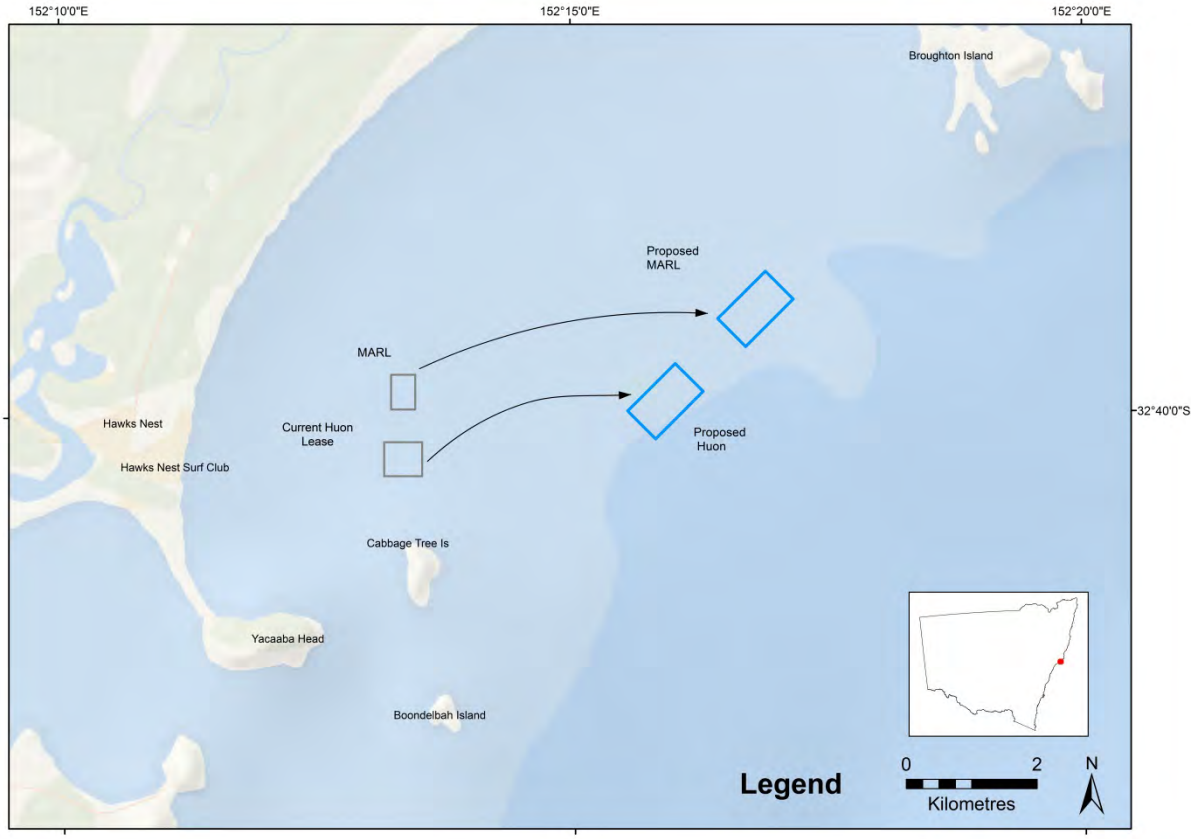
**Application to modify the consents approving finfish aquaculture for Pisces Aquaculture Holding Pty Ltd and NSW Department of Primary Industries (NSW DPI)**




# Huon Aquaculture Group Limited Commercial Aquaculture Lease Providence Bay, NSW

Modification Report

# Marine Aquaculture Research Lease Providence Bay, NSW

Modification Report

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# 1 INTRODUCTON

The NSW Government recognises the need to look at opportunities for sustainable and viable aquaculture to support regional NSW economies and to meet the future food security needs of the State.

Two aquaculture leases approved to undertake finfish aquaculture in sea pens are located in Providence Bay off Hawks Nest near Port Stephens.

Pisces Aquaculture Holdings Pty Ltd (Pisces) received consent to operate a commercial finfish farm in 2001 under Section 80 of the *Environmental Planning and Assessment Act 1979*. The second consent was granted to NSW Department of Primary Industries (NSW DPI) in 2013 to operate a Marine Aquaculture Research Lease (MARL) under Section 115W of the *Environmental Planning and Assessment Act 1979.* The MARL is in close proximity to the Pisces lease.

Following an EOI process conducted by NSW DPI in 2013-2014, Huon Aquaculture Group Limited (Huon) was selected as the preferred research partner to work with NSW DPI on the MARL. Huon subsequently purchased the lease authorised in the Pisces consent in 2014.

Huon and NSW DPI are seeking approval from the NSW Minister for Planning to modify the Pisces (DA No. 81-04-01 & Modification) and NSW DPI (SSI-5118) fish farming consents in Providence Bay, NSW.

The proposed modifications include relocating the two leases further offshore into deeper water, increase the number and size of pens, expand the area of the leases to accommodate mooring lines and add a permanently moored feed storage barge to each lease site.

The aquaculture engineering technologies currently used in the Australian aquaculture industry have evolved significantly since the Pisces and NSW DPI approved aquaculture farms were lodged for assessment. The proposed modifications would allow for the use of current leading edge technology and farming practices, as well as improve the capacity of the MARL to provide commercially relevant research results.

The proposed modifications to the Huon Lease and the MARL would not result in any significant environmental impact.

# 2 STRATEGIC CONTEXT

## 2.1 PLANS AND POLICIES

NSW DPI is responsible for the promotion of a viable and environmentally sustainable aquaculture industry. Aquaculture requires consent or approval under the *Environmental Planning and Assessment Act 1979 (EP&A Act)* and an Aquaculture Permit issued under the *Fisheries Management Act 1994* (FM Act). Aquaculture undertaken on public water land (such as oyster aquaculture) also requires an aquaculture lease issued under the FM Act.

The objects of the FM Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. The objects include: to conserve fish stocks and key fish habitats; to conserve threatened species, populations and ecological communities of fish and marine vegetation; and to promote ecologically sustainable development (ESD), including the conservation of biological diversity. Consistent with those objects, the FM Act also has the objective of promoting viable aquaculture industries and provide social and economic benefits for the wider community of NSW.

The Act and Regulations make provisions for putting conditions on aquaculture permits and leases, marking of lease areas, pest and disease management, aquaculture industry development and compliance provisions for aquaculture operators who fail to meet their obligations.

The principal objective of the proposed MARL is to contribute to the development of sustainable marine aquaculture in NSW. NSW DPI has prepared Sustainable Aquaculture Strategies for the oyster and land based aquaculture industries in NSW.

The strategies include guidelines for sustainable aquaculture development and operation which are gazetted as Aquaculture Industry Development Plans under the FM Act. This embeds the principles of ESD into the NSW DPI assessment of aquaculture permit and lease applications and covers issues such as species and site selection, design, operation and industry best practice, and water quality protection. The strategies put in place a planning framework for aquaculture that is supported by *State Environmental Planning Policy 62 - Sustainable Aquaculture*. They also provide the community with a clear understanding of this emerging sector and the policy framework in which it is required to work in.

The activities undertaken at the MARL would support the development of a NSW Marine Waters Sustainable Aquaculture Strategy.

Under the 'Future of Fish Farming Program', Huon have a number of policies and plans on their website detailing current and future farming practices being implemented. Some of these include: farm monitoring programs; a policy on marine debris; a Community Partnerships program; and a 'Sustainability Dashboard' that provides real time reports on farming operations (www.huonaqua.com.au).

## 2.2 JUSTIFICATION

The proposed modification of the Huon and NSW DPI lease sites provides the opportunity to enhance the objectives of the MARL to provide commercially relevant research for the development of a sustainable and viable aquaculture industry in NSW.

The principal objective of the MARL is to provide NSW DPI and research partners with the opportunity to extend successful marine hatchery research to its next stage in an offshore commercially relevant sea cage trial. This objective is still relevant to the proposed modification sites.

In additional the following research objectives outlined in the MARL EIS are important in informing the development of evidenced based policies and procedures to promote best practice for the sustainable development of sea cage aquaculture in NSW. This includes:

- Evaluating suitable husbandry practices for aquaculture in the temperate marine environment of NSW. This will include evaluating and adapting existing husbandry practises employed in the cooler waters of South Australia and Tasmania;
- Evaluating and further developing the dietary development research undertaken in small controlled research tanks by extending the research to a commercial level. This will include the testing of feeding efficiency and growth performance models developed as part of the tank based research;
- Evaluating the use of terrestrial protein and energy sources such as legumes (e.g. lupins, field peas, faba beans), oilseeds (soybean meal and soy protein concentrates), cereals (wheat and gluten products) and by-products of the

rendering industry such as meat and poultry meal as partial or complete replacement of fish meal and fish oil in aquaculture feeds;

- Evaluating and further developing the water temperature growth performance models for marine finfish. Data indicates that the prevailing sea surface water temperatures in NSW are conducive to rapid growth of the proposed research species. These models need to be fully tested on a commercial scale against the effects that seasonal changes in water temperature have on the production of these species in NSW. Included in this research is the evaluation of the biological and economic implications of growing species such as Yellowtail Kingfish in the warmer waters of NSW. All these factors need to be evaluated over two or three year production cycles in order to obtain the most reliable scientific information;
- Investigating water quality parameters in the area of the Research Lease.
- Evaluating the environmental impacts of a marine aquaculture farm in the NSW marine environment on a 'green field' site;
- Investigating novel methods for the assessment of ecosystem change;
- The environmental research may also include the evaluation of the effectiveness of employing mitigation measures such as bioremediation activities, fallowing, anti-predator netting, bird exclusion nets, controlled feeding strategies, management of deceased fish inside sea cages and entanglement avoidance strategies and protocols;
- Investigating economic aspects of marine aquaculture production in NSW. This includes supply chain issues such as the supply of fingerlings, feeds, equipment, services and sale of product;
- Investigating the structural integrity and stability of current sea cage infrastructure and their suitability in the high energy marine environment of NSW; and
- Provision of a research platform for students from the University of Newcastle and/or any other research partners (e.g. CSIRO). The research would need to be consistent with the above research objectives or complement these objectives.

The modification has included the relocation of both currently approved aquaculture lease sites. This is to ensure that the above research objectives and the monitoring requirements regarding the interactions between the lease areas can provide relevant information to inform the development of evidenced based policies and procedures including the NSW Marine Waters Sustainable Aquaculture Strategy.

NSW DPI and their collaborators are currently involved in three major research projects on Yellowtail Kingfish that relate directly to the MARL. These projects are being funded by the Fisheries Research & Development Corporation (FRDC) and several major industry participants. The focus of these projects is to:

1. Gain a better understanding of the genetic diversity of Yellowtail Kingfish stocks in NSW waters through microsatellite technology (FRDC Project No. 2013-729);
2. Develop new technologies and strategies for the land-based production of juvenile Yellowtail Kingfish and management of brood-stock (FRDC Project No. 2015-213); and
3. Understand and refine the nutritional requirements of Yellowtail Kingfish and how their requirements are affected by the environment (FRDC Project No. 2016-200.20).

Collectively these national research projects have attracted approximately $2.7 million in cash to NSW DPI research agencies and involve multi-disciplinary teams working in most states of Australia. The majority of the research in NSW will be conducted in dedicated research facilities at the Port Stephens Fisheries Institute (PSFI) and then validated on the MARL platform.

The matters outlined in the MARL EIS justifying the location of the MARL within Providence Bay are still relevant except that the new aquaculture infrastructure no longer requires protection from islands or other land masses.

The proposed modification is considered to offer significant benefits in achieving the above research objectives and mitigation of environmental and community concerns as outlined below:

- The proposed modifications will not result in a significant environmental impact or significant expansion of either consent;

- The proposed movement of the farm leases offshore will enable the latest technology for finfish aquaculture to be used;
- The proposal improves the capacity of the MARL to provide commercially relevant research thereby improving the ability to meet the research objectives of the MARL;
- The leases would still be located within the same Marine Park zoning and the characteristics of the proposed sites are similar to the approved lease areas;
- The movement of the leases further off-shore into deeper water and proposed amendments will lead to a reduction in specific impacts:
  - Reduced visual impact for Hawks Nest residents;
  - Reduced interaction with inshore boating traffic;
  - A reduction in feed boat traffic;
  - A greater buffer zone to Cabbage Tree Island (notably to seals and Gould's petrels);
  - Reduced interaction with divers and recreational fishers around Cabbage Tree Island and key wreck sites;
  - Predators (e.g. seals, sharks and birds) will be prevented from entering the pens; and
  - Increased water movement, improved water quality within pens and a reduced risk of environmental impact due to placement in deeper waters.

# 3 STATUTORY CONTEXT

## 3.1 LEGISLATION

The *Environmental Planning and Assessment Act 1979* provides the statutory framework for the Huon and NSW DPI planning approvals to conduct finfish aquaculture in Providence Bay off Port Stephens.

Pursuant to Sections 80 and 115W of the *Environmental Planning and Assessment Act 1979* Huon and NSW DPI are seeking for the modification of their respective approvals.

Modification applications have been lodged under Section 75W and 115ZI of the *Environment Planning and Assessment Act 1979* to cover both consents as the operations on both leases will be operated under similar conditions.

If this modification application is successful, two instruments of modification would be issued by NSW Department of Planning and Environment (NSW DPE).

## 3.2 PISCES CONSENT (HUON LEASE)

Pisces Marine Aquaculture Pty Ltd began operating a 14 hectare (ha) trial Snapper farm in February 1999 under provisions of Section 3 of the *Environmental Planning and Assessment Regulation 1994*. Before proceeding to commercial culture, the company was required to lodge a State Significant Development application with an Environmental Impact Statement (EIS) to NSW DPE (formerly NSW Department of Urban Affairs and Planning).

On 6 August 2001, the NSW Minister for Planning approved the application (DA No. 81-04-01) from Pisces Marine Aquaculture Pty Ltd for a commercial fish farm in Providence Bay with associated land based facilities at Oyster Cove in the Port Stephens Local Government area. The approval included construction and operation of a fish farm approximately 3.5 km off Bennetts Beach comprising nine sea pens (6 x 120 m circumference, 4 x 80m circumference) within a 30 ha (580 x 520 m) area (AL06/098).

In March 2004, the venture went into voluntary receivership and was purchased by a new owner, Pisces Aquaculture Holdings Pty Ltd. An application was lodged in 2008 by this company to modify the consent. The modifications included:

- An additional sea pen – the site is now approved for ten sea pens which include six 120 m and four 80 m circumference pens;
- Additional fish species; and
- Limited on-site processing.

The modification was approved 26 February 2009 by NSW DPE. The Pisces consent has 40 conditions relating to operation and environmental performance. Huon subsequently purchased the lease authorised in the Pisces consent in 2014.

### 3.3 NSW DPI CONSENT

On 31 May 2013, NSW DPE approved a State Significant Infrastructure application *SSI-5118* from NSW DPI for the development of a 20 ha (530 x 370 m) Marine Aquaculture Research Lease in Providence Bay. This lease is located approximately 3.5 km off Hawks Nest and about 500 m north of the Huon Lease.

An Environmental Impact Statement and draft Environmental Management Plan were prepared by NSW DPI and exhibited October/November 2012. The local community was informed of the process with meetings held during the preparation of the EIS and community "drop-in" information days held during the exhibition period.

The research lease was approved to operate for five years and will build on the fish breeding and diet development research currently undertaken at the Port Stephens Fisheries Institute. The consent authorised eight sea pens between 80 to 120 m in circumference and multiple finfish species with an operational lifespan of five years.

The project approval requires that some 60 conditions relating to administration, sea pen construction, maintenance, decommissioning, specific environmental conditions, environmental management and reporting are met. These conditions recognise issues raised by the community and agencies to safeguard the environment and assess the sustainability of the activity.

The research will investigate and develop new technologies for the marine aquaculture industry. Key outcomes from the research would be: proving the farming suitability of species such as Yellowtail Kingfish; developing diets; validating equipment and technology; and undertaking environmental monitoring.

## 3.4 EPBC REFERRAL

The MARL was referred to the Department of Sustainability, Environment, Water, Population and Communities in 2013. In accordance with sections 75 and 77a of the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) the MARL activity was deemed not to be a controlled action.

On the 25 February 2016, NSW DPI referred the modification matter for consideration to Department of the Environment under the EPBC Act.

# 4 BACKGROUND TO PROPONENTS

## 4.1 HUON

Huon (*www.huonaqua.com.au)* is Australia's largest majority family-owned aquaculture company. Peter and Frances Bender began farming fish in 1986 starting with one pen and a lone employee. Since then the company has evolved to become a fully vertically integrated operation that produces approximately 20,000 tonnes of Atlantic Salmon and Ocean Trout each year. Employing over 500 people and with operations across Tasmania and most Australian states, Huon has become an iconic brand for the State and an integral part of its cultural and economic landscape. For the 2013/14 financial year, Huon achieved a turnover of approximately $195 million.

Huon staff take pride in their culture of innovation and have a reputation of being at the forefront of the industry. Huon is driven by the understanding that technologies need to evolve to operate efficiently and sustainably within the natural environment. Diversification into the farming of Yellowtail Kingfish will build on production methods and equipment that have been developed by Huon in Tasmania over 25 years to meet the growing demand for food fish.

Huon is listed on the ASX (Code HUO) and has a market capitalisation at the time of writing of $427 million. Huon is currently rolling out a $43 million predator protection system (Fortress pens) across its Tasmanian farms over the next three years. The main structural components of the Fortress pens are manufactured in NSW. This technology is enabling Huon to relocate inshore sea pens into higher energy offshore waters in Tasmania as a key part of its Controlled Growth Strategy.

## 4.2 NSW DPI

NSW DPI (*www.dpi.nsw.gov.au)* is the key NSW government agency responsible for promoting the development of viable and sustainable aquaculture. The Port Stephens Fisheries Institute has an international reputation for aquaculture research. NSW DPI has a history of marine finfish research, as well as hatchery and nursery production, including a trial Snapper farming operation in Botany Bay in the 1990's and supporting the commercial finfish industry in NSW with seed stock supply and research support.

NSW DPI has developed sustainable aquaculture strategies for both the oyster and land based aquaculture industries. The research to be undertaken on the MARL will greatly assist NSW DPI in the development of the NSW Marine Waters Sustainable Aquaculture Strategy.

# 5 PROPOSED MODIFICATIONS

The key proposed modification is to relocate the current Huon and NSW DPI lease sites further offshore close to the 40 m contour line (Figure 1). This is still within NSW State waters and also still within the same Habitat Protection Zone of the Port Stephens Great Lakes Marine Park as the approved aquaculture sites.

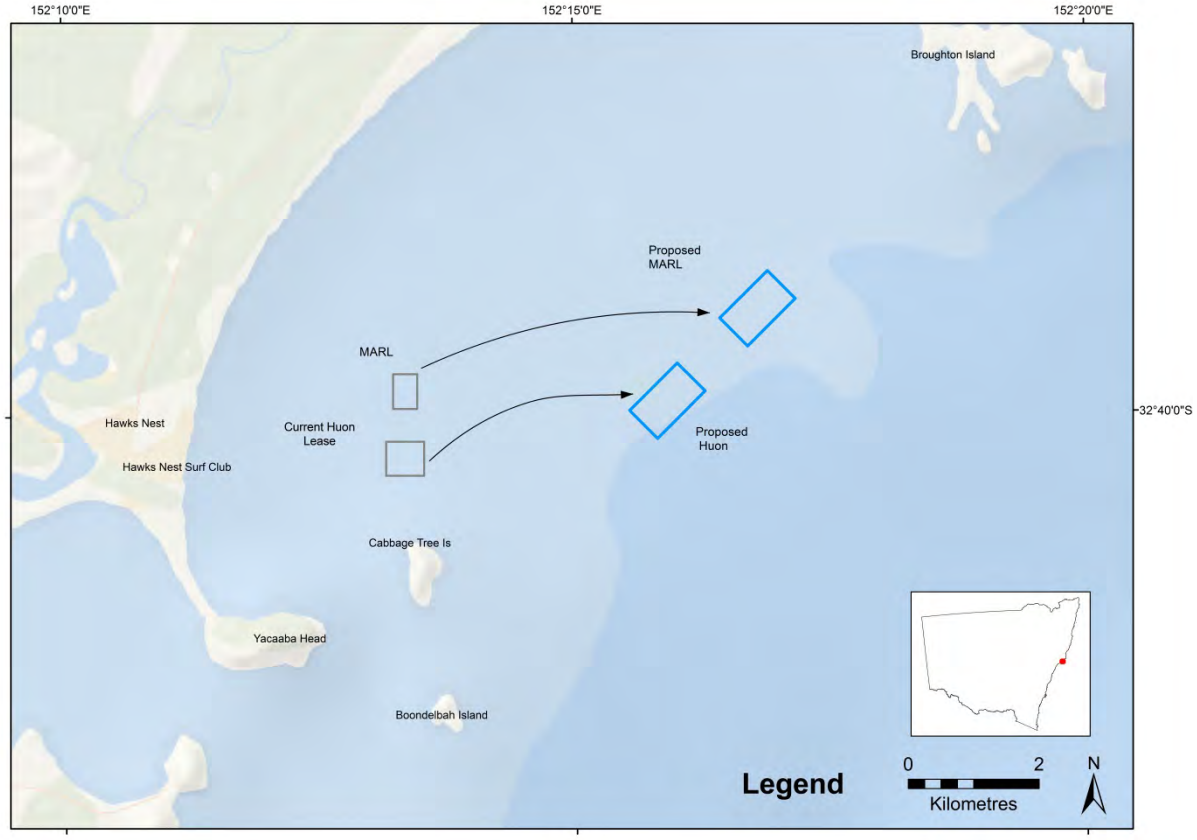


**Figure 1: Existing lease areas in relation to proposed lease sites (Source: NSW DPI, 2015).**

It is understood that the current approved sites of the Huon and NSW DPI leases were the best sites for the existing sea pen technology at the time they were selected. However, the aquaculture industry has evolved quite rapidly and in a relatively short period of time there have been dramatic changes to pen size, depth, construction and materials.

It would be problematic to use leading edge technology and farming practices on the current approved lease sites that have a maximum depth of 22 m. The deeper and higher energy (wave and wind) sites can accommodate the new technologically advanced Fortress pens and are located in areas with stronger currents and greater water movement. The Fortress pens have been deployed by Huon in Storm Bay Tasmania which has similar sea state characteristics to Providence Bay.

The proposed modification site characteristics will enhance fish health and further mitigate the potential environmental risks for the local and wider environment. In addition, by moving individual leases further away from one another it also minimises potential biosecurity risks. The alignment of the leases to the contour line and the predominant current and wind direction will optimise the flushing of the proposed lease sites with oxygenated water.

The latest research indicates that moving aquaculture into deeper waters and offshore sites will better support sustainable farming activities. This will significantly enhance the objectives of the MARL to provide commercially relevant research.

Initially only two to three pens would be located on the MARL, serviced by in-pen feed hoppers. This will allow the initial research and monitoring on the MARL to inform the stages of development on the MARL and the Huon lease.

A summary of the proposed modifications and the current approved matters as outlined in the Pisces and MARL EIS's and approvals are outlined in Table 1.

**Table 1: Comparison of current approved matters and proposed modifications.**

| Consent Details | Pisces<br>DA No. 81-04-01 & Modification | NSW DPI<br>SSI-5118 | Proposed Modifications |
|---|---|---|---|
| *Site location* | 3 km offshore of Hawks Nest<br>Water Depth: 15-22 m<br>(**Condition 2**) | 3.5 km off Hawks Nest, 500 m north of Pisces Lease<br>Water depth: 18-22 m<br>(**Condition B2**) | Proposed Huon Lease site 7.5 km off Hawks Nest<br>Proposed MARL 9.1 km off Hawks Nest<br>Water depth: 38-43 m. |
| *Farm size, number and type of pens* | Size: 30 ha (580 x 520 m)<br>Pens: 6 x 120 m and 4 x 80 m circumference<br>(**Condition 18**) | Size: 20 ha (530 x 370 m)<br>Pens: 8 x 80-120 m circumference<br>(**Condition B2**) | Size: 62 ha per lease site (602 x 1029 m)<br>Pens: 12 x 120 - 168 m circumference (per lease site) |
| *Fish species to be farmed* | • Snapper<br>• Mulloway<br>• Slimy Mackerel<br>• Yellowtail Scad<br>• Yellowtail Kingfish<br>• Yellowfin Bream<br>(**Condition 5 & 6**) | • Yellowtail Kingfish<br>• Snapper<br>• Mulloway<br>• Southern Bluefin Tuna<br>• Slimy Mackerel<br>• Yellowtail Scad<br>Other species as approved by the Director-General for culture or bio-remediation research<br>(**Condition B9 & 10**) | • Yellowtail Kingfish<br>• Snapper<br>• Mulloway<br>• Slimy Mackerel<br>• Yellowtail Scad<br>• Yellowfin Bream<br>• Southern Bluefin Tuna<br>Other species as approved by the Director-General for culture or bio-remediation research. |
| *Stocking density* | A maximum standing stock of 998 tonnes.<br>Stocking density of no more than 12 kg/m$^3$.<br>No more than 1,680,000 | A maximum standing stock of 998 tonnes.<br>Stocking density of no more than 12 kg/m$^3$.<br>(**Condition B8**) | Standing stock to be staged on Huon Lease.<br>Initially 998 tonnes with the option to increase to 1200 tonnes provided monitoring results on MARL and Huon Leases indicate no significant negative impact from 998 tonne density. |

| | | | |
|---|---|---|---|
| | fingerlings annually.<br>(**Condition 9**) | | |
| *Net cleaning* | Net washing at land based facility.<br>(**Condition 30**) | Approved for *in situ* net cleaning<br>(**EIS**) | Propose to remove condition 30 to enable current technologies to be employed. Huon will use *in situ* net cleaning robots. |
| *Feeding* | Fish fed a pelletised diet which would be distributed to the fish with an operator controlled blow feeder.<br>(**EIS**) | Commercially manufactured pellets would be used to feed the fish either by hand or a 'feed hopper' attached to a blower.<br>(**Conditions D4 & 5, EIS**) | Update MARL condition D 4 & 5 and update Huon lease conditions to permit the use of initially in-pen floating feed hoppers. Then once sufficient pens are installed the deployment of a feed barge employing latest technologies to deliver feed with electronic feed monitoring and the use of in-pen hopper based systems with electronic feed monitoring. Stand-alone pen hopper based system to be used temporarily until feed barge is available. |
| *Land based infrastructure* | • Existing infrastructure<br>− main building;<br>− depuration plant;<br>− car park;<br>− delivery area;<br>− outdoor storage areas; and<br>− timber wharf.<br>• Installation of a holding cage located adjacent to the timber wharf.<br>• Installation of a net washing machine. | None | Port Stephens Fisheries Institute for hatchery operations. Use of Nelson Bay to allow staff transit to and from leases. Main feed store, pen building area, mooring equipment and gear maintenance will be in Newcastle to avoid potential issues with truck movements and amenity in Port Stephens. |

The following provides an overview of matters within DA No. 81-04-01 which are no longer valid for the proposed modification.

| *Condition No.* | **Pisces**<br>DA No. 81-04-01 | **Reason for Modification** |
|---|---|---|
| *10* | Structural adequacy for all new buildings | Former land based site is not being considered as part of the modified operations. Any future land based developments to be assessed separately under Part 4 of the EP&A Act. |
| *31* | Use of Oyster Cove site for holding and harvesting fish | Oyster Cove site is not being considered as part of the modified operations. |

## 5.1 DETAILS OF PROPOSED MODIFICATIONS AND BENEFITS

### 5.1.1 Relocation of Sites

To enable the use of the latest technologically advanced sea pens, a site with a depth profile of at least 35 m is ideal.

The proposed modification is to relocate the Huon and MARL leases further offshore to sites that have adequate depth profiles to accommodate the technologically advanced sea pens. The Huon and MARL leases are currently located about 3.5 km off Hawks Nest. The modification would result in the leases being located approximately 7.5 km (Huon) and 9.1 km (MARL) offshore from Hawks Nest (See Figure 1).

The proposed modification sites have characteristics comparable to the current approved sites in that they are still within NSW State waters and the Habitat Protection Zone of the Port Stephens Great Lakes Marine Park.

NSW DPI has contracted bathymetry mapping of the seabed type to identify any habitat boundaries. The proposed lease areas comprise of soft sediments dominated by sand. The proposed modification sites consist of relatively mobile fine sand.

The nearest mapped areas of reef are located approximately 1.1 km and 1.7 km from the proposed MARL and Huon location. These distances are approximately 500 m further than the current lease areas are to mapped reef areas. This increased distance will therefore reduce any potential impacts from the aquaculture activity on nearby reefs.

These proposed lease locations are categorised as high energy environments with similar wave, current, tidal, sea surface temperature and water quality as the currently approved sites.

Other than the increase in depth, the proposed modification lease sites have principally the same characteristics as the currently approved sites.

*Benefits*

The proposed modification of relocating the leases further offshore and into deeper water will lead to a reduction in specific impacts including the following:

- Reduced visual impact for Hawks Nest residents;
- Reduced interaction with inshore boating traffic;
- Reduced interaction with divers and recreational fishers around Cabbage Tree Island and key wreck sites;
- Reduced probability of interactions with seals and negative impacts on the Gould's petrel due to the increased buffer distance to Cabbage Tree Island; and
- Reduced environmental impacts and improved fish stock health due to the increased flushing capacity of the sites due to greater water depth.

### 5.1.2 Lease Area

To accommodate the Fortress pens, feed barge and associated mooring equipment in deeper waters, the lease areas would need to be increased to 62 ha each (602 x 1029 m). As illustrated in Figure 2, the increased area is primarily to accommodate the anchoring systems.

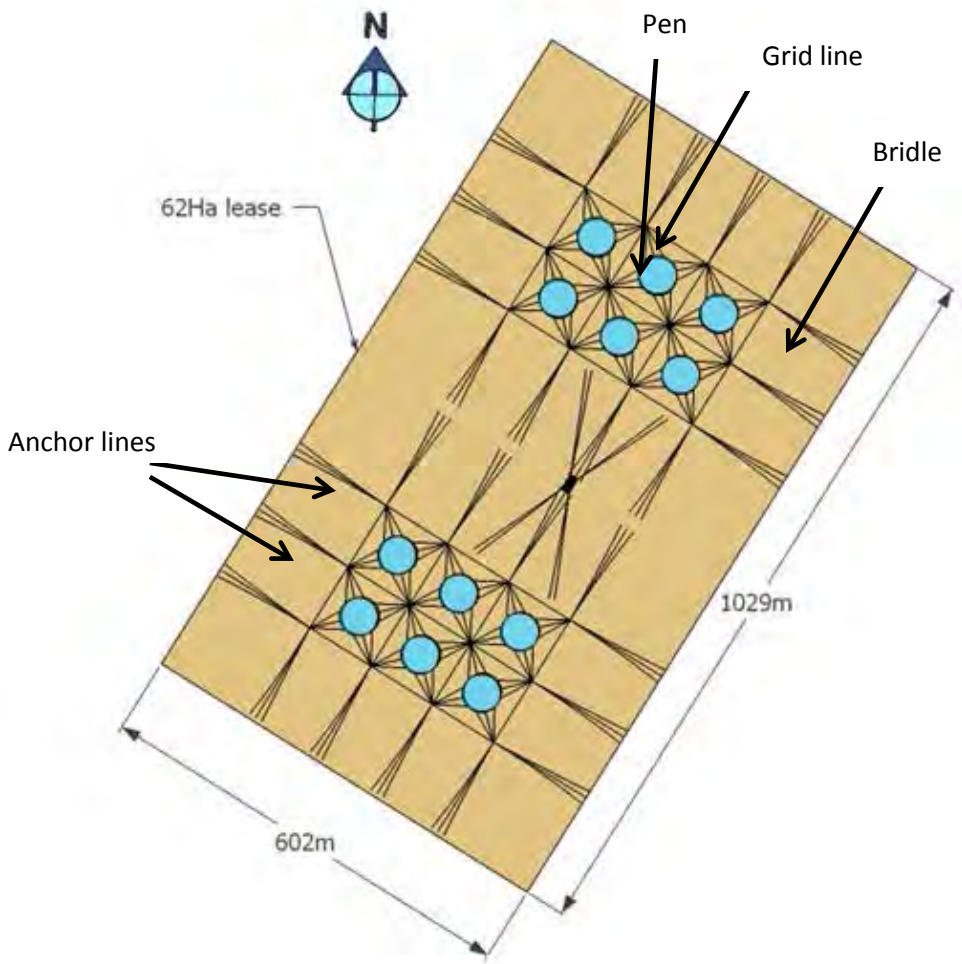


**Figure 2: Proposed new lease layout (Source: Huon, 2015).**

The mooring system components (Figure 3) are specified based on the depths and sea conditions present within Providence Bay. Each anchor line is a combination of rope and chain terminating in a 2 tonne Stingray type anchor. The grid lines are tensioned by the anchor lines and the bridles are used to attach the pens to the grid lines.

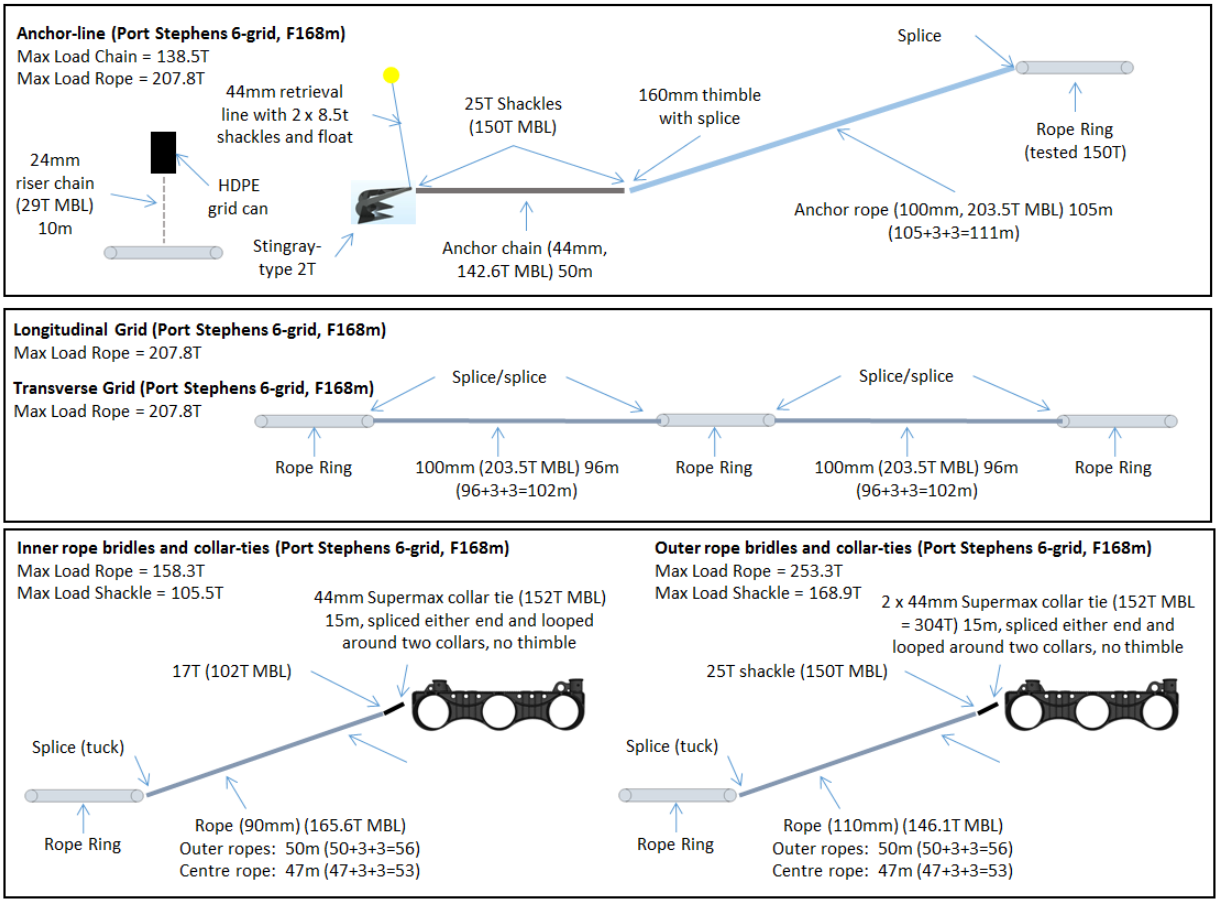


**Figure 3: Mooring components (Source: Huon, 2015).**

### 5.1.3 Lease Infrastructure

*Sea pens*

The EIS's for the currently approved Huon and MARL leases include details on sea pen technologies that have now become outdated. The latest sea pen production technologies include improved systems that are specifically engineered to handle offshore sea conditions, reduce predation from birds, sharks and mammals and to prevent fish escapement.

The proposed modification is to utilise the latest technologically advanced sea pens known as Fortress pens which have a minimum design size of between 120

and 168 m circumference. These sea pens are proposed to be utilised on both of the modification sites (Figure 4). The use of the same sea pens on the proposed modification sites will enable the research objectives of the MARL to provide commercially relevant research to be achieved. A full description of the sea pens can be found in Appendix A.

**Figure 4: New Fortress pen (Source: Huon, 2015).**

The number of pens currently approved for deployment on the approved leases is proposed to be modified from the currently approved ten in DA No. 81-04-01 and Modification (Pisces) consent and eight in SSI-5118 (MARL) consent to twelve for each of the proposed lease sites along with a permanently moored feed barge (See Figure 2).

This would result in an increase in pen surface area from 0.89 ha (Huon Lease) and 0.92 ha (MARL) to 2.25 ha at each lease. The surface area of 12 pens on 62 ha = 3.6% of the total lease area versus 3% for 10 pens on the current Huon Lease. As illustrated in Figure 2, the majority of the lease area is required to accommodate the mooring systems in the deeper water of the proposed lease sites.

*Benefits*

The larger size pens (168 m circumference vs 120 m in the current consent conditions) create more space for fish resulting in a lower stocking density. Reduced stocking densities minimise stress to stock and provides the fish with a more optimal environment to thrive in (e.g. greater oxygen levels).

The design of the proposed sea pens prevents predators from entering the sea pens and therefore prevents entrapment. The net design and material discourages birds from resting on the pens and prevents them from accessing fish feed which reduces the likelihood of bird entanglements. If predators are unable to enter the sea pens and interact with the standing stock, the attractiveness of the leases to predators such as sharks is greatly reduced.

Preventing predator interactions with cultured stock minimises fish stress, injury and loss. This allows the cultured fish to eat consistently, have better feed conversion ratios, faster growth rates which will result in healthier fish and less waste entering the environment. In deeper water wastes would be dispersed over a larger area making it easier for the environment to assimilate it. The combination of lower stocking densities, increased oxygen flow and reduced stress in turn decreases mortality rates and stock losses.

The design of the proposed sea pens also reduces the OH&S risks associated with sea pens as they incorporate a flat, enclosed walkway which provides a safer and more stable work platform for farm workers particularly in bad weather. In addition, the design prevents seals from accessing the walkways which will reduce the likelihood of interactions between aggressive seals and employees.

The new pens also have a greater ability to cope with extreme weather which reduces the risk of damage and associated debris.

*Feeding Technology*

The current approved lease sites have permission to deliver fish feed through blower systems mounted on a vessel or a feed. These systems generally require the manual handling of feed bags to supply the blower system and also rely on the operator to take visual cues from the surface activity of fish to deliver feed.

The proposed modification is to employ the current best practice feeding technologies as part of the sea pen infrastructure.

Initially feeding will be done using individual floating hoppers positioned centrally in each pen (Figure 5). These introduce feed by a spinning disc to achieve a spread across the surface area of the pen. Fish appetite is measured by infra-red sensor technology and the feed rate adjusted to match the ingestion rate of the fish.

**Figure 5: 168m Fortress pen with centrally mounted feed hopper (Source: Huon, 2015)**

As the number of pens in use increases, the hopper based technology will be replaced by a single purpose built feed barge moored permanently on the lease to deliver the fish feed. The proposed feed barges deliver the feed via air blower systems. Whilst blowers are approved under the two current consents, these were deck mounted and launched the feed into the air.

In the feed barges the blowers are mounted below deck in insulated machinery spaces and the pellets are delivered via reticulated polyethylene pipes to a central pivoting arm that spreads the feed across the pen surface with very low waste. This is achieved through the use of video surveillance devices to accurately deliver the required amount of feed to the sea pens. The electronic systems monitor fish behaviour within the sea pens and also monitor the feed falling within the pens to vary or stop the delivery of feed if it is not being eaten.

The proposed barge design has a low profile and is painted blue to minimise visual impact. They will be permanently moored on-site and do not have their own propulsion systems (Figure 6 and 7). The barge is rated for Operational Area C defined as a 4.5 m significant wave height and 450 Pa gusting wind pressure. A 4.5 m significant wave means you can expect occasional waves (1 every 1000) of 8.4 m and a rogue of even more (when peaks coincide). A wind of 450 Pa is about 53 knots. The stability of the barges meets the requirements for a Class A vessel (independent operation at sea, significant wave greater than 6 m). Specifications for the feed barge can be found in Appendix B.

**Figure 6: Feed barge (Source: Huon, 2015).**

**Figure 7: Feed barge at a 550 m distance (Source: Huon, 2015).**

*Benefits*

The proposed feed barge technology mitigates excess feed entering the surrounding waters which results in fewer nutrients discharging into the environment.

It also provides for better feed conversion ratios as feeding can be tailored to the cultured stock requirements. For example, Yellowtail Kingfish feed faster (higher ingestion rate) than most other species commercially farmed. The proposed feed barge is specifically designed to match the desired feed rate of the fish, reducing stress caused by "scramble competition" and providing optimal feed efficiency.

The proposed feed barge holds up to 320 tonnes of feed in eight separate feed hoppers that are connected in such a way that any population of fish has a choice of two different feeds. A dedicated blower transports the feed in an airstream through floating high density polythene pipe to each individual pen. This is the only feeding system that can simultaneously feed all pens at the appropriate rate of delivery. The feed barges can be filled in a single trip from a large vessel and will hold at least one week's food. All the machinery to measure and transport the food out to the fish is kept in a stable, dry space below deck rather than exposed to the elements.

The installation of the proposed feed barge system will reduce feed boats trips from daily to weekly thereby reducing the amount of vessel traffic. When coupled with the pens being moved further offshore, this represents a significant reduction in feed boat traffic noise, particularly at key times such as dawn and dusk.

The new barge system provides a safer work environment at full production volume and allows fish feeding staff to focus on feeding the fish rather than maintaining the feed hoppers. NSW Roads and Maritime Services (NSW RMS) have been provided with a copy of the Feed Barge Safety Management Plan. NSW RMS is confident that the plan provides a robust series of processes to ensure the safe operation of the vessel (S. Stroud – NSW RMS 2015, *pers. comm.*).

The robust technology of the proposed modification will employ the latest feed delivery systems (feed barge) which will result in less physical impact on workers

and the mitigation features employed will prevent potential wastes entering the environment.

### 5.1.4 In situ Net Cleaning

The consent for the MARL (SSI-5118) authorises the use of *in situ* net cleaning equipment. This technology was not available when the Pisces EIS was written and therefore was not included in its consent DA No. 81-04-01. The proposed modification is to include the use of *in situ* net cleaning on the proposed Huon Lease.

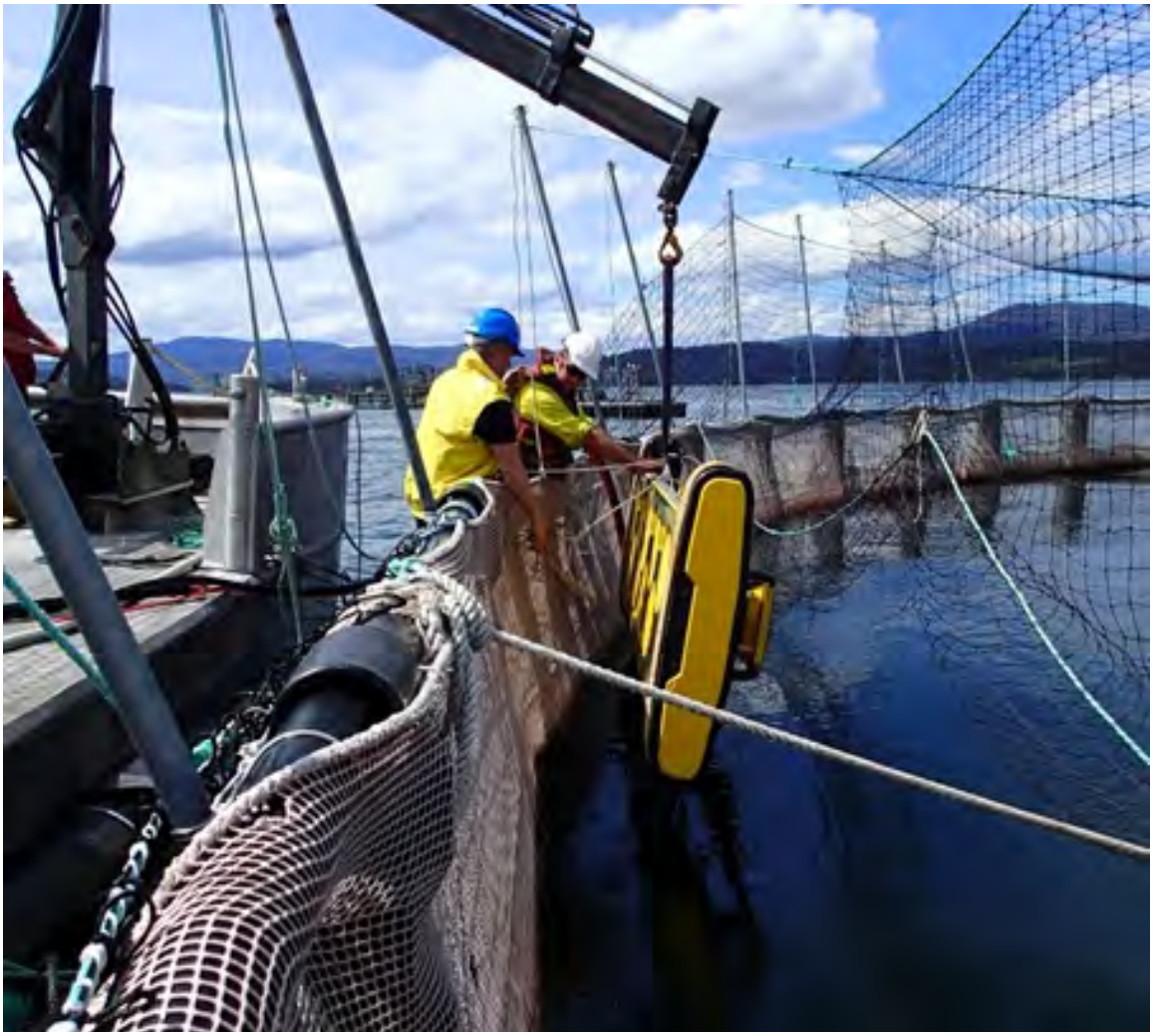

**Figure 8: RONC net cleaner being deployed in a non-Fortress pen (Source: Huon, 2015).**

**Figure 9: RONC net cleaner in operation - note retro-jets holding the unit against the net (Source: Huon, 2015).**

The *in situ* net cleaner works by positioning rotating high pressure water jets close to the surface of the net (Figure 8 and 9). This washes the biofilm and fouling from the net dispersing this fine material in the water. No chemicals are added - the cleaner uses seawater only. The unit is controlled by an operator in the wheelhouse of the net cleaning vessel and the net cleaner has inbuilt fore and aft video cameras to help the operator navigate the net and check for cleanliness and any wear on the net. The manufacturers of the two systems used by Huon include Multi Pump Innovation and Marine Inspector and Cleaner (See Web Reference 1 and 2).

*Benefits*

The *in situ* net cleaning equipment removes the need for antifouling paint coatings on the nets removing any risk of environmental impact from copper on organisms in the water column or sediment.

The *in situ* net cleaning technology also removes the requirement to routinely change the nets for cleaning ashore. This prevents fish loss during net changing and prevents damage to the nets from crane handling and mechanical washing. Fish loss during net changing can be as a result of direct escapes if a mistake is made in the procedure and/or timing of tasks. It can also occur from predator attacks when the configuration of the net is temporarily compromised to allow for net removal or during installation where new nets can become damaged.

As the nets will be cleaned every few days *in situ*, the level of fouling will be very small during the interval between cleans. Consequently there will be minimal natural organic matter "discharged" into the environment during each clean.

### 5.1.5 Land Based Operations

The current approval DA No. 81-04-01 & Modification for the former Pisces operation approves the use of a land based facility at Oyster Cove. The characteristics of this are deemed no longer suitable for the land based operations of deployment and routine maintenance to support the current and proposed modification offshore operational activities.

The proposed modification is to enable the use of the Port Stephens Fisheries Institute (PSFI) and alternate land based site(s) rather than the Oyster Cove site. It is likely that this will be in Newcastle (Figure 10). Huon and NSW DPI will progress any additional land based sites under a separate Part 4 application as required under the *Environmental Planning and Assessment Act 1979*.

**Figure 10: Example of land based requirements (Source: Huon, 2015).**

*Benefits*

Land based sites suitable for the construction of pens and the storage of sufficient feed to buffer against logistic delays and/or appetite fluctuation are not easily available in Port Stephens. Suitable sites are available in Newcastle along with many established companies that can provide the required materials and services. Whilst the land based site will not result in high levels of noise, odour or light pollution, there are clear advantages to locating it in an industrial area.

### 5.1.6 Fish Species

The current approval for the Huon Lease (DA No. 81-04-01 & Modification) approves the culture of the following fish species:

- Snapper;
- Mulloway;
- Slimy Mackerel;
- Yellowtail Scad;
- Yellowtail Kingfish; and
- Yellowfin Bream.

It is proposed that a condition from the MARL be retained in the modification application for both leases that states that “other species be approved by the

Director General of Planning and Environment for culture and bioremediation research".

This enables the culture of other species provided they have been assessed by NSW DPI and NSW DPE as suitable. This would enable Huon to employ new innovative sustainability measures such as bioremediation practices which are at the cutting edge of recent research activities elsewhere in the world to mitigate environmental impacts.

The proposed modification would also permit Huon to farm new aquaculture species as they came on line or to adapt to changing consumer demands in regards to preferred species of fish to eat.

*Benefits*

The proposed modification would permit Huon to farm new species on the proposed Huon Lease to meet changing consumer preferences or to employ environmentally sustainable practices such as bioremediation culture of organisms. This would be consistent with the MARL consent.

### 5.1.7 Maximum Standing Stock 998 to 1200 tonne

The production model developed will involve stocking the fingerlings for a calendar year on the leases. The fingerlings will grow to market size in approximately 13-14 months following stocking and be harvested in the sequence that they were stocked i.e. one pen per month. The lease configuration requested (See Figure 2) is a scalable model that will fit this production plan and allow for efficient operation and fallowing (resting) of the leases. The production plan proposed will achieve expected returns on investment. Whilst this increased level of production will result in additional load on the marine environment, this is still well below the trigger values recommended in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000).

### 5.1.8 Update of Conditions in DA No. 81-04-01 Consent

The consent DA No. 81-04-01 for the Huon Lease was issued in 2001 when the development of offshore marine aquaculture was in its early developmental stage in Australia.

The proposed modification to the DA No. 81-04-01 & Modification consent conditions is to bring it in line with those attributed to SSI-5118 (MARL) which employs the current environmental monitoring and operational requirements.

*Benefits*

The proposed modification would ensure there is consistency with the mitigation measures employed to minimise potential environmental impacts across the two consents undertaking similar aquaculture activities. This would ensure greater consistency with the monitoring of potential environmental impacts on both sites and provide valuable information on the cumulative performance of the two leases. In addition, it would provide key stakeholders with a better understanding and ability to compare the environmental performance of the leases and enhance the research objectives of the MARL.

# 6 CONSULTATION

Preliminary consultation was initially undertaken with representatives of the following key government agencies to ascertain if they could identify any issues with the proposed modification that had not been previously identified during the consent processes for the subject lease sites:

- Port Stephens - Great Lakes Marine Park
- Environmental Protection Authority
- Roads and Maritime Services
- Water Police
- NSW State Aquaculture Steering Committee
- Office of Environment and Heritage
- National Parks and Wildlife Service
- Department of Premiers and Cabinet
- NSW Department of Primary Industries (Fisheries NSW, Lands)
- NSW Department of Industry
- NSW Food Authority
- Port Stephens Council
- Newcastle City Council
- Great Lakes Council

The agency representatives did not identify any additional issues to those outlined in Section 8 of this document or previously considered in the Marine Aquaculture Research Lease, Environmental Impact Statement. However, they did welcome the opportunity to review the modification document.

Huon also undertook consultation with local State and Federal members of parliament.

In addition, NSW DPI and/or Huon undertook a number of meetings and/or telephone conversations with community groups to both provided information about the proposed modification and to also seek any other issues not previously identified by NSW DPI, Huon and the above key government agencies. These stakeholders included:

- Tomaree Ratepayers and Residents Association

- EcoNetwork – Port Stephens Inc.
- Port Stephens Tourism
- Newcastle Commercial Fishermans Co-op
- Commercial fishers
- Broughton Island Hut Users
- Hawks Nest Fishing Club
- Newcastle Port Stephens Game Fishing Club
- John 'Stinker' Clarke (Recreational fishing representative)
- Worimi Local Aboriginal Land Council
- Tea Gardens Hawks Nest Surf Life Saving Club
- Hawks Nest Sports Store
- Tackleworld Port Stephens
- Local aquaculture representatives
- Myall Waterways Chamber of Commerce
- Port Stephens Yacht Club
- Marine Rescue Port Stephens
- Imagine Cruises / Dolphin Swim Australia
- Hawks Nest Tea Gardens Progress Association

The issues that were raised by these community stakeholders during discussions included:

- The risk that the aquaculture activity would attract more sharks to the area of Providence Bay
- Provision of buoys for recreational fishers near the aquaculture infrastructure
- Composition of the feed to be used
- Nutrient discharges from the site and its potential impacts
- Navigation in the locality and how the lease sites would be identified
- Where the product would be processed and sold.
- Potential impacts on tourism
- Why not locate the leases in another part of the State

- Should such a development be located within a Marine Park
- The potential number of jobs that may be created.
- Where would the land based operations be located
- Will there be further expansion
- Operational and legal issues concerning the management of an aquaculture lease site
- Avoid recreational fishing reefs
- Use of chemicals on the lease sites
- Capability of the infrastructure to withstand the sea conditions
- Marine fauna (Whales, dolphins, sharks, seabirds, etc.) interactions and the risk of entanglement

The issues raised by the above community groups were previously addressed in the Marine Aquaculture Research Lease EIS and associated Response to Submissions. Additional information regarding the proposed modification has also been outlined in this document if not adequately addressed in the above two documents.

It is acknowledged that this is not an exhaustive list of all potential community stakeholders within the Port Stephens region. However, the public exhibition period and associated advertising of the proposed modification provides a further opportunity for all community stakeholders to raise their respective issues regarding the proposed modification.

During the public exhibition period, NSW DPI in association with Huon will be conducting two community 'drop-in' information sessions. These sessions will be held at the following locations:

- Hawks Nest Community Centre, 71 Booner Street, Hawks Nest– Wednesday 16 March 2016 from 2:30pm-6:30pm; and
- Nelson Bay Community Hall, 6 Norburn Ave, Nelson Bay– Thursday 17 March 2016 from 2:30pm-6:30pm.

The Modification Application will also be publicly displayed between 10 March 2016 and 24 March 2016 with exhibition at the following locations:

- The Department of Planning and Infrastructure - Information Centre (23-33 Bridge Street, Sydney NSW);

- Port Stephens Council – Tomaree Library, Town Centre Circuit (Salamander Bay NSW)
- Great Lakes Council – Tea Gardens Customer Service Centre, 245 Myall Street, Tea Gardens NSW;
- Fisheries NSW - Port Stephens Fisheries Institute (Taylors Beach Road, Taylors Beach NSW).

Advertisements will be placed in the following publications:

- Port Stephens Examiner; and
- Myall Coast News.

An electronic copy of the Modification Application will be available on the NSW Department of Planning and Environment website.

An electronic copy of the Modification Application will also be available on the NSW Department of Primary Industries website (along with a Question and Answer document and other relevant links) at:

http://www.dpi.nsw.gov.au/fisheries/aquaculture

Following the public exhibition period a Response to Submissions document will be prepared to inform the wider public on the issues raised during public exhibition and how they may be mitigated.

# 7 ANALYSIS OF ENVIRONMENTAL IMPACT

The risk assessment of potential impacts undertaken in the Marine Aquaculture Research Lease - Environmental Impact Statement (MARL EIS) provides a framework for analysing the potential environmental impacts of this proposed modification. The Pisces EIS and the associated potential impacts that were identified were used as a template in the preparation of the MARL EIS. Therefore, potential impacts in the Pisces EIS were considered in the MARL EIS and assessment process.

A total of 27 issues were identified and assessed in the MARL EIS. Table 3 provides an overall analysis of the impacts of the proposed modification against that of the MARL EIS risk assessments. The analysis has considered the risk rating within the MARL EIS and compared it with the potential impacts of the proposed modification. Changes in the risk rating are identified as either decreasing or potentially increasing the risk rating or if unchanged given a neutral classification.

The analysis of potential environmental impacts associated with the proposed modification has identified that the risk rating of the MARL EIS has remained neutral for 23 risk issues, decreased for three and potentially an increase for one risk issue. The proposed modifications may have resulted in an overall decrease in potential environmental impacts in some cases but as the risk issue already had a negligible rating, it remained unchanged.

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**Table 2: Summary of environmental, social and economic issues including ranking and proposed mitigation measures.**

| Issue & MARL EIS chapter reference (No.) | MARL Risk Rating | Expected Change | Mitigation | Risk Rating after Modification |
|---|---|---|---|---|
| Site / Construction / Infrastructure (8.1) | | | | |
| Significance of habitat loss and shading due to the installation of sea cage infrastructure **(8.1.1)** | Negligible | Neutral | ▪ *Sites proposed have similar sandy substrate with no environmentally sensitive or unique areas.*<br>▪ *Infrastructure still consists of an open and streamlined sea pen design.* | *Negligible* |
| Decommissioning **(8.1.2)** | Low | Neutral | ▪ *Proposed sites are on similar mobile sand, reasonable depth, high energy environment.*<br>▪ *MARL remains as a short-term research operation.* | Low |
| Impact on noise levels – construction and deployment stage **(8.1.3)** | Low | Decrease | ▪ *Relocation of the leases further offshore (3.5 km to 7.5 & 9.1 km) will result in reduced levels of noise reaching land based receptors.*<br>▪ *Use of Newcastle Harbour for some operational activities (pen construction/feed transfer) will reduce vessel and motor vehicle movements within the Port Stephens and their potential noise impacts on the local community.*<br>▪ *The approximate doubling to tripling of the distance from shore and the potential use of some Newcastle Harbour based operation sites is considered to reduce the risk rating from 'Low' to 'Negligible'.*<br>▪ *The potential impact on marine fauna would remain unchanged.* | Negligible |
| Impacts on existing land based infrastructure **(8.1.4)** | Negligible | Neutral | ▪ *Still propose to use existing approved land based facilities at PSFI and Newcastle Harbour foreshore industrial ground.* | Negligible |

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| Structural integrity and stability of sea cage infrastructure **(8.1.5)** | Low | Neutral | ▪ *Use of latest innovative offshore sea pen and feed barge technology that has been designed for Australian conditions.*<br>▪ *An objective in the MARL EIS was to evaluate latest engineering knowledge in the NSW marine environment. All programs and protocols in the EIS's and approvals would still be applied.* | Low |
| Climate change and impact of sea cages on coastal processes and water flow **(8.1.6)** | Negligible | Neutral | ▪ *No significant change in site and infrastructure characteristics and species remain unchanged. The open, streamlined and flexible design of the infrastructure is retained* | Negligible |
| Impact of sea cage infrastructure on navigation and other waterway users **(8.1.7)** | Negligible | Potential Increase | ▪ *Proposed modified lease sites are in proximity to vessel movement routes used by experienced offshore recreational fishers and some tourist operators traversing between Port Stephens, Broughton Island and nearby reefs.*<br>▪ *Navigation marks, notice to mariners, information in local publications and media would still be used to mitigate this impact.*<br>▪ *Feed barge could act as an additional navigation reference mark and barge and lease extremities would be marked to RMS specifications.*<br>▪ *Construction of sea pens is proposed to be undertaken in Newcastle Harbour which would mitigate the impact of deployment activities on Port Stephens waterway users. Newcastle Harbour is already recognised as a commercial port.*<br>▪ *Although there are no formal records of routes taken by fishers, anecdotal information would appear to indicate that more (percentage unknown) would take an offshore route to Broughton Island and offshore reefs than the previous inshore route adjacent to the current approved lease sites. In light of this the risk rating has been increased from 'Negligible' to 'Low'.* | Low |

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| Operation (8.2) | | | | |
| Impacts on Communities **(8.2.1)** | | | | |
| Impacts on visual amenity and odours **(8.2.1.1)** | Low | Decrease | ▪ *Relocation further offshore will greatly reduce the impact on visual amenity and any potential odours generated by the operation.*<br>▪ *The approximate doubling to trebling of the distance from shore and the potential use of some Newcastle Harbour based operation sites is considered to reduce the risk rating from 'Low' to 'Negligible'.* | Negligible |
| Impacts of marine vessel and vehicular transport **(8.2.1.2)** | Negligible | Decrease | ▪ *It is proposed to service the modified lease sites from predominantly Newcastle Harbour. This will reduce the vessel movements and large truck movements in and out of the commercial wharf precinct of Nelson Bay.*<br>▪ *The use of the feed barge would reduce the requirement for daily feed vessel trips to the proposed leases to undertake feeding activities. Although the assessment identifies a decrease in risks. This matter already had the lowest risk rating of 'Negligible'.* | Negligible |
| Impacts on Aboriginal and European heritage **(8.2.1.3)** | Negligible | Neutral | ▪ *A significant buffer zone to prevent impact on heritage items in wider region is retained.* | Negligible |
| Impacts on noise levels – operational stage **(8.2.1.4)** | Negligible | Neutral | ▪ *Relocation of the leases to further offshore (3.5 km to 7.5 & 9.1 km) will result in reduced levels of noise reaching land based receptors.* | Negligible |
| Impacts on adjacent aquaculture lease **(8.2.1.5)** | Negligible | Neutral | ▪ *Buffer zone, navigation aids, Water Quality and Benthic Environment Monitoring Program, Disease, Parasite and Pest Management Plan will remain in place.* | Negligible |
| Work health and safety | Low | Neutral | ▪ *All management plans and protocols outlined in the MARL EIS* | Low |

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| issues **(8.2.1.6)** | | | *and approval will continue.*<br>▪ *Although the proposed new sea cage design has added human safety features, operating in a marine environment is still considered to have a 'Low' risk rating.* | |
| Impacts on the local economy **(8.2.1.7)** | Negligible | Neutral | ▪ *No management required – potential positive benefits.* | Negligible |
| Impacts on the Environment **(8.2.2)** | | | | |
| Impacts on marine habitats – water quality, nutrients and sedimentation **(8.2.2.1)** | Moderate | Neutral | ▪ *Similar high energy environment, reasonable depth, mobile sands and daily operations and management practices remain the same.*<br>▪ *A 'Moderate' risk rating still applies to this category* | Moderate |
| Fish feed - source, composition and sustainability issues **(8.2.2.2)** | Low | Neutral | ▪ *Feed will still be sourced from sustainable suppliers and research component will continue to look at fish meal/oil replacements, improvements in food conversion ratio and diet development.*<br>▪ *Minimal feed wastage – demand feeding using latest delivery technologies.*<br>▪ *The risk rating of 'Low' is still considered appropriate as the activity type remains unchanged and diet development research is ongoing into fish meal/oil replacement.* | Low |
| Impacts of chemical use **(8.2.2.3)** | Moderate | Neutral | ▪ *Chemicals will continue to be administered in accordance with APVMA.*<br>*Research on other species has shown a decrease in disease, parasite and pest issues when sea pens are moved to deeper waters and also require less chemical use.* | Moderate |
| Genetic composition of cultured stock and impacts of escaped cultured stock on wild stock genetics and | Low | Neutral | ▪ *No proposed changes to broodstock, hatchery and biosecurity protocols.*<br>▪ *Use of latest innovative offshore sea cage technology that has been designed for Australian conditions should mitigate any* | Low |

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| competition **(8.2.2.4)** | | | *potential stock escapements.* | |
| Disease transmission, cultured stock diseases and introduced pests **(8.2.2.5)** | Moderate | Neutral | ▪ *Recent research on Southern Bluefin Tuna has shown a reduced incidence of disease, parasite and pest issues when leases are relocated into deeper waters. However, this research has not been undertaken on Yellowtail Kingfish in Australian waters.*<br>▪ *The disease risk rating of 'Low' is still considered appropriate as the hatchery protocols and Disease, Parasite and Pest Management Plan will still be applied. However, due to the limited information on the risk of pathogens and pest associated with sea pen farms in Australian waters the risk rating of 'Moderate' still applies to this matter.* | Moderate |
| Impacts of artificial lights on fauna species **(8.2.2.6)** | Low | Neutral | ▪ *The proposed leases will be approximate double to triple the distance from Cabbage Tree Island to that of the current lease locations.*<br>▪ *Hours of operation – predominately daylight.*<br>▪ *Vessel lights – shielded and concentrated downwards, barge lights (other than navigation mast head light) turned off or shuttered at night.*<br>▪ *Low intensity mast head light required under RMS navigational requirements. These lights are generally of less intensity than navigation marks on leases.* | Low |
| Entanglement and ingestion of marine debris **(8.2.2.7)** | Low | Neutral | ▪ *No proposed changes to the objective of using latest infrastructure design and utilising the Marine Fauna Interaction Management Plan, entanglement protocol, maintenance and operational procedures to further mitigate entanglement risks*<br>▪ *The use of a feed barge has the potential to reduce the risk of marine debris as feed would be delivered in bulk rather than manual handling of numerous 20 kg feed bags on the lease sites.* | Low |
| Animal welfare issues | Negligible | Neutral | ▪ *All staff will still be made aware of their obligations under the* | Negligible |

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| **(8.2.2.8)** | | | *Animal Research Act 1985.*<br>▪ *All staff will still be required to comply with Aquaculture Code of Conduct and all plans and protocols as outlined in the EIS's and approvals.* | |
| Risk of vessel strike and acoustic pollution **(8.2.2.9)** | Low | Neutral | ▪ *Use of a feed barge would reduce the vessel traffic movements required to deliver feed to the sea pens. Vessels supplying feed barges would operate out of Newcastle Harbour and less vessel movements would be required to meet feeding requirements.*<br>▪ *No proposed changes to mitigation actions within the EIS's and approvals.* | Low |
| Impacts on threatened / protected species and matters of NES **(8.2.2.10)** | Low | Neutral | ▪ *Proposed relocation of leases does not result in any additional threatened/protected species or matters of NES identified in the EIS's being impacted.*<br>▪ *Infrastructure and management of leases remains similar.*<br>▪ *Improved pen design may potentially reduce interaction with marine mammals and predators.* | Low |
| Impacts on migratory pathways, behavioural changes and predatory interactions (notably whales and sharks) **(8.2.2.11)** | Moderate | Neutral | ▪ *New Fortress pen has been designed to reduce predator interactions and the risk of predator entanglement.*<br>▪ *Management programs and protocols as outlined in the EIS's and approvals to be maintained.*<br>▪ *These matters were of particular concern to the community. Therefore, to ensure adequate management attention is provided to these matters it is considered appropriate to maintain the risk rating.* | Moderate |
| Impacts on Areas of Conservation Significance - World Heritage, Ramsar Wetlands, MPA, national parks, critical habitat and natural | Low | Neutral | ▪ *Proposed relocation of the leases does not change its relationship to Areas of Conservation Significance in the region.*<br>▪ *Management programs and protocols as outlined in the EIS's and approvals to be maintained.* | Low |

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| reefs **(8.2.2.12)** | | | | |
| Waste disposal - bio/general/equipment waste **(8.2.2.13)** | Negligible | Neutral | ▪ *No proposed changes to Waste Management or Water Quality and Benthic Environment Monitoring programs or plans in the EIS's and approvals.* | Negligible |

# 8 Review of the Potential proposed modification risks

The following is a review of the risk analysis undertaken as part of the MARL EIS in context with the proposed modification. The chapter numbers of the MARL EIS correspond with those within this document.

## 8.1 SITE SELECTION / CONSTRUCTION / INFRASTRUCTURE RISKS

### 8.1.1 Habitat Loss and Shading

Visual interpretation of acoustic backscatter and hillshaded bathymetry data from seafloor surveys of the proposed modification lease sites indicate that the substratum consists of soft sediments only. The sites are dominated by sand and coarse/fine sand with a depth ranging from 38 to 43 m as shown in Figure 11.

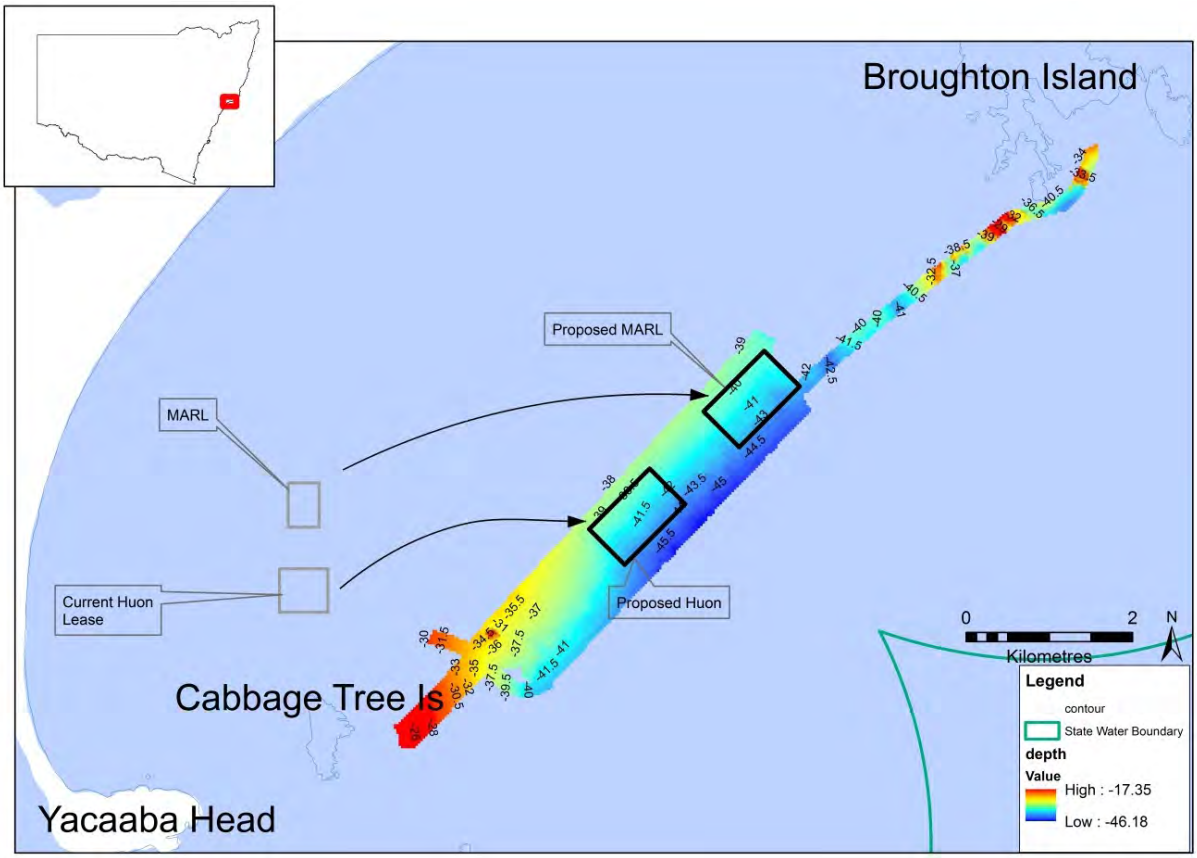


**Figure 11: Seafloor mapping of proposed modification sites (Source: NSW DPI, 2015).**

The soft sediment habitat appears to be similar to the existing approved lease sites. The installation of the sea pens and associated infrastructure will impact on a relatively small area of soft sediment habitat beneath the sea pens. The principle

design of the floating sea pens is similar to that outlined in the Pisces and Marl EIS's and approvals. The total sea bed area directly underneath a sea pen including the predator netting is about 2,605 m².

The installation of the sea pen infrastructure will result in the loss of a relatively small area of pelagic habitat contained in the sea pens where the predator nets extend from the floating HDPE collars on the water's surface down to a depth of about 22 m. The total volume of the water column that will be occupied by an individual predator mesh net and the enclosed fish stock will be approximately 38,391.5 m³ or a total of 921,396 m³ for the 24 sea pens over the two lease sites.

The area of Providence Bay bound by the points of Broughton Island, Boondelbah Island and Yacaaba Headland (Figure 12) is comprised of approximately 8,470 ha and has a volume of about 1,881,261 ML. The proposed modification leases would occupy about 1.5% of this area of Providence Bay while the sea pens would only occupy about 0.07%. The area of pelagic habitat occupied by the sea pens is about 0.049% of the volume of the subject area in Providence Bay.

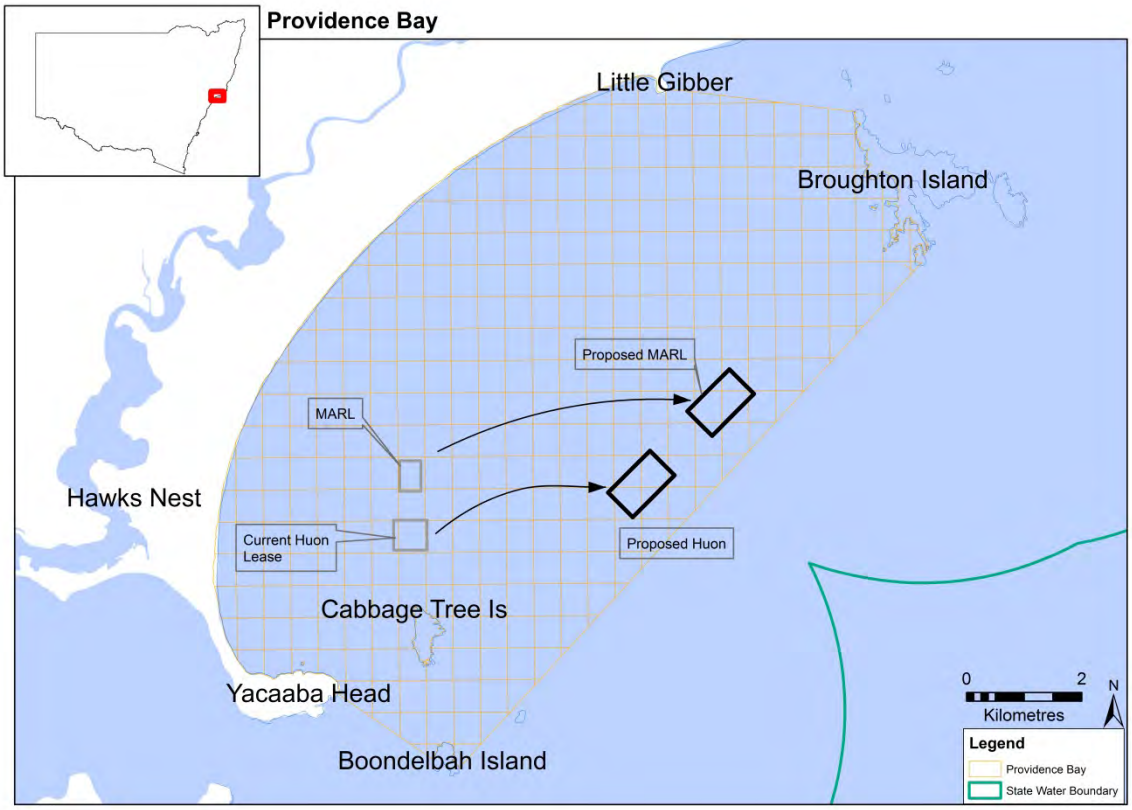


**Figure 12: Area of Providence Bay (Source: NSW DPI, 2015).**

*Conclusion*

The area of soft sediment benthic and pelagic habitat that is expected to be impacted by the modification is still thought to be 'negligible' when considered in context with the extensive areas of similar habitat in the direct and wider area.

### 8.1.2 Decommissioning

As outlined in the MARL EIS, many studies have been conducted on the impacts of marine finfish sea cage farms on the benthic environment in Australian waters and in most cases the impacts have been found to be highly localised and restricted to the area beneath or in the immediate vicinity of sea cages (McGhie *et al*., 2000; Hoskin & Underwood, 2001; DPIWE, 2004; Woods *et. al.*, 2004; Felsinga *et al*., 2005; McKinnon *et al*., 2008; Edgar *et al*., 2010; Tanner & Fernandes, 2010).

Several studies have investigated the effect of fallowing on the recovery of the benthic environment beneath fish cages and the results indicated that any anoxic sediments returned to oxic conditions within 12 to 24 months (Butler *et al*., 2000; McGhie *et al*., 2000; MacLeod *et al*., 2002).

As the substrate within the boundaries of the modification leases is composed of soft sediment, no earth works will be required during decommissioning. In addition, the sandy substrate is relatively mobile and the proposed sites are well flushed with strong currents so it is expected that the sands will naturally redistribute over the disturbed area.

*Conclusion*

The site characteristics are similar to that of the approved leases and therefore the risk of the proposed modification lease sites becoming significantly degraded and requiring rehabilitation is still thought to be 'low' when considered in context with the findings of other sea pen farms in Australia, the high energy environment of Providence Bay, the feeding practices that will be adopted and the type of substrate present.

### 8.1.3 Noise

*Impact on the Community*

The nature of the noise generated by the proposed modification in conjunction with the construction, transport and deployment of the sea pen and barge infrastructure operations will be similar to that of the operations approved on the Huon and MARL leases. Industry best practices for noise management as outlined in the MARL EIS will be employed during the construction and deployment of the sea pens to minimise the impacts of noise.

The proposed larger sea pens would result in them being most likely constructed at a site in the Port of Newcastle. The sea cage construction will be undertaken in accordance with approvals for the selected land based site.

This would result in a reduction of vehicular and boating traffic in the Port Stephens region (land and water) associated with the installation of infrastructure. The movement further offshore will also decrease potential noise impacts on land based stakeholders.

An online modelling program used in noise calculations for the MARL EIS indicated that the noise from a diesel generator (84 dB) used on the MARL would be about 12dB at Hawks Nest. Relocation of the leases further offshore at distances of about 7.5 km (Huon) and 9.1 km (MARL) would result in the diesel generator noise dropping to 7.5 dB and 5.8 bB, respectively. This level of noise would be difficult to hear from nearby beaches and residential areas of Hawks Nest.

*Conclusion*

The risk of the noise on the proposed modification lease sites associated with the construction of the sea pens having a significant impact on the community is thought to decrease from 'low' to negligible when considered in context with the proposed location.

*Impact on Marine Fauna*

Marine fauna behaviour can potentially be disrupted by exposure to anthropogenic noise, including temporary shifts of migratory corridors or habitat areas, masking of calls to prey, conspecifics and/or important environmental sounds, as well as short-term behavioural reactions (Richardson *et al.,* 1985).

The MARL EIS identified that there is the potential for the transport and deployment of the sea pens to introduce anthropogenic noise (i.e. acoustic pollution) into the

marine environment via marine vessel transport and the installation of the anchors and chains. The proposed transportation and construction activities associated with the proposed modification activities are similar to that of the existing approved leases. In addition, the Marine Fauna Interaction Management Plan and Observer Protocol outlined in Appendix 2 of the MARL EIS would be implemented as part of the modification.

*Conclusion*

The risk of marine fauna being significantly impacted by noise generated during the transportation and deployment of the sea pen infrastructure is still thought to be 'low' when considered in context with the activity, the existing noise levels and the management measures that will be implemented i.e. Marine Fauna Interaction Management Plan and Observer Protocol.

### 8.1.4 Land Based Infrastructure

The proposed modification does not include the construction of any new land based infrastructure. As outlined in the MARL EIS, it is proposed that PSFI, the Port of Newcastle and possibly the Nelson Bay Commercial Fishermen's Co-operative will be utilised for construction and operational activities. Existing marina facilities in Port Stephens would also be used for personnel and service vessels.

Planning consent DA No. 81-04-01 permitted the use of a site at Oyster Cove for operational activities. It is not anticipated that this site would be part of any future operational activities for the proposed modification.

The proposed sea pens are now more likely to be constructed at Newcastle and this would result in a reduction of vehicular traffic in and around the Nelson Bay area. The potential increase in traffic in the Newcastle area would be negligible in context with current vehicular movements in the area. Any future land based operations or development will be dealt with in accordance with Part 4 of the EP&A Act.

*Conclusion*

The risk of existing land based infrastructure being significantly impacted by activities associated with the construction and operational stages of the proposed modification is considered to be 'negligible'.

### 8.1.5 Structural Integrity and Stability – Sea Pen Infrastructure

The MARL EIS outlined that the innovation in the development of modern sea pen systems had been substantial in recent years, particularly with the movement of farms offshore into high energy areas rather than sheltered inshore locations.

The proposed modification is based around the utilisation of the latest innovative engineering knowledge which was not available at the time of writing the Pisces or MARL EIS's. The principal structure type will remain consistent with the Pisces and MARL EIS's i.e. floating collared sea pens, which will be secured using an anchoring and bridle (mooring) system. The selection of mooring system components and layout has been specifically designed for Providence Bay. The proposed feed barge on the leases would be moored using similar anchoring and bridle systems.

Huon Aquaculture has installed a wave/current buoy in Providence Bay near the lease areas. The wave/current buoy continuously records wave height and direction; and current speed and direction at 1 metre depth intervals down to 30 metre depth. The buoy has been collecting data since December 2015. This data will be correlated with the Bureau of Meteorology prevailing wind speed, direction and barometric pressure by Huon's mooring design consultants. This provides a "back-cast" from the historical weather data of wave heights, current speeds and directions so that the mooring designs are based on the worst conditions encountered locally. This data will then be referred to international anchorage modellers to design appropriate anchorage systems for the modification sites.

The data collected so far indicates that the location has similar characteristics to Storm Bay in Tasmania where the proposed Fortress pens are currently in use. A shark monitoring device to detect tagged sharks was also installed on the buoy.

The inspection and maintenance procedures described in the MARL EIS and consent will be implemented as part of the modification i.e. Structural Integrity and Stability Monitoring Program.

*Conclusion*

The risk of the structural integrity and stability of the sea pen and feed barge infrastructure being significantly impacted (i.e. becoming dislodged or compromised in any way) by severe weather is still thought to be 'low' when installed as per the

loading analysis and maintained through a Structural Integrity and Stability Monitoring Program as outlined in Appendix 2 of the MARL EIS.

### 8.1.6 Climate Change and Coastal Processes

Waves travelling from deep water to the shallower areas may be transformed by the processes of refraction, shoaling, attenuation, reflection, breaking and diffraction (Demirbilek, 2002). At the depth of the proposed leases (38 to 43 m), the wave transformation processes may include refraction, shoaling, diffraction and reflection.

The MARL EIS identified that as the sea pen and feed barge infrastructure will not significantly impede the path of waves or currents as it is not a solid obstruction but an open structure of mesh nets and mooring infrastructure consisting of ropes and chains that are secured to the seafloor using a system of anchors. The sea pen infrastructure of the proposed modification is principally the same as that in the Pisces and MARL EIS's and approvals.

Concerns about the impact of climate change on the operation of the modification leases and species would remain unchanged to that outlined in the MARL EIS.

*Conclusion*

The risk of coastal processes and water flow being significantly impacted by the installation of the proposed sea pen and feed barge infrastructure is still thought to be 'negligible' when considered in context with the streamline and flexible design of the infrastructure, the pens and barges are floating, the regular cleaning regime that will be implemented and the deep water locality away from geomorphological formations. The impact of climate change on the operation of the modification leases is also thought to be 'negligible' when considered in context with the proposed sea pen and barge design and the species that will be cultured.

### 8.1.7 Navigation and Interactions with Other Waterway Users

The proposed location for the modification leases is in the open marine waters of Providence Bay and not in any recognised navigation channels or shipping port approaches.

The leases are not in a recognised SCUBA diving site or significant commercial or recreational fishing ground and should not adversely impact yachting regattas held in the region.

The proposed modification lease sites are however, located in a part of Providence Bay that may be utilised by recreational and commercial vessels travelling to Broughton Island or dolphin/whale watching operators that venture north of Cabbage Tree Island. However, the proposed modification leases do not pose an impediment to vessels travelling through this area and have been aligned to mitigate any impact to boating traffic traversing from Port Stephens to Broughton Island.

The proposed modification lease sites are contained within the Habitat Protection Zone of the Port Stephens Great Lakes Marine Park. This zone only permits commercial fishing activities using line and trapping of fish and lobster harvesting with restrictions. These commercial activities are generally associated with reef areas. The proposed lease sites however, are located over sandy substrate so the modification should not significantly impact on commercial fishing activities.

Recreational fishing in the proposed sites may include occasional drift fishing for flathead and potentially fishers targeting large pelagic species like Marlin. However, as outlined in the MARL EIS the proposed leases would only occupy a very small proportion of the suitable habitat for this activity. Also, the area of the current leases which is closer to Port Stephens would become available again for this activity.

Recreational fishers tend to predominately target species associated with reef systems in the locality. The proposed lease sites are located over sandy substrate and therefore should have no significant impact on key recreational fishing sites in Providence Bay (Figure 13).

Tourist operators using the area for whale watching or dolphin swimming will still have abundant navigable waters. Experience in other parts of Australia has demonstrated a positive link with aquaculture operators and tourism. The two proposed lease areas will only occupy about 1.5% of Providence Bay.

As outlined in the MARL EIS, waterway user groups will be informed about general boating rules in the vicinity of the leases and will be strongly recommended against passing and anchoring in the immediate vicinity of the sea pen infrastructure. The extremities of aquaculture leases and the moored feed barges will be marked with

appropriate navigational marks in accordance with NSW Roads and Maritime Services (NSW RMS) requirements and IALA recommendations.

The Australian Hydrographic Office would also be notified of the location of the modification lease sites, a 'Notice to Mariners' will be issued and official charts will be amended. NSW RMS will also be notified of the lease locations so relevant publications and maps can be amended to include their location.

A Traffic Management Plan will be implemented to minimise and monitor any impacts on navigation and other waterway users during the construction and operational stage.

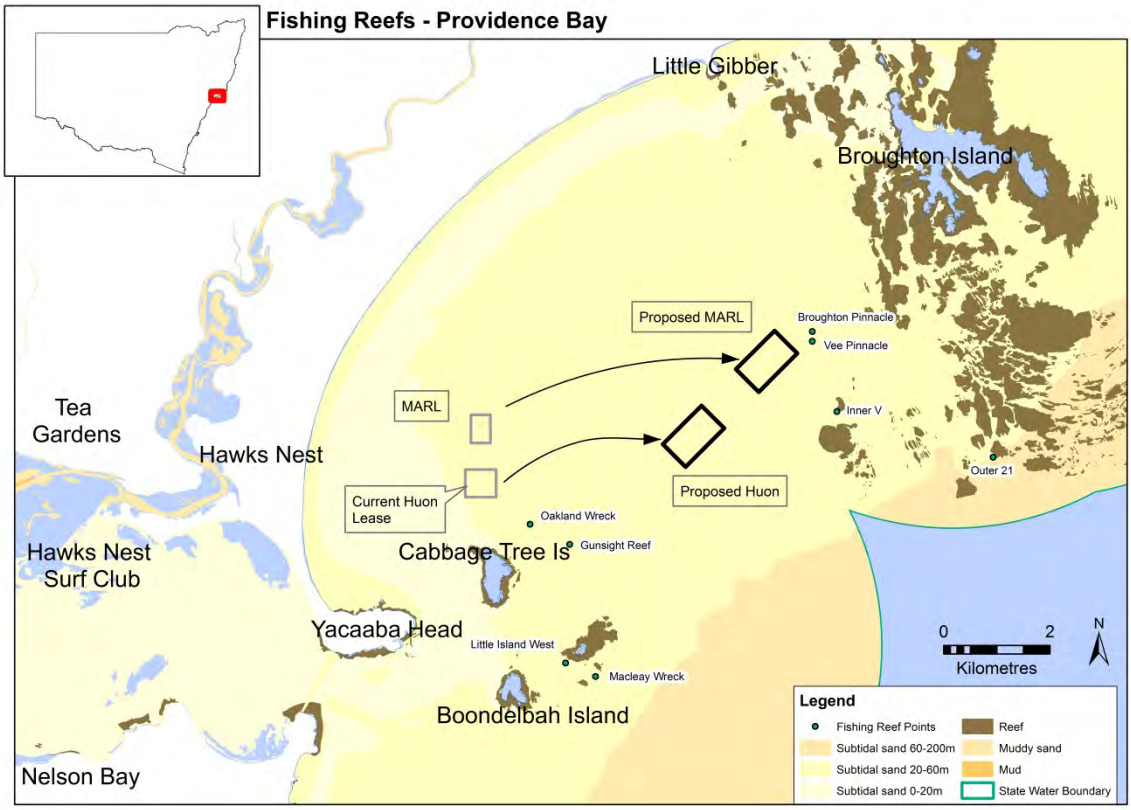


**Figure 13: Recreation fishing reefs in relation to proposed lease sites (Source: NSW DPI, 2015).**

*Conclusion*

The risk of safe navigation and other waterway users being significantly impacted by the proposed modification and its operation is considered to alter from 'negligible' to 'low' due to vessels travelling to Broughton Island requiring to 'keep watch' and

possibly diverge slightly from a straight line transit line. However, the leases are not located in a high use area, they are not obstructing safe navigation, they are not located in an area of significant recreational or commercial importance and the area is not unique in the direct or wider study area. In addition, appropriate navigational marks will be displayed, notifications will be made to relevant authorities and the community, amendments will be made to relevant documents, lease operational staff will act in accord with the Australian Aquaculture Code of Conduct (See Appendix 7 of MARL EIS) and waterway user interactions will be regularly reviewed.

## 8.2 OPERATIONAL RISKS

### 8.2.1 Impacts on the Community

#### 8.2.1.1 Visual Amenity and Odours

The MARL EIS identified that the lease infrastructure would pose a negligible risk on the visual amenity of the region. The proposed modification is looking to move the currently approved Huon and MARL aquaculture leases further offshore.

The residential area of Hawks Nest is predominantly screened from view by coastal sand dunes along the beach front. There are two major land based vantage points in the region with high visitor numbers from which persons may be able to view the sea cage infrastructure, including the summit of Mount Tomaree and Hawks Nest Surf Lifesaving Club. The Summit of Mount Tomaree is located at a distance of about 5.5 and 6.4 km from the current approved lease sites. The proposed modification lease sites would see the distances increasing to approximately 8.7 km for the proposed Huon site and 10.6 km for the proposed MARL site with Cabbage Tree Island obscuring the view of the leases.

The distance from the Hawks Nest Surf Lifesaving Club and car park would increase from the current approved lease sites of 3.5 km to approximately 7.0 km for the proposed Huon site and 8.6 km for the proposed MARL site.

The principle design features outlined in the MARL EIS for the sea pens would be utilised to minimise the visibility of the sea pen infrastructure including the feed barge. This includes the use of dark coloured materials, minimising and streamlining

surface infrastructure, maximising subsurface infrastructure and maintaining a low profile design.

The high energy environment of the proposed modification sites will result in the infrastructure not being clearly visible in the distance from these vantage points except during calm and clear weather conditions.

Potential odour issues associated with the proposed modification leases will be managed as described in the MARL EIS and associated EMP.

*Conclusion*

The risk of the visual amenity of Providence Bay being significantly impacted by the proposed modification is still considered to be 'negligible' due to the distance from key landmarks, the sea pen and barge design features that will be utilised, the use of vessels that are similar to existing boats in the area and the high energy sea state conditions that are characteristic of Providence Bay. The risk of the proposed modification significantly increasing odour levels in Providence Bay is also still considered to be 'negligible'.

#### 8.2.1.2 Marine Vessel and Vehicular Transport

*Marine Vessel Transport*

During the operational stage for the current approved leases, the marine vessel movements are expected to be in the range of one to three return trips per day. Consequently, the impacts of which were considered to be negligible when compared to the overall number of vessel movements in and around Port Stephens.

The use of the Newcastle Port facilities for pen construction and some other operational matters along with the installation of a feed barge as part of the sea pen infrastructure, would greatly reduce the vessel movements each day by up to two return trips. The feed supply trips are likely to be only once a week under the proposed modification.

A Traffic Management Plan will be implemented throughout the operational stage to ensure service vessels associated with the modification do not cause congestion, impede safe navigation or have any other impact on other waterway users (Appendix 2 of MARL EIS).

*Conclusion*

The risk of the marine vessel transport associated with the proposed modification leases having a significant impact on other recreational or commercial waterway users via impeding safe navigation and/or access to wharf, mooring and jetty facilities is still considered to be 'negligible'.

*Vehicular Transport*

The number of vehicular movements during the operational stage is likely to drop from two to four trips per week to about one to two trips. More frequent trips were required with the current leases to supply feed, facilitate net changes and transport harvested stock but this would decrease due to the proposed use of feed management systems (in pen hoppers and/or barge) and *in situ* cleaning of culture nets. Also, these movements are likely to be relocated from Nelson Bay Marina to the Port of Newcastle which is better equipped to handle large truck movements. This would result in a decrease in the potential impacts associated with the current approved aquaculture operations.

The wharf facilities at PSFI and the Nelson Bay Commercial Fishermen's Co-operative are still suitable for transferring some materials and providing services but will be limited to small scale operations.

*Conclusion*

The potential risk of the vessel and vehicular traffic associated with the proposed modification having a significant impact on other waterway and road users is considered to be 'negligible'. This risk is considered to decrease with the proposed modifications due to the deployment of feed management systems (in pen hoppers and/or barge) and *in situ* net cleaning which would reduce vessel and vehicular traffic.

#### 8.2.1.3 Aboriginal and European Heritage

*Aboriginal Heritage*

During the preparation of the Pisces and MARL EIS's, information and data on Aboriginal heritage in the Port Stephens region was sourced from literature, previous heritage studies, field investigations, database searches and community

consultation. There was no record of any detailed archaeological investigations of the seabed in Providence Bay and this is considered to be largely due to the mobile nature of the sandy seabed and strong current flows in this region which would hamper such investigations.

The proposed modification leases are located further offshore in a high energy marine environment with a depth ranging from 38 to 43 m over a seabed composed of mobile sands. The mobile nature of the sandy seabed and strong current flows in this region are considered to hamper further investigations.

NSW DPI has consulted with the Worimi Local Aboriginal Land Council (WLALC) regarding the proposed relocation of the leases. No concerns were raised about potential impacts of the proposed modification leases on known culturally significant sites. The matter of a land claim by the WLALC over a portion of Providence Bay was raised and discussed during consultation. However, the proposed modification leases are located outside of the current WLALC's land claim area.

*European Heritage*

A survey of the seafloor beneath the area proposed for the proposed modification leases was undertaken by NSW OEH in early 2015. No large objects that may be considered to be European heritage items were identified during the swath acoustic survey.

*Ship and Plane Wrecks*

A desktop review of ship and plane wrecks known or potentially occurring in the direct study area was undertaken for the Pisces and MARL EIS's. This review identified the presence of the *SS Oakland* and *SS Macleay* shipwrecks in Providence Bay. These wrecks are located approximately 1 to 3.8 km respectively from the approved Huon Lease and approximately 1.7 to 5 km from the approved MARL Lease. The modification would result in the proposed Huon Lease being about 2.9 to 4.3 km from the shipwrecks and the proposed MARL about 4.8 to 6.2 km from these sites (Figure 14). The plane wreck is reportedly located about 8 to 11 km from the proposed modification leases.

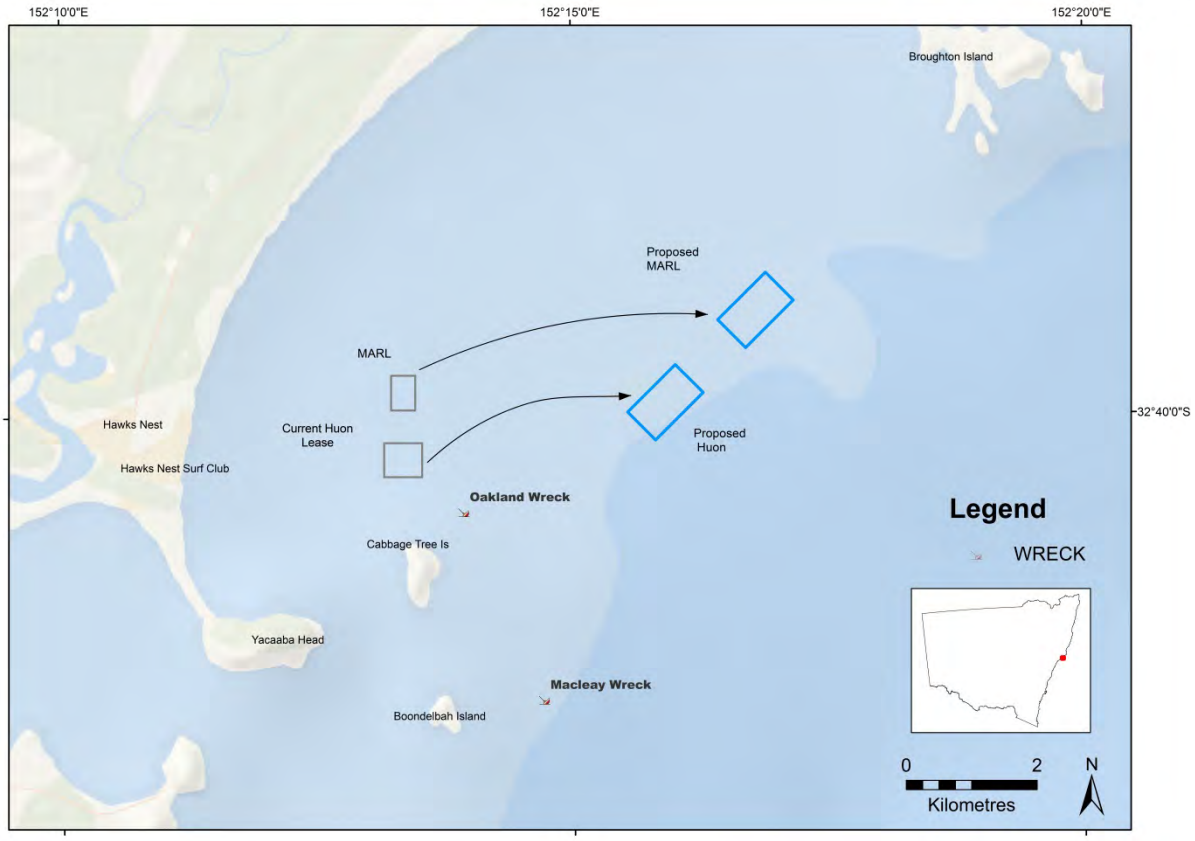


**Figure 14: Heritage sites (shipwrecks) in relation to proposed leases (Source: NSW DPI, 2015).**

The shipwrecks are used as recreational dive sites and the overall increase in distance of the proposed leases would assist in mitigating the perception of the aquaculture leases increasing shark interactions on dive sites.

*Conclusion*

The risk of the proposed modification having a significant impact on Aboriginal and European heritage items and/or areas near or in Providence Bay is still considered to be 'negligible'.

### 8.2.1.4 Noise

The principal source of noise in Providence Bay is generated by the sea state conditions and vessels movements undertaken by existing waterway users. The distance of the proposed modification leases from the nearest residential area, the sea state, wind conditions and existing background noise will ensure the attenuation of any noise generated by service vessels and associated operational and maintenance activities.

An online modelling program used for noise calculations in the MARL EIS (Web Reference 3) indicated that the noise from the feed barge (67.2 dB) if used on the current MARL Lease would be less than 1 dB at Hawks Nest. Relocation of the leases further offshore at distances of about 7.5 km (Huon) and 9.1 km (MARL) would result in the feed barge noise being indistinguishable against background noise. Figure 15 provides an overview of noise levels (dB) emitted by common sources to provide a comparative to the noise emitted from the operation of the leases.

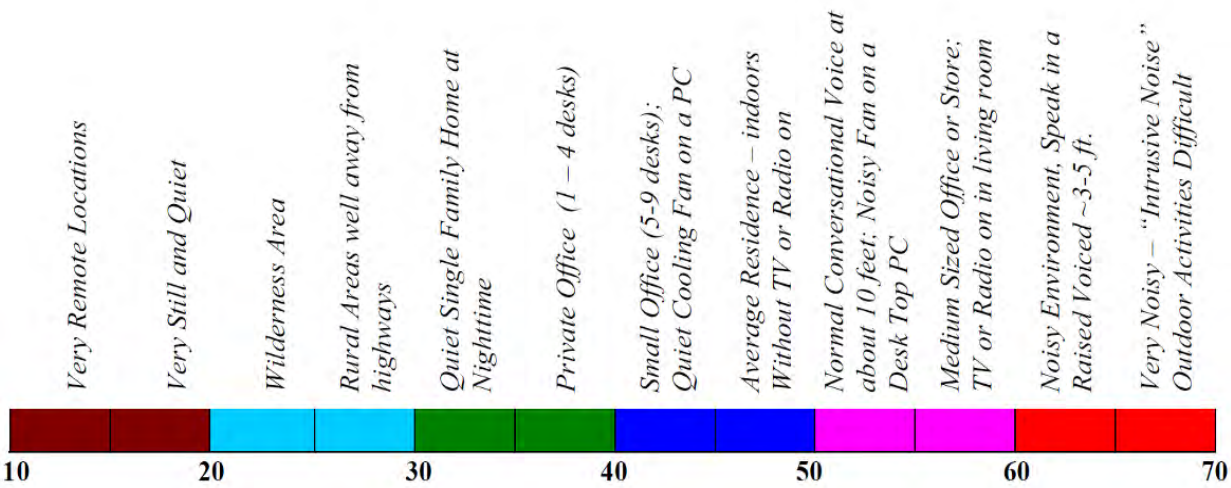


**Figure 15: Examples of noise levels (dB) emitted by common sources (Source: Ray, 2010).**

The modelling results suggest that the noises associated with the daily operation of the leases are likely to be difficult to hear from nearby beaches and residential areas of Hawks Nest.

NSW OEH is responsible for the regulation of noise from activities scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act). The *POEO (Noise Control) Regulation 2008* also sets certain limits on noise emissions from vessels, motor vehicles and domestic use of certain equipment (Web Reference 4). This Act and Regulation will be consulted throughout the operational stage for both leases to ensure compliance with all relevant provisions (Web Reference 4).

Industry best practices for noise management will be employed during the operation of the proposed modification leases to minimise the impacts of noise on surrounding communities. Some examples of industry best practices include:

- Keeping all marine vessel motors well maintained and in good condition;

- Fitting sound suppression devices (e.g. mufflers) on equipment where possible;
- Reducing boat speed near sensitive areas;
- Complying with any directions of authorised NSW Maritime officers;
- Acknowledging complaints and aiming to resolve them cooperatively;
- Minimise noise and use courteous language in the vicinity of residential neighbours and other waterway users;
- Maintain good communication between the community and project staff; and
- Ensure truck drivers are informed of designated vehicle routes, parking locations, acceptable delivery hours or other relevant practices e.g. no extended periods of engine idling and minimising the use of engine brakes.

*Conclusion*

The risk of the noise associated with the operation of the proposed modification leases having a significant impact on surrounding communities is still considered to be 'negligible' when considered in context with the distance from residential areas and the implementation of industry best practices.

#### 8.2.1.5 Adjacent Aquaculture Lease

The currently approved Huon and MARL aquaculture leases are located approximately 500 m apart mitigating potential navigational and environmental impacts.

A buffer distance of approximately 1 km is proposed between leases as a result of the modification application to provide an adequate buffer between the leases for recreational and commercial vessels, as well as vessels installing and/or removing large components (e.g. floating double collar sea pens). In addition, this buffer distance will mitigate any potential cumulative water quality, health management, biosecurity or benthic impacts associated with either lease along with the policies, plans and protocols outlined in the MARL EIS and approvals to be implemented across both sites. The increased distance between the leases will also mitigate any potential impacts associated with navigation and vessel movements.

*Conclusion*

The risk of the proposed modification leases having a significant impact on each other is still considered to be 'negligible' when considered in context with the 1 km buffer zone between the leases, the installation of the navigational buoys that will clearly delineate the leases and the policies, plans and protocols that will be implemented.

#### 8.2.1.6 Work Health and Safety

There are a number of potential WH&S hazards associated with the construction, deployment and operation of aquaculture leases. The main hazards identified include SCUBA diving, construction and deployment activities, service and maintenance activities, navigation issues, use and storage of chemicals, contamination of feed, stock and the environment, and waste disposal. These matters were addressed in the Pisces and MARL EIS's.

To mitigate potential WH&S risks of operating in an offshore environment, the proposed modification sea pens have incorporated modern safety features. The flat, slip resistant, enclosed walkway of the new pens provides a safer and more stable work platform for farm workers particularly in bad weather. Seals are also unable to access the walkways, reducing the likelihood of aggressive seals interacting with employees.

The Pisces and MARL EIS's outlined a number of WH&S risk mitigation measures such as ensuring staff and contractors have relevant qualifications and undergo a WH&S induction program, as well as the development of a WH&S Management Plan. These measures would be implemented as part of the proposed modification.

For personal safety, recreational boaters, fishers, spear fishermen and divers should remain outside the proposed modification leases which will be delineated by yellow cardinal markers. Under the FM Act it is an offence to interfere or damage anything within a lease. It is proposed to investigate the opportunity to provide moorings for recreational fishers on the extremities of the proposed lease areas.

*Conclusion*

The risk associated with WH&S matters during the construction, deployment and operational stages of the proposed modification leases is still thought to be 'low'

when considered in context with the proposed mitigation measures as outlined in the MARL EIS.

#### 8.2.1.7 Economics

The Pisces and MARL EIS's outlined a number of direct and indirect benefits to the regional economy of Port Stephens.

Direct employment opportunities include staff and/or contractors for construction, transportation and deployment of the sea cage infrastructure, including construction workers, welders, crane operators, skippers, deckhands, observers, truck drivers and structural engineers. Staff and contractors will also be required for service, maintenance and hatchery activities, including commercial divers, skippers, deckhands, technicians, truck drivers, research scientists, veterinary doctors and support staff.

Once fully operational the leases are expected to result in approximately 25 full-time equivalent positions.

The direct economic benefits to the local economy includes the purchase of goods, such as fuel and materials, and use of services, such as vessel and vehicle servicing, as well as accommodation and food services for visiting personnel.

Huon has established a valued place in the communities that they operate in and are committed to open communication and feedback. Examples of their transparency include; a Sustainability Dashboard on their website; farm open days (attended by 3-5000 locals and visitors; and active engagement with environmental non-governmental organisations (ENGOs) and other stakeholders including tourism operators. For example, Huon in Tasmania is providing access to pen infrastructure and on-site staff experts to answer questions from tourists on locally operated tourist vessels and providing educational videos for tourist operators.

The increased distance of the proposed modification leases offshore should not result in a significant impact on the dolphin and whale watching businesses that may use the area of Providence Bay. Existing Tasmanian eco-tourism ventures in both of Huon's existing operating regions operate in harmony with its fish farming activities.

The purpose of the MARL is to expand the land based research trials of specific finfish species and to investigate the economic viability of culturing these species in offshore sea pens in NSW waters.

*Conclusion*

The risk of the proposed modification leases having a negative impact on the regional economy of Port Stephens is still thought to be 'negligible' when considered in context with the fact that aquaculture has been a catalyst for economic development and has benefited many tour operators across Australia.

### 8.2.2 IMPACTS ON THE ENVIRONMENT

#### 8.2.2.1 Water Quality, Nutrients and Sedimentation

*Site Selection*

The proposed modification leases have similar characteristics to the approved Huon and MARL leases. Visual interpretation of acoustic backscatter and hillshaded bathymetry data indicate that the seafloor in the survey area consists of relatively homogenous soft sediment (most likely sand) with a depth ranging from 38 to 43 m.

*Waste Inputs*

Worldwide there is extensive literature on the impacts of marine finfish aquaculture inputs on the marine environment (de Jong & Tanner, 2004). A risk assessment conducted by SARDI on marine finfish aquaculture revealed that the impacts of fish faeces and uneaten feed on water quality and sediments were perceived to be the most important issues for the industry in South Australia (de Jong & Tanner, 2004).

The main types of waste inputs into the marine environment from sea cage aquaculture include residual food, faecal matter, metabolic by-products, biofouling and therapeutics (Pillay, 2004). The production of faecal matter and metabolic by-products obviously depends on stocking densities and the digestibility of feed while the input of residual food and therapeutics is dependent on operational practices. The input of this organic matter can cause changes to the physical, chemical and biological characteristics of the receiving marine environment (Aguado-Gime'nez & Garcia-Garcia, 2004).

The main types of waste inputs into the marine environment from the proposed modification leases would be consistent with that identified in the Pisces and MARL EIS's for the currently approved sites.

However, the proposal to utilise feed barges on the modification leases has the potential to reduce wastes from uneaten feed. The technology employed in the proposed feed barges incorporates the use of electronic underwater monitoring of fish feeding behaviour and monitors the feed pellets within the sea pens. If feeding activity is reduced the barges have the ability to reduce feed output or if feed is identified as not being eaten it will cut the supply of feed. The current approved manual feed blower systems rely on the operator's ability to identify from the surface the fish feeding activity and has no ability to identify if pellets are not being eaten. The feed barge feeding systems significantly reduces the magnitude of the impact on the environment due to uneaten feed.

*Dissolved Nutrients*

The use of the larger sea pens on larger lease areas will result in a decrease in the nutrient concentrations leaving the lease sites as shown in the following calculations.

*Water Exchange Calculations*

The approximate dimensions of the proposed modification lease are about 602 x 1029 m with the longest distance running in a north south direction. The proposed leases will be located in water with a depth ranging from 38 to 43 m. The water current in the locality predominately runs in a north south direction at about 0.1 m/s.

To undertake the calculations for the daily volume of water that passes through the proposed leases the length of 1029 m and the minimal depth of 38 m has been used.

- Water current @ 0.1m/sec = 6 m/min = 360 m/hr = 8640 m/day
- Water current (m/day) / longest dimension of MARL Lease (m) = number of times water will be exchanged per day:
    - 8640 / 1029 = 8.4 times/day
- Volume of the MARL Lease = length x width x height (m)
    - 1029 x 602 x 38 = 23,539,404 $m^3$
        - 23,539,404 $m^3$ x 1000 L = 23,539,404,000 L = 23,539.4 ML

- Volume of the MARL Lease (L) x number of exchanges per day = water exchanged through MARL Lease (L/day)
    - 23,539.4 ML x 8.4 = 197,731 ML/day

*Nitrogen Concentration Calculations*

The MARL EIS identified that the total nitrogen (assumed dissolved) output per tonne of fish produced per year was about 145.69 kg. The maximum standing biomass on the approved leases is 998 tonne. The proposed modification is also requesting to have the ability to amend the standing biomass to 1200 kg which would be subject to the monitoring outcomes for the 998 tonne standing biomass. The above nutrient output and maximum standing biomass has been used in the following calculations.

*Nitrogen Load*

- Maximum standing biomass (t) x dissolved nitrogen per tonne of stock (kg) = dissolved nitrogen (kg per year)
    - 998 x 145.69 = 145,398 kg N/year
    - 1200 x 145.69 = 174,828 kg N /year
        - 145,398 / 365 = 398.4 kg N/day
        - 174,828 / 365 = 478.98kg N /day

*Concentration of Nitrogen*

- Dissolved nitrogen (µg/day) / water exchanged through MARL Lease (L/day) = dissolved nitrogen leaving proposed modification leases each day (µg/L)
    - 398,400,000,000 / 197,731,000,000 = 2.01 µg/L dissolved N per day
    - 478,980,000,000 / 197,731,000,000 = 2.42 µg/L dissolved N per day

*Phosphorus Concentration Calculations*

The MARL EIS identified that the total phosphorus (assumed dissolved) output per tonne of fish per year was 47 kg. The above nutrient output and maximum standing biomass has been used in the following calculations.

*Phosphorus Load*

- Maximum standing biomass (t) x dissolved phosphorus per tonne of stock (kg) = dissolved phosphorus (per year and day)
    - 998 x 47 = 46,906 kg P/year
    - 1200 x 47 = 56,400 kg P/year
        - 46,906 / 365 = 128.5 kg P/day
        - 56,400 / 365 = 154.52 kg P/day

*Concentration of Phosphorus*

- Dissolved phosphorus (µg/day) / water exchanged through MARL Lease (L/day) = dissolved nitrogen leaving MARL Lease each day (µg/L)
    - 128,500,000,000 / 197,731,000,000 = 0.65 µg/L dissolved P per day
    - 154,520,000,000 / 197,731,000,000 = 0.78 µg/L dissolved P per day

The trigger values for nitrogen, total phosphorus, ammonium and oxides of nitrogen in a slightly disturbed marine ecosystem according to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* are provided in Table 4 (ANZECC and ARMCANZ, 2000). These values provide a guideline by which to assess the impact of the proposed modification on water quality in Providence Bay.

Prichard *et al*. (2003) found that the surface waters of south eastern Australia typically have an oxidised nitrogen content of 10 µg/L and a reactive phosphorus content of about 8 µg/L while the deeper nutrient rich waters typically have an oxidised nitrogen content of 70-140 µg/L and a reactive phosphorus content of 20-25 µg/L. The natural concentrations of nitrogen and phosphorus in seawater constantly fluctuate depending on climatic conditions, ocean currents, occurrences of local upwellings and discharges from adjacent land catchments.

The potential maximum nutrient levels in the water leaving the proposed modification leases have been estimated to be 2.01 -2.42 µg/L of nitrogen and 0.65 -0.78µg/L of phosphorus. These concentrations are considerably lower than the typically natural background concentrations for oxidised nitrogen of 10 µg/L and reactive phosphorus of about 8 µg/L. The combination of the estimated nutrient contributions of the proposed modification leases and the natural background concentrations is also

lower than the trigger values recommended in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (2000). Therefore, it is considered unlikely that the operation of the proposed modification leases will have a significant cumulative impact on nutrient levels or water quality in Providence Bay or the surrounding region.

**Table 3: The default trigger values for water quality parameters according to the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and the estimated values for nutrient inputs into Providence Bay associated with the proposed leases. TN = total nitrogen and TP = total phosphorus.**

| | **TN** µg $L^{-1}$ | **TP** µg $L^{-1}$ |
|---|---|---|
| **ANZECC & ARMCANZ Guidelines** | 120 | 25 |
| **Estimations for 998 standing biomass** | 2.01 | 0.65 |
| **Estimations for 1200 standing biomass** | 2.42 | 0.78 |

It should be noted that the nutrient calculations for the proposed modification were based on a worst case scenario. To validate the modelling, water sampling would be undertaken to test the nutrient concentrations in both background and proposed modification lease waters at an appropriate scale in order to test the nutrient outputs from the leases. This sampling would commence on the proposed Huon modification lease once sea pens are stocked at commercial levels.

*Therapeutics*

Therapeutics may need to be used to treat cultured stock for disease, control pests (e.g. parasites) or assist with the handling and transfer of fish. Based on the experiences of other offshore aquaculture operations, the proposed modification leases would have a reduced need to use chemicals (See Section 8.2.2.3 – Chemical Use).

*Mitigation Measures*

Mitigation measures including a Water Quality and Benthic Environment Monitoring Program as outlined in the Pisces and MARL EIS's and consents, will be implemented as part of the proposed modification.

*Conclusion*

The risk of the proposed modification having a significant impact on marine habitats in Providence Bay and the wider region is still thought to be 'low' when considered in context the high energy environment of Providence Bay, the use of the technologies associated with the feed barge, the Water Quality and Benthic Environment Monitoring Program and the implementation of a range of daily operational and maintenance procedures that minimise dissolved and particulate waste inputs.

Overall however, the risk of the proposed modification having a significant impact on marine habitats is still considered to be 'moderate' due to the uncertainty about many factors such as feed type, variations due to differing species, how different marine communities will respond and the influence of the NSW high energy coastal environment.

#### 8.2.2.2 Fish Feed – Source, Composition and Sustainability

As outlined in the MARL EIS, one of the primary objectives of the approved MARL is to evaluate and further develop the dietary development research undertaken in small controlled research tanks at PSFI. This work will continue as part of the proposed modification for the MARL lease and allow the research to be undertaken under current commercial best practice.

*Conclusion*

The risk of fish feed used during the operation of the proposed modification leases having a significant impact on wild fish stocks in Australian and international waters by means of increasing the demand for bait fish and trash fish is still thought to be 'low'.

#### 8.2.2.3 Chemical Use

Worldwide, a range of chemicals are used in aquaculture for the purpose of transporting live organisms, in feed formulation, health management, manipulation and enhancement of reproduction, for processing and adding value to the final product (Douet *et al*., 2009).

As outlined in the Pisces and MARL EIS's, some chemicals and therapeutics (i.e. veterinary pharmaceuticals) are used in accordance with the Australian Pesticides

and Veterinary Medicines Authority (APVMA) to manage disease, control pests, fish handling, post-harvest transportation and euthanizing fish.

The proposed modification includes relocation of the Huon and MARL Leases further offshore into deeper waters. Recent research undertaken on moving Southern Bluefin Tuna (SBT) sea pen aquaculture further offshore has found a significant effect on the health and performance of this species. SBT ranched further offshore when compared to SBT ranched in the traditional near shore environment, had superior health, an enhanced survival rate and an increased condition index at 6 weeks of ranching. The offshore cohort had no signs of a *C. forsteri infection* and a 5% prevalence of a *Caligus* spp. infection compared to a prevalence of 85% for *C. forsteri* and 55% for *Caligus* spp. near shore at 6 weeks of ranching (Kirchhoff, 2011).

The reduced incidence of parasites results in less stress on the stock and therefore a better feed conversion ratio, which in turn results in fewer nutrients entering the environment. In addition, less veterinary chemicals are required to treat the fish which further reduces the potential of chemicals entering the environment and the probability of resistance issues.

*Conclusion*

The risk of chemicals used during the operation of the proposed modification leases having a significant impact on the marine environment and/or the surrounding communities is still thought to be 'low' when considered in context with the APVMA and licensed veterinarians regulating chemical use, the infrequent treatments, the low doses used, the regular investigations into safe treatment concentrations and methods and the use of liners. However, the overall risk for chemical use associated with the proposed modification leases is considered to be 'moderate' due to the current knowledge base on ecotoxicity, degradation rates and the potential impacts of chemicals in the NSW coastal marine environment.

#### 8.2.2.4 Genetics and Escapement

Loss of genetic diversity is a potential concern if escapees establish breeding stocks in the wild and cross breed with wild populations (Pillay, 2004). The genetic integrity

of wild stocks is most at risk when farmed fish originate from broodstock outside the range of the local genetic population.

As outlined in the Pisces and MARL EIS's and consents, the fingerlings produced for the Huon and MARL Leases will be derived from broodstock that has either been collected from stocks local to the marine farming activity or from the same recognised genetic population. Broodstock will be collected from local genetic populations in sufficient numbers to ensure that the genetic diversity of the fingerlings produced for stocking is not compromised.

In addition, the proposed sea pens with their added predator exclusion features will mitigate predator interactions, which in turn will reduce the opportunity for fish to escape from damaged pens (See Appendix A).

The use of *in situ* net cleaning technology also removes the requirement to routinely change the nets for cleaning which prevents fish loss during this process. Fish escapement during net changing can be as a result of direct escapes if a mistake is made in the procedure and/or timing of tasks; predator attack when the configuration of the net is temporarily compromised to allow for net removal; or due to damage to the new net during installation. The use of the new Fortress pens and *in situ* net cleaning technology will reduce the risk of escapements.

*Conclusion*

The risk of cultured stock having a significant impact on the genetic integrity of wild populations, competition and predation levels and/or food chains is still thought to be 'low' when considered in context with using broodstock that will be sourced locally or from the same genetic population, the use of breeding techniques that will ensure genetic integrity, the poor survival skills of cultured stock, use of the new Fortress pens, use of *in situ* net cleaning technology and the policies, procedures and plans from the Pisces and MARL EIS's and approvals which would be carried over as part of the modification.

#### 8.2.2.5 Disease and Introduced Pests

A wide variety of disease causing organisms and parasites exist worldwide (de Jong & Tanner, 2004). Disease is not just the result of the pathogen itself but a complex interaction between the pathogen, the aquatic animal and the environmental

conditions (PIRSA, 2002). Pathogens types include parasites, fungi, bacteria and viruses, which usually infect fish when their immune system is depressed, the epidermis is damaged and/or succeeding periods of severe stress caused by factors such as poor water quality or rough handling (Barker *et al.,* 2009).

However, strict health monitoring programs help to ensure early identification of pathogens so appropriate management is implemented before severe infestations occur (PIRSA, 2003). The prevention of infections is generally much easier than control and can usually be achieved by careful handling, good husbandry practices and maintenance of water quality (PIRSA, 2003; Barker *et al.,* 2009). Also, cultured stocks are checked and declared healthy and free of diseases and parasites when they are transferred into sea cages so it is more likely that the initial transfer of pathogens is from wild to cultured stock (Bouloux *et al*., 1998; PIRSA, 2003).

There is no definitive evidence that marine aquaculture has caused an increase in the occurrence of 'native' pathogens in wild stocks according to de Jong & Tanner (2004).

The initial step in preventing the occurrence of diseases and parasites in aquaculture stocks starts with the production of quality disease and parasite free hatchery stock. This is accomplished through the implementation of strict hatchery procedures.

The hatchery disease management, translocation practices, sea pen management and emergency biosecurity plans, policies or procedures as outlined in the Pisces and MARL EIS's and consents would still be appropriate as part of the proposed modification.

The extra buffer distance and the recent research undertaken by Kirchhoff (2011) regarding moving sea pens further offshore has the potential to reduce the incidence of diseases, parasites and pests.

*Conclusion*

The risk of the proposed modification having a significant impact on the occurrence of pathogens in wild populations is still thought to be 'low' when considered in context with the implementation of a Disease, Parasite and Pest Management Plan, which includes guidelines and protocols for surveillance regimes and monitoring, the implementation of strict husbandry practices, the reporting of notifiable aquatic

diseases, the relocation further offshore, and the removal of biofouling as outlined in the MARL EIS.

However, due to limited information on the risks of pathogens and pests associated with sea pen farms in Australian waters, a 'moderate' risk ranking is still considered the most appropriate until further research is conducted on the issue.

#### 8.2.2.6 Artificial Lights

Artificial lights have been raised as a potential issue associated with the Huon and MARL aquaculture developments in Providence Bay due to the perception that navigation and vessel lights may cause disorientation and stress to some species of seabirds and possibly impede their navigation abilities when returning to their nests on the offshore islands at night. Gould's petrels (*Pterodroma leucoptera leucoptera*), the little penguin (*Eudyptula minor),* wedge-tailed shearwaters (*Puffinus pacificus*), sooty shearwaters (*Puffinus griseus*), short-tailed shearwaters (*Puffinus tenuirostris*) and white-faced storm petrels (*Pelagodroma marina*) are among the species that breed on Cabbage Tree Island, Boondelbah Island and/or Broughton Island (DECCW, 2010a).

A range of studies have been conducted on the impacts of light pollution associated with street lighting, house lights, shopping centres and offshore oil rigs on wildlife (Verheijen, 1985; Rodriguez & Rodriguez, 2006).

Recent investigations suggest that the navigation abilities of the Gould's petrel are not impacted by maritime navigation lights but this species does become distressed when artificial lights are in close proximity to their breeding habitat (Y. Kim 2011, *pers. comm*.). However, these observations are not conclusive and it is recommended that any interactions between seabirds and the Huon and MARL leases are closely monitored to ensure that there are no adverse effects from the navigational marker or vessel lights.

The currently approved aquaculture lease sites are located about 2 km from Cabbage Tree Island and 4 km from Boondelbah Island. The proposed modification would see the aquaculture leases being located about 3.7 and 5.6 km from Cabbage Tree Island and approximately 5.1 and 7.0 km from Boondelbah Island.

If night operations are undertaken, lighting on service vessels will be restricted to interior and navigation lights, lights will be shielded to concentrate light downward specifically onto the work site and staff will navigate well away from Cabbage Tree Island when commuting to and from the Huon and MARL leases.

The only lighting that would be routinely visible at night would be legally required marker lights on cardinal buoys at the edge of the leases and a mast light (single white visible all-round at 2 nautical miles) on the feed barge. Any other barge lights will be shielded, concentrated downwards, turned off when not in use or shuttered at night. Reed *et al*. (1985) for example, found that the number of grounded petrels decreased by more than 40% on Kauai, Hawaii when lights were shielded to avoid upward radiation. Similarly, shielding and changing the frequency of lighting on oil rigs was found to reduce light pollution impacts on seabirds in the North Sea (Van De Laar, 2007).

**Figure 16: View of a feed barge (centre of picture and inserts) during day and night at 3.2 km (Source: Huon, 2015).**

In accordance with the MARL EIS and SSI-5118 consent, any interactions between seabirds and the proposed modification leases will be monitored to ensure that there are no adverse effects from the navigational marker or vessel lights as outlined in the Marine Fauna Interaction Management Plan in the MARL EIS – Appendix 2.

*Conclusion*

The risk of artificial lights used during the operation of the proposed modification having a significant impact on light sensitive species, notably the Gould's petrel and the little penguin, is still thought to be 'low' when considered in context with the distance from the offshore islands, the positioning of the leases away from residential areas, the use of low intensity flashing white strobe lights with a low profile and the measures that will be implemented to shield vessel lights at night.

#### 8.2.2.7 Entanglement and Ingestion of Marine Debris

The Key Threatening Process - entanglement and ingestion of marine debris, which is listed under the *Threatened Species Conservation Act 1995* and the *Environment Protection and Biodiversity Conservation Act 1999*, is potentially relevant to the proposed modification.

Entanglement refers to the process in which wild fauna become caught in the physical structures of mariculture facilities, including floating cages, anti-predator nets and mooring lines (McCord *et al*., 2008). Marine debris consists of raw plastics, packaging materials, fishing gear (nets, ropes, line and buoys) and convenience items and is sourced from ship waste, the seafood industry, recreational activities and both rural and urban discharges into rivers, estuaries and coastal areas.

Marine animals can become entangled in or ingest anthropogenic debris which can lead to a range of lethal and sub-lethal effects, such as reduced reproductive success, fitness, ability to catch prey and avoid predators, strangulation, poisoning by polychlorinated biphenyls, infections, blockages, increased drag, perforations and loss of limbs (Web Reference 5).

*Mitigation Measures*

The Pisces and MARL EIS's and consents contain a number of mitigation measures which will be implemented as part of the proposed modification measures to minimise the risk of entanglement and ingestion of marine debris, which include:

- Implementation of the Structural Integrity and Stability Monitoring Program;
- Implementation of daily operational and maintenance procedures that minimise the attraction of wild fish and other potential predators;

- Implementation of the Waste Management Plan;
- Implementation of the Marine Fauna Interaction Management Plan; and
- Implementation of the Marine Fauna Entanglement Avoidance Protocol.

In addition the design features of the new technologically advanced Fortress pens and the *in situ* cleaning of culture nets greatly reduces the potential for entanglement and generation of marine debris. The use of the feed barge on the leases will also reduce the potential for debris such as small feed bags entering the environment.

*Conclusion*

It is possible to virtually eliminate entanglement risks for marine predators by adopting appropriate design features such as that being proposed in this modification, being vigilant with gear maintenance and using appropriate feeding regimes. Hence, the risk of entanglement and ingestion of marine debris associated with the proposed modification is still thought to be 'low' when considered in context with the sea pen design features and the policies, procedures and plans outlined in the Pisces and MARL EIS's and consents which would be carried over into approvals.

#### 8.2.2.8 Animal Welfare

The proposed modification does not look to alter the potential animal welfare concerns associated with the transportation and culture of the stock from that outlined in the Pisces and MARL EIS's and consents.

The proposed modification MARL Lease will still be subject to the *Animal Research Act 1985* and covered by a current Animal Research Authority issued by an accredited Animal Care and Ethics Committee.

The transport and husbandry techniques and practices on both proposed modification leases will also still comply with the *Australian Aquaculture Code of Conduct* as outlined in Appendix 7 of the MARL EIS.

*Conclusion*

The risk of the proposed modification conflicting with NSW animal welfare requirements is still thought to be 'negligible' when considered in context with the obligations of the *Animal Research Act 1985* and the use of the *Australian Code of*

*Practice for the Care and Use of Animals for Scientific Purposes* and the *Australian Aquaculture Code of Conduct* and the *Guide to Acceptable Procedures and Practices for Aquaculture and Fisheries Research*.

#### 8.2.2.9 Vessel Strike and Acoustic Pollution

Vessels in Port Stephens waters consist of small recreational fishing boats, dive boats, dolphin and whale watching boats, luxury cruisers, commercial fishing trawlers and occasionally small passenger cruise ships. The number of vessels in Providence Bay and associated acoustic pollution levels vary according to weather conditions and seasons, where commercial and recreational vessel traffic is significantly greater over summer.

The use of a feed barge on the proposed modification leases will greatly reduce the number of vessel movements required to daily service the leases as identified in the Pisces and MARL EIS's. Consequently, the potential impact of vessel strikes and acoustic pollution will be reduced (See Section 8.2.1.2).

Vessels will still be required to adhere to NSW Roads and Maritime Services speed limits and slow down in sensitive areas. In particular, vessels will be restricted to a maximum speed of 25 knots in Port Stephens which is in accordance with current restrictions for commercial vessels operating in the port. In addition, the Observer Protocol outlined in the MARL EIS and approval would be employed for both of the proposed modification sites.

It should be noted that the permanently moored feed barge has been specially designed and manufactured to minimise noise pollution. The attached report shows the acoustic signature of an identical barge when operational.

*Conclusion*

The risk of the proposed modification having a significant impact on the occurrence of vessel strikes to marine fauna or acoustic pollution levels is still thought to be 'low' when considered in context with the small number of vessel movements and the mitigation measures that will be implemented as outlined in the Pisces and MARL EIS's and consents.

### 8.2.2.10 Threatened / Protected Species and Matters of NES

The assessments of significance for State and Commonwealth matters as well as matters of national environmental significance (NES) were undertaken as part of the Pisces and MARL EIS's. The location of the proposed modification leases are still primarily within the same general location of Providence Bay and therefore the assessments undertaken as part of the Pisces and MARL EIS's are still relevant to the proposed modification (Figure 17).

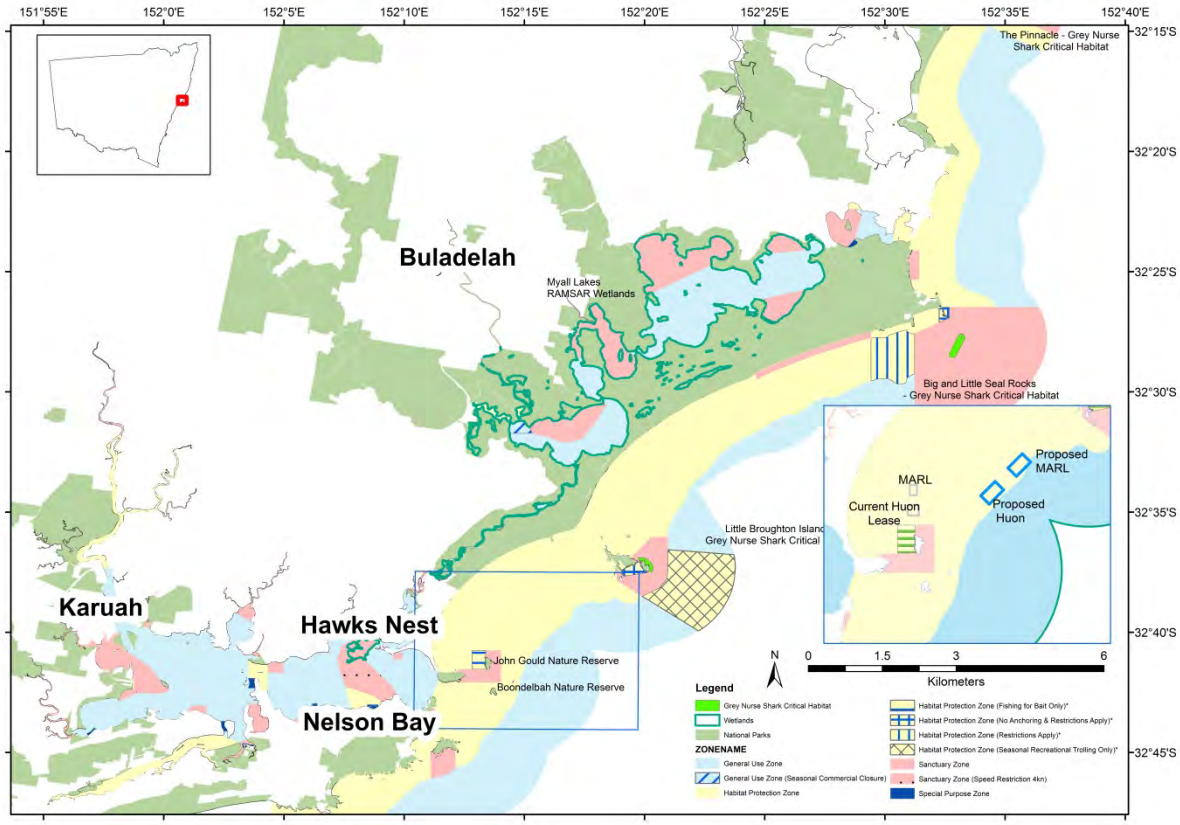


**Figure 17: Areas of conservation significance near and/or within Providence Bay (Source: NSW DPI, 2015).**

The MARL EIS contains detailed assessments of significance for State and Commonwealth matters as well as matters of national environmental significance.

*Conclusion*

The risk of the proposed modification having a significant impact on threatened species, protected species, matters of NES or any other matters protected under the EPBC Act is still thought to be 'low' when considered in context with the various mitigation measures that would be employed as outlined in the Pisces and MARL EIS's and consents.

#### 8.2.2.11 Migratory Pathways, Behavioural Changes and Predatory Interactions

*Migratory Pathways*

Humpback and southern right whales migrate between summer feeding grounds in Antarctica and warmer winter breeding grounds in the tropical and subtropical areas along the east coast of Australia (Web Reference 6). The northern migration occurs between May to August while the southern migration to Antarctic waters occurs during September to December.

Juvenile Great White Sharks are resident in Providence Bay for extended periods ranging from weeks to months between September and February but the highest numbers of sharks have been detected from November to January.

Similar to the approved leases there will be a sufficient area of unobstructed waters either side of the proposed modification leases which whales and sharks can safety navigate. It is expected that the area obstructed by the proposed modification sea pen and feed barge infrastructure is unlikely to have a significant impact of whale migratory pathways or shark movements given that there are extensive areas of similar habitat available in the direct and wider study area which whales and sharks can use for this purpose. Also, the proposed modification infrastructure is similar to that on the approved leases.

*Behavioural Changes and Predatory Interactions*

In the Pisces and MARL EIS's a number of species in Providence Bay represent potential predators of the fish cultured in the sea pens, including sharks, seals, seabirds and dolphins.

As outlined in the MARL EIS, it is difficult to predict the extent and severity of depredation losses and gear destruction, which largely depends on feeding behaviour, aggressiveness, the predator's population biology, migratory movements and the effectiveness of control measures (McCord *et al*., 2008).

The sea pen infrastructure proposed for the modification leases has been designed to specifically mitigate the interactions of predator impacts on cultured stock. The design features of these new technologically advanced sea pens are outlined in Appendix A.

*Mitigation Measures*

As the proposed modification is primarily the same activities as per the approved aquaculture lease sites the management plans, policies and procedures identified in the Pisces and MARL EIS's and consents would be carried over to mitigate potential impacts of this modification proposal.

In addition the attractiveness of the pens to predatory marine fauna will be mitigated by:

- Removal of moribund fish (potential food source and attractant for sharks and seals) by divers initially and then by automated retrieval systems as the project progresses.
- The employment of feed management systems that incorporate the use of electronic underwater monitoring of fish feeding behaviour and monitors the feed pellets within the sea pens. This will mitigate the loss of feed pellets from the pens and therefore reduce the attractiveness of the pens as a food source to marine fauna.

*Conclusion*

The risk of the proposed modification having a significant impact on migratory pathways, the behaviour of marine fauna and predatory interactions is still thought to be 'low' when considered in context of the current approved leases, the extensive area of unobstructed waters in Providence Bay, and the range of mitigation measures that will minimise the attraction of marine fauna and associated interactions.

The overall risk however, is considered to be 'moderate' given that there is uncertainty about whale and shark critical habitat, migratory pathways, potential behavioural changes and predatory interactions, particularly as human safety is involved. This risk ranking will ensure adequate management attention is provided for these issues until the research activities validate this assessment.

#### 8.2.2.12 Areas of Conservation Significance

The proposed modification is still contained within the Habitat Protection Zone of the Port Stephens Great Lakes Marine Park and principally is contained within the same region studied as part of the Pisces and MARL EIS's. The areas of conservation

significance and the potential risks on them therefore remains primarily the same (Figure 18).

In accordance with the approvals for the current approved leases, monitoring programs will be carried over as part of the modification.

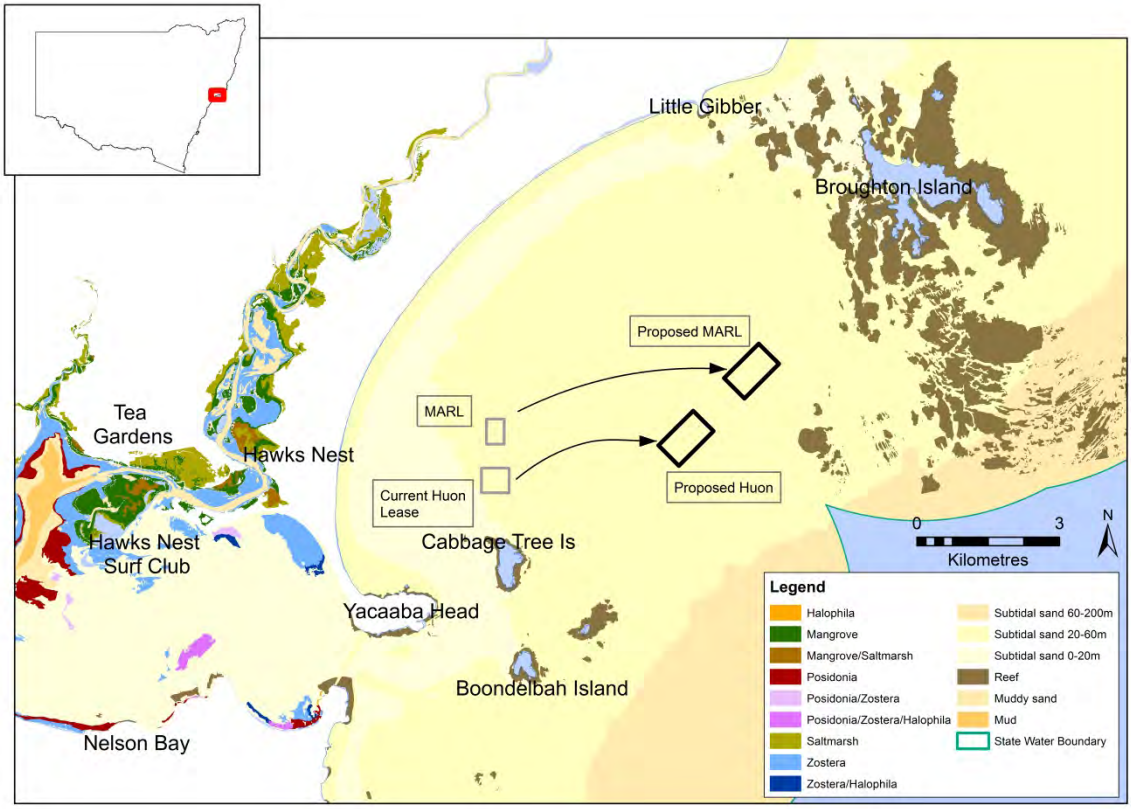


**Figure 18: PSGLMP map highlighting zoning and areas of conservation significance (Source: NSW DPI, 2015).**

*Conclusion*

The risk of the proposed modification having a significant impact on areas of conservation significance is still thought to be 'low' when considered in context with the distance between these areas, the high energy environment of Providence Bay, the substrate type present, and the range of mitigation and management measures that will be implemented.

### 8.2.2.13 Waste Disposal

The Pisces and MARL EIS's outlined the potential range of wastes, including bio waste (i.e. dead fish and biofouling), general waste (e.g. plastic, containers and bags) and obsolete/worn infrastructure (e.g. ropes and nets), that may be generated

from the proposed modification leases. The new technologically advanced sea pen and feed barge systems to be utilised on the proposed modification leases are reported to result in less wastes such as ropes and feed bags. The feed monitoring system incorporated into the technology of the in pen feed hoppers and feed barge will reduce feed wastes entering the environment.

The Pisces and MARL EIS's and consents have outlined operational and maintenance procedures, policies and plans to mitigate potential waste issues and these would be carried over into the proposed modification.

*Conclusion*

The risk of waste generated from the operation of the proposed modification leases having a significant impact on the environment or humans is still thought to be 'negligible' when considered in context with the mitigation measures that will be carried over from the current approvals for the Huon and MARL Leases.

The respective Environmental Management Plans for the Huon and MARL Leases will ensure that the commitments in the Pisces and MARL EIS's and consents and any other approval or licence conditions are fully implemented.

# 9 MITIGATION OF ENVIRONMENTAL IMPACTS

The Pisces and MARL EIS's both contain environmental management plans, policies and procedures to ensure that the commitments in the EIS's, subsequent assessment reports and any approval or licence conditions are fully implemented to address potential environmental impacts.

In consideration that the proposed modification activities are principally the same as that outlined in the Pisces and MARL EIS's and consents, it is considered that the same approved environmental management and mitigation measures be undertaken. To achieve this an Environmental Management Plan (EMP) will be developed for both of the proposed modification leases which will include information such as operational objectives, indicators, performance criteria, sampling methods, data requirements, timeframes, specific locations and emergency response plans. The frame work of the Draft EMP as outlined in the MARL EIS will be used in formulation of the respective EMP's.

The objectives of the EMP's are to ensure that the proposed modification is sustainably managed and that its operation does not have a significant impact on the marine environment, surrounding communities or staff. The EMP will aim to ensure the following:

- Aquaculture best practices are employed during all stages;
- Marine fauna interactions are minimised;
- Water quality is maintained and nutrient inputs are kept within safe levels for humans and marine communities;
- The structural integrity and stability of the sea pen infrastructure, including feed barges, is maintained;
- The occurrence of disease, parasites, pests and escapees is minimised and if these events do occur, prompt management and/or remedial action will be implemented;
- The safety of staff and surrounding communities is maintained;
- Waste is appropriately disposed;
- Navigational safety in Providence Bay, the Port of Newcastle and Port Stephens is maintained;
- The local community is kept informed of activities, and

- The performance of the proposed modification leases are regularly evaluated by reviewing environmental management reports and monitoring records.

The EMP's will be used as a reference for staff and contractors involved with the various stages of the proposed modification. Huon and NSW DPI will be committed to and responsible for ensuring that all mitigation and management measures are carried out as described in the EMP's. The EMP's will ensure that the commitments in the EIS and the proposed modification subsequent assessment reports and any approval or licence conditions are fully implemented.

# 10 CONCLUSION

In accordance with Section 75W and 115ZI of the *Environment Planning and Assessment Act 1979,* Huon Aquaculture Group Limited and NSW Department of Primary Industries is seeking the Minister for Planning's approval to modify DA No. 81-04-01 its modification along with SSI-5118 fish farming consents in Providence Bay, NSW.

*The proposed modifications in summary are to:*

- *Relocate the current lease sites further offshore;*
- *Permit the use of twelve 120 to 168 metre diameter sea pens on the proposed leases;*
- *Permit the use of feed management systems (in-pen hopper and/or feed barge) on the proposed leases; and*
- *Adjust the lease sizes to accommodate the anchoring system required in the greater depth of water on the proposed sites.*

The proposed modifications would allow for the use of current leading edge technology and farming practices, and also improve the capacity of the MARL to provide commercially relevant research results.

The proposed modifications would not result in any significant changes to the potential risks or increase environmental impacts associated with the Huon or MARL leases. In addition the modification should enhance community amenity and environmental performance.

# 11 REFERENCES


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## Appendix A

# Sea Pen Specifications

# Sea Pen Specifications

The critical success factors in pen operation are to ensure containment (no fish loss) and deter predators. This is achieved via optimal design of the pen and nets, material used, construction quality, installation and operation.

The key component is the stanchion (bracket that holds the floating pipe collars together and supports the nets). This was designed by Huon and consultant experts and is manufactured by specialist injection moulders in New South Wales. The stanchions are made from impact modified Nylon providing the strength of steel with the flexibility of plastic – they have been load tested to over 38 Tonnes (Figure 1 and 2).

*Figure 1: Fortress pen Injection moulded Nylon Stanchion 120m/168m in foreground, 240m stanchion in background (Source: Huon Aquaculture 2015)*

*Figure 2: Fortress pen Injection moulded Nylon Stanchion undergoing load testing (Source: Huon Aquaculture 2015)*

The floating pipe collars are High Density Polyethylene (450 mm outside diameter, SDR13.6), they are butt welded to form the distinctive ring shape and the internal voids are filled with pre-formed expanded polystyrene to maintain buoyancy in the

event of damage to the collar. A pen collar is three concentric rings of this pipe – known as a “Triple-Collar” (Figure 3)

*Figure 3: Section of triple-collar showing stanchions, pipes and fittings (Source: Huon Aquaculture 2015)*

The net material is Ultra High Strength Polyethylene (UHSPE):

1) Containment UHSPE 15mm or 35mm mesh knotless net
2) Predator (Bird) UHSPE 60mm mesh bird net supported by flexible bird poles
3) Predator (Seal and Shark) UHSPE 125mm mesh, double-knotted predator net, extending around the inner net and 2.8m above the water

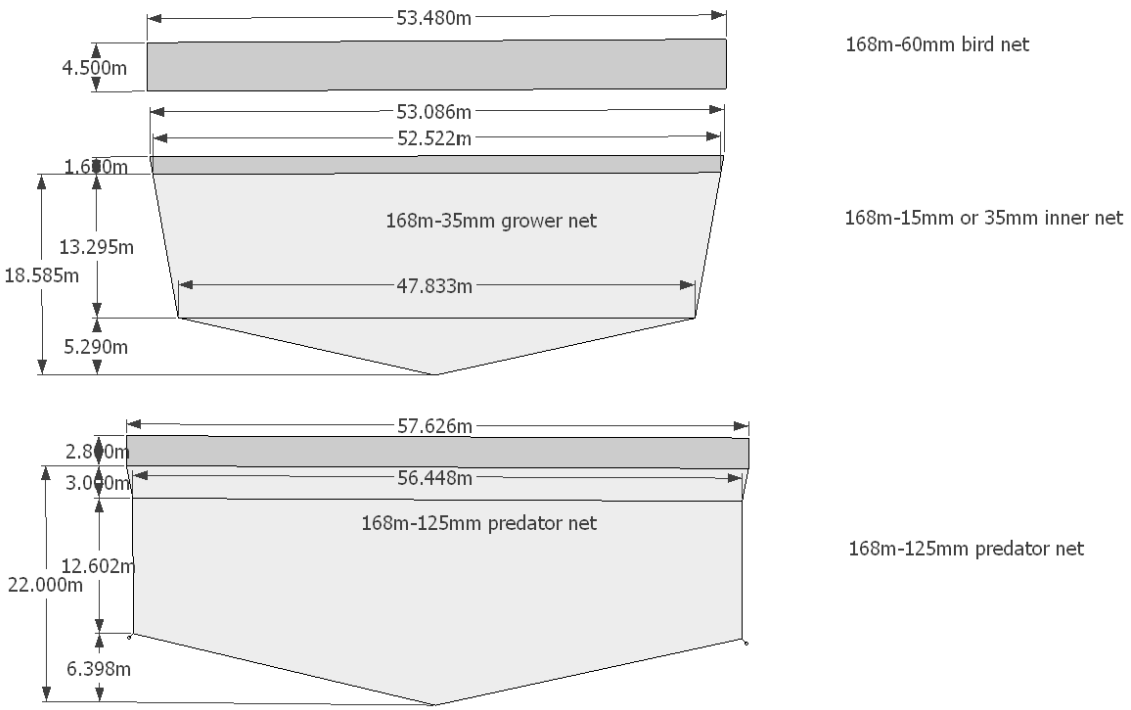


*Figure 4: Dimensions for a 168m diameter pens (Source: Huon Aquaculture 2015)*

Predator nets incorporate a 4mm twine with over 1200kg break-load assembled into a double-knotted impenetrable barrier. Depending on the early experience on-site, the predator net may be augmented by the use of stainless steel wire woven into the UHSPE matrix.

*Figure 5: Example of the netting used for the Fortress pens (Source: Huon Aquaculture 2015)*

The nets panels are attached to framing ropes that provide the basic shape of the net when hung and transfer the loads from the weighting system to the mesh. This results in the required tension to deter predators, maintains the open area of each mesh to maximise water flow and provides a stable living space for the fish to occupy.

The containment net is supported above the waterline by stainless steel hooks on the stanchions. The top edge of the net is sewn to a rope that runs around the circumference. This rope is called the headline and is attached to the downlines, these are framing ropes that run vertically down the side wall.

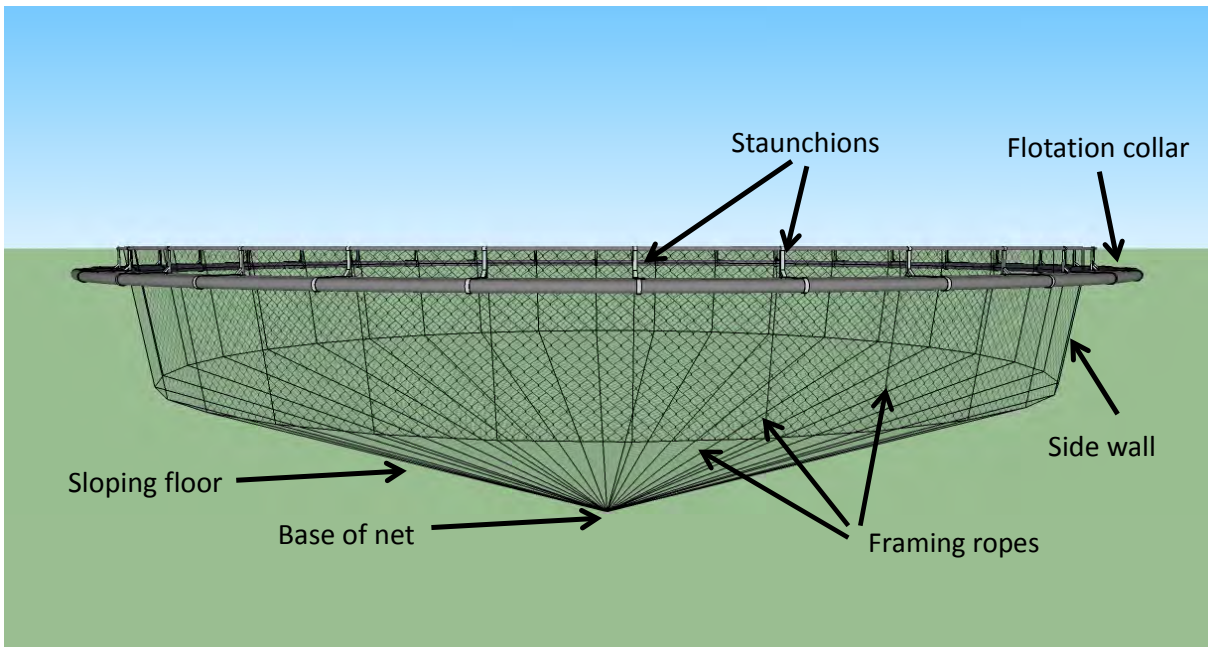


*Figure 6:* Flotation collar and containment net configuration – cross section *(Source: Huon Aquaculture 2015)*

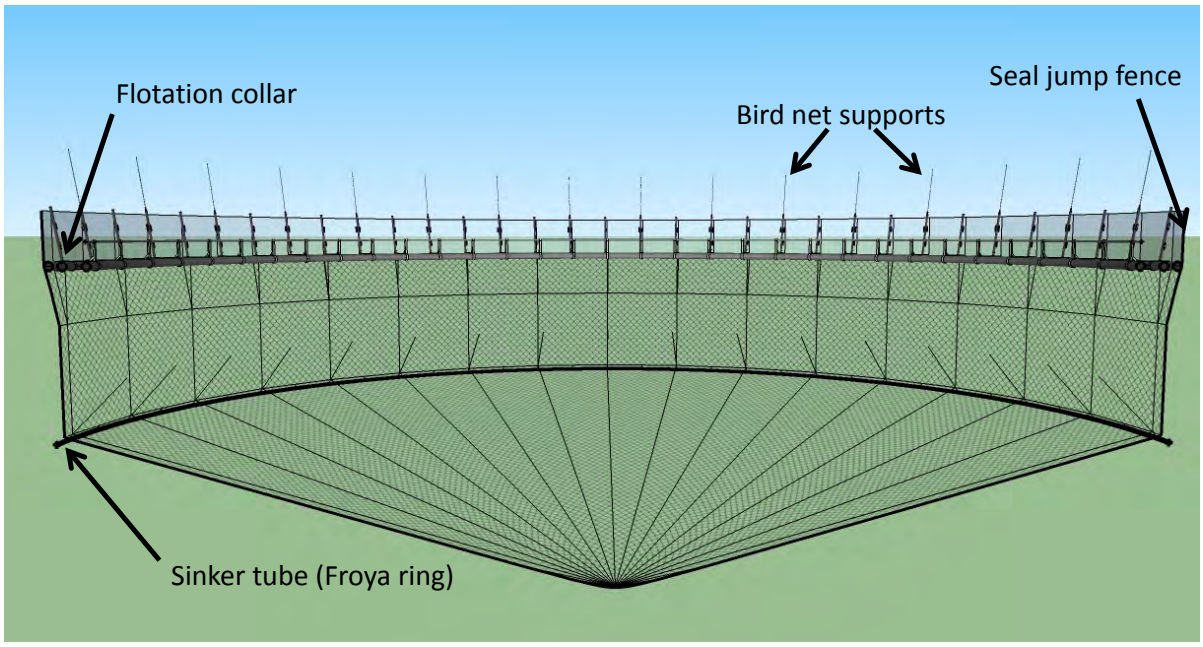


*Figure 7:* Flotation collar and *predator net configuration (Source: Huon Aquaculture 2015)*

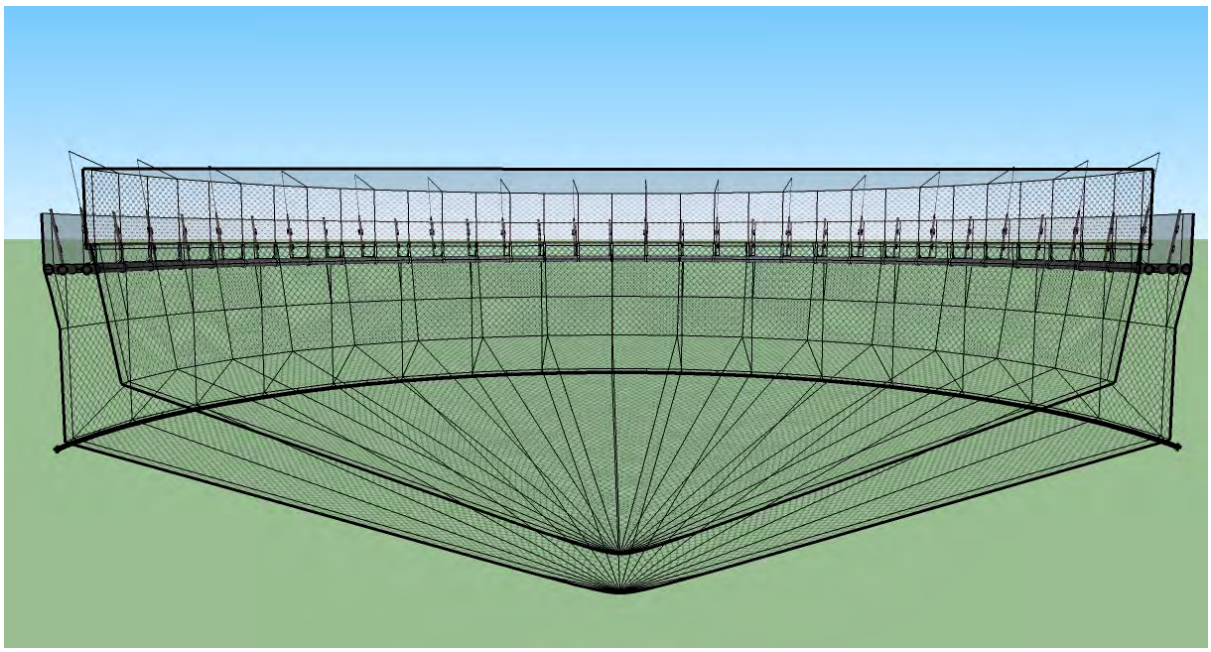

*Figure 8: Fully assembled pen – cross section (Source: Huon Aquaculture 2015)*

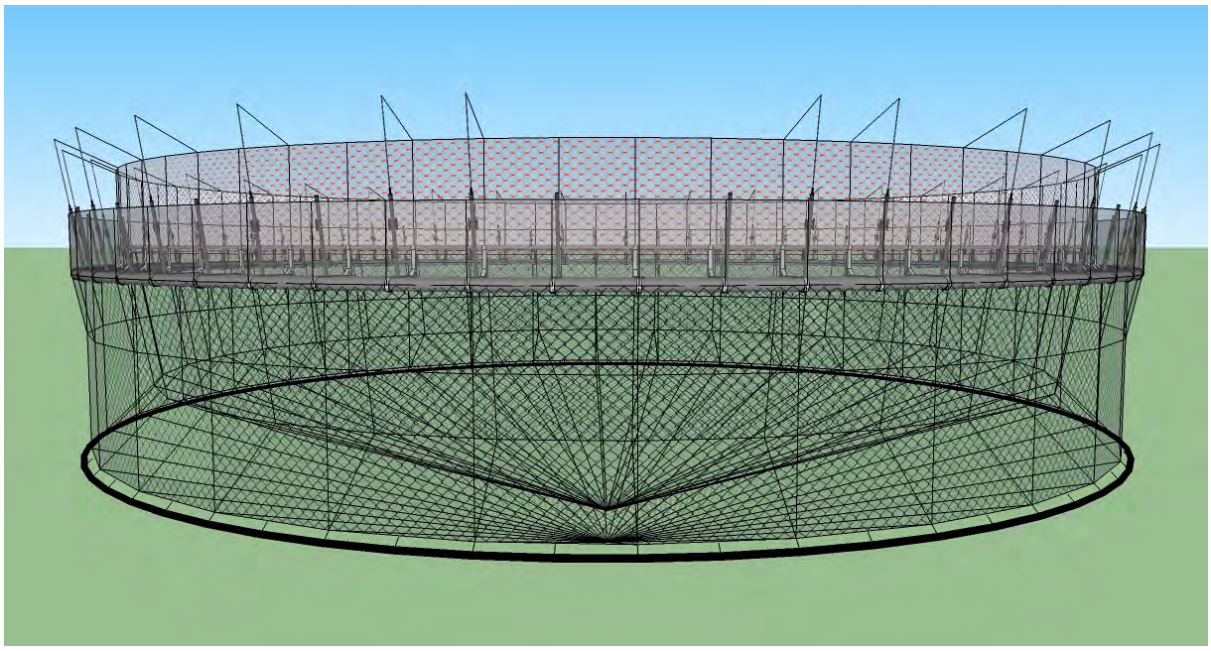

*Figure 9: Fully assembled pen (Source: Huon Aquaculture 2015)*

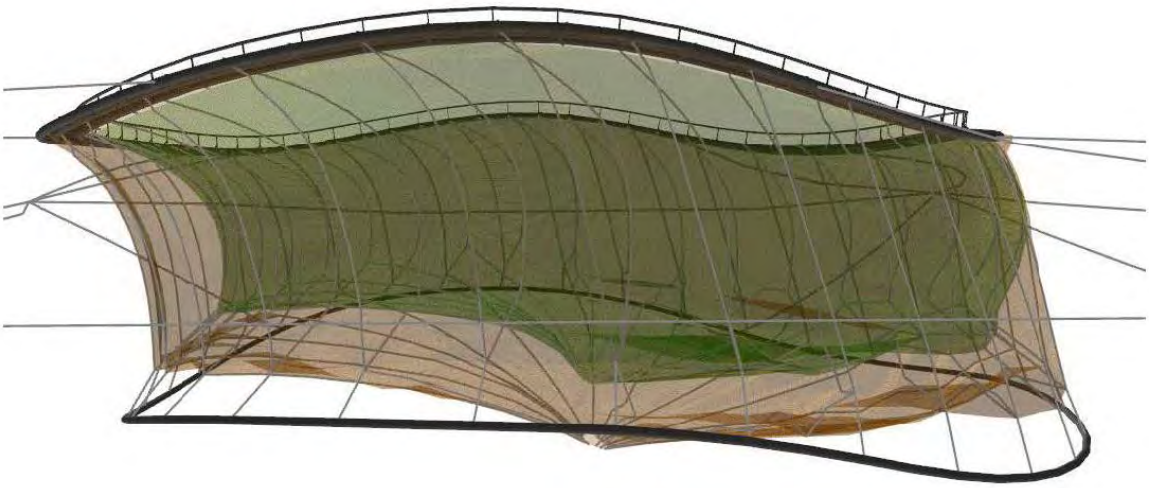

*Figure 10: Modelling of pen distortion in extreme conditions, note that the key structural and containment features remain functional despite significant distortion (Source: Huon Aquaculture 2015)*

**Appendix B**

# Floating In-Pen Hoppers

# &

# Feed Barge Specifications

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Design of Cruising Motor & Sailing Boats
Conversions and Refurbishments
Stability Assessments
Project Management
System Design & Optimisation
Marine & Aquaculture Solutions

# - HUON 3 TONNE FLOATING FEEDER -

# STABILITY COMPLIANCE REPORT

## EDITION 1a, 09/01/2016

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**COMPLIANCE CLAUSE**

Compliance with the NSCV stability criteria specified in this manual does not ensure the vessel may not capsize or founder.

The Master must, at all times, exercise caution and good seapersonship with regard to present and future weather conditions, the navigational environment and the vessel's resources in order to discharge his/her responsibilities to the safety to the vessel and its complement. Particular care should be taken during crane lifting operations to ensure the load is under control at all times and that the stability of the vessel is not degraded by sea or weather conditions.

## STABILITY CRITERIA

The feeders are unpowered, provide no accommodations and are not normally crewed. Acordingly, they meet the definition of Dumb Barges' within the National Standard for Commercial Vessels (NSCV) Subsection 6A. The minimum stability criteria for Dumb Barges are specified in Chapter 5D 'Alternative Comprehensive Criteria for Dumb Barges' of the subsection and are reproduced below.

| NSCV SUBSECTION 6A CHAPTER 5D - ALTERNATIVE COMPREHENSIVE STABILITY CRITERIA FOR DUMB BARGES | | |
|---|---|---|
| **No.** | **Application Limits** | **Criterion description** |
| 5D.1a | Operational Areas A, B & C | The area beneath the $G_FZ$ curve between 0° and the least of the angle of maximum righting arm, $G_FZ_{max}$, the downflooding angle or 40° shall not be less than 4.58 metre-degrees. |
| 5D.1b | Operational Areas D & E | The area beneath the $G_FZ$ curve between 0° and the least of the angle of maximum righting arm, $G_FZ_{max}$, the downflooding angle or 40° shall not be less than 3.05 metre-degrees. |

As the criteria differ between Operational Areas C and D, the environmental parameters of those areas under the NSCV are of concern in considering the stability of the feeders. The relevant parameters are reproduced below -

| NSCV OPERATIONAL AREA PARAMETERS (Ref: NSCV Part B, Table 6) | | |
|---|---|---|
| **Characteristic** | **Operational C** | **Operational Area D** |
| Assumed Gusting Wind Pressure | 450 Pa | 360 Pa |
| Design Significant Wave Height | 4.5 m | 2.5 m |
| Beaufort Scale | 7 (near gale) | 6 (strong breeze) |
| Operational Characteristics | Restricted operations within a few hours travel of coast. | Operation within Sheltered Waters |

## DESCRIPTION OF THE FEEDERS

The feeders consist of a fabricated aluminium bin mounted above a rectangular float constructed from polyethylene pipe.

The full volume of the bin is 6.667m$^3$ but, due to the Angle of Repose of the feed, adjusted to 30° to account for the spreading vanes within the bin hatch, the maximum volume of feed contained is 4.983 m$^3$. With a Specific Gravity of 0.667, this volume represents 3.324 tonnes of feed. The bin should not be overfilled by forcing or shovelling feed to the upper corners as this will significantly reduce the stability of the feeder.

At the base of the bin is a spinning disc to distribute the feed.

The polyethylene float is 4.150 metres long, 4.150 metres wide and constructed of pipe with a diameter of 0.800 metre. The float has no inspection or other openings and, accordingly, is regarded as being completely watertight and without any downflooding point.

The underside of the bin is 360mm above the upper surface of the float.

## BILGE WATER & WATERTIGHT INTEGRITY

It is assumed throughout this document that the watertight integrity of the float is maintained and that there is no bilge water present. As the free surface effect of any bilge water will have significant effects on the feeder's stability, any leaking feeder should be removed from service and repaired .

## WINDAGE

For the purposes of this document, the Design Waterline is taken to be at a mean draft of 0.541 metres in seawater, corresponding to a total displacement of 4.949 tonnes and a load of 3.324 tonnes of feed. In that condition, the feeder has a windage profile of 4.437 square metres acting on a lever of 1.476 metres.

A wind pressure of 360 Pascals, that considered relevant for Operational Areas D, will result in an effective heeling moment of 2,358 N.m (0.240 tonne.metres).

A wind pressure of 450 Pascals, that considered relevant for Operational Areas C, will result in an effective heeling moment of 2,947 N.m (0.300 tonne.metres).

Although not required by the Chapter C4 stability criteria, the heeling lever curves for both 360 Pa and 450 Pa winds are included in the Loading Condition analyses in this document, for information.

## PERSONS ON BOARD

The feeder is not normally crewed but a maintenance person may be, at times, required to board the feeder and the effect of an 100kg person (in excess of the NSCV 80kg 'standard' person) on one side of the feeder is included in the Loading Conditions of this document for information.

## THE VERTICAL CENTRE OF GRAVITY OF FEED IN THE BIN

| **FEEDER BIN CONTENTS**<br>(Bin Bottom 1,160mm above Vertical Datum)<br><br>Ullage measured from bin upper surface **down** to apex of feed pyramid | | Contents: Bulk Fish Feed<br>Specific Gravity: 0.667<br>Vertical Datum: Underside of Float ***(+ve up)***<br>Long'l Datum: Midship ***(+ve frd)***<br>Trans. Datum: Feeder Centreline ***(+ve Pt)*** | |
|---|---|---|---|
| **Ullage (m)** | **Volume ($m^3$)** | **Weight (t)** | **VCG (m)** |
| -0.100 | 4.983 | 3.324 | 1.957 |
| 0.100 | 3.832 | 2.556 | 1.857 |
| 0.300 | 2.679 | 1.787 | 1.757 |
| 0.500 | 1.679 | 1.120 | 1,657 |
| 0.700 | 0.965 | 0.644 | 1.558 |
| 0.900 | 0.488 | 0.365 | 1.459 |

## SUMMARY OF LOADING CONDITIONS CONSIDERED

| **NSCV Subsection 6A** | | **Chap 5D – Comprehensive Criteria for Dumb Barges** | | | | | |
|---|---|---|---|---|---|---|---|
| **Criterion** | | **Req'd** | **Cond. 1** | **Cond. 2** | **Cond. 3** | **Cond. 4** | **Cond. 5** |
| | Weight of Feed | | 0.000 t | 1.787 t | 2.400 t | 2.750 t | 3.324 t |
| | Angle of Maximum GZ | / | 12.9° | 14.7° | 12.7° | 11.5° | 9.7° |
| | Value of Maximum GZ | / | 1.291 m | 0.878 m | 0.623 m | 0.494 m | 0.292 m |
| | Heel angle under the effect of 360 Pa wind | / | 0.8° | 0.8° | 0.8° | 0.9° | 1.1° |
| | Heel angle under the effect of 450 Pa wind | / | 1.0° | 1.0° | 1.1° | 1.1° | 1.3° |
| | Heel angle under the effect of 1 crew on side | / | 0.3° | 0.4° | 0.4° | 0.4° | 0.4° |
| 5D 1a | Area under GZ curve to angle of maximum GZ | 4.58 m.deg | 11.70 deg.m | 8.16 deg.m | 4.92 deg.m | 3.50 deg.m | 1.84 deg.m |
| 5D 1b | Area under GZ curve to angle of maximum GZ | 3.05 m.deg | 11.70 deg.m | 8.16 deg.m | 4.92 deg.m | 3.50 deg.m | 1.84 deg.m |
| | **Allowable Operational Area** | **/** | **C & D** | **C & D** | **C & D** | **D only** | **E only*** |

**** see comments in Conclusions re operation on Op Area E***

## CONCLUSIONS

The feeders were originally designed to hold up to 3 tonnes of feed and be employed in Operational Areas D and E.

The feeders were designed at a time when the Uniform Shipping Laws Code (USL) of Australia were in force and before the introduction of the National Standard for Commercial Vessels. The most applicable criteria of the USL, require only adequate initial stability (i.e. GM) and had no requirement for righting energy (indicated by area under the GZ curve). The analyses of Conditions 4 and 5 shows that the feeders do not possess sufficiient area under the GZ curve when loaded with more than approximately 2.750 tonnes of feed to meet the NSCV criteria. None the less, experience has shown the feeders to possess adequate stability when operated in Operational Area E (Huon River, Tasmania) over the passed eleven years. Accordingly, it can be considered that the feeders possess adequate stability for operation within Operational Area E only with loads between 2.750 and 3.000 tonnes.

The analysis of this document shows that the feeders have adequate stability under Chapter 5D of the NSCV Subsection 6A, applicable to Dumb Barges without accommodations, for operation in Operational Areas C, D and E when loaded with no more than 2.400 tonnes of feed or Operational Areas D and E when loaded with no more than 2.750 tonnes of feed. In no case should the hoppers contain more than 3.000 tonnes of feed.

In addition to the minimum criteria of Chapter 5D, the heel angles induced by gusting winds of 360 Pa (Op Area D) and 450 Pa (Op Area C) were considered and found to be less than 1.5 degrees and, therefore, to be of no concern when the feeders are normally loaded.

As the feeders possess very high initial stability and the maximum righting arm occurs at a relatively low angle, stability in large waves should also be considered in excess to the Chapter 5D criteria. It is noted that the angle of maximum righting arm, when loaded with no more than 2.750 tonnes of feed, is greater than ten degrees. Accordingly, the stability of the feeders in large waves can be considered to be acceptable.

Finally, the heeling effect of an 100kg person on the side of the feeder was considered and found to be of no concern with regard to the stability of the feeder.

## ANNEX – LOADING CONDITIONS

### Loading Condition 01 – Lightship

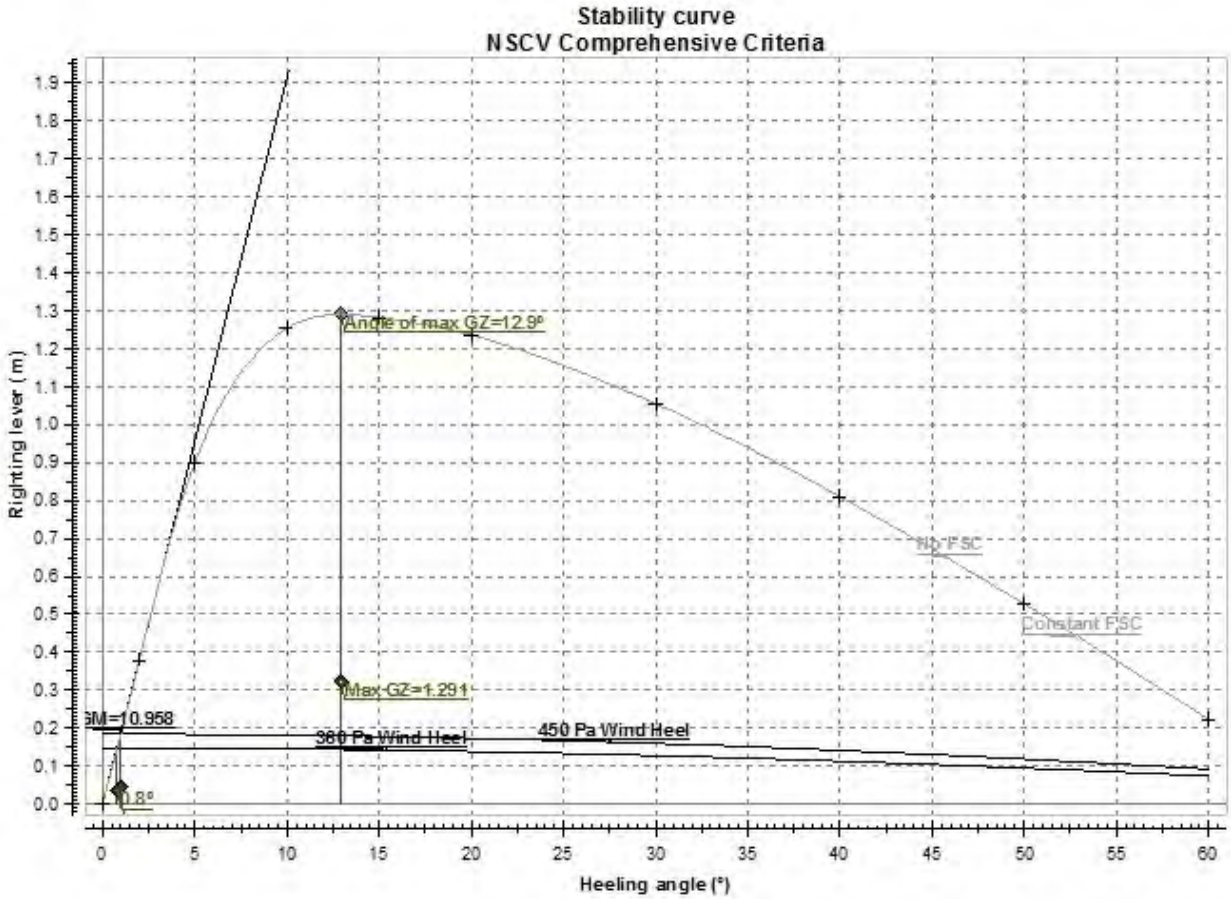
**COMPLIANCE: The feeder bin contains no feed in this condition.**
**The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 0.000 | 0.000 |
| LIGHTSHIP | 1.625 | 0.000 | 0.000 | 0.000 | 0.000 | 1.105 | 3.380 | 0.000 |
| DISPLACEMENT | 1.625 | | 0.000 | | 0.000 | | 3.380 | 0.000 |
| | | 0.000 | | 0.000 | | 1.105 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.105 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 12.063 m |
| Draft at Aft Perp. | 0.230 m | | GM (solid) | 10.958 m |
| Draft (mean) | 0.230 m | | GM (fluid) | 10.958 m |
| Draft at Frd Perp | 0.230 m | | Rate of Immersion | 0.099 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.043 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 12.9° | | / | N/R |
| | Value of Maximum GZ | 1.291 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.0° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.3° | | / | N/R |
| 5D.1a | Area under GZ curve to 12.9° | 11.70 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 12.9° | 11.70 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.418 | 0.039 | 0.000 | 0.000 | 0.379 | 0.401 |
| **5.0º** | 0.997 | 0.096 | 0.000 | 0.000 | 0.900 | 2.349 |
| **10.0º** | 1.446 | 0.192 | 0.000 | 0.000 | 1.254 | 7.965 |
| **15.0º** | 1.568 | 0.286 | 0.000 | 0.000 | 1.282 | 14.325 |
| **20.0º** | 1.615 | 0.378 | 0.000 | 0.000 | 1.237 | 20.685 |
| **30.0º** | 1.607 | 0.552 | 0.000 | 0.000 | 1.055 | 32.207 |
| **40.0º** | 1.520 | 0.710 | 0.000 | 0.000 | 0.810 | 41.543 |
| **50.0º** | 1.374 | 0.846 | 0.000 | 0.000 | 0.523 | 48.247 |
| **60.0º** | 1.180 | 0.957 | 0.000 | 0.000 | 0.223 | 52.028 |



**Loading Condition 02 – 1.787 tonnes of feed in bin**

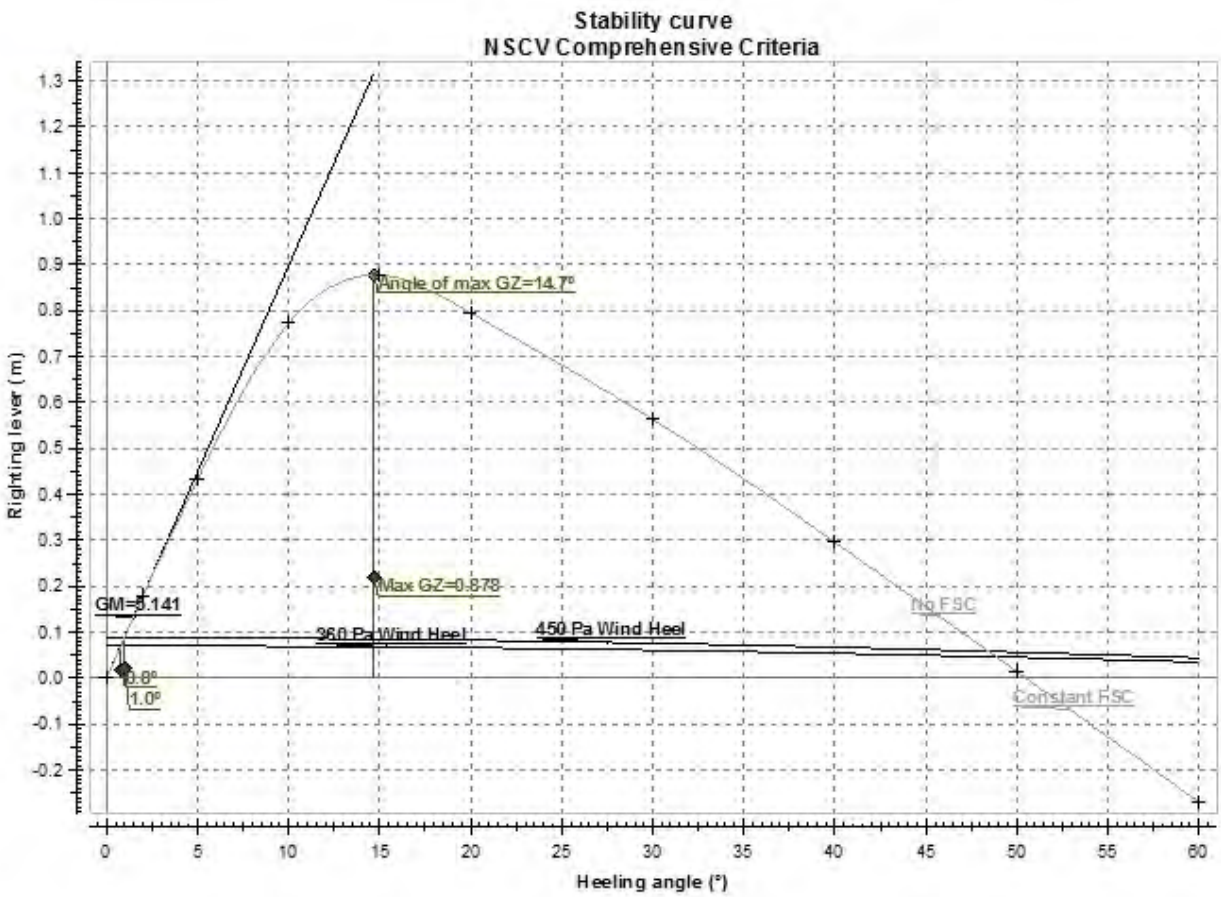
**COMPLIANCE: The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 1.787 | 0.000 | 0.000 | 0.000 | 0.000 | 1.757 | 3.140 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 1.787 | | 0.000 | | 0.000 | | 3.140 | 0.000 |
| LIGHTSHIP | 1.625 | 0.000 | 0.000 | 0.000 | 0.000 | 1.105 | 1.796 | 0.000 |
| DISPLACEMENT | 3.412 | | 0.000 | | 0.000 | | 4.936 | 0.000 |
| | | 0.000 | | 0.000 | | 1.446 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.446 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 6.588 m |
| Draft at Aft Perp. | 0.398 m | | GM (solid) | 5.141 m |
| Draft (mean) | 0.398 m | | GM (fluid) | 5.141 m |
| Draft at Frd Perp | 0.398 m | | Rate of Immersion | 0.110 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.042 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 14.7° | | / | N/R |
| | Value of Maximum GZ | 0.878 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.0° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.4° | | / | N/R |
| 5D.1a | Area under GZ curve to 14.7° | 8.160 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 14.7° | 8.160 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.229 | 0.050 | 0.000 | 0.000 | 0.178 | 0.172 |
| **5.0º** | 0.559 | 0.126 | 0.000 | 0.000 | 0.433 | 1.089 |
| **10.0º** | 1.024 | 0.251 | 0.000 | 0.000 | 0.772 | 4.183 |
| **15.0º** | 1.252 | 0.374 | 0.000 | 0.000 | 0.878 | 8.423 |
| **20.0º** | 1.290 | 0.495 | 0.000 | 0.000 | 0.795 | 12.663 |
| **30.0º** | 1.286 | 0.723 | 0.000 | 0.000 | 0.563 | 19.425 |
| **40.0º** | 1.226 | 0.930 | 0.000 | 0.000 | 0.296 | 23.800 |
| **50.0º** | 1.122 | 1.108 | 0.000 | 0.000 | 0.014 | 25.327 |
| **60.0º** | 0.982 | 1.253 | 0.000 | 0.000 | -0.270 | 25.327 |



**Loading Condition 03 – 2.400 tonnes of feed in bin**

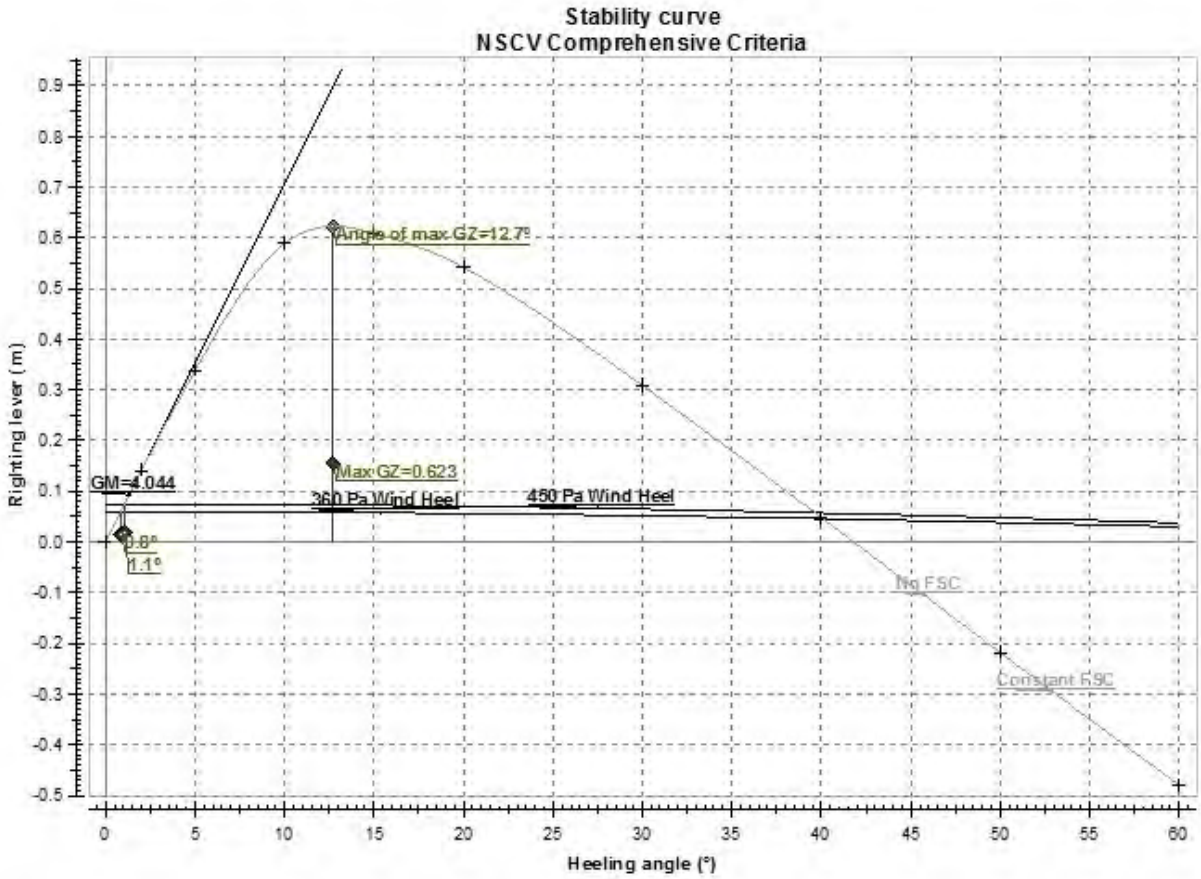
**COMPLIANCE: The feeder bin should contain no more than 2.4 tonnes of feed in Op Area C.**
**The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 2.400 | 0.000 | 0.000 | 0.000 | 0.000 | 1.857 | 4.457 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 4.457 | 0.000 |
| LIGHTSHIP | 1.625 | 0.000 | 0.000 | 0.000 | 0.000 | 1.105 | 1.796 | 0.000 |
| DISPLACEMENT | 4.025 | | 0.000 | | 0.000 | | 6.253 | 0.000 |
| | | 0.000 | | 0.000 | | 1.553 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.553 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 5.597 m |
| Draft at Aft Perp. | 0.454 m | | GM (solid) | 4.044 m |
| Draft (mean) | 0.454 m | | GM (fluid) | 4.044 m |
| Draft at Frd Perp | 0.454 m | | Rate of Immersion | 0.109 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.039 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 12.7° | | / | N/R |
| | Value of Maximum GZ | 0.623 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.1° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.4° | | / | N/R |
| 5D.1a | Area under GZ curve to 12.7° | 4.92 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 12.7° | 4.92 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.194 | 0.054 | 0.000 | 0.000 | 0.140 | 0.172 |
| **5.0º** | 0.474 | 0.135 | 0.000 | 0.000 | 0.339 | 0.860 |
| **10.0º** | 0.859 | 0.270 | 0.000 | 0.000 | 0.589 | 3.266 |
| **15.0º** | 1.011 | 0.402 | 0.000 | 0.000 | 0.609 | 6.303 |
| **20.0º** | 1.073 | 0.531 | 0.000 | 0.000 | 0.542 | 9.225 |
| **30.0º** | 1.085 | 0.777 | 0.000 | 0.000 | 0.309 | 13.523 |
| **40.0º** | 1.047 | 0.998 | 0.000 | 0.000 | 0.048 | 15.299 |
| **50.0º** | 0.971 | 1.190 | 0.000 | 0.000 | -0.219 | 15.356 |
| **60.0º** | 0.865 | 1.345 | 0.000 | 0.000 | -0.480 | 15.356 |



**Loading Condition 04 – 2.750 tonnes of feed in bin**

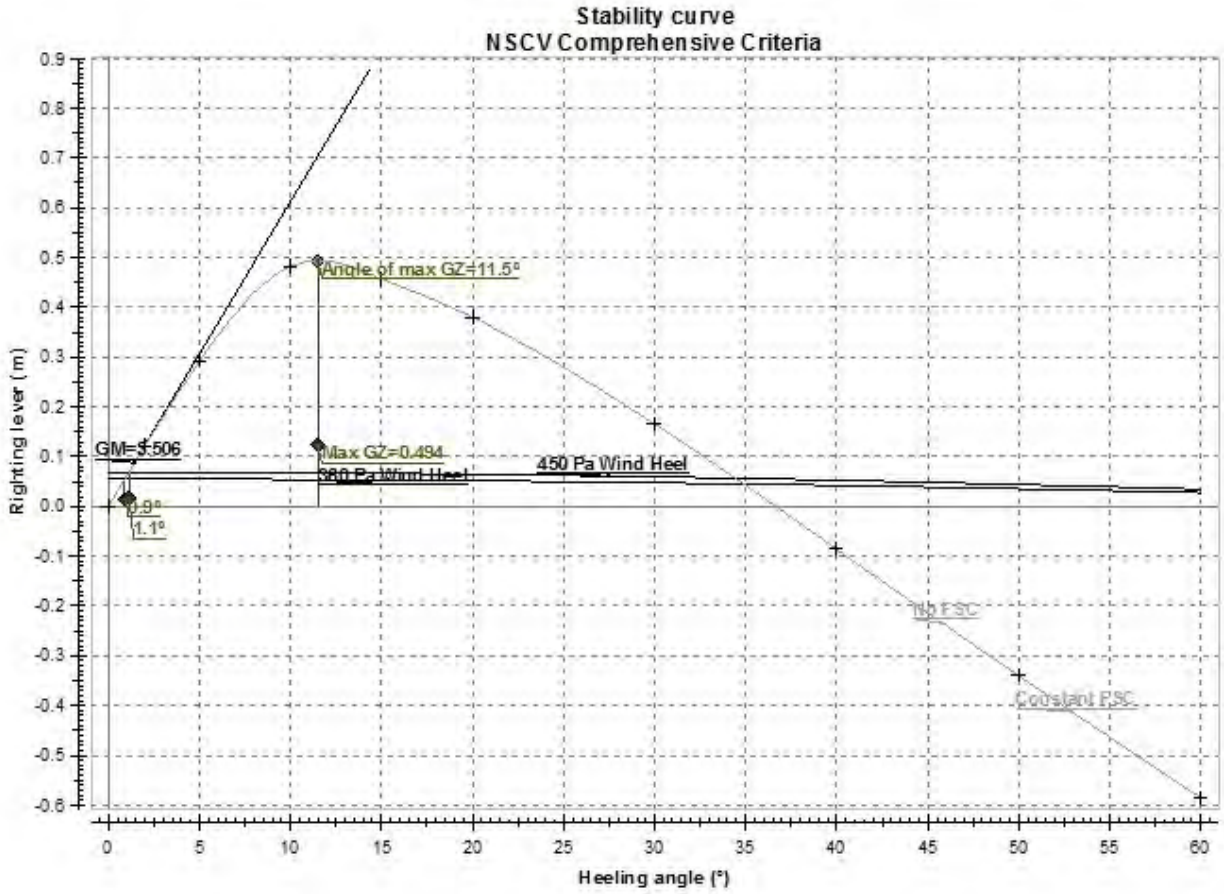
**COMPLIANCE: The feeder in this condition possesses sufficient stability for Operational Area D only.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 2.750 | 0.000 | 0.000 | 0.000 | 0.000 | 1.882 | 5.176 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 2.750 | | 0.000 | | 0.000 | | 5.176 | 0.000 |
| LIGHTSHIP | 1.625 | 0.000 | 0.000 | 0.000 | 0.000 | 1.105 | 1.796 | 0.000 |
| DISPLACEMENT | 4.375 | | 0.000 | | 0.000 | | 6.972 | 0.000 |
| | | 0.000 | | 0.000 | | 1.593 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.593 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 5.099 m |
| Draft at Aft Perp. | 0.487 m | | GM (solid) | 3.506 m |
| Draft (mean) | 0.487 m | | GM (fluid) | 3.506 m |
| Draft at Frd Perp | 0.487 m | | Rate of Immersion | 0.107 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.037 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 11.5° | | / | N/R |
| | Value of Maximum GZ | 0.494 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.9° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.1° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.4° | | / | N/R |
| 5D.1a | Area under GZ curve to 11.5° | 3.50 deg.m | ≥ | 4.58 m.deg | NO |
| 5D.1b | Area under GZ curve to 11.5° | 3.50 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.177 | 0.056 | 0.000 | 0.000 | 0.122 | 0.115 |
| **5.0º** | 0.431 | 0.139 | 0.000 | 0.000 | 0.293 | 0.745 |
| **10.0º** | 0.759 | 0.277 | 0.000 | 0.000 | 0.483 | 2.750 |
| **15.0º** | 0.870 | 0.412 | 0.000 | 0.000 | 0.457 | 5.157 |
| **20.0º** | 0.925 | 0.545 | 0.000 | 0.000 | 0.380 | 7.277 |
| **30.0º** | 0.962 | 0.797 | 0.000 | 0.000 | 0.166 | 10.028 |
| **40.0º** | 0.938 | 1.024 | 0.000 | 0.000 | -0.086 | 10.601 |
| **50.0º** | 0.880 | 1.221 | 0.000 | 0.000 | -0.340 | 10.601 |
| **60.0º** | 0.794 | 1.380 | 0.000 | 0.000 | -0.586 | 10.601 |



**Loading Condition 05 – 3.324 tonnes of feed in bin**

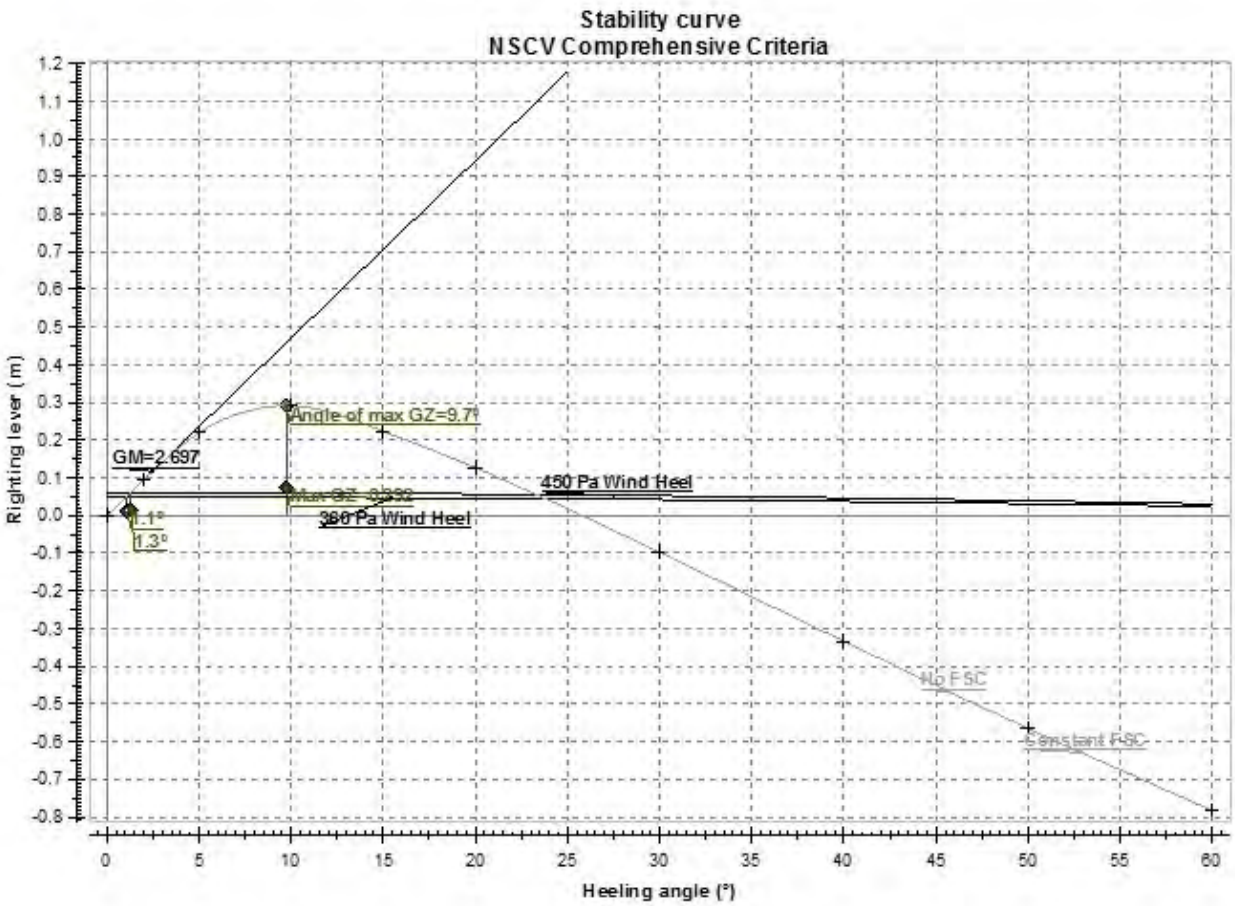
**COMPLIANCE: The feeder bin is loaded to 100mm above the bin top in this condition.**
**The feeder in this condition possesses INADEQUATE stability for operation only.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 3.324 | 0.000 | 0.000 | 0.000 | 0.000 | 1.957 | 6.505 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 3.324 | | 0.000 | | 0.000 | | 6.505 | 0.000 |
| LIGHTSHIP | 1.625 | 0.000 | 0.000 | 0.000 | 0.000 | 1.105 | 1.796 | 0.000 |
| DISPLACEMENT | 4.950 | | 0.000 | | 0.000 | | 8.301 | 0.000 |
| | | 0.000 | | 0.000 | | 1.677 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.677 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 4.374 m |
| Draft at Aft Perp. | 0.541 m | | GM (solid) | 2.697 m |
| Draft (mean) | 0.541 m | | GM (fluid) | 2.697 m |
| Draft at Frd Perp | 0.541 m | | Rate of Immersion | 0.103 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.032 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 9.7° | | / | N/R |
| | Value of Maximum GZ | 0.292 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 1.1° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.3° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.4° | | / | N/R |
| 5D.1a | Area under GZ curve to 9.7° | 1.84 deg.m | ≥ | 4.58 m.deg | NO |
| 5D.1b | Area under GZ curve to 9.7° | 1.84 deg.m | ≥ | 3.05 m.deg | NO |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.152 | 0.059 | 0.000 | 0.000 | 0.093 | 0.115 |
| **5.0º** | 0.366 | 0.146 | 0.000 | 0.000 | 0.220 | 0.573 |
| **10.0º** | 0.583 | 0.291 | 0.000 | 0.000 | 0.291 | 1.948 |
| **15.0º** | 0.658 | 0.434 | 0.000 | 0.000 | 0.224 | 3.266 |
| **20.0º** | 0.701 | 0.574 | 0.000 | 0.000 | 0.127 | 4.126 |
| **30.0º** | 0.741 | 0.839 | 0.000 | 0.000 | -0.098 | 4.527 |
| **40.0º** | 0.744 | 1.078 | 0.000 | 0.000 | -0.334 | 4.527 |
| **50.0º** | 0.719 | 1.285 | 0.000 | 0.000 | -0.566 | 4.527 |
| **60.0º** | 0.669 | 1.452 | 0.000 | 0.000 | -0.783 | 4.527 |



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# - HUON 6 TONNE FLOATING FEEDER - (LOW BIN VERSION)

# STABILITY COMPLIANCE REPORT

## EDITION 1b, 09/01/2016

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**COMPLIANCE CLAUSE**

Compliance with the NSCV stability criteria specified in this manual does not ensure the vessel may not capsize or founder.

The Master must, at all times, exercise caution and good seapersonship with regard to present and future weather conditions, the navigational environment and the vessel's resources in order to discharge his/her responsibilities to the safety to the vessel and its complement. Particular care should be taken during crane lifting operations to ensure the load is under control at all times and that the stability of the vessel is not degraded by sea or weather conditions.

## STABILITY CRITERIA

The feeders are unpowered, provide no accommodations and are not normally crewed. Acordingly, they meet the definition of Dumb Barges' within the National Standard for Commercial Vessels (NSCV) Subsection 6A. The minimum stability criteria for Dumb Barges are specified in Chapter 5D 'Alternative Comprehensive Criteria for Dumb Barges' of the subsection and are reproduced below.

| NSCV SUBSECTION 6A CHAPTER 5D - ALTERNATIVE COMPREHENSIVE STABILITY CRITERIA FOR DUMB BARGES | | |
|---|---|---|
| **No.** | **Application Limits** | **Criterion description** |
| 5D.1a | Operational Areas A, B & C | The area beneath the $G_FZ$ curve between 0° and the least of the angle of maximum righting arm, $G_FZ_{max}$, the downflooding angle or 40° shall not be less than 4.58 metre-degrees. |
| 5D.1b | Operational Areas D & E | The area beneath the $G_FZ$ curve between 0° and the least of the angle of maximum righting arm, $G_FZ_{max}$, the downflooding angle or 40° shall not be less than 3.05 metre-degrees. |

As the criteria differ between Operational Areas C and D, the environmental parameters of those areas under the NSCV are of concern in considering the stability of the feeders. The relevant parameters are reproduced below -

| NSCV OPERATIONAL AREA PARAMETERS (Ref: NSCV Part B, Table 6) | | |
|---|---|---|
| **Characteristic** | **Operational C** | **Operational Area D** |
| Assumed Gusting Wind Pressure | 450 Pa | 360 Pa |
| Design Significant Wave Height | 4.5 m | 2.5 m |
| Beaufort Scale | 7 (near gale) | 6 (strong breeze) |
| Operational Characteristics | Restricted operations within a few hours travel of coast. | Operation within Sheltered Waters |

## DESCRIPTION OF THE FEEDERS

The feeders consist of a fabricated aluminium bin mounted above a rectangular float constructed from polyethylene pipe.

The full volume of the bin is 16m$^3$ but, due to the Angle of Repose of the feed, adjusted to 30° to account for the spreading vanes within the bin hatch, the maximum volume of feed contained is 9.717 m$^3$. With a Specific Gravity of 0.667, this volume represents 6.481 tonnes of feed. The bin should not be overfilled by forcing or shovelling feed to the upper corners as this will significantly reduce the stability of the feeder.

At the base of the bin is a spinning disc to distribute the feed.

The polyethylene float is 6 metres long, 5 metres wide and constructed of pipe with a diameter of 1 metre. The float has no inspection or other openings and, accordingly, is regarded as being completely watertight and without any downflooding point.

It should be noted that some feeders have been modified by raising the bin up to 500mm. The stability of those feeders is considered in a separate document. This document considers only the stability in the original configuration, with the underside of the bin 360mm above the upper surface of the float.

## BILGE WATER & WATERTIGHT INTEGRITY

It is assumed throughout this document that the watertight integrity of the float is maintained and that there is no bilge water present. As the free surface effect of any bilge water will have significant effects on the feeder's stability, any leaking feeder should be removed from service and repaired .

## WINDAGE

For the purposes of this document, the Design Waterline is taken to be at a mean draft of 0.623 metres in seawater, corresponding to a total displacement of 9.451 tonnes and a load of 6.481 tonnes of feed. In that condition, the feeder has a windage profile of 7.917 square metres acting on a lever of 1.696 metres.

A wind pressure of 360 Pascals, that considered relevant for Operational Areas D, will result in an effective heeling moment of 4,834 N.m (0.493 tonne.metres).

A wind pressure of 450 Pascals, that considered relevant for Operational Areas C, will result in an effective heeling moment of 6,042 N.m (0.616 tonne.metres).

Although not required by the Chapter C4 stability criteria, the heeling lever curves for both 360 Pa and 450 Pa winds are included in the Loading Condition analyses in this document, for information.

## PERSONS ON BOARD

The feeder is not normally crewed but a maintenance person may be, at times, required to board the feeder and the effect of an 100kg person (in excess of the NSCV 80kg 'standard' person) on one side of the feeder is included in the Loading Conditions of this document for information.

## THE VERTICAL CENTRE OF GRAVITY OF FEED IN THE BIN

| **FEEDER BIN CONTENTS**<br>(Bin Bottom 1,360mm above Vertical Datum)<br><br>Ullage measured from bin upper surface **down** to apex of feed pyramid | | Contents: Bulk Fish Feed<br>Specific Gravity: 0.667<br>Vertical Datum: Underside of Float ***(+ve up)***<br>Long'l Datum: Midship ***(+ve frd)***<br>Trans. Datum: Feeder Centreline ***(+ve Pt)*** | |
|---|---|---|---|
| **Ullage (m)** | **Volume ($m^3$)** | **Weight (t)** | **VCG (m)** |
| -0.100 | 9.717 | 6.481 | 2.333 |
| 0.100 | 7.377 | 4.920 | 2.233 |
| 0.300 | 5.332 | 3.265 | 2.133 |
| 0.500 | 3.701 | 2.469 | 2.033 |
| 0.700 | 2.442 | 1.629 | 1.934 |
| 0.900 | 1.506 | 1.005 | 1.834 |
| 1.100 | 0.846 | 0.564 | 0.375 |

## SUMMARY OF LOADING CONDITIONS CONSIDERED

| **NSCV Subsection 6A** | **Chap 5D – Comprehensive Criteria for Dumb Barges** | | | | | |
|---|---|---|---|---|---|---|
| **Criterion** | | **Required** | **Cond'n 1** | **Cond'n 2** | **Cond'n 3** | **Cond'n 4** |
| | Weight of Feed | | 0.000 t | 3.265 t | 6.000 t | 6.481 t |
| | Angle of Maximum GZ | / | 13.0° | 15.5° | 11.9° | 11.2° |
| | Value of Maximum GZ | / | 1.644 m | 1.247 m | 0.656 m | 0.553 m |
| | Heel angle under the effect of 360 Pa wind | / | 0.7° | 0.6° | 0.7° | 0.8° |
| | Heel angle under the effect of 450 Pa wind | / | 0.8° | 0.8° | 0.9° | 0.9° |
| | Heel angle under the effect of 1 crew on side | / | 0.3° | 0.3° | 0.3° | 0.4° |
| 5D.1a | Area under GZ curve to angle of maximum GZ | 4.58 m.deg | 15.40 deg.m | 12.67 deg.m | 4.74 deg.m | 3.79 deg.m |
| 5D.1b | Area under GZ curve to angle of maximum GZ | 3.05 m.deg | 15.40 deg.m | 12.67 deg.m | 4.74 deg.m | 3.79 deg.m |
| | **Allowable Operational Area** | / | **C & D** | **C & D** | **C & D** | **D only** |

## CONCLUSIONS

The feeders were originally designed to hold up to 6 tonnes of feed and be employed in Operational Areas D and E. Although the feeders were designed before the introduction of the National Standard for Commercial Vessels, the analysis of this document shows that the feeders have adequate stability under Chapter 5D of the NSCV Subsection 6A, applicable to Dumb Barges without accommodations, for operation in Operational Areas C, D and E when loaded with no more than six tonnes of feed or Operational Areas D and E when loaded with more than six tonnes of feed. In no case should the hoppers contain more than 6.5 tonnes of feed.

In addition to the minimum criteria of Chapter 5D, the heel angles induced by gusting winds of 360 Pa (Op Area D) and 450 Pa (Op Area C) were considered and found to be less than one degree and, therefore, to be of no concern when the feeders are normally loaded.

As the feeders possess very high initial stability and the maximum righting arm occurs at a relatively low angle, stability in large waves should also be considered in excess to the Chapter 5D criteria. It is noted that the angle of maximum righting arm in all loading conditions considered is greater than ten degrees. Accordingly, the stability of the feeders in large waves can be considered to be acceptable.

Finally, the heeling effect of an 100kg person on the side of the feeder was considered and found to be of no concern with regard to the stability of the feeder.

## ANNEX – LOADING CONDITIONS

### Loading Condition 01 – Lightship

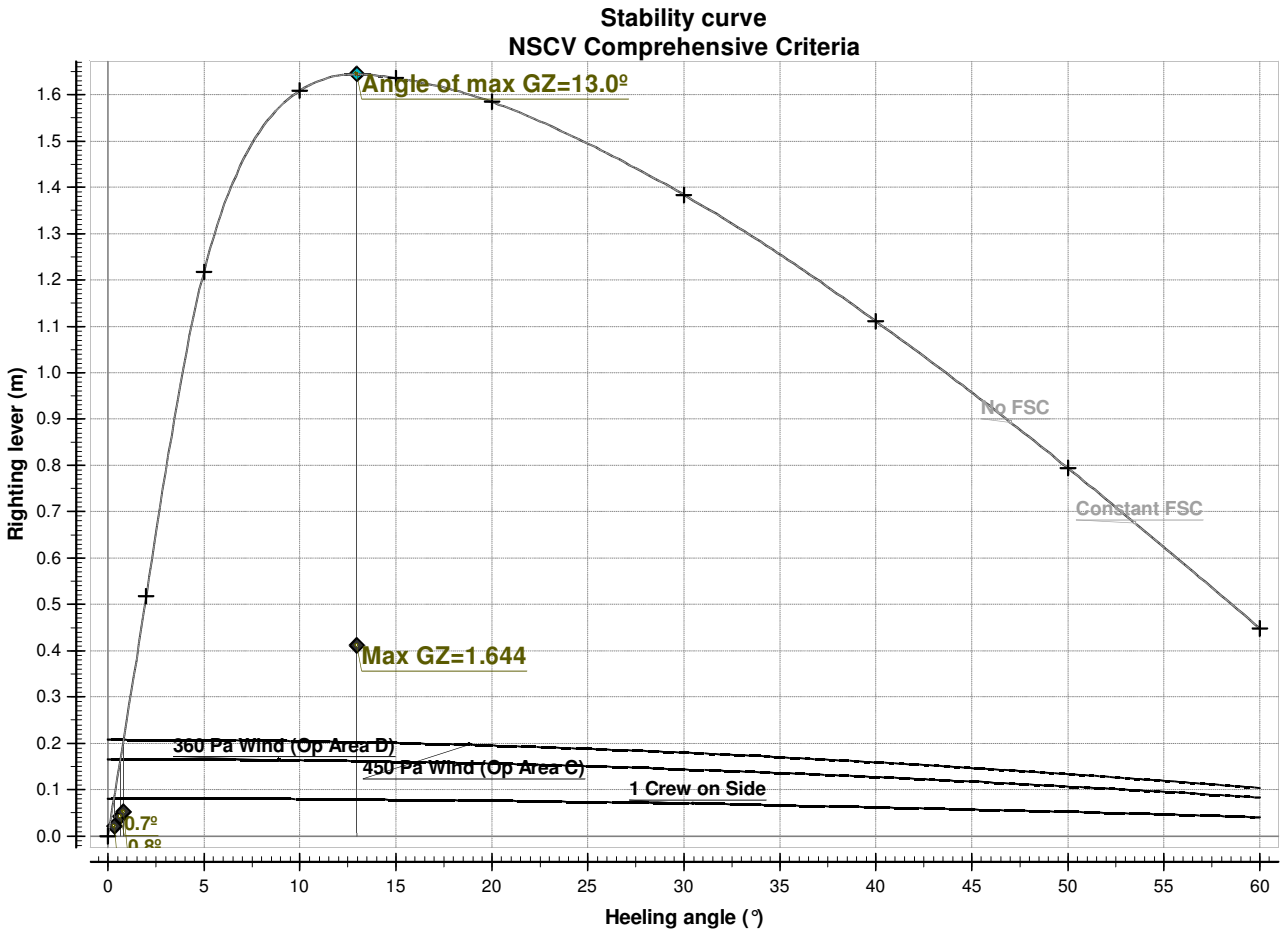
**COMPLIANCE: The feeder bin contains no feed in this condition.**
**The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 0.000 | 0.000 |
| LIGHTSHIP | 2.970 | 0.000 | 0.000 | 0.000 | 0.000 | 1.138 | 3.380 | 0.000 |
| DISPLACEMENT | 2.970 | | 0.000 | | 0.000 | | 3.380 | 0.000 |
| | | 0.000 | | 0.000 | | 1.138 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.138 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 16.097 m |
| Draft at Aft Perp. | 0.260 m | | GM (solid) | 14.959 m |
| Draft (mean) | 0.260 m | | GM (fluid) | 14.959 m |
| Draft at Frd Perp | 0.260 m | | Rate of Immersion | 0.161 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.105 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 13.0° | | / | N/R |
| | Value of Maximum GZ | 1.644 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.7° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.3° | | / | N/R |
| 5D.1a | Area under GZ curve to 13° | 15.40 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 13° | 15.40 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.557 | 0.040 | 0.000 | 0.000 | 0.517 | 0.516 |
| **5.0º** | 1.317 | 0.099 | 0.000 | 0.000 | 1.217 | 3.209 |
| **10.0º** | 1.806 | 0.198 | 0.000 | 0.000 | 1.609 | 10.543 |
| **15.0º** | 1.930 | 0.294 | 0.000 | 0.000 | 1.635 | 18.737 |
| **20.0º** | 1.973 | 0.389 | 0.000 | 0.000 | 1.584 | 26.759 |
| **30.0º** | 1.952 | 0.569 | 0.000 | 0.000 | 1.384 | 41.714 |
| **40.0º** | 1.843 | 0.731 | 0.000 | 0.000 | 1.111 | 54.206 |
| **50.0º** | 1.666 | 0.871 | 0.000 | 0.000 | 0.794 | 63.775 |
| **60.0º** | 1.434 | 0.985 | 0.000 | 0.000 | 0.448 | 70.021 |



**Loading Condition 02 – 3.265 tonnes of feed in bin**

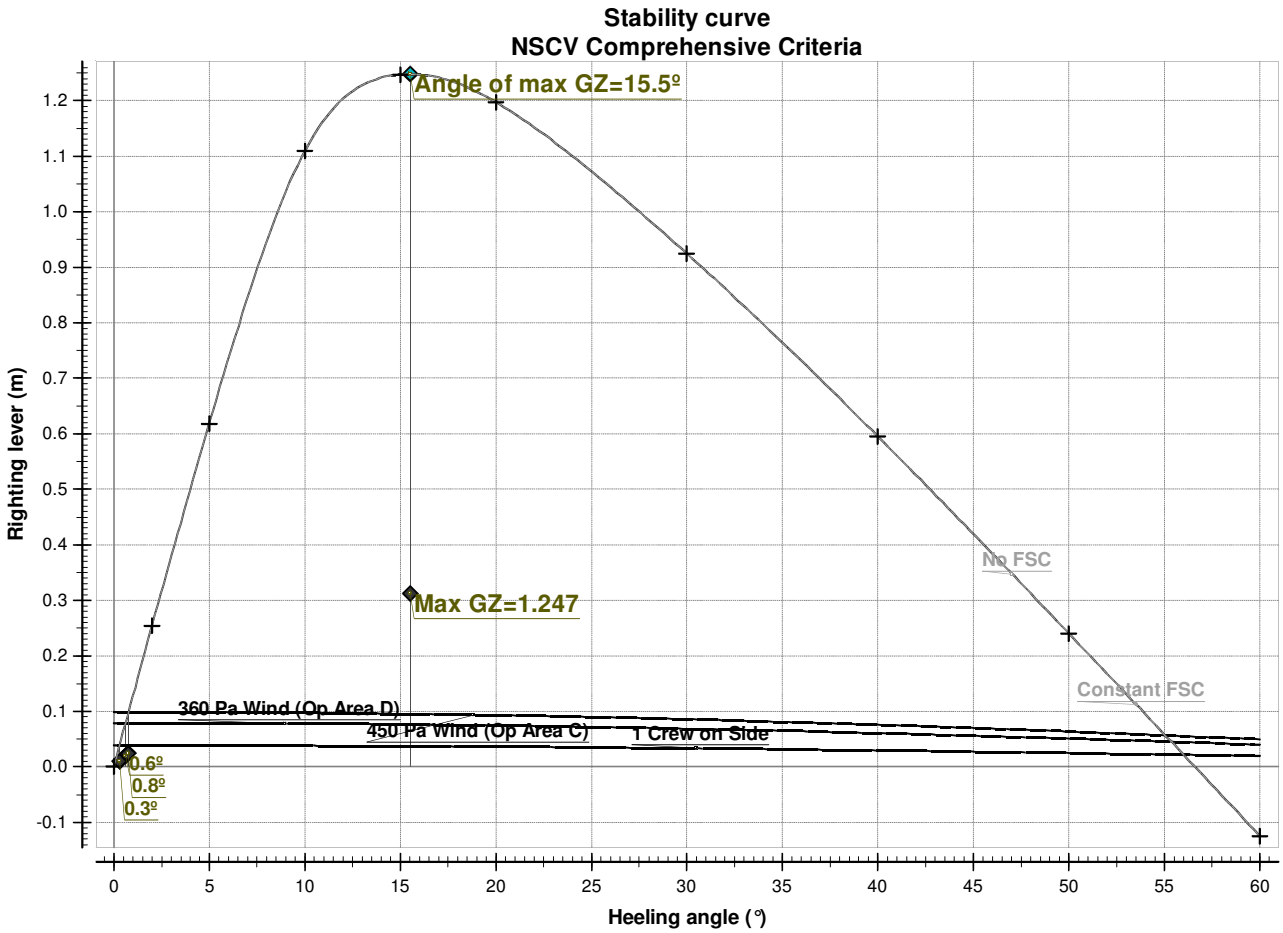
**COMPLIANCE: The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 3.265 | 0.000 | 0.000 | 0.000 | 0.000 | 2.133 | 6.964 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 6.964 | 0.000 |
| LIGHTSHIP | 2.970 | 0.000 | 0.000 | 0.000 | 0.000 | 1.138 | 3.380 | 0.000 |
| DISPLACEMENT | 6.235 | | 0.000 | | 0.000 | | 10.344 | 0.000 |
| | | 0.000 | | 0.000 | | 1.659 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.659 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 8.973 m |
| Draft at Aft Perp. | 0.447 m | | GM (solid) | 7.314 m |
| Draft (mean) | 0.447 m | | GM (fluid) | 7.314 m |
| Draft at Frd Perp | 0.447 m | | Rate of Immersion | 0.183 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.111 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 15.5° | | / | N/R |
| | Value of Maximum GZ | 1.247 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.6° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.3° | | / | N/R |
| 5D.1a | Area under GZ curve to 15.5° | 12.67 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 15.5° | 12.67 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.312 | 0.058 | 0.000 | 0.000 | 0.254 | 0.229 |
| **5.0º** | 0.763 | 0.145 | 0.000 | 0.000 | 0.618 | 1.547 |
| **10.0º** | 1.397 | 0.288 | 0.000 | 0.000 | 1.109 | 6.017 |
| **15.0º** | 1.676 | 0.429 | 0.000 | 0.000 | 1.247 | 12.033 |
| **20.0º** | 1.765 | 0.567 | 0.000 | 0.000 | 1.197 | 18.164 |
| **30.0º** | 1.754 | 0.829 | 0.000 | 0.000 | 0.924 | 28.879 |
| **40.0º** | 1.661 | 1.066 | 0.000 | 0.000 | 0.595 | 36.500 |
| **50.0º** | 1.511 | 1.271 | 0.000 | 0.000 | 0.240 | 40.683 |
| **60.0º** | 1.312 | 1.437 | 0.000 | 0.000 | -0.125 | 41.485 |



**Loading Condition 03 – 6 tonnes of feed in bin**

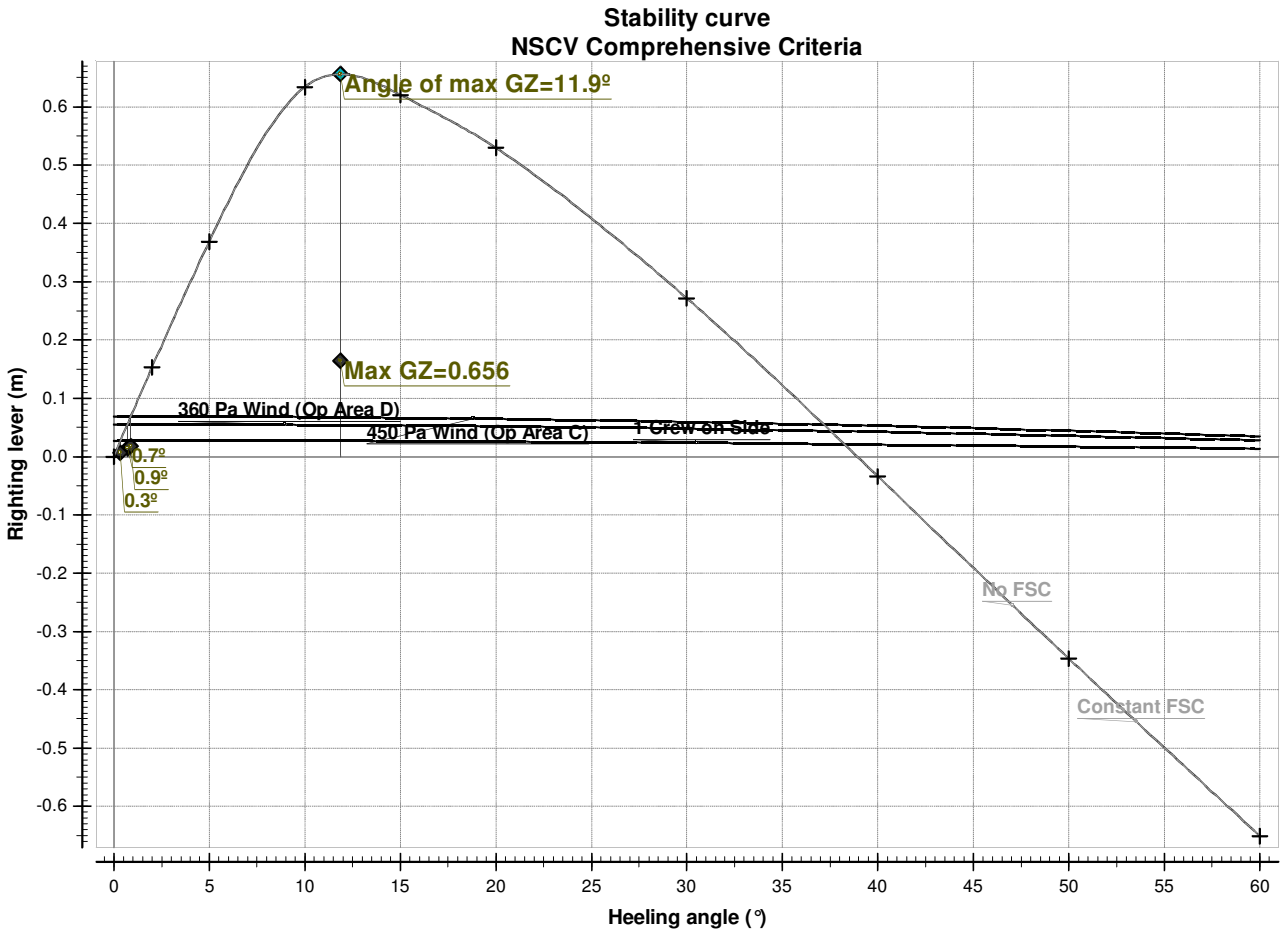
**COMPLIANCE: The feeder bin should contains no more than 6 tonnes of feed in Op Area C.**
**The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 6.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.300 | 13.800 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 13.800 | 0.000 |
| LIGHTSHIP | 2.970 | 0.000 | 0.000 | 0.000 | 0.000 | 1.138 | 3.380 | 0.000 |
| DISPLACEMENT | 8.970 | | 0.000 | | 0.000 | | 17.180 | 0.000 |
| | | 0.000 | | 0.000 | | 1.915 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.915 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 6.309 m |
| Draft at Aft Perp. | 0.596 m | | GM (solid) | 4.394 m |
| Draft (mean) | 0.596 m | | GM (fluid) | 4.394 m |
| Draft at Frd Perp | 0.596 m | | Rate of Immersion | 0.181 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.100 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 11.9° | | / | N/R |
| | Value of Maximum GZ | 0.656 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.7° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 0.9° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.3° | | / | N/R |
| 5D.1a | Area under GZ curve to 11.9° | 4.74 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 11.9° | 4.74 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.219 | 0.067 | 0.000 | 0.000 | 0.153 | 0.172 |
| **5.0º** | 0.536 | 0.167 | 0.000 | 0.000 | 0.369 | 0.917 |
| **10.0º** | 0.966 | 0.333 | 0.000 | 0.000 | 0.634 | 3.553 |
| **15.0º** | 1.116 | 0.496 | 0.000 | 0.000 | 0.620 | 6.761 |
| **20.0º** | 1.185 | 0.655 | 0.000 | 0.000 | 0.529 | 9.626 |
| **30.0º** | 1.229 | 0.958 | 0.000 | 0.000 | 0.271 | 13.695 |
| **40.0º** | 1.197 | 1.231 | 0.000 | 0.000 | -0.034 | 14.955 |
| **50.0º** | 1.120 | 1.467 | 0.000 | 0.000 | -0.347 | 14.955 |
| **60.0º** | 1.008 | 1.659 | 0.000 | 0.000 | -0.651 | 14.955 |



**Loading Condition 04 – 6.481 tonnes of feed in bin**

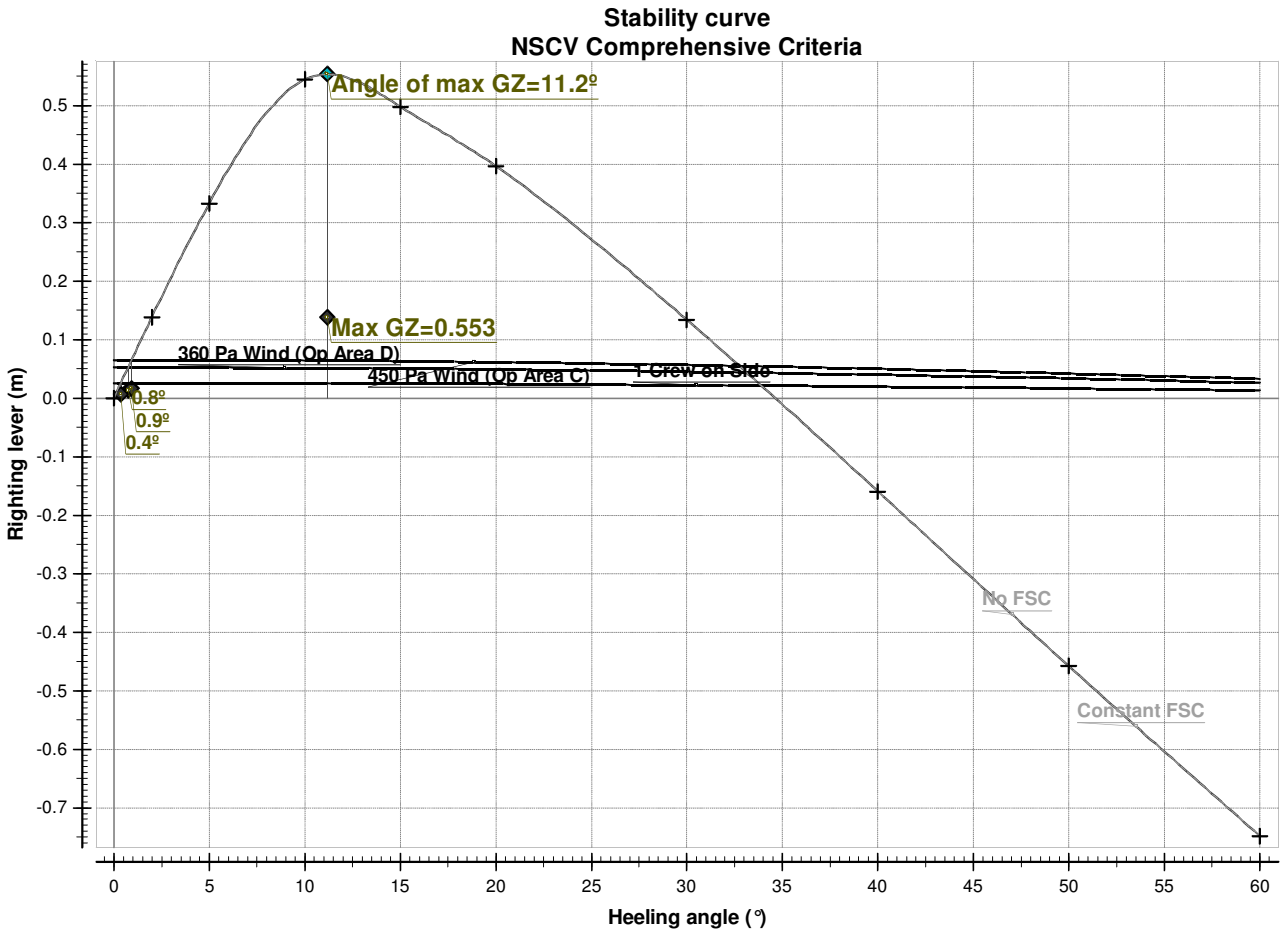
**COMPLIANCE: The feeder bin is loaded to 100mm above the bin top in this condition.**
**The feeder in this condition possesses sufficient stability for Op Area D only.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 6.481 | 0.000 | 0.000 | 0.000 | 0.000 | 2.333 | 15.120 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 15.120 | 0.000 |
| LIGHTSHIP | 2.970 | 0.000 | 0.000 | 0.000 | 0.000 | 1.138 | 3.380 | 0.000 |
| DISPLACEMENT | 9.451 | | 0.000 | | 0.000 | | 18.500 | 0.000 |
| | | 0.000 | | 0.000 | | 1.957 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.957 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 5.951 m |
| Draft at Aft Perp. | 0.623 m | | GM (solid) | 3.994 m |
| Draft (mean) | 0.623 m | | GM (fluid) | 3.994 m |
| Draft at Frd Perp | 0.623 m | | Rate of Immersion | 0.179 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.097 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 11.2° | | / | N/R |
| | Value of Maximum GZ | 0.553 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 0.9° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.4° | | / | N/R |
| 5D.1a | Area under GZ curve to 11.2° | 3.79 deg.m | ≥ | 4.58 m.deg | NO |
| 5D.1b | Area under GZ curve to 11.2° | 3.79 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.207 | 0.068 | 0.000 | 0.000 | 0.138 | 0.115 |
| **5.0º** | 0.503 | 0.171 | 0.000 | 0.000 | 0.333 | 0.860 |
| **10.0º** | 0.884 | 0.340 | 0.000 | 0.000 | 0.544 | 3.152 |
| **15.0º** | 1.004 | 0.507 | 0.000 | 0.000 | 0.498 | 5.845 |
| **20.0º** | 1.066 | 0.669 | 0.000 | 0.000 | 0.396 | 8.079 |
| **30.0º** | 1.112 | 0.979 | 0.000 | 0.000 | 0.134 | 10.772 |
| **40.0º** | 1.099 | 1.258 | 0.000 | 0.000 | -0.159 | 11.059 |
| **50.0º** | 1.041 | 1.499 | 0.000 | 0.000 | -0.458 | 11.059 |
| **60.0º** | 0.947 | 1.695 | 0.000 | 0.000 | -0.748 | 11.059 |



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Design of Specialist Commercial Vessels
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# - HUON 6 TONNE FLOATING FEEDER - (HIGH BIN VERSION)

# STABILITY COMPLIANCE REPORT

## EDITION 1a, 09/01/2016

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**COMPLIANCE CLAUSE**

Compliance with the NSCV stability criteria specified in this manual does not ensure the vessel may not capsize or founder.

The Master must, at all times, exercise caution and good seapersonship with regard to present and future weather conditions, the navigational environment and the vessel's resources in order to discharge his/her responsibilities to the safety to the vessel and its complement. Particular care should be taken during crane lifting operations to ensure the load is under control at all times and that the stability of the vessel is not degraded by sea or weather conditions.

## STABILITY CRITERIA

The feeders are unpowered, provide no accommodations and are not normally crewed. Acordingly, they meet the definition of Dumb Barges' within the National Standard for Commercial Vessels (NSCV) Subsection 6A. The minimum stability criteria for Dumb Barges are specified in Chapter 5D 'Alternative Comprehensive Criteria for Dumb Barges' of the subsection and are reproduced below.

| NSCV SUBSECTION 6A CHAPTER 5D - ALTERNATIVE COMPREHENSIVE STABILITY CRITERIA FOR DUMB BARGES | | |
|---|---|---|
| **No.** | **Application Limits** | **Criterion description** |
| 5D.1a | Operational Areas A, B & C | The area beneath the $G_FZ$ curve between 0° and the least of the angle of maximum righting arm, $G_FZ_{max}$, the downflooding angle or 40° shall not be less than 4.58 metre-degrees. |
| 5D.1b | Operational Areas D & E | The area beneath the $G_FZ$ curve between 0° and the least of the angle of maximum righting arm, $G_FZ_{max}$, the downflooding angle or 40° shall not be less than 3.05 metre-degrees. |

As the criteria differ between Operational Areas C and D, the environmental parameters of those areas under the NSCV are of concern in considering the stability of the feeders. The relevant parameters are reproduced below -

| NSCV OPERATIONAL AREA PARAMETERS (Ref: NSCV Part B, Table 6) | | |
|---|---|---|
| **Characteristic** | **Operational C** | **Operational Area D** |
| Assumed Gusting Wind Pressure | 450 Pa | 360 Pa |
| Design Significant Wave Height | 4.5 m | 2.5 m |
| Beaufort Scale | 7 (near gale) | 6 (strong breeze) |
| Operational Characteristics | Restricted operations within a few hours travel of coast. | Operation within Sheltered Waters |

## DESCRIPTION OF THE FEEDERS

The feeders consist of a fabricated aluminium bin mounted above a rectangular float constructed from polyethylene pipe.

The full volume of the bin is 16m$^3$ but, due to the Angle of Repose of the feed, adjusted to 30° to account for the spreading vanes within the bin hatch, the maximum volume of feed contained is 9.717 m$^3$. With a Specific Gravity of 0.667, this volume represents 6.481 tonnes of feed. The bin should not be overfilled by forcing or shovelling feed to the upper corners as this will significantly reduce the stability of the feeder.

At the base of the bin is a spinning disc to distribute the feed.

The polyethylene float is 6 metres long, 5 metres wide and constructed of pipe with a diameter of 1 metre. The float has no inspection or other openings and, accordingly, is regarded as being completely watertight and without any downflooding point.

It should be noted that some feeders have been modified by raising the bin up to 500mm. This document considers the stability of those feeders. The stability of the feeders in the original configuration, with the underside of the bin 360mm above the upper surface of the float, is considered in a separate document.

## BILGE WATER & WATERTIGHT INTEGRITY

It is assumed throughout this document that the watertight integrity of the float is maintained and that there is no bilge water present. As the free surface effect of any bilge water will have significant effects on the feeder's stability, any leaking feeder should be removed from service and repaired .

## WINDAGE

For the purposes of this document, the Design Waterline is taken to be at a mean draft of 0.623 metres in seawater, corresponding to a total displacement of 9.451 tonnes and a load of 6.481 tonnes of feed. In that condition, the feeder has a windage profile of 7.917 square metres acting on a lever of 2.060 metres.

A wind pressure of 360 Pascals, that considered relevant for Operational Areas D, will result in an effective heeling moment of 5,871 N.m (0.598 tonne.metres).

A wind pressure of 450 Pascals, that considered relevant for Operational Areas C, will result in an effective heeling moment of 7,339 N.m (0.748 tonne.metres).

Although not required by the Chapter C4 stability criteria, the heeling lever curves for both 360 Pa and 450 Pa winds are included in the Loading Condition analyses in this document, for information.

## PERSONS ON BOARD

The feeder is not normally crewed but a maintenance person may be, at times, required to board the feeder and the effect of an 100kg person (in excess of the NSCV 80kg 'standard' person) on one side of the feeder is included in the Loading Conditions of this document for information.

## THE VERTICAL CENTRE OF GRAVITY OF FEED IN THE BIN

| **FEEDER BIN CONTENTS**<br>(Bin Bottom 1,360mm above Vertical Datum)<br><br>Ullage measured from bin upper surface **down** to apex of feed pyramid | | Contents: Bulk Fish Feed<br>Specific Gravity: 0.667<br>Vertical Datum: Underside of Float ***(+ve up)***<br>Long'l Datum: Midship ***(+ve frd)***<br>Trans. Datum: Feeder Centreline ***(+ve Pt)*** | |
|---|---|---|---|
| **Ullage (m)** | **Volume ($m^3$)** | **Weight (t)** | **VCG (m)** |
| -0.100 | 9.717 | 6.481 | 2.833 |
| 0.100 | 7.377 | 4.920 | 2.733 |
| 0.300 | 5.332 | 3.265 | 2.633 |
| 0.500 | 3.701 | 2.469 | 2.533 |
| 0.700 | 2.442 | 1.629 | 2.434 |
| 0.900 | 1.506 | 1.005 | 2.334 |
| 1.100 | 0.846 | 0.564 | 2.275 |

## SUMMARY OF LOADING CONDITIONS CONSIDERED

| **NSCV Subsection 6A** | **Chap 5D – Comprehensive Criteria for Dumb Barges** | | | | | |
|---|---|---|---|---|---|---|
| **Criterion** | | **Required** | **Cond'n 1** | **Cond'n 2** | **Cond'n 3** | **Cond'n 4** |
| | Weight of Feed | | 0.000 t | 3.265 t | 5.700 t | 6.481 t |
| | Angle of Maximum GZ | / | 12.5° | 14.5° | 11.8° | 10.7° |
| | Value of Maximum GZ | / | 1.606 m | 1.157 m | 0.634 m | 0.482 m |
| | Heel angle under the effect of 360 Pa wind | / | 0.8° | 0.8° | 0.9° | 1.0° |
| | Heel angle under the effect of 450 Pa wind | / | 1.0° | 1.0° | 1.2° | 1.3° |
| | Heel angle under the effect of 1 crew on side | / | 0.3° | 0.3° | 0.4° | 0.4° |
| 5D.1a | Area under GZ curve to angle of maximum GZ | 4.58 m.deg | 14.40 deg.m | 10.74 deg.m | 4.58 deg.m | 3.13 deg.m |
| 5D.1b | Area under GZ curve to angle of maximum GZ | 3.05 m.deg | 14.40 deg.m | 10.74 deg.m | 4.58 deg.m | 3.13 deg.m |
| | **Allowable Operational Area** | **/** | **C & D** | **C & D** | **C & D** | **D only** |

## CONCLUSIONS

The feeders were originally designed to hold up to 6 tonnes of feed and be employed in Operational Areas D and E. Although the feeders were designed before the introduction of the National Standard for Commercial Vessels, the analysis of this document shows that the feeders have adequate stability under Chapter 5D of the NSCV Subsection 6A, applicable to Dumb Barges without accommodations, for operation in Operational Areas C, D and E when loaded with no more than 5.7 tonnes of feed or Operational Areas D and E when loaded with more than six tonnes of feed. In no case should the hoppers contain more than 6.5 tonnes of feed.

In addition to the minimum criteria of Chapter 5D, the heel angles induced by gusting winds of 360 Pa (Op Area D) and 450 Pa (Op Area C) were considered and found to be less than 1.5 degrees and, therefore, to be of no concern when the feeders are normally loaded.

As the feeders possess very high initial stability and the maximum righting arm occurs at a relatively low angle, stability in large waves should also be considered in excess to the Chapter 5D criteria. It is noted that the angle of maximum righting arm in all loading conditions considered is greater than ten degrees. Accordingly, the stability of the feeders in large waves can be considered to be acceptable.

Finally, the heeling effect of an 100kg person on the side of the feeder was considered and found to be of no concern with regard to the stability of the feeder.

## ANNEX – LOADING CONDITIONS

### Loading Condition 01 – Lightship

**COMPLIANCE: The feeder bin contains no feed in this condition.**
**The feeder in this condition possesses sufficient stability for Op Areas C & D**

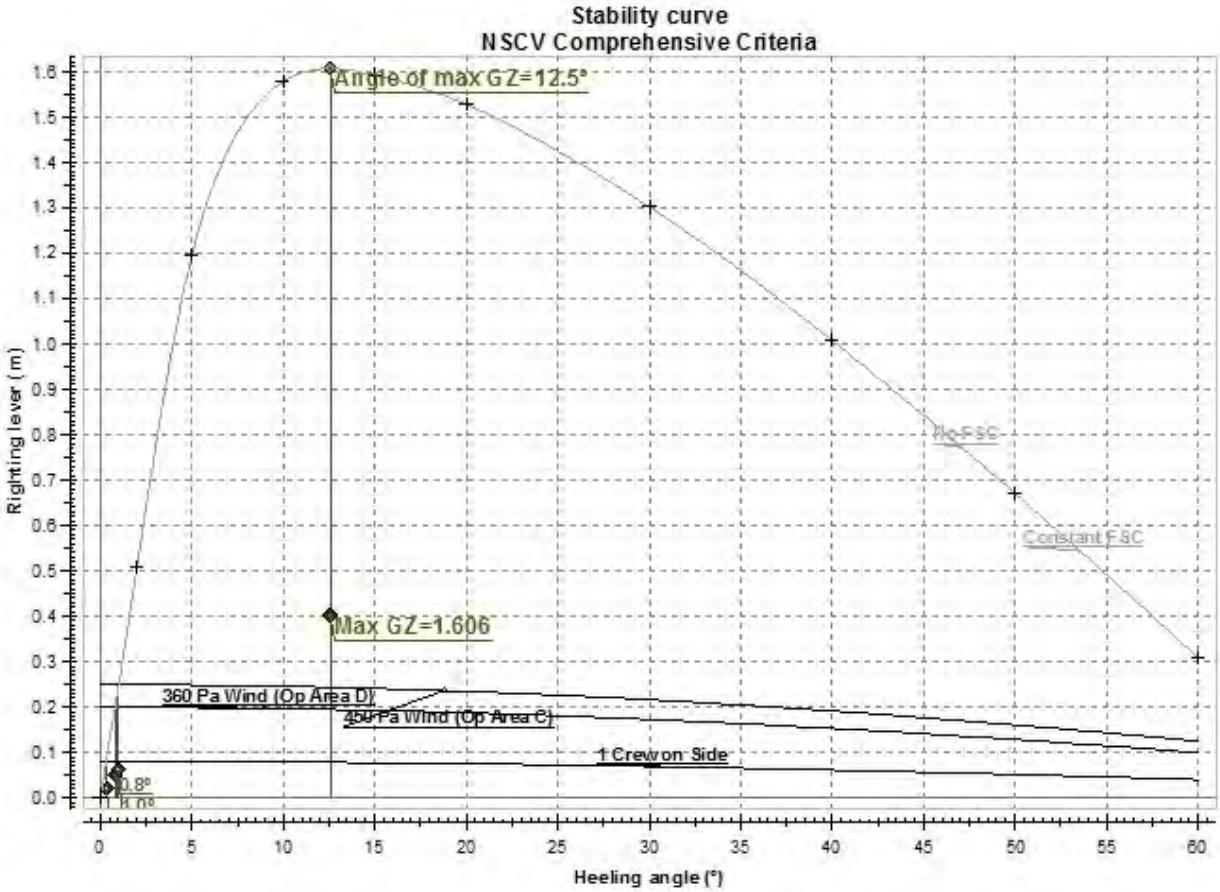
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | +ve direction | UP |
|---|---|---|---|---|
| | Long'l Datum | Midship | +ve direction | FRD |
| | Trans. Datum | Vessel Centreline | +ve direction | PORT |
| | | | Water S. G. | 1.025 |

| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
|---|---|---|---|---|---|---|---|---|
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 0.000 | 0.000 |
| LIGHTSHIP | 3.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.300 | 3.900 | 0.000 |
| DISPLACEMENT | 3.000 | | 0.000 | | 0.000 | | 3.900 | 0.000 |
| | | 0.000 | | 0.000 | | 1.3.00 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.300 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 15.974 m |
| Draft at Aft Perp. | 0.262 m | | GM (solid) | 14.675 m |
| Draft (mean) | 0.262 m | | GM (fluid) | 14.675 m |
| Draft at Frd Perp | 0.262 m | | Rate of Immersion | 0.162 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.104 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 12.5° | | / | N/R |
| | Value of Maximum GZ | 1.606 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.0° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.3° | | / | N/R |
| 5D.1a | Area under GZ curve to 12.5° | 14.40 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 12.5° | 14.40 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |



**Loading Condition 02 – 3.265 tonnes of feed in bin**

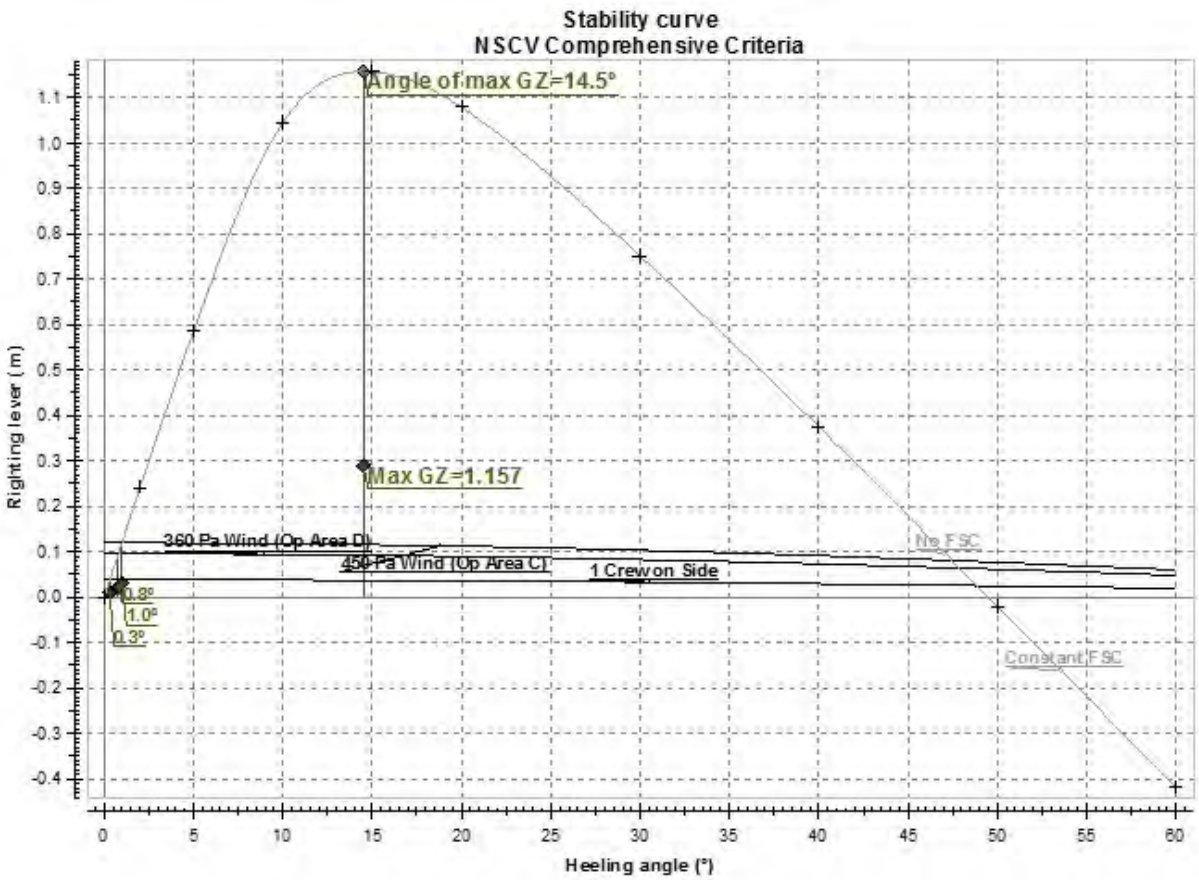
**COMPLIANCE: The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 3.265 | 0.000 | 0.000 | 0.000 | 0.000 | 2.633 | 8.597 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 8.597 | 0.000 |
| LIGHTSHIP | 3.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.300 | 3.900 | 0.000 |
| DISPLACEMENT | 6.265 | | 0.000 | | 0.000 | | 12.497 | 0.000 |
| | | 0.000 | | 0.000 | | 1.995 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 1.995 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 8.932 m |
| Draft at Aft Perp. | 0.448 m | | GM (solid) | 6.937 m |
| Draft (mean) | 0.448 m | | GM (fluid) | 6.937 m |
| Draft at Frd Perp | 0.448 m | | Rate of Immersion | 0.183 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.107 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 14.5° | | / | N/R |
| | Value of Maximum GZ | 1.157 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.8° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.0° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.3° | | / | N/R |
| 5D.1a | Area under GZ curve to 14.5° | 10.74 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 14.5° | 10.74 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.311 | 0.070 | 0.000 | 0.000 | 0.241 | 0.229 |
| **5.0º** | 0.759 | 0.174 | 0.000 | 0.000 | 0.586 | 1.490 |
| **10.0º** | 1.392 | 0.346 | 0.000 | 0.000 | 1.045 | 5.673 |
| **15.0º** | 1.673 | 0.516 | 0.000 | 0.000 | 1.157 | 11.288 |
| **20.0º** | 1.761 | 0.682 | 0.000 | 0.000 | 1.079 | 16.961 |
| **30.0º** | 1.749 | 0.997 | 0.000 | 0.000 | 0.751 | 26.186 |
| **40.0º** | 1.657 | 1.282 | 0.000 | 0.000 | 0.375 | 31.802 |
| **50.0º** | 1.507 | 1.528 | 0.000 | 0.000 | -0.021 | 33.635 |
| **60.0º** | 1.309 | 1.727 | 0.000 | 0.000 | -0.418 | 33.635 |



**Loading Condition 03 – 5.7 tonnes of feed in bin**

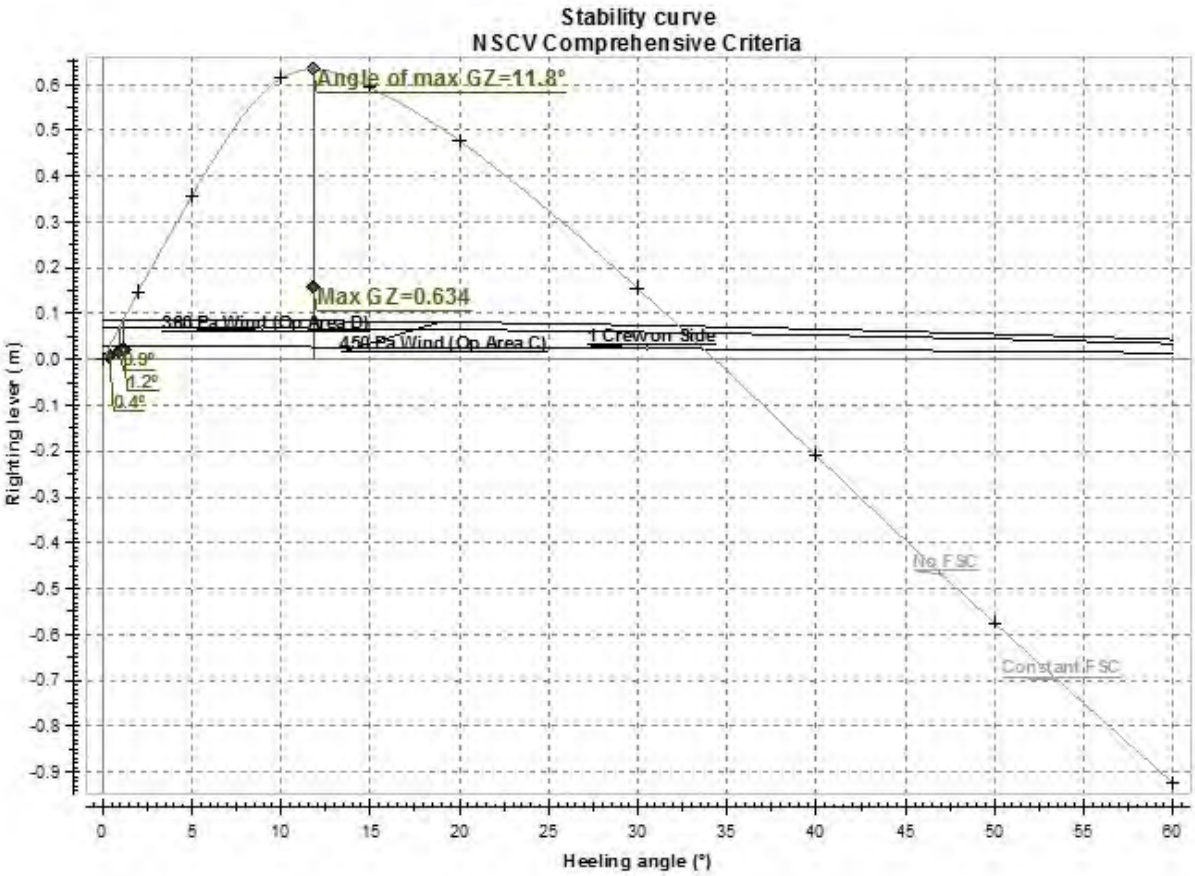
**COMPLIANCE: The feeder bin should contains no more than 5.7 tonnes of feed in Op Area C**
**The feeder in this condition possesses sufficient stability for Op Areas C & D**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 5.700 | 0.000 | 0.000 | 0.000 | 0.000 | 2.780 | 15.846 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 15.846 | 0.000 |
| LIGHTSHIP | 3.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.300 | 3.900 | 0.000 |
| DISPLACEMENT | 8.700 | | 0.000 | | 0.000 | | 19.746 | 0.000 |
| | | 0.000 | | 0.000 | | 2,270 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 2.270 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 6.527 m |
| Draft at Aft Perp. | 0.581 m | | GM (solid) | 4.258 m |
| Draft (mean) | 0.581 m | | GM (fluid) | 4.258 m |
| Draft at Frd Perp | 0.581 m | | Rate of Immersion | 0.182 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.096 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 11.8° | | / | N/R |
| | Value of Maximum GZ | 0.634 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 0.9° | | / | N/R |
| | Heel angle under the effect of 450 Pa wind | 1.2° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.4° | | / | N/R |
| 5D.1a | Area under GZ curve to 11.8° | 4.58 deg.m | ≥ | 4.58 m.deg | YES |
| 5D.1b | Area under GZ curve to 11.8° | 4.58 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.227 | 0.079 | 0.000 | 0.000 | 0.148 | 0.172 |
| **5.0º** | 0.554 | 0.198 | 0.000 | 0.000 | 0.357 | 0.917 |
| **10.0º** | 1.008 | 0.394 | 0.000 | 0.000 | 0.614 | 3.440 |
| **15.0º** | 1.181 | 0.587 | 0.000 | 0.000 | 0.593 | 6.635 |
| **20.0º** | 1.254 | 0.776 | 0.000 | 0.000 | 0.477 | 9.225 |
| **30.0º** | 1.290 | 1.135 | 0.000 | 0.000 | 0.155 | 12.434 |
| **40.0º** | 1.248 | 1.459 | 0.000 | 0.000 | -0.211 | 12.778 |
| **50.0º** | 1.163 | 1.739 | 0.000 | 0.000 | -0.575 | 12.778 |
| **60.0º** | 1.041 | 1.965 | 0.000 | 0.000 | -0.924 | 12.778 |



**Loading Condition 04 – 6.481 tonnes of feed in bin**

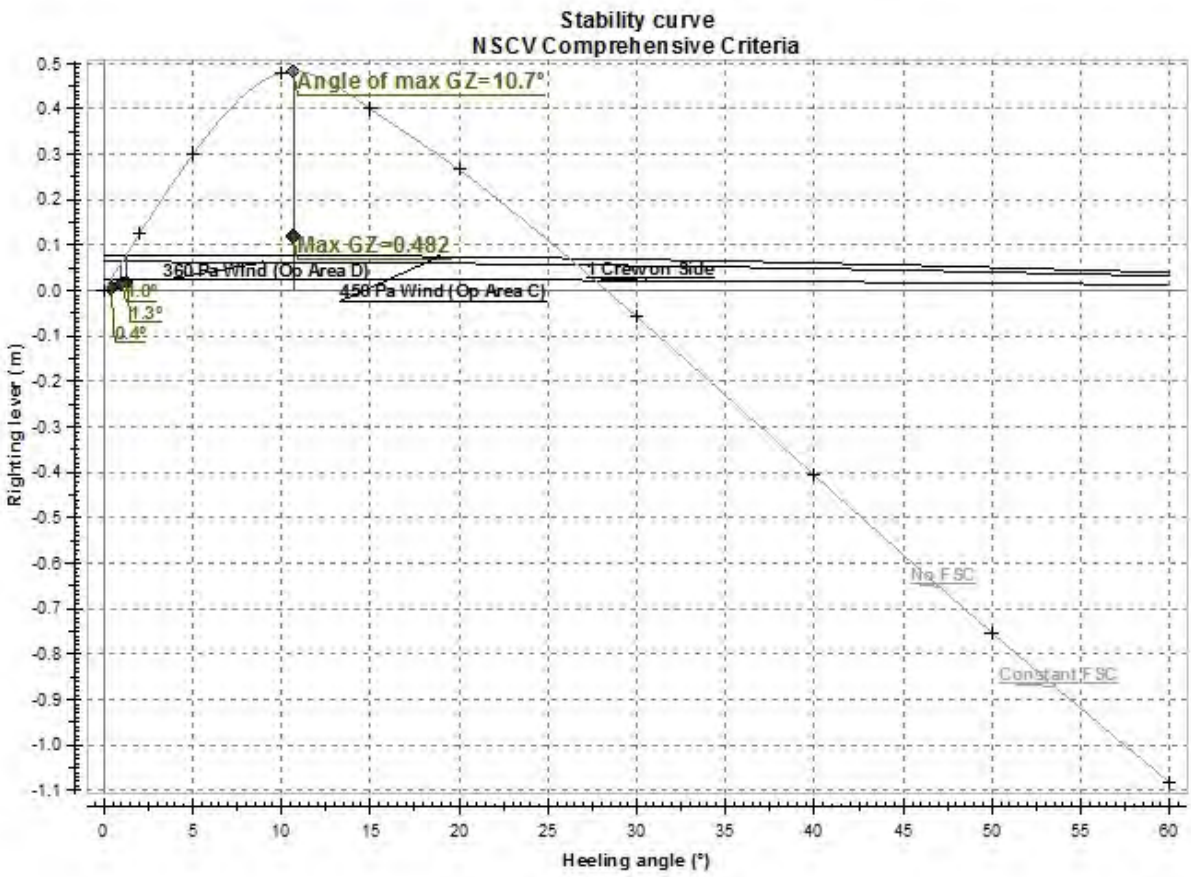
**COMPLIANCE: The feeder bin is loaded to 100mm above the bin top in this condition.**
**The feeder in this condition possesses sufficient stability for Op Area D only.**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **DWT TABLE** | Vertical Datum | Base Line (Underside of float) | | | | +ve direction | | UP |
| | Long'l Datum | Midship | | | | +ve direction | | FRD |
| | Trans. Datum | Vessel Centreline | | | | +ve direction | | PORT |
| | | | | | | Water S. G. | | 1.025 |
| ITEM | W'ght | LCG | LM | TCG | TM | VCG | VM | FSM |
| | tonnes | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***m*** | ***t.m*** | ***t.m*** |
| | | | | | | | | |
| Feed | 6.481 | 0.000 | 0.000 | 0.000 | 0.000 | 2.833 | 18.361 | 0.000 |
| | | | | | | | | |
| DEADWEIGHT | 0.000 | | 0.000 | | 0.000 | | 18.361 | 0.000 |
| LIGHTSHIP | 3.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.300 | 3.900 | 0.000 |
| DISPLACEMENT | 9.481 | | 0.000 | | 0.000 | | 22.261 | 0.000 |
| | | 0.000 | | 0.000 | | 2.346 | | |
| Free Surface Correction | | | | | | 0.000 | | |
| $VCG_f$ | | | | | | 2.346 | | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | 0.0° | | KMT | 5.960 m |
| Draft at Aft Perp. | 0.622 m | | GM (solid) | 3.615 m |
| Draft (mean) | 0.622 m | | GM (fluid) | 3.615 m |
| Draft at Frd Perp | 0.622 m | | Rate of Immersion | 0.179 t/cm |
| Trim by Bow | 0.000 m | | Moment to trim 1cm | 0.091 t.m / cm |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5D – Comprehensive Criteria for Dumb Barges | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| | Angle of Maximum GZ | 10.7° | | / | N/R |
| | Value of Maximum GZ | 0.482 m | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 1.0° | | / | N/R |
| | Heel angle under the effect of 360 Pa wind | 1.3° | | / | N/R |
| | Heel angle under the effect of 1 crew on side | 0.4° | | / | N/R |
| 5D.1a | Area under GZ curve to 10.7° | 3.13 deg.m | ≥ | 4.58 m.deg | NO |
| 5D.1b | Area under GZ curve to 10.7° | 3.13 deg.m | ≥ | 3.05 m.deg | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| ***deg*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m*** | ***m.deg*** |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| **2.0º** | 0.207 | 0.082 | 0.000 | 0.000 | 0.125 | 0.115 |
| **5.0º** | 0.504 | 0.204 | 0.000 | 0.000 | 0.300 | 0.745 |
| **10.0º** | 0.887 | 0.407 | 0.000 | 0.000 | 0.479 | 2.808 |
| **15.0º** | 1.007 | 0.607 | 0.000 | 0.000 | 0.400 | 5.100 |
| **20.0º** | 1.069 | 0.802 | 0.000 | 0.000 | 0.267 | 6.761 |
| **30.0º** | 1.115 | 1.173 | 0.000 | 0.000 | -0.057 | 7.907 |
| **40.0º** | 1.102 | 1.508 | 0.000 | 0.000 | -0.406 | 7.907 |
| **50.0º** | 1.044 | 1.797 | 0.000 | 0.000 | -0.753 | 7.907 |
| **60.0º** | 0.938 | 2.031 | 0.000 | 0.000 | -1.083 | 7.907 |



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Design of Specialist Commercial Vessels
Design of Cruising Motor & Sailing Boats
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Stability Assessments
Project Management
System Design & Optimisation
Marine & Aquaculture Solutions

# - UNPOWERED SITE BARGE 'HUNTER' -

# OPERATOR'S STABILITY MANUAL
# &
# STABILITY COMPLIANCE REPORT

## EDITION 1a, 10/12/2015

An approved and stamped copy of this Stability Book must be on board the vessel and available to the persons responsible for the safe loading and operation of the vessel at all times the vessel is in operation.

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| **VESSEL PARTICULARS** | | |
|---|---|---|
| **AMSA Unique Identifier** | 5607 | |
| **Measured Length** | 23.950 metres | $L_M$ |
| **Length on Deck** | 23.950 metres | $L_{OD}$ |
| **Length for Hydrostatics** | 23.950 metres | $L_H$ |
| **Moulded Breadth** | 11.453 metres | $B_M$ |
| **Moulded Depth** | 2.990 metres | $D_M$ |
| **Design Mean Draft** | 2.116 metres | $T_D$ |
| **Lightship Displacement** | 231.761 tonnes | *L'SHIP* |
| **Displacement at Design Draft** | 618.387 tonnes (salt water) | $DISP_D$ |
| **Maximum Number of Persons** | 12 Persons | |

**COMPLIANCE CLAUSE**

Compliance with the NSCV stability criteria specified in this manual does not ensure the vessel may not capsize or founder.

The Master must, at all times, exercise caution and good seapersonship with regard to present and future weather conditions, the navigational environment and the vessel's resources in order to discharge his/her responsibilities to the safety to the vessel and its complement. Particular care should be taken during crane lifting operations to ensure the load is under control at all times and that the stability of the vessel is not degraded by sea or weather conditions.

NOTES

01. THIS DOCUMENT IS TO BE READ IN CONJUNCTION WITH ALL OTHER DOCUMENTS PROVIDED WITH REFERENCE TO THE PROJECT.
02. THE CLIENT SHOULD FULLY INSPECT AND CHECK THIS DOCUMENT FOR CONSISTENCY, ACCURACY, OMISSIONS AND FITNESS FOR PURPOSE BEFORE ITS USE. ANY FINDINGS SHOULD BE REPORTED TO DESIGNER.
03. THIS DOCUMENT IS NOT TO BE COPIED IN ANY MANNER WITHOUT PRIOR PERMISSION.
04. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
05. DO NOT SCALE FROM THIS DRAWING. ASK!

| | |
|---|---|
| SCALE: | 1/100 |
| PAPER SIZE: | A3 |
| JOB: | 5607 / 20750 HAC BARGE |
| DWG No.: | GA - 067 - R02 |
| DATE: | 06/05/2015 |
| DRAWN: | MURRAY ISLES |
| | 3rd ANGLE PROJECTION |

# MURRAY ISLES

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| | |
|---|---|
| CLIENT: | HAYWARDS STEEL FABRICATION & CONSTRUCTION |
| VESSEL: | 23.750 MT OFFSHORE FEED BARGE 'HUNTER' |
| TITLE: | GENERAL ARRANGEMENTS 1 |

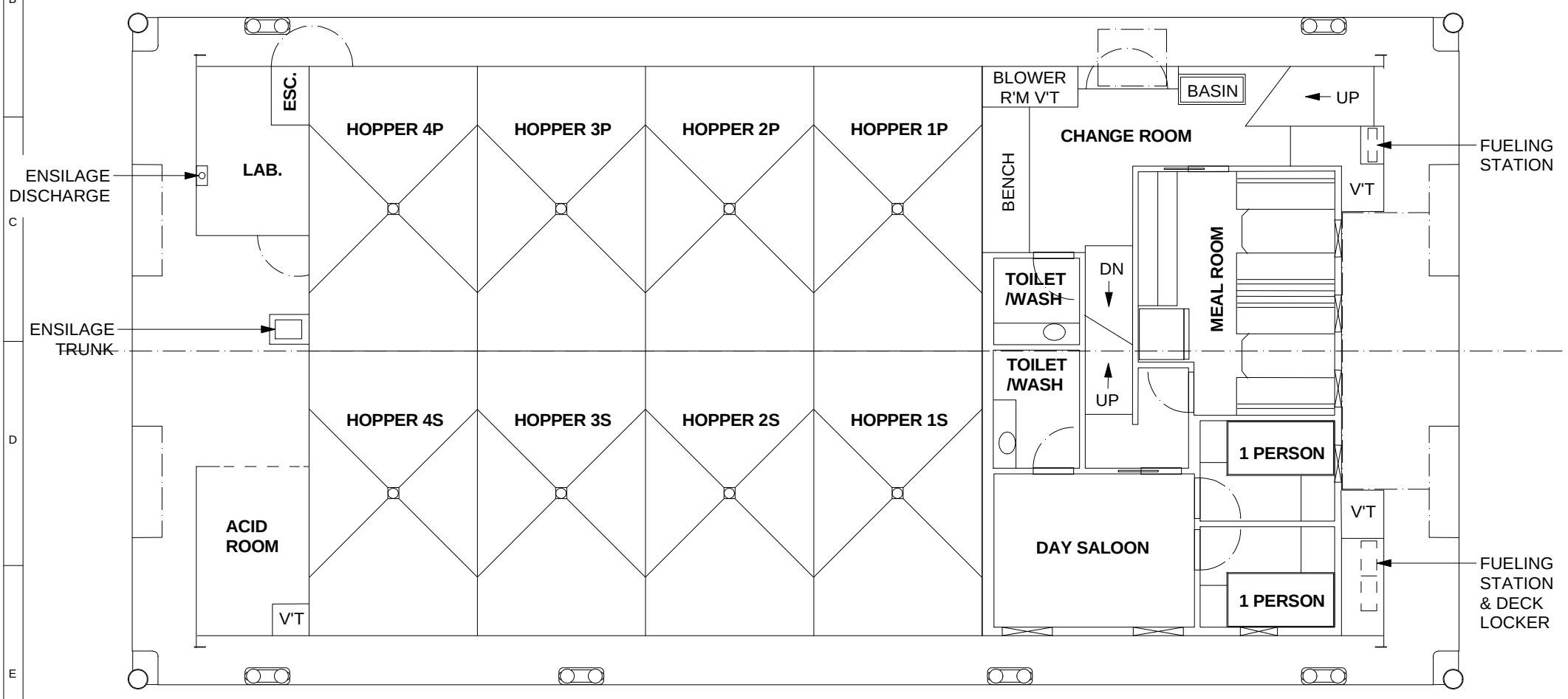
**THIS DOCUMENT IS FOR RELEASE**

| No. | DATE | REVISION | LOCAT'N |
|---|---|---|---|
| 01 | 07/05/2015 | DO TANKS & BLOWER ROOM ARRANGEMENT REVISED IN OFFSHORE VERSION | |
| 02 | 01/12/2015 | DIESEL-ELECTRIC POWER SYSTEM FITTED, BATTERIES ON UPPER DK | |

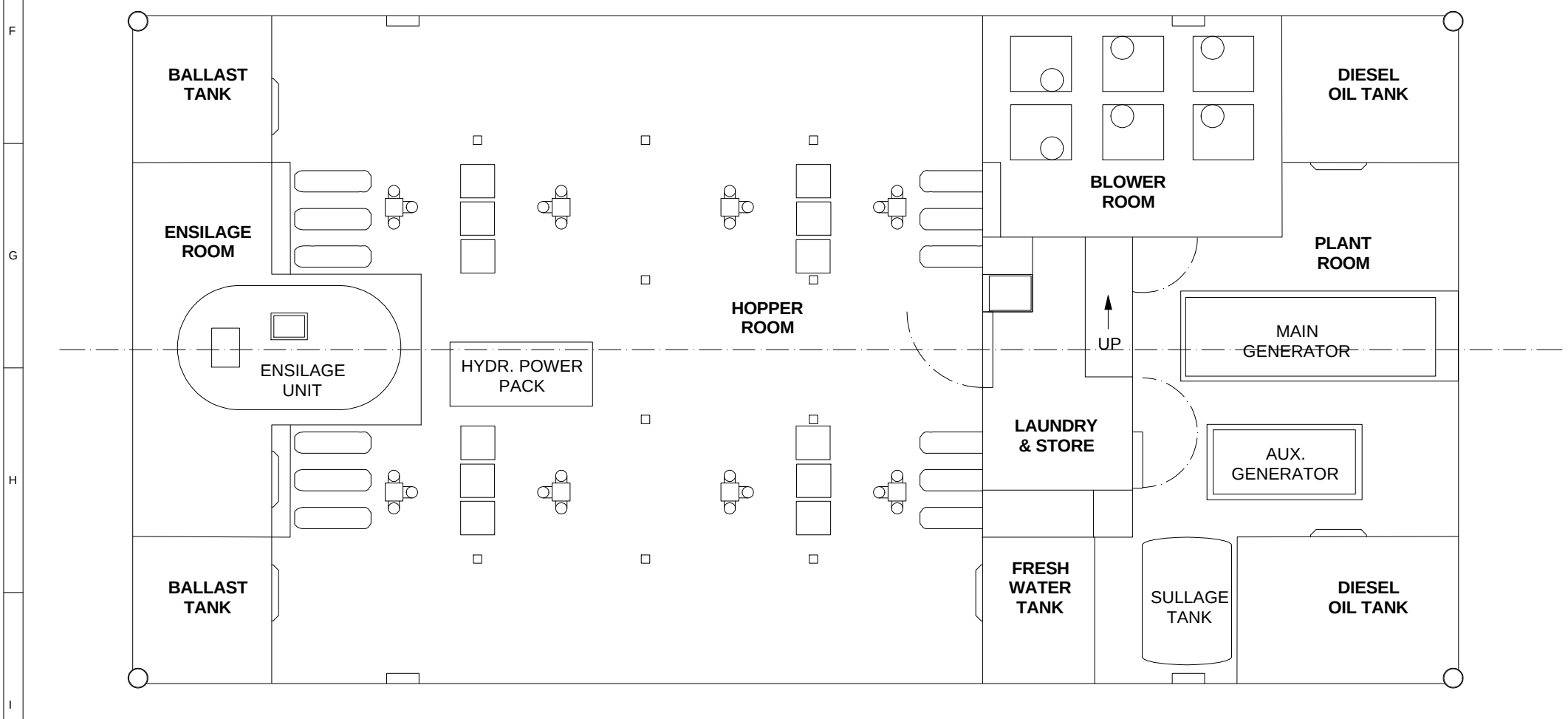
## VESSEL PARTICULARS

| | |
|---|---|
| AMSA UNIQUE IDENTIFIER | 5607 |
| MEASURED LENGTH | 23.750 m |
| LENGTH ON DECK | 23.750 m |
| MOULDED BREADTH | 11.453 m |
| MOULDED DEPTH | 2.990 m |
| LIGHTSHIP DISPLACEMENT | 238.533 t |
| DESIGN DISPLACEMENT | 625.527 t |
| DESIGN MEAN DRAFT | 2.139 m |
| DESIGN MEAN FREEBOARD | 0.865 m |
| MINIMUM FREEBOARD | 0.775 m |

## WEATHER DECK PLAN




## LOWER DECK PLAN



NOTES

01. THIS DOCUMENT IS TO BE READ IN CONJUNCTION WITH ALL OTHER DOCUMENTS PROVIDED WITH REFERENCE TO THE PROJECT.
02. THE CLIENT SHOULD FULLY INSPECT AND CHECK THIS DOCUMENT FOR CONSISTENCY, ACCURACY, OMISSIONS AND FITNESS FOR PURPOSE BEFORE ITS USE. ANY FINDINGS SHOULD BE REPORTED TO DESIGNER.
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| | |
|---|---|
| SCALE: | 1/100 |
| PAPER SIZE: | A3 |
| JOB: | 5607 / 20750 HAC BARGE |
| DWG No.: | GA - 068 - R02 |
| DATE: | 06/05/2015 |
| DRAWN: | MURRAY ISLES |
| | 3rd ANGLE PROJECTION |


# MURRAY ISLES

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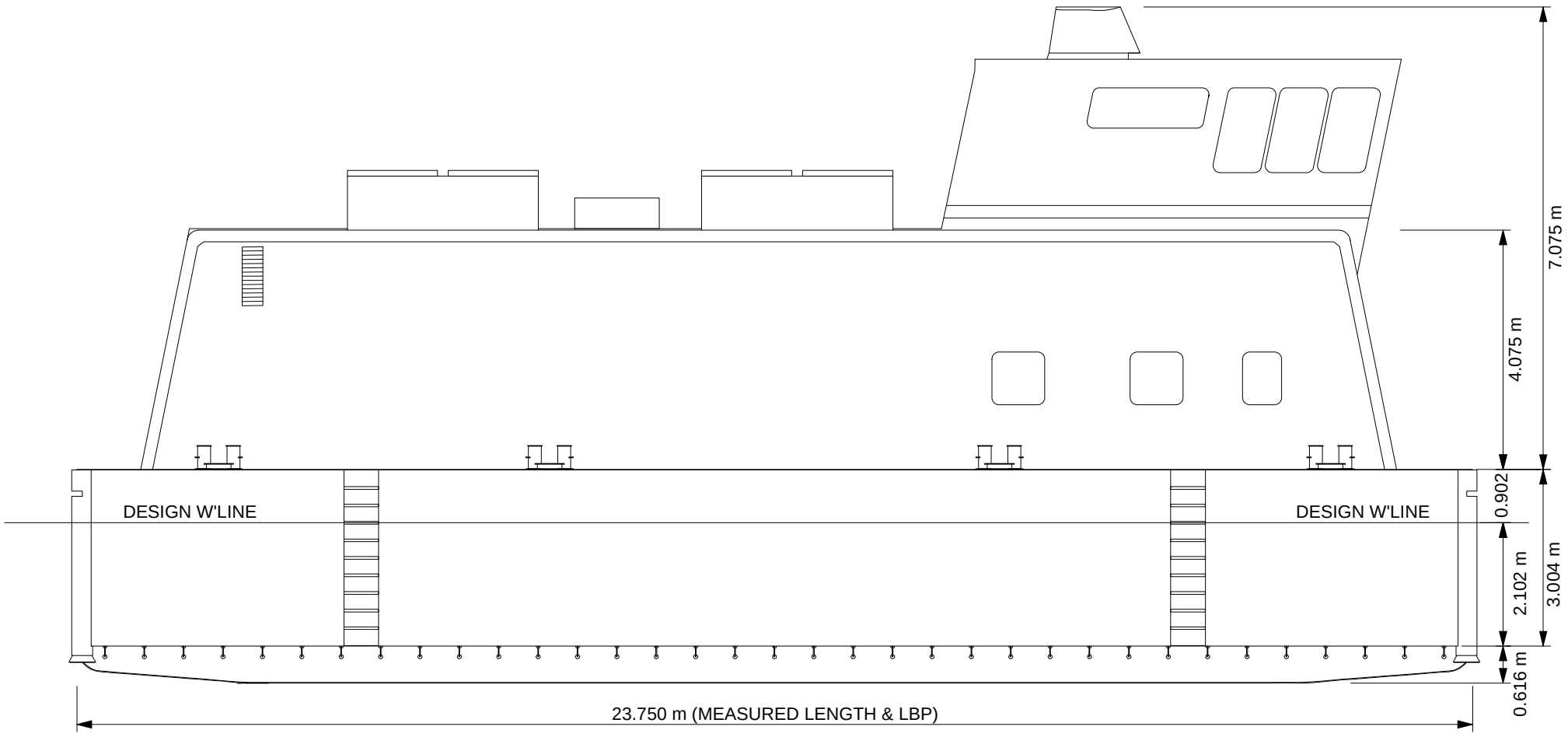
www.facebook.com/Islesdesign

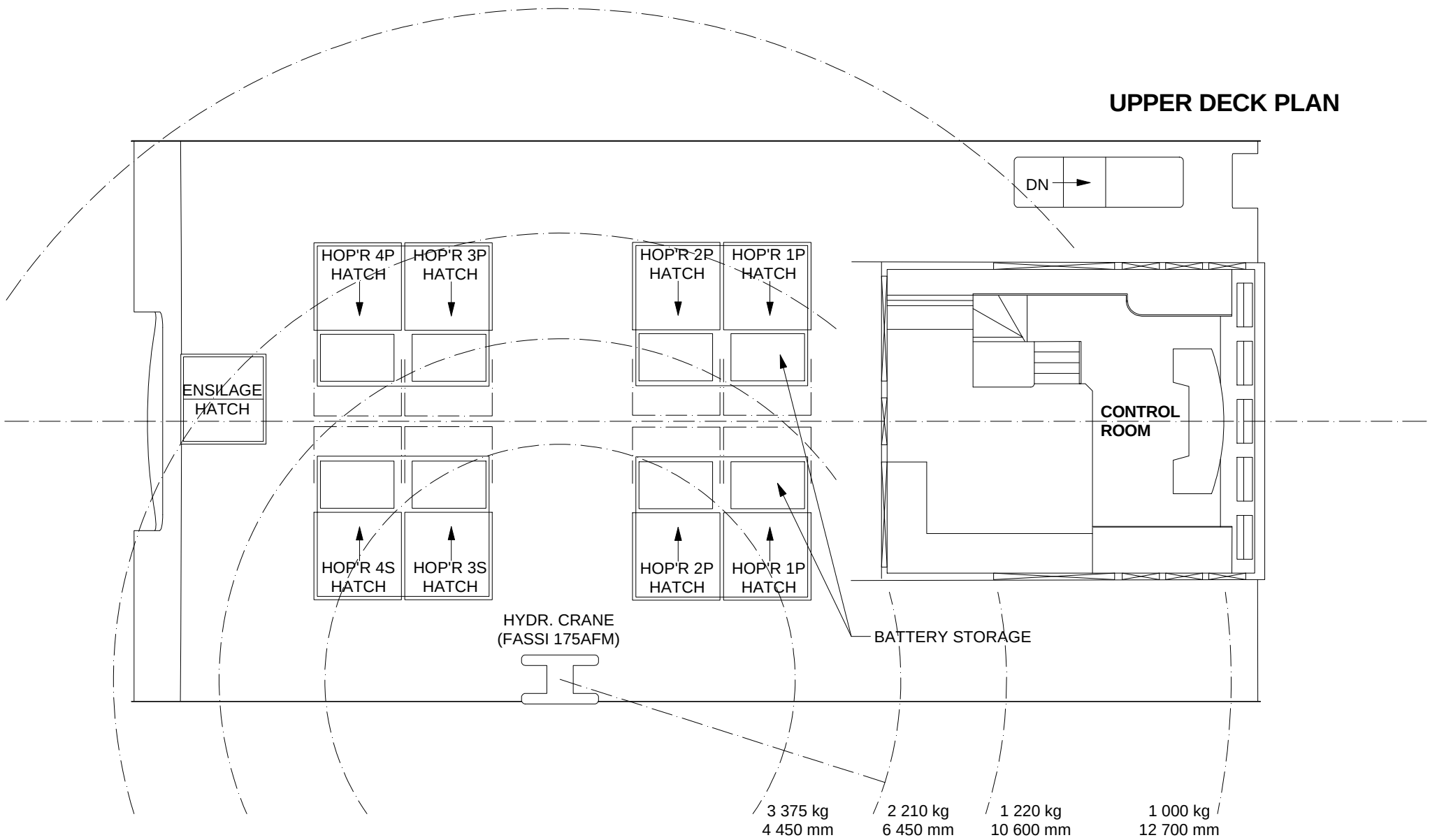

| | |
|---|---|
| CLIENT: | HAYWARDS STEEL FABRICATION & CONSTRUCTION |
| VESSEL: | 23.750 MT OFFSHORE FEED BARGE ' HUNTER' |
| TITLE: | GENERAL ARRANGEMENTS 2 |

**THIS DOCUMENT IS FOR RELEASE**

| No. | DATE | REVISION | LOCAT'N |
|---|---|---|---|
| 01 | 07/05/2015 | CONTROL ROOM ENLARGED IN OFFSHORE VERSION | |
| 02 | 01/12/2015 | DIESEL-ELECTRIC POWER SYSTEM FITTED, BATTERIES ON UPPER DK | |




## UPPER DECK PLAN



## AREAS OF OPERATION

The vessel has been designed in accordance with the Australian National Standard for Commercial Vessels, applying the requirements of Lloyd's Seagoing Pontoon & Lighters Rules. Accordingly, the vessel is structurally suitable for use beyond Operational Areas D and E.

## STABILITY CRITERIA

The vessel must meet the requirements of the National Standard for Commercial Vessels (NSCV) Subsection 6A. The criteria applied in this Stability Book are the Comprehensive Criteria of general application with respect to the weather conditions of Operational Areas C.

The operations of the vessel should not exceed the limits presented in this Operator's Stability Manual unless a further stability assessment is carried out and the vessel's stability found to be compliant with the current minimum criteria.

| NSCV SUBSECTION 6A CHAPTER 5A COMPREHENSIVE STABILITY CRITERIA OF GENERAL APPLICATION TO ALL VESSELS | | |
|---|---|---|
| **No.** | **Application Limits** | **Criterion description** |
| Cl. 3.8 | Vessels of moderate heel consequence | The maximum angle of static heel shall not exceed -<br>$\theta_s = 10°$ under the effect of a single heeling moment;<br>$\theta_c = 15°$ under the effect of two combined heeling moments. |
| 5A.1 | All vessels within application, Cl 5.2 | The angle of maximum righting lever $\theta_{max}$ shall occur at an angle of heel not less than 15°. |
| 5A.2a | $\theta_{max} = 15°$ | The area under the Rightling Lever (GZ) curve up to an angle of 15° shall not be less than 4.01 metre-degs (0.070 metre-rads). |
| 5A.2b | $15° < \theta_{max} < 30°$ | The area under the Righting Lever (GZ) curve up to the angle of maximum righting lever ($\theta_{max}$) shall not be less than the area determined by use of the formula:<br>$A_{\theta\text{-}\theta max} = 3.15 + 0.057\,(30 - \theta_{max})$<br>where<br>$A_{\theta\text{-}\theta max}$ = the area under the GZ lever curve up to $\theta_{max}$ in m-degrees<br>$\theta_{max}$ = the angle of heel of the maximum GZ, in degrees |
| 5A.2c | $\theta_{max} \geq 30°$ | The area under the Righting Lever (GZ) curve up to an angle of 30° shall not be less than 3.15 metre-degs (0.055 metre-rads). |
| 5A.3 | All vessels within application, Cl 5.2 | The area under the Righting Lever (GZ) curve up to an angle of 40°, or the angle of flooding, θf if this is less than 40°, shall not be less than 5.16 metre-degs (0.090 metre-rads). |
| 5A.4 | All vessels within application, Cl. 5.2 | The area under the Righting Lever (GZ) curve between the angles of heel of 30° and 40°, or between 30° and the angle of flooding θf if this angle is less than 40°, shall be not less than 1.72 metre-deg (0.030 metre-rads). |
| 5A.5 | All vessels within application, Cl. 5.2 | The righting lever shall have a value not less than 0.2 metres at an angle of heel equal to or greater than 30°. |
| 5A.6c | Class 3 (fishing vessels) | The minimum metacentric height ($G_FM_O$) shall not be less than 0.20 m. |

| NSCV SUBSECTION 6A CHAPTER 5A COMPREHENSIVE STABILITY CRITERIA OF GENERAL APPLICATION TO ALL VESSELS | | |
|---|---|---|
| **No.** | **Application Limits** | **Criterion description** |
| 5A.7a | All Class C, D & E vessels | The angle of heel $\theta_h$ shall not exceed $\theta_s$ (see Clause 3.8, above) when any of the individual heeling moments due to person crowding, wind or turning is applied. |
| 5A.9 | $\theta_{max} < 25°$ or<br>($\theta_s > 10$ &<br>$\theta_h > 10°$) | The angle under the Righting Levers (GZ) curve and above the largest single heeling lever curve up to the lesser of 40° and the angle flooding, $\theta_f$, shall not be less than,<br>$A_{RS} = 1.03 + 0.2\ A_{40/f}$<br>where<br>$A_{RS}$ = minimum residual area under GZ curve and above largest single heeling lever curve up to the lesser of 40° and $\theta_f$ in metre-degs.<br>$A_{40/\theta f}$ = total area under the GZ curve up to the lesser of 40° and $\theta_f$ in metre-degs. |

## BILGE WATER, SLACK TANKS & WATERTIGHT INTEGRITY

All compartments shall be kept dry and free of bilge water so far as practical in order to minimise free surface effects, which reduces the vessel's stability.

The number of tanks which are or may become slack (i.e. have a free liquid surface) should be kept to a minimum in order to maximise the vessel's stability.

The watertight integrity of all the vessel's compartments should be maintained and checked regularly.

## HEEL & TRIM

A permanent heel reduces the vessels stability. Every effort should be made to maintain the vessel in an upright condition at all times.

The consideration of a Loading Condition in this Stability Manual should not be taken as implying the vessel is seaworthy or seakindly in the associated trim. The Master should satisfy him/herself of the efficient and safe operation of the vessel in any trim condition.

## DOWNFLOODING POINTS

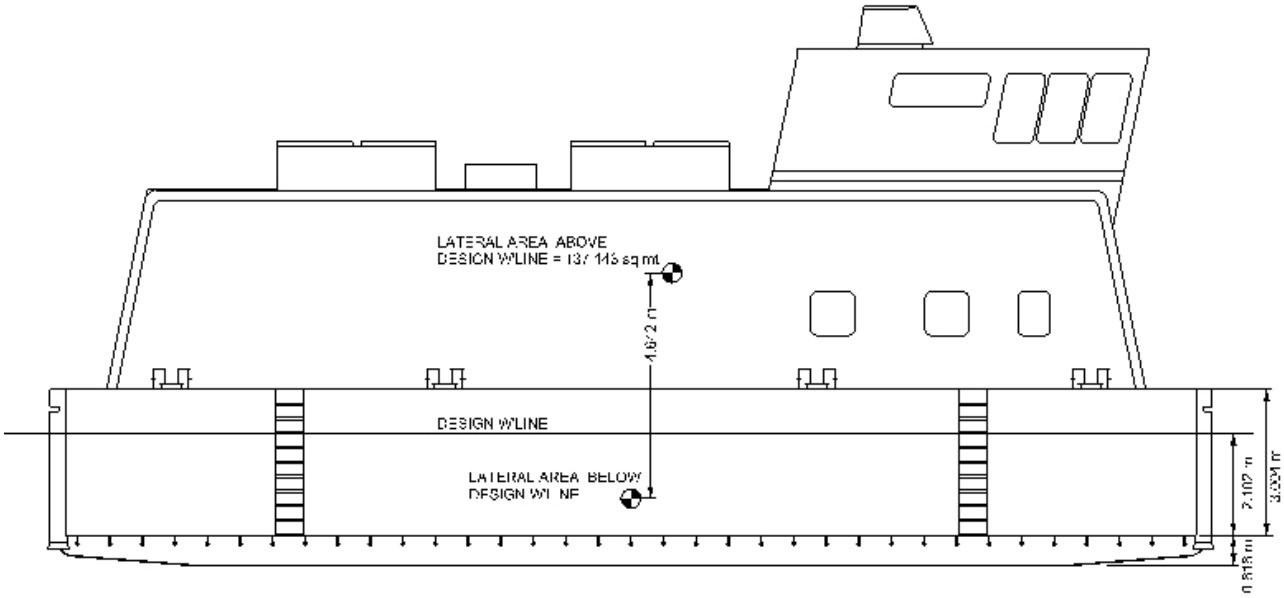
Downflooding Points are those points through which the buoyant volume of the vessel may be flooded through listing, trim or sea conditions, reducing the flotation, stability or both. Every effort should be made to maintain the buoyant integrity of the vessel at all times through the closure of hatches and doors when in operation and, particularly, in poor weather.

When the doors and hatches are properly secured and the windows in good repair, the table on the following page list the coordinates of possible points of flooding exist. These vents might not be able to be closed when machinery in the relevant spaces is operated.

| Downflooding Points | | | | |
|---|---|---|---|---|
| Description | Location | Longitudinal | Transverse | Height |
| | | m | m | m |
| Plant Room Ventilator | P & S, frd | 21.900 | 2.700 | 5.305 |
| Blower Room Ventilator | P | 16.500 | 5.100 | 5.750 |
| Hopper Room Ventilator | P & S | 3.100 | 5.100 | 5.750 |
| Longitudinal Datum: After face of stern transom, +ve FRD<br>Transverse Datum: Vessel Centreline, +ve PORT<br>Vertical Datum: Underside of Bottom Plate, +ve UP | | | | |

## WINDAGE

For the purposes of this Stability Book, the Design Waterline is taken to be at a mean draft of 2.139 metres, corresponding to a loading of 329 tonnes of fish feed and a displacement of 625.527 tonnes, as shown below. In that condition, the vessel has a windage profile of 137.143 square metres acting on a lever of 4.642 metres about the centre of the immersed profile. Accordingly, a wind pressure of 450 Pascals, that considered relevant for Operational Areas C, will result in a heeling moment of 29.203 tonne.metres.




## WATER BALLAST & BALLAST TANKS

The vessel was designed with two ballast tanks aft. In the intended operation these tanks are not to be used and their effects are considered in the Loading Conditions. Should it be decided to use these tanks, additional analyses of the vessel's stability should be carried out beforehand to ensure compliance with the current stability criteria.

## CARGO & HOPPER NOTES

This Stability Book considers the vessel's stability when loaded with bulk fish feed of a density of 650 kg/m$^3$ (SG = 0.65) and an angle of recline of approximately 40°. Should it be intended to load the vessel with a cargo significantly differing from these characteristics or in Operational Areas beyond Operational Area C, an additional stability analysis should be carried out before so loading the vessel.

The vessel has been designed for a maximum loading of 329 tonnes of fish feed loaded equally in all six hoppers. The amount of feed in any hopper should not exceed 41.15 tonnes at any time.

The vessel should not be loaded with a difference in weights between the port and starboard sides at any time such that the list in calm weather exceeds 9.2 degrees. When near the fully loaded condition, such a list will be produced by a weight difference of 97.092 tonnes.

## SUMMARY OF LOADING CONDITIONS AND COMPLIANCE

| NSCV Subsection 6A | | Chap 5A – Comprehensive Criteria | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Areas of Operation | | C, D & E | | | | | | |
| **Criterion** | | **Req'd** | **01** | **02** | **03** | **04** | **05** | **06** |
| 5A.1 | Angle of Maximum GZ (Deg.) | 15 | 21.2 | 25.5 | 31.0 | 35.6 | 30.6 | 33.5 |
| 5A.2b | Area under GZ curve to lesser of 30° or angle of $GZ_{max}$ (Deg.m) | varies | 35.86 | 30.68 | 28.36 | 14.91 | 19.76 | 10.58 |
| 5A.3 | Area under GZ curve to 40° or downflooding angle (Deg.m) | 5.16 | 78.44 | 56.88 | 43.29 | 18.92 | 22.54 | 16.27 |
| 5A.4 | Area under GZ curve 30° – 40° or down-flooding angle (Deg.m) | 1.720 | 21.35 | 17.82 | 14.94 | 4.005 | 2.785 | 5.684 |
| 5A.5 | Maximum GZ beyond 30° (m) | 0.200 | 2.473 | 1.885 | 1.515 | 0.929 | 1.030 | 0.769 |
| 5A.6c | GM (m) | 0.350 | 11.85 | 8.393 | 5.132 | 3.003 | 3.231 | 3.807 |
| 5A.7a | Heel angle under the effect of 450 Pa wind (Deg.) | 10 | 0.8 | 2.7 | 3.0 | 3.6 | 1.5 | 9.7 |
| 5A.9 | Residual Area between GZ & Windage curves to 40° (Deg.m) | varies | 73.64 | N/R | N/R | N/R | N/R | N/R |
| **COMPLIANCE** | | / | YES | YES | YES | YES | YES | YES |

## ANNEX A – LIGHTSHIP SURVEY

| | | | | | |
|---|---|---|---|---|---|
| Vessel Name | | HUNTER | | | |
| AMSA Unique Identifier | | 5607 | | | |
| Owner | | Huon Aquaculture Company Pty Ltd | | | |
| Date & Time of Survey | | 04/12/015 | | | |
| Location of Inclining Exp't | | Haywards Shipyard, Margate, Tasmania | | | |
| | | | | | |
| Weather | | Calm | | | |
| Wind | | 5 Knots, settled | | | |
| Sea | | Flat | | | |
| Water Specific Gravity | | 1.025 | | | |
| | | | | | |
| Measured Length (LM) | | 23.950 metres | | | |
| Moulded Breadth (B) | | 11.453 metres | | | |
| Moulded Depth (D) | | 2.990 metres | | | |
| Thickness of Keel | | 0.008 metres | | | |
| Thickness of Deck | | 0.006 metres | | | |
| Condition of Vessel | | Launched new-build with all normal equipment on board | | | |
| Mooring | | Port to wharf, slack springs under observation. | | | |
| | | | | | |
| Persons onboard during Inclining Experiment | | Joseph Nunn (Haywards) | | 80 kg | |
| | | 3 Builder's Employees | | 240 kg | |
| | | | | | |
| Freeboards | Port | Average | Starboard | Dist. Apart | Initial List |
| Forward | Weather Deck at forward perpendicular | | | | |
| | 1.780 m | 1.805 m | 1.830 m | 11.960 m | 0.240° |
| Aft | Weather Deck at after perpendicular | | | | |
| | 2.420 m | 2.450 | 2.480 m | 11.960 m | 0.287° |
| | | | | | |
| Length between Freeboard Measurements | | | 23.750 m | Trim by Bow | 0.645 m |
| Length between Perpendiculars | | | 23.750 m | Trim by Bow | 0.645 m |
| Draft Correction Forward | | | | | 0.000 m |
| Draft Correction Aft | | | | | 0.000 m |
| | | | | | |
| Draft at Frd Freeboard Location | | | 3.004 – 1.805 metres | | 1.199 m |
| Draft at Frd Perpendicular | | | 1.199 + 0.000 metres | | 1.199m |
| Draft at Aft Freeboard Location | | | 3.004 – 2.450 metres | | 0.554 m |
| Draft at Aft Perpendicular | | | 0.554 – 0.000 metres | | 0.554 m |
| Derived Draft Midship | | | (1.259+ 0.551) / 2 | | 0.877 m |
| | | | | | |
| Mean List | | | (0.240 + 0.287) / 2 | | 0.264° |

| **Vessel Hydrostatics in Surveyed Trim (0.645 m by Bow)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Draft** | **Vol** | **Disp** | **LCB** | **VCB** | **LCF** | **KMT** | **KML** | **MCT** | **TPC** |
| *m* | *$m^3$* | *t* | *m* | *m* | *m* | *m* | *m* | *t.m/cm* | *t/cm* |
| 0.877 | 251.192 | 257.472 | 13.331 | 0.458 | 11.875 | 14.055 | 54.110 | 5.817 | 2.917 |

**Displacement adjusted for Water Density**

Displacement as Surveyed (SG =1.025) = (1.025/1.025) x 257.472
= 257.472 tonnes

## ANNEX B – LIGHTSHIP DERIVATION

| KNOWN WEIGHTS OFF | | | |
|---|---|---|---|
| **ITEM** | **Weight (t)** | **LCG (m)** | **LM (t.m)** |
| Vessel as Surveyed | 257.472 | 13.331 | 3432.359 |
| - 4 Persons | - 0.320 | 12.000 | - 3.840 |
| - Tools & Incidentals | - 0.100 | 12.000 | - 1.200 |
| - 27,196 Lt Diesel Oil (Linked Tanks) | - 22.845 | 22.123 | - 505.400 |
| - Ensilage Bin Tipper | - 0.250 | 2.750 | - 0.688 |
| - Frd Pipe Raft & Support Frame | - 1.433 | 24.195 | - 34.671 |
| - Aft Pipe Raft & Frame Modifications | - 2.010 | -0.276 | + 0.555 |
| Lightship as Surveyed | 230.514 | **12.525** | 2887.115 |

By comparison, the tabulation of the weights of construction and fit out of the parent vessel, the HIBBS (AMSA identifier 5463) were found to be -

Lightship = 228.068 tonnes (98.89% of the measured Lightship)
LCG = 12.878 m (1.47% of the Measured Length more than the measured LCG).
VCG = 2.890 m (20.56% of the KMT in the measured lightship condition)

## CONSIDERATION OF THE VESSEL, AS SURVEYED, AS A SISTER OF 'HIBBS'

Clause 3.3.5.3 of Part 6C of the National Standard for Commercial Vessels requires that the considered vessel's lightship displacement be within 4% of that of the parent vessel and the lightship Longitudinal Centre of Gravity be within 2% of the Length Between Perpendiculars of that of the parent vessel for the vessel to be a near sister and within half those values to be considered a sister.

As shown above, the vessel's lightship displacement, determined from the lightship survey, was found to be within 1.11% of that of the parent vessel after accounting for know weight variations. The vessel's lightship Longitudinal Centre of Gravity, however, was found to be 1.47% of the LBP from that of the parent vessel. It is noted that the vessel's hullform is rectilinear with a Block Coefficient of 1.00 rather than a normal 'ship' form. As a result, the vessel has higher longitudinal stability than typical and, accordingly, the measured difference in lightship Longitudinal Centre of Gravity of 147% of the stipulated requirement is considered to be acceptable and the vessel, as surveyed, may reasonably be considered a sister of the HIBBS (AMSA Identifier 5463).

## CONSIDERATION OF WEIGHTS ADDED AFTER SURVEY AND OTHER WEIGHT SHIFTS

After launching, the bottoms of the eight feed hoppers were lined with 20mm plywood. This modification adds 3.75 tonnes to the lightship displacement as well as raising the cargo centre of gravity 190mm.

The machinery arrangements of the vessel differs from the arrangements of the HIBBS in that 3.477 tonnes of storage batteries were added on the upper deck and the weight of the ship's service generator was altered.

These changes are addressed in the following 'weights on' table.

| **LIGHTSHIP WEIGHTS ON ITEMS** | | | | | |
|---|---|---|---|---|---|
| **ITEM** | **Weight (t)** | **LCG (m)** | **LM (t.m)** | **VCG (m)** | **VM (tm)** |
| Parent Vessel (HIBBS) | 228.068 | 12.968 | 2957.586 | 2.890 | 659.117 |
| Ensilage Bin Tipper | 0.250 | 2.750 | 0.688 | 7.650 | 1.913 |
| Frd Pipe Raft & Frame | 1.433 | 24.195 | 34.671 | 1.750 | 2.508 |
| Aft Pipe Raft & Frame | 2.010 | -0.276 | - 0.555 | 1.750 | 3.518 |
| Plywood Hopper Linings | 3.750 | 10.153 | 38.074 | 2.370 | 8.888 |
| Storage Batteries | 3.744 | 14.680 | 54.962 | 7.400 | 27.706 |
| Battery Frames | 0.200 | 14.680 | 2.936 | 7.400 | 1.480 |
| - MTU Ship's Gen. | -1.992 | 17.685 | -35.229 | 1 | -1.992 |
| + Yanmar Ship's Gen | 1.070 | 17.685 | 18.923 | 1 | 1.070 |
| Lightship | 238.533 | **12.879** | 2992.390 | **2.952** | 667.054 |

Accordingly, the lightship characteristics determined from the above tabulation of construction weights -

Lightship Displacement = 238.533 tonnes
Longitudinal Centre of Gravity = 12.879 metres forward of the After Perpendicular.
Vertical Centre of Gravity = 2.952 + 0.295 = 3.247 metres above the Base Line

## ANNEX C – HYDROSTATICS TABLES

| | | | |
|---|---|---|---|
| **HUNTER** Unpowered Barge | **TRIM** | Water Specific Gravity | 1.025 |
| HYDROSTATIC DATA | 0.500 metre by Stern | Length between Perps. | 23.750 m |
| Vertical Datum | Base Line (Underside of Bottom Plating | +ve direction | UP |
| Longitudinal Datum | After Face of Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

| **Draft** | **Volume** | **Disp't** | **LCB** | **VCB** | **LCF** | **KMT** | **KML** | **MCT** | **TPC** |
|---|---|---|---|---|---|---|---|---|---|
| *m* | *$m^3$* | *t* | *m* | *m* | *m* | *m* | *m* | *t.m/cm* | *t/cm* |
| **0.800** | 229.287 | 235.019 | 10.638 | 0.413 | 11.875 | 15.316 | 59.210 | 5.818 | 2.917 |
| **0.900** | 257.735 | 264.178 | 10.775 | 0.462 | 11.875 | 13.709 | 52.720 | 5.813 | 2.917 |
| **1.000** | 286.183 | 293.337 | 10.885 | 0.510 | 11.875 | 12.433 | 47.550 | 5.809 | 2.917 |
| **1.100** | 314.631 | 322.496 | 10.975 | 0.559 | 11.875 | 11.398 | 43.320 | 5.806 | 2.917 |
| **1.200** | 343.079 | 351.656 | 11.050 | 0.609 | 11.875 | 10.544 | 39.810 | 5.804 | 2.917 |
| **1.300** | 371.526 | 380.815 | 11.114 | 0.658 | 11.875 | 9.829 | 36.840 | 5.801 | 2.917 |
| **1.400** | 399.974 | 409.974 | 11.168 | 0.707 | 11.875 | 9.223 | 34.300 | 5.799 | 2.917 |
| **1.500** | 428.422 | 439.133 | 11.215 | 0.757 | 11.875 | 8.705 | 32.110 | 5.798 | 2.917 |
| **1.600** | 456.870 | 468.292 | 11.257 | 0.807 | 11.875 | 8.258 | 30.200 | 5.796 | 2.917 |
| **1.700** | 485.318 | 497.451 | 11.293 | 0.856 | 11.875 | 7.869 | 28.520 | 5.795 | 2.917 |
| **1.800** | 513.766 | 526.610 | 11.325 | 0.906 | 11.875 | 7.529 | 27.040 | 5.794 | 2.917 |
| **1.900** | 542.213 | 555.769 | 11.354 | 0.955 | 11.875 | 7.231 | 25.710 | 5.793 | 2.917 |
| **2.000** | 570.661 | 584.928 | 11.380 | 1.005 | 11.875 | 6.967 | 24.520 | 5.792 | 2.917 |
| **2.100** | 599.109 | 614.087 | 11.404 | 1.055 | 11.875 | 6.732 | 23.450 | 5.791 | 2.917 |
| **2.200** | 627.557 | 643.246 | 11.425 | 1.105 | 11.875 | 6.524 | 22.480 | 5.791 | 2.917 |
| **2.300** | 656.005 | 672.405 | 11.445 | 1.155 | 11.875 | 6.338 | 21.610 | 5.790 | 2.917 |
| **2.400** | 684.453 | 701.564 | 11.463 | 1.204 | 11.875 | 6.172 | 20.800 | 5.789 | 2.917 |
| **2.500** | 712.901 | 730.723 | 11.479 | 1.254 | 11.875 | 6.023 | 20.070 | 5.789 | 2.917 |
| **2.600** | 741.348 | 759.882 | 11.494 | 1.304 | 11.875 | 5.890 | 19.390 | 5.788 | 2.917 |
| **2.700** | 769.796 | 789.041 | 11.508 | 1.354 | 11.875 | 5.770 | 18.770 | 5.788 | 2.917 |

| **Nomenclature** | |
|---|---|
| Draft | Mean draft from the Underside of the Bottom Plate to the undisturbed waterline |
| Volume | Total displaced volume to the outside og the hull plating |
| Displacement | Total displacement to the outside of the hull plating in sea water (S. G. = 1.025) |
| LCB | Longitudinal Centre of Buoyancy measured from the after face of the stern transom |
| VCB | Vertical Centre of Buoyancy measured from the underside of the bottom plating |
| LCF | Longitudinal Centre of Flotation measured from the after face of the stern transom |
| KMT | Transverse metacentric height measured from underside of the bottom plating |
| KML | Longitudinal metacentric height measured from underside of the bottom plating |
| MCT | Moment to change trim |
| TPC | Tonnes per centimetre rate of immersion |

| | | | |
|---|---|---|---|
| **HUNTER** Unpowered Barge | **TRIM** | Water Specific Gravity | 1.025 |
| HYDROSTATIC DATA | LEVEL | Length between Perps. | 23.750 m |
| Vertical Datum | Base Line (Underside of Bottom Plating | +ve direction | UP |
| Longitudinal Datum | After Face of Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

| **Draft** | **Volume** | **Disp't** | **LCB** | **VCB** | **LCF** | **KMT** | **KML** | **MCT** | **TPC** |
|---|---|---|---|---|---|---|---|---|---|
| *m* | *$m^3$* | *t* | *m* | *m* | *m* | *m* | *m* | *t.m/cm* | *t/cm* |
| **0.800** | 229.287 | 235.019 | 11.875 | 0.400 | 11.875 | 15.300 | 59.160 | 5.814 | 2.916 |
| **0.900** | 257.735 | 264.178 | 11.875 | 0.450 | 11.875 | 13.694 | 52.680 | 5.809 | 2.916 |
| **1.000** | 286.183 | 293.337 | 11.875 | 0.500 | 11.875 | 12.420 | 47.500 | 5.806 | 2.916 |
| **1.100** | 314.631 | 322.496 | 11.875 | 0.550 | 11.875 | 11.386 | 43.280 | 5.802 | 2.916 |
| **1.200** | 343.079 | 351.656 | 11.875 | 0.600 | 11.875 | 10.533 | 39.770 | 5.800 | 2.916 |
| **1.300** | 371.526 | 380.815 | 11.875 | 0.650 | 11.875 | 9.819 | 36.810 | 5.798 | 2.916 |
| **1.400** | 399.974 | 409.974 | 11.875 | 0.700 | 11.875 | 9.214 | 34.270 | 5.796 | 2.916 |
| **1.500** | 428.422 | 439.133 | 11.875 | 0.750 | 11.875 | 8.697 | 32.090 | 5.794 | 2.916 |
| **1.600** | 456.870 | 468.292 | 11.875 | 0.800 | 11.875 | 8.250 | 30.180 | 5.793 | 2.916 |
| **1.700** | 485.318 | 497.451 | 11.875 | 0.850 | 11.875 | 7.862 | 28.500 | 5.791 | 2.916 |
| **1.800** | 513.766 | 526.610 | 11.875 | 0.900 | 11.875 | 7.522 | 27.010 | 5.790 | 2.916 |
| **1.900** | 542.213 | 555.769 | 11.875 | 0.950 | 11.875 | 7.224 | 25.690 | 5.789 | 2.916 |
| **2.000** | 570.661 | 584.928 | 11.875 | 1.000 | 11.875 | 6.960 | 24.500 | 5.788 | 2.916 |
| **2.100** | 599.109 | 614.087 | 11.875 | 1.050 | 11.875 | 6.726 | 23.430 | 5.787 | 2.916 |
| **2.200** | 627.557 | 643.246 | 11.875 | 1.100 | 11.875 | 6.518 | 22.470 | 5.787 | 2.916 |
| **2.300** | 656.005 | 672.405 | 11.875 | 1.150 | 11.875 | 6.333 | 21.590 | 5.786 | 2.916 |
| **2.400** | 684.453 | 701.564 | 11.875 | 1.200 | 11.875 | 6.167 | 20.790 | 5.785 | 2.916 |
| **2.500** | 712.901 | 730.723 | 11.875 | 1.250 | 11.875 | 6.018 | 20.050 | 5.785 | 2.916 |
| **2.600** | 741.348 | 759.882 | 11.875 | 1.300 | 11.875 | 5.885 | 19.380 | 5.784 | 2.916 |
| **2.700** | 769.796 | 789.041 | 11.875 | 1.350 | 11.875 | 5.765 | 18.760 | 5.784 | 2.916 |

| **Nomenclature** | |
|---|---|
| Draft | Mean draft from the Underside of the Bottom Plate to the undisturbed waterline |
| Volume | Total displaced volume to the outside og the hull plating |
| Displacement | Total displacement to the outside of the hull plating in sea water (S. G. = 1.025) |
| LCB | Longitudinal Centre of Buoyancy measured from the after face of the stern transom |
| VCB | Vertical Centre of Buoyancy measured from the underside of the bottom plating |
| LCF | Longitudinal Centre of Flotation measured from the after face of the stern transom |
| KMT | Transverse metacentric height measured from underside of the bottom plating |
| KML | Longitudinal metacentric height measured from underside of the bottom plating |
| MCT | Moment to change trim |
| TPC | Tonnes per centimetre rate of immersion |

| | | | |
|---|---|---|---|
| **HUNTER** Unpowered Barge | **TRIM** | Water Specific Gravity | 1.025 |
| HYDROSTATIC DATA | 0.500 metre by Bow | Length between Perps. | 23.750 m |
| Vertical Datum | Base Line (Underside of Bottom Plating | +ve direction | UP |
| Longitudinal Datum | After Face of Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

| **Draft** | **Volume** | **Disp't** | **LCB** | **VCB** | **LCF** | **KMT** | **KML** | **MCT** | **TPC** |
|---|---|---|---|---|---|---|---|---|---|
| *m* | *$m^3$* | *t* | *m* | *m* | *m* | *m* | *m* | *t.m/cm* | *t/cm* |
| **0.800** | 229.287 | 235.019 | 13.112 | 0.413 | 11.875 | 15.316 | 59.210 | 5.818 | 2.917 |
| **0.900** | 257.735 | 264.178 | 12.975 | 0.462 | 11.875 | 13.709 | 52.720 | 5.813 | 2.917 |
| **1.000** | 286.183 | 293.337 | 12.865 | 0.510 | 11.875 | 12.433 | 47.550 | 5.809 | 2.917 |
| **1.100** | 314.631 | 322.496 | 12.775 | 0.559 | 11.875 | 11.398 | 43.320 | 5.806 | 2.917 |
| **1.200** | 343.079 | 351.656 | 12.700 | 0.609 | 11.875 | 10.544 | 39.810 | 5.804 | 2.917 |
| **1.300** | 371.526 | 380.815 | 12.636 | 0.658 | 11.875 | 9.829 | 36.840 | 5.801 | 2.917 |
| **1.400** | 399.974 | 409.974 | 12.582 | 0.707 | 11.875 | 9.224 | 34.300 | 5.800 | 2.917 |
| **1.500** | 428.422 | 439.133 | 12.535 | 0.757 | 11.875 | 8.705 | 32.110 | 5.798 | 2.917 |
| **1.600** | 456.870 | 468.292 | 12.493 | 0.807 | 11.875 | 8.258 | 30.200 | 5.796 | 2.917 |
| **1.700** | 485.318 | 497.451 | 12.457 | 0.856 | 11.875 | 7.869 | 28.520 | 5.795 | 2.917 |
| **1.800** | 513.766 | 526.610 | 12.425 | 0.906 | 11.875 | 7.529 | 27.040 | 5.794 | 2.917 |
| **1.900** | 542.213 | 555.769 | 12.396 | 0.955 | 11.875 | 7.231 | 25.710 | 5.793 | 2.917 |
| **2.000** | 570.661 | 584.928 | 12.370 | 1.005 | 11.875 | 6.967 | 24.520 | 5.792 | 2.917 |
| **2.100** | 599.109 | 614.087 | 12.346 | 1.055 | 11.875 | 6.732 | 23.450 | 5.791 | 2.917 |
| **2.200** | 627.557 | 643.246 | 12.325 | 1.105 | 11.875 | 6.524 | 22.480 | 5.791 | 2.917 |
| **2.300** | 656.005 | 672.405 | 12.305 | 1.155 | 11.875 | 6.338 | 21.610 | 5.790 | 2.917 |
| **2.400** | 684.453 | 701.564 | 12.287 | 1.204 | 11.875 | 6.172 | 20.800 | 5.789 | 2.917 |
| **2.500** | 712.901 | 730.723 | 12.271 | 1.254 | 11.875 | 6.023 | 20.070 | 5.789 | 2.917 |
| **2.600** | 741.348 | 759.882 | 12.256 | 1.304 | 11.875 | 5.890 | 19.390 | 5.788 | 2.917 |
| **2.700** | 769.796 | 789.041 | 12.242 | 1.354 | 11.875 | 5.770 | 18.770 | 5.788 | 2.917 |

| **Nomenclature** | |
|---|---|
| Draft | Mean draft from the Underside of the Bottom Plate to the undisturbed waterline |
| Volume | Total displaced volume to the outside og the hull plating |
| Displacement | Total displacement to the outside of the hull plating in sea water (S. G. = 1.025) |
| LCB | Longitudinal Centre of Buoyancy measured from the after face of the stern transom |
| VCB | Vertical Centre of Buoyancy measured from the underside of the bottom plating |
| LCF | Longitudinal Centre of Flotation measured from the after face of the stern transom |
| KMT | Transverse metacentric height measured from underside of the bottom plating |
| KML | Longitudinal metacentric height measured from underside of the bottom plating |
| MCT | Moment to change trim |
| TPC | Tonnes per centimetre rate of immersion |

# ANNEX D – RIGHTING LEVER TABLES

| **HUNTER** Unpowered Barge<br>**RIGHTING LEVER DATA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Trim | | 0.500 metres by stern | |
| | | | | | | | Length between Perps | | 23.750 metres | |
| | | | | | | | Water Specific Gravity | | 1.025 | |
| **Draft** | **Righting Levers (KN) – metres** | | | | | | | | | |
| *m* | **0.0º** | **2.0º** | **5.0º** | **10.0º** | **15.0º** | **20.0º** | **30.0º** | **40.0º** | **50.0º** | **60.0º** |
| | | | | | | | | | | |
| **0.800** | 0.000 | 0.535 | 1.340 | 2.533 | 3.217 | 3.622 | 3.990 | 4.008 | 3.854 | 3.608 |
| **0.900** | 0.000 | 0.479 | 1.199 | 2.341 | 3.069 | 3.505 | 3.887 | 3.934 | 3.828 | 3.637 |
| **1.000** | 0.000 | 0.434 | 1.087 | 2.162 | 2.929 | 3.389 | 3.781 | 3.867 | 3.809 | 3.671 |
| **1.100** | 0.000 | 0.398 | 0.997 | 2.000 | 2.794 | 3.271 | 3.678 | 3.807 | 3.795 | 3.708 |
| **1.200** | 0.000 | 0.368 | 0.922 | 1.856 | 2.665 | 3.148 | 3.581 | 3.752 | 3.785 | 3.744 |
| | | | | | | | | | | |
| **1.300** | 0.000 | 0.343 | 0.860 | 1.731 | 2.539 | 3.024 | 3.489 | 3.702 | 3.778 | 3.778 |
| **1.400** | 0.000 | 0.322 | 0.807 | 1.624 | 2.414 | 2.898 | 3.401 | 3.655 | 3.773 | 3.807 |
| **1.500** | 0.000 | 0.304 | 0.761 | 1.533 | 2.288 | 2.775 | 3.318 | 3.612 | 3.770 | 3.831 |
| **1.600** | 0.000 | 0.288 | 0.722 | 1.454 | 2.163 | 2.655 | 3.238 | 3.571 | 3.768 | 3.849 |
| **1.700** | 0.000 | 0.275 | 0.688 | 1.385 | 2.042 | 2.539 | 3.162 | 3.532 | 3.767 | 3.861 |
| | | | | | | | | | | |
| **1.800** | 0.000 | 0.263 | 0.658 | 1.325 | 1.927 | 2.427 | 3.089 | 3.496 | 3.765 | 3.867 |
| **1.900** | 0.000 | 0.252 | 0.632 | 1.268 | 1.822 | 2.319 | 3.019 | 3.462 | 3.761 | 3.867 |
| **2.000** | 0.000 | 0.243 | 0.609 | 1.212 | 1.727 | 2.215 | 2.951 | 3.429 | 3.754 | 3.862 |
| **2.100** | 0.000 | 0.235 | 0.589 | 1.156 | 1.641 | 2.118 | 2.885 | 3.398 | 3.744 | 3.854 |
| **2.200** | 0.000 | 0.228 | 0.570 | 1.101 | 1.563 | 2.026 | 2.822 | 3.369 | 3.730 | 3.842 |
| | | | | | | | | | | |
| **2.300** | 0.000 | 0.221 | 0.554 | 1.047 | 1.491 | 1.942 | 2.760 | 3.340 | 3.713 | 3.826 |
| **2.400** | 0.000 | 0.215 | 0.535 | 0.995 | 1.426 | 1.865 | 2.700 | 3.312 | 3.692 | 3.808 |
| **2.500** | 0.000 | 0.210 | 0.513 | 0.947 | 1.366 | 1.796 | 2.642 | 3.283 | 3.668 | 3.788 |
| **2.600** | 0.000 | 0.205 | 0.486 | 0.901 | 1.312 | 1.733 | 2.586 | 3.254 | 3.641 | 3.766 |
| **2.700** | 0.000 | 0.195 | 0.457 | 0.859 | 1.262 | 1.676 | 2.531 | 3.223 | 3.612 | 3.742 |

| **HUNTER** Unpowered Barge<br>**RIGHTING LEVER DATA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Trim | | LEVEL | |
| | | | | | | | Length between Perps | | 23.750 metres | |
| | | | | | | | Water Specific Gravity | | 1.025 | |
| **Draft** | **Righting Levers (KN) – metres** | | | | | | | | | |
| *m* | **0.0º** | **2.0º** | **5.0º** | **10.0º** | **15.0º** | **20.0º** | **30.0º** | **40.0º** | **50.0º** | **60.0º** |
| | | | | | | | | | | |
| **0.800** | 0.000 | 0.534 | 1.338 | 2.574 | 3.248 | 3.647 | 4.036 | 4.037 | 3.875 | 3.615 |
| **0.900** | 0.000 | 0.478 | 1.198 | 2.374 | 3.096 | 3.528 | 3.921 | 3.961 | 3.849 | 3.645 |
| **1.000** | 0.000 | 0.434 | 1.086 | 2.184 | 2.951 | 3.415 | 3.809 | 3.893 | 3.829 | 3.679 |
| **1.100** | 0.000 | 0.398 | 0.996 | 2.006 | 2.814 | 3.303 | 3.705 | 3.832 | 3.814 | 3.716 |
| **1.200** | 0.000 | 0.368 | 0.921 | 1.856 | 2.682 | 3.180 | 3.606 | 3.776 | 3.803 | 3.754 |
| | | | | | | | | | | |
| **1.300** | 0.000 | 0.343 | 0.859 | 1.730 | 2.556 | 3.049 | 3.513 | 3.725 | 3.795 | 3.793 |
| **1.400** | 0.000 | 0.322 | 0.806 | 1.623 | 2.435 | 2.920 | 3.425 | 3.677 | 3.790 | 3.831 |
| **1.500** | 0.000 | 0.304 | 0.761 | 1.532 | 2.312 | 2.796 | 3.341 | 3.633 | 3.786 | 3.860 |
| **1.600** | 0.000 | 0.288 | 0.722 | 1.453 | 2.180 | 2.677 | 3.261 | 3.592 | 3.784 | 3.880 |
| **1.700** | 0.000 | 0.275 | 0.688 | 1.384 | 2.050 | 2.561 | 3.185 | 3.553 | 3.783 | 3.891 |
| | | | | | | | | | | |
| **1.800** | 0.000 | 0.263 | 0.658 | 1.324 | 1.934 | 2.448 | 3.111 | 3.516 | 3.784 | 3.896 |
| **1.900** | 0.000 | 0.252 | 0.632 | 1.271 | 1.829 | 2.339 | 3.040 | 3.481 | 3.784 | 3.896 |
| **2.000** | 0.000 | 0.243 | 0.609 | 1.223 | 1.735 | 2.233 | 2.972 | 3.448 | 3.780 | 3.891 |
| **2.100** | 0.000 | 0.235 | 0.588 | 1.167 | 1.649 | 2.130 | 2.906 | 3.416 | 3.771 | 3.881 |
| **2.200** | 0.000 | 0.228 | 0.570 | 1.109 | 1.571 | 2.036 | 2.842 | 3.386 | 3.758 | 3.869 |
| | | | | | | | | | | |
| **2.300** | 0.000 | 0.221 | 0.554 | 1.055 | 1.500 | 1.951 | 2.780 | 3.357 | 3.740 | 3.853 |
| **2.400** | 0.000 | 0.215 | 0.539 | 1.004 | 1.435 | 1.874 | 2.720 | 3.329 | 3.718 | 3.834 |
| **2.500** | 0.000 | 0.210 | 0.525 | 0.956 | 1.375 | 1.804 | 2.661 | 3.302 | 3.694 | 3.814 |
| **2.600** | 0.000 | 0.205 | 0.500 | 0.911 | 1.321 | 1.741 | 2.604 | 3.275 | 3.666 | 3.791 |
| **2.700** | 0.000 | 0.201 | 0.470 | 0.869 | 1.271 | 1.683 | 2.549 | 3.247 | 3.636 | 3.766 |

| HUNTER Unpowered Barge<br>**RIGHTING LEVER DATA** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Trim | | 0.500 metre by bow | |
| | | | | | | | Length between Perps | | 23.750 metres | |
| | | | | | | | Water Specific Gravity | | 1.025 | |
| **Draft** | **Righting Levers (KN) – metres** | | | | | | | | | |
| *m* | **0.0º** | **2.0º** | **5.0º** | **10.0º** | **15.0º** | **20.0º** | **30.0º** | **40.0º** | **50.0º** | **60.0º** |
| | | | | | | | | | | |
| **0.800** | 0.000 | 0.535 | 1.340 | 2.533 | 3.217 | 3.622 | 3.992 | 4.020 | 3.877 | 3.638 |
| **0.900** | 0.000 | 0.479 | 1.199 | 2.341 | 3.069 | 3.505 | 3.891 | 3.951 | 3.855 | 3.668 |
| **1.000** | 0.000 | 0.434 | 1.087 | 2.162 | 2.929 | 3.389 | 3.790 | 3.888 | 3.837 | 3.701 |
| **1.100** | 0.000 | 0.398 | 0.997 | 2.000 | 2.794 | 3.271 | 3.690 | 3.830 | 3.824 | 3.737 |
| **1.200** | 0.000 | 0.368 | 0.922 | 1.856 | 2.665 | 3.150 | 3.596 | 3.777 | 3.814 | 3.774 |
| | | | | | | | | | | |
| **1.300** | 0.000 | 0.343 | 0.860 | 1.731 | 2.539 | 3.027 | 3.507 | 3.728 | 3.807 | 3.810 |
| **1.400** | 0.000 | 0.322 | 0.807 | 1.624 | 2.414 | 2.904 | 3.421 | 3.682 | 3.802 | 3.842 |
| **1.500** | 0.000 | 0.304 | 0.761 | 1.533 | 2.288 | 2.784 | 3.340 | 3.639 | 3.798 | 3.870 |
| **1.600** | 0.000 | 0.288 | 0.722 | 1.454 | 2.164 | 2.667 | 3.262 | 3.599 | 3.796 | 3.889 |
| **1.700** | 0.000 | 0.275 | 0.688 | 1.385 | 2.045 | 2.553 | 3.186 | 3.560 | 3.795 | 3.901 |
| | | | | | | | | | | |
| **1.800** | 0.000 | 0.263 | 0.658 | 1.325 | 1.933 | 2.443 | 3.114 | 3.524 | 3.795 | 3.906 |
| **1.900** | 0.000 | 0.252 | 0.632 | 1.268 | 1.830 | 2.336 | 3.044 | 3.490 | 3.793 | 3.906 |
| **2.000** | 0.000 | 0.243 | 0.609 | 1.213 | 1.737 | 2.233 | 2.977 | 3.457 | 3.789 | 3.901 |
| **2.100** | 0.000 | 0.235 | 0.589 | 1.158 | 1.653 | 2.135 | 2.912 | 3.426 | 3.780 | 3.892 |
| **2.200** | 0.000 | 0.228 | 0.570 | 1.105 | 1.576 | 2.044 | 2.848 | 3.395 | 3.767 | 3.879 |
| | | | | | | | | | | |
| **2.300** | 0.000 | 0.221 | 0.554 | 1.054 | 1.506 | 1.960 | 2.787 | 3.367 | 3.749 | 3.863 |
| **2.400** | 0.000 | 0.215 | 0.536 | 1.005 | 1.441 | 1.883 | 2.727 | 3.339 | 3.728 | 3.845 |
| **2.500** | 0.000 | 0.210 | 0.514 | 0.958 | 1.382 | 1.814 | 2.669 | 3.312 | 3.703 | 3.824 |
| **2.600** | 0.000 | 0.205 | 0.490 | 0.915 | 1.328 | 1.750 | 2.613 | 3.285 | 3.676 | 3.801 |
| **2.700** | 0.000 | 0.196 | 0.465 | 0.874 | 1.279 | 1.693 | 2.557 | 3.256 | 3.646 | 3.777 |

## ANNEX E – TANK & HOPPER CALIBRATION TABLES

| | | | |
|---|---|---|---|
| **HUNTER** Unpowered Barge | | Contents | Sea Water |
| Port Ballast Tank | | Contents S. G. | 1.025 |
| (Stbd Ballast Tank similar but with -ve TCG) | | Trim | LEVEL |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | After Face of Stern Transom | +ve direction | FRD |
| Transom Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:** Apply maximum FSM (3.770 t.m) if the tank is, or will become, slack during voyage

| Sound'g | Ullage | Volume | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| *m* | *m* | *$m^3$* | *tonnes* | *m* | *m* | *m* | *t.m* |
| **0.000** | 2.990 | 0.000 | 0.000 | 0.000 | 0.000 (CL) | 0.000 | 3.770 |
| **0.100** | 2.890 | 0.642 | 0.658 | 1.249 | 4.669 (PS) | 0.050 | 3.770 |
| **0.200** | 2.790 | 1.284 | 1.316 | 1.249 | 4.669 (PS) | 0.100 | 3.770 |
| **0.300** | 2.690 | 1.926 | 1.974 | 1.249 | 4.669 (PS) | 0.150 | 3.770 |
| **0.400** | 2.590 | 2.568 | 2.632 | 1.249 | 4.669 (PS) | 0.200 | 3.770 |
| **0.500** | 2.490 | 3.209 | 3.290 | 1.249 | 4.669 (PS) | 0.250 | 3.770 |
| **0.600** | 2.390 | 3.851 | 3.948 | 1.249 | 4.669 (PS) | 0.300 | 3.770 |
| **0.700** | 2.290 | 4.493 | 4.605 | 1.249 | 4.669 (PS) | 0.350 | 3.770 |
| **0.800** | 2.190 | 5.135 | 5.263 | 1.249 | 4.669 (PS) | 0.400 | 3.770 |
| **0.900** | 2.090 | 5.777 | 5.921 | 1.249 | 4.669 (PS) | 0.450 | 3.770 |
| **1.000** | 1.990 | 6.419 | 6.579 | 1.249 | 4.669 (PS) | 0.500 | 3.770 |
| **1.100** | 1.890 | 7.061 | 7.237 | 1.249 | 4.669 (PS) | 0.550 | 3.770 |
| **1.200** | 1.790 | 7.703 | 7.895 | 1.249 | 4.669 (PS) | 0.600 | 3.770 |
| **1.300** | 1.690 | 8.344 | 8.553 | 1.249 | 4.669 (PS) | 0.650 | 3.770 |
| **1.400** | 1.590 | 8.986 | 9.211 | 1.249 | 4.669 (PS) | 0.700 | 3.770 |
| **1.500** | 1.490 | 9.628 | 9.869 | 1.249 | 4.669 (PS) | 0.750 | 3.770 |
| **1.600** | 1.390 | 10.270 | 10.527 | 1.249 | 4.669 (PS) | 0.800 | 3.770 |
| **1.700** | 1.290 | 10.912 | 11.185 | 1.249 | 4.669 (PS) | 0.850 | 3.770 |
| **1.800** | 1.190 | 11.554 | 11.843 | 1.249 | 4.669 (PS) | 0.900 | 3.770 |
| **1.900** | 1.090 | 12.196 | 12.501 | 1.249 | 4.669 (PS) | 0.950 | 3.770 |
| **2.000** | 0.990 | 12.838 | 13.158 | 1.249 | 4.669 (PS) | 1.000 | 3.770 |
| **2.100** | 0.890 | 13.479 | 13.816 | 1.249 | 4.669 (PS) | 1.050 | 3.770 |
| **2.200** | 0.790 | 14.121 | 14.474 | 1.249 | 4.669 (PS) | 1.100 | 3.770 |
| **2.300** | 0.690 | 14.763 | 15.132 | 1.249 | 4.669 (PS) | 1.150 | 3.770 |
| **2.400** | 0.590 | 15.405 | 15.790 | 1.249 | 4.669 (PS) | 1.200 | 3.770 |
| **2.500** | 0.490 | 16.047 | 16.448 | 1.249 | 4.669 (PS) | 1.250 | 3.770 |
| **2.600** | 0.390 | 16.689 | 17.106 | 1.249 | 4.669 (PS) | 1.300 | 3.770 |
| **2.700** | 0.290 | 17.331 | 17.764 | 1.249 | 4.669 (PS) | 1.350 | 3.770 |
| **2.800** | 0.190 | 17.973 | 18.422 | 1.249 | 4.669 (PS) | 1.400 | 3.770 |
| **2.900** | 0.090 | 18.614 | 19.080 | 1.249 | 4.669 (PS) | 1.450 | 3.770 |
| **2.990** | 0.000 | 19.192 | 19.672 | 1.249 | 4.669 (PS) | 1.495 | 3.770 |

| | | | |
|---|---|---|---|
| **HUNTER** Unpowered Barge | | Contents | Fresh Water |
| Fresh Water Tank | | Contents S. G. | 1.000 |
| | | Trim | LEVEL |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | After Face of Stern Transom | +ve direction | FRD |
| Transom Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:** Apply maximum FSM (2.940 t.m) if the tank is, or will become, slack during voyage

| Sound'g | Ullage | Volume | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| *m* | *m* | *$m^3$* | *tonnes* | *m* | *m* | *m* | *t.m* |
| **0.000** | 2.990 | 0.000 | 0.000 | 0.000 | 0.000 (CL) | 0.000 | 2.940 |
| **0.100** | 2.890 | 0.513 | 0.513 | 16.226 | -4.669 (SB) | 0.050 | 2.940 |
| **0.200** | 2.790 | 1.026 | 1.026 | 16.226 | -4.669 (SB) | 0.100 | 2.940 |
| **0.300** | 2.690 | 1.539 | 1.539 | 16.226 | -4.669 (SB) | 0.150 | 2.940 |
| **0.400** | 2.590 | 2.053 | 2.053 | 16.226 | -4.669 (SB) | 0.200 | 2.940 |
| **0.500** | 2.490 | 2.566 | 2.566 | 16.227 | -4.669 (SB) | 0.250 | 2.940 |
| **0.600** | 2.390 | 3.079 | 3.079 | 16.227 | -4.669 (SB) | 0.300 | 2.940 |
| **0.700** | 2.290 | 3.592 | 3.592 | 16.227 | -4.669 (SB) | 0.350 | 2.940 |
| **0.800** | 2.190 | 4.105 | 4.105 | 16.226 | -4.669 (SB) | 0.400 | 2.940 |
| **0.900** | 2.090 | 4.618 | 4.618 | 16.226 | -4.669 (SB) | 0.450 | 2.940 |
| **1.000** | 1.990 | 5.131 | 5.131 | 16.226 | -4.669 (SB) | 0.500 | 2.940 |
| **1.100** | 1.890 | 5.645 | 5.645 | 16.227 | -4.669 (SB) | 0.550 | 2.940 |
| **1.200** | 1.790 | 6.158 | 6.158 | 16.227 | -4.669 (SB) | 0.600 | 2.940 |
| **1.300** | 1.690 | 6.671 | 6.671 | 16.226 | -4.669 (SB) | 0.650 | 2.940 |
| **1.400** | 1.590 | 7.184 | 7.184 | 16.227 | -4.669 (SB) | 0.700 | 2.940 |
| **1.500** | 1.490 | 7.697 | 7.697 | 16.227 | -4.669 (SB) | 0.750 | 2.940 |
| **1.600** | 1.390 | 8.210 | 8.210 | 16.226 | -4.669 (SB) | 0.800 | 2.940 |
| **1.700** | 1.290 | 8.723 | 8.723 | 16.227 | -4.669 (SB) | 0.850 | 2.940 |
| **1.800** | 1.190 | 9.237 | 9.237 | 16.227 | -4.669 (SB) | 0.900 | 2.940 |
| **1.900** | 1.090 | 9.750 | 9.750 | 16.227 | -4.669 (SB) | 0.950 | 2.940 |
| **2.000** | 0.990 | 10.263 | 10.263 | 16.227 | -4.669 (SB) | 1.000 | 2.940 |
| **2.100** | 0.890 | 10.776 | 10.776 | 16.226 | -4.669 (SB) | 1.050 | 2.940 |
| **2.200** | 0.790 | 11.289 | 11.289 | 16.226 | -4.669 (SB) | 1.100 | 2.940 |
| **2.300** | 0.690 | 11.802 | 11.802 | 16.227 | -4.669 (SB) | 1.150 | 2.940 |
| **2.400** | 0.590 | 12.315 | 12.315 | 16.227 | -4.669 (SB) | 1.200 | 2.940 |
| **2.500** | 0.490 | 12.829 | 12.829 | 16.226 | -4.669 (SB) | 1.250 | 2.940 |
| **2.600** | 0.390 | 13.342 | 13.342 | 16.226 | -4.669 (SB) | 1.300 | 2.940 |
| **2.700** | 0.290 | 13.855 | 13.855 | 16.226 | -4.669 (SB) | 1.350 | 2.940 |
| **2.800** | 0.190 | 14.368 | 14.368 | 16.227 | -4.669 (SB) | 1.400 | 2.940 |
| **2.900** | 0.090 | 14.881 | 14.881 | 16.227 | -4.669 (SB) | 1.450 | 2.940 |
| **2.990** | 0.000 | 15.343 | 15.343 | 16.227 | -4.669 (SB) | 1.495 | 2.940 |

| | | | |
|---|---|---|---|
| **HUNTER** | | Contents | Black Water (Sullage) |
| **SULLAGE TANK** | | Contents S. G. | 1.000 |
| **(STBD FREESTANDING TANK)** | | Trim | LEVEL |
| Vertical Datum | Underside of Bottom Plating | +ve direction | UP |
| Longitudinal Datum | Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:** Apply maximum FSM (1.350 t.m) if tank will be or become slack during voyage.

| **Sound'g** | **Ullage** | **Volume** | **Weight** | **LCG** | **TCG** | **VCG** | **FSM** |
|---|---|---|---|---|---|---|---|
| *m* | *m* | *$m^3$* | *tonnes* | *m* | *m* | *m* | *t*m* |
| 0.000 | 1.400 | 0.000 | 0.000 | 18.990 | -4.650 | 0.340 | 0.617 |
| 0.100 | 1.300 | 0.165 | 0.165 | 18.990 | -4.650 | 0.390 | 0.617 |
| 0.200 | 1.200 | 0.359 | 0.359 | 18.990 | -4.650 | 0.447 | 0.945 |
| 0.300 | 1.100 | 0.642 | 0.642 | 18.990 | -4.650 | 0.511 | 1.152 |
| 0.400 | 1.000 | 0.965 | 0.965 | 18.990 | -4.650 | 0.571 | 1.263 |
| | | | | | | | |
| 0.500 | 0.900 | 1.311 | 1.311 | 18.990 | -4.650 | 0.629 | 1.325 |
| 0.600 | 0.800 | 1.668 | 1.668 | 18.990 | -4.650 | 0.688 | 1.350 |
| 0.700 | 0.700 | 2.028 | 2.028 | 18.990 | -4.650 | 0.739 | 1.341 |
| 0.800 | 0.600 | 2.380 | 2.380 | 18.990 | -4.650 | 0.791 | 1.299 |
| 0.900 | 0.500 | 2.717 | 2.717 | 18.990 | -4.650 | 0.840 | 1.215 |
| | | | | | | | |
| 1.000 | 0.400 | 3.023 | 3.023 | 18.990 | -4.650 | 0.886 | 1.067 |
| 1.100 | 0.300 | 3.270 | 3.270 | 18.990 | -4.650 | 0.923 | 0.617 |
| 1.200 | 0.200 | 3.435 | 3.435 | 18.990 | -4.650 | 0.951 | 0.617 |
| 1.300 | 0.100 | 3.600 | 3.600 | 18.990 | -4.650 | 0.980 | 0.617 |
| 1.400 | 0.000 | 3.763 | 3.763 | 18.990 | -4.650 | 1.011 | 0.000 |

| | | | |
|---|---|---|---|
| **HUNTER** Unpowered Barge | | Contents | Diesel Oil |
| Port Diesel Oil Tank | | Contents S. G. | 0.840 |
| | | Trim | LEVEL |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | After Face of Stern Transom | +ve direction | FRD |
| Transom Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:** Apply maximum FSM (3.580 t.m) if the tank is, or will become, slack during voyage

| Sound'g | Ullage | Volume | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| *m* | *m* | *$m^3$* | *tonnes* | *m* | *m* | *m* | *t.m* |
| **0.000** | 2.990 | 0.000 | 0.000 | 0.000 | 0.000 (CL) | 0.000 | 3.580 |
| **0.100** | 2.890 | 0.742 | 0.623 | 22.309 | 4.667 (PS) | 0.050 | 3.580 |
| **0.200** | 2.790 | 1.483 | 1.246 | 22.309 | 4.667 (PS) | 0.100 | 3.580 |
| **0.300** | 2.690 | 2.225 | 1.869 | 22.309 | 4.667 (PS) | 0.150 | 3.580 |
| **0.400** | 2.590 | 2.967 | 2.492 | 22.309 | 4.667 (PS) | 0.200 | 3.580 |
| **0.500** | 2.490 | 3.708 | 3.115 | 22.309 | 4.667 (PS) | 0.250 | 3.580 |
| **0.600** | 2.390 | 4.450 | 3.738 | 22.309 | 4.667 (PS) | 0.300 | 3.580 |
| **0.700** | 2.290 | 5.192 | 4.361 | 22.309 | 4.667 (PS) | 0.350 | 3.580 |
| **0.800** | 2.190 | 5.933 | 4.984 | 22.309 | 4.667 (PS) | 0.400 | 3.580 |
| **0.900** | 2.090 | 6.675 | 5.607 | 22.309 | 4.667 (PS) | 0.450 | 3.580 |
| **1.000** | 1.990 | 7.417 | 6.230 | 22.309 | 4.667 (PS) | 0.500 | 3.580 |
| **1.100** | 1.890 | 8.158 | 6.853 | 22.309 | 4.667 (PS) | 0.550 | 3.580 |
| **1.200** | 1.790 | 8.900 | 7.476 | 22.309 | 4.667 (PS) | 0.600 | 3.580 |
| **1.300** | 1.690 | 9.642 | 8.099 | 22.309 | 4.667 (PS) | 0.650 | 3.580 |
| **1.400** | 1.590 | 10.383 | 8.722 | 22.309 | 4.667 (PS) | 0.700 | 3.580 |
| **1.500** | 1.490 | 11.125 | 9.345 | 22.309 | 4.667 (PS) | 0.750 | 3.580 |
| **1.600** | 1.390 | 11.867 | 9.968 | 22.309 | 4.667 (PS) | 0.800 | 3.580 |
| **1.700** | 1.290 | 12.609 | 10.591 | 22.309 | 4.667 (PS) | 0.850 | 3.580 |
| **1.800** | 1.190 | 13.350 | 11.214 | 22.309 | 4.667 (PS) | 0.900 | 3.580 |
| **1.900** | 1.090 | 14.092 | 11.837 | 22.309 | 4.667 (PS) | 0.950 | 3.580 |
| **2.000** | 0.990 | 14.834 | 12.460 | 22.309 | 4.667 (PS) | 1.000 | 3.580 |
| **2.100** | 0.890 | 15.575 | 13.083 | 22.309 | 4.667 (PS) | 1.050 | 3.580 |
| **2.200** | 0.790 | 16.317 | 13.706 | 22.309 | 4.667 (PS) | 1.100 | 3.580 |
| **2.300** | 0.690 | 17.059 | 14.329 | 22.309 | 4.667 (PS) | 1.150 | 3.580 |
| **2.400** | 0.590 | 17.800 | 14.952 | 22.309 | 4.667 (PS) | 1.200 | 3.580 |
| **2.500** | 0.490 | 18.542 | 15.575 | 22.309 | 4.667 (PS) | 1.250 | 3.580 |
| **2.600** | 0.390 | 19.284 | 16.198 | 22.309 | 4.667 (PS) | 1.300 | 3.580 |
| **2.700** | 0.290 | 20.025 | 16.821 | 22.309 | 4.667 (PS) | 1.350 | 3.580 |
| **2.800** | 0.190 | 20.767 | 17.444 | 22.309 | 4.667 (PS) | 1.400 | 3.580 |
| **2.900** | 0.090 | 21.509 | 18.067 | 22.309 | 4.667 (PS) | 1.450 | 3.580 |
| **2.990** | 0.000 | 22.176 | 18.628 | 22.309 | 4.667 (PS) | 1.495 | 3.580 |

| | | | |
|---|---|---|---|
| **HUNTER** Unpowered Barge | Contents | Diesel Oil | |
| Starboard Diesel Oil Tank | Contents S. G. | 0.840 | |
| | Trim | LEVEL | |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | After Face of Stern Transom | +ve direction | FRD |
| Transom Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:** Apply maximum FSM (4.350 t.m) if the tank is, or will become, slack during voyage

| Sound'g | Ullage | Volume | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| *m* | *m* | *$m^3$* | *tonnes* | *m* | *m* | *m* | *t.m* |
| **0.000** | 2.990 | 0.000 | 0.000 | 0.000 | 0.000 (CL) | 0.000 | 4.350 |
| **0.100** | 2.890 | 0.901 | 0.757 | 21.999 | -4.667 (SB) | 0.050 | 4.350 |
| **0.200** | 2.790 | 1.802 | 1.514 | 21.999 | -4.667 (SB) | 0.100 | 4.350 |
| **0.300** | 2.690 | 2.704 | 2.271 | 21.999 | -4.667 (SB) | 0.150 | 4.350 |
| **0.400** | 2.590 | 3.605 | 3.028 | 21.999 | -4.667 (SB) | 0.200 | 4.350 |
| **0.500** | 2.490 | 4.506 | 3.785 | 21.999 | -4.667 (SB) | 0.250 | 4.350 |
| **0.600** | 2.390 | 5.407 | 4.542 | 21.999 | -4.667 (SB) | 0.300 | 4.350 |
| **0.700** | 2.290 | 6.309 | 5.299 | 21.999 | -4.667 (SB) | 0.350 | 4.350 |
| **0.800** | 2.190 | 7.210 | 6.056 | 21.999 | -4.667 (SB) | 0.400 | 4.350 |
| **0.900** | 2.090 | 8.111 | 6.813 | 21.999 | -4.667 (SB) | 0.450 | 4.350 |
| **1.000** | 1.990 | 9.012 | 7.570 | 21.999 | -4.667 (SB) | 0.500 | 4.350 |
| **1.100** | 1.890 | 9.914 | 8.327 | 21.999 | -4.667 (SB) | 0.550 | 4.350 |
| **1.200** | 1.790 | 10.815 | 9.084 | 21.999 | -4.667 (SB) | 0.600 | 4.350 |
| **1.300** | 1.690 | 11.716 | 9.841 | 21.999 | -4.667 (SB) | 0.650 | 4.350 |
| **1.400** | 1.590 | 12.617 | 10.598 | 21.999 | -4.667 (SB) | 0.700 | 4.350 |
| **1.500** | 1.490 | 13.518 | 11.356 | 21.999 | -4.667 (SB) | 0.750 | 4.350 |
| **1.600** | 1.390 | 14.420 | 12.113 | 21.999 | -4.667 (SB) | 0.800 | 4.350 |
| **1.700** | 1.290 | 15.321 | 12.870 | 21.999 | -4.667 (SB) | 0.850 | 4.350 |
| **1.800** | 1.190 | 16.222 | 13.627 | 21.999 | -4.667 (SB) | 0.900 | 4.350 |
| **1.900** | 1.090 | 17.123 | 14.384 | 21.999 | -4.667 (SB) | 0.950 | 4.350 |
| **2.000** | 0.990 | 18.025 | 15.141 | 21.999 | -4.667 (SB) | 1.000 | 4.350 |
| **2.100** | 0.890 | 18.926 | 15.898 | 21.999 | -4.667 (SB) | 1.050 | 4.350 |
| **2.200** | 0.790 | 19.827 | 16.655 | 21.999 | -4.667 (SB) | 1.100 | 4.350 |
| **2.300** | 0.690 | 20.728 | 17.412 | 21.999 | -4.667 (SB) | 1.150 | 4.350 |
| **2.400** | 0.590 | 21.630 | 18.169 | 21.999 | -4.667 (SB) | 1.200 | 4.350 |
| **2.500** | 0.490 | 22.531 | 18.926 | 21.999 | -4.667 (SB) | 1.250 | 4.350 |
| **2.600** | 0.390 | 23.432 | 19.683 | 21.999 | -4.667 (SB) | 1.300 | 4.350 |
| **2.700** | 0.290 | 24.333 | 20.440 | 21.999 | -4.667 (SB) | 1.350 | 4.350 |
| **2.800** | 0.190 | 25.235 | 21.197 | 21.999 | -4.667 (SB) | 1.400 | 4.350 |
| **2.900** | 0.090 | 26.136 | 21.954 | 21.999 | -4.667 (SB) | 1.450 | 4.350 |
| **2.990** | 0.000 | 26.947 | 22.635 | 21.999 | -4.667 (SB) | 1.495 | 4.350 |

| | | | |
|---|---|---|---|
| **HUNTER - HOPPER 4P (AFTER PORT)** | Contents | Bulk Fish Food | |
| **(HOPPER 4S (AFTER STBD) SIMILAR** | Contents S. G. | 0.65 | |
| **BUT WITH NEGATIVE TCG)** | Trim | LEVEL | |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:**
- ¤ An angle of repose of 40° is assumed for the upper surface of the food.
- ¤ Soundings and ullages are taken from the apex of the upper surface of the food.
- ¤ -ve ullages are above the underside of the upper deck (i.e. 0.500 is 500mm below the level of the deck underside inside the hatch coaming).

| **Sound'g** | **Ullage** | **Volume** | **Weight** | **LCG** | **TCG** | **VCG** | **FSM** |
|---|---|---|---|---|---|---|---|
| *(m)* | *(m)* | *(m^3)* | *(tonnes)* | *(m)* | *(m)* | *(m)* | *(t*m)* |
| 0.000 | 6.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 0.225 | 5.810 | 0.017 | 0.011 | 5.626 | 2.827 | 1.156 | 0.0021 |
| 0.475 | 5.560 | 0.094 | 0.061 | 5.626 | 2.827 | 1.277 | 0.0200 |
| 0.725 | 5.310 | 0.275 | 0.179 | 5.626 | 2.827 | 1.401 | 0.0820 |
| 0.975 | 5.060 | 0.605 | 0.393 | 5.626 | 2.827 | 1.525 | 0.3111 |
| 1.225 | 4.810 | 1.128 | 0.733 | 5.626 | 2.827 | 1.650 | 0.5353 |
| | | | | | | | |
| 1.475 | 4.560 | 1.888 | 1.227 | 5.626 | 2.827 | 1.775 | 0.0624 |
| 1.725 | 4.310 | 2.930 | 1.905 | 5.626 | 2.827 | 1.899 | 1.9029 |
| 1.975 | 4.060 | 4.298 | 2.794 | 5.626 | 2.827 | 2.024 | 3.1371 |
| 2.225 | 3.810 | 6.037 | 3.924 | 5.626 | 2.827 | 2.149 | 5.0277 |
| 2.475 | 3.560 | 8.184 | 5.320 | 5.626 | 2.827 | 2.274 | 6.8586 |
| | | | | | | | |
| 2.725 | 3.310 | 10.616 | 6.900 | 5.626 | 2.827 | 2.399 | 9.6856 |
| 2.975 | 3.060 | 13.273 | 8.627 | 5.626 | 2.827 | 2.524 | 12.4783 |
| 3.225 | 2.810 | 16.154 | 10.500 | 5.626 | 2.827 | 2.649 | 15.7647 |
| 3.475 | 2.560 | 19.260 | 12.519 | 5.626 | 2.827 | 2.774 | 19.5827 |
| 3.725 | 2.310 | 22.590 | 14.684 | 5.626 | 2.827 | 2.899 | 23.9722 |
| | | | | | | | |
| 3.975 | 2.060 | 26.144 | 16.994 | 5.626 | 2.827 | 3.024 | 28.9730 |
| 4.225 | 1.810 | 29.916 | 19.445 | 5.626 | 2.827 | 3.149 | 33.2367 |
| 4.475 | 1.560 | 33.754 | 21.940 | 5.626 | 2.827 | 3.274 | 33.2367 |
| 4.725 | 1.310 | 37.592 | 24.435 | 5.626 | 2.827 | 3.399 | 33.2367 |
| 4.975 | 1.060 | 41.430 | 26.930 | 5.626 | 2.827 | 3.524 | 33.2367 |
| | | | | | | | |
| 5.225 | 0.810 | 45.269 | 29.425 | 5.626 | 2.827 | 3.649 | 33.2367 |
| 5.475 | 0.560 | 49.107 | 31.920 | 5.626 | 2.827 | 3.774 | 33.2367 |
| 5.725 | 0.310 | 52.945 | 34.414 | 5.626 | 2.827 | 3.899 | 33.2367 |
| 5.975 | 0.060 | 56.783 | 36.909 | 5.626 | 2.827 | 4.024 | 33.2367 |
| 6.225 | -0.190 | 60.237 | 39.154 | 5.626 | 2.827 | 4.137 | 33.2367 |
| | | | | | | | |
| 6.425 | -0.390 | 63.307 | 41.150 | 5.626 | 2.827 | 4.237 | 33.2367 |

| | | | |
|---|---|---|---|
| **HUNTER - HOPPER 3P (HOPPER 3S SIMILAR BUT WITH NEGATIVE TCG)** | | Contents | Bulk Fish Food |
| | | Contents S. G. | 0.65 |
| | | Trim | LEVEL |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:**
- ¤ An angle of repose of 40° is assumed for the upper surface of the food.
- ¤ Soundings and ullages are taken from the apex of the upper surface of the food.
- ¤ -ve ullages are above the underside of the upper deck (i.e. 0.500 is 500mm below the level of the deck underside inside the hatch coaming).

| **Sound'g** | **Ullage** | **Volume** | **Weight** | **LCG** | **TCG** | **VCG** | **FSM** |
|---|---|---|---|---|---|---|---|
| *(m)* | *(m)* | *(m^3)* | *(tonnes)* | *(m)* | *(m)* | *(m)* | *(t*m)* |
| 0.000 | 6.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 0.225 | 5.810 | 0.017 | 0.011 | 8.644 | 2.827 | 1.156 | 0.0021 |
| 0.475 | 5.560 | 0.094 | 0.061 | 8.644 | 2.827 | 1.277 | 0.0200 |
| 0.725 | 5.310 | 0.275 | 0.179 | 8.644 | 2.827 | 1.401 | 0.0820 |
| 0.975 | 5.060 | 0.605 | 0.393 | 8.644 | 2.827 | 1.525 | 0.3111 |
| 1.225 | 4.810 | 1.128 | 0.733 | 8.644 | 2.827 | 1.650 | 0.5353 |
| | | | | | | | |
| 1.475 | 4.560 | 1.888 | 1.227 | 8.644 | 2.827 | 1.775 | 1.0624 |
| 1.725 | 4.310 | 2.930 | 1.905 | 8.644 | 2.827 | 1.899 | 1.9029 |
| 1.975 | 4.060 | 4.298 | 2.794 | 8.644 | 2.827 | 2.024 | 3.1371 |
| 2.225 | 3.810 | 6.037 | 3.924 | 8.644 | 2.827 | 2.149 | 5.0277 |
| 2.475 | 3.560 | 8.184 | 5.320 | 8.644 | 2.827 | 2.274 | 6.8586 |
| | | | | | | | |
| 2.725 | 3.310 | 10.616 | 6.900 | 8.644 | 2.827 | 2.399 | 9.6856 |
| 2.975 | 3.060 | 13.273 | 8.627 | 8.644 | 2.827 | 2.524 | 12.4783 |
| 3.225 | 2.810 | 16.154 | 10.500 | 8.644 | 2.827 | 2.649 | 15.7647 |
| 3.475 | 2.560 | 19.260 | 12.519 | 8.644 | 2.827 | 2.774 | 19.5827 |
| 3.725 | 2.310 | 22.590 | 14.684 | 8.644 | 2.827 | 2.899 | 23.9722 |
| | | | | | | | |
| 3.975 | 2.060 | 26.144 | 16.994 | 8.644 | 2.827 | 3.024 | 28.9730 |
| 4.225 | 1.810 | 29.916 | 19.445 | 8.644 | 2.827 | 3.149 | 33.2367 |
| 4.475 | 1.560 | 33.754 | 21.940 | 8.644 | 2.827 | 3.274 | 33.2367 |
| 4.725 | 1.310 | 37.592 | 24.435 | 8.644 | 2.827 | 3.399 | 33.2367 |
| 4.975 | 1.060 | 41.430 | 26.930 | 8.644 | 2.827 | 3.524 | 33.2367 |
| | | | | | | | |
| 5.225 | 0.810 | 45.269 | 29.425 | 8.644 | 2.827 | 3.649 | 33.2367 |
| 5.475 | 0.560 | 49.107 | 31.920 | 8.644 | 2.827 | 3.774 | 33.2367 |
| 5.725 | 0.310 | 52.945 | 34.414 | 8.644 | 2.827 | 3.899 | 33.2367 |
| 5.975 | 0.060 | 56.783 | 36.909 | 8.644 | 2.827 | 4.024 | 33.2367 |
| 6.225 | -0.190 | 60.237 | 39.154 | 8.644 | 2.827 | 4.137 | 33.2367 |
| | | | | | | | |
| 6.425 | -0.390 | 63.307 | 41.150 | 8.644 | 2.827 | 4.237 | 33.2367 |

| | | | |
|---|---|---|---|
| **HUNTER - HOPPER 2P (HOPPER 2S SIMILAR BUT WITH NEGATIVE TCG)** | | Contents | Bulk Fish Food |
| | | Contents S. G. | 0.65 |
| | | Trim | LEVEL |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:**
- An angle of repose of 40° is assumed for the upper surface of the food.
- Soundings and ullages are taken from the apex of the upper surface of the food.
- -ve ullages are above the underside of the upper deck (i.e. 0.500 is 500mm below the level of the deck underside inside the hatch coaming).

| **Sound'g** | **Ullage** | **Volume** | **Weight** | **LCG** | **TCG** | **VCG** | **FSM** |
|---|---|---|---|---|---|---|---|
| *(m)* | *(m)* | *(m^3)* | *(tonnes)* | *(m)* | *(m)* | *(m)* | *(t*m)* |
| 0.000 | 6.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 0.225 | 5.810 | 0.017 | 0.011 | 11.662 | 2.827 | 1.156 | 0.0021 |
| 0.475 | 5.560 | 0.094 | 0.061 | 11.662 | 2.827 | 1.277 | 0.0200 |
| 0.725 | 5.310 | 0.275 | 0.179 | 11.662 | 2.827 | 1.401 | 0.0820 |
| 0.975 | 5.060 | 0.605 | 0.393 | 11.662 | 2.827 | 1.525 | 0.3111 |
| 1.225 | 4.810 | 1.128 | 0.733 | 11.662 | 2.827 | 1.650 | 0.5353 |
| | | | | | | | |
| 1.475 | 4.560 | 1.888 | 1.227 | 11.662 | 2.827 | 1.775 | 1.0624 |
| 1.725 | 4.310 | 2.930 | 1.905 | 11.662 | 2.827 | 1.899 | 1.9029 |
| 1.975 | 4.060 | 4.298 | 2.794 | 11.662 | 2.827 | 2.024 | 3.1371 |
| 2.225 | 3.810 | 6.037 | 3.924 | 11.662 | 2.827 | 2.149 | 5.0277 |
| 2.475 | 3.560 | 8.184 | 5.320 | 11.662 | 2.827 | 2.274 | 6.8586 |
| | | | | | | | |
| 2.725 | 3.310 | 10.616 | 6.900 | 11.662 | 2.827 | 2.399 | 9.6856 |
| 2.975 | 3.060 | 13.273 | 8.627 | 11.662 | 2.827 | 2.524 | 12.4783 |
| 3.225 | 2.810 | 16.154 | 10.500 | 11.662 | 2.827 | 2.649 | 15.7647 |
| 3.475 | 2.560 | 19.260 | 12.519 | 11.662 | 2.827 | 2.774 | 19.5827 |
| 3.725 | 2.310 | 22.590 | 14.684 | 11.662 | 2.827 | 2.899 | 23.9722 |
| | | | | | | | |
| 3.975 | 2.060 | 26.144 | 16.994 | 11.662 | 2.827 | 3.024 | 28.9730 |
| 4.225 | 1.810 | 29.916 | 19.445 | 11.662 | 2.827 | 3.149 | 33.2367 |
| 4.475 | 1.560 | 33.754 | 21.940 | 11.662 | 2.827 | 3.274 | 33.2367 |
| 4.725 | 1.310 | 37.592 | 24.435 | 11.662 | 2.827 | 3.399 | 33.2367 |
| 4.975 | 1.060 | 41.430 | 26.930 | 11.662 | 2.827 | 3.524 | 33.2367 |
| | | | | | | | |
| 5.225 | 0.810 | 45.269 | 29.425 | 11.662 | 2.827 | 3.649 | 33.2367 |
| 5.475 | 0.560 | 49.107 | 31.920 | 11.662 | 2.827 | 3.774 | 33.2367 |
| 5.725 | 0.310 | 52.945 | 34.414 | 11.662 | 2.827 | 3.899 | 33.2367 |
| 5.975 | 0.060 | 56.783 | 36.909 | 11.662 | 2.827 | 4.024 | 33.2367 |
| 6.225 | -0.190 | 60.237 | 39.154 | 11.662 | 2.827 | 4.137 | 33.2367 |
| | | | | | | | |
| 6.425 | -0.390 | 63.307 | 41.150 | 11.662 | 2.827 | 4.237 | 33.2367 |

| | | | |
|---|---|---|---|
| **HUNTER - HOPPER 1P (FORWARD PORT) (HOPPER 1S (FORWARD STBD) SIMILAR BUT WITH NEGATIVE TCG)** | Contents | Bulk Fish Food | |
| | Contents S. G. | 0.65 | |
| | Trim | LEVEL | |
| Vertical Datum | Underside of Hull Bottom Plating | +ve direction | UP |
| Longitudinal Datum | Stern Transom | +ve direction | FRD |
| Transverse Datum | Vessel Centreline | +ve direction | PORT |

**NOTE:**
- ¤ An angle of repose of 40° is assumed for the upper surface of the food.
- ¤ Soundings and ullages are taken from the apex of the upper surface of the food.
- ¤ -ve ullages are above the underside of the upper deck (i.e. 0.500 is 500mm below the level of the deck underside inside the hatch coaming).

| **Sound'g** | **Ullage** | **Volume** | **Weight** | **LCG** | **TCG** | **VCG** | **FSM** |
|---|---|---|---|---|---|---|---|
| *(m)* | *(m)* | *(m^3)* | *(tonnes)* | *(m)* | *(m)* | *(m)* | *(t*m)* |
| 0.000 | 6.035 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 0.225 | 5.810 | 0.017 | 0.011 | 14.680 | 2.827 | 1.156 | 0.0021 |
| 0.475 | 5.560 | 0.094 | 0.061 | 14.680 | 2.827 | 1.277 | 0.0200 |
| 0.725 | 5.310 | 0.275 | 0.179 | 14.680 | 2.827 | 1.401 | 0.0820 |
| 0.975 | 5.060 | 0.605 | 0.393 | 14.680 | 2.827 | 1.525 | 0.3111 |
| 1.225 | 4.810 | 1.128 | 0.733 | 14.680 | 2.827 | 1.650 | 0.5353 |
| | | | | | | | |
| 1.475 | 4.560 | 1.888 | 1.227 | 14.680 | 2.827 | 1.775 | 1.0624 |
| 1.725 | 4.310 | 2.930 | 1.905 | 14.680 | 2.827 | 1.899 | 1.9029 |
| 1.975 | 4.060 | 4.298 | 2.794 | 14.680 | 2.827 | 2.024 | 3.1371 |
| 2.225 | 3.810 | 6.037 | 3.924 | 14.680 | 2.827 | 2.149 | 5.0277 |
| 2.475 | 3.560 | 8.184 | 5.320 | 14.680 | 2.827 | 2.274 | 6.8586 |
| | | | | | | | |
| 2.725 | 3.310 | 10.616 | 6.900 | 14.680 | 2.827 | 2.399 | 9.6856 |
| 2.975 | 3.060 | 13.273 | 8.627 | 14.680 | 2.827 | 2.524 | 12.4783 |
| 3.225 | 2.810 | 16.154 | 10.500 | 14.680 | 2.827 | 2.649 | 15.7647 |
| 3.475 | 2.560 | 19.260 | 12.519 | 14.680 | 2.827 | 2.774 | 19.5827 |
| 3.725 | 2.310 | 22.590 | 14.684 | 14.680 | 2.827 | 2.899 | 23.9722 |
| | | | | | | | |
| 3.975 | 2.060 | 26.144 | 16.994 | 14.680 | 2.827 | 3.024 | 28.9730 |
| 4.225 | 1.810 | 29.916 | 19.445 | 14.680 | 2.827 | 3.149 | 33.2367 |
| 4.475 | 1.560 | 33.754 | 21.940 | 14.680 | 2.827 | 3.274 | 33.2367 |
| 4.725 | 1.310 | 37.592 | 24.435 | 14.680 | 2.827 | 3.399 | 33.2367 |
| 4.975 | 1.060 | 41.430 | 26.930 | 14.680 | 2.827 | 3.524 | 33.2367 |
| | | | | | | | |
| 5.225 | 0.810 | 45.269 | 29.425 | 14.680 | 2.827 | 3.649 | 33.2367 |
| 5.475 | 0.560 | 49.107 | 31.920 | 14.680 | 2.827 | 3.774 | 33.2367 |
| 5.725 | 0.310 | 52.945 | 34.414 | 14.680 | 2.827 | 3.899 | 33.2367 |
| 5.975 | 0.060 | 56.783 | 36.909 | 14.680 | 2.827 | 4.024 | 33.2367 |
| 6.225 | -0.190 | 60.237 | 39.154 | 14.680 | 2.827 | 4.137 | 33.2367 |
| | | | | | | | |
| 6.425 | -0.390 | 63.307 | 41.150 | 14.680 | 2.827 | 4.237 | 33.2367 |

## ANNEX F – LOADING CONDITIONS

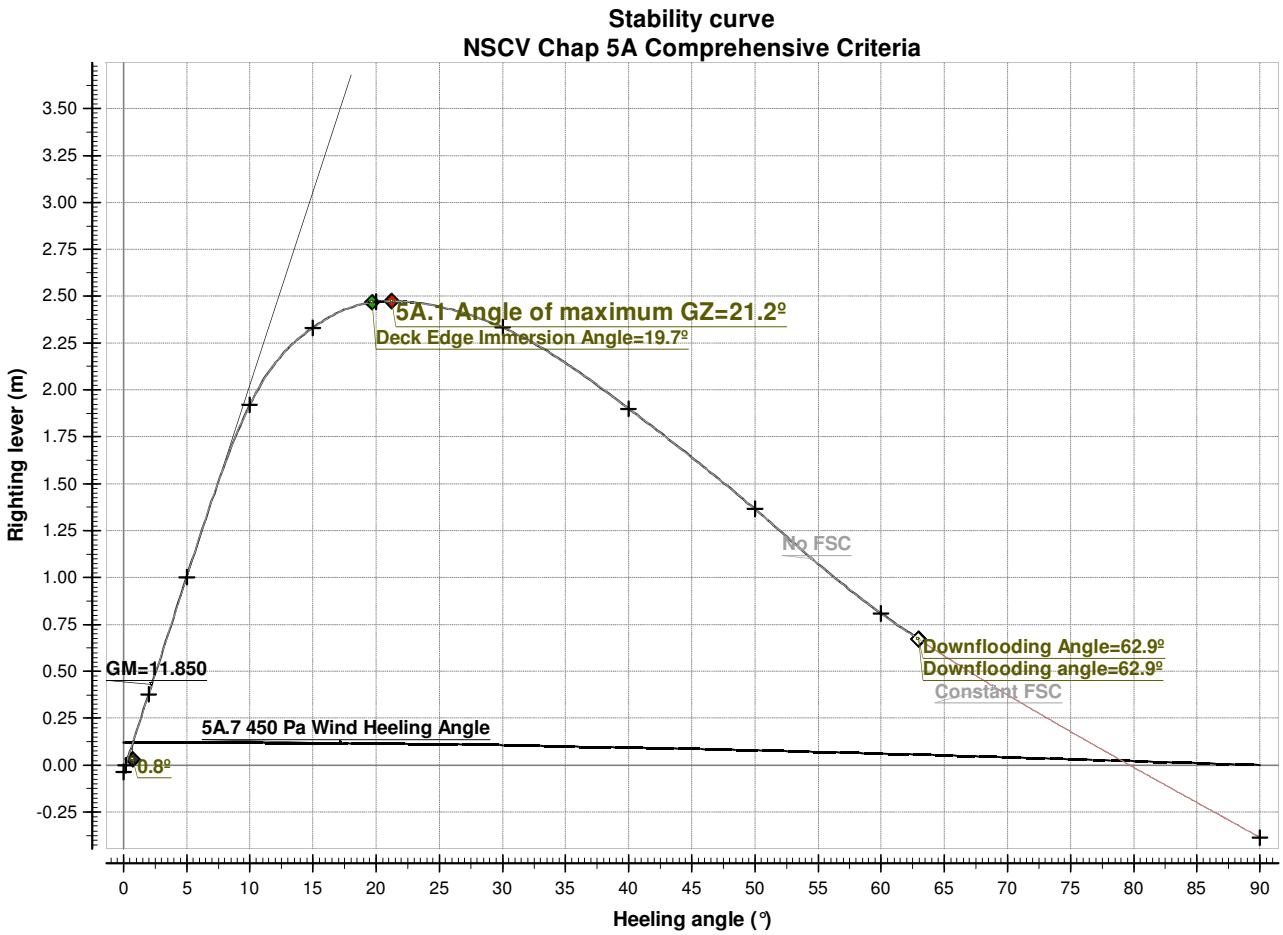
| | |
|---|---|
| **Loading Condition 01**<br>**Lightship** | Vertical Datum: Underside of Bottom Plate, +ve UP<br>Longitudinal Datum: After Face of Stern Transom,<br>Transverse Datum: Vessel Centreline, +ve PORT |
| **Compliance** | The vessel complies with NSCV 6A Chap 5A in this loading condition |

| Item | SG | Full | Weight | LCG | TCG | VCG |
|---|---|---|---|---|---|---|
| | *t/m³* | *%* | *t* | *m* | *m* | *m* |
| Pt Ballast Tank | 1.025 | 0 | | | | |
| St Ballast Tank | 1.025 | 0 | | | | |
| Fresh Water Tank | 1.000 | 0 | | | | |
| Pt Diesel Oil Tank | 0.840 | 0 | | | | |
| St Diesel Oil Tank | 0.840 | 0 | | | | |
| 10% Sullage Tank | 1.000 | 0 | | | | |
| 8 Crew (Weather Deck) | | | | | | |
| 4 Crew (Upper Deck) | | | | | | |
| Stores & Effects | | | | | | |
| Hopper 1P (Frd) | 0.650 | 0 | | | | |
| Hopper 1S (Frd) | 0.650 | 0 | | | | |
| Hopper 2P | 0.650 | 0 | | | | |
| Hopper 2S | 0.650 | 0 | | | | |
| Hopper 3P | 0.650 | 0 | | | | |
| Hopper 3S | 0.650 | 0 | | | | |
| Hopper 4P (Aft) | 0.650 | 0 | | | | |
| Hopper 4S (Aft) | 0.650 | 0 | | | | |
| DEADWEIGHT | | | 0.000 | 0.000 | 0.000 | 0.000 |
| LIGHTSHIP | | | 238.533 | 12.879 | -0.035 | 3.247 |
| DISPLACEMENT | | | 238.533 | 12.879 | -0.035 | 3.247 |
| FREE SURFACE CORRECTION | | | | | | 0.000 |
| $VCG_F$ | | | | | | 3.247 |

| **HYDROSTATIC PARTICULARS** | | | |
|---|---|---|---|
| List | -0.2° | KM | 15.097 m |
| Draft at Aft Perp. | 0. 595 m | VCG | 3.247 m |
| Draft (mean) | 0.812 m | GM (solid) | 11.850 m |
| Draft at Frd Perp | 1.029 m | GM (fluid) | 11.850 m |
| Trim by Bow | 0.433 m | Rate of Immersion | 2.916 t/cm |
| Downflooding Angle | 62.9° | Moment to trim 1cm | 5.532 t.m / cm |
| Deck Edge Imm'n Angle | 19.7° | | |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5A – Comprehensive Criteria | | | | |
| Areas of Operation | C, D & E | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| 5A.1 | Angle of Maximum GZ | 21.2° | ≥ | 15° | YES |
| 5A.2b | Area under GZ curve to 21.2° | 35.864 deg.m | ≥ | 3.656 deg.m | YES |
| 5A.3 | Area under GZ curve to 40° | 78.438 deg.m | ≥ | 5.16 deg.m | YES |
| 5A.4 | Area under GZ curve 30° – 40° | 21.350 deg.m | ≥ | 1.72 deg.m | YES |
| 5A.5 | Maximum GZ beyond 30° | 2.473 m | ≥ | 0.200 m | YES |
| 5A.6c | GM | 11.850 m | ≥ | 0.350 m | YES |
| 5A.7a | Heel angle under the effect of 450 Pa wind | 0.8° | ≤ | 10° | YES |
| 5A.9 | Residual Area between GZ & Windage curves to 40° | 73.64 deg.m | ≥ | 16.72 deg.m | YES |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| *deg* | *m* | *m* | *m* | *m* | *m* | *m.deg* |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.035 | -0.035 | 0.000 |
| **2.0º** | 0.045 | 0.010 | 0.000 | 0.035 | 0.000 | 0.000 |
| **5.0º** | 0.527 | 0.113 | 0.000 | 0.035 | 0.379 | 0.344 |
| **10.0º** | 1.320 | 0.283 | 0.000 | 0.035 | 1.003 | 2.407 |
| **15.0º** | 2.519 | 0.564 | 0.000 | 0.034 | 1.921 | 9.856 |
| **20.0º** | 3.206 | 0.840 | 0.000 | 0.034 | 2.331 | 20.685 |
| **30.0º** | 3.613 | 1.111 | 0.000 | 0.033 | 2.469 | 32.776 |
| **40.0º** | 3.987 | 1.623 | 0.000 | 0.030 | 2.333 | 57.071 |
| **50.0º** | 4.014 | 2.087 | 0.000 | 0.027 | 1.900 | 78.444 |
| **60.0º** | 3.875 | 2.487 | 0.000 | 0.022 | 1.365 | 94.832 |
| **90.0º** | 3.638 | 2.812 | 0.000 | 0.018 | 0.809 | 105.604 |



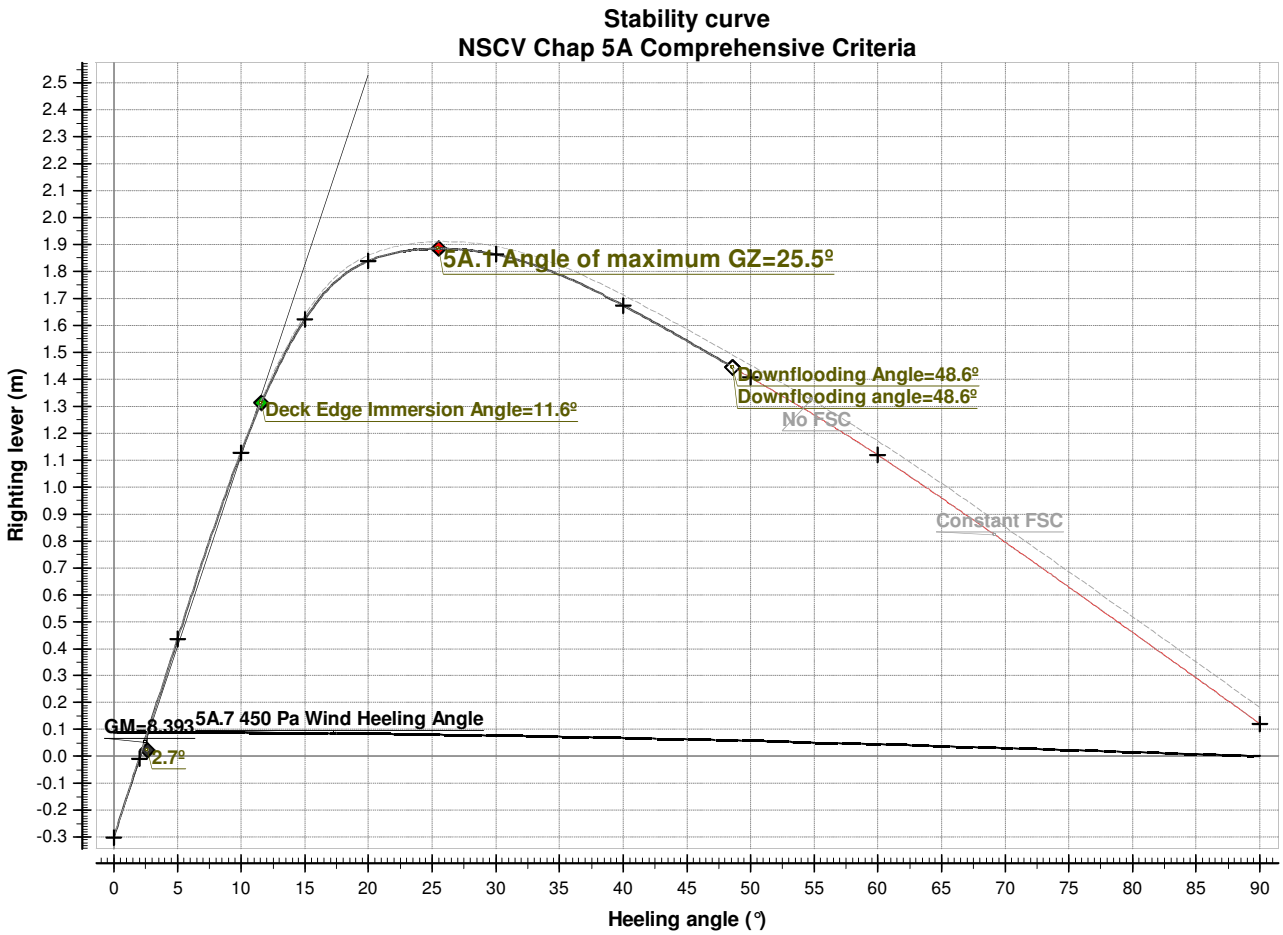
| **Loading Condition 02**<br>**Approx. 10% Cargo & Full Tanks** | Vertical Datum: Underside of Bottom Plate, +ve UP<br>Longitudinal Datum: After Face of Stern Transom, +ve FRD<br>Transverse Datum: Vessel Centreline, +ve PORT |
|---|---|
| **Compliance** | The vessel complies with NSCV 6A Chap 5A in this loading condition |

| Item | SG | Full | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| | *t/m³* | *%* | *t* | *m* | *m* | *m* | *t.m* |
| Pt Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| St Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| Fresh Water Tank | 1.000 | 98.0 | 15.036 | 16.227 | -4.669 | 1.465 | 2.940 |
| Pt Diesel Oil Tank | 0.840 | 98.0 | 18.256 | 22.309 | 4.667 | 1.465 | 3.580 |
| St Diesel Oil Tank | 0.840 | 98.0 | 22.183 | 21.999 | -4.667 | 1.465 | 4.350 |
| 10% Sullage Tank | 1.000 | 10.0 | 0.359 | 18.990 | -4.650 | 0.447 | 1.350 |
| 8 Crew (Weather Deck) | | | 0.640 | 15.000 | 0.000 | 4.000 | 0.000 |
| 4 Crew (Upper Deck) | | | 0.320 | 18.000 | 0.000 | 8.200 | 0.000 |
| Stores & Effects | | | 1.000 | 15.000 | 0.000 | 1.750 | 0.000 |
| Hopper 1P (Frd) | 0.650 | 9.5 | 3.924 | 14.680 | 2.827 | 2.149 | 0.000 |
| Hopper 1S (Frd) | 0.650 | 9.5 | 3.924 | 14.680 | -2.827 | 2.149 | 0.000 |
| Hopper 2P | 0.650 | 9.5 | 3.924 | 11.662 | 2.827 | 2.149 | 0.000 |
| Hopper 2S | 0.650 | 9.5 | 3.924 | 11.662 | -2.827 | 2.149 | 0.000 |
| Hopper 3P | 0.650 | 9.5 | 3.924 | 8.644 | 2.827 | 2.149 | 0.000 |
| Hopper 3S | 0.650 | 9.5 | 3.924 | 8.644 | -2.827 | 2.149 | 0.000 |
| Hopper 4P (Aft) | 0.650 | 9.5 | 3.924 | 5.626 | 2.827 | 2.149 | 0.000 |
| Hopper 4S (Aft) | 0.650 | 9.5 | 3.924 | 5.626 | -2.827 | 2.149 | 0.000 |
| DEADWEIGHT | | | 89.186 | 16.765 | -1.011 | 1.748 | 19.760 |
| LIGHTSHIP | | | 238.533 | 12.879 | -0.035 | 3.247 | 0.000 |
| DISPLACEMENT | | | 327.719 | 13.936 | -0.301 | 2.839 | 19.760 |
| FREE SURFACE CORRECTION | | | | | | 0.060 | |
| $VCG_F$ | | | | | | 2.899 | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | -2.1° | | KM | 11.292 m |
| Draft at Aft Perp. | 0.503 m | | VCG | 2.899 m |
| Draft (mean) | 1.118 m | | GM (solid) | 8.454 m |
| Draft at Frd Perp | 1.733 m | | GM (fluid) | 8.393 m |
| Trim by Bow | 1.229 | | Rate of Immersion | 2.922 t/cm |
| Downflooding Angle | 48.6° | | Moment to trim 1cm | 5.518 t.m / cm |
| Deck Edge Imm'n Angle | 11.6° | | | |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5A – Comprehensive Criteria | | | | |
| Areas of Operation | C, D & E | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| 5A.1 | Angle of Maximum GZ | 25.5° | ≥ | 15° | YES |
| 5A.2b | Area under GZ curve to 25.5° | 30.684 deg.m | ≥ | 3.409 deg.m | YES |
| 5A.3 | Area under GZ curve to 40° | 56.882 deg.m | ≥ | 5.16 deg.m | YES |
| 5A.4 | Area under GZ curve 30° – 40° | 17.815 deg.m | ≥ | 1.72 deg.m | YES |
| 5A.5 | Maximum GZ beyond 30° | 1.885 m | ≥ | 0.200 m | YES |
| 5A.6c | GM | 8.393 m | ≥ | 0.350 m | YES |
| 5A.7a | Heel angle under the effect of 450 Pa wind | 2.7° | ≤ | 10° | YES |
| 5A.9 | Residual Area between GZ & Windage curves to 40° | | ≥ | | N/R |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| *deg* | *m* | *m* | *m* | *m* | *m* | *m.deg* |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.301 | -0.301 | 0.000 |
| **2.0º** | 0.394 | 0.099 | 0.002 | 0.301 | -0.008 | 0.000 |
| **5.0º** | 0.987 | 0.247 | 0.005 | 0.300 | 0.434 | 0.630 |
| **10.0º** | 1.927 | 0.493 | 0.010 | 0.296 | 1.127 | 4.584 |
| **15.0º** | 2.662 | 0.735 | 0.016 | 0.290 | 1.621 | 11.575 |
| **20.0º** | 3.113 | 0.971 | 0.021 | 0.283 | 1.839 | 20.342 |
| **30.0º** | 3.573 | 1.419 | 0.030 | 0.260 | 1.863 | 39.079 |
| **40.0º** | 3.768 | 1.825 | 0.039 | 0.230 | 1.674 | 56.899 |
| **50.0º** | 3.820 | 2.175 | 0.046 | 0.193 | 1.406 | 72.313 |
| **60.0º** | 3.779 | 2.459 | 0.052 | 0.150 | 1.118 | 84.976 |
| **90.0º** | 3.021 | 2.839 | 0.060 | 0.000 | 0.121 | 103.713 |



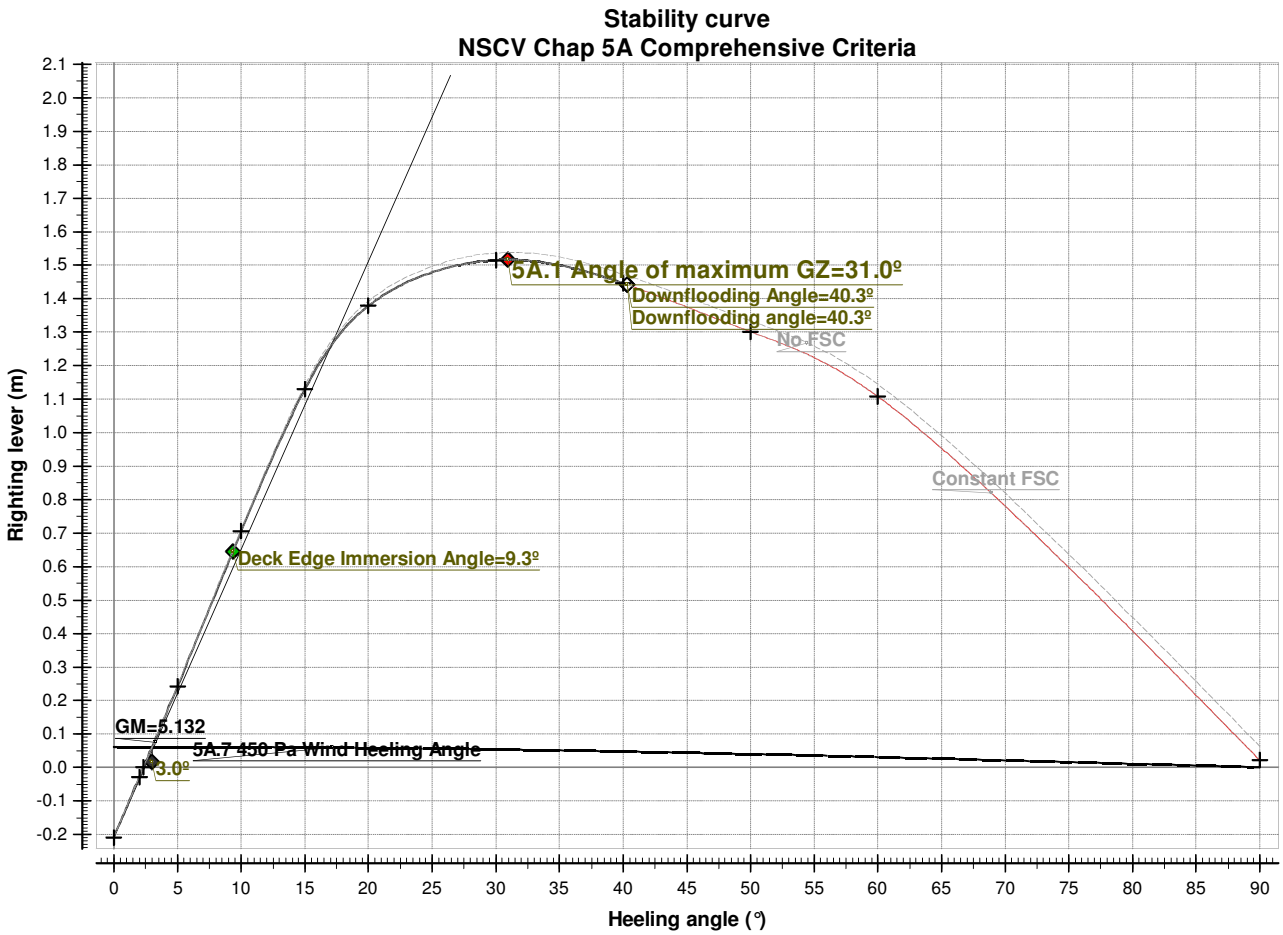
| | |
|---|---|
| **Loading Condition 03**<br>**Approx. 50% Cargo & Full Tanks** | Vertical Datum: Underside of Bottom Plate, +ve UP<br>Longitudinal Datum: After Face of Stern Transom, +ve FRD<br>Transverse Datum: Vessel Centreline, +ve PORT |
| **Compliance** | The vessel complies with NSCV 6A Chap 5A in this loading condition |

| Item | SG | Full | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| | *t/m³* | *%* | *t* | *m* | *m* | *m* | *t.m* |
| Pt Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| St Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| Fresh Water Tank | 1.000 | 98.0 | 15.036 | 16.227 | -4.669 | 1.465 | 2.940 |
| Pt Diesel Oil Tank | 0.840 | 98.0 | 18.256 | 22.309 | 4.667 | 1.465 | 3.580 |
| St Diesel Oil Tank | 0.840 | 98.0 | 22.183 | 21.999 | -4.667 | 1.465 | 4.350 |
| 10% Sullage Tank | 1.000 | 10.0 | 0.359 | 18.990 | -4.650 | 0.447 | 1.350 |
| 8 Crew (Weather Deck) | | | 0.640 | 15.000 | 0.000 | 4.000 | 0.000 |
| 4 Crew (Upper Deck) | | | 0.320 | 18.000 | 0.000 | 8.200 | 0.000 |
| Stores & Effects | | | 1.000 | 15.000 | 0.000 | 1.750 | 0.000 |
| Hopper 1P (Frd) | 0.650 | 53.3 | 21.940 | 14.680 | 2.827 | 3.274 | 0.000 |
| Hopper 1S (Frd) | 0.650 | 53.3 | 21.940 | 14.680 | -2.827 | 3.274 | 0.000 |
| Hopper 2P | 0.650 | 53.3 | 21.940 | 11.662 | 2.827 | 3.274 | 0.000 |
| Hopper 2S | 0.650 | 53.3 | 21.940 | 11.662 | -2.827 | 3.274 | 0.000 |
| Hopper 3P | 0.650 | 53.3 | 21.940 | 8.644 | 2.827 | 3.274 | 0.000 |
| Hopper 3S | 0.650 | 53.3 | 21.940 | 8.644 | -2.827 | 3.274 | 0.000 |
| Hopper 4P (Aft) | 0.650 | 53.3 | 21.940 | 5.626 | 2.827 | 3.274 | 0.000 |
| Hopper 4S (Aft) | 0.650 | 53.3 | 21.940 | 5.626 | -2.827 | 3.274 | 0.000 |
| DEADWEIGHT | | | 233.314 | 12.680 | -0.387 | 2.843 | 19.760 |
| LIGHTSHIP | | | 238.533 | 12.879 | -0.035 | 3.247 | 0.000 |
| DISPLACEMENT | | | 471.847 | 12.781 | -0.209 | 3.047 | 19.760 |
| FREE SURFACE CORRECTION | | | | | | 0.042 | |
| $VCG_F$ | | | | | | 3.089 | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | -2.3° | | KM | 8.220 m |
| Draft at Aft Perp. | 1.213 m | | VCG | 3.089 m |
| Draft (mean) | 1.612 m | | GM (solid) | 5.174 m |
| Draft at Frd Perp | 2.012 m | | GM (fluid) | 5.132 m |
| Trim by Bow | 0.799 m | | Rate of Immersion | 2.920 t/cm |
| Downflooding Angle | 40.3° | | Moment to trim 1cm | 5. 360 t.m / cm |
| Deck Edge Imm'n Angle | 9.3° | | | |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5A – Comprehensive Criteria | | | | |
| Areas of Operation | C, D & E | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| 5A.1 | Angle of Maximum GZ | 31.0° | ≥ | 15° | YES |
| 5A.2b | Area under GZ curve to 30.0° | 28.358 deg.m | ≥ | 3.150 deg.m | YES |
| 5A.3 | Area under GZ curve to 40° | 43.290 deg.m | ≥ | 5.16 deg.m | YES |
| 5A.4 | Area under GZ curve 30° – 40° | 14.938 deg.m | ≥ | 1.72 deg.m | YES |
| 5A.5 | Maximum GZ beyond 30° | 1.515 m | ≥ | 0.200 m | YES |
| 5A.6c | GM | 5.132 m | ≥ | 0.350 m | YES |
| 5A.7a | Heel angle under the effect of 450 Pa wind | 3.0° | ≤ | 10° | YES |
| 5A.9 | Residual Area between GZ & Windage curves to 40° | | ≥ | | N/R |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| *deg* | *m* | *m* | *m* | *m* | *m* | *m.deg* |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.209 | -0.209 | 0.000 |
| **2.0º** | 0.287 | 0.106 | 0.001 | 0.209 | -0.030 | 0.000 |
| **5.0º** | 0.719 | 0.266 | 0.004 | 0.208 | 0.241 | 0.344 |
| **10.0º** | 1.447 | 0.529 | 0.007 | 0.206 | 0.705 | 2.693 |
| **15.0º** | 2.130 | 0.789 | 0.011 | 0.202 | 1.129 | 7.334 |
| **20.0º** | 2.631 | 1.042 | 0.014 | 0.196 | 1.378 | 13.695 |
| **30.0º** | 3.240 | 1.523 | 0.021 | 0.181 | 1.515 | 28.364 |
| **40.0º** | 3.591 | 1.958 | 0.027 | 0.160 | 1.446 | 43.319 |
| **50.0º** | 3.801 | 2.334 | 0.032 | 0.134 | 1.301 | 57.014 |
| **60.0º** | 3.887 | 2.638 | 0.036 | 0.104 | 1.108 | 69.218 |
| **90.0º** | 3.110 | 3.047 | 0.042 | 0.000 | 0.021 | 86.810 |



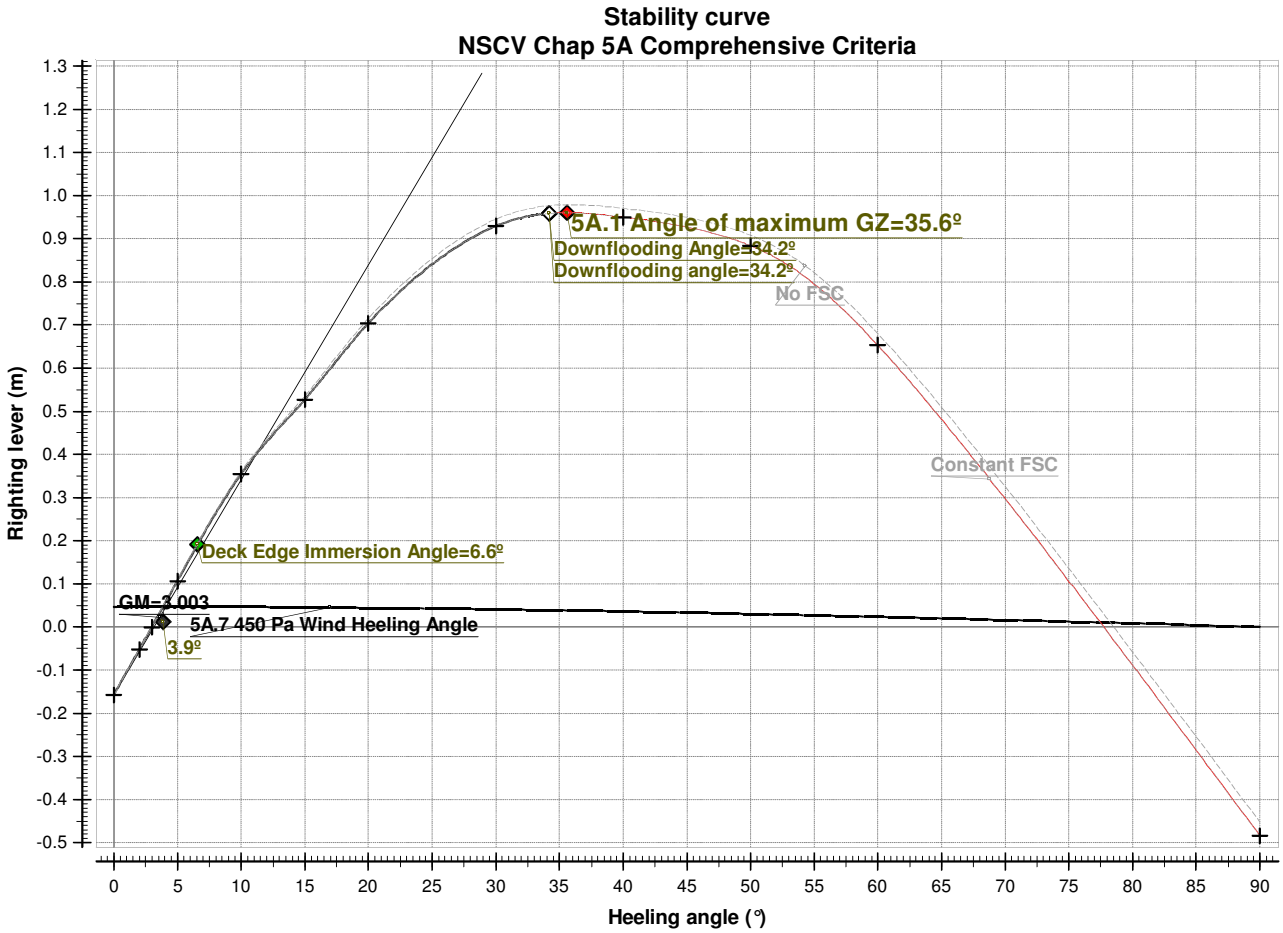
| **Loading Condition 04**<br>**100% Cargo & Full Tanks** | Vertical Datum: Underside of Bottom Plate, +ve UP<br>Longitudinal Datum: After Face of Stern Transom, +ve FRD<br>Transverse Datum: Vessel Centreline, +ve PORT |
|---|---|
| **Compliance** | The vessel complies with NSCV 6A Chap 5A in this loading condition |

| Item | SG | Full | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| | *t/m³* | *%* | *t* | *m* | *m* | *m* | *t.m* |
| Pt Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| St Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| Fresh Water Tank | 1.000 | 98.0 | 15.036 | 16.227 | -4.669 | 1.465 | 2.940 |
| Pt Diesel Oil Tank | 0.840 | 98.0 | 18.256 | 22.309 | 4.667 | 1.465 | 3.580 |
| St Diesel Oil Tank | 0.840 | 98.0 | 22.183 | 21.999 | -4.667 | 1.465 | 4.350 |
| 10% Sullage Tank | 1.000 | 10.0 | 0.359 | 18.990 | -4.650 | 0.447 | 1.350 |
| 8 Crew (Weather Deck) | | | 0.640 | 15.000 | 0.000 | 4.000 | 0.000 |
| 4 Crew (Upper Deck) | | | 0.320 | 18.000 | 0.000 | 8.200 | 0.000 |
| Stores & Effects | | | 1.000 | 15.000 | 0.000 | 1.750 | 0.000 |
| Hopper 1P (Frd) | 0.650 | 100.0 | 41.150 | 14.680 | 2.827 | 4.237 | 0.000 |
| Hopper 1S (Frd) | 0.650 | 100.0 | 41.150 | 14.680 | -2.827 | 4.237 | 0.000 |
| Hopper 2P | 0.650 | 100.0 | 41.150 | 11.662 | 2.827 | 4.237 | 0.000 |
| Hopper 2S | 0.650 | 100.0 | 41.150 | 11.662 | -2.827 | 4.237 | 0.000 |
| Hopper 3P | 0.650 | 100.0 | 41.150 | 8.644 | 2.827 | 4.237 | 0.000 |
| Hopper 3S | 0.650 | 100.0 | 41.150 | 8.644 | -2.827 | 4.237 | 0.000 |
| Hopper 4P (Aft) | 0.650 | 100.0 | 41.150 | 5.626 | 2.827 | 4.237 | 0.000 |
| Hopper 4S (Aft) | 0.650 | 100.0 | 41.150 | 5.626 | -2.827 | 4.237 | 0.000 |
| DEADWEIGHT | | | 386.994 | 11.677 | -0.233 | 3.832 | 19.760 |
| LIGHTSHIP | | | 238.533 | 12.879 | -0.035 | 3.247 | 0.000 |
| DISPLACEMENT | | | 625.527 | 12.135 | -0.158 | 3.609 | 19.760 |
| FREE SURFACE CORRECTION | | | | | | 0.032 | |
| $VCG_F$ | | | | | | 3.641 | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | -3.0° | | KM | 6.644 m |
| Draft at Aft Perp. | 1.980 m | | VCG | 3.641 m |
| Draft (mean) | 2.139 m | | GM (solid) | 3.035 m |
| Draft at Frd Perp | 2.298 m | | GM (fluid) | 3.003 m |
| Trim by Bow | 0.318 m | | Rate of Immersion | 2.920 t/cm |
| Downflooding Angle | 34.2° | | Moment to trim 1cm | 5.120 t.m / cm |
| Deck Edge Imm'n Angle | 6.6° | | | |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5A – Comprehensive Criteria | | | | |
| Areas of Operation | C, D & E | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| 5A.1 | Angle of Maximum GZ | 35.6° | ≥ | 15° | YES |
| 5A.2b | Area under GZ curve to 30.0° | 14.909 deg.m | ≥ | 3.150 deg.m | YES |
| 5A.3 | Area under GZ curve to 34.2° | 18.915 deg.m | ≥ | 5.16 deg.m | YES |
| 5A.4 | Area under GZ curve 30° – 34.2° | 4.005 deg.m | ≥ | 1.72 deg.m | YES |
| 5A.5 | Maximum GZ beyond 30° | 0.929 m | ≥ | 0.200 m | YES |
| 5A.6c | GM | 3.003 m | ≥ | 0.350 m | YES |
| 5A.7a | Heel angle under the effect of 450 Pa wind | 3.6° | ≤ | 10° | YES |
| 5A.9 | Residual Area between GZ & Windage curves to 40° | | ≥ | | N/R |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| *deg* | *m* | *m* | *m* | *m* | *m* | *m.deg* |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.158 | -0.158 | 0.000 |
| **2.0º** | 0.232 | 0.126 | 0.001 | 0.157 | -0.053 | 0.000 |
| **2.8°** | 0.347 | 0.188 | 0.002 | 0.157 | 0.000 | 0.000 |
| **5.0º** | 0.581 | 0.315 | 0.003 | 0.157 | 0.107 | 0.115 |
| **10.0º** | 1.142 | 0.627 | 0.005 | 0.155 | 0.354 | 1.261 |
| **15.0º** | 1.621 | 0.934 | 0.008 | 0.152 | 0.526 | 3.495 |
| **20.0º** | 2.097 | 1.234 | 0.011 | 0.148 | 0.704 | 6.590 |
| **30.0º** | 2.886 | 1.805 | 0.016 | 0.136 | 0.929 | 14.898 |
| **40.0º** | 3.411 | 2.320 | 0.020 | 0.121 | 0.950 | 24.410 |
| **50.0º** | 3.774 | 2.765 | 0.024 | 0.101 | 0.884 | 33.692 |
| **60.0º** | 3.884 | 3.126 | 0.027 | 0.079 | 0.653 | 41.543 |
| **90.0º** | 3.157 | 3.609 | 0.032 | 0.000 | -0.484 | 47.502 |



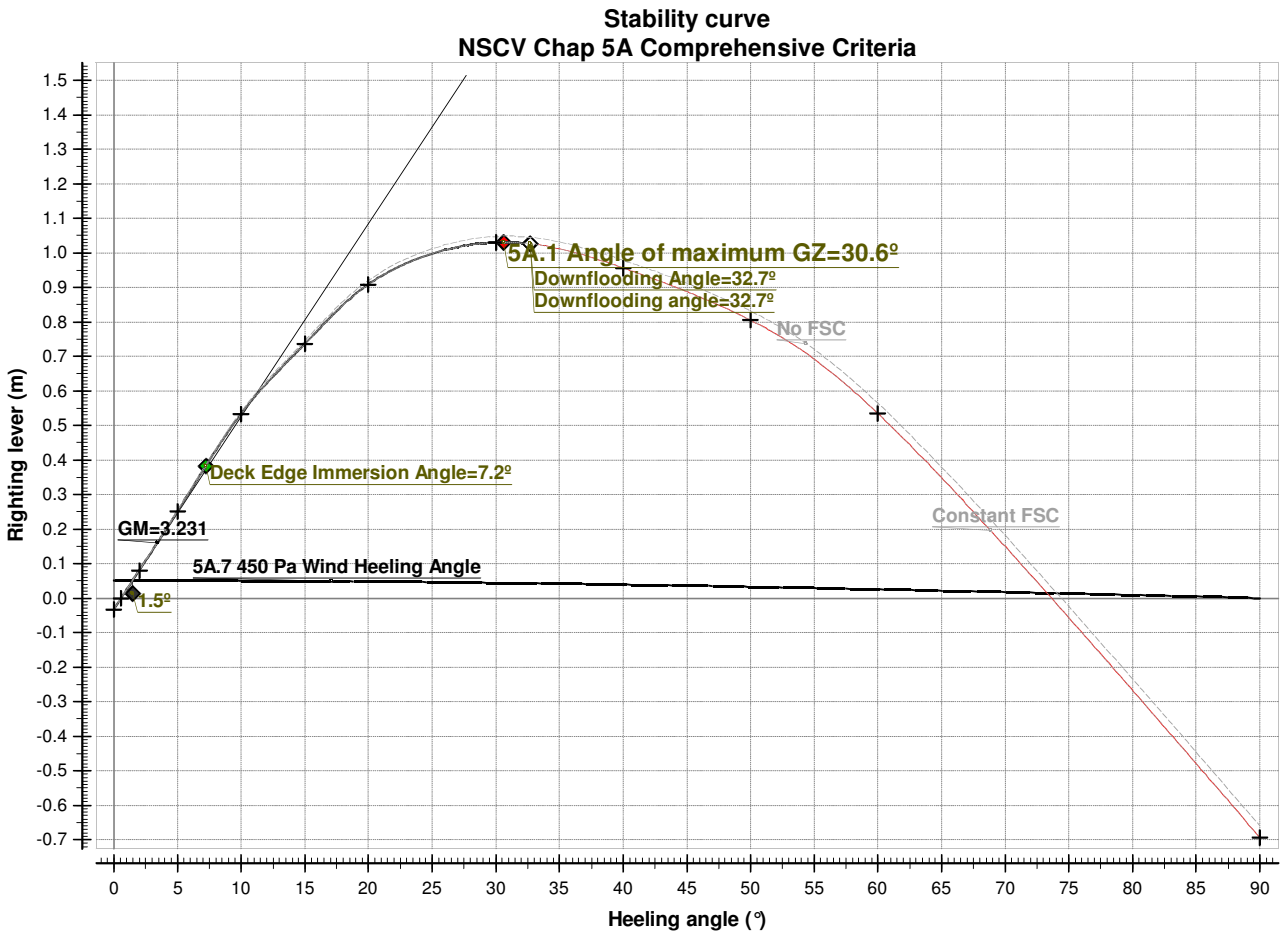
| | |
|---|---|
| **Loading Condition 05**<br>**100% Cargo & 10% Tanks** | Vertical Datum: Underside of Bottom Plate, +ve UP<br>Longitudinal Datum: After Face of Stern Transom, +ve FRD<br>Transverse Datum: Vessel Centreline, +ve PORT |
| **Compliance** | The vessel complies with NSCV 6A Chap 5A in this loading condition |

| Item | SG | Full | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| | *t/m³* | *%* | *t* | *m* | *m* | *m* | *t.m* |
| Pt Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| St Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| Fresh Water Tank | 1.000 | 10.0 | 1.534 | 16.227 | -4.669 | 0.149 | 2.940 |
| Pt Diesel Oil Tank | 0.840 | 10.0 | 1.863 | 22.309 | 4.667 | 0.150 | 3.580 |
| St Diesel Oil Tank | 0.840 | 10.0 | 2.264 | 21.999 | -4.667 | 0.150 | 4.350 |
| 10% Sullage Tank | 1.000 | 10.0 | 0.359 | 18.990 | -4.650 | 0.447 | 1.350 |
| 8 Crew (Weather Deck) | | | 0.640 | 15.000 | 0.000 | 4.000 | 0.000 |
| 4 Crew (Upper Deck) | | | 0.320 | 18.000 | 0.000 | 8.200 | 0.000 |
| Stores & Effects | | | 1.000 | 15.000 | 0.000 | 1.750 | 0.000 |
| Hopper 1P (Frd) | 0.650 | 100.0 | 41.150 | 14.680 | 2.827 | 4.047 | 0.000 |
| Hopper 1S (Frd) | 0.650 | 100.0 | 41.150 | 14.680 | -2.827 | 4.047 | 0.000 |
| Hopper 2P | 0.650 | 100.0 | 41.150 | 11.662 | 2.827 | 4.047 | 0.000 |
| Hopper 2S | 0.650 | 100.0 | 41.150 | 11.662 | -2.827 | 4.047 | 0.000 |
| Hopper 3P | 0.650 | 100.0 | 41.150 | 8.644 | 2.827 | 4.047 | 0.000 |
| Hopper 3S | 0.650 | 100.0 | 41.150 | 8.644 | -2.827 | 4.047 | 0.000 |
| Hopper 4P (Aft) | 0.650 | 100.0 | 41.150 | 5.626 | 2.827 | 4.047 | 0.000 |
| Hopper 4S (Aft) | 0.650 | 100.0 | 41.150 | 5.626 | -2.827 | 4.047 | 0.000 |
| | | | | | | | |
| DEADWEIGHT | | | 337.180 | 10.392 | -0.027 | 4.160 | 19.760 |
| LIGHTSHIP | | | 238.533 | 12.879 | -0.035 | 3.247 | 0.000 |
| DISPLACEMENT | | | 575.713 | 11.408 | -0.033 | 3.782 | 19.760 |
| FREE SURFACE CORRECTION | | | | | | 0.034 | |
| $VCG_F$ | | | | | | 3.816 | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | -0.6° | | KM | 7.047 m |
| Draft at Aft Perp. | 2.231 m | | VCG | 3.816 m |
| Draft (mean) | 1.968m | | GM (solid) | 3.265 m |
| Draft at Frd Perp | 1.706 m | | GM (fluid) | 3.231 m |
| Trim by Bow | -0.526 m | | Rate of Immersion | 2.917 t/cm |
| Downflooding Angle | 32.7° | | Moment to trim 1cm | 5.116 t.m / cm |
| Deck Edge Imm'n Angle | 7.2° | | | |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5A – Comprehensive Criteria | | | | |
| Areas of Operation | C, D & E | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| 5A.1 | Angle of Maximum GZ | 30.6° | ≥ | 15° | YES |
| 5A.2b | Area under GZ curve to 30.0° | 19.757 deg.m | ≥ | 3.150 deg.m | YES |
| 5A.3 | Area under GZ curve to 32.7° | 22.542 deg.m | ≥ | 5.16 deg.m | YES |
| 5A.4 | Area under GZ curve 30° – 32.7° | 2.785 deg.m | ≥ | 1.72 deg.m | YES |
| 5A.5 | Maximum GZ beyond 30° | 1.030 m | ≥ | 0.200 m | YES |
| 5A.6c | GM | 3.231 m | ≥ | 0.350 m | YES |
| 5A.7a | Heel angle under the effect of 450 Pa wind | 1.5° | ≤ | 10° | YES |
| 5A.9 | Residual Area between GZ & Windage curves to 40° | | ≥ | | N/R |

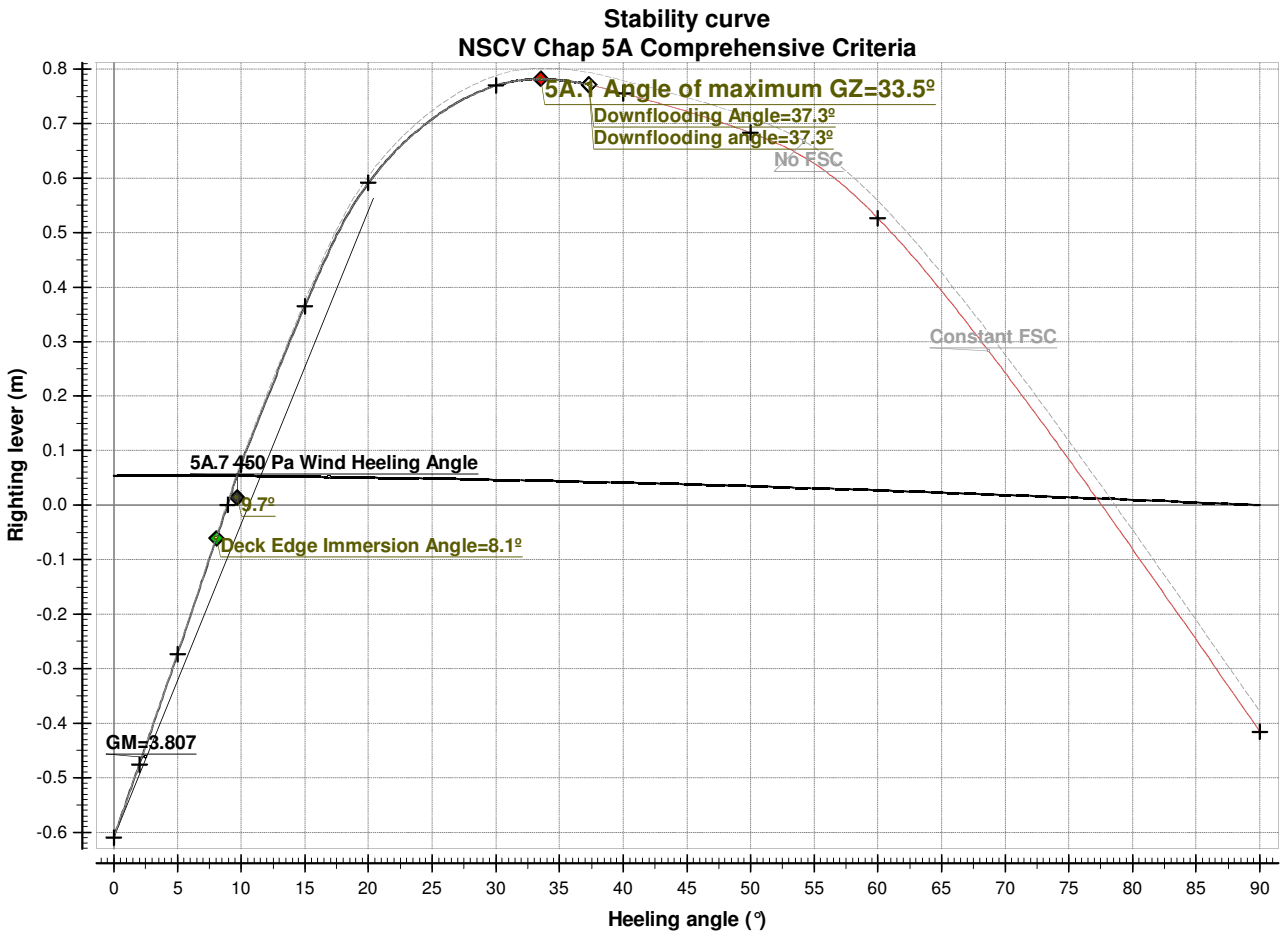
| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| *deg* | *m* | *m* | *m* | *m* | *m* | *m.deg* |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.033 | -0.033 | 0.000 |
| **2.0º** | 0.246 | 0.132 | 0.001 | 0.033 | 0.080 | 0.057 |
| **5.0º** | 0.616 | 0.330 | 0.003 | 0.033 | 0.251 | 0.573 |
| **10.0º** | 1.229 | 0.657 | 0.006 | 0.033 | 0.534 | 2.521 |
| **15.0º** | 1.755 | 0.979 | 0.009 | 0.032 | 0.736 | 5.730 |
| **20.0º** | 2.245 | 1.293 | 0.012 | 0.031 | 0.909 | 9.856 |
| **30.0º** | 2.967 | 1.891 | 0.017 | 0.029 | 1.030 | 19.769 |
| **40.0º** | 3.435 | 2.431 | 0.022 | 0.025 | 0.956 | 29.796 |
| **50.0º** | 3.750 | 2.897 | 0.026 | 0.021 | 0.805 | 38.678 |
| **60.0º** | 3.856 | 3.275 | 0.030 | 0.017 | 0.535 | 45.496 |
| **90.0º** | 3.123 | 3.782 | 0.034 | 0.000 | -0.693 | 49.278 |



| **Loading Condition 06**<br>**82.300 tonnes Asymmetric Loading** | Vertical Datum: Underside of Bottom Plate, +ve UP<br>Longitudinal Datum: After Face of Stern Transom, +ve FRD<br>Transverse Datum: Vessel Centreline, +ve PORT |
|---|---|
| **Compliance** | The vessel complies with NSCV 6A Chap 5A in this loading condition |

| Item | SG | Full | Weight | LCG | TCG | VCG | FSM |
|---|---|---|---|---|---|---|---|
| | *t/m³* | *%* | *t* | *m* | *m* | *m* | *t.m* |
| Pt Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| St Ballast Tank | 1.025 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | 3.770 |
| Fresh Water Tank | 1.000 | 98.0 | 15.036 | 16.227 | -4.669 | 1.465 | 2.940 |
| Pt Diesel Oil Tank | 0.840 | 98.0 | 18.256 | 22.309 | 4.667 | 1.465 | 3.580 |
| St Diesel Oil Tank | 0.840 | 98.0 | 22.183 | 21.999 | -4.667 | 1.465 | 4.350 |
| 10% Sullage Tank | 1.000 | 10.0 | 0.359 | 18.990 | -4.650 | 0.447 | 1.350 |
| 8 Crew (Weather Deck) | | | 0.640 | 15.000 | 0.000 | 4.000 | 0.000 |
| 4 Crew (Upper Deck) | | | 0.320 | 18.000 | 0.000 | 8.200 | 0.000 |
| Stores & Effects | | | 1.000 | 15.000 | 0.000 | 1.750 | 0.000 |
| Hopper 1P (Frd) | 0.650 | 100.0 | 41.150 | 14.680 | 2.827 | 4.237 | 0.000 |
| Hopper 1S (Frd) | 0.650 | 100.0 | 41.150 | 14.680 | -2.827 | 4.237 | 0.000 |
| Hopper 2P | 0.650 | 0.0 | 0.000 | 11.662 | 2.827 | 4.237 | 0.000 |
| Hopper 2S | 0.650 | 100.0 | 41.150 | 11.662 | -2.827 | 4.237 | 0.000 |
| Hopper 3P | 0.650 | 0.0 | 0.000 | 8.644 | 2.827 | 4.237 | 0.000 |
| Hopper 3S | 0.650 | 100.0 | 41.150 | 8.644 | -2.827 | 4.237 | 0.000 |
| Hopper 4P (Aft) | 0.650 | 100.0 | 41.150 | 5.626 | 2.827 | 4.237 | 0.000 |
| Hopper 4S (Aft) | 0.650 | 100.0 | 41.150 | 5.626 | -2.827 | 4.047 | 0.000 |
| | | | | | | | |
| DEADWEIGHT | | | 304.694 | 12.087 | -1.060 | 3.723 | 19.760 |
| LIGHTSHIP | | | 238.533 | 12.879 | -0.035 | 3.247 | 0.000 |
| DISPLACEMENT | | | 543.227 | 12.435 | -0.610 | 3.514 | 19.760 |
| FREE SURFACE CORRECTION | | | | | | 0.036 | |
| $VCG_F$ | | | | | | 3.550 | |

| **HYDROSTATIC PARTICULARS** | | | | |
|---|---|---|---|---|
| List | -8.9° | | KM | 7.357 m |
| Draft at Aft Perp. | 1.565 m | | VCG | 3.550 m |
| Draft (mean) | 1.857 m | | GM (solid) | 3.843 m |
| Draft at Frd Perp | 2.150 m | | GM (fluid) | 4.807 m |
| Trim by Bow | 0.585 m | | Rate of Immersion | 2.942 t/cm |
| Downflooding Angle | 37.3° | | Moment to trim 1cm | 5.205 t.m / cm |
| Deck Edge Imm'n Angle | 8.1° | | | |

| **EVALUATION OF CRITERIA** | | | | | |
|---|---|---|---|---|---|
| NSCV Subsection 6A | Chap 5A – Comprehensive Criteria | | | | |
| Areas of Operation | C, D & E | | | | |
| **Criterion** | | **Attained** | | **Required** | **Pass** |
| 5A.1 | Angle of Maximum GZ | 33.5° | ≥ | 15° | YES |
| 5A.2b | Area under GZ curve to 30.0° | 10.578 deg.m | ≥ | 3.150 deg.m | YES |
| 5A.3 | Area under GZ curve to 37.1° | 16.267 deg.m | ≥ | 5.16 deg.m | YES |
| 5A.4 | Area under GZ curve 30° – 37.1° | 5.684 deg.m | ≥ | 1.72 deg.m | YES |
| 5A.5 | Maximum GZ beyond 30° | 0.769 m | ≥ | 0.200 m | YES |
| 5A.6c | GM | 3.807 m | ≥ | 0.350 m | YES |
| 5A.7a | Heel angle under the effect of 450 Pa wind | 9.7° | ≤ | 10° | YES |
| 5A.9 | Residual Area between GZ & Windage curves to 40° | | ≥ | | N/R |

| Righting levers | | | | | | |
|---|---|---|---|---|---|---|
| Heel | KN sin(ø) | VCG sin(ø) | GG' sin(ø) | TCG cos(ø) | GZ | Area |
| *deg* | *m* | *m* | *m* | *m* | *m* | *m.deg* |
| **0.0º** | 0.000 | 0.000 | 0.000 | 0.610 | -0.610 | 0.000 |
| **2.0º** | 0.257 | 0.123 | 0.001 | 0.609 | -0.476 | 0.000 |
| **5.0º** | 0.643 | 0.306 | 0.003 | 0.607 | -0.274 | 0.000 |
| **10.0º** | 1.291 | 0.610 | 0.006 | 0.600 | 0.074 | 0.057 |
| **15.0º** | 1.872 | 0.910 | 0.009 | 0.589 | 0.364 | 1.146 |
| **20.0º** | 2.378 | 1.202 | 0.012 | 0.573 | 0.591 | 3.610 |
| **30.0º** | 3.073 | 1.757 | 0.018 | 0.528 | 0.769 | 10.601 |
| **40.0º** | 3.505 | 2.259 | 0.023 | 0.467 | 0.755 | 18.336 |
| **50.0º** | 3.795 | 2.692 | 0.028 | 0.392 | 0.683 | 25.556 |
| **60.0º** | 3.907 | 3.043 | 0.032 | 0.305 | 0.527 | 31.744 |
| **90.0º** | 3.135 | 3.514 | 0.036 | 0.000 | -0.415 | 36.557 |