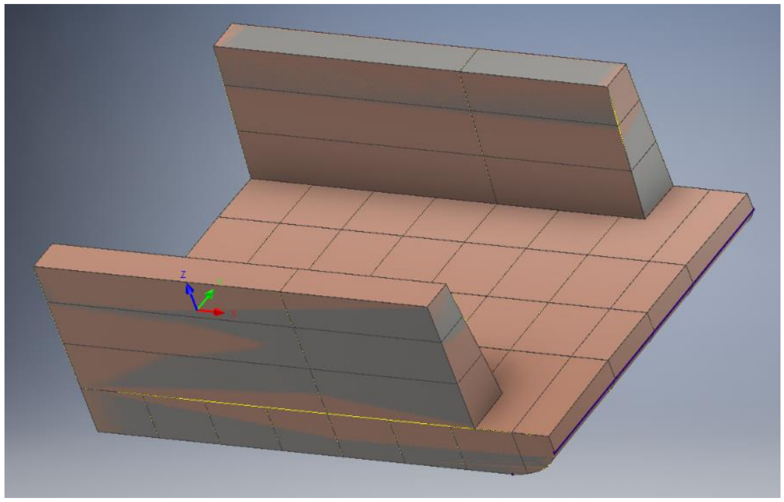

Figure 4.6.7.2: CAD model of the dock tank No. 4, 5 and 6

4.6.8 Maximum allowable differential head between tanks and exterior dry dock draft

FEA assessment was carried out to determine the load on the ballast tanks when the exterior floating dock draft is at the wing deck level whilst the internal water ballast tanks are all empty. The model from ***Figure 4.6.7.2*** above was used for this analysis.

4.6.9 Data and calculations substantiating adequacy of mooring attachments on the floating docks' structure

The floating docks' mooring arrangement consists of four bollards fitted on the pontoon deck. The drawing and scantling of the bollard is shown in ***Figure 4.6.9.1***.

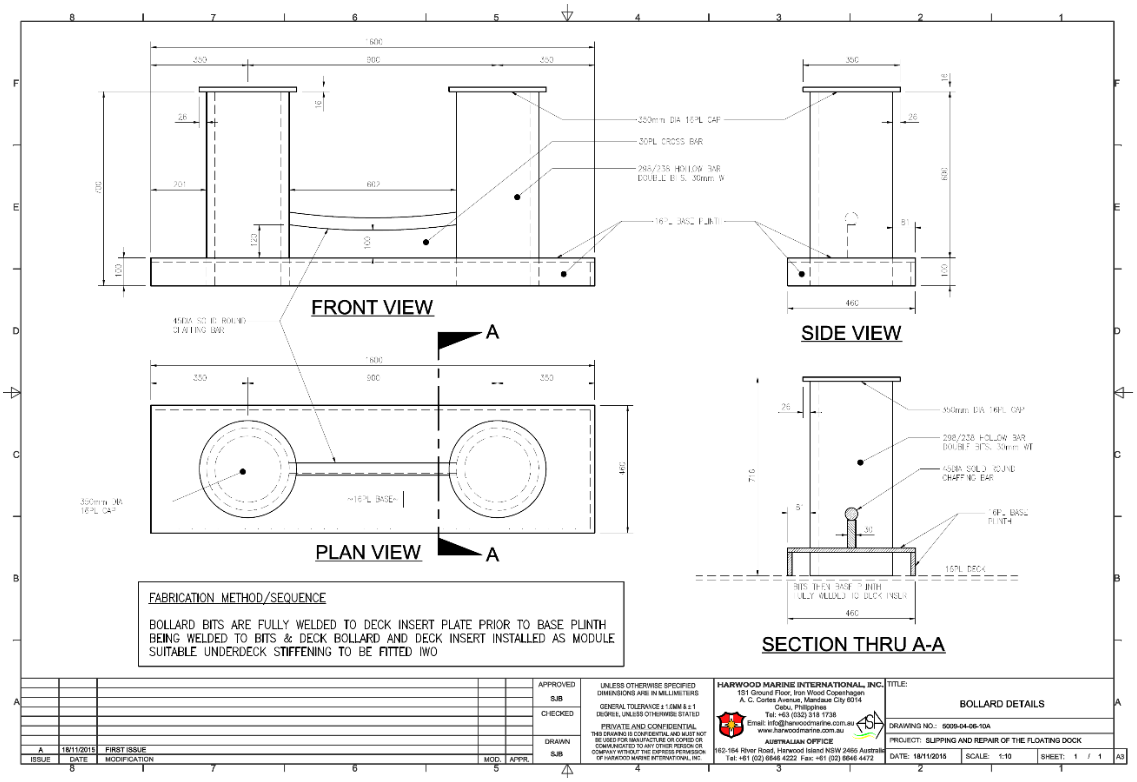

Figure 4.6.9.1: Bollard details

FEA was used to identify the maximum load that the bollard can withstand in accordance with the International Standard “ISO 13795 – Ship’s mooring and towing fittings – Welded steel bollards for sea-going vessels”

4.6.10 Maximum allowable differential head between adjacent tanks (or group of adjacent tanks) to produce a bending moment equal to the maximum allowable value

To investigate the maximum bending moment from the ballast tanks’ load, the methodology laid out in ***Section 4.6.1*** was used to calculate the load when Tanks No. 4, 5, 6, 7, 8 and 9 fully filled.

4.7 FEA Details

4.7.1 Software Details

The FEA calculations for the floating dock have been carried out using a general-purpose Finite Element Analysis software suite, which is inbuilt into Inventor™. The module uses ANSYS (a simplified version) for the FEA calculations.

4.7.2 Model Meshing

The meshing arrangement of the models and their mesh settings in the FEA software are shown between ***Figure 4.7.2.1*** to ***4.7.2.5*** and ***Table 4.7.2.1*** respectively

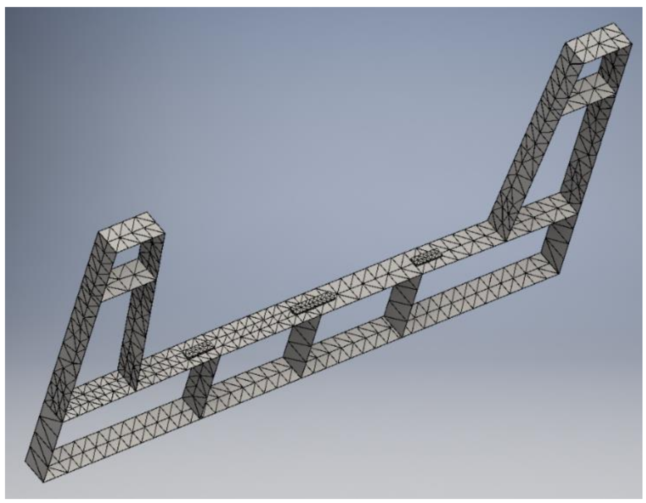

Figure 4.7.2.1: Transverse strength analysis model

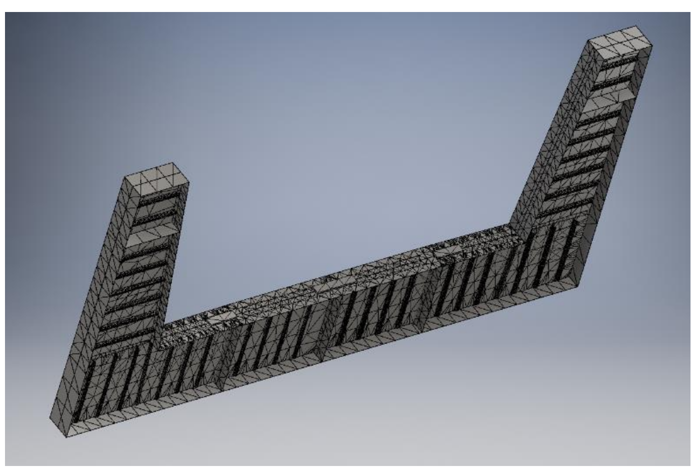

Figure 4.7.2.2: Transverse watertight bulkhead analysis model

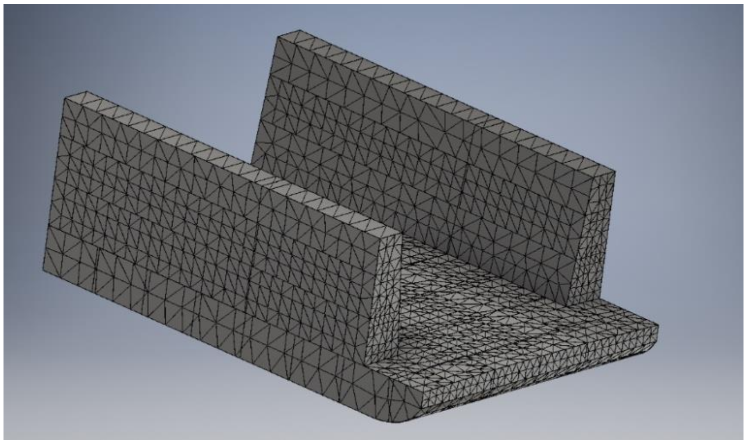

Figure 4.7.2.3: Differential tank heads analysis model

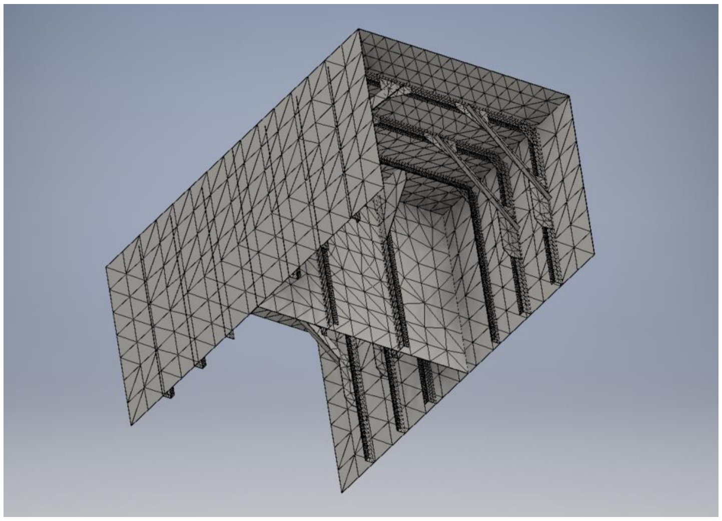

Figure 4.7.2.4: Deck structure analysis model

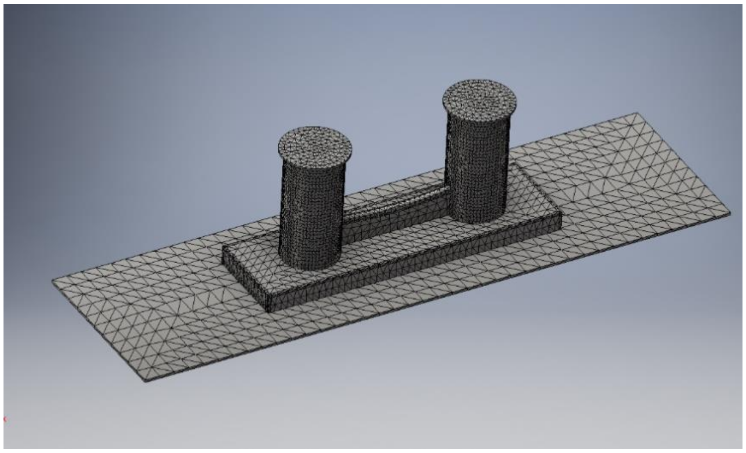

Figure 4.7.2.5: Mooring bollards analysis model

Table 4.7.2.1: Model FEA mesh settings

Model	No. of Nodes	No. of elements	Average element size (as a fraction of bounding bow length)	Minimum element size (as a fraction of average size)
Transverse strength	10287	4333	0.75	0.75
Transverse watertight bulkhead	191849	95434	0.90	0.90
Differential tank heads	128047	64999	0.90	0.90
Deck Structure	156037	80384	0.65	0.50
Mooring bollards	114900	64725	0.10	0.20

4.8 Assessment Result

4.8.1 Maximum Allowable Longitudinal Bending Moment

The calculated maximum allowable longitudinal bending moment with 1,740 tonne of load acting on the floating dock amidships was 169,269 kN.m, which corresponds to the Factor of Safety of 1.67. ***Figure 4.8.1.1*** and ***4.8.1.2*** show the load distribution and calculated bending moment along the length of the floating dock and ***Appendix II*** lists the detailed calculations.

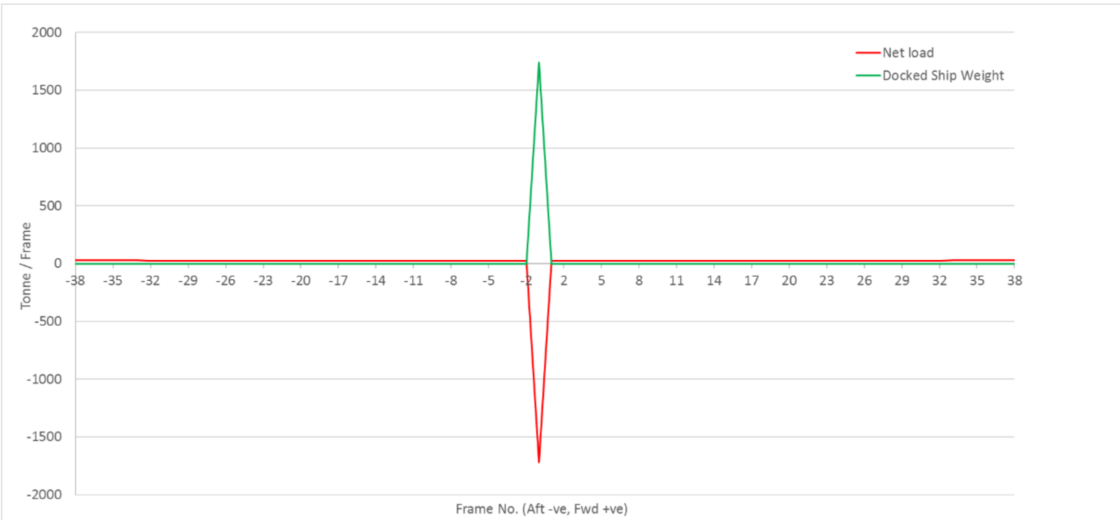

Figure 4.8.1.1 Load Distribution

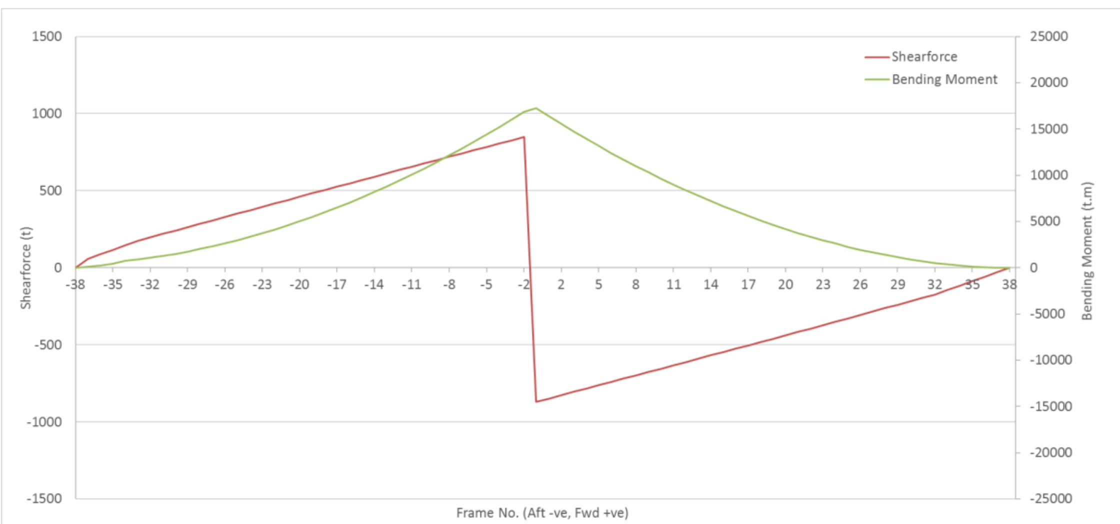

Figure 4.8.1.2 Bending Moment Calculation

The calculated longitudinal bending moment of the floating dock, whilst docked with the harbour tug, Huon class minehunter and Paluma class surveying ship are 73,279kN.m, 20,699kN.m and 28,747kN.m respectively with all their Factor of Safety exceeding 1.6. ***Figures 4.8.1.3*** and ***4.8.1.8*** show their load distribution and calculated bending moment.

Figure 4.8.1.3 Load Distribution – Harbour tug

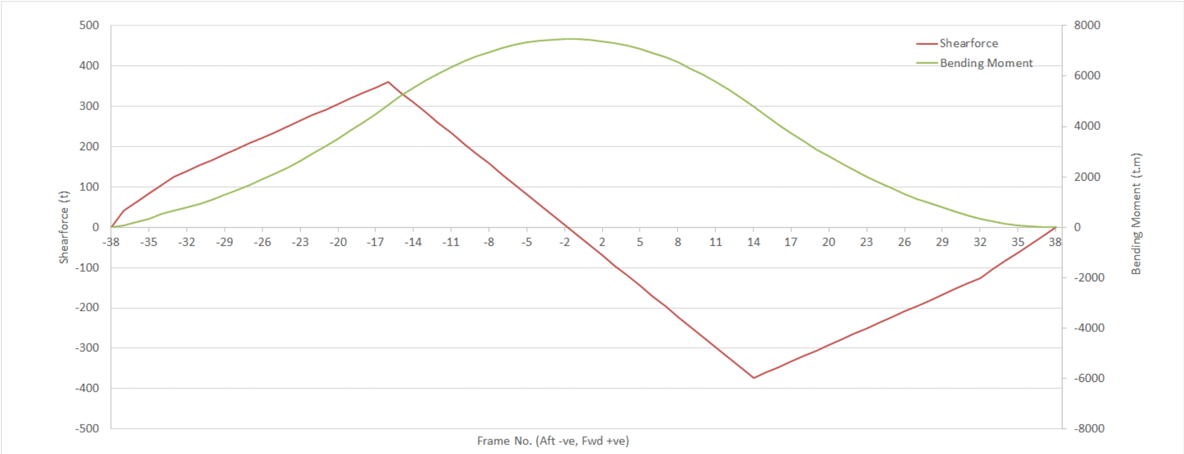

Figure 4.8.1.4 Bending Moment Calculation – Harbour tug

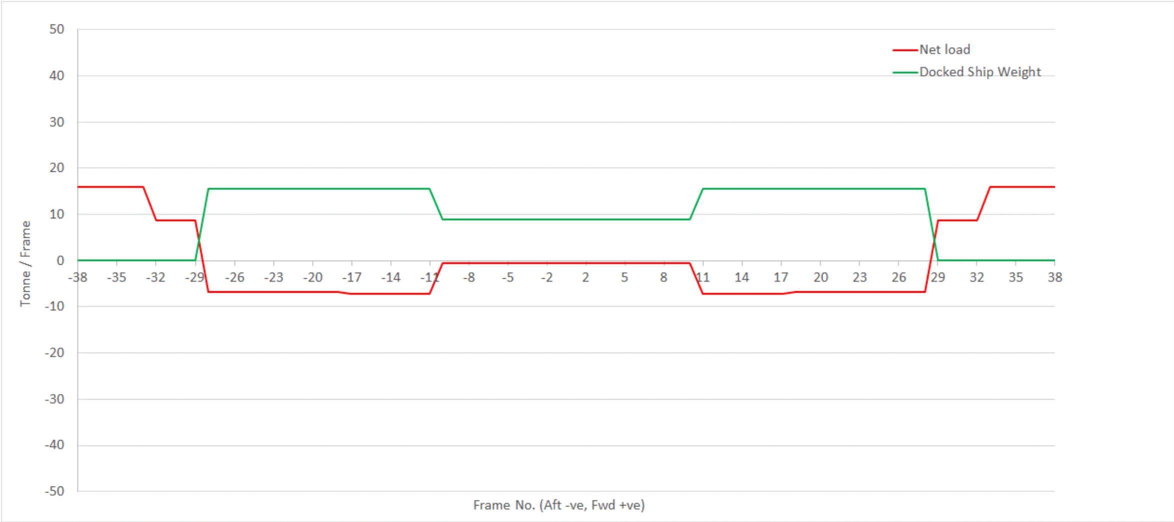

Figure 4.8.1.5 Load Distribution – Huon Class Minehunter

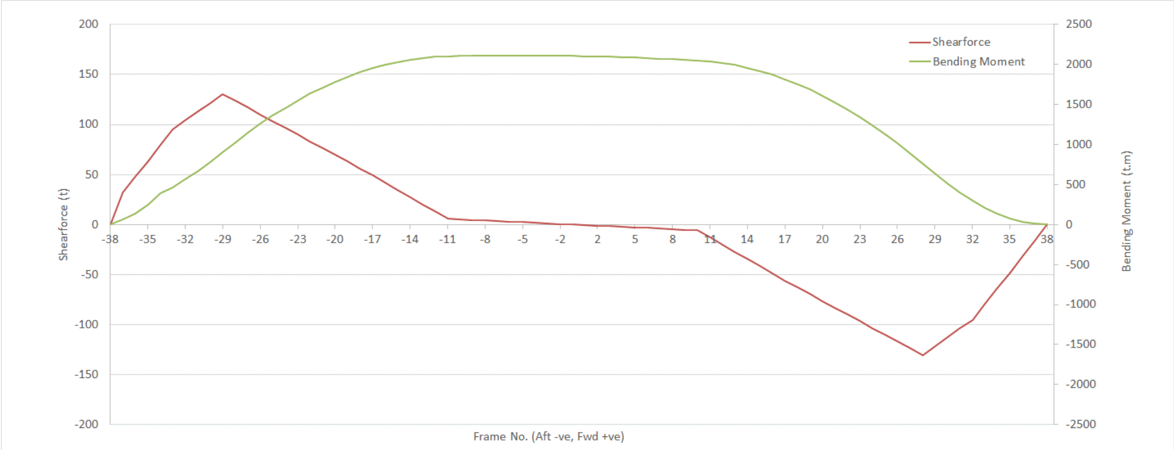

Figure 4.8.1.6 Bending Moment Calculation – Huon Class Minehunter

Figure 4.8.1.7 Load Distribution – Paluma Class Surveying Ship

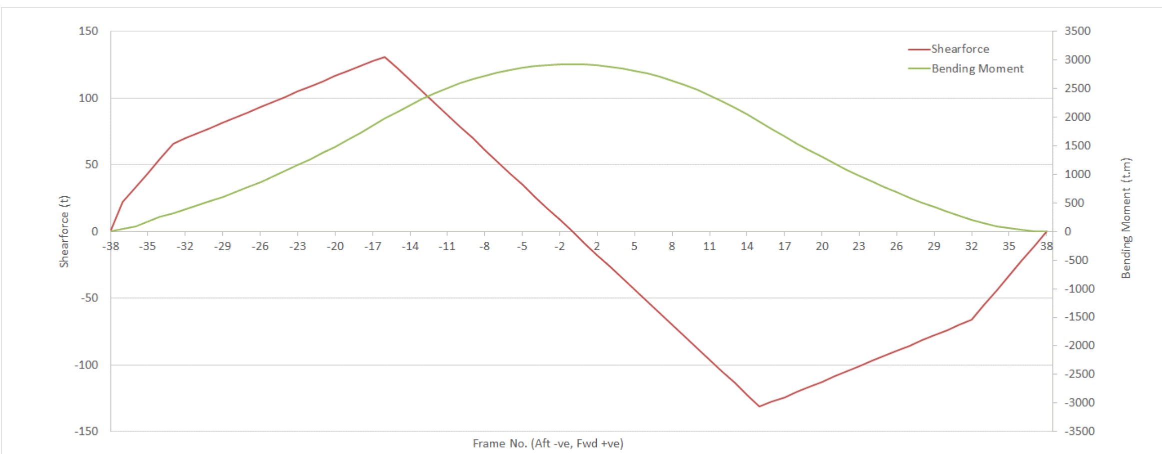

Figure 4.8.1.8 Bending Moment Calculation – Paluma Class Surveying Ship

4.8.2 Transverse strength calculation substantiating the maximum allowable pontoon deck loading in long tons (LT) per linear foot

The FEA result shows that the maximum allowable pontoon deck loads for Phase 1 operating condition are 65 tonnes per block, and the corresponding maximum stress are 92 MPa with its equivalent Factor of Safety of 2.25. This is equivalent to a maximum pontoon deck load of 22.5 tonnes per linear foot. ***Figure 4.8.2.1*** and ***4.8.2.2*** shows the FEA result.

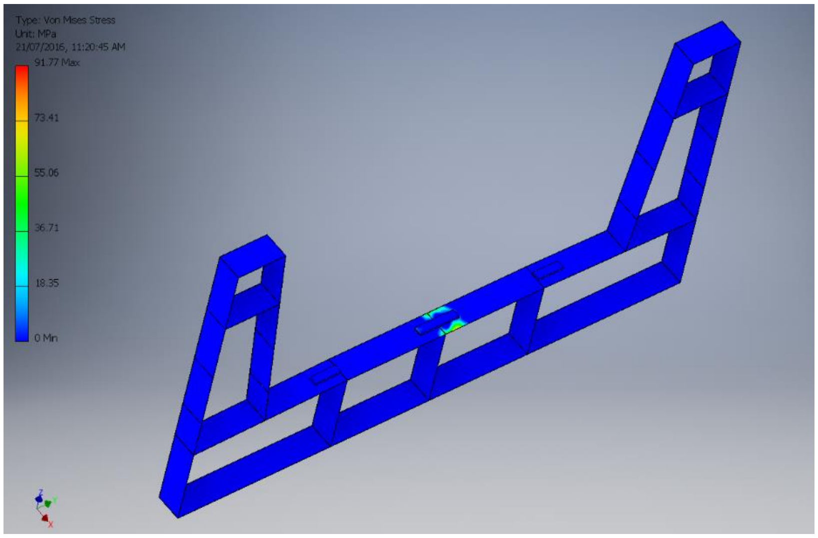

Figure 4.8.2.1 Maximum block load at normal operating condition - Phase 1 (100% load on CL block)

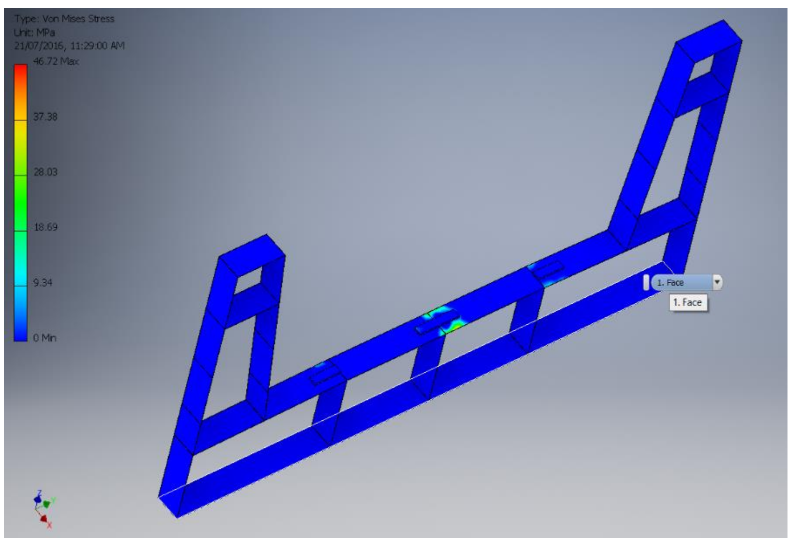

Figure 4.8.2.2 Maximum block load at normal operating condition - Phase 1 (50% load on CL block & 50% load on side blocks)

Applying the same load from above, the result for Phase 3 and Phase 2.5 operating conditions are 87 MPa and 40 MPa with their equivalent Factor of Safety of 2.3 and 5.1 respectively. ***Figures 4.8.2.3*** to ***4.8.2.6*** show these results.

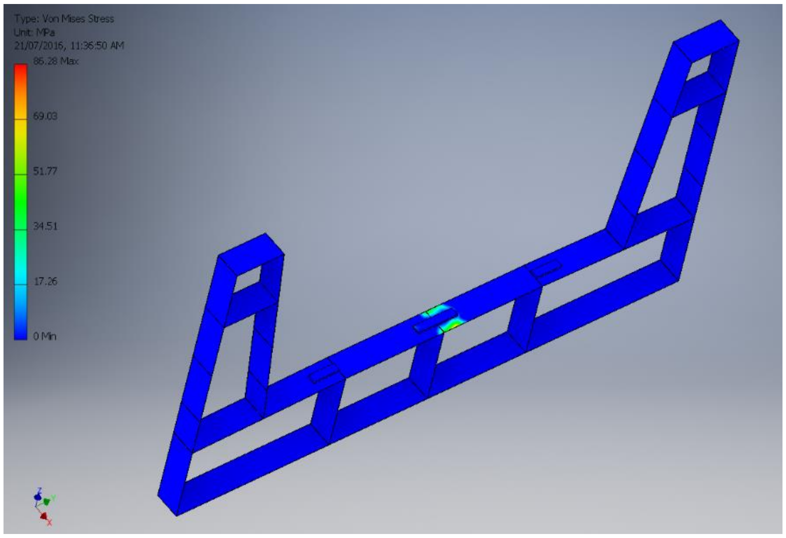

Figure 4.8.2.3 Waterline up to docked vessel keel – Phase 3 (100% load on CL block)

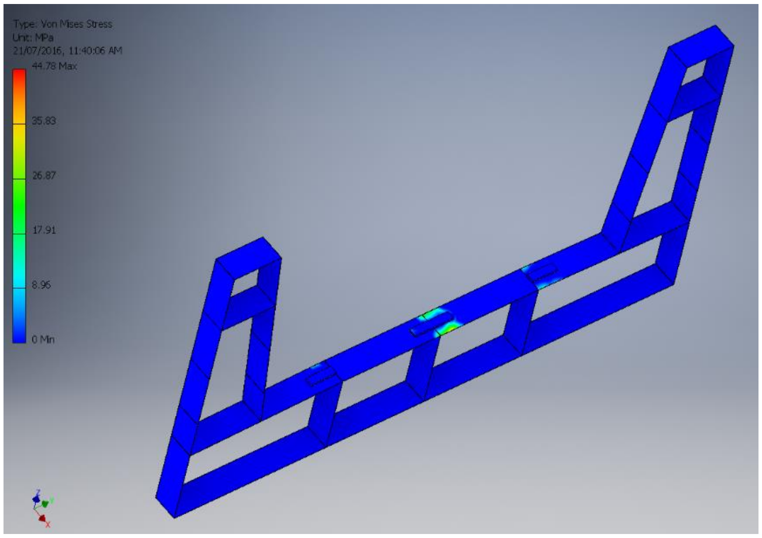

Figure 4.8.2.4 Waterline up to docked vessel keel - Phase 3 (50% load on CL block & 50% load on side blocks)

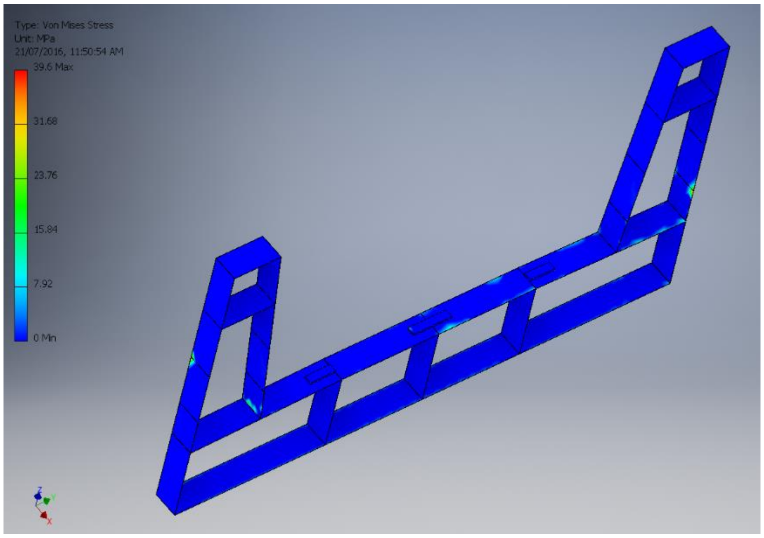

Figure 4.8.2.5 Partial load, maximum head condition – Phase 2.5 (100% load on CL block)

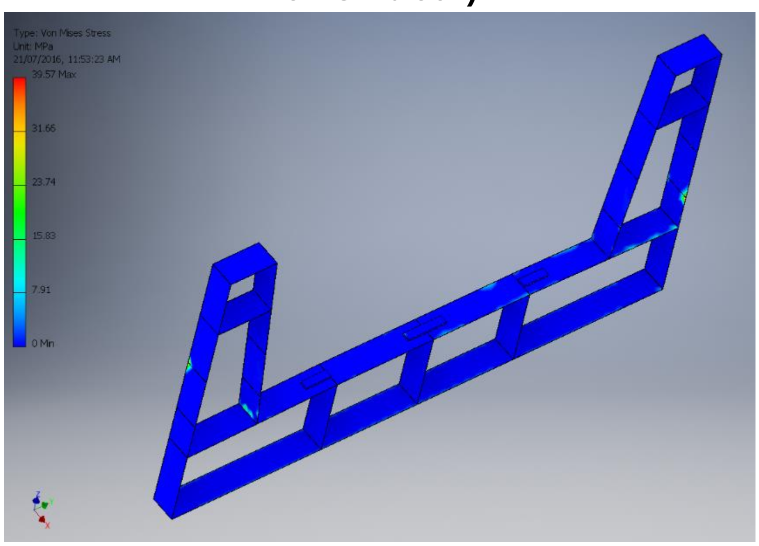

Figure 4.8.2.6 Partial load, maximum head condition – Phase 2.5 (50% load on CL block, 50% side blocks load)

4.8.3 Longitudinal deflection calculation corresponding to maximum allowable bending moment

The longitudinal deflection corresponding to the maximum allowable bending moment calculated in ***Section 4.8.1*** above is 99 mm at the floating dock amidships. The detailed calculations are listed in ***Appendix II***.

4.8.4 Maximum keel block and side block loading calculations including local pontoon deck structure under docking blocks.

From the UGL report the calculated maximum keel and side block is 30 tonnes. The detail calculations are listed in ***Appendix I***.

Maximum load of pontoon deck structure under the docking block are calculated to 65 tonnes per block from ***Section 4.8.2***, this calculated load exceeded the maximum load that the keel and side block can withstand.

4.8.5 Maximum pontoon deck loading at other than keel block and side block locations, if different than that of the blocking area

The FEA result shows that the maximum stress of the pontoon deck from the hydrostatic head of 7.8m (when the dock fully submerge to its waterline is up to the top deck) is 26 MPa with its equivalent Factor of Safety of 8. The above hydrostatic head is corresponding to maximum deck loading of 7.9 t/m^2.

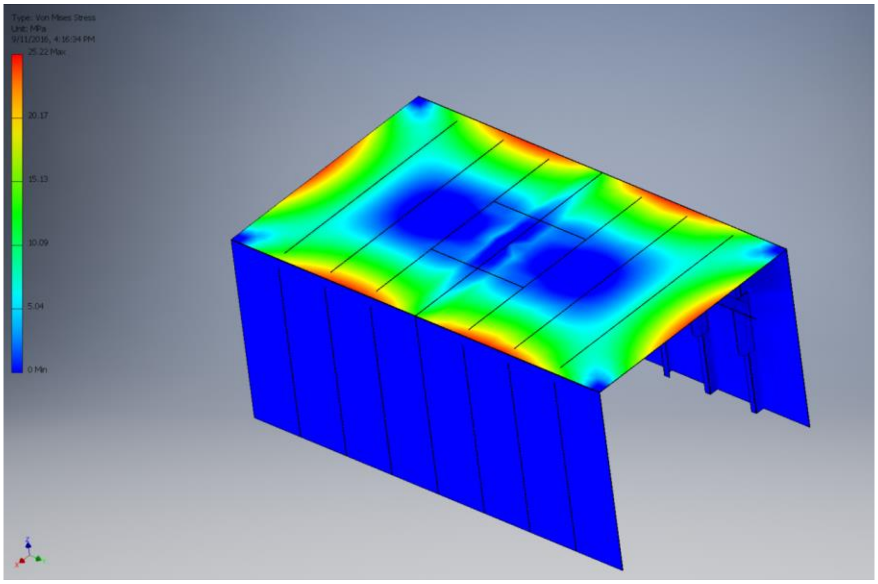

Figure 4.8.5.1: Maximum pontoon deck load

4.8.6 Longitudinal and transverse watertight bulkhead design calculations

The FEA result shows that the maximum stress from the water ballast head of 8.2m is 64 MPa with its equivalent Factor of Safety of 3.2. The result from the FEA is shown in ***Figure 4.8.6.1***.

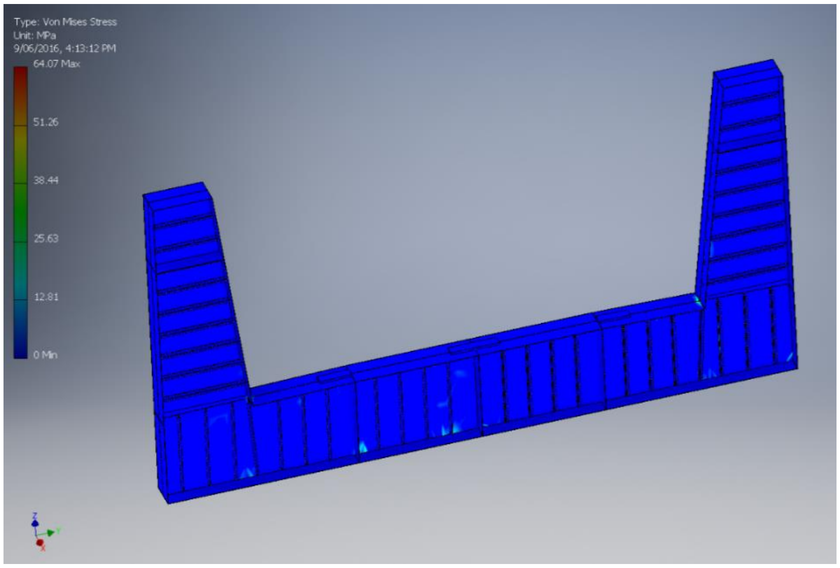

Figure 4.8.6.1: Maximum water ballast head

The stress from a centre line block load of 63 tonnes are 105 MPa with its equivalent Factor of Safety is 1.9. The result of the FEA is shown in ***Figure 4.8.6.2***.

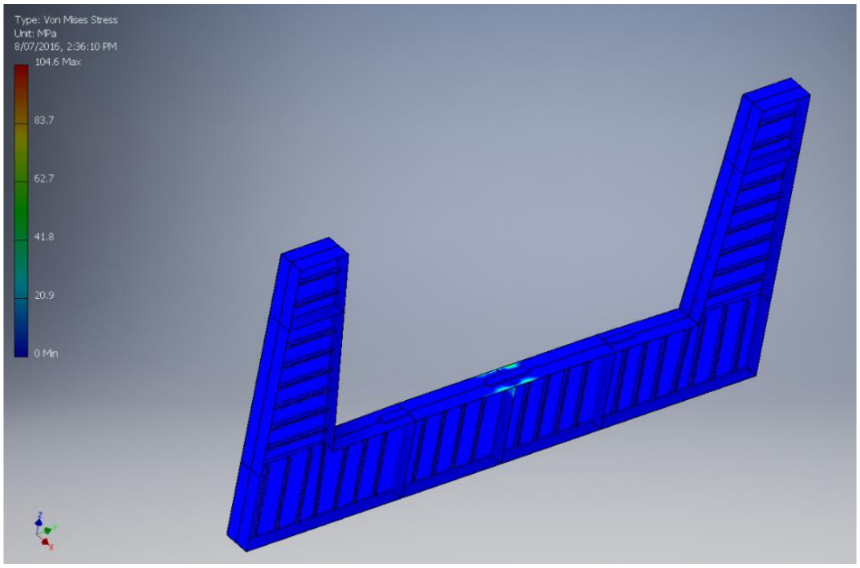

Figure 4.8.6.2: CL block load

4.8.7 Maximum allowable differential head between adjacent tanks.

The calculated maximum stress on the floating docks' tank structure with ballast tank No.1 filled to 5.6 m and other tanks empty is 9 MPa with its equivalent Factor of Safety of 23. ***Figure 4.8.7.1*** shows the result.

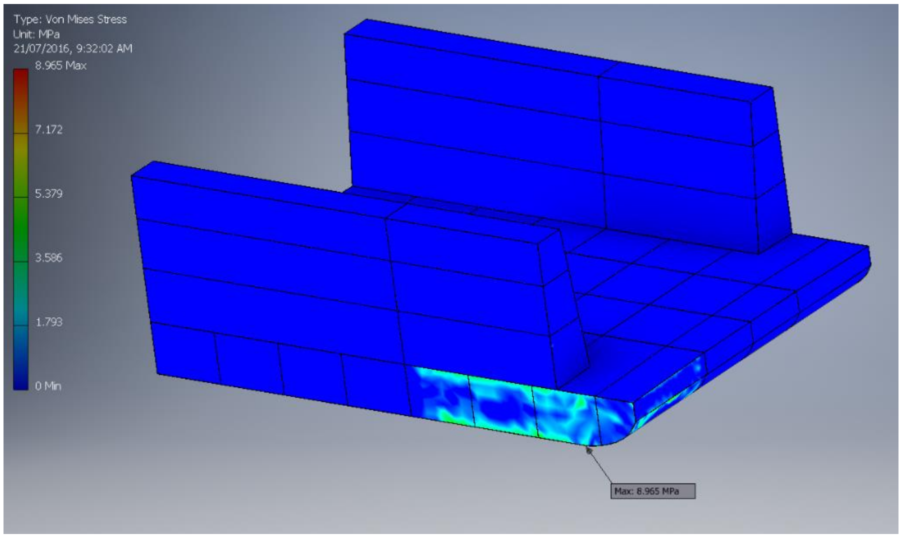

Figure 4.8.7.1: FEA result – No.1 Ballast tank filled to 5.6m

The calculated maximum stress on the floating docks' tank structure with ballast tank No.4 filled to 2.75 m and other tanks empty is 11 MPa with its equivalent Factor of Safety of 18.8. ***Figure 4.8.7.3*** shows the result.

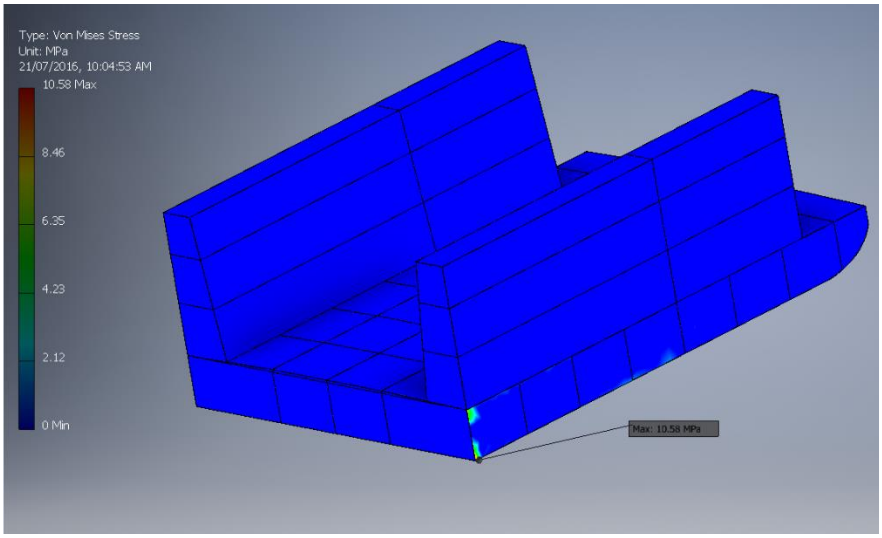

Figure 4.8.7.2: FEA result – No.4 Ballast tank filled to 2.75m

4.8.8 Maximum allowable differential head between tanks and exterior dry dock draft.

The FEA result shows that the maximum stress on the floating docks' tank structure taking the exterior dock draft up to the wing deck level and empty internal tanks is 63 MPa and its equivalent Factor of Safety of 3.2. ***Figure 4.8.8.1*** shows the result.

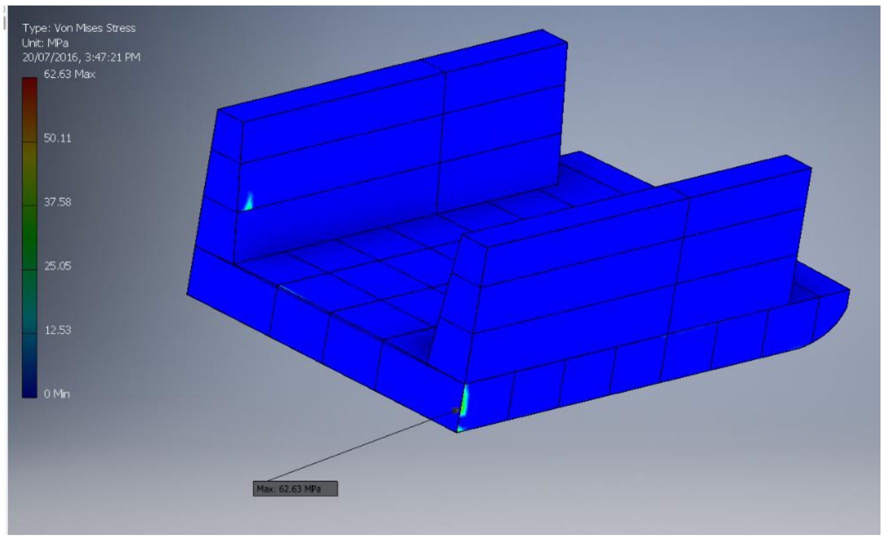

Figure 4.8.8.1: FEA result - empty ballast tanks & draft up to wing deck

4.8.9 Data and calculations substantiating adequacy of mooring attachments on the dock's structure

The maximum load that the bollards can withstand is 23 tonnes and the FEA result is shown in ***Figure 4.8.9.1***.

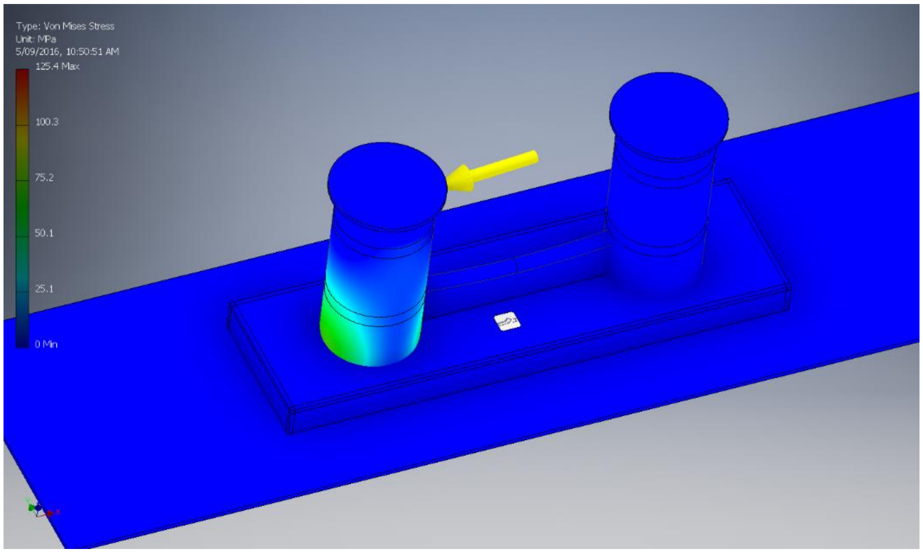

Figure 4.8.9.1: FEA result – maximum load on bollard

4.8.10 Maximum allowable differential head between adjacent tanks to produce a bending moment equal to the maximum allowable value

The calculations show that the maximum bending moment of the floating dock with ballast tanks No. 4, 5, 6, 7, 8 and 9 fully ballasted is 88,093 kN.m with its equivalent Factor of Safety of 3.2. ***Figures 4.8.10.1*** and ***4.8.10.2*** shows the load distribution and the bending moment respectively. The detailed calculations are listed in ***Appendix III***.

Figure 4.8.10.1 Load Distribution

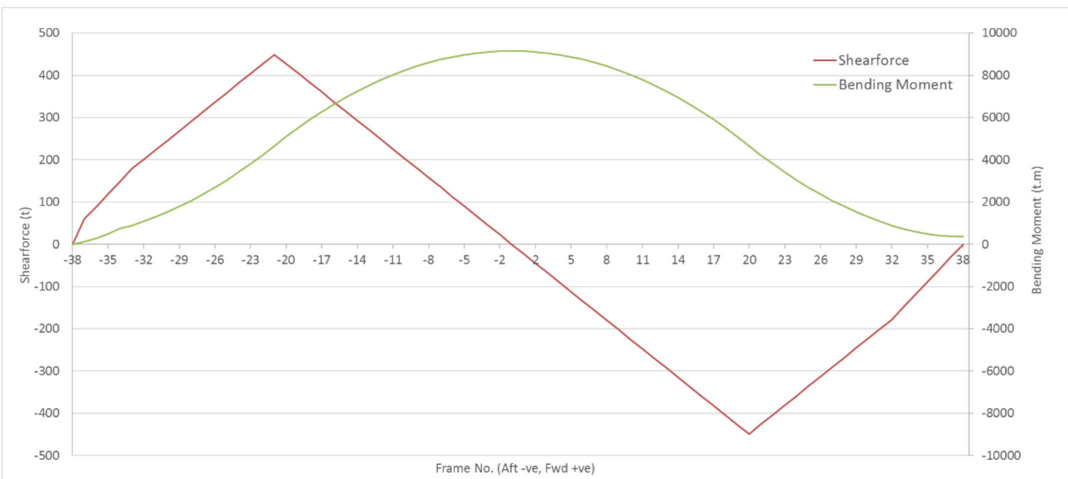

Figure 4.8.10.2 Bending Moment Calculation

4.9 Result Summary

The results of the assessment from ***Section 4.8*** are summaries in the table below. The Factor of Safety of each of the assessment exceed 1.66, which is the minimum requirement from the MIL-STD.

Table 4.9.1 Structural Assessment Result Summary

Section	item	Load category	Load Magnitude	Maximum Stress	Factor of Safety
4.8.1	Maximum allowable longitudinal bending moment	Single point load acting on Dock midships	1740 tonnes	124 MPa	1.67
	Longitudinal bending moment from harbour tug	Harbour tug	1120 tonnes	53.6 MPa	3.9
	Longitudinal bending moment from Huon class minehunter	Huon class minehunter	735 tonnes	15.1 MPa	13.7
	Longitudinal bending moment from Paluma class surveying ship	Paluma class surveying ship	364 tonnes	21.0 MPa	9.8
4.8.2	Transverse strength substantiating maximum allowable pontoon deck loading (Phase 1 Operation)	100% load on centreline block	22.5 tonnes per linear foot	92.0 MPa	2.2
		50% load on centreline block & 50% load on side blocks		46.8 MPa	4.4
	Transverse strength substantiating maximum allowable pontoon deck loading (Phase 3 Operation)	100% load on centreline block		86.3 MPa	2.3
		50% load on centreline block & 50% load on side blocks		44.8 MPa	4.6
	Transverse strength substantiating maximum allowable pontoon deck loading (Phase 2.5 Operation)	100% load on centreline block		40.0 MPa	5.1
		50% load on centreline block & 50% load on side blocks		40.0 MPa	5.1
4.8.3	Longitudinal deflection calculation corresponding to Maximum allowable bending moment	Single point load acting on Dock midships	1740 tonnes	Maximum deflection of 99 mm	1.67
4.8.4	Maximum keel block & side block loading calculations	See UGL report in ***Appendix I***			
4.8.5	Maximum pontoon deck loading at other than keel block & side block location	Uniform load over the pontoon deck	7.9 tonnes per m^2	26 MPa	8.0
4.8.6	Longitudinal & transverse watertight bulkhead	Hydrostatic head from water ballast	Hydrostatic head of 8.2 m	64 MPa	3.2

		Blocking load on centreline block	63 tonnes	105 MPa	1.9
4.8.7	Maximum allowable differential head between adjacent tanks	Hydrostatic head from water ballast	Hydrostatic head of 5.6 m	11 MPa	18.8
4.8.8	Maximum allowable differential head between tanks & exterior dry dock draft	Hydrostatic head from external draft	Hydrostatic head of 10.5 m	63 MPa	3.2
4.8.9	Mooring attachments loading calculation	Mooring line load	23 tonnes	124 MPa	1.67
4.8.10	Maximum allowable differential head between adjacent tanks to produce a bending moment equal to the maximum allowable value	Load from fully filled tank No.4,5,6,7,8,9	1785 tonnes	64.4 MPa	3.2

5 Stability Assessment

5.1 Introduction

The stability assessment of the existing floating dock has been carried out to determine if both the intact and damage stability characteristics comply with the MIL-SPEC requirements.

The intent of the intact stability requirement is to ensure that the floating dock has sufficient stability to withstand both static and environmental conditions throughout its various phases of operations. The damage stability and reserve buoyancy requirements are to ensure the dock has the capacity to withstand a moderate level of damage and resultant flooding without unduly endangering a docked vessel.

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This as[illegible]ability data available (lightweight and VCG) is from the floating docks' inclining experiment in 1974. As the floating dock is currently being refurbished, once the work is completed an inclining experiment is to be carried out.

The Wolfson Unit HST stability software has been used to calculate the docks' hydrostatics and damage stability characteristics.

5.2 General Information

5.2.1 Datum

The location of the datum for the floating dock are:

Direction	**Location**	**+ve**
Vertical	Baseline; underside of keel	Upwards
Longitudinal	Midships	Forward
Transverse	Centreline	Port

5.2.2 Ballasting Arrangement

The following ballast tank soundings were used for the five phases of operation to keep the floating dock at a level trim:

	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**
Dock Draft (m)	8.68	6.10	4.10	2.90	2.38
Tank No.	**Tank Sounding (m)**				
1, 3, 10, 12	5.00	2.04	1.14	0.79	0.30
2, 4, 5, 6, 7, 8, 9, 11	100% pressed	2.04	1.14	0.79	0.30

5.3 Weight Determination

For the preliminary stability assessment, the lightship weight of this floating dock was taken from the original inclining experiment as stated in ***Section 4.4.1***.

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5.4 Stability Criteria

This section summarised the stability and buoyancy criteria in Section 5.1.3.3.1 of the MIL-STD.

5.4.1 Buoyancy requirements

- The minimum rated freeboard at the lowest point of the pontoon deck of the dock with the ship lifted shall be 12 inches (0.305 m).

- The Minimum freeboard (measured from the top deck at side) in the fully ballasted-down condition shall be 3.25 feet (0.991 m).

Notes: “Fully ballasted-down” shall mean:
(a) Tanks 100 percent full in docks where the bottom of the tank vent terminates at the level of the top of the tank.
(b) In docks designed on the isothermal compression principle, to the ballast free surface level in the compressed state. Calculations shall be provided to prove the setting of the vent bottoms will limit submergence. Condition of maximum submergence shall be verified during the submergence test required by 5.1.6.3 of the MIL-STD.

5.4.2 Intact stability requirements

The intact stability shall be determined for all modes of operation, including the five critical phases of stability shown on ***Figure 5.4.2.1***. Longitudinal stability shall be included for phases 3 and 4. Free surface effects shall be determined and included in the calculations. Intact stability shall meet the requirements stated below:

- Metacentric Height (GM) in the phase of minimum stability shall not be less than 5 feet (1.524 m). A lifting capacity curve of ship's adjusted VCG versus lifting capacity as shown in ***Figure 5.4.2.2*** shall be presented based on the dock in the phase of minimum intact stability with the minimum GM stated from above.

- The dock shall withstand the effects of beam winds stated below without hee

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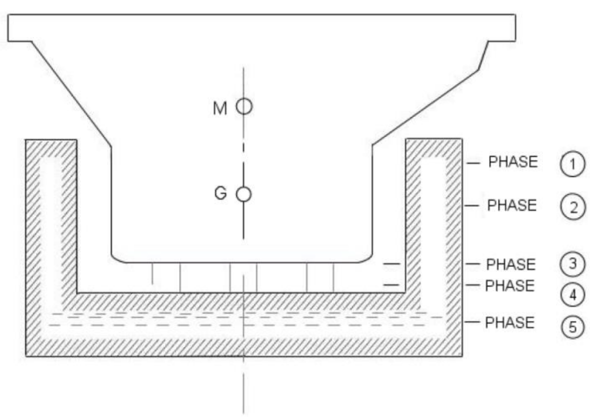
(a) I … he ship is fully docked, ship and dock system in phase 5 shown on ***Figure 5.4.2.1***.
(b) Determine the angle of heel under 20-knot beam wind, when the ship and dock system is in its minimum-stability phase.
(c) Determine the wind that would cause 15-degree heel when the ship and dock system is in its minimum-stability phase.



Phase 1 - Fully ballasted-down condition. The ship is floating independently and the dry dock is in the submerged condition before the ship bears on the blocks.

Phase 2 - Partial liftoff. The ship starts bearing on the blocks and one-half of the ship's weight is supported by the floating dock.

Phase 3 - Ship keel at water level. The ship's keel is about to leave the waterplane.

Phase 4 - Top of pontoon at water level. The water level between the wingwalls is just above the top of the pontoon.

Phase 5 - Normal-operating condition. Top of pontoon is at or above the minimum freeboard.

Figure 5.4.2.1: Phases in the docking operations for stability calculations

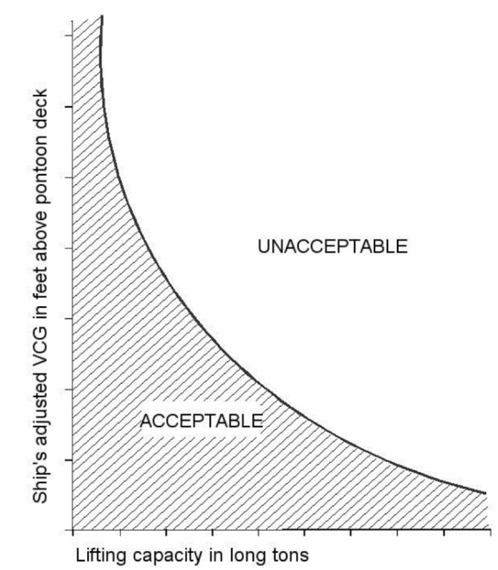


Figure 5.4.2.2: Limiting curve of docked vessel adjusted VCG vs. dock lifting capacity

5.4.3 Damaged stability and reserve buoyancy requirements.

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The dry ... for the worst co... 5 degrees, trimming more than the lesser of 3 degrees or 20 feet, submerging the margin line (see 3.2.12 of the MIL-STD) or exceeding the maximum allowable differential heads provided under 5.1.3.4.1.h and 5.1.3.4.1.i of the MIL-STD.

- In the fully ballasted condition, phase 1 shown on ***Figure 5.4.2.1***, the following two types of casualties and resultant flooding shall be assumed:

(a) Side shell damage: Damage shall be assumed to occur between main transverse bulkheads with penetration up to but not through the inner wing wall. The safety deck shall be assumed to be ruptured.
(b) Bottom shell damage: Damage shall be assumed to occur between main and transverse bulkheads such that the complete space between main transverse bulkheads floods. The safety deck may be assumed to remain watertight.

- In the de-ballasted condition with the ship on the blocks, phase 5 shown on ***Figure 5.4.2.1***, the following two types of casualties and resultant flooding shall be assumed:

(a) Side shell damage: Damage shall be assumed to occur on the side shell at a main transverse bulkhead such that the two adjacent tanks or spaces are flooded. Damage shall be assumed to penetrate up to but not through the inner wing wall. The safety deck shall be assumed to be ruptured. For closed-ended docks, the basin shall be assumed flooded.

(b) Bottom shell damage: Damage shall be assumed to occur on the dock bottom at the intersection of a main transverse watertight bulkhead and a main longitudinal watertight bulkhead such that all tanks or spaces adjacent to the intersection are flooded. The safety deck shall be assumed to be undamaged. For closed-ended docks, the basin shall be assumed flooded.

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5.5 *Assessment Results*

5.5.1 Buoyancy requirements

The calculated maximum lifting capacity of the floating dock versus the range of docked vessel longitudinal positions is as shown in ***Figure 5.5.1.1***.

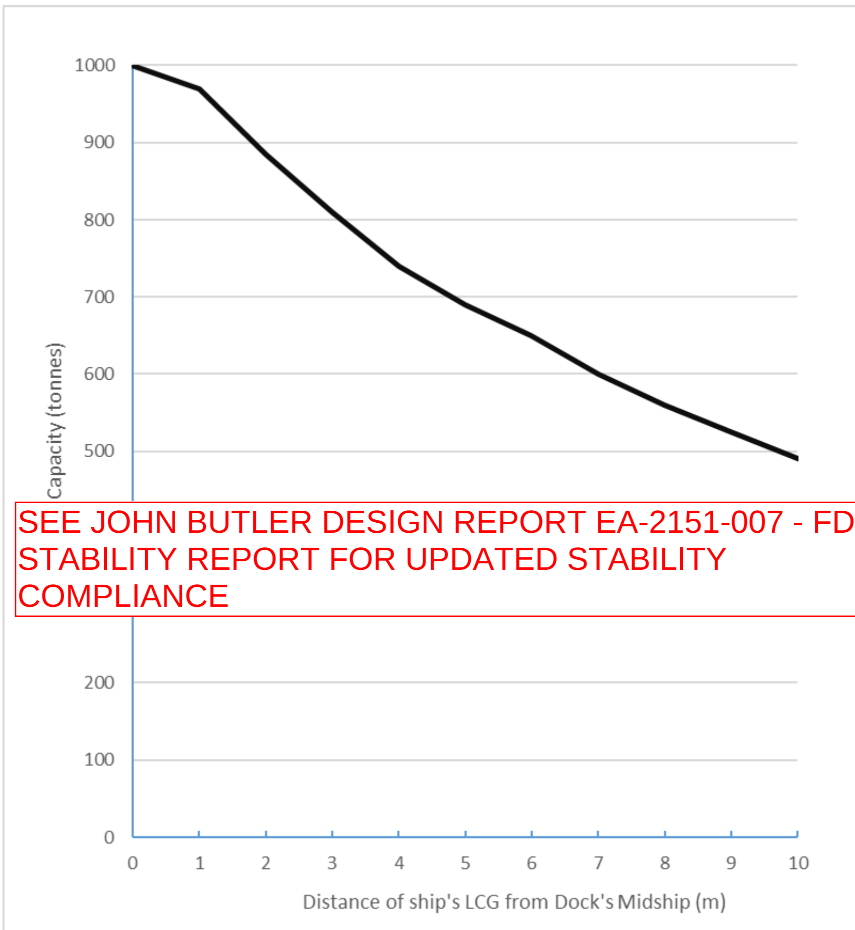

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Figure 5.5.1.1 Floating dock lifting capacity variation with docked vessel longitudinal locations.

The minimum freeboard in the fully ballasted down position is to be verified through a submerging test in accordance to the Clause 5.1.6.3 of the MIL-STD.

5.5.2 Intact stability requirements

5.5.2.1 GM Calculation

The calculated maximum lifting capacity versus docked vessel adjusted VCG in Phase 3 operation is as shown in ***Figure 5.5.2.1.1*** below.

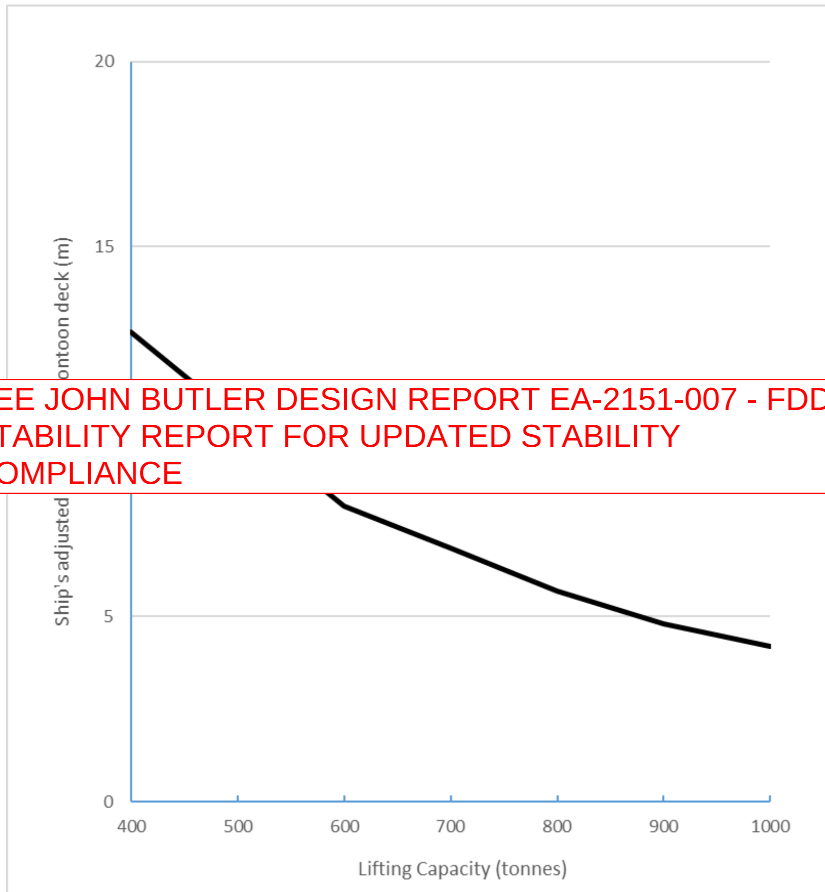

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Figure 5.5.2.1.1: Limiting curve of docked vessel adjusted VCG vs. dock lifting capacity

The floating docks' GM for the other phases of operation with a 1000 tonnes docked ship were calculated as follow:

Table 5.5.2.1.1: GM in four phase of operations

	Ship	Ballast	Total	VCG	Draught	GM	Status
	tonne	tonne	tonne	m	m	m	
Phase 1	-	3314	4763	3.61	8.68	2.56	Comply
Phase 2	500	2222	4179	4.47	6.10	1.98	Comply
Phase 4	1000	839	3304	6.26	2.90	3.73	Comply
Phase 5	1000	308	2773	7.34	2.30	7.90	Comply

Note: the adjusted VCG of the docked ship is 5.2m from the pontoon deck

5.5.2.2 Heeling from beam winds

The calculated angles of heel under wind loading are summarized in ***Table 5.5.2.2.1***.

Table 5.5.2.2.1: Heeling from beam winds effect

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Criteria [illegible]	[illegible]	[illegible]	[illegible]**us**
Heel an[illegible] wind with ship docked in Phase 5	[illegible] degree	[illegible]	[illegible]ply
Heel angle under 20 knot beam wind with ship dock minimum stability	Maximum 15 degree	0.24	Comply
Determine windspeed that would cause 15-degree heel in minimum stability Phase	-	155 knots	N/A

5.5.3 Damaged stability and reserve buoyancy requirements.

The damage stability calculations were carried out for the side shell damage in way of the forward transverse bulkheads. This is to investigate if the Dock will comply with the MIL-STD under the worst-case scenario.

The Floating Dock loading condition in Phase 5 operation (1 foot slack ballast in all tanks, vessel docked) prior to damage is listed in the following:

Table 5.5.3.1: Dock loading condition prior to damage – Phase 5 operation

Items	**Weight (tonnes)**	**VCG (m)**
Floating Dock	1449	5.585
Docked Vessel	1000	8.100
Tank No.1	21	0.152
Tank No.2	26	0.152
Tank No.3	21	0.152
Tank No.4	27	0.152
Tank No.5	35	0.152
Tank No.6	27	0.152
Tank No.7	27	0.152
Tank No.8	35	0.152
Tank No.9	[illegible]	[illegible]
Tank No.12	21	0.152
Total:	**2763**	**7.348**

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Table 5.5.3.2: Dock damaged condition – Phase 5 operation, side shell damage

Damaged Compartments	Equilibrium GM (m)	Equilibrium angle of heel (degree)	Equilibrium draft (m)	Equilibrium trim (m)	Comply
Tank 1 & 4	2.74	20.4 to Port	3.44	3.09 (by bow)	Not Comply
Tank 3 & 6	2.74	20.4 to Starboard	3.44	3.09 (by bow)	Not Comply
Tank 4 & 7	3.98	20.4 to Port	2.94	0.00	Not Comply
Tank 6 & 9	3.98	20.4 to Starboard	2.94	0.00	Not Comply
Tank 7 & 10	2.74	20.4 to Port	3.44	3.09 (by stern)	Not Comply
Tank 9 & 12	2.74	20.4 to Starboard	3.44	3.09 (by stern)	Not Comply

Table 5.5.3.3: Dock damaged condition – Phase 5 operation, bottom shell damage

Damaged Compartments	Equilibrium GM (m)	Equilibrium angle of heel (degree)	Equilibrium draft (m)	Equilibrium trim (m) / (deg)	Compliance
Tank 2 & 5	2.608	0	3.87	4.575 / 5.1 (by the bow)	Not Comply
Tank 5 & 8	0.456	0	2.94	0	Comply
Tank 8 & 11	2.608	0	3.87	4.575 / 5.1 (by the stern)	Not Comply

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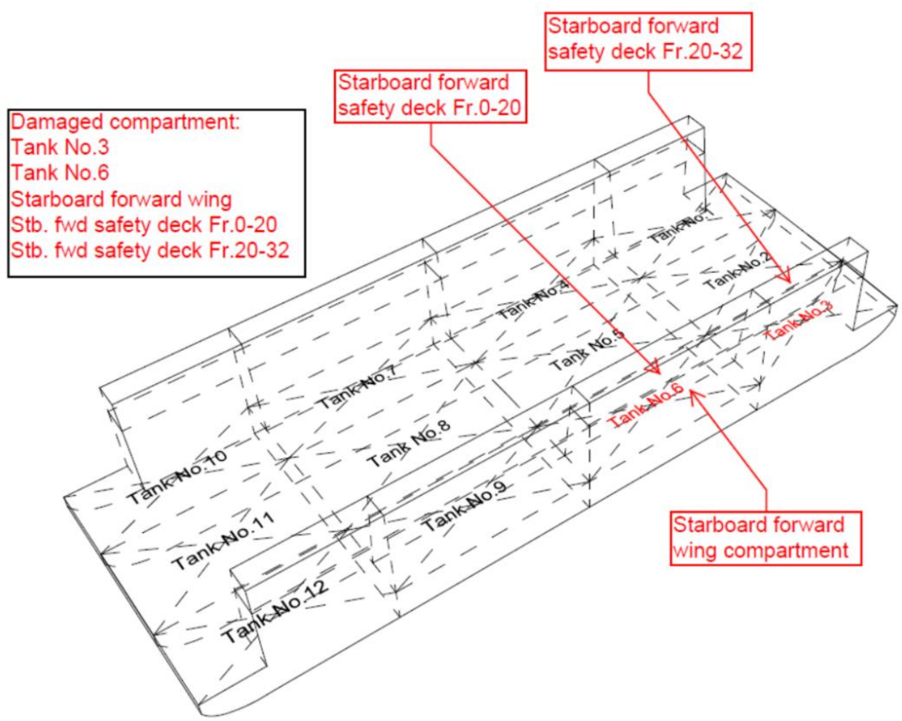
In both the … the above case … compartment, safety deck compartment from frame 0 to 20 and frame 20 to 32 as shown in ***Figure 5.5.3.1*** were assessed.



5.5.3.1: Damaged compartments for stability calculations

Summary of calculations of both conditions are listed in ***Table 5.5.3.1.1***. and it indicates that neither of the conditions comply with the MIL-STD criteria.

	Fully ballasted	De-ballasted
Displacement (tonnes)	4155	2773
Initial Draft (m)	8.68	2.38
Vertical Centre of Gravity (m)	2.80	6.93
Equilibrium GM (m)	0.00	3.04
Equilibrium Heel Angle (deg.)	112	30
Equilibrium trim (m)	12.50	2.97

The large angle of heel after damage was due to the significant loss of reserves buoy tank at the floati

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6 Conclusion

The structural assessment was carried out to identify the loading limit on both the longitudinal strength and the local structural component strength, which were specified within section 5.1.3.4 of the MIL-STD.

The maximum allowable longitudinal bending moment was calculated and found to be 169,269 kN.m. This corresponds to 1,740 tonne of load acting on the floating dock amidships. The midships deflection due to the above load was calculated and found to be 99 mm. The calculated deflection should be used by the floating dock operator to check if the dock is within its loading limit throughout its operations.

The results show that the longitudinal bending moment in each of the docked vessel scenarios are within the stress limitation.

The loading limit of each of the local structural components were calculated as follows:

- The maximum transverse strength was calculated to support a maximum pontoon deck load of 65 tonnes per block and its corresponding load of 22.5 tonnes per linear foot.
- The maximum keel block stand load from UGL assessment was calculated at 30 tonnes.
- The watertight bulkheads were assessed with loading from the both the tank head and also the docked vessel, and results show that their maximum stress are within the limitation.
- The maximum pontoon deck loading at other than keel block and side block locations was calculated to 7.9 tonne per metre square.
- The maximum mooring bollard load was calculated at 23 tonnes.

The intact and damage stability were calculated to determine the floating dock stability characteristics and its compliance with 5.1.2.3 of the MIL-STD

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The in[illegible] the GM and th[illegible]

The maximum lifting capacity versus docked vessel adjusted VCG and also the maximum lifting capacity of the dock versus the range of docked vessel longitudinal positions were calculated with result presented in Section 5.5 of this report. These results are to be used as a guidance when lifting vessels with various VCG and longitudinal placement on the floating dock.

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The dam nd de-ballasted not comply with the MIL-STD. The large angle of heel was due to the significant loss of the reserve buoyancy from the forward wing compartment and also from the side tank at the floating dock end.

To comply with the damage stability requirements, additional watertight bulkheads could be added to reduce the size of the tanks.

This preliminary stability assessment is subject to change once the actual stability data is obtained through the inclining experiment.

7 Disclaimer

The under signed shall not be liable in any way to any person or company in respect to any claim for any kind, including claims for negligence, for loss occasioned to any person or company in consequence of any person or company acting or refraining from action as a result of material in this report.

Signed,

Prepared by:

Martin Mok
Naval Architect

for Shearforce Maritime Services Pty. Ltd.
16th November 2016

Validated by:

Lina Diaz
Senior Naval Architect

for Shearforce Maritime Services Pty. Ltd.
16th November 2016

Appendix G – Curriculum Vitae – Rick Plain

Curriculum Vitae

Rick Plain

Civil Engineer

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Rick Plain is an Engineer at Royal HaskoningDHV in Brisbane, Australia.

He has professional experience in coastal and maritime engineering, geotechnical engineering and construction management. Through this, Rick has been involved in the implementation of the full project lifecycle from planning and investigation through to detailed design documentation, environmental assessment and overseeing construction of the projects.

Rick has developed specific skills in design and investigation of seawalls and revetments, undertaking coastal process studies, design of maritime structures including boat ramps and jetties, navigation impact assessments and boating studies, dredging investigations, flood studies, river stabilisation works, design of scour protection works and geotechnical investigations.

Nationality
Australian

Years of experience
7 years

Years with Royal HaskoningDHV
7 years

Professional memberships
Member of Engineers Australia (IEAust)

Qualifications
2014 University of New South Wales (UNSW), BEng (Hons 1) (Civil)
2014 University of New South Wales (UNSW), BCom (Dist) (Financial Economics)

Industry Certificates
WorkCover Construction Induction "White" Card
Transport for NSW Rail Industry Safety Induction (Expired)

Languages
English

Professional experience
Foreshore Protection

Palm Beach Shoreline Project
(City of Gold Coast)
> 2018-2019, Gold Coast, QLD, Australia

The Palm Beach shoreline project involved design and construction of an artificial reef to provide surf amenity and coastal protection. RHDHV were initially engaged to undertake numerical modelling and design of the artificial reef. Our engagement extended throughout the detailed design process, contractor engagement and construction certification.

Rick was involved in preparing Tender documentation including the Technical Specification and Schedules and he was involved in the Early Tender Involvement (ETI) process, which involved a number of meetings with shortlisted Contractors. During construction, Rick undertook quarry inspections to certify quality of the rock and he will be involved in certification of construction.

Rip Road Reserve
(Central Coast Council)
> 2018-2019, Central Coast, NSW, Australia

RHDHV were engaged to design and document a vertical sandstone block seawall with integrated foreshore access steps and a dinghy launching skid. A rip rap revetment was designed for a section of foreshore to reduce foreshore excavation, where aboriginal artefacts were identified.

Iron Cove Seawall
(City of Canada Bay)
> 2015-2017, Central Coast, NSW, Australia

A 1km section of degraded foreshore were upgraded. Heritage aspects were particularly important. The project initially comprised rock mounds and salt marsh berms to enhance the local ecosystem. However, due to issues regarding land boundaries and funding, the rock mounds and salt marsh berms were removed from the design.

Dobroyd Point Seawall
(Inner West Council)
> 2020, Dobroyd, NSW, Australia

The existing seawall was proposed to be upgraded to accommodate widening of the footpath for the Bay Run and GreenWay projects. The design included saltmarsh berms and vegetated swales to enhance the environment.

Coffs Creek
(Coffs Harbour City Council)
> 2020, Coffs Harbour, NSW, Australia

Two separate sites in Coffs Creek were identified in the CZMP as requiring remediation. Both sites comprised timber seawalls, which were dilapidated and undercut. The preferred solution comprised a combination of rock revetment, sandstone blocks and KYOWA rock bags.

Brooms Head
(Clarence Valley Council)
> 2020, Brooms Head, NSW, Australia

The project involved an extension of the existing back beach revetment and the design of beach access stairs. An end control structure was incorporated in the design to limit the impact of end effects.

Kingscliff Seawall
(Tweed Shire Council)
> 2016, Kingscliff, NSW, Australia

Kingscliff is a recognised coastal erosion hot spot in NSW. RHDHV was engaged to design and document coastal protection works, which comprised a rock revetment, secant pile wall and concrete bleachers to protect the Surf Life Saving Club, caravan park and council owned land. Rick was involved in the detailed design and documentation of the work.

Lyne Park Seawall Reconstruction
(Woollahra Municipal Council)
> 2015-2016, Woollahra, NSW, Australia

A section of seawall 290m in length required reconstruction. RHDHV investigated the seawall and prepared a detailed design and tender documentation for the works. Subcontractors involved in the project included marine ecologist, heritage consultant, geotechnical consultants, environmental consultants and surveyors.

Woollahra Emergency Seawall Repairs
(Woollahra Municipal Council)

> 2016, Woollahra, NSW, Australia

The NSW coast experienced a severe East Coast Low (ECL) between the 4th and 6th June 2016, which produced large swells and high wind from the north east. The ECL combined with a Spring Tide that resulted in higher than normal high tide levels. Wide spread damage was experienced along the NSW coast, including two sandstone block seawalls at Woollahra.

RHDHV was engaged by Woollahra Municipal Council to provide advice to secure the site and prepare designs to reconstruct the seawall. The total length of wall requiring reconstruction was in excess of 50 m. Rick was the project manager for the job and was involved in detailed design, preparing all documents and coordinating sub-consultants.

Elfin Hill Road Reserve Foreshore Stabilisation
(Gosford City Council)

> 2014, Green Point, NSW, Australia

Elfin Hill Road Reserve was identified as an unstable, receding shoreline. Foreshore stabilisation design undertaken by RHDHV included a site investigation and development of conceptual designs. The designs focused on environmentally friendly seawalls that would enhance the estuarine environment in a sustainable manner while protecting public interests and recreational amenity. The designs incorporated structures, which could be amended in the future to allow for climate change.

Natural Waterways Assets – High Priority Site Assessments
(The Hills Shire Council)

>2015, The Hills Shire Council, NSW, Australia

A number of natural waterways within The Hills Shire Council were identified to be in poor condition. A field investigation was undertaken to examine the waterways and determine the risk of the waterway to life, property, infrastructure and the environment. Concept designs and cost estimates were provided for each site to remediate and improve the condition of the waterway.

Riverbank Protection

Guthega Power Station Riverbank Protection
(Snowy Hydro Pty Ltd / Leed Engineering and Construction Pty Ltd)

> 2020-2021 Snowy River, NSW, Australia

Preparation of detailed design documentation for repair of a failed section of stone pitching. stabilisation of eroded creek bank areas adjacent to sewer and roads assets. Design documentation included detail design drawings, technical specification, schedule of quantities, pre-construction cost estimate and design report.

Oxford Creek Bank Restoration and Batter Stabilisation
(Warringah Council)

> 2015 - 2016 Oxford Falls, NSW, Australia

Preparation of detailed design documentation for stabilisation of eroded creek bank areas adjacent to sewer and roads assets. Design documentation included detail design drawings, technical specification, schedule of quantities, pre-construction cost estimate and design report.

Scour Protection

Southport Superyacht Facility
(MGN Civil)

> 2020, Southport, QLD, Australia

A Design and Construct Contract was awarded for a superyacht facility at Southport Yacht Club. RHDHV were engaged to undertake the design of a revetment adjacent to the berthing pocket. A key consideration in the design was the propeller wash directed towards the revetment from the bow thrusters.

Overseas Passenger Terminal Scour Protection
(McConnell Dowell / PANSW)

> 2021, Sydney, NSW, Australia

A Design and Construct Contract was awarded for installation of scour protection at the Overseas Passenger Terminal in Sydney Cove. The project aimed to limit erosion and deposition, in order to maintain chartered depths. The scour protection mattress comprised a 350mm thick grout filled mattress. Physical modelling was undertaken by the Water Research Laboratory. A key consideration in the design was the edge of the scour protection, which comprised a hinged edge block placed in a trench to limit the potential for underscour.

Boating Infrastructure

NSW Boat Launching Ramps Guidelines Update
(NSW Roads and Maritime Services)
> 2014-2015, NSW, Australia

The NSW Boat Launching Ramps Guidelines were prepared by the Public Works Department in 1985. The document remains largely relevant and had stood the test of time. However, in recent decades, changes have emerged with recreational boats and launching facilities including an increase in engine capacity, an increase in the size of trailerable boats and an increase in the number of trailerable boats registered with RMS. The changes prompted a review and update of the Boat Launching Ramps Guidelines. A Performance Enquiry was included to determine public perception towards boat ramps and performance of boat ramps in recent decades.

Sans Souci Marine Centre
(Roads and Maritime Services)
> 2019, Sydney, NSW, Australia

RHDHV has been recently engaged to prepare concept designs, performance specification and construction certification for the marine centre at Sans Souci, which is shared be 3 governments agencies. The project includes design of a marina, boat ramp and associated facilities.

Picnic Point Boat Ramp
(Murray River Council)
> 2019, Picnic Point, NSW, Australia

RHDHV were engaged to undertake detailed design of the boat ramp and adjacent foreshore protection at Picnic Point on the Murray River.

Snowy 2.0
(Snowy Hydro Pty Ltd)
> 2018, Cooma, NSW, Australia

RHDHV were engaged to prepare concept designs for the boat ramp at Talbingo Reservoir.

Tonkin Oval Boat Ramp
(Sutherland Shire Council)
> 2015, Cronulla, NSW, Australia

RHDHV were engaged to undertake investigations and concept design of the boat ramp at Tonkin Oval.

Burnum Burnum Boat Ramp
(Sutherland Shire Council)
> 2015, Cronulla, NSW, Australia

RHDHV were engaged to undertake investigations and concept design of the boat ramp at Burnum Burnum.

Lake Jindabyne and Eucumbene Boat Ramps
(Snowy Monaro Regional Council)
> 2015, Jindabyne, NSW, Australia

RHDHV were engaged to undertake investigations and concept design of boat ramp upgrades at Lake Jindabyne and Lake Eucumbene.

Dredging and Reclamation

Snowy 2.0
(Snowy Hydro Pty Ltd)
> 2018-2019, Cooma, NSW, Australia

Snowy 2.0 is a pumped hydro-electric scheme connecting two existing reservoirs within the Snowy Scheme. RHDHV were initially engaged to prepare reference designs for the placement of excavated rock within the reservoirs. The reference designs included numerical modelling, physical modelling of sediment behaviour and assessment of operational impacts. Our role continued throughout Contractor, to inform the Client of risks associated with the Contractors proposed methodology, and provided input into the Environmental Impact Statement.

Rick was directly responsible for the physical modelling of sediment behaviour and undertaking a navigation impact assessment. He provided significant input into the reference designs and was involved in Contractor engagement.

HMAS Cerberus
(Aurecon)
> 2020-current, Western Port, Victoria, Australia

RHDHV were engaged to undertake design and documentation of maintenance dredging and ancillary marine works including repairs to the lead channel markers and boat ramp. Our engagement included preparation of an environmental assessment for the proposed works. Rick is the project manager for the project and has been involved in all facets of the project.

The Entrance
(Central Coast Council)
> 2020, The Entrance, NSW, Australia
RHDHV were engaged to undertake design and documentation of maintenance dredging at The Entrance, including sediment sampling and analysis. The material was proposed to be pumped to the ocean beach on the northern side of The Entrance.

Clontarf Tidal Pool Dredging and Seawall Projects
(Northern Beaches Council)
> 2019, Clontarf, NSW, Australia
The Clontarf Tidal Pools are periodically dredged to improve amenity. In addition, Council prepared a landscape masterplan to improve amenity of the adjacent shoreline. Rick was involved in preparing the design and documentation for the dredging and beach nourishment. Rick also undertook detailed design of the shoreline structures including a seawall, bleachers and disabled access ramp.

Ourimbah Creek Dredging Project
(Wyong Shire Council)
> 2015 - 2016 Tuggerah Lakes, NSW, Australia
Development of a dredging strategy for removal, handling and disposal of dredged material from the entrance to Ourimbah Creek. The scope of work involved hydrographic survey, sediment sampling, navigation channel design and preparation of a Dredging Plan and REF for implementation of the project which aims to improve navigability.

Shoalhaven Dredging Project
(Shoalhaven City Council)
> 2014-2015, Shoalhaven, NSW, Australia
Shoalhaven City Council engaged RHDHV to investigate and design dredging plans at 5 separate sites and reuse the sand for coastal protection works at 4 nearby locations. The project involved site investigations, detailed design, preparation of the technical specification and associated environmental plans including Review of Environmental Factors (REF) and Acid Sulphate Management Plans.

Settlement Shores Canal Maintenance Plan Review
(Port Macquarie-Hastings Council)
> 2015 - 2016 Port Macquarie, NSW, Australia
Review and update of the existing Canal Maintenance Plan last prepared in 2004. The scope of investigative work included collection of hydrographic and land survey, inspection of assets within the canal system (including boat ramps, jetties, pontoons revetment walls, beach areas, rock protection, stormwater outlets and footpaths), sediment sampling and analysis. The main deliverables for the project comprise an updated Canal Maintenance Plan and an REF for the proposed dredging works.

Boating Studies and Navigation Impact Assessments

Navigation Impact Assessments – Pattons Slipway, Noakes Boat Yard, Western Harbour and Beaches Link Tunnel, Barangaroo, Kangaroo Point Snowy 2.0.
(Various)
> 2016-current, NSW, Australia
Rick has been involved in the preparation of navigation and safety impact assessments for numerous public and private companies. These studies range from small scale investigations to large scale investigations that disrupt shipping and ferry services.

South West Rocks Boating Study
(Transport for NSW)
> 2020-current, South West Rocks, NSW, Australia
RHDHV have been engaged to undertake a study at South West Rocks to investigate options to improve offshore access for recreational, commercial and cruise vessels.

Murray River Bank Erosion
(Transport for NSW)
> 2019-2020, Corowa, NSW, Australia
RHDHV were engaged to assess the impact of boat wash on the banks of the Murray River between Corowa and Bundalong.

Mid North Coast Boating Plans
(NSW Roads & Maritime Services)
> 2016 Mid North Coast, NSW, Australia

Investigation of study areas in the Lower Hastings River, Camden Haven River, Cundletown and South West Rocks to develop concept designs for recreational boating infrastructure including boat ramps, floating pontoons, passive craft launching facilities, jetties/wharves and upgrades/repairs to existing boating infrastructure.

Great Lakes Boating Studies
(NSW Roads & Maritime Services)
> 2016 Port Stephens and Myall River, NSW, Australia

Investigation of study areas at Tea Gardens/Hawks Nest, North Arm Cove, Nerong Harbour and Tahlee to develop concept designs for recreational boating infrastructure including boat ramps, dinghy storage, boat moorings, floating pontoons, passive craft launching facilities and jetties/wharves.

Construction Supervision

Beresford Foreshore Coastal Protection
(City of Greater Geraldton)
> 2014-2015 and 2017, Geraldton, WA, Australia

Beresford Foreshore is a receding shoreline. RHDHV were initially engaged to undertake site investigations, wave modelling and prepare concept designs, detailed design and technical specifications for the project. The detailed design involved beach nourishment and design of more than 1 km of revetments, detached breakwaters and groynes.

Rick was seconded to the City of Greater Geraldton for 10 months to serve as the Superintendents Representative. Rick was based onsite fulltime and his role involved overseeing construction of the works to ensure they were carried out in accordance with the design documentation.

Little Sandy Creek Bridge
(Camden Valley Council)
> 2020, Camden, NSW, Australia

RHDHV were engaged to undertake detailed design of scour protection works adjacent to the bridge abutment at Little Sandy Creek Bridge. Rick was involved in detailed design and construction supervision.

Lord Howe Island Revetment Construction
(Lord Howe Island Board)
> 2015, Lord Howe Island, NSW, Australia

Various foreshore protection works have been constructed at Lord Howe Island over the last 50 years. The latest of which was an emergency rock revetment at Windy Point. The revetment was designed by RHDHV and it was 6 m high and over 60 m long. The revetment tied in with adjacent structures.

Rick was seconded to Lord Howe Island Board on a short term basis to provide cover for the board's project manager. His role involved overseeing construction of the seawall and compliance of the works in accordance with the design documentation.

Stockton Revetment
(Newcastle City Council)
> 2016, Newcastle, NSW, Australia

RHDHV was engaged to design and document a rock revetment at Stockton, NSW. The revetment is over 75 m long. Rick was involved in quarry inspections, rock selection, drop testing of rock to ensure conformance and compliance with the requirements of the design.

Frazer Street Collaroy
(Private Resident)
> 2015, Collaroy, NSW, Australia

Collaroy and Narrabeen beach is 3.5 km long and it is recognised as a coastal erosion hot spot in NSW. As part of any DA submitted to Council, the applicant is required to ensure the foundations of the proposed structure would not be undermined. Rick was involved in overseeing construction of a rock revetment and ensure conformance and compliance of the work. In a recent storm event, that lead to significant erosion, the revetment performed as expected while neighbouring properties were evacuated.

Shellharbour Boat Ramp Upgrade
(Shellharbour City Council)
> 2015, Shellharbour, NSW, Australia

The boat ramp at Shellharbour was in poor condition and identified as an asset requiring repair. The design of the upgrade was completed by RHDHV and included an eastern ramp and a western ramp, separated by the existing slipway.

Rick was involved in detailed design and site inspections during construction to ensure conformance and compliance of the works in accordance with the design documentation.

Beach Nourishment and Dune Restoration

Wooli Beach Management Scheme (Clarence Valley Council)

> 2020-current, Wooli, NSW, Australia

RHDHV were engaged to prepare a beach management scheme for Wooli Beach, which involved beach scraping and sand backpassing. The investigation was underpinned by an analysis of the beach using photogrammetry and aerial photography (CoastSat).

Wooli Sand Sourcing Investigation (Clarence Valley Council)

> 2014-2015, Wooli, NSW, Australia

Wooli Beach was reported to be receding at a rate of 0.5 metres per year. Beach nourishment was identified as an option to offset recession and protect the village from coastal erosion. The study identified and assessed a number of different sand sources around Wooli including offshore marine sand, dune sand and estuary sand from Wooli Wooli River. A field investigation including sediment sampling was conducted at accessible sand sources to determine compatibility of the sand source with native beach material. A cost estimate was produced for each sand source along with details of legislative constraints and restrictions in accessing the different sand sources.

Soldiers Beach Dune Restoration Plan (Central Coast Council)

> 2016 Soldiers Beach, NSW, Australia

Preparation of a restoration plan for management of bitou bush within the degraded dune vegetation at Soldiers Beach. This included field inspection and mapping of bitou bush extents, preparation of drawings and specifications, and community consultation.

Professional Training

2017 26th NSW Coastal Conference, Port Stephens, Australia
2016 26th NSW Coastal Conference, Coffs Harbour, Australia

Publications

Plain, R., Blumberg, G., Cross, J., Dufour, M., 2017, Beresford Foreshore Coastal Protection Project – Getting Dirty in the West. NSW Coastal Conference, 2013, Port Stephens, Australia.