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TAHAROA

Inspection and Audit of Port Taharoa Operations

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Our Reference: CW/812/R01/NC/SLB

EXECUTIVE SUMMARY

Cwaves Ltd (Cwaves) was instructed by Maritime New Zealand (MNZ) to conduct an inspection and audit of the Port of Taharoa operations, pursuant to Section 33T of the Maritime Transport Act 1994. The objectives of the audit were to review the risk assessments of the Port Taharoa operations; review the development of the operational parameters imposed by the Harbour Master for Port Taharoa; review the engineering analyses for the SBM and to attend the port to witness a vessel mooring and departure.

This report documents our findings and provides a series of recommendations to the Director of MNZ on the appropriate Operational Limits and associated conditions for the current and future operation for the port. It also provides recommendations to the Director of MNZ for improvements to be implemented by New Zealand Steel (NZS), as the operators of Port Taharoa, in order to satisfy the requirements of the New Zealand Port and Harbour Marine Safety Code (NZPMSC) and to improve the safety of the operations at Port Taharoa.

The principal findings of the audit are:

1. Port Taharoa is in an exposed location and consists solely of a Single Buoy Mooring (SBM) offshore terminal that is open to the sea and to hostile conditions.

2. The current export vessel (TAHAROA DESTINY) is specially designed for the trade and includes significant improvements compared to the previous vessels that were employed at Taharoa. The future expansion of the trade to three vessels presents a heightened risk due to the initial lack of experience of the crew and management of the second vessel (TAHAROA EOS) with Port Taharoa and its unique operation.

3. The Taharoa SBM is 38 years old, was built to approved drawings, but has never been maintained in 'class'. It is in a fair condition, but is considered to require significant improvements to the inspection and maintenance regime to continue to be operated for the future Taharoa operations. Particular focus is required on fatigue sensitive components.

4. To date, the SBM has been operated with un-certified critical equipment (4 D-shackles between the tri-plate and the turntable) for which the breaking strength, proof-loading and Safe Working Load are not known. Following the audit, the operator has committed to replace these components.

5. A number of flaws and / or inconsistencies have been identified in the previous engineering analyses conducted for the SBM, which will likely render some of the results and conclusions drawn to be invalid.

6. Examples of recommendations and rectifications required by the certifying body (ABS Consulting Pte Ltd) have been found not to have been implemented or actioned. This includes the scheduled inspection of critical fatigue sensitive items.

7. The risk assessments conducted comply with the New Zealand Port and Harbour Marine Safety Code (NZPMSC) requirements. A number of 'Heightened Risk' events did not adequately describe the reality of the operations, as witnessed during the audit and recommendations for improvements have been made.

8. The current Operational Limits should be maintained, as incorporated into the Exemption Certificate issued by the Director, MNZ on 2nd February 2015. Following resolution of the pilotage situation and expiry of the Exemption Certificate, the Harbour Master's current Operational Limits should apply, including the prohibition of submergence of the Load Line. The auditors could not find any compelling reason to recommend an increase in the Operational Limits.

9. Attempts to address the previous 'single-point failure' that existed with the single licensed pilot have failed. At the time of the audit, there was no licensed pilot and approved training plan, resulting in the issuance of an Exemption Certificate under certain conditions by the Director of MNZ, to enable the continued operation of the terminal. At the time of release of this report, a pilot has been licensed (with conditions) and a training plan approved.

10. The Taharoa SBM and its operation is no different to an SBM used for the export of hydro-carbons in respect of the need to maintain the integrity of the SBM, the safety of personnel (for line, hose handling etc.) and navigational / pilotage aspects. The use of oil industry standards and guidelines is therefore considered to be equally applicable. There has been a lack of engagement with the oil industry in this regard and use should be made of their considerable experience and expertise in the operation and maintenance of SBM's.

A total of 42 recommendations are made to the Director of MNZ.

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1 INTRODUCTION

1.1 Preamble.

1.1.1 Cwaves Ltd (Cwaves) was instructed by the Director of Maritime New Zealand (MNZ) to carry out an inspection and audit of the Port Taharoa Operations, under the statutory powers given to the Director as per the new Part 3A of the Maritime Transport Act 1994.

1.1.2 The Port of Taharoa is operated by New Zealand Steel Limited (NZS), a subsidiary of Bluescope Steel Pty Ltd of Australia.

1.1.3 This report documents the findings resulting from the audit and makes a number of recommendations considered necessary to improve the standard and margin of safety at the Port of Taharoa.

1.1.4 Throughout this report, we use "*italics*" where we quote from other documents. Wording in bold or underlining are our emphases, where stated.

1.1.5 All times expressed in HHMM hours are local time (GMT + 11).

1.2 Scope of Work

1.2.1 The Scope of Work (SoW) of the audit was defined by the Terms of Reference provided by MNZ to Cwaves. The Terms of Reference are provided in Appendix A.

1.2.2 The SoW can be summarised as follows:

- i) Review the recent history of the Port of Taharoa;
- ii) Review the previous risk assessments conducted;
- iii) Review the development and nature of the Taharoa Harbour Master's current operational parameters;
- iv) Review of the mooring system and its development;
- v) Carry out a statutory inspection and audit to include reviews of relevant documentation, interviews with key persons and witnessing operations at the Port of Taharoa.
- vi) Provide a report with appropriate recommendations to the Director of MNZ.

1.2.3 The audit consisted of two phases; a document review phase and an on-site inspection. With regard to the document reviews, we have reviewed a number of documents provided by both MNZ and NZS. The documents that we have considered are listed in Appendix B. The majority of documents were provided to us before or during the audit, however, a number of documents were provided following the audit as a result of the discussions held. Where appropriate, we refer to those documents in this report.

1.2.4 The on-site component of the audit was completed in September 2014, by Captain Nicholas Cooper and Mr Simon Burnay of Cwaves, attending MNZ offices in Wellington, New Zealand, NZS offices at Glenbrook and subsequently at the Port of Taharoa.

1.2.5 This report has been written by both of the above named persons. All of the opinions contained within this report should be read as our joint opinion, appropriate to the respective expertise of each author.

1.3 The Experience of the Authors

1.3.1 The qualifications and experience of the authors are shown in the C.V.'s in Appendix C. A summary of the relevant experience of each author is given below.

1.3.2 Nicholas Cooper (NC): I have sailed on dry cargo vessels, including bulk carriers, up to and including Cape and Panamax size for almost forty years, including twenty five years in command. During my five years in Command of Cape size bulk carriers I set up the IACS Enhanced Survey Programme, the new IMO Ballast Water Management Plan, and carried out detailed studies and calculations on the loading computer for Lloyds, which were later used for the Class approved Loading and Discharging Sequences. I have about fifteen years' experience of Safety Management Systems (SMS), including the review, revision and setting up the SMS on a Cape size bulk carrier for an international shipping company, including Internal and External Audits. I also have ten years' experience operating the SMS of a major international container company, including Internal and External Audits and Master's Reviews of the SMS. In addition, I have ten years' experience as a Superintendent and Marine Surveyor and four years' experience as a Marine Consultant, investigating marine incidents and acting as an Expert Witness at litigation.

1.3.3 Simon Burnay (SLB): I am a Naval Architect, specialising in vessel hydrodynamics, moorings and marine operations. I have approximately 15 years' experience as a marine consultant during which, I have provided analysis and opinion in relation to a wide range of vessel mooring and marine operations matters. I was formerly a director of a UK based marine consultancy firm, providing technical analysis to vessel owners, charterers and oil/gas majors on offshore terminals, including ship-handling, pilotage and mooring aspects. This included undertaking mooring and operability analyses for existing and proposed offshore terminals in exposed locations worldwide and defining safe operating limits in conjunction with a range of stakeholders, including various oil majors. I also have experience of the Taharoa SBM, having been involved with operability assessments on behalf of ship operators and for previous incident investigations concerning the TAHAROA EXPRESS.

1.4 Background

1.4.1 New Zealand Steel Limited (NZS) operates a bulk carrier loading operation at Taharoa for the export of 'Iron-sand'[1]. The iron sands are pumped out to the export vessel in slurry form via two sub-sea pipelines, which rise at the Single Buoy Mooring (SBM). This is located 1.85 nautical miles offshore on the west coast of the North Island of New Zealand. This operation is unique and there are no other similar operations in the maritime world. The iron sands settle rapidly, and the water, which comprises about 50% of the slurry mixture, is decanted from the holds via the ballast system to open sea, at which point the vessel departs the SBM.

1.4.2 The current export vessel, the "TAHAROA DESTINY" ("TD") started service in 2012, and was specially built and designed for this service. It is classed as an 'Ore Carrier', whereas previous vessels on this trade were traditional Cape-size bulk carriers. This means that the vessel is double hulled with wide side wing ballast tanks, and flush sided holds, which minimises the sloshing effects of free water on top of the iron sands cargo. Additional features that were built in to this vessel included a raised forecastle deck for additional protection of the crew from sea and spray when securing or letting go the main hawser, and a Schilling Rudder which

[1] 'Iron-sand' is the name commonly given to the naturally occurring deposits of Titanomagnetite that exist in the Taharoa region.

offers greatly improved steering capabilities at the very slow speeds required for approaching the SBM. An improved de-watering system was also incorporated in the vessels six cargo holds.

1.4.3 A special mooring post incorporating a load cell was also installed; the main towing lead was increased in diameter from a standard Panama Lead size, and lined with stainless steel to minimise hawser friction, and a dedicated mooring winch installed aft of and in line with the mooring post, to avoid passing the hawser messenger line around a series of roller fairleads to minimise 'snap back' zones in the case of the messenger line parting. The deck crane was located on the starboard side between No.1 and No.2 Cargo Holds for the operation of lifting, connecting and disconnecting the two slurry pipes.

1.4.4 These design features were built in to the "TD" following a series of serious and potentially serious safety incidents to previous vessels, which included fatalities and serious injuries on the "TAHAROA ENTERPRISE" in 1978, when the mooring messenger line parted under strain. The de-watering system failed on the "TAHAROA EXPRESS" in June 2007, resulting in the vessel taking on a twenty-two degree list and having to seek port of refuge in Tasman Bay while a salvage operation was mounted to stabilize the vessel and return it to upright.

1.4.5 The SBM is 38 years old and is not registered with a Classification Society. It is therefore not "Classed". It was taken out of the water for the first time in 1985 and again in 2009 for dry-docking and refurbishment, and laid further offshore with a new set of six anchor chains and 'Stevpris' anchors, which have improved holding power compared to the previous set of 'Bruce' anchors. The previous 21 inch diameter hawser was replaced with a 23 inch diameter hawser of 70 metre length in 2011.

1.4.6 Port Taharoa is a compulsory pilotage area, and tug services are not available. The vessel's operations are attended by a dedicated support vessel, which operates from the nearby harbour of Kawhia, and access to the vessel for the pilot, operations staff, visitors, stores, provisions and crew changes is provided by helicopter from the Operations Centre. The service boat also acts as the helicopter stand-by vessel.

1.4.7 On 15th March 2012 the Harbour Master at that time, Captain John Ireland, advised NZS that he was imposing operational safety parameters for the new vessel "TD" at the buoy in its new location. These would be a maximum significant wave height (Hs) for mooring of 2.6 m, and a maximum Hs for departure 2.9 m, maximum wind speed of 30 knots, and maximum allowable "peak" loading on the hawser of 136 tonnes. These safety parameters were apparently based on a report by the buoy manufacturers, SBM, dated 2004. In addition, the Harbour Master was not prepared to allow the vessel's Load Line to be submerged at any stage of the loading. The current Harbour Master, Richard Lough, has upheld these safety parameters, which have been opposed by NZS.

2 THE PORT OF TAHAROA

2.1.1 The Port of Taharoa is located on the West Coast of the North Island of New Zealand, approximately 60 nautical miles to the North of New Plymouth. Figure 2.1 shows the location of Taharoa.

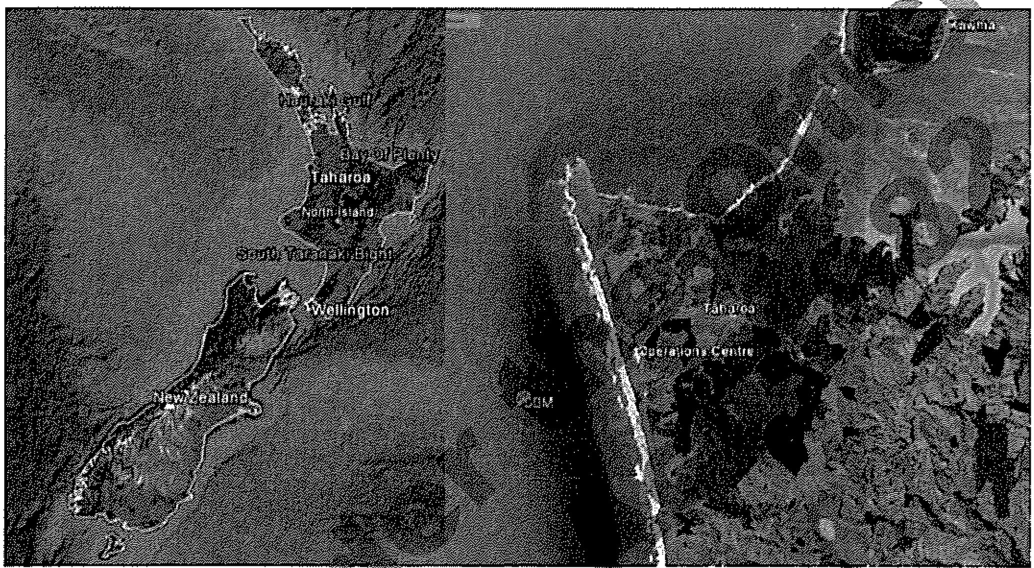

Figure 2.1 – Location of Taharoa
(Image courtesy Google Earth)

2.1.2 The port is operated by NZS and consists of one Single Buoy mooring (SBM), located approximately 1.8 nautical miles from the shore. The SBM is used to load Iron-sand from the NZS Taharoa mine site to vessels for export to steel mills in China.

2.1.3 The Iron-sand is mined from the deposits at Taharoa and is mixed with fresh water to pump to the SBM via a submarine pipeline as a slurry, where it is pumped on-board the export vessel. The slurry is then allowed to settle and the water drains off and is pumped over-board before the vessel sails.

2.1.4 The Port of Taharoa is defined by Harbour Limits consisting of a circle of 5 nautical miles radius centred on the Mine Pump House and intersecting a line drawn towards 270 degrees (true) from Albatross Point[2]. The limits of the pilotage district are defined by a seaward arc of a circle of radius 3 nautical miles centred on the

[2] TM-6000-011 - Taharoa Port Information - FINAL v3.0 - 8 Sep 14.

terminal pumping station (38° 10.6'S, 174° 42.4'E)[3]. Pilotage is required for all vessels greater than 500 gross tonnage.

2.1.5 The SBM is located in water depths of approximately 32 metres.

2.1.6 Figure 2.2 below, shows the arrangement of the Port of Taharoa[4].

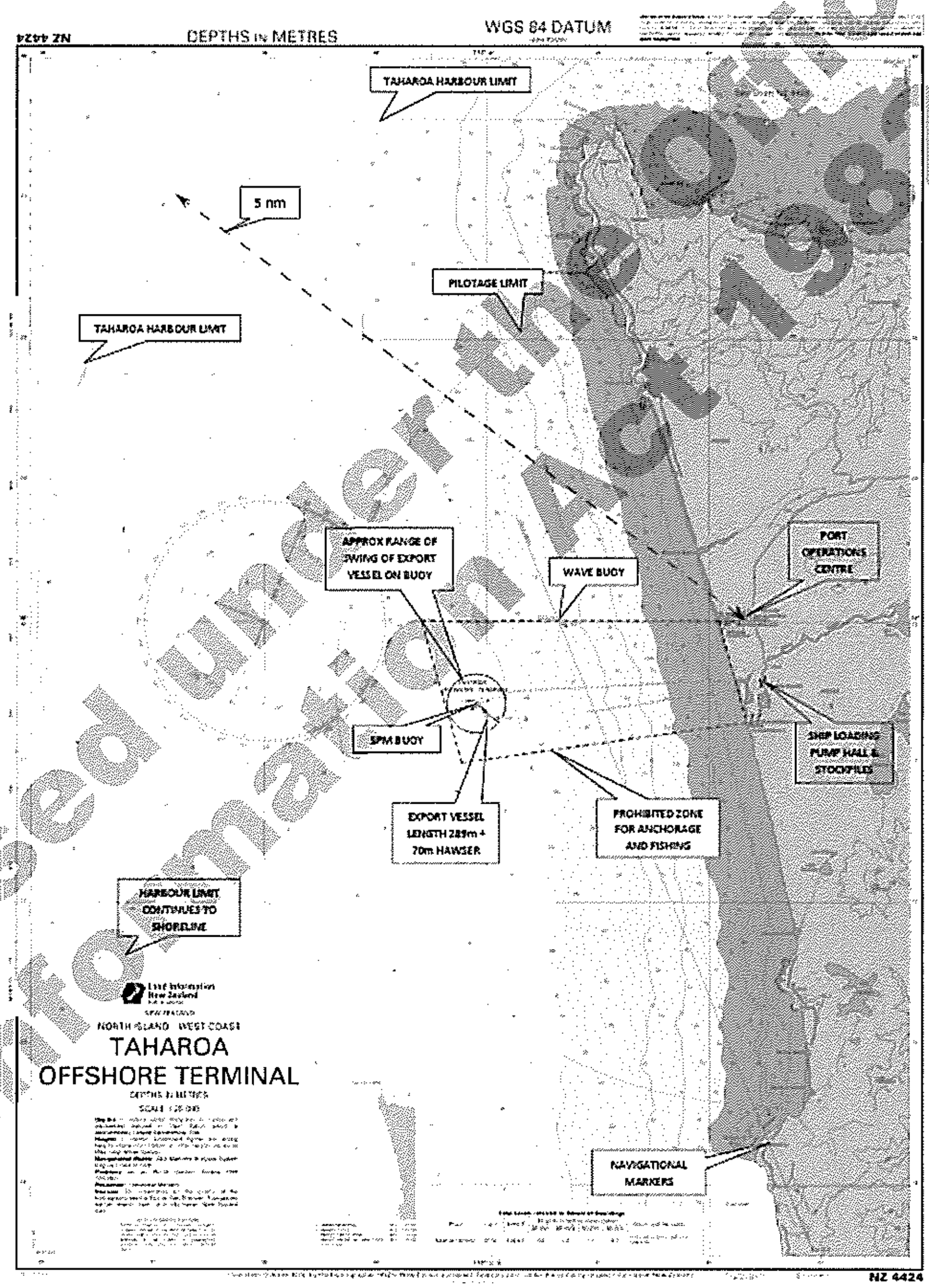

Figure 2.2 – Layout of the Port of Taharoa

[3] Maritime Rule Part 90, Appendix I.

[4] TM-6000-011 - Taharoa Port Information - FINAL v3.0 - 8 Sep 14.

3 THE VESSELS EMPLOYED AT THE PORT OF TAHAROA

3.1 Historical

3.1.1 Between 1999 and 2012, the vessel employed for the export of Ironsand from Taharoa was the TAHAROA EXPRESS. She was a Cape size Bulk Carrier of a standard 9 hold arrangement, built in 1990 and converted to carry Ironsand, enabling the de-watering process.

3.1.2 The TAHAROA EXPRESS experienced a number of serious incidents during her employment for the transport of Ironsand from Taharoa. These included:

i) 2003: Hawser failure in wave conditions of in excess of 4.5m significant wave height, believed to be due to over-loading of the hawser;

ii) 2004: Engine failure on approach to SBM, requiring the release of both anchors to secure the vessel;

iii) 2007: Cargo shift and severe list developed due to water ingress in duct keel causing failure of de-ballasting system, resulting in large body of water retained in holds with worsening and adverse weather conditions.

iv) 2009: Cargo shift and moderate list developed due to operational errors in rotating cargo loading nozzles, causing non-uniform cargo loading and cargo shifting.

v) 2008 – 2011: Hull cracking due to previous incidents and stresses induced by alternate hold loading pattern.

3.1.3 The TAHAROA EXPRESS was a converted Capesize bulk carrier and was not purposely design for the specialised trade in which she was employed at Taharoa.

3.2 The Current Vessel; TAHAROA DESTINY

3.2.1 The TAHAROA DESTINY is a purpose designed ore carrier for the carriage of Ironsand cargoes, loaded as a slurry. Her principal particulars are given below and Figure 3.1 shows the TAHAROA DESTINY.

Figure 3.1 – The TAHAROA DESTINY

Flag State	:	Japan
IMO Number	:	9605322
Built	:	2012 by Mitsubishi Heavy Industries, Nagasaki
LOA	:	290.40 m.
Breadth	:	45.00 m
Tonnages	:	90,276 (Gross), 32,426 (Net).
Deadweight	:	176,594 mt on 18.314m summer draft
Holds / Hatches	:	6 / 6
Engine(s)	:	HITACHI 2SA6CY diesel of 17,000 kW at 84.2 rpm.
Speed	:	14.5 knots
Class	:	Nippon Kaiji Kyokai (Class NK)

3.2.2 Compared to a Cape size bulk carrier (such as the TAHAROA EXPRESS) the six holds of the TAHAROA DESTINY are relatively narrow, with large ballast tanks adjacent to each hold. This hold design reduces the free surface effects[5] due to

[5] Free Surface Effect is the effect whereby a ship experiences a loss of stability due to the 'free' movement of a liquid' surface in a tank or compartment. It is primarily a function of the width of the compartment and can be a serious problem, causing significant and even catastrophic loss of stability.

the loading of the slurry and will also reduce the risk of the cargo sloshing, which can potentially cause structural damage to the vessel's holds.

3.2.3 The de-ballasting system on the TAHAROA DESTINY is also improved compared to that employed on the TAHAROA EXPRESS and allows quicker de-canting of the water from the hold, including drainage ports at the top of stow level on the transverse cargo hold bulkheads.

3.2.4 The TAHAROA DESTINY is propelled by a MAN B&W type 6S70ME-C8 marine diesel engine, developing 17,000 kW at 84.2 rpm. Compared to the TAHAROA EXPRESS, she has a relatively high installed power[6] and reportedly has good power output at low speed, which is an important factor for manoeuvring to and from the SBM.

3.2.5 The TAHAROA DESTINY is fitted with a Schilling Rudder, given her excellent manoeuvrability. This enables her to turn with a tight turning circle compared to typical bulk carriers of her size. More importantly, it also enables her to utilise transverse thrust generated by the rudder at slow speeds. This allows the pilot considerable control over the vessel and particularly the vessel's heading in the approaches to the SBM.

[6] In terms of Installed Power / Displacement ratio (as an indicator of her relative power), the TAHAROA DESTINY is approximately 20% higher than the TAHAROA EXPRESS.

4 THE TAHAROA SINGLE BUOY MOORING (SBM)

4.1 General Particulars of the SBM

4.1.1 The Taharoa SBM is a Catenary Anchor Leg Mooring (CALM) buoy design that is typical of their type. It was designed by SBM Offshore, Monaco and built by Price-Norsteel Fabricators Ltd, New Zealand. The SBM was installed in 1978.

4.1.2 The principal particulars of the buoy are given below and Figure 4.1 shows the buoy out of the water, as photographed during an inspection conducted by Worley Parsons in 2009[7].

Main Body Diameter (moulded)	:	11.0 m
Main Body Depth (moulded)	:	3.73 m
Overall Height	:	7.1 m
Centre-well Diameter	:	4.8 m
Lower Skirt Diameter	:	14.5 m
Draft (free-floating)	:	2.1 m
Displacement	:	181.1 tonnes
Draft (moored)	:	3.22 m
Minimum Freeboard	:	1.58
Classification	:	Not Classed [1]

Note [1]: We understand that the original SBM specification for the buoy states that the buoy should be built and certified in accordance with the American Bureau of Shipping (ABS) "Rules for Building and Classing Single Point Moorings". The buoy is not classed, but we note that there is a Lloyd's Register certificate certifying that the buoy was built in accordance with the approved drawings. This certificate is not a 'Class' certificate.

[7] Worley Parsons Report 401010-00534-000-NA-REO-0001-B, dated 21st May 2009; "Inspection Report – Taharoa CALM Buoy".

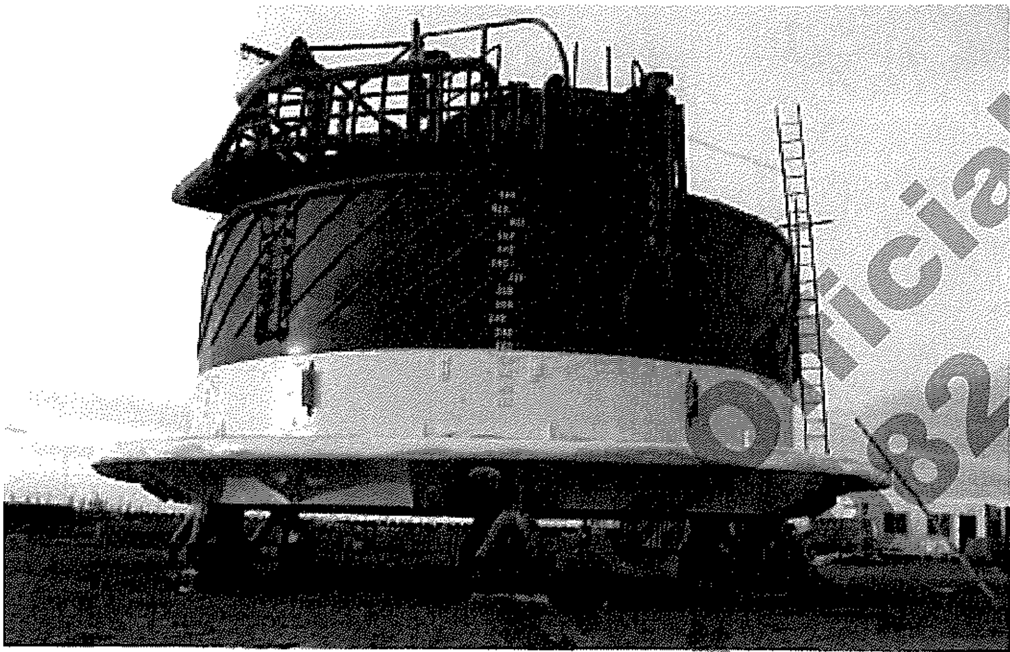

Figure 4.1 – The Taharoa CALM Buoy
(Photograph extracted from Worley Parsons Report 401010-00534-000-NA-REO-0001-B, dated 21st May 2009; "Inspection Report – Taharoa CALM Buoy")

4.1.3 The buoy consists of a single 11m outer diameter hull of all welded steel construction and has a centre-well of diameter 4.8 m. The centre-well houses the diver's platform, two 12 inch slurry pipes and a water flush pipe, which connect to the sub-surface flexible risers to enable transfer of the slurry to the central pipe flange.

4.1.4 At the base of the buoy, a skirt is provided around the circumference of the hull, which provides protection to the buoy and the under-sea components.

4.1.5 The buoy is divided into six water-tight compartments, each separated by a radial bulkhead. Outboard of each of these bulkheads, is located each of the chain-stopper housings.

4.1.6 It is reported that the SBM Specification for the buoy states that the buoy should be fabricated using mild steel having a minimum yield stress of 22 kg/mm^2 (215 N/mm^2). We have subsequently been provided with material certificates indicating that the steel used was in excess of this requirement.[8]

[8] "Manufacturing Report for the New Zealand Steel Mining ltd Ironsand Slurry Buoy. Taharoa Project", SBM Report SO. 1079, undated.

4.1.7 On top of the hull of the buoy is the main turn-table arrangement, which houses the vessel mooring equipment, slurry export piping and connection to the floating hoses, turntable winch and various ancillary equipment, including a boat launch platform, A-Frame hoist and associated rigging.

4.1.8 The turn-table rotates around the top surface of the buoy on the Main Rotating Bearing (MRB).

4.1.9 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 4.2 – The Taharoa CALM Buoy Afloat
(Drawing taken from INTECSEA Report 401027-00001-MA-REP-0005 of 10th Sept. 2013)

4.1.10 Figure 4.3 shows a photograph of the buoy afloat at Taharoa and Figure 4.4 shows a close-up of the mooring equipment (both taken in September 2014 by the authors).

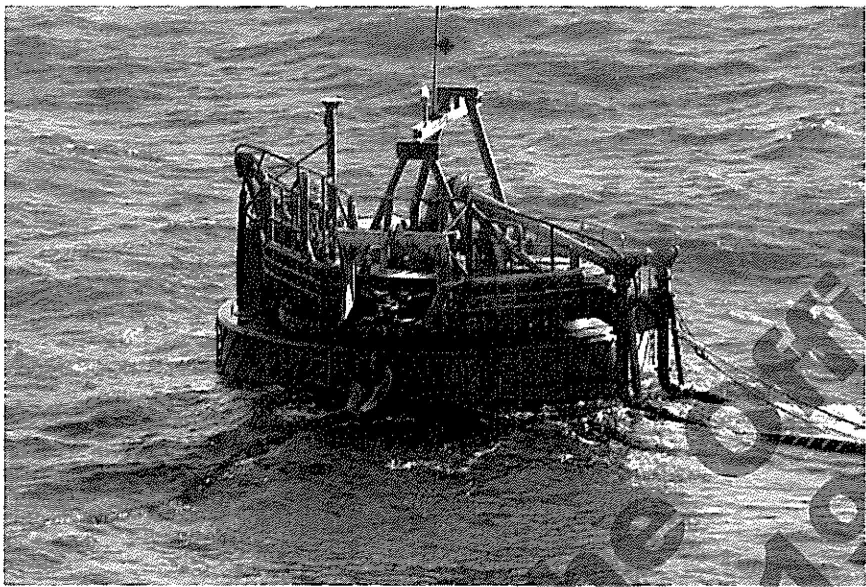

Figure 4.3 – The Taharoa CALM Buoy Afloat

s 9(2)(b)(ii) of the OIA

[redacted]

Figure 4.4 – Close-up of the Mooring Equipment on the Taharoa SBM

4.1.11 Sub-sea, the CALM buoy consists of the flexible risers that are connected to a Pipe Line End Manifold (PLEM) and six anchor legs, spaced equally at 60 degree intervals.

4.1.12 s 9(2)(b)(ii) of the OIA [redacted]

4.1.13 [redacted]

4.1.14 [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 4.5 – Hawser Arrangement

(Drawing from INTECSEA Report 401027-00001-MA-REP-0005 of 10th Sept. 2013)

4.1.15 s 9(2)(b)(ii) of the OIA [redacted]

4.2 The Mooring Analyses

4.2.1 A number of mooring analyses have been conducted for the Taharoa SBM. Table 4.1 below summarises the analyses that have been completed.

Date	Originator	Description
2004[9]	SBM Offshore	Mooring analysis conducted following hawser parting after changing length from 50m to 70m. Objective to identify if this was the cause and make recommendations to avoid repeat partings.
2007[10]	AMC Search Ltd	Physical model tests to estimate increase in hawser loads for a larger vessel (180,000DWT) compared to existing vessel (150,000 DWT), estimate reduction in max. permissible wave height for larger vessel to give same loads and determine worst case condition.
2012[11]	INTECSEA	For the purpose of an 'In Principle' approval with respect to the new vessel and new location of the buoy.
2013[12]	INTECSEA	To investigate the mooring and anchoring design of the buoy at the new location in respect of the TAHAROA DESTINY and review its 'Fitness for Purpose'.

Table 4.1 – Summary of Mooring Analyses Conducted for the Taharoa SBM

Note: We have not sighted a copy of the 2012 INTECSEA mooring analysis report, although we do not consider this to be critical as the 2013 report is the more relevant.

4.2.2 The principal mooring analyses that we consider here are the 2004 SBM and the 2013 INTECSEA reports. The 2007 model tests conducted by AMC Search are of some use to assist in verifying the results of the analytical methods, but are of limited scope.

4.2.3 The purpose of a mooring analysis is to examine the loads and response of the mooring system and the response of the vessel in a range of relevant environmental conditions versus the allowable limits of the system to ensure that the system is not overloaded beyond safe limits[13].

9 Single Buoy Moorings Inc. Report No. SE19052, dated 23rd February 2004; "Mooring Analysis for CALM SO10790".
10 AMC Search Ltd Report No. 07/M/03, dated October 2007; "Loads on a Single Buoy Mooring".
11 INTECSEA Report No. 401027-00001-MA-REP-0002, dated 14th February 2012; "Mooring Analysis".
12 INTECSEA Report No. 401027-00001-MA-REP-0005, dated 10th September 2013; "Taharoa Buoy Modifications: Mooring Analysis Report; Taharoa Destiny".
13 See also API RP-2SK, "Design and Analysis of Station-keeping Systems for Floating Structures", section 5.1.1.

4.2.4 There are a number of industry codes and guidelines that provide the format and framework for the design and operation of offshore mooring systems, including the necessary mooring analysis. These include:

i) International Standards Organisation (ISO), 19901-7:2005 Petroleum and Natural Gas Industries — Specific Requirements for Offshore Structures — Part 7: "Station-keeping Systems for Floating Offshore Structures and Mobile Offshore Units".

ii) American Petroleum Institute (API), Recommended Practice (RP) 2SK, "Design and Analysis of Station-keeping Systems for Floating Structures", October 2005, Addendum 2008;

iii) Oil Companies International Marine Forum (OCIMF), "Mooring Equipment Guidelines" 3rd Edition (MEG-3), 2008 and "Recommendations for Equipment Employed in the Bow Mooring of Conventional Tankers at Single Buoy Moorings", 4th Edition, May 2007.

iv) Det Norske Veritas (DNV), "Position Mooring", DNV-OS-E301, October 2013.

v) GL Noble Denton, Guidelines for Moorings, 0032/ND Rev. 1, June 2013[14].

vi) Classification Society rules, e.g. ABS "Rules for Building and Classing Single Point Moorings", 2014.

4.2.5 The 2004 SBM mooring analysis does not state which codes or guidelines were used.

4.2.6 The 2013 INTECSEA analysis references the API RP-2SK and OCIMF MEG-3 codes / guidelines. In our opinion, this is in accordance with normal industry practice.

[14] Germanischer Lloyd (GL) and Noble Denton have now merged with DNV and their respective rules and guidelines are in the process of being combined.

4.2.7 The principal result of the 2004 analysis is that the longer hawser increases the mooring loads due to the increased tendency of the vessel to 'fish-tail'[15].

4.2.8 We have identified a number of issues and / or inconsistencies with the 2004 SBM report. These are not described in detail here as the 2004 SBM analysis has been superseded by the later analyses performed and the changes to the mooring system itself. However, it is useful to understand the SBM analysis and SBM's recommendations with respect to the development of the Harbour Master's operational parameters.

4.2.9 The most significant issues that we have identified are summarised below:

i) The vessel model used appears to be inaccurate and based on limited data. Of most significance is the unrealistically high water-plane area which will affect the response of the vessel in the analysis and may result in inaccurate hawser loads;

ii) The hawser modelled was of 70 metres length plus two 10 metre chafing chains at each end. This was incorrect, as the hawser is an un-ended double grommet type, with only a short chain section at the buoy end. The increased effective hawser length modelled will affect the results, potentially increasing the amount of 'fish-tailing', which causes higher hawser loads. However, the analysis was still able to provide an assessment of the effect of hawser length (which was the objective) on a relative basis, albeit with likely inaccuracies in the absolute results.

iii) It was a quasi-static analysis, which means that only the slowly varying wave drift forces acting on the vessel were applied. Higher frequency motions (e.g. pitching) were not calculated and hence a Dynamic Amplification Factor (DAF) was applied to the hawser load results to take account of the higher frequency dynamic effects. The DAF applied was 1.3, although it is not

[15] 'Fish-tailing' is the phenomenon whereby the moored vessel will tend to yaw in an oscillatory manner to either side under the action of the varying weather and sea conditions to which it is subject. As the vessel rotates to one side, the hawser stretches and the load on the hawser increases until it retards the motion of the vessel, causing it to rotate back to the other side until the load in the hawser increases again in the same manner. It is an oscillatory motion and can cause high peak, 'snatch' loads in the hawser and uncontrolled motions. It is therefore undesirable.

stated how this is derived. This approach is not in accordance with normal or best practice for the determination of hawser loads.

4.2.10 We note that NZS highlighted the same points, apparently based on input from an external consultancy Ship & Offshore Pty Ltd[16].

4.2.11 MNZ, in a letter to SBM Offshore[17], sought SBM's "*comment on the design and performance parameters of the buoy in light of NZ Steel's development plans for the facility*". With respect to the mooring analysis, MNZ sought confirmation of the original design criteria for the buoy, the advice given to NZS in the 2004 report regarding the maximum operating parameters and whether failure of a single leg could lead to a progressive failure of the remaining mooring system.

4.2.12 The SBM Offshore response[18] provided answers as follows:

i) The original design criteria of the buoy were:

- Maximum vessel size: 150,000 DWT;
- Operational Conditions: Significant Wave Height (H_S) of 4.1 m, wave period of 10.1 sec (assumed), wind of 40 knots and current of 1 knot.
- Survival Conditions (100 year conditions): H_S of 7.47 m, wave period of 14.1 sec (assumed), wind of 80 knots and current of 2.5 knots.

ii) The advice given in the 2004 SBM mooring analysis was that the 70 metre hawser resulted in the original design mooring force (hawser load) of 2500 kN with operating conditions of H_S = 2.6m, a 30 knot wind and 1 knot current. The use of the 50 metre hawser resulted in lower hawser loads (reduced 'fishtailing') and accordingly, a higher operational sea state (H_S = 2.8 m) was recommended.

iii) SBM advised that in the event of failure of one of the six mooring legs of the buoy, the buoy is designed such that there is no capsize. They did not advise on the possibility of progressive failure of the remaining legs and referred

[16] "Review of Mooring Analysis for CALM SO10790", Ship & Offshore Pty. Ltd, Author: C. Bonay, dated 27th March 02 [sic], contained within a document titled "SBM Mooring Analysis 2004; Commentary by NZSM (undated, no ref. no.)

[17] "Single Buoy Mooring at Port of Taharoa", ref: CSM, dated 20th September 2011.

[18] SBM Offshore Technical Response Sheet, Ref; TRS.IP97564.300911, dated 3rd October 2011.

only to the Operation and Maintenance Manual for the Taharoa buoy in respect of inspection requirements.

4.2.13 With regard to the design operational criteria, SBM have stated the maximum vessel size for the Taharoa buoy was 150,000 DWT. The current vessel, TAHAROA DESTINY is 176,594 DWT. At face value, this means that the vessel exceeds the design criteria, however the mooring system has undergone a number of upgrades since the original design, including a new, higher capacity hawser and new anchors.

4.2.14 The design operational criteria advised by SBM to MNZ in 2011 differs from that stated in their 2004 mooring analysis. The 2004 analysis states that the design sea state was H_S = 3.7 m and period = 9.9 seconds (zero up-crossing period), whereas the 2011 response from SBM sates H_S = 4.1 m and period = 10.1 seconds (SBM do not state which period parameter this is). The reason for this discrepancy is unknown.

4.2.15 Further, in an e-mail from SBM to MNZ[19], SBM stated that the Taharoa buoy had a design life of 20 years.

4.2.16 The 2013 INTECSEA mooring analysis was commissioned by NZS to analyse the Taharoa CALM buoy at the new location (500 metres further offshore) and for the new vessel (TAHAROA DESTINY). s 9(2)(b)(ii) of the OIA [redacted]

4.2.17 s 9(2)(b)(ii) of the OIA [redacted]

[19] E-mail from s 9(2)(a) of OIA [redacted] of SBM to Victor Lenting of MNZ, dated 21st September 2011.

4.2.18 s 9(2)(b)(ii) of the OIA [redacted]

4.2.19 [redacted]

4.2.20 [redacted]

4.2.21 [redacted]

4.2.22 [redacted]

[20] "Taharoa Metocean Conditions; A summary of the wave, ocean current and wind statistics for facilities design", Report No. P0086-01, dated 22nd December 2011.

[21] INTECSEA Calculation Sheet No. 401010-00534-NA-CAL-0004, dated 15th July 2009; "Metocean Data".

s 9(2)(b)(ii) of the OIA [redacted]

Figure 4.6 – Datawell Buoy Measured Wave Data Analysed by INTECSEA

4.2.23 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 4.7 – Satellite Observation Wave Data by BMT ARGOSS

[22] See Table 4.8 of "Taharoa Metocean Conditions; A summary of the wave, ocean current and wind statistics for facilities design", Report No. P0086-01, dated 22nd December 2011.

4.2.24 In our opinion, the use of on-site measured data for the mooring analysis would be more appropriate than hindcast models and more so, compared to using assumed values from empirical formulae. Therefore, whilst INTECSEA have assessed a range of wave periods in accordance with the API guidelines, we consider that the range used is inappropriate and neglects the majority of wave period conditions that dominate the wave climate at Taharoa.

4.2.25 In simple terms, the motion of the vessel moored at a CALM buoy will consist of two components;

i) A low frequency (slowly varying) component, often referred to 'as wave drift', which causes the vessel to 'drift' in the direction of the waves. This effect tends to describe the 'horizontal' motion of the vessel[23].

ii) A high frequency (more rapidly varying) component of motion, caused by wave action on the vessel. This effect tends to describe the 'vertical' motions of the vessel, although will also affect the yawing of the vessel.

4.2.26 Whilst it is well documented that the motion of vessels at an offshore mooring is heavily influenced by the wave drift forces[24] (which tend to increase with decreasing wave period), the vertical motions of the vessel will tend to increase with increasing wave period (up to a point and then decrease again). It is our experience and expectation that the resulting hawser loads will increase at these larger wave periods, due to the increased motions and the consequential 'snatch' loadings that are generated in the hawser.

4.2.27 The INTECSEA report does not appear to have investigated these higher wave periods and therefore, the peak hawser loads presented in the INTECSEA analysis potentially neglect important components of vessel motions that may affect the peak hawser loads predicted.

[23] Horizontal motions are surge (longitudinal motions), sway (transverse / lateral motions) and yaw (heading change). Vertical motions are heave (motion up or down), pitch (rotation of the vessel about the transverse axis) and roll (rotation about the centre-line axis).

[24] See API RP-2SK, section 3.1.1 for example.

4.2.28 The analysis was undertaken using the JONSWAP wave spectrum[25], which was developed based on wave measurements for a sea area with a relatively small fetch (the North Sea). In our opinion, in combination with our comments regarding wave periods above (para. 4.2.17 – 4.2.27), this is not consistent with the conditions at Taharoa, which has a large fetch due to its exposure to the Southern Ocean, based on the dominant W / SW conditions.

4.2.29 s 9(2)(b)(ii) of the OIA [redacted]

4.2.30 [redacted]

4.2.31 [redacted]

4.2.32 [redacted]

4.2.33 [redacted]

[25] The JONSWAP (JOint North Sea WAve Project) spectrum was derived from a series of wave measurements taken in the North Sea and found that the seas are never fully developed, that is they are characterised by the relatively short fetch of the area (Hasselmann K., et al, "Measurements of wind-wave growth and swell decay during the Joint North Sea Wave Project (JONSWAP)" 1973).

s 9(2)(b)(ii) of the OIA [redacted]

Table 4.2 – Principal Results of the 2013 INTECSEA Mooring Analysis – Operational Conditions

4.2.34 s 9(2)(b)(ii) of the OIA [redacted]

4.2.35 INTECSEA have compared the mooring analysis results against the API RP-2SK standards to check that the necessary safety margins are compliant and state that all items are compliant.

4.2.36 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA
[redacted]

Table 4.3 – Safety Factors for the Mooring System Intact

s 9(2)(b)(ii) of the OIA
[redacted]

Table 4.4 – Safety Factors for the Mooring System Damaged

Notes:

s 9(2)(b)(ii) of the OIA
[redacted]

4.2.37 The joining D Shackles attaching the tri-plate to the turntable are of unknown type and age. We are advised that no certification for these shackles can be provided and their breaking strength, proof load and SWL are therefore unconfirmed or unknown. The mooring system at Taharoa has therefore been operated with critical components that are un-certified and of unknown strength.

4.2.38 As a result of this finding, we understand the NZS have committed to replace these 4 shackles and the 200 tonne SWL hawser shackles and until the replacement units are fitted to reduce the SWL for the mooring system as a whole to 200 tonnes (see email from NZS to Cwaves in Appendix D)[26].

4.2.39 All other components are compliant with the requirements of API and OCIMF. However, the foregoing comments about the validity of the mooring analysis may mean that there are some inaccuracies in the results for the peak hawser, mooring and anchor loads and we would recommend that this is re-assessed.

4.2.40 We note that the ABS Rules 2014 require a safety factor of at least 1.6 for the anchor loads in the damaged case (Part 3, Ch 4, Sect. 1 / 3) and at least 2.0 for the mooring lines (Part 3, Ch 4, Sect. 1 / 5). The INTECSEA results give a safety factor of 1.19 and 1.45 respectively, neither of which comply with the ABS Rules, although they do comply with the API RP-2SK Recommended Practice. It is not clear from the available documentation, if ABS have assessed this requirement of their Rules in issuing the Fitness for Purpose Certificates, although we note that they state "*We found that the submitted design and calculations as described therein to be generally satisfactory subject to the following comments....*"[27].

4.2.41 The mooring analysis does not make any explicit mention of the risk of progressive failure in the event of a single line failure, although we note that the maximum loads are less than the 'as-new' MBL of all components and it follows therefore, that progressive failure was presumably not found to occur. We would recommend that a more explicit statement of this is made. In light of the time it takes the vessel to

[26] The SWL of 200 tonnes is based on the SWL figure marked on the spare of the D shackle used to join the mooring hawser to the 3-link chain at the buoy. According to the certificates supplied with the NZS email (Appendix D), this has an MBL of 1000 tonnes.

[27] ABS Letter of Review and Approval in Principal [sic] to Move to New Location, 26th March 2013. Further, subsequent to the audit, INTECSEA have confirmed that the damaged case was assessed under ABS Rules 2014 3-5-1-7 Alternative Design Criteria and approved accordingly.

disconnect from the buoy (circa 1 hour, as witnessed on-board by Cwaves), this is a potentially critical scenario in the event of a single line failure.

4.2.42 We would therefore recommend that an analysis be undertaken to check the sensitivity of the INTECSEA results to the factors highlighted above.

4.3 Installation of the Mooring System

4.3.1 The mooring analysis is used to establish to peak loads in the mooring system that can be expected to occur. Since the ability of the SBM to stay on station is dependent to a large extent on the ability of the anchors to hold, it is a requirement that the anchors are proof loaded on installation to ensure that there is adequate holding capacity.

4.3.2 The API RP-2SK (Section 7.4.3) requires;

"*For permanent moorings with drag anchors, the mooring lines should be test loaded to at least 80% of the maximum storm load determined by a dynamic mooring analysis for the intact condition. This requirement is based....on experience with drag anchors in hard clay where deep anchor penetration can be achieved. For drag anchors on hard or sand seafloors...., a higher anchor test load may be appropriate.*"

4.3.3 The ABS Rules 1996 and 2014 require:

1996: "*On deployment of the mooring system with drag anchors, each mooring line is to be pull tested to 80% of the maximum design load....*"

2014: "*After the mooring system is deployed, each mooring line will be required to be pull-tested. During the test, each mooring line is to be pulled to the maximum design load determined by dynamic analysis for the intact design condition.... For certain high efficiency drag anchors in soft clay, the test load may be reduced to not less than 80 percent of the maximum intact design load.*"

4.3.4 Similarly, ISO 19901 – 7[28] requires:

[28] ISO 19901" Stationkeeping systems for floating offshore structures and mobile offshore units" – Part 7, section 10.4.6.2. 2nd Edition, 2013.

"For mooring lines with drag anchors, the test load magnitude in soft clay where deep anchor penetration can be achieved shall be equal to at least 80 % of the force induced by the environmental design situation as determined by a dynamic analysis of the intact condition …. In hard, sandy, or layered soils, where anchor penetration can be limited to no more than one fluke length, the test load magnitude shall be higher, and should be 100 % or more…."

4.3.5 s 9(2)(b)(ii) of the OIA [redacted]

4.3.6 [redacted]

4.3.7 [redacted]

4.3.8 INTECSEA and NZS have stated that the installation of the anchors complied with the requirements for installation and pull testing. Based on the above, this would appear to be incorrect.

4.3.9 s 9(2)(b)(ii) of the OIA [redacted]

4.3.10 The relevant guidelines and standards as described in paragraphs 4.3.2 – 4.3.4 do not state that the pull test load should be according to the Survival condition and

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[29] ABS Consulting Report No. SG2730011-01R1 of 7th May 2012, 'Witness Installation and Tension Pull Test of Six Stevpris Mk 6 Anchor)

all state that it should be based on the maximum 'design' load, which is the Operating condition.

4.3.11 It should also be noted that the requirement of 80% of the maximum mooring load is based on clay soils, which provide good anchor penetration. The API standard requires the pull test load to be higher than 80% for sand soils, although it is necessary to consider that the seabed composition at Taharoa, whilst sand in the general sense, may not conform to typical 'sand' properties. We would recommend further investigation of the seabed material properties with respect to anchor holding power.

4.3.12 s 9(2)(b)(ii) of the OIA [redacted]

4.4 The Condition of the SBM

4.4.1 The buoy was constructed in 1977 and is now 38 years old.

4.4.2 The following inspections of the buoy have been carried out:

i) 1985: Out-of-water inspection and repairs by Wanganui Engineering[32];

ii) 2009: Out-of-water inspection (OWI) by Worley Parsons[33];

iii) 2012: In-water inspection (IWI) by INTECSEA[34];

[30] WorleyParsons, "Basis of Design – Phase 2", Report No. 401027-00001-GE-REP-0001, Revision 1, 5-Mar-2013.

[31] The Vryhof Anchor Manual provides data on the Stevpris Mk 6 anchor for different sea bed types.

[32] NZS have advised us of this inspection subsequent to the audit visit.

[33] Worley Parsons Report 401010-00534-000-NA-REP-0001-B of 21st May 2009; "Inspection Report – Taharoa CALM Buoy".

[34] INTECSEA Report No. 401027-00001-MA-REP-0003, dated 31st March 2012; "Taharoa Buoy Modifications – In-water Inspection Report".

iv) 2012: General condition survey by ABS Consulting[35] [36];

v) 2014: Annual Survey, Special Periodical Survey and Underwater Inspection In-Lieu of Dry-docking (UWILD) Survey by ABS Consulting[37];

4.4.3 The following paragraphs summarise the key findings of each of the above inspections, although we note that there is no information available for the 1985 inspection. Since this was 24 years prior to the 2009 inspection and we are unaware of any further out-of-water inspections, this is not considered important.

4.4.4 The 2009 Worley Parsons (WP) OWI report recorded the following key findings:

i) The buoy is not classed. SBM's Specification for the buoy states that it should be built and certified to ABS rules.

ii) The SBM Specification states that the buoy should be constructed from ordinary mild steel (of minimum yield stress of 22 kg/mm^2) and supplied with a Classification Society certificate. WP recommended that records be searched to find the certificate. We have subsequently been provided with material certificates confirming this.

iii) WP note that the buoy was fabricated with steel 1-2mm thicker than specified by SBM, which they consider to be beneficial to the fatigue life.

iv) The plating of the buoy body showed only light corrosion, indicating that the coating and cathodic protection systems were functioning well.

v) Plate thickness measurements were taken by SGS after the inspection by WP. It was reported that most surfaces had lost very little thickness.

vi) It was reported that that the above water line coatings showed significant breakdown. These surfaces were recommended to be blasted and recoated.

[35] It should be noted that the condition surveys and Fitness for Purpose certificates are provided by ABS Consulting (S) Pte Ltd, not ABS Classification Society, although they are part of the same group.
[36] ABS Report No. 2730011, dated 22nd March 2012; "(Preliminary) General Condition Survey Report for Taharoa CALM Buoy".
[37] ABS Report No. SG3255564-01-01, dated 6th June 2014; "New Zealand Taharoa CALM Buoy".

vii) The pipe fender surrounding the buoy was no longer tubular (split, flattened) due to collision damage. The skirt also showed signs of significant collision damage. This indicates that collision damage cannot be omitted as a risk factor.

viii) The original SBM specification specified that 3/6 (alternate) compartments are filled with foam. This was not done and all compartments are void. The purpose of the foam is to provide adequate buoyancy in case of two-compartment damage. NZS advise that the buoy satisfies the ABS stability criteria[38], although we have not sighted this document and we therefore suggest that it is confirmed that damage stability calculation has been based on the operating specification without foam-filled compartments. It is also noted that foam filling of the compartments reduces the ability to inspect and maintain the buoy structure. In light of the age, condition and need for rigorous inspection, we consider that it is reasonable to avoid foam filling, providing the buoy satisfies the damaged stability criteria.

ix) The seizure and replacement of the main rotating bearing in 2005 was thought to be the result of submergence in seawater as a result of a collision or the seating not complying with the manufacturer's flatness requirements.

x) WP recommended that a fatigue analysis be carried out on the mooring chains and the hawser connection equipment (tri-plate, chafe chain and shackles).

xi) A 15mm crack and significant wear to the rocker support housing was sighted on anchor leg chain hawse #3. No such defects were found in the other five hawse castings/rocker housings.

xii) There is no report on the condition of the access manholes and watertight seals.

4.4.5 The 2012 INTECSEA IWI report recorded the following key findings:

[38] INTECSEA Report "00001-MA-CAL-0016-0; Damage Stability Calculations".

i) An in-water inspection was carried out in January 2012. Accordingly, it was not possible to inspect the underwater areas of the buoy. No thickness measurements were taken.

ii) Confirmed that blasting and coating appeared to have been carried out in accordance with the recommendations of the 2009 OWI. Only minor breakdown of coating was found.

iii) The recommendation that the stability of the buoy with two adjacent compartments flooded is assessed is reiterated. (The same observation and recommendation was made in 2009.). As per para. 4.4.4 viii), we understand that this has been completed.

iv) All other recommendations from the 2009 OWI, relating to steelwork, have been noted as carried out.

v) Some cracking of the coating system was observed on the welded connections of structural members around the chain hawse box structures. The report states "*This is considered to be due to slight relative movement between the highly-loaded structural members in this region*." No cracks to the structure were noted, but INTECSEA recommended that close attention be paid to these areas in future inspections.

vi) It was noted that the shackle pins in the Tri-plate were showing signs of wear and a recommendation was made that they be replaced at the earliest opportunity.

vii) The recommendation to undertake a fatigue analysis on key components was reiterated.

viii) There is no mention of the condition of the structural items noted in the 2009 report, such as protecting the SBM from collision damage.

4.4.6 The 2012 ABS General Condition Survey report recorded the following key findings:

i) Only the above water areas were inspected. A number of deficiencies requiring corrective action are reported and it is stated that the survey was

limited by time and that a "*thorough inspection is essential and necessary to uncover any remaining items requiring corrective actions*".

ii) The buoy was found to be in 'Fair'[39] condition generally, with the exception of the items requiring corrective actions. These were mostly areas of indentations and localised buckling on the external hull of the buoy. ABS have documented the necessary corrective action in the report.

iii) ABS stated that to complete the Certification (for fitness for purpose) that a full detailed inspection needs to be carried out, thickness measurements to be undertaken, turntable rotation test, full NDT on all mooring / lifting lugs, lifting appliances to be proof load tested and a number of tests to be carried out.

4.4.7 The 2014 Annual Survey, Special Periodical Survey and UWILD report recorded the following key findings:

i) Man-hole covers and the structural areas of the hull were found to be satisfactory.

ii) The internal structure of the six tanks was found to be in fair to good condition. However, six spots of localised corrosion and wastage were found to have thickness measurements less than 90% of the original thickness (that is greater than 10% wastage). The ABS reports stated that they are considered satisfactory for the time and to be re-examined annually and permanently repaired at the next dry-docking.

iii) Fatigue sensitive areas (as identified in the INTECESA Fatigue Analysis report, no. 401027-0001-ST-REP-0002 Rev.0) were close up examined and Non-Destructive Examination (NDE) carried out. A number of areas considered fatigue sensitive were not able to be NDE and are listed in the 2014 ABS report. No apparent defects were observed, so it is stated that the NDE must be carried out no later than the next annual survey (31st May 2015).

[39] The ABS definition of Fair is; "*Condition with wear and tear and other deficiencies of minor nature not requiring correction or repair.*"

iv) The ABS report further states that all fatigue sensitive areas should be close-up examined with NDE by an attending ABS surveyor annually until such conditions are permanently dealt with at the next dry-docking and no later than 31st December 2016.

v) A list of 13 items requiring rectification as soon as possible is given, with a deadline of no later than 31st December 2016. This list includes 4 items remaining from the 2012 ABS survey, indicating that the corrective actions required by ABS then, had not been completed. The ABS surveyor reports that evidence of sealing compound was found in way of affected areas on the main deck (although no water ingress was observed).

4.5 Fatigue Analysis

4.5.1 A fatigue analysis was conducted by INTECSEA[40] to assess the fatigue life of the buoy due to *"its extended service life and its re-positioning at a new location".*

4.5.2 The fatigue analysis used a Finite Element Analysis (FEA) model to assess the structural response of the buoy due to the mooring loads placed upon it (as taken from the INTECSEA mooring analyses). The stresses that the various components experience under these loads were then assessed for fatigue sensitivity and fatigue damage assessed, taking into account the various sea-sates for the 'next' 20 years of service life.

4.5.3 INTECSEA have reported that sixteen structural details were identified as being sensitive to fatigue loading and were then specifically analysed. Of these sixteen details, six were identified as being critical in terms of fatigue life.

4.5.4 The fatigue analysis considered the buoy hull, turntable arrangements and associated structural details on both. However, it did not consider the critical mooring equipment such as the 'D' Shackles, Tri-plate, Link-plate and chafing chain.

4.5.5 The fatigue analysis assumes a buoy utilisation of 9% and less than or equal to 3.3/m Hs. This appears to be for the TAHAROA DESTINY only with the 2012 70m

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[40] INTECSEA report 401027-00001-ST-REP-0002, dated 24th April 2013; "Taharoa Buoy Modifications; Fatigue Analysis Report".

hawser with 21" circumference. No account is taken of the future increased utilisation with 2 extra vessels (potential utilisation of 27%), nor the higher loads experienced due to the larger 23" hawser. Therefore, we consider that the fatigue analysis is not valid for the current and future usage profile of the Taharoa SBM, as it likely underestimates the development of future fatigue damage due to the increased utilisation of the buoy and higher mooring loads than those analysed.

4.5.6 The fatigue analysis report makes a number of recommendations for inspection and NDT of specific fatigue sensitive components. These are summarised in Table 4.5 below.

Item ID	Description	Calculated Fatigue Life	Recommendations
D1'	Butt weld (single side only, with backweld) 10mm to 10mm plate diaphragm at angle	N/A	Review inspection reports or perform Ultrasonic Testing (UT) at next available opportunity (*"at next inspection and maintenance operation if in near future*). If weld root free from defects – annual inspection and NDT every 2.5 years. If weld root has defects, a "*more cautious inspection regime"* required.
D5	Butt weld (single side only, with backweld) 10mm to 12mm plate WT bulkhead		
D6	Butt weld (single side only, with backweld) 10mm to 16mm plate at radial girder @ el +0.8m behind chain hawse well		
D11	Butt weld (single side) 10mm to 16mm skirt deck plate		
D6	As above	16 years from date of fatigue analysis report	No immediate action providing assumed 'Class' fatigue category is correct. See D6 above.
D18	Chain hawse well weld	Crack initiation predicted to have already occurred. 2009 inspections show damage to welds at	Chain hawse supporting structure is highly sensitive to fatigue. Recommended to be very cautious: - Leg 3: Annual visual inspection of entire area. NDT 50% of area every 2.5 years. 100% tested every 5 years.

		chain hawse recess	- Legs 1-2, 4-6: Annual visual inspection of entire area. NDT 25% of area every 2.5 years. NDT 50% of area every 5 years.
D22	3.5mm double side fillet weld of 10mm skirt supporting bracket to 10mm skirt deck plate	7 years from date of report.	Annual visual inspection of 100% of the weld area from 2013. NDT 25% of the weld area every 2.5 years.

Table 4.5 – Summary of Recommendations from Fatigue Analysis

4.5.7 Section 7 of the fatigue analysis report covers 'safety factors'. It states that "The Taharoa CALM buoy is not classed by any classification society. Unless requested by New Zealand regulations and authorities, it is the responsibility of New Zealand Steel to define what an acceptable level of risk for the asset is.....".

4.5.8 It is then stated that "*failure of any of the sixteen structural details identified as fatigue sensitive is unlikely to lead to safety consequences*" for reasons stated as the buoy being unmanned, that the buoy meets the ABS damage stability criteria[41] and that the one line damaged case in the mooring analysis satisfies ABS requirements, such that buoy will maintain its position in the event of a failed mooring line.

4.5.9 INTECSEA have introduced proposed factors of safety based on the ABS Rules and advise that if these safety factors are used, then additional structural details require specific attention, including detail D1' at leg 3, detail D11 at leg 3, detail D19 at leg 3 and detail D22 between legs 3 and 4.

4.5.10 Notwithstanding the previous comments regarding the suitability of the analysis and the input data (para. 4.5.4 – 4.5.5 above), the INTECSEA Fatigue analysis report makes clear recommendations for the inspection and testing of critical components.

4.5.11 There has been a considerable body of work in the offshore industry on mooring system failures and in particular by analysing a number of known failures for which

[41] INTECSEA report No. 401027-00001-MA-CAL-0016 – rev 0 – "Damage Stability Calculation". We have not sighted this report and cannot confirm the assumptions on which the results are produced. As descr bed above in para 4.4.4 (viii), the buoy was not filled with foam contrary to the specification of SBM and hence, the basis of the damaged stability analysis should be confirmed.

investigation results have been shared. It is therefore useful and important to note some of the outcomes of these reviews, which have assessed commonalities between failures and known issues that occur.

4.5.12 The Offshore Technology Conference (OTC) has published a number of these reviews and have advised on fatigue calculations as follows:

i) *"....estimation of remaining fatigue failure life is challenging and current inspection techniques cannot detect crack development until close to failure. ...and current analysis techniques for estimation of OPB [Out of Plane Bending] fatigue provide a wide range of results due to the sensitivity of analysis to very small change in parameters[42]."*

ii) *"There is no standard approach to selecting fatigue environmental conditions and application of codes and standards (DNV, BV, API). There have been cases where a revisit of fatigue analysis using updated fatigue curves and a reassessment of environmental combinations have shown that fatigue life predicted was over estimated by a factor of ten."[43]*

iii) *"The top three components that cause the most incidents were chain, connectors (including shackle, H-Link, tri-plate) and wire rope. One surprising finding is that the novel nature of the failure mechanisms was found in some incidents...such as OPB, chain hockling/twisting, flawed flash welds, low fracture toughness, pitted corrosion. Obviously, unknown or new failure mechanisms are troubling because, since they are unanticipated, they cannot be easily prevented with any existing integrity practices. "[44]*

4.5.13 It is well known and established that fatigue analyses are highly sensitive to the inputs used and assumptions made and require a large number of variables to be defined. As outlined in para 4.5.12 above, this is of particular relevance to offshore mooring systems, given the difficulty of undertaking adequate and rigorous inspections. In our opinion, a conservative approach must therefore be essential.

[42] OTC 24025, "A Historical Review on Integrity Issues of Permanent Mooring Systems", OTC 2013, Ma et al, page 10 para 5.
[43] OTC 24181; "Application of Lessons Learned from Field Experience to Design, Installation and Maintenance of FPS Moorings", Najhi et al, page 8 para 2.
[44] OTC 24025 page 12 para 3/4.

4.6 Inspection and Maintenance Regime for the SBM

4.6.1 During our attendance at the Glenbrook offices of NZS, we were presented with a document describing NZS's inspection and maintenance regime for the Taharoa SBM.[45]

4.6.2 Table 4.6 below summarises this inspection schedule and compares to the guidelines provided by OCIMF[46].

4.6.3 It should be noted that whilst the OCIMF report provides 'guidelines' and as such is non-mandatory, it is based on a large body of experience drawn from the tanker and offshore industry and may be considered as 'best practice'. The OCIMF guidelines do specify that the schedules (scope and frequency) can be "*altered to suit requirements of the individual terminal*" and that "*reference should be made to manufacturer's manuals for specific details*". We note that, as described in para 4.2.12(iii) above, SBM apparently produced such a manual, although this has not been sighted.

ID	NZS Inspection Schedule	ID	Equivalent OCIMF Guidelines
Pre-Loading & Pre arrival Inspection			
1	s 9(2)(b)(ii) of the OIA [redacted]	A	As per NZS [redacted] plus check buoy trim and freeboard, check mooring connection equipment (shackles, tri-plate etc.) and hatch covers to water-tight compartments.
Arrival / Mooring Inspection			
2	s 9(2)(b)(ii) of the OIA [redacted]		
		Weekly	
		B	All pre-arrival checks [redacted] & A) plus; board buoy and lubricate key components (incl. main bearing), sound compartments for water ingress, check buoy fendering /

[45] NZS Presentation; "Taharoa Port Asset Management; Inspections and Maintenance Schedule", DRAFT Version 1.1, dated 4th September 2014.

[46] OCIMF Report; "Single Point Mooring Maintenance and Operations Guide", 2nd Edition, 1995.

			skirt for damage, check centre-well for contamination, drain bearing cavity.
Post Ship-loading Inspection			
3	s 9(2)(b)(ii) of the OIA [redacted]		
		Monthly	
		C	All weekly checks (B) plus; Lift mooring equipment to deck and check hawser and floats, 3 link chain, thimbles/eyes, connecting chains/shackles, check all valves, electrical systems, battery boxes to be dry. Diver inspection of hose strings, clean growth from anodes, rotate turntable with launch (check for resistance/ noise), check bearing protection system, measure chain angles and chain wear under buoy.
Six (6) Weekly Maintenance			
4	s 9(2)(b)(ii) of the OIA [redacted]		
Six (6) Monthly Maintenance			
5	s 9(2)(b)(ii) of the OIA [redacted]	D	As per C plus; pressure test hoses in-situ, inspect buoy compartments for corrosion / damage, repair paintwork damage, measure chain wear at seabed. Check anchors and chain connections. Check PLEM, surface piping.
Nine (9) Monthly Maintenance			
6	s 9(2)(b)(ii) of the OIA [redacted]		

Annual Inspection and Maintenance			
7	s 9(2)(b)(ii) of the OIA [redacted]	E	All checks in D plus; complete inspection of catholic protection system, cleaned and replaced as required. Inspect selected areas of hull for thickness, check swivel seals, drive plate and pipework for thickness. Chain turntable bearing, check anchors and chains (disconnect from buoy, check working section for wear, check for anchor drag and re-position as required, check for signs of scouring).
Two (2) Yearly Inspection / Maintenance			
8	s 9(2)(b)(ii) of the OIA [redacted]		
Three (3) Yearly Inspection / Maintenance			
9	s 9(2)(b)(ii) of the OIA [redacted]		
Five (5) Yearly Inspection / Maintenance			
10	s 9(2)(b)(ii) of the OIA [redacted]		
10 – 15 Year Expected Maintenance			
11	s 9(2)(b)(ii) of the OIA [redacted]		

Table 4.6 – Comparison of NZS Inspection and Maintenance Regime with OCIMF

4.6.4 The OCIMF Guidelines were designed for oil terminals and as such can justifiably be considered to provide stringent requirements with respect to inspection and

maintenance for avoiding oil pollution. Since the Taharoa terminal is used to export a naturally occurring mineral product, pollution is a less significant concern (at least as far as the export product itself is concerned).

4.6.5 However, in examining the inspection and maintenance regime of NZS, it appears from the documentation provided, that some key areas are or have been considerably more 'relaxed' than industry best practice. In particular:

i) s 9(2)(b)(ii) of the OIA [redacted]

The ABS Certificate states that it is subject to: "*Fatigue sensitive areas......are to be close-up examined with NDE, by an attending ABS surveyor annually until... permanently dealt with at the next out-of-water docking but no later than 31st December 2016*" and "*Rectification of findings listed in the attached Memorandum No. SG3255564-Memo-01 dated 31st May 2014".* The NZS inspection and maintenance schedule sighted at the time of the audit makes no mention of these specific requirements or even that the Fitness for Purpose Certificate is conditional on them. s 9(2)(b)(ii) of the OIA [redacted] There is no mention of these critical areas in the documents sighted at the time of the audit. However, NZS has subsequently supplied a copy of the Master In-Service Inspection Plan (MISIP) document of 26/08/2013[48], which shows annual visual inspections were scheduled, with close-up visual inspections and NDT scheduled every 3 years. The MISIP document is annotated for future revision indicating an intention to comply with the requirements of the ABS Certificate. However, it does not appear to indicate that the annual NDE inspection of the fatigue sensitive areas as required by ABS is to be performed.

ii) NZS do not state any requirement to check the condition of the hatch covers of the water-tight compartments. These are a critical component of the

[47] ABS Certificate SG3255564-C2-2014, Conditional Certificate, valid until 31st May 2015.

[48] NZS Document No. 815-TAH-01-REP-022-REV1 of 26/08/2013.

watertight integrity of the system and should be inspected regularly. The OCIMF Guidelines recommend a weekly inspection.

iii) The NZS schedule for checking the hawser is based around vessel arrivals and loading operation, compared to monthly as per OCIMF. Currently, vessels call at Taharoa at intervals greater than 1 month, although we note that the hawser is stored in the SBM locker between vessel calls.

iv) Lubrication of key components such as the main bearing is recommended on a weekly basis by OCIMF, compared to the NZS schedule of 6 weeks.

v) OCIMF recommends to measure chain wear on a monthly basis, compared to annually as per the NZS schedule. Further, OCIMF recommends to measure chain wear at touch-down (sea-bed) every 6 months. The NZS schedule does not make reference to measurement of chain wear at touchdown. NZS have subsequently advised that their inspection regime is based on API-RP-2I, with which we note, that it complies.

vi) The NZS schedule refers to annual under-water inspections to ensure compliance with ABS rules and maintain the Fitness for Purpose certificate. The OCIMF recommendations are for diver inspections of hoses, anodes and chains, chain stoppers etc. every month.

vii) OCIMF recommends selected measurements for plate / structure thickness for the buoy on an annual basis. The NZS schedule provided in the MISIP document provides for measurements (thickness gauging) at 3 yearly intervals. In light of the fatigue sensitivity of areas of the buoy's hull, we consider that is an important aspect of inspection and maintenance.

viii) The inspection of the mooring legs, by disconnecting them one at a time and inspecting the working section is recommended to be performed annually by OCIMF. The NZS schedule state that this will be done every 3 years.

ix) The NZS schedule appears to suggest that an underwater inspection in lieu of dry-dock (UWILD) is acceptable every 5th year. This would appear to be contradictory to the known difficulty of inspecting for fatigue damage in water and the recommendations of the fatigue analysis report and conditions of the ABS Fitness for Purpose Certificate.

4.6.6 The relevant API standard, RP-2I[49] states, at Section 4.5.3, that periodic surveys should be conducted at least every 5 years with visual inspection of the above water components conducted annually. A periodic survey is intended to provide measurements to check the buoy structure and mooring components against the original as-built specification. The NZS schedule is compliant with the API requirements and exceeds them in terms of inspection period.

4.6.7 The inspection schedule specified by NZS appears to meet the relevant ABS Rules for surveys in service[50], although does not appear to provide for the annual NDE inspection of fatigue sensitive components (as required by ABS). In view of the age of the SBM, future increase in service utilisation and risks of fatigue damage, we consider that an increased inspection regime is required.

4.7 Hawser Management

4.7.1 During our attendance at NZS offices, we were provided with a document describing NZS's procedure for assessing the residual strength and life of the mooring hawser[51].

4.7.2 In general terms, the procedure can be described as follows:

s 9(2)(b)(ii) of the OIA

i) [redacted]

ii) [redacted]

[49] API RP 2I, "In-Service Inspection of Mooring Hardware for Floating Structures", 3rd Edition (2008).

[50] Rules for Building and Classing Single Point Moorings

[51] NZS report; "Taharoa Mooring Hawser; Strength, Inspection and Life Assessment", version 1.0 (DRAFT), September 2014.

[52] Trelleborg report no. EX1562-SV-003, S10B04, "Report on Hawser Friction", dated 24th February 2010.

iii) This quantity of cycles for each load grouping is then used to determine the extent of the de-rating of the MBL of the hawser.

iv) Upon retirement of each hawser, it is sent for destructive testing to determine its residual MBL and compared to the predicted result using the method outlined above.

4.7.3 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 4.8 - Hawser Residual MBL Calculation

4.7.4 s 9(2)(b)(ii) of the OIA [redacted]

4.7.5 Whilst the analysis shows reasonable correlation to date, there is evidence of a diverging trend with increased use and this should be considered in the predictions. Also, the prediction of rope strength in-service is fraught with difficulties due to the number of variables involved, many of which cannot be assessed. The only accurate method of determining residual strength is to test an appropriate sample to destruction. Over time, this will allow a body of experience to be developed that can be used to inform the predictions, however, in these relatively early stages of such predictions, it should, in our opinion, be used with caution.

4.7.6 The above method of prediction will only remain valid as long as the hawser is stored and maintained in accordance with the manufacturer's instructions (as it depends on the manufacturer's de-rating method). If, for any reason, it is not (e.g. the rope comes loose from its storage and remains in the water), then it is likely to lose considerably more strength than predicted and the utmost caution should be exercised with regard to its future usage.

4.8 The Overall Integrity of the Mooring System

4.8.1 The Taharoa SBM buoy was built in 1977 and is now 38 years old. The original specification by SBM Offshore is understood to have specified that the buoy should be built and certified to ABS Rules. However, the buoy was not built in class and has not been classed through-out its service life. NZS have provided a certificate from Lloyds Register of Shipping (LR), certifying that the construction was witnessed by the LR surveyor and was in accordance with the specification[53]. However, the more recent condition surveys and inspections suggest that there were a number of deviances from the specification (thicker steel for the buoy hull, no foam filling of alternate compartments) and hence there is some ambiguity over the exact construction details and its compliance with the specification.

4.8.2 The buoy was specified to be constructed of mild steel. Subsequent to the audit, certification has been provided confirming the grade of steel used.

4.8.3 Each of the six mooring legs are made up of 4 sections of U3 steel stud-link chain, joined by Kenter Shackles.

[53] Lloyd's Register Certificate No. C983, dated 26th October 1977, issued at Auckland.

4.8.4 U3 grade steel is an ordinary 'marine' grade steel for chains and is not approved by Class societies who require R grade steel chain for mooring chains to be used on offshore installations (ABS Guide for the Certification of Offshore Mooring Chain, Feb 2014).

4.8.5 Kenter shackles are known to have been the cause of mooring failures due to fatigue cracking and subsequent component failure[54]. Therefore, a mooring leg with 3 Kenter shackles in the 'line' is considered to represent a fatigue risk and requires a rigorous inspection regime to identify any fatigue damage early.

4.8.6 The new Stevpris Mk6 anchors are a high holding power design and providing properly installed, will provide additional mooring security compared to the previous Bruce anchors.

4.8.7 s 9(2)(b)(ii) of the OIA [redacted] There is no chafing chain at the ship, as per normal industry practice (Ref OCIMF MEG-3), s 9(2)(b)(ii) of the OIA [redacted]. The rationale for the use of the soft eye system is reasonable, however, we are of the opinion that the current system as observed in September 2014 does not provide an effective or safe quick release system (see section 10.3.2).

4.8.8 Of most significant note is that the 4 joining 'D' shackles s 9(2)(b)(ii) of the OIA [redacted] are not certified units. No records have been available to confirm their SWL, MBL or proof load. The buoy has been continually operated with these shackles despite this lack of proven capacity, which would be in contravention of all relevant guidelines and standards for an SBM. These units should be removed from service and replaced immediately with properly certified and tested shackles.

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[54] JIP FPS Mooring Integrity, HSE Report 444, 2006, Section 11.

[55] "Mooring Operations; Soft Eye Hawser vs OCIMF; Presentation to Harbour Master and MNZ", Jan 2015.

4.8.9 The SBM was originally designed for a 20 year service life and for a 150,000 DWT vessel with H_S = 4.1m, T_P = 10.1 sec, wind of 40 knots and 1 knot current. Whilst it has been somewhat upgraded (hawser, anchors), this means that the buoy in operation now exceeds the design vessel and is significantly over its service life, although it operating limits have been reduced.

4.8.10 The mooring analysis conducted by INTECSEA in 2013, whilst extensive in scope has a number of important issues in our opinion:

i) s 9(2)(b)(ii) of the OIA [redacted]. The available sea state data for Taharoa (either from the Datawell wave buoy or hindcast models) shows that the majority of wave periods are in the range 10-16 seconds. This means that the hawser loads determined in the mooring analysis may be unrepresentative of the actual sea-states that are experienced on site.

ii) Additionally, the JONSWAP wave spectrum was used, which was developed for the North Sea in Europe and is representative of a short-crested (not fully developed) sea. We would expect the Taharoa site to experience well developed seas. Hence, the hawser loads predicted may be further invalidated by this.

iii) The mooring analysis was conducted for the 21" hawser which is no longer used and will provide lower hawser loads. s 9(2)(b)(ii) of the OIA [redacted]

iv) Therefore, the statements of INTECSEA of the safety factors obtained against API requirements are incorrect as they have used the incorrect results from the 21" hawser. However, when using the correct results [redacted] the safety factors do comply with the API requirements with the exception of the 4 joining 'D' shackles, which are of unknown SWL/MBL and therefore do not meet the criteria.

4.8.11 In our opinion, it is possible that the results of the mooring analysis, based on the above observations are not accurate. Therefore, an analysis of the sensitivity of the results to these factors should be carried out.

4.8.12 In determining the anchor pull test requirement for installation of the new anchors, s 9(2)(b)(ii) of the OIA [redacted] In the event, the pull test load achieved was 170 tonnes, as witnessed by ABS. Whilst the anchors are reported to have bedded in and we are unaware of any reports of the SBM moving out of alignment of the PLEM, there is the risk that, in the higher environmental conditions the anchors may move until they bed in further.

4.8.13 It is known that the buoy was not foam filled as per the original specification, and we are unable to confirm if it complies with the damage stability requirements based on the mooring analysis documentation available.

4.8.14 The surveys and inspections carried out by ABS and INTECSEA demonstrate that the buoy is in a reasonable condition for its age. There are however a number of key areas that have been identified as requiring remedial work and attention. These include a number of fatigue sensitive areas and specific recommendations for testing and inspection of them.

4.8.15 We consider that the fatigue analysis carried out to be invalid as it is based on assumptions that are incorrect, including use of the old 21" hawser, not including critical hardware (tri-plate etc.) and not including the operation of 3 vessels through the proposed life of the buoy. The fatigue damage is therefore likely to be under-predicted and has not even been assessed for key components.

4.8.16 The inspection and maintenance regime documented by NZS appears to meet the requirements of ABS, but is significantly more relaxed than the industry standard guidelines provided by OCIMF. In particular, there is no mention of the specific fatigue sensitive areas that ABS and INTECSEA highlighted and placed specific conditions upon and the schedule for inspection of the mooring lines is considerably longer in interval than expected. In light of the known risks of fatigue damage to these critical components, we would recommend a more rigorous inspection regime for the continued use of the buoy and in particular for the planned increase in operations to three vessels.

4.8.17 In general, we consider that the buoy is in a fair condition for its current usage profile and age. However, we would highlight as follows:

i) The use of uncertified and untested critical equipment in the mooring system, although we note NZS have committed to replacing these units.

ii) Possible under-estimation of peak mooring loads and significant underestimation of future fatigue damage based on three vessels in service;

iii) An inspection regime that, whilst fulfilling the requirements of ABS, is, in our opinion, of the minimum standard necessary for the current operation and is insufficient for the future usage profile of the terminal.

4.8.18 Therefore, in light of the increased utilisation of the buoy, we would recommend that as a minimum, an expanded and more cautious inspection and maintenance regime be put in place as soon as possible. We note the MISIP document provided by NZS, which provides a planned maintenance schedule for the current single vessel operation and a stated intention to revise it according to most of the findings of the ABS survey requirements. As described in para. 4.6.5 (i), it does not appear to include the annual NDE inspection of fatigue sensitive components required by ABS.

4.8.19 We also recommend that use is made of the considerable body of work done in the oil and gas industry on mooring system integrity. In particular, the methodology developed by Oil and Gas UK for Mooring Integrity Risk Assessments[56] is recommended for critically analysing the risk of failure of the mooring system at each component in the system. This is then used to inform the inspection and maintenance requirements as risk mitigating actions.

56 Oil & Gas UK Report, "Mooring Integrity Guidance", November 2008.

5 NEW ZEALAND STEEL RISK ASSESSMENTS

5.1 The Arriscar Harbour Risk Assessment Review of November 2013

5.1.1 A Hazard Identification and Controls Adequacy Workshop was held in July 2012, facilitated and recorded by Lloyds Register. The Review was published by Arriscar Pty Ltd, but by the same personnel who were previously with Lloyds.

5.1.2 Attending the Workshop were representatives of Lloyds Register, NZS, MNZ, the Waikato Regional Council, NYK management, SBM Consultants, support vessel manager and marine consultants to NZS. The Pilot did not attend but provided a written submission.

5.1.3 The Workshop was held over three days, and adhered to the principles and methodology equivalent to that set out in the 'Final Guidelines for Port & Harbour Risk Assessment and Safety Management Systems'. These Guidelines provide detailed guidance on Risk Assessments and Safety Management Systems in order to comply with the New Zealand Port and Harbour Marine Safety Code. This Code, and the Guidelines are similar to the United Kingdom Port Marine Safety Code, and the accompanying Guidelines to Good Practice on Port Marine Operations.

5.1.4 The 2009 Risk Assessment was reviewed, and 26 hazard scenarios were identified in groups according to the relevant 'Operational Activity', which comprised;

- Pre-arrival & Approaches to Harbour; Approach to SBM, within Harbour limits;
- Mooring activities;
- Loading of iron-sand slurry onto the Export vessel;
- Decanting and dewatering;
- Mooring disconnection from SBM;
- Pilot the vessel outside of Harbour limits; and
- Harbour wide risks.

5.2 Risk Assessment Review: Description of Heightened Risk Events

5.2.1 The five highest ranked risks in terms of impact on safety were identified and discussed in detail at the Workshop under the heading '*Description of Heightened Risk Events*', which we summarise below:

5.2.2 Section 5.2.1 '*Export vessel forced to leave the port limits before complete de-watering*': This hazard scenario focused mainly on the issue of submergence of the Load Line, which we deal with later in this Report. The rapid development of adverse weather and failure of the vessel's de-watering system were identified as the two most likely factors for the vessel being forced to leave port limits before de-watering was completed. Due to the design of the "TD", sloshing forces are reduced when compared to the previous Export vessel, and therefore the risk of structural damage is significantly reduced. We consider that this section should be re-named "*Export vessel forced to leave the SBM before complete de-watering*", as the vessel is effectively 'at sea' once it lets go the SBM hawser, regardless of whether it is within harbour limits.

5.2.3 Section 5.2.2 "*Excessive load on the SBM (mooring system)*": This section covers the integrity of the SBM itself, and the safe working loads of the hawser. The worst case scenario was identified as occurring when the vessel is in ballast condition, which creates heavy yawing at times, potentially leading to structural failure of the SBM, failure of the hawser and grounding of the Export vessel.

5.2.4 Section 5.2.3 "*Safety of the Support Vessel Compromised*": The risk is if the support vessel has to remain on station for extended periods, or seek shelter. The support vessel is only required for the arrival operation of attaching the hawser and lifting the two slurry pipes, and as safety stand-by vessel for the helicopter. We consider that if the weather is too severe for the support vessel to operate, then it is likewise too severe for the Export vessel to attempt the approach and mooring manoeuvres. If severe weather is imminent, the Export vessel does not need the support vessel when letting go the hawser or lowering the slurry pipes. The Pilot and other personnel on board the Export vessel may not be able to disembark by helicopter due to the support vessel being off station, but this is purely a commercial consideration and there are no additional risks involved.

5.2.5 Section 5.2.4 "*Loading incomplete and Export vessel leaves the SBM due to unplanned event without completing cargo loading*": The reasons for the leaving the SBM were identified as;

- Change in weather;
- Mooring line failure;
- On-board ship emergency;

- Failure of the SBM;
- Failure of the onshore loading facilities.

5.2.6 Sloshing damage and cargo movement in the holds, as identified in Section 5.2.1, were significantly reduced due to the Export vessel's improved design. A crucial risk factor was the ship's crew being struck by a moving slurry pipe during disconnection in an emergency situation, causing multiple injuries or a fatality. We discuss the issue of the operation of picking up and letting go the slurry pipes in a later section of this Report. However, we consider that this whole operation, as it is currently performed, has not been properly addressed in the risk assessment, and in our opinion it is a high risk operation throughout, with a high potential for serious injury or fatality, regardless of whether it is an emergency situation or not.

5.3 Description of Risk Events in the ALARP Region

5.3.1 Eleven Risk Events were identified which fall into the 'As Low as Reasonably Practicable' category. Each Hazard Scenario was given a Risk Ranking, which is found in Table 3 of the Arriscar Review, which uses the standard categories of risks to People, Property, Environment and Harbour Stakeholders. This methodology complies with the 'Guidelines'.

5.3.2 Sections 5.3.1 and 5.3.4, "*Vessel grounding on approach to SBM*" and "*Vessel grounding on departure from SBM*". Potential causes were engine or steering failure, human error or adverse weather conditions. The Arriscar Review, section 5.3.1, states "*The most likely consequences from this hazard scenario is damage to the vessel's rudder or steering, and the Export vessel then being unable to move unassisted. The worst credible consequences escalate from rudder or steering damage to loss of hull integrity/loss of ship due to grounding*". In our opinion, this event has been correctly identified in the Hazard Assessment as C4 – Catastrophic.

5.3.3 Based on our experience, and as discussed in detail in paragraphs 5.3.7 – 5.3.15 below, a grounding at Taharoa has the potential to be irreversible and could result in the total loss of the vessel, with the potential for pollution. The bunker fuel oil, or HFO that the vessel consumes is, in its unheated state, well known for being difficult to clean up and dispose of. It is thick and reverts to a near tar like state once the volatile elements have evaporated. However, the bunker tanks on this

type of vessel are usually side wing tanks in way of the engine room, and are unlikely to be breached in the event of grounding on a sandy bottom. A grounding could jeopardise the whole basis of the export business at Taharoa for NZS, and this is again correctly identified as a C4 – 'Catastrophic' consequence. As the export vessel is near-new, we consider the possibility of engine and steering failure to be very low. Long range weather forecasts are obtained from Met Ocean Solutions. The highest risk would in our opinion arise from the sudden onset of severe weather which was not forecast. However, as the Master and Duty Officers are never 'off duty', we consider that there is an adequate level of vigilance on board to be able to detect and recognise this onset of severe weather, and take appropriate action to leave the SBM at short notice.

5.3.4 A further key mitigating action is adherence to the weather limits put into place for Port Taharoa, which will significantly reduce the likelihood of the vessel being in a potential grounding situation in adverse weather conditions.

5.3.5 Section 5.3.3 "*Mooring line failure*": Although the mooring hawser has been replaced with a larger diameter hawser, and the SBM moved 529 metres further offshore to provide more sea room between the SBM and the limiting depth contour line, there is still the potential for a mooring line failure, especially when the vessel is in ballast and subject to 'fish tailing' or yawing. This has been recognized in the Arriscar Review, where it states "*In the event of excessive strain on the mooring line (from adverse ocean swell conditions) it may be possible for the mooring line to fail during operation*".

5.3.6 This section of the Review goes on to state "*According to the ABS (American Bureau of Shipping) "Rules for Building and Classing Single Point Moorings" there must be at least three ship lengths from the buoy to the applicable minimum depth. The minimum depth is the ship's laden draft plus 20%. With "TAHAROA EXPRESS" 4.4 ship lengths were available. This has increased to 5.2 ship lengths for "TD" when using the relocated SBM. That is an improvement of 170% of the Code requirement*". While this statement may be technically correct and complies with the ABS Rules, a prudent and practical Master would be concerned with the distance from the stern of the vessel to the safe contour line. In any type of emergency it will be the stern and not the bow that is closest to the safe contour line.

5.3.7 We advised the NZS team that we considered that there was less than three ship's lengths available before the vessel, in the loaded condition, risked grounding. The scenarios that could lead to a grounding include main engine failure during mooring or unmooring, or a main engine failure, fire or blackout at any stage of the arrival and departure operations. Other scenarios would start with the failure of the mooring system, which would lead to an unintended disconnection of the vessel from the SBM. At this point, with the vessel drifting, for a grounding to occur, there would then need to be a failure of the main engine and an inability to arrest the drift of the vessel with the anchors.

5.3.8 As described in paragraph 5.3.3 above, we consider that the probability of such a sequence of events is very low. However, the potentially catastrophic[57] consequences of a vessel grounding warrant further examination in order to better understand the implications and hence the risk profile with regard to a grounding.

5.3.9 If the vessel grounded under the influence of on-shore wind, sea and swell, it is most likely to beach parallel to the shoreline. With the vessel beam-on to the swell, scouring of sea-bed material under the bow and stern sections will occur. The effect of scouring is to create a 'spit' of sea-bed material around the midships area as the waves break around the bow and stern, leaving the fore and aft ends of the vessel un-supported by the sea-bed. This would likely lead to structural damage and ultimately can result in total hull failure, whereby the vessel 'breaks' up.

5.3.10 Deploying both anchors on a long scope of chain may arrest the vessels drift to the shore line, as was the case for the "TAHAROA EXPRESS" in 2003 during the engine failure incident. A light vessel will be more susceptible to strong winds and will yaw substantially even with two anchors down, while a deep laden vessel will pitch in a heavy swell, with a tendency to 'snatch' the anchors and pull them out of the ground. The actual ability to successfully deploy the anchors in this scenario is difficult to predict or quantify. We understand that NZS are commissioning a study on this matter, but would urge caution with any theoretical study of large vessel anchoring, which is often dictated by basic practical considerations.

[57] 'Catastrophic' in this context refers to standard risk assessment terminology for the consequence or severity of an event, typically representing consequences such as major or long-term impact on the environment, severe damage or total loss of property, downtime greater than 2 weeks, death of personnel. The Maritime New Zealand document "Guidelines for Port & Harbour Risk Assessment and Safety Management Systems in New Zealand" provides definitions of consequence levels.

5.3.11 In the event of a grounding, the first priority of any salvage attempt is normally to remove the bunker fuel oil / hydrocarbons to minimise the risk of pollution. With the vessel having side wing fuel tanks in way of the Engine Room, the risk of pollution is reduced compared to vessels with double bottom tanks, although is still a possibility to be considered. However, the location of Port Taharoa, the large surf zone, potential for heavy sea conditions and the lack of local shoreside infrastructure would make the recovery of pollutants from a grounded vessel a challenging exercise that could delay the salvage of the vessel.

5.3.12 If the vessel was unable to be pulled free from a grounded location quickly, then it is likely in our opinion, that discharging part of the cargo to lighten the vessel would be necessary in order to re-float it. To do so, would require a significant mobilisation of heavy equipment (e.g., bulldozers, mobile cranes with grabs, conveyor belts) and a suitable crane barge or vessel to lift them on to the vessel.

5.3.13 There are too many variables to be able to predict how long it would take for the vessel to break up. Height and frequency of swell is a major determining factor, as is the effect of scouring. A double hulled ore carrier would be able to sustain considerably more pounding by ocean swells than a standard single skinned Cape-size bulk carrier. Hence, in our opinion, break-up of the vessel could take a time of some small number of weeks into months, depending considerably on the conditions. We consider that, if it was not possible to pull the vessel off quickly, then it could take several weeks to remove bunkers and lighten the vessel sufficiently for salvage, accounting for the significant logistical difficulties.

5.3.14 In winter months, we consider that a salvage operation would be a very challenging situation and subject to the conditions, has a real chance of not succeeding, resulting in a wreck removal situation. The propensity for heavy seas and swell would prevent salvage vessels approaching the grounded vessel for a large proportion of the time, preventing access to fuel tanks and cargo for lightering.

5.3.15 A salvage operation in summer months has a higher chance of success due to the improved conditions making access to the vessel possible for a greater proportion of time, therefore giving greater ability to remove pollutants and lighten the vessel. However, we would highlight that, in our experience, even sea conditions of 2 – 3 metres wave heights can cause delays to salvage operations due to, for example, the ability of divers to operate and vessels to come alongside safely.

5.3.16 Section 5.3.5 "*Helicopter crash (i.e. transfer of personnel/stores etc. to and from the export vessel)*": This Risk Event has scored 5 for Safety and Property in the Risk Rankings. We consider that the Frequency F3 'Possible', and the Consequence category C3 'Major', were correctly identified. In the Hazard Assessment, this event was given a C3 'Major' Consequence rating which we consider correct, but only an F4 'Unlikely' Frequency rating. We consider that this Frequency rating should also have been F3 'Possible', for consistency and based on the known occurrences of helicopter crashes in the offshore industry.

5.3.17 Sections 5.3.6 and 5.3.8 "*Support vessel collides with the Export vessel*" and "*Person from Support vessel thrown overboard*": We consider that these risks have been correctly assessed. The support vessel colliding with the Export vessel is likely to result in structural damage, but not to the point of sinking or foundering, while a man overboard runs the real risk of drowning.

5.3.18 Sections 5.3.9 and 5.3.10 "*Dropped loading hose during hook up*" and "*Dropped loading hose during release*": The Review goes on to state "*The most likely consequence from a dropped hose was identified as multiple minor injuries to the export vessel crew members on the foredeck. The worst credible consequence would be multiple major injuries or a single fatality*". We disagree with this statement. This Risk Event has scored 5 on the Risk Ranking, whereas we consider that it should have scored 7, based on Consequence C3 'Major', and Frequency F2 'Likely'. This opinion is based on our observation of the current slurry pipe hook-up and release operations on board the "TD", which we report on in section 7.2 of this Report.

5.4 Risk Assessment Review: Risk Assessment Criteria - Appendix A

5.4.1 We have reviewed the risk criteria used for the Taharoa Harbour Risk Assessment, and we consider that it complies with the 'Guidelines'.

5.4.2 The Frequency Matrix, Consequence Matrix and Risk Rating Matrix were used throughout and in this respect the Review complies with best industry practice and standards.

5.4.3 The correct methodology has been observed throughout the process. In our opinion, the review complies with the New Zealand Port & Harbour Marine Safety

Code, sections 2.2. 'Risk Assessment & Safety Management', and 2.2.4 'Risk Assessment'.

5.5 Risk Assessment Review: Conclusions of the Arriscar Report

5.5.1 The Review correctly stated in Para 2 "*that in most of the hazard scenarios, controls are largely reliant on human intervention and operational procedures rather than engineering systems*". We agree that "*there is a high reliance of the experience and skill of those associated with the export vessel loading operation (i.e. pilots, masters, ship's crew and port operations staff)*" and consider that there is the potential for single point failure throughout the operation. If there is one link missing in the 'chain', for example, the support vessel out of action, then the whole operation is compromised.

5.5.2 In Para 6 the authors of this Review state "*Many of the incidents or near miss incidents that have occurred within the harbour, if not for the experience, skill and quick thinking of those associated with the export vessel loading operation (i.e. pilots, masters, ship's crew, port operations staff) could have resulted in far worse consequences*". We entirely agree with this statement, and our findings and recommendations are informed by the sentiments stated in this section, and in section 5.5.1 above. We note also, that NZS and the Vessel owners have made good progress in covering and mitigating a number of previous risks through improved procedures and training.

5.6 Summary – Risk Assessment Review

5.6.1 The Workshop and subsequent Review were, in our opinion, conducted in a professional manner with guidance from the Lloyds Register Facilitator and Technical Secretary. Input to the Hazard Identification, Risk Analysis, Controls Adequacy, Control Measures, Preventative Controls and Mitigative Controls was from all port stakeholders (except the Pilot as mentioned in section 2.1.2 above). The whole process complied with the Port & Harbour Risk Assessment and Safety Management Systems Guidelines.

6 THE HARBOUR MASTER'S OPERATIONAL SAFETY PARAMETERS

6.1 Background

6.1.1 On 15th March 2012, Captain John Ireland, as the then Harbour Master imposed reduced operational safety parameters for the first port call of the new vessel "TAHAROA DESTINY". These were:

- Mooring of the ship is not to occur in significant waves heights exceeding 2.6 metres;
- Loading is to be suspended if the strain gauge fitted to the "TAHAROA DESTINY" records loads above 136 tonnes;
- Loading operations are to be suspended when the significant wave height exceeding 2.9 metres is encountered;
- The vessel must be ready to depart the SBM at all times;
- The vessel's load line must not be submerged at any time.

6.2 The Load Line Issue

6.2.1 We understand that the submergence of the Load Line and the operational parameters are the main issues of contention between NZS and the Harbour Master.

6.2.2 In a letter dated 16th April 2004 the then Harbour Master of Taharoa, Captain W.J. Hutchings gave permission in writing as follows to the Master of the "TAHAROA EXPRESS" to: "*The m/v "TAHAROA EXPRESS" is given permission to depart the SPM buoy situated at the Taharoa Iron Sands Terminal in an overloaded condition*", followed by a list of limiting conditions.

6.2.3 Captain John Ireland, former Harbour Master, imposed a prohibition of submergence of the load line as mentioned in Section 6.1.1 above, and this prohibition has been upheld by the current Harbour Master Captain Richard Lough.

6.2.4 Taharoa Harbour was constituted a "Harbour" by a New Zealand Gazette Notice dated 16th July 1970. The Harbour Limits are defined on NZ Chart 4424, and have as its limits a 5 nautical mile radius from the Pump House. If an export vessel is within the Harbour Limits then it is "in port".

6.2.5 However, we consider that from a practical point of view the Taharoa SBM, and any vessel moored to it, is in a totally exposed and potentially hostile marine environment, as there is no harbour, either natural or man-made, sheltered headland, estuary, river or port protected by breakwaters. There is no shelter except Tasman Bay some 12 hours steaming to the south. It is identified as an "Offshore Terminal" on the NZ Chart. Captain Ireland stated in an email to NZS, dated 28th January 2013, *"It is self-evident that Taharoa is not a port or protected anchorage and the ship is effectively at sea during its entire loading operation".* We are agree with this position.

6.2.6 Nippon Kaiji Kyokai (NKK), the vessels Classification Society, issued an "Overdraft at harbour condition"[58], which states that the vessel can withstand overloading by 0.8 metres in waves of 4.275 metres. This Certificate was approved by the Japanese Government. In our opinion this Certificate is not a permission to overload the vessel; it is a statement regarding its structural integrity under those conditions. There are no endorsements to this effect on the vessel's current Load Line Certificate, issued by NKK on 24 h July 2013[59] on behalf of the Government of Japan. The NKK certificate is not an Exemption Certificate which must be granted by the Flag Administration, in this case Japan.

6.2.7 On 19th July 2012 s 9(2)(a) of the OIA [redacted] Deputy Director of the Maritime Bureau of Land, Infrastructure, Transport and Tourism (MLIT), Japan, (the equivalent authority to Maritime New Zealand or the UK Maritime and Coastguard Agency) sent an email to Kenny Crawford of MNZ in which he stated "*This certificate cannot supersede the load lines specified in the ICLL Certificate, which means that the ship shall be subject to paragraph 1 of Article 12 the appropriate load lines on the sides … shall not be submerged at any time* **when the ship puts to sea** (our emphasis), *during the voyage or on arrival".* He goes on to state "*However, when the weather suddenly changes during the loading, the ship may need to put to sea in an overloaded condition in order to avoid causing damage to port facilities and/or the ship herself. In such a case, we regard it is 'force majeure' and will approve she can leave the buoy but it shall be within the extent of force majeure".* This is not

[58] NKK Certificate No. 12HE1400 dated 26th June 2012.

[59] NKK Certificate No. 13HO07146-LLC.

an Exemption Certificate. It is an email exchange between the Flag State and NZS and is not in our opinion an official document.

6.2.8 NZS have previously relied heavily on the Class Certificate and Flag State statement to justify submerging the load line. In their Taharoa Port Operational Parameters – History and Derivation, Section D.1., they state "*The Taharoa Destiny has a valid Overdraft Certificate issued by Class NK and approval to use the practice by the Flag State".*

6.2.9 Paragraph 1 of Article 12 of the International Convention on Load Lines Convention (LLC) 2005 states " *Except as provided in paragraphs (2) and (3) of this Article, the appropriate load lines on either sides of the ship corresponding to the season of the year and the zone or area in which the ship may be shall not be submerged at any time* ***when the ship puts to sea*** (our emphasis), *during the voyage or on arrival".* Japan, is a member of the International Maritime Organisation (IMO) and a party to this Convention.

6.2.10 We consider that [redacted] s 9(2)(a) of the OIA has not directly addressed the issue which NZS raises which is whether the "TD's" Load Line can be submerged during loading operations while the vessel is secured to the SBM. We consider that the vessel is effectively at sea during its entire loading operation and because the vessel loads on an exposed coastline and lee shore, it would be wrong to submerge the load line at any stage. We therefore think that focusing only on the wording of the LLC does not address the safety issues that arise with the "TD". This opinion is based on the information available to the Cwaves auditors at the time of the audit; that it could take up to 18 hours to complete de-watering.

6.2.11 NZS, in their submission to the Committee Secretariat to the Transport and Industrial Relations Committee on the Marine Legislation Bill, at Paragraph 30, when quoting from the US Coast Guard Load Line Policy Notes, state at sub paragraph 28.1 "*Many nations exempt ships of unusual service (of which the TAHAROA DESTINY clearly is) from load line conventions in particular circumstances in recognition of their special nature".* We disagree with this statement. The "TD" may be different, but it is not "*of unusual service*"; The "TD" is classed as an 'Ore Carrier' by the vessel's Classification Society ClassNK. The de-watering system does not make it an 'unusual' vessel; if it did then this would be reflected in the vessel's Class Notation. This Policy Note refers to Float

On/Float Off (FLO/FLO) vessels which are classed as 'Heavy Cargo Carriers'. Other special service or unusual vessels include; Heavy Lift Vessels, Dredgers, Survey and Research vessels, Cable and Pipe Laying vessels, Dive Support vessels, Fishing vessels and Anchor Handling Tugs. The Class Certificate for these vessels will record their particular special service under 'Type of Ship'.

6.2.12 Further, in our experience, Protection and Indemnity (P&I) insurance policies provided by P&I Clubs usually require a vessel Owner to comply at all times with Class, Flag and International rules and regulations, else insurance cover is prejudiced. Similarly, Hull and Machinery (H&M) Underwriters would require the same and both may reject a claim if it was established that the vessel had, at the relevant time, operated with the Load Line submerged without the necessary authority to do so. In the event of a casualty, the vessel may then be uninsured. We therefore consider that the vessel's H&M and P&I insurers should be fully appraised of the situation.

6.2.13 Therefore, any technical or operational debate on whether the Load Line can be submerged has to be within the context of the regulatory and legal framework concerning Load Lines. In that context, approval would be required from both the vessel's Flag State and the Coastal state in which the port is situated (NZ). In our opinion, the vessel's insurers (P&I and H&M) must be also be informed and approve sought to ensure insurance coverage.

6.2.14 We note that regardless of the debate about the precise meaning of Article 12 of the LLC and the approvals required, the Harbour Master has exercised his powers to prohibit submergence of the Load Line. Therefore, no approval exists.

6.3 Hawser Peak Loads

6.3.1 The imposition of a 136 tonnes peak loading limit on the hawser appears to stem [redacted]

6.3.2 [redacted]

s 9(2)(b)(ii) of the OIA

[redacted]

6.3.3 In a detailed email dated 1st June 2014 from Kenny Crawford of MNZ to Harbour Master Richard Lough, who was seeking MNZ's views on the NZS request to raise the strain gauge limit, he advised as follows:

- *"there are only two occasions (in 19 loadings) when the strain gauge has exceeded 136 tonnes (V005 and V011) … this was considered to be more of a 'spike' than a prolonged exceeding of the limit";*
- *"V005 the "TD" left the buoy due to swell forecast";*
- *V012 it would appear that the vessel left the buoy due to swell forecast";*
- *V015, TD left the buoy twice due to deteriorating weather";*
- *The actual limiter on the operation of the vessel is only the significant wave height. Furthermore, the three times that the ship had needed to cast off have been prior to the Hs limit being reached – this is down to the forecasting system";*
- *Therefore, we cannot see the benefit of having any limit on the strain gauge, as the safe loading of the vessel is being controlled by the Hs restriction";*
- *Therefore, it would be our recommendation that the 136 tonnes limit on the strain gauge be removed altogether";*
- *While the information is really useful, and the use of the strain gauge should be encouraged, there is no benefit from setting a limit on this, so long as the Hs operational parameter is maintained".*

6.3.4 The strain gauge limit was removed from the operational parameters in June 2014. We are in agreement with this decision. Whilst we agree that the strain gauge readings are a useful monitoring tool, they should be used in conjunction with the other available tools (e.g. weather forecasts and wave rider buoy readouts) to ensure that all safety factors are accounted for and within the required limits. The strain gauge reading is, in effect, the 'end result' of a wide variety of variables coming together to create the hawser loads being measured. It is therefore impossible to determine if all of the relevant variables are within the required limits solely by assessing the strain gauge readings and it provides no, or very limited capability for assessing personnel safety.

6.4 Significant Wave Height (Hs) Mooring and Departure

6.4.1 We have been provided with a 'History of Port Operational Parameters' by NZS[60], and these are summarised below:

- *"1978 150,000 DWT Vessel operating at a maximum Hs of 4.1 m, wind 40 knots";*
- *"1990's Hs is 3.5m for berthing and 4.0m for departure";*
  TAHAROA EXPRESS
- *"2004 Berthing 3.0m Hs, departure 3.3m Hs, based on consensus from all parties and advice from pilot";*
  TAHAROA DESTINY
- *" 2012 (April) Berthing 2.6m, departure 2.9m, reason given is the arrival of the larger vessel and concerns of the age of the mooring system";*
- *"Berthing 2.6m Hs, departure 2.9m Hs, Harbour Master advises that the interim operational parameters are now permanent".*

6.5 Commitment to Safety at Taharoa

6.5.1 In a letter titled 'Harbour Master's Directions – Taharoa Destiny' to Captain John Ireland from NZS dated 28th May 2013, they state at paragraph 10 "*NZ Steel's continued commercial operation at Taharoa is dependent upon the safe operation of ships at the SPM and any shortcuts compromising that safe operation are unthinkable*". They go on to state at paragraph 92 "*The safe operation of loading operations at Port Taharoa should therefore rest clearly with the master who will make decisions in consultation with the pilot*".

6.5.2 In a letter titled 'NZSM's Response on your proposal to remove hawser strain gauge limits' dated 19th July 2014 addressed to Captain Richard Lough, NZS state "*The proposed parameters are nothing more than guidelines. Loading operations are always under the direction and control of the ship's master and the pilot. If there is any concern about safe operation, loading will cease even though the prevailing wind, wave height and hawser strain might be less than the applicable maximum*".

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[60] NZS Report, "Taharoa Port Operational Parameters", Version 2.0 (FINAL), dated 12th September 2014.

6.5.3 NZS have stated a commitment to safety, and recognition that the safe operation at Taharoa rests with the Master and Pilot. However, we consider that there are several factors that are inconsistent with these statements. In particular, these are:

i) Reliance over many years on a one-Pilot operation, for whatever reason, resulted in the port having no licensed Pilot available between November 2014 and July 2015 (section 7.3 discusses this in more detail).

ii) Submerging the load line as proposed by NZS, would, in our opinion, be an erosion of safety margins, as this reduces the under-keel clearance, freeboard and reserve buoyancy of the vessel.

iii) Operating the SBM with uncertified critical components over a long period of time.

iv) A maintenance and inspection schedule that does not meet normal industry best-practice 'standards' for critical components, such as the mooring chains and associated equipment and structural details.

6.6 Recommendations for Operational Limits

6.6.1 This section provides our recommendations to the Director of MNZ in regard to the operational limits for Port Taharoa.

6.6.2 We propose that the use of the word 'parameters' be discontinued, and that the word 'limits', be substituted when any reference is made to what used to be 'parameters'. 'Limits' is a standard term used in the offshore oil and gas industry.

6.6.3 Any Harbour Master's Direction should be titled 'Operational Limits for Port Taharoa', and should be endorsed with the wording 'The decision to moor at or unmoor from the SBM is always at the sole discretion of the Master in consultation with the Pilot, provided that they are within the Harbour Master's limits'.

6.6.4 In practical terms, we consider that this may mean that the Pilot/Master, at their discretion, temporarily decrease the operational limits based on the situation at the time, to ensure the safety of the vessel, crew, service vessel and the SBM.

6.6.5 During the period that the TAHAROA DESTINY is operating under an Exemption Certificate, we recommend that the operational limits as detailed in Annex A of the

Certificate issued by the Director of MNZ on 2nd February 2015 be applied. At the time of issue of this report, we understand that a licensed pilot is now in place and that a pilotage training program has been approved. Therefore, the exemption has now expired.

6.6.6 We recommend that for the first visit of the "TAHAROA EOS", provided that a fully trained and licensed Pilot is on board, that a structured training plan be in place and that dummy SBM training be used, plus reducing mooring limits at the discretion of the Harbour Master. For subsequent voyages, operating limits may also be reduced at the discretion of the Harbour Master.

6.6.7 There are three principal factors that must be considered in the definition of the operational limits. These are:

i) The integrity of the SBM;

ii) The safety of personnel;

iii) Navigational safety and pilotage.

6.6.8 Since SBM's are used almost exclusively for the loading of hydro-carbons, we have examined the typical operational limits and standards employed within the oil and gas industry, as this is the most appropriate source of relevant and comparable information. Clearly, the oil industry will apply stringent standards to mitigate the risk of oil pollution, which is a risk that is less significant at Taharoa due to the benign nature of the export product. However, the pollution risk from ruptured fuel tanks still exists, as we have detailed in paragraphs 5.3.7 – 5.3.15 above.

6.6.9 However, we consider that these 'standards' are applicable to the Taharoa terminal for the following reasons:

i) The safety of the vessel is to a large extent dependent on the integrity of the SBM, which must be able to maintain station given its location on an exposed, lee shore with potentially hostile conditions.

ii) The safety of personnel, both on-board the export vessel and the support craft, is highly dependent on the equipment they are required to use, the

loads on the mooring system, motions of the vessels and hence the weather conditions.

iii) The safety of the vessel and personnel are highly dependent on the skill and experience of the pilot to ensure that the connection to the SBM and disconnection is conducted in a manner that does not put either at undue risk. We consider it essential that the crew have a high level of competency, and are able to communicate effectively in English with the Pilot and others involved in the mooring and unmooring operation.

iv) The factors described above do not alter because the export product has altered.

6.6.10 Appendix E provides examples of operational limits typical of offshore terminals in the oil and gas industry. In our experience, these are also similar to terminals exposed to swell conditions, where the limiting conditions are often defined by the safe operability of the tugs and line handling boats.

6.6.11 Regarding the integrity of the SBM, in addition to oil industry standards, we have considered the following aspects:

i) The SBM is currently in-use with un-tested and uncertified critical components. From that point of view alone, an increase in the operating limits is impossible to justify.

ii) The SBM is 38 years old, which is well beyond its reported design life. It is reported to have been built with larger scantlings than specified and has been subject to upgrading in recent years for the anchors and chains. Based on the most recent inspections (out-of-water in 2009, in-water in 2014), the SBM hull appears to be in a fair condition.

iii) The SBM and associated mooring system contains a number of components and structural details that are known to be highly sensitive to fatigue damage. The inspection regime required by ABS has been carried out. However, the NZS inspection schedule is, in our view, significantly more relaxed than industry best-practice for fatigue sensitive components (chains stoppers, chains, Kenter shackles), especially when considering the future operation of the SBM. Fatigue damage is proven to be hard to predict accurately and

the fatigue analysis conducted to date is not valid for the future usage profile of the buoy.

iv) The reduction in hawser strength with use appears to be able to be predicted reasonably well and the hawser is retired based on defined limits (18 months or 28 moorings, whichever is first).

v) The mooring analysis conducted to determine the loads on the mooring system may give inaccurate results and the loads used to determine the anchor pull test requirements were in our opinion, incorrect. If the anchors are subject to loads higher than 170 tonnes, it is possible they will drag until they further bed-in. This may change the excursion of the SBM in heavy weather conditions, potentially allowing it to move some metres closer to shore.

6.6.12 Based on the above points and having considered the full breadth of documentation made available, in conjunction with the observations from our attendance at Taharoa, we cannot see any compelling reasons to increase the current operating limits from the perspective of the integrity of the buoy.

6.6.13 For any increase in the operating limits to be justifiable in the future, based on the future operating profile of the SBM, we consider that, as a minimum, an expanded and more cautious inspection and planned maintenance regime be implemented that meets industry best practice, in particular with respect to fatigue damage of critical components. It would be preferable, in light of the tripling of the usage profile of the buoy, that a new SBM be put in place, utilising the existing one as a spare.

6.6.14 Regarding the safety of personnel (both on the export vessel and service craft), in addition to oil industry standards, we have considered the following aspects, based on our observations at the time of our attendance:

i) The high degree of manual handling and intervention required for the Taharoa mooring connection / disconnection and slurry connection / disconnection operations, using the current hardware arrangements.

ii) The apparent regular need for personnel to work close to, under and next to loaded lines, suspended loads and snap back zones for these operations.

iii) The complicated arrangements for slurry pipe connection, securing and disconnection.

iv) The small 'zodiac' support craft used as a line handling boat and the agility and timing required by the crew of the MJ to transfer from the MJ to the 'zodiac' on a routine basis. This small vessel has no tow post for line handling / trailing and the crew are exposed to the elements. It requires continual agile boat handling to avoid larger waves and does not provide a stable platform for transfer of personnel to the SBM.

v) Our observations of the mooring and departure operations during our attendance at Taharoa and the informal feedback provided by the crew of the TAHAROA DESTINY, pilot and NYK representative. At times during these operations, the conditions were marginal to the current operational limits.

6.6.15 We consider that the degree of manual handling and human intervention required to complete the operations is too great and could easily have been 'designed out' with more appropriate equipment, such as that typically found on tankers serving SBM's world-wide. Therefore, we believe that the current operational limits are already at the higher end of the acceptable range and would not recommend any increase from the perspective of personnel safety.

6.6.16 We can foresee that the operational limits could be increased in the future on the basis of considerable improvements made to the equipment on the export vessels (see section 10.3) and the support craft, such that the exposure of personnel is considerably reduced. We note that this would require significant investment.

6.6.17 Regarding the safety of navigation and pilotage, in addition to oil industry standards, we have considered the following aspects:

i) The nature of the navigation and ship-handling required for the Taharoa SBM, its location and its exposure to weather;

ii) The feedback obtained during interviews and reported that pilot skill was considered to be a significant factor in averting previous incidents or reducing the extent of them. Whilst many of the causes of these previous incidents

have been mitigated, the remaining risks concerning pilotage must still be considered.

iii) The current status of the pilotage arrangements, licensed pilot availability, status of pilotage training plans and the time required to fully implement these.

iv) The dependency of the export and support vessel crew on the pilot for their safety.

v) The tendency of a vessel to 'fish-tail' (particularly in the ballast condition) in stronger environmental conditions (noting the operational limits), with the associated propensity to cause high hawser loads (in turn affecting the integrity do the SBM) and the ability to use the engine astern and lack of pull-back tug.

6.6.18 The Director of MNZ has already provided direction on the operational limits whilst there was no licensed pilot in place, as defined in the Exemption Certificate for s 9(2)(a) of the OIA [redacted] and s 9(2) [redacted] of the TAHAROA DESTINY. We agree with these limits.

6.6.19 When a licensed pilot is in place, then in light of the issues associated with the integrity of the SBM and personnel safety, we consider that the same operational limits should be maintained. An increase in the operational limits would only be justifiable in our opinion, on the basis of the improvements outlined in paragraphs 6.6.12 and 6.6.15 above in addition to the licensed pilot being in place.

6.6.20 In summary, it is our considered view that the operational limits should be as shown in Table 6.1 below:

ID	Safety Factor	Operational Limits	
		Current	Future
1	Integrity of the SBM	As per current limits imposed by Harbour Master	Possible increase, but only with significant improvements made to all 3 factors.
2	Safety of Personnel		
3	Pilotage		

Table 6.1 – Current and Future Operational Limits

6.6.21 The current operating limits are defined in Annex One of the Exemption Certificate No. 18 -EX-15 and are reproduced below in Table 6.2

	Berthing			Departure		
Phase	HS Maximum	Wind Maximum	Night Berthing	HS Maximum	Wind Maximum	Night Departure
Current Limits imposed by Harbourmaster	2.6m	30 knot	Prohibited	2.9 m	40 knot	Permitted
Training Voyages (Dummy SPM or partial)	2.0 m	20 knot	Prohibited	2.6 m	30 knot	Prohibited
Training Voyages (Actual)	2.0 m	20 knot	Prohibited	2.6 m	30 knot	Prohibited
Assessment Voyages	2.5 m	25 knot	Prohibited	[illegible]	30 knot	Prohibited
Restricted Voyages	2.5 m	25 knot	Prohibited	[illegible]	30 knot	Prohibited

Table 6.2 –Operational Limits as per Exemption Cert. No. 18 -EX-15

6.6.22 In addition, we recommend the inclusion of the following into the Operational Limits:

i) During Loading: Master and Pilot to continuously monitor and assess weather forecasts, and if there is a likelihood that the Port Operational Limits will be exceeded before completion of loading, stop loading, disconnect the slurry pipes, continue de-watering and 'stand-by' main engine ready to let go at short notice. The decision to stop loading must be made in adequate time to allow for dewatering[61].

ii) The hawser strain gauge is to be used as an Operational Guideline. If there are two pulls of 167 tonnes or more in a 30 minute period, Master and Pilot to assess weather conditions and whether to continue loading operations, and suspend loading if a single pull of 212 tonnes is experienced[62]. Note,

[61] We note that detailed procedures are contained in TM-6000-061 "Weather Monitoring and Response procedure". However, in addition to these procedures, we feel that an additional clause should be inserted in the 'Operational Limits' document as per that stated.

[62] These figures are based on the United Kingdom Offshore Operators Association (UKOOA) recommended figures of 15% and 19%, respectively, minus 10% for fairlead frictional loss, of the 'as-new', dry MBL of the hawser (1241 tonnes). These figures are, in our experience, commonly used by oil majors, responsible for SBM operations.

that these figures are based on the 'as-new' dry condition of the hawser and should be revised accordingly with each hawser usage.

iii) Main Engine to be kept on 10-15 minutes 'Notice' at all times. If Hs exceeds 2.5m then Main Engine to put on 'Stand By' and on Bridge Control ready for immediate starting. Main Engine not to be immobilised at any time without express permission of the Harbour Master.

iv) Cargo loading to stop and if appropriate the vessel to depart the SBM if any other conditions which in the opinion of the Master, in consultation with the Pilot and Port Captain/Port Manager present a risk to life, the environment or property.

7 CWAVES AUDIT OF PORT TAHAROA OPERATIONS

7.1 Introduction

7.1.1 We attended the Headquarters of New Zealand Steel in Auckland on 15th and 16th September 2014, as auditors delegated by the Director of Maritime New Zealand.

7.1.2 In addition to the authors of this report, attending throughout the two days were:

- s 9(2)(a) of the OIA [redacted], NZS;
- s 9(2)(a) of the OIA [redacted], NZS;
- s 9(2)(a) of the OIA [redacted], NZS;
- s 9(2)(a) of the OIA [redacted], NZS;
- s 9(2)(a) of the OIA [redacted], NZS;
- s 9(2)(a) of the OIA [redacted], NZS (part);
- s 9(2)(a) of the OIA [redacted], Master Mariner, Brookes Bell on behalf of NZS;
- Captain Kirk Mendonsa, Senior Technical Advisor, MNZ;

7.1.3 The main part of the audit consisted of a series of presentations by various members of the NZS management team. Each presentation represented a different section or aspect of their Safety Management System. Individual and group interviews and discussions were held with all members of the management team throughout the two days. We deal with some, but not all, of these individually, and not necessarily in the order that they were presented. We have indicated where appropriate when the various elements of the SMS comply with the New Zealand Port Marine Safety Code (NZPMSC, or PMSC).

7.1.4 **01 – s 9(2)(b)(ii) of the OIA [redacted]:** This initial presentation was an overall review of:

- Community and employment;
- Investment and expansion;
- The wider NZ Minerals mining and logistic activities;
- Wider BlueScope logistic activities;
- NZ Minerals and BlueScope management in context.

7.1.5 Although not strictly relevant to the audit, the following points were raised and discussed:

- Taharoa is the most exposed and remote place on the North Island of New Zealand;
- There has been a significant investment and expansion of plant;
- A second SBM is scheduled for 2016;
- NZS has a responsibility to the local community, not just to the corporation;
- NZS need to address anchorages and a VTS (Vessel Traffic System);
- Vessels have copies of the NZS procedures;
- The onshore facility at Kawhia where spare hoses and hawsers are stored;
- The support vessel "MARGARET J" is limited to a swell height of 3.5 metres when crossing the bar at Kawhia outbound to Taharoa.
- MNZ have issued a Solid Bulk Cargo Certificate in compliance with the International Maritime Solid Bulk Cargoes Code (IMSBC Code) certifying that 'Titanomagnetite', commonly known as ironsands, is a Category C bulk cargo. This certificate states that the voyage must not commence until the free water has been discharged;
- A training package detailing the properties and characteristics, including NZSs' and other laboratory studies of the ironsands;

7.1.6 We consider that NZS have exercised due diligence by taking a wide reaching top-to-bottom view of the whole mining, port and vessel operation.

7.1.7 **04 -** s 9(2)(b)(ii) of the OIA [redacted]: Defines the Regulatory Environment, and Accountability and Responsibilities of MNZ, Waikato Regional Council (WRC), Harbour Master, NZS and Vessel. The Harbour Safety Management System is the responsibility of WRC and MNZ, while the Port Safety Management System is the responsibility of NZS.

7.1.8 Currently the Port and Mine operating Procedures are integrated, with no clear distinction between them. We considered that the two should be separated and at the time of audit, NZS agreed to consider steps to distinguish the two.

7.1.9 **02 –** s 9(2)(b)(ii) of the OIA [redacted]**:** A review of major incidents involving the pervious vessel "TAHAROA EXPRESS", including tail shaft defect,

mooring hawser failure, main engine failure on approach to the SBM, two incidents of cargo shift and severe list, and hull cracks.

7.1.10 As a result of these incidents, NZS implemented the following mitigation measures: "Replacement vessel(s) Taharoa Destiny, and others, purpose built slurry carrier of iron ore design. Replacement vessels far less susceptible to this hazard due to iron ore carrier design with narrow holds thus minimising or eliminating the risk of cargo movement and ship's design provides enhanced buoyancy and vessel stability and ballasting capability. Tailored MetOcean forecasting system in place". **Complies with PSMC 2.2.3.1 (f).**

7.1.11 **05 –** s 9(2)(b)(ii) of the OIA [redacted]**:** This policy document is an overall view of the Crisis and Emergency Management and Incident Response, and describes the structure and responsibilities of the Crisis Management Team, Emergency Management Team and the Incident Response Team. **Complies with PMSC 2.2.3.2 (f).**

7.1.12 **05 –** s 9(2)(b)(ii) of the OIA [redacted]**:** Summarises the NZS status of risk management. Includes WRC/MNZ/NZS Risk Assessment for Taharoa Port, with Hazard Scenario Summary of 26 risks identified in the Arriscar Risk Assessment Review mentioned in section 2.1.4 of this report. Includes "*Risk updating and reporting, Monthly Risk report and Keeping the Taharoa Port manual up to date*". **Complies with PMSC 2.1.4.**

7.1.13 **05 –** s 9(2)(b)(ii) of the OIA [redacted]**:** Identifies four additional hazards, with fourteen existing risks impacted by the introduction of one or more vessels to the trade. Additional factors which the port operators have considered and will be implementing are grouped under the headings; Harbour Management; Support Facilities; New vessels; Asset Management and Resources. We consider that NZS have committed considerable resources into identifying the multiple impacts that the introduction of new vessels will have on the overall operation of not only the port, but the mine as well. **Complies with PMSC 2.2.2.1 (f).**

7.1.14 **05 –** s 9(2)(b)(ii) of the OIA [redacted]**:** Details of technical meetings between NYK and new vessel operators Cara Shipping. Implementation plan for 2nd vessel. The 'Port Role Clarity Matrix' tabulates the decision and compliance

chain and clarifies and defines the roles and responsibilities of the Master/Vessel, Pilot, Load Supervisor and Port/Shore. Four categories in the chain were defined as; Decides, Advises, Communicates and Complies. **Compliance with PMSC 2.1.4** where it states "*In addition to a periodic review, a special review may be required where for example, harbour operations change beyond the range allowed for in the development of the harbour safety management system*".

7.1.15 **07 –** s 9(2)(b)(ii) of the OIA [redacted] **:** NZS have plans in hand for implementing a Vessel Traffic Service (VTS) at Taharoa, originally intended to be implemented by March 2015 in anticipation of multi-vessel operations. NZS have advised that these plans will include installing an AIS (Automatic Identification System) transponder on the support vessel, and an AIS network receiver in the VTS Operation Centre. A VTS Manual will be compiled with details of the VTS system, area of control and communications etc. At the time of audit, we advised NZS on an informal basis that any VTS operators should be trained to appropriate international standards. Details of VTS Operator training courses could be obtained from the New Zealand Maritime School in Auckland. **Complies with PMSC 2.4.6**. At the time of issue of this report, we are not aware if this has been completed.

7.1.16 **08 –** s 9(2)(b)(ii) of the OIA [redacted] **:** This section deals with the schedule for inspection and maintenance of the buoy, floating hoses, hawser, links and shackles and anchor chain. The number of spares for each component is also stated. Maintenance of the whole system is managed by Marine Mooring Consultants (MMC), who also operate the support vessel "MARGARET J". The test certificates for the various components in the total mooring system were not all kept in the same place, with some being held by MMC and some by NZS. We recommended that all relevant certificates be located, identified and kept in one register under the control of the Senior Project Engineer, who has oversight and responsibility for the maintenance of the whole system.

7.1.17 At the time of our attendance at Taharoa the SBM was being operated with uncertified components, namely the elongated "D" shackles attaching the turntable to the triangle plate, and there is no record of when they were installed. We understand that these are to be replaced with certified shackles. The "D" shackle joining the hawser to the open chain links attached to the triangle plate is of 200 tonnes SWL.

7.1.18 As described in Section 4.6, although NZS have an inspection and maintenance regime in place, it falls short, in our opinion, of industry practice and is insufficient for the future usage profile of the SBM. NZS carry the requisite number of spare parts to replace worn out or damaged components in the whole mooring system. However, they have allowed the SBM to operate with uncertified components, which NZS have recognised and have committed to replace (Appendix D).

7.1.19 **09 – s 9(2)(b)(ii) of the OIA [redacted]:** NZS have put together a comprehensive presentation, made on 19th February 2014 to Cara Shipping, Owners of the new vessel "TAHAROA EOS", which is expected to enter service early in 2015. A summary of the Expected Outcomes from this presentation were:

- To have a clear understanding of its roles and responsibilities at Taharoa Port;
- Regulatory Environment for Taharoa Port;
- Accountabilities and Responsibilities at Taharoa Port;
- Overview and Orientation of Taharoa Port Standard Operating Procedures;
- Specific briefing on Taharoa Port Loading Procedures;
- Specific briefing on Taharoa Weather Procedures and systems;
- Review of Taharoa Port Hazard and Risk review;
- Initial discussion on the required Vessel Port Operational procedures;
- Initial Timeline of actions to be completed before first loading in April 2015.

7.1.20 In anticipating the risks for the new multi-vessel operation, NZS are fully aware that this is a new vessel, with new management and crew, and without the benefit of the experience and knowledge acquired by NYK over the years operating vessels at Taharoa, and which they were not willing to share with the Owners of the new vessel. A training package for the new vessel has been compiled with schematic diagrams enhanced by videos of the hawser and slurry pipe pickup and letting go procedures. s 9(2)(a) of the OIA [redacted], and we advised, that in our opinion, it is essential that he attend on board for at least the first two loadings of the new vessel. NZS have held meetings with the new Management and Senior Officers.

7.1.21 Any operational decisions concerning mooring and departing the SBM of the new vessel will be dependent on the status of the Taharoa pilotage at that time. If the pilotage operations are controlled by an Exemption Certificate issued by the

Director of MNZ, then the 'Training Voyages' operational limits (e.g. as set out in the Exemption Certificate, No. 18-EX-15 of 2nd February 2015) should apply. However, because the Master, Officers and Crew are not familiar with the Taharoa operation, we recommend that these operational limits apply for at least the new vessel's first three port calls. The Harbour Master and a suitably qualified MNZ Master Mariner should attend on board during the first three port calls, both at arrival and departure. The decision to perform one or more port calls, in addition to the first three port calls with the reduced limits, should be assessed and risk reviewed by the Harbour Master in consultation with the Master and Pilot(s).

7.1.22 It was at this stage of the presentation that we advised NZS that employing a Port Captain would be beneficial. We explained that such a person would be an ex-Chief Officer or Master well experienced in bulk carrier operations, and would be familiar with loading and ballasting and de-ballasting sequences. Knowledge of the bulk carrier codes, safety management systems, ship-handling and management attributes would come with an experienced officer. He/she would work directly with the Port Manager and the vessel's command and officers, and would assist them with the pre-arrival formalities relating to the cargo to be loaded, the expected weather for the loading period, and generally the whole port call from the mariners perspective.

7.1.23 The current Port Manager, in our view, appeared to be a capable manager, with a positive management style and a good grasp and knowledge of the NZS safety management system. However, we are of the opinion that a Port Captain, with appropriate bulk carrier experience either as Master of Chief Officer, would form the link between the Port Manager, NZS Management and the vessel, the support vessel and wider regulatory authorities like MNZ.

7.1.24 We consider that NZS have anticipated the additional risks, taken reasonable measures, and have made the necessary resources available for the first call of the new vessel. The third vessel will be operated by NYK and it was felt by NZS that there was an adequate pool of knowledge within NYK to manage this vessel.

7.1.25 **10 – Taharoa Port Navigational Aids**: Details of the service and maintenance procedures for the anchorage limit beacons, 20 metre contour line beacons, solar powered light and radar reflector on the SBM, batteries for the Waverider and TriAxys buoys, and the leading lights in Kawhia Harbour. All navigation aids

located offshore are maintained by Kawhia Marine Division. A hydrographic survey was carried out in 2015. **Complies with PMSC 2.3.1 Hydrography and 2.3.5 Aids to Navigation.**

7.1.26 **11 – Helicopter Operations**: This service is provided by Helicopters New Zealand (HNZ), who operate a 'Squirrel' single engine helicopter capable of carry five people, including the Pilot. The helicopter is tasked with transferring the Pilot and other personnel to and from the vessel, delivering under-slung loads of provisions, crew changes, vessel's Agent, Immigration and Customs personnel for the arrival formalities. The helicopter is not contracted for medevac operations.

7.1.27 The same helicopter is also used to transfer NZS personnel to and from their headquarters at Glenbrook, south of Auckland. The support vessel is the safety stand by vessel required by NZS during helicopter flights between the Operations Centre and the Export vessel, although we understand that this is not a New Zealand Civil Aviation Authority (CAA) requirement. There is a dedicated Controller stationed in the Operations Centre who handles communications and liaises all flights with the Pilot, export vessel and support vessel.

7.1.28 We advised NZS of our concerns about the helicopter not being available to the export vessel for medevac operations, and our recommendation is that efforts be made to engage with HNZ to discuss the possibility of including medevac operations in their contract. We pointed out that this situation may also affect their own personnel at the nearby mine site. The helicopter Pilot confirmed during our attendance at Taharoa that the 'Squirrel' helicopter currently in use is capable of taking a stretcher with the removal of the front passenger seat. There are no medical facilities at Taharoa, the nearest being at Kawhia which is over an hour's drive along narrow twisting roads, and in our opinion not a viable alternative to medevac to Hamilton. In case the 'Squirrel" is non-operational, or weather-bound, larger twin engine helicopters are located at New Plymouth and Hamilton.

7.1.29 As part of our attendance at MNZ, we were able to attend the Rescue Coordination Centre (RCC) at Wellington and subsequently advised NZS of their role, of which they appeared not to be aware. We explained that the RCCNZ was tasked with providing assistance and locating, delegating and directing a variety of resources like tugs, pollution control vessels and all-weather helicopters to the scene of any type of incident, accident or emergency. It was also within their remit to coordinate

with Maritime New Zealand, Coast Guard, Naval and Military, Police, Fire, Ambulance and Hospital services. They also have a wide variety of communications capability, including direct satellite, VHF and UHF links to any naval, merchant or fishing vessel and military and civilian helicopters and aircraft.

7.1.30 We advised NZS that sending a small delegation to RCCNZ at Wellington, would be beneficial to gain first-hand knowledge of the functions of this facility and its capabilities on a regional, national or international level.

7.1.31 We advised NZS that RCCNZ Wellington hold copies of Emergency Response Procedures for all relevant marine operators and would take on a co-ordination role in the event of an emergency. For instance, although NZS have lodged their Pollution and Oil Spill Response plans with the regional and national oil spill response centres, they have not lodged them with RCC. The NZS Helicopter Emergency Response Procedure requires them to call HNZ in Taranaki for assistance, whereas if they call RCC in the first instance, NZS will have access to not only any available HNZ helicopters, but those of other civilian and military operators in that, or other areas within a short flying time to Taharoa.

7.1.32 Although helicopter operations are not specifically mentioned in the PMSC, we consider that they fall under the category of marine services, which concerns the use of harbour craft and tugs. **Complies with PMSC 2.7 Marine Services**.

7.1.33 **12 – Kawhia Marine**: Kawhia Marine is a subsidiary company owned by NZS and is based in Kawhia harbour. They provide the following assets: s 9(2)(b)(ii) of the OIA [redacted] The management of the facilities, assets and vessels is contracted to Marine Mooring Consultants.

7.1.34 Kawhia Marine is audited by the Health and Safety Department of New Zealand Steel. All maintenance work at Taharoa is undertaken by MMC, but overseen by NZS. A separate diving contractor is engaged when underwater work is required on the SBM or the anchor chains. **Complies with PMSC 2.7 Marine Services.**

7.2 13 – Port Taharoa Training

7.2.1 This subject was covered in five separate presentations. Each presentation comprised a separate training package or module aimed at all levels of the operations staff involved at the port. Legal, compliance and detailed operational procedures concerning the mooring and loading operations were all included in these training modules. A Training Matrix has been created showing the progress of training for each of the personnel involved, and the sixteen training modules that will eventually comprise the total training requirements. At present there are six existing training packages, two under development and a further eight for development before 1st February 2015. We consider that NZS have taken all reasonable measures to ensure that their staff are adequately trained for their respective positions in the organisation. **Complies with PMSC 2.1.5.3 Competence Standards and 2.2.1.1 (d) Harbour Safety Policy.**

7.3 14 – Pilotage

7.3.1 At the time of our attendance at Glenbrook, there was only one full time Pilot, Captain Jim McMaster, who was the incumbent pilot there for over 30 years.

7.3.2 We understand that Captain McMaster had advised NZS of his intention to retire some years ago (prior to 2011). At that stage, it would be natural and logical for NZS to have immediately started the process of assessing the future pilotage requirements and succession planning for that eventuality.

7.3.3 There was only one other licensed Pilot for Taharoa, s 9(2)(a) of the OIA [redacted]. We understand however that he has only been available for one or two moorings a year, that he is not available for the training of new pilots, and that his licence has in any case expired, due to not maintaining proficiency at that port.

7.3.4 In 2011, NZS sent a scope of work to seven ports and pilotage providers in Australia and New Zealand to gauge interest in providing pilotage at Taharoa. Three of the parties contacted responded. The others either showed no interest, or were short of pilots themselves.

7.3.5 The Australian Reef Pilots (ARP) proposal was selected and their Pilot Training Programme approved by the Director of MNZ on 7th February 2014. It is apparent that there were a number of delays in reaching this stage.

7.3.6 Training of the first trainee Pilot commenced on 13th March 2014, and consisted of four 'observations', three 'approaches' and an 'approach and connection'. On the final approach to the SBM, the Master had to intervene and countermand an order for 'Full Astern'.

7.3.7 Captain McMaster expressed his dissatisfaction with the candidate, who he considered to be inexperienced and lacking the necessary ship-handling skills required to take a large ore carrier up to, and moor to the SBM.

7.3.8 In a letter entitled 'Training Progress to Date' concerning the trainee Pilot, to the Harbour Master, Captain Richard Lough dated 16h May 2014, Captain McMaster stated "*It has always been my contention that the role of Pilot /Berthing Master at Taharoa requires previous experience as a Berthing pilot...Taharoa is not the place to commence a career as a Berthing pilot...it is my view that attempting to train a Pilot without them having previous Berthing Pilot experience is failing to recognize and accept this basic fact. In effect, Taharoa is not for learners".*

7.3.9 We consider that this statement is a correct reflection of the situation regarding any pilot training programme for Taharoa. We do note however, that the availability of pilots with Cape-size berthing experience in New Zealand is very limited or nil.

7.3.10 The ARP Pilot Training Programme was revoked by the Director of MNZ on 20th June 2014. It appears to us that NZS considered that ARP were an appropriate pilotage provider, based on their 2011/2012 Pilot Review and selection process, which we understand to have been managed by someone with marine experience. However, this has not resulted in the sustainable provision of pilots with the appropriate experience. We have stated elsewhere in this report that the Director should recommend that NZS undertake the necessary evaluation to employ a Port Captain for the operations at Taharoa, to increase the marine experience 'on the ground'.

7.3.11 We were advised by MNZ in an email dated 27th November 2014 that Captain McMaster had retired as Pilot. We understand this to mean that he will also not be providing any training for potential pilot candidates during any hand-over period.

7.3.12 During our meetings and discussion on pilotage matters with NZS, we were surprised that NZS and ARP, had not searched for potential pilots further afield,

such as the UK North Sea, West Africa and Brazil, or even in their own local area at Taranaki, where FPSO operations are commonplace.

7.3.13 With the December 2014 call of the "TD" imminent, the Director of MNZ issued a Rule Exemption Certificate pursuant to Section 47 of the Maritime Transport Act 1994, dated 12th December 2014, valid for twelve months.

7.3.14 Under the conditions of the Exemption Certificate (EC), Pilots from the ETL Group at Taranaki were to attend with the Harbour Master and a MNZ Master Mariner with experience in the offshore tanker and Floating Production Storage and Offloading (FPSO) industry. The vessel's Master was also named in the EC. A second Exemption Certificate to include both serving Masters of the "TD" was issued on 2nd February 2015.

7.3.15 The ETL Group Pilots are tasked with mooring large tankers to the stern of a FPSO at the Taranaki offshore oil and gas terminals. In our opinion, this operation has many similarities to the Taharoa pilotage operation.

7.3.16 The similarities with the Taharoa operation are that vessels have to be brought up, in light ballast condition, at very low speeds to, and in line with, the stern of the FPSO. The hawser pickup procedure is also similar, involving the use of messenger lines taken to a dedicated winch which is used to pick up and release the hawser.

7.3.17 Control of the vessel in the final approaches to the FPSO will require the same ship-handling skills that are required at Taharoa, and we consider that experienced Pilots from Taranaki should possess these skills. We also consider that their Pilots would exercise a great deal of ship-handling caution, as the potential for damage and pollution are greater at Taranaki.

7.3.18 The main difference is that at Taharoa the Pilots from Taranaki would now have to familiarise themselves with the totally different approach to the SBM. This involves approaching the shore line from the northwest, and turning the vessel through nearly 180° to approach the buoy. In our opinion therefore the use of a tug for mooring purposes is not recommended at Taharoa due to the unusual approach to the buoy, and would not be of any benefit. Other factors that would affect the Taharoa operation are wind, and the need to keep the vessel outside the 20 metre

contour line. At Taranaki, being many miles offshore and in deep water, the approach to the FPSO can be made in a straight line, from any direction and from a long way off.

7.3.19 At Taranaki, the tug is secured to the stern of the tanker when the tanker is about 3 miles from the FPSO. Once the hawser is made fast, the tug keeps the SBM, FPSO and tanker in line, and is used to minimise fishtailing, or yawing of the tanker, which is more pronounced while the vessel is in light condition, and which imposes greater snatch loads on the hawser. In the offshore industry, this setup is used for both SBM and FPSO shuttle tanker operations.

7.3.20 The other major difference between the two operations, is that at Taranaki a break-away from the FPSO carries very little risk to the vessel or the operation. It will drift away from the FPSO and the attached tug can tow it clear. At Taharoa a break-away carries far greater risks due to the proximity of the shoreline and the need to take immediate action to avoid grounding.

7.3.21 We consider therefore that despite their experience with handling large vessels similar to the "TD" at Taranaki, any Pilots should in our opinion have a suitable training period at Taharoa due to the different circumstances prevailing there.

7.3.22 At the time of issue of this report, we have been made aware by MNZ that a licensed pilot is now in place (with conditions) and the Pilot Training Programme has been approved. Accordingly, the Exemption Certificate has expired.

7.3.23 In our opinion, the subject of pilot training and succession planning was not given the urgency or the relevant level of expert input it required. Whilst there are a number of causes, there was a significant delay in obtaining the approval of the Pilot Training Programme and we find it difficult to understand why the originally selected pilotage provider could not provide pilots of acceptable experience.

7.3.24 The New Zealand Port & Harbour Marine Safety Code, at section 2.5.3 states "*A pilot service provider must ensure the service is properly managed and take all reasonable steps to ensure a safe service is provided*". Annex C of the Guidelines to the Code at section 2.4.1. Pilotage states "*To develop and maintain pilotage procedures to achieve the objectives set out in this subsection*". In our opinion, the

requirements of the NZPMSC or the Guidelines, were not met by the original pilotage provider.

7.3.25 The New Zealand Port & Harbour Marine Safety Code, at section 1.1.6 states "*Under s 65 of the Maritime Transport Act 1994, a port company has a statutory duty to provide port facilities and services in a manner that does not cause any unnecessary risk or danger to persons or property*". In practical terms, this means that although NZS are not the pilot service provider, they must ensure it has a provider in place that does comply with the MTA.

7.3.26 In our opinion, NZS should have sought advice from the near-by offshore oil and gas industry at Taranaki, and should also have consulted bodies like the New Zealand Pilot's Maritime Association, who are members of the International Maritime Pilots Association (IMPA).

7.3.27 We recommend that pilot training at Taharoa should adhere to the provisions of the Training Programme, as now approved by the Director of MNZ. In our opinion, a number of moorings and departures undertaken during the training period should be overseen by the Harbour Master. This will provide oversight and feedback to the Director on pilot training progress, and provide assurance that the required competencies are being complied with. We also recommend that two or more pilots are trained up during this period, to take account of the two new vessels due to enter service in 2015. Having two or more trained and licensed Pilots would reduce or eliminate the possibility of single point of failure due to no Pilot being available.

7.3.28 Hands-on practical training on board the "TD" should in our opinion be supplemented by simulator training, which we understand is available at the New Zealand Maritime School in Auckland. We also recommend that consideration be given to manned model training, which, for example is available at Port Ash, Australia, where a model bulk carrier is one of the model vessels. The manned model course includes training on SBM operations. We consider that this is even more crucial for the second vessel, the "TAHAROA EOS", the crew of which will have no prior knowledge or experience with SBM operations.

8 SAFETY MANAGEMENT PROCEDURES

8.1 During our attendance in Wellington and Taharoa we reviewed thirty two Procedures relating to the port and safety operations at Taharoa. The TM (Taharoa Minesite) 6000 series of procedures deals with operational matters, while the 7000 series deals with emergency procedures. We have commented on those procedures that require revision of various aspects related to emergency contacts and procedures and hazard identification. Our comments and suggested insertions are in underline.

8.2 TM-6000-011 Taharoa Port Information:

8.2.1 **3.**[redacted] s 9(2)(b)(ii) of the OIA Under 'Hazard' and 'Key Risks' we have identified two that need revision:

8.2.2 "*Failure of the messenger line resulting in harm* or fatalities *to the export vessel or support crew".* Despite revised mooring procedures introduced on the "TD", this is still a high risk operation and the potential for fatalities still exist.

8.2.3 "*Support vessel capsizes resulting in harm* or fatalities *to crew*". If the support vessel's small inflatable work boat is not waterborne there are no other craft available locally at short notice to assist. Although the "TD" crew are trained in rescue operations using their Fast Rescue Craft (FRC), sea and swell conditions at the time may make it impossible to launch the FRC.

8.2.4 **4.**[redacted] s 9(2)(b)(ii) of the OIA Tender Vessel: "means the assisting Vessel for mooring, unmooring and line connection services to the loading vessel, and helicopter safety stand-by vessel".

8.2.5 **7.1.**[redacted] s 9(2)(b)(ii) of the OIA "There is no resident doctor or nurse. The nearest hospital is in Te Kuiti, about one hour's drive away over winding roads. Should medical treatment be required NZS Port Manager and Agent should be contacted, prior to mooring to enable arrangements be made with the company's doctor, some one and a half hours drive to Te Awamutu. Vessel's Master will advise on the urgency of the medical treatment required".

8.2.6 **7.16** [redacted] s 9(2)(b)(ii) of the OIA "*The Support Vessel provides berthing support to the Export Vessel and will standby vessels moored to the SBM for the entire loading, <u>and is also the helicopter stand-by vessel</u>*". Although the Civil Aviation Authority (CAA) do not require a safety stand-by vessel for overwater operations up to 100 nm offshore, we commend NZS for making it a requirement under their SMS for the Taharoa operation.

8.2.7 **7.22** [redacted] s 9(2)(b)(ii) of the OIA "In the event of fire on the ship and assistance is required Call NZS Operations centre VHF CH.7, <u>RCC Wellington and the Harbour Master</u>…".

8.2.8 7.23 Oil Pollution: "must be reported immediately to Operations Centre VHF CH 7, and all Tier 1, 2 & 3 contacts. For Tier 2 & 3 oil pollution incidents National Oil Spill Service Centre Auckland, and RCC Wellington must be informed.

8.3 [redacted] s 9(2)(b)(ii) of the OIA

8.3.1 7. Operations Centre Accountability: For Tier 1, 2 & 3 oil spills add: *<u>Port Manager and Port Captain</u>*. Change any references to *<u>MSA to MNZ</u>*.

8.4 [redacted] s 9(2)(b)(ii) of the OIA

8.4.1 **4. Responsibility**: "Provide preliminary advice to the relevant regulatory authorities, including MNZ, Harbour Master, Fire Brigade, Police, <u>and RCCNZ Wellington and Marine Pollution Response Service (MPRS), Auckland, as appropriate</u>".

8.5 [redacted] s 9(2)(b)(ii) of the OIA:

8.5.1 **4. Hazard/Risk Mitigation**: "The Master informs the Pilot, NZS, Harbour Master, <u>Port Manager and Port Captain</u>".

8.6 [redacted] s 9(2)(b)(ii) of the OIA:

8.6.1 **7.2.2**: "Notwithstanding the above, it is noted that the safe operation of the Terminal is governed by loads in the hawser rather than vessel deadweight and the above operating parameters may be increased provided that the hawser load monitoring indicates that expected loads will be within agreed limits". Delete and replace with: <u>Hawser load limits have been included as Port Operating Guidelines,</u>

<u>but they are one of several factors to be considered by the Master and Pilot when deciding to leave the SBM before completion of loading.</u>

8.7 [redacted]:

8.7.1 [redacted] "In addition to the ABS rule (20% UKC) Taharoa Port requires a safety contingent over and above the Minimum Manoeuvring Area – the Contingent Manoeuvring Area, defined such that the distance between the SBM and the Maximum Draft Shore Contour – <u>for the Vessel concerned of no less than 5 ship lengths</u>". No allowance has been made in this procedure for the increase in draft due to rolling and pitching, despite the inclusion of this in the 2014 ABS Rules.

8.7.2 The Minimum Manoeuvring Area procedure is based on the 2014 ABS Rules for Single Point Moorings, which state "*the manoeuvring areas must be the max buoy offset (+/- 12m intact, +/- 23m damaged) + hawser length + 3 x length of largest vessel*". In the case of the "TD" with an intact buoy this would be 8m + 60 + 873 = 941 metres, although NZS have allowed 990 metres.

8.7.3 The Swing Circle according to the ABS Rules is buoy offset + hawser length + ship length + 30m safety margin, or 412 metres, although NZS have allowed 440 metres. The Swing Circle is applied as a navigational aid for other vessels within the port.

8.7.4 The distance from the SBM to the 25m contour line is 1108m, or 3.81 ship lengths, and therefore compliant with ABS requirements. However, we consider that the controlling safety factor is the distance from the stern of the vessel to the relevant contour line, and not from the SBM, as we have discussed in section 5.3.6 above.

8.7.5 A 10° roll would increase the midships draft by 3.5 metres, and a 2° pitch would increase the bow or stern draft by approximately 5 metres. In the conditions that would cause the hawser or SBM to fail, i.e. high winds and swell, the vessel will roll and pitch, and the rolling severity will increase the further the bow falls off the wind and swell until it is on the beam when maximum rolling will occur. We do note however, that such severe roll and pitch motions are only likely to occur in conditions beyond the operating parameters of the terminal and that in the loaded condition when under-keel clearance is lowest, there will be less tendency to roll

compared to the ballast condition. During our attendance at Taharoa, the vessel was rolling to approximately 10 - 12° during the approach to the SBM (ballast condition).

8.7.6 Regarding water depth, the 2014 ABS Rules state "*requires a minimum under keel clearance of 1m after heave, pitch and roll are accounted for*". The vessel could be drawing 19.2 metres draft plus 5 metres for pitch or 3.5 metres for roll (say), increasing the draft to about 24-25 metres[63]. The 25 metre contour line is about 750 metres from where the stern of the vessel would be if it broke free of the SBM, which is about 2.5 ship's lengths.

8.7.7 In the arrival ballast condition and during the early stages of loading up to about 15 metres stern draft, we consider that the 20 metre contour line is a safe limiting line. This would put the stern of the "TD", when berthed at the SBM, about 970 metres, or 3.4 ship lengths from the 20 metre contour line. The same leading beacon line is used by the Pilot as the eastern-most limit during the north eastern approach and turn to the SBM, in water depths of 23m or greater.

8.7.8 Even assuming that the vessel reacts immediately to the hawser or SBM failure with an ahead engine movement, the stern will have moved inside the 30 metre contour line by that time. We consider that this is the best case scenario.

8.7.9 If both anchors were let go as soon as the vessel was free of the SBM, and a reasonable scope of chain paid out, say seven or eight shackles (190/200 m), this then reduces the distance from the stern of the vessel to the 25 metre contour line to about 500 metres. Being a sandy bottom, it is in our opinion poor holding ground, something that NZS have acknowledged in TM-6000-011, section 7.11 Anchorage where they state "*Vessels awaiting the berth are normally anchored about 1.5 nautical miles west north west of the SPM in poor holding ground*".

8.7.10 In our opinion the procedure should be revised to reflect the safe distance from the stern of the vessel when fully loaded to the 25 metre contour line. In the arrival, ballast condition and during the early stages of loading we consider that the 20 metre contour line is the safe limit.

[63] A more exact motions analysis would determine the extent of rolling and pitching in the appropriate sea-states, thus enabling a more precise determination of under-keel clearance and hence the safe depth contour.

8.8 s 9(2)(b)(ii) of the OIA [redacted]**):**

8.8.1 4. Procedure paragraph d); Include RCCNZ at Wellington on the Taharoa Emergency Contacts List.

8.9 s 9(2)(b)(ii) of the OIA [redacted]**:**

8.9.1 4. Hazard/Risk Mitigation: Add: Helicopter cannot operate if the Support Vessel is not on station.

8.10 s 9(2)(b)(ii) of the OIA [redacted]**:**

8.10.1 2. Policy, 3. Responsibility, 4. Safety: Mining Operations Manager should be replaced by Port Manager/Port Captain.

8.10.2 5. Procedure, 5.1 Safe Access to Ship: Add: In our opinion, the only safe means of access to the ship is by helicopter. At Taharoa, the vessel always lies head on to wind, sea and swell, and at no time except in near-flat calm conditions would it be safe in our opinion, for a small craft to come alongside for personnel transfer. The only way to safely transfer personnel is if the vessel puts the wind, sea and swell anything from three to five points off the bow to provide a 'lee' side, which is how pilot transfers all over the world take place. However, in our opinion this is not a practical consideration for the operation at Taharoa with the vessel moored to the SBM and the slurry pipes connected.

8.11 s 9(2)(b)(ii) of the OIA [redacted]

8.11.1 **2. Introduction, 4. Procedure**: Revise this procedure to reflect the role of the Port Manager and future Port Captain (if actioned) during a ship emergency.

9 ATTENDANCE AT KAHWIA HARBOUR

9.1 Kawhia – Marine Mooring Consultants

9.1.1 We attended at the premises of Marine Mooring Consultants (MMC) at Kahwia Harbour on Wednesday 17th September, where we met s 9(2)(a) of the OIA Owner and Manager of MMC.

9.1.2 We boarded the support vessel "MARGARET J" (MJ), met the Skipper and several of the deckhands and made a short tour of the vessel. The "MJ" is a steel hulled converted fishing vessel with a raised forecastle (see Figure 9.1).

Figure 9.1 - The "MARGARET J" working off-shore Taharoa

9.1.3 The vessel has been issued with a 'Minimum Safe Crewing Document' issued by MNZ, and which specifies the manning requirements depending if the vessel is operating in Inshore, Restricted Coastal or Coastal areas. While attending the export vessel at the SBM, the "MJ" carries extra crew to allow for rest periods and twenty four hours a day operations.

9.1.4 The "MJ" was audited by MNZ and issued with a 'Safe Ship Management Certificate' in 2010. This means that the operators have a Safety Management System, with the appropriate Procedures governing the safe operation of the vessel including emergency procedures. It is similar in structure and nature to the Safety Management Systems operated by vessels over 500 gross tons under the

International Safety Management Code (ISM Code). The vessel has, since our attendance at Kahwia, been audited by MNZ and issued with a Marine Operator Safety System (MOSS) Certificate under the new regulatory regime that has replaced the Safe Ship Management system. The new regulatory regime requires an Operator safety management system which documents all the procedures and processes for safe operations, survey and maintenance of the ship.

9.1.5 Departure from Kahwia Harbour is limited by a swell height of 3.5 metres across the bar at the harbour entrance. If the vessel cannot re-enter Kahwia Harbour due to high wind and swell conditions, then she can shelter and anchor behind Albatross Point in Arohaki Bay. The "MJ" keeps the local Coast Guard station informed of their movements at all times.

9.1.6 It is equipped with a towing winch aft, a knuckle-boom crane on the foredeck, and a small inflatable work boat of a 'zodiac' type, which is launched when the vessel reaches the SBM, and is used to stream out the export vessel's messenger line and the messenger lines for picking up the slurry hoses. The 'zodiac' is powered by a 30HP tiller controlled outboard motor. A spare motor is kept in the hold of the "MJ".

9.1.7 s 9(2)(b)(ii) of the OIA [redacted]. We observed this operation at Taharoa and noted that three crew members boarded the SBM from the 'zodiac', leaving only one person on board the "MJ". Similarly, 2 crew members remain on-board after the 'zodiac is launched to assist with mooring operations. The "MJ" is issued with a 'Minimum Safe Crewing Document' (MSCD) issued by MNZ, which states that there should be a minimum of four crew on board. The "MJ" is therefore not compliant with her MSCD and Marine Mooring Consultants should consult with NZS to resolve this situation.

9.1.8 The Skipper advised us that one his responsibilities was keeping the Pilot informed on the status and tension in the hawser messenger line during hawser pick up, an important function as a tight messenger line could result in it parting and endangering the support vessel, the rubber boat and the vessel's crew working on the forecastle of the "TD".

9.1.9 The vessel has a full hyperbaric diving decompression chamber installed in what was the fish hold. This is operated by a contracted diving team when underwater work or inspections are required on the SBM and anchor chains.

9.1.10 From the "MJ", we accompanied [redacted] on a tour of the MMC premises, where spare hawsers, floating sections of slurry pipe, spare shackles for the SBM and lengths of SBM anchor chain are stored. The two new spare hawsers are stored in a container to protect them from ultra-violet deterioration, and to keep them dry during their long periods of storage.

9.1.11 [redacted] was present throughout. We understand that [redacted] is responsible for overseeing all the SBM maintenance programmes and hawser lifetime management, and for keeping track of all the components in the system, along with their certificates. We requested a copy of all certificates for all the components in the existing system, and those for all the spares being kept at MMS. He stated that the certificates for the elongated "D" shackles on the SBM (see Figure 9.2), which attach the turntable to the triangle plate were not available, and it was not known if they were original, or replacements. The Working Load of the triangle plate was derived from its design and mass, and not from proof testing.

[redacted]

Figure 9.2 - Uncertified Elongated "D" Shackles on the SBM

9.1.12 We found the all the storage areas, workshops, office and facilities well ordered, clean and tidy. [redacted] explained that all the crew of the "MJ" were from the local fishing community and were very skilled and professional in the type of work that they are doing. He was aware of the need to recruit and train new crew due to the increase in shipping movements expected with the introduction of the second export vessel in May 2015, and a third later the same year. He concluded our visit by saying that in his opinion the Taharoa operation was unique, and was probably the most exposed CALM buoy in the world.

10 ATTENDANCE AT TAHAROA

10.1 The "Taharoa Destiny" – Hawser Pick-Up and Letting Go

10.1.1 We boarded the "TD" mid-afternoon on Wednesday 17th September and proceeded to the bridge where we introduced ourselves to the Master, [redacted] [redacted] the Pilot Captain Jim McMaster, and [redacted] the NYK representative.

10.1.2 We remained on the bridge to observe the approach manoeuvre up to about 500 metres from the buoy, when we proceeded forward to observe the hawser pick up operation. While on the bridge we took the opportunity of measuring the depth of the surf line, which was clearly visible on the Radar, using the variable range marker. We measured this to be 0.268 nautical miles, or 500 metres in extent (see Figure 10.1).

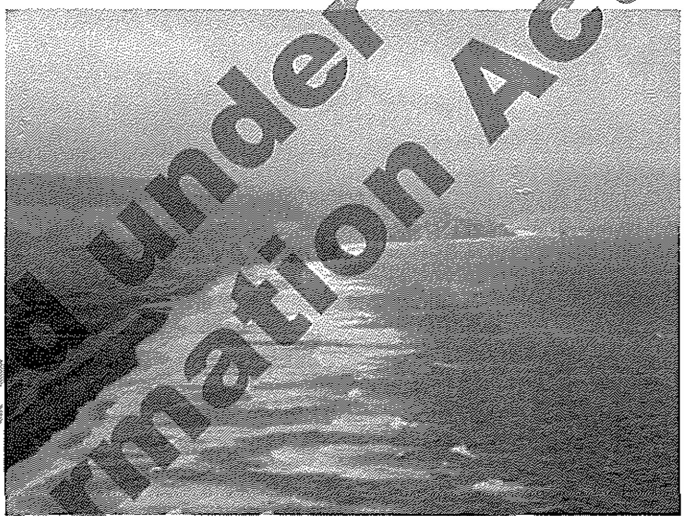

Figure 10.1 - 500 metre Surf Line at Taharoa

10.1.3 The ship's messenger line, which is on a dedicated winch located some five metres aft of the large stainless steel central towing lead, was being 'paid out' as the "MJ's" 'zodiac' carried the end towards the end of the hawser messenger line, where the ends of the two messenger lines were joined by a small shackle.

10.1.4 The slack on the messenger line was picked up as the "TD" moved ahead very slowly towards the buoy. The operation was being controlled by the Chief Officer, and we observed that his primary task was to make sure that there was no weight brought on the messenger by maintaining a very slack catenary. There were

several occasions when the ship's head fell off the wind, and he had to pay out the messenger in order to maintain a slack line. We noted that the winch controls were placed between the two drums comprising the forward winch, and although not in line with the messenger, would still come within the snap back zone if the messenger parted under strain. In our opinion two sets of winch controls should have been located in a remote location, ideally against the forward facing bulwarks two to three metres either side of the main centre lead.

10.1.5 When the hawser eye was between the waterline and the centre lead we noted that the winch drum was nearly full, with the risk of turns riding over the side of the drum. We also noted that the winch was slightly off-centre with the centre fairlead, which would account for bunching up on the winch drum (Figure 10.2). Crew members intervened on at least two occasions to push and pull the messenger one way or the other to prevent it overriding the side of the drum. Although there was only the weight of the partially raised hawser on the messenger line, we consider that this requirement to pull, push and guide the messenger on to the drum by hand was a high risk operation. The main risk was not from the messenger parting, but from slipping or stumbling and getting a hand or arm trapped under the messenger while it was being heaved up.

10.1.6 There is also a high risk of a turn of rope riding over the edge of the winch drum and jamming up between the winch drum and the supporting frame. Depending on the severity of the jam, it can be anything from a minor inconvenience to a major operation requiring tools and knowledge of how to clear the jam. The winch would be immobilised and hence, if the ship drops back or off the wind, all the weight could come on the messenger, which would part under that sort of strain. Unless the crew had been warned and cleared from the whole area, there would be a very high risk of serious injury or fatality resulting from the recoil or snap-back. See section 10.3 for recommendations for improvement.

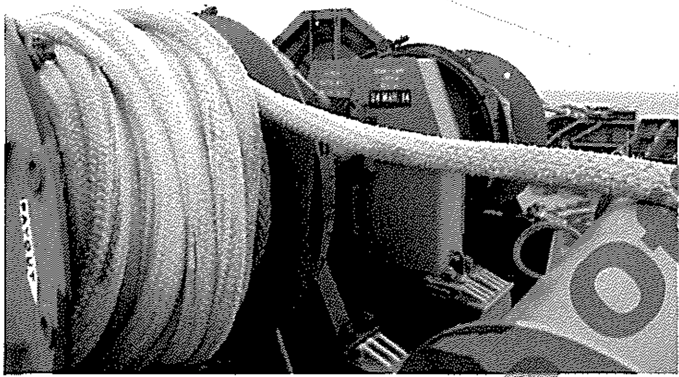

Figure 10.2 - Hawser Messenger on Winch Drum Bunching

10.1.7 During the approach to the buoy we were able to observe the effectiveness of the Schilling rudder. Although the approach to the buoy is head to wind and sea, with the very slow speeds involved in the approach, it is inevitable that the head 'falls off' the wind. This occurred three times, and on each occasion we could observe that hard-over rudder had been applied with a short burst of ahead engine movement, as the propeller wash was being thrust out at right angles to the stern. These corrections to bring the bow back in line with the buoy were accomplished without the vessel gaining headway, an important factor considering the close proximity to the SBM. This advanced rudder design has the same effect as a bow thruster at slow / zero speeds and we consider that it provides considerable improvements and risk mitigation compared to normal spade rudders.

10.1.8 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.3 - Set-up for Departure

10.1.9 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.4 - Adjusting the Side-Pull Mooring Ropes

10.1.10 s 9(2)(b)(ii) of the OIA [redacted]

10.1.11 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.5 - Hawser Eye Heaved Up but Not Clear Of the Mooring Post

10.1.12 s 9(2)(b)(ii) of the OIA [redacted]

10.1.13 s 9(2)(b)(ii) of the OIA [redacted]

10.1.14 We consider both the pick-up and letting go operations are high risk with too much crew intervention working at close quarters with large diameter messenger ropes and mooring lines and winches. s 9(2)(a) of the OIA [redacted] who was present during both

operations mentioned in passing that this was "*high risk to his crew*". See section 10.3 for recommendations for improvement.

10.2 The Slurry Pipe Pick-up and Letting Go Operations

10.2.1 The slurry pipes are two long sections of floating hose connected to the SBM, and after the vessel has settled to the buoy these are then free-floating down the starboard side of the vessel.

10.2.2 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.6 - Four-Roller Box Lead and 'Gallows'

10.2.3 s 9(2)(b)(ii) of the OIA [redacted]

10.2.4 [redacted]

10.2.5 [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.7 - Hooking Up the End of the Slurry Pipe

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.8 – The Top of the 'Gallows'

10.2.6 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.9 – The Damaged Gallows Ladder

10.2.7 s 9(2)(b)(ii) of the OIA [redacted]

10.2.8 [redacted]

10.2.9 [redacted]

s 9(2)(b)(ii) of the OIA [redacted] This is a high risk hazardous operation.

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.10 - Slurry Pipe Hang-off Chain with 1 Tonne Shackle – Inboard End

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.11 - Slurry Pipe Hang-off Chain – Outboard End

10.2.10 s 9(2)(b)(ii) of the OIA [redacted] s 9(2)(b)(ii) of the OIA [redacted] All the crew members involved are exposed to a high risk of potential injury for the duration of the operation.

10.2.11 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.12 - Remote Release Snap Block Attaching to End of Slurry Pipe

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.13 - Slurry Pipe Disconnected and Suspended by Crane

10.2.12 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.14 - Releasing the Slurry Pipe Hang-Off Chains

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.15 - Releasing the Slurry Pipe Hang-off Chains

10.2.13 s 9(2)(b)(ii) of the OIA [redacted]

s 9(2)(b)(ii) of the OIA [redacted]

Figure 10.16 - Releasing the Slurry Pipe

10.2.14 We consider that the whole operation of picking up and releasing the slurry pipes is very high risk. During our attendance, the Chief Officer conceded in discussion that "*this was as easy/good as it gets*", and "*usually stuff bouncing around all over the place*", while s 9(2)(a) of the OIA [redacted] was of the opinion that "*the slurry pipe connection is big headache for us – difficult – risk for crew*". In particular, we observed:

- Crew were working under heavy suspended loads at all times;
- Working close to and under the slurry pipe pick-up messenger line which was under tension;
- Climbing up the gallows and leaning out and attaching the crane hook without safety harness or fall-arrester gear;
- Operating the crane off-vertical;
- Operating chain blocks horizontally with the high potential for jamming them, which we observed;
- Leaning outboard under the rails to attach the heavy snap hooks to the support chains, and;
- Leaning out and under the rails to release them.

10.2.15 Whilst there was clearly some examples of poor personal safety measures taken, much of the issues we observed and have identified here were due to the design of the equipment on the vessel.

10.2.16 The mixture of equipment in the slurry pipe support chain setup, with widely different safe working loads also gave us cause for concern. Snap hooks were 15 tonnes, the chains 10 tonnes, the chain blocks 10 tonnes, the oval links 10 tonnes, but in the middle of this set-up we found a one tonne shackle, which we understand to have failed on a subsequent voyage. In our opinion this rendered the whole set-up unsafe.

10.2.17 We would recommend that the whole slurry pipe pick-up and letting go operation should be re-thought with the prime focus being on minimising exposure of the crew to all the hazards mentioned in section 10.2.14 above.

10.2.18 During the whole operation of hawser and slurry pipe pick up and letting go, we were able to observe the "MJ's" 'zodiac' at work. The crew are highly skilled and obviously very used to this kind of close-quarters work with lines and hawsers. However, as a line-handling boat and helicopter stand-by rescue boat, we consider that it is totally unsuitable. For such an exposed and potentially hostile location, we consider that it is too small and too light to provide a sufficiently stable platform to its crew, and provides no protection from the sea or elements. It has minimal rescue capabilities, and has an outboard motor with an exposed propeller which would render it extremely hazardous to any persons in the water.

10.2.19 Figure 10.17 shows some examples of typical line-handling vessels employed at offshore terminals.

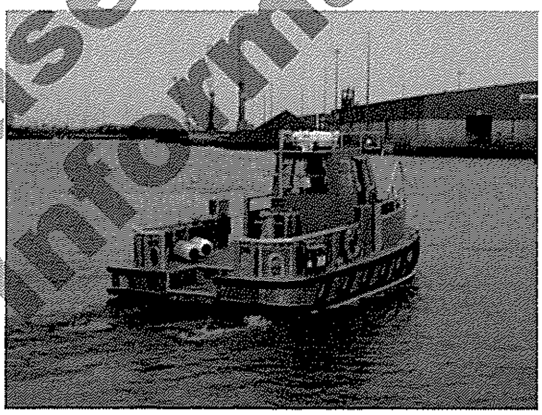

Figure 10.17 – Typical Offshore Line Handling Boats

10.3 Comment on the Hawser and Slurry Pipe Operations

10.3.1 In the short term, we recommend that consideration is given to the following suggestions for improvement, noting that a number of these recommendations would have to be implemented by the vessel owners / managers:

i) On the slurry pipes either install longer hang-off chains on the first flange to avoid the crew having to lean out and under the railings to make them fast or release them, or move the first flange further inboard by installing a shorter first section of floating hose. This would be the preferred option.

ii) Replace the clamping band screw-down system with a simple 'over-centre' lever operated system.

iii) Replace the chain blocks with simple lever operated, cable ratchet lever hoists. They are a simple and one-man operable tensioning tool, and they can be operated horizontally.

iv) s 9(2)(b)(ii) of the OIA [redacted] at present is large, heavy and cumbersome. A smaller remote release snap hook could be sourced. This hook could be tripped by a strong light lanyard operated from the deck. Replace s 9(2)(b)(ii) of the OIA [redacted] at present with a short high modulus nylon strop, which is much lighter, softer and far more flexible.

v) Install quick release, 'Camlock' fittings to both slurry pipe manifold flanges. This would eliminate the requirement for anything up to six crew members to be working close to suspended loads and underneath the slurry pipe flanges while they connect, and disconnect the slurry pipes, and hook up the remote release block.

vi) For the hawser pick-up and letting go operations, consider replacing the current set-up of using mooring ropes either side of the messenger to guide the hawser eye to, and away from the mooring post. One such device is a 'griphoist', which is a small lever operated winch that uses self-gripping jaws to move rope or wire through the winch. They are small, portable and lightweight, and are ideal for one-man operation. Attachment to the messenger would be by small made-on-board one metre long strops, which

would mean easy hook-on and off and the crew member would not have to get too close to the messenger.

vii) Replace the current s 9(2)(b)(ii) of the OIA [redacted] which will prevent bunching and crowding on the winch drum, and will be easier for the workboat crew, and ship's crew to handle. We understand that post-audit trials were made with a 45mm diameter 'Dyneema' rope were made, but was not favoured by the vessel's operators, and the large diameter pick-up rope restored for operations post V26.

10.3.2 In the longer term, we recommend that consideration be given to the following suggestions for improvement. These suggestions would, in some cases, require structural modifications to the vessel and significant investment.

i) Replace the existing mooring post on the vessel with standard offshore mooring arrangements. This could be either a quick release hook, with remote emergency release or a standard chain stopper and chafing chain arrangement. A load cell can be incorporated into either arrangement and there are numerous makes on the market. We understand that NYK, NZS and the Pilots would not support chafing chain type arrangements, and that NZS has presented a full Hazard and Risk Review to MNZ on the use of soft eye against chafing chain. Retaining the soft eye mooring hawser does however mean that there is no emergency release in case of an emergency that would require it, and this risk must be fully realised and taken into account by NZS, MNZ and the vessel operators.

ii) The diameters of the ship's hawser messenger, and the hawser messenger itself are too large. They should be replaced with one smaller diameter high modulus rope, which will eliminate bunching or riding up of the messenger on the hawser pick-up winch. This single messenger would be about 200 metres long, and would be retained by the vessel. With this setup there is no need for a long dedicated messenger attached to the hawser, although a short nylon 'tail' or pickup rope on the hawser will still be required to facilitate connection to the ship's messenger line. This pickup rope need only be long enough that, when departing the SBM, it reaches from the winch to the water and the slack comes on it when the hawser is fully afloat, and not part

suspended by this pickup rope. The three or four turns of light rope are then cut through at the joint between the pickup rope and the ship's messenger. When the export vessel leaves the SBM, either under normal or emergency conditions, there is no need for the Pilot or Master to worry about 150 metres of heavy messenger rope floating directly downwind from the buoy and obstructing the departure with the potential of fouling the propeller.

iii) For the slurry pipe pick up and release operations consideration should be given to ensuring that they can be picked up and released without the need to use the crane, or send men up the gallows to release the pick-up hawser and hook on the crane slings and hooks. A series of four-roller box fairleads are already in place directly in line with and behind the hose support cradles, which are rounded between the ship's side and the horizontal section of the cradles. There is a mooring winch between number one and two hatches which is in-line with the four-roller box fairleads. Consider heaving the slurry pipes up and onto the cradles or chutes using this arrangement. Additional rollers or guides may be required to ensure a smooth and uninterrupted direct pull between the ends of the slurry pipes and the manifold flanges. The radius between the horizontal section of the pipe cradle and the ship's side may need to be lined with a non-slip surface such as stainless steel, or Teflon, to minimise friction.

iv) High modulus polyethylene fibre ropes should be used for this purpose. They are light weight and high strength and will float, and for instance a 16mm diameter rope of this type would have a breaking strength of about 20 tonnes. A 19mm diameter rope, which is half the size of the mooring rope currently used, would have a breaking strength of about 28 tonnes. A light weight line of this size would be easily manageable by the crew, and would remove the need to run what is in effect a small mooring rope from the forecastle and over the top of the gallows, and for a crew member to climb the gallows to hook on the crane and release the messenger. A small, lightweight high tensile 'Crosby' type snap hook could be spliced into the end and would not weigh the end of the line down to the point of it sinking. But if it did then a short flotation collar could be attached to the end of this rope and would not impede safe and ease of handling.

v) Install marine breakaway couplings at the inner end of the slurry pipes. Although there is no pollution risk associated with the ironsands slurry, these couplings would eliminate the need for the crew to release the slurry pipes in any sort of emergency, and would save considerable time in this otherwise high risk operation.

vi) The 'zodiac' on the "MJ" should be replaced with a more suitable work-boat for offshore line-handling, preferably with water jet propulsion. The boat should be fitted with a short towing post on the transom for streaming out the hawser messenger, and suitable rescue equipment. This would include a portable searchlight, two buoyant rescue quoits, thermal protective aids and a first aid outfit.

10.3.3 The set-up and hardware arrangements on-board the TD were of some surprise to us and it appears that there has been no attempt to consult operators of FPSO's and SBM's in the offshore oil and gas industry, or even NYK, who operate a fleet of 32 VLCC and 3 Aframax tankers and should have the requisite experience in-house.

10.3.4 We consider that the whole ship-board hawser and slurry pipe system should have been designed and constructed to offshore tanker industry standards. In our opinion, this consultation should have been done during the design and concept stage for the "TD". Then, the numerous high risk activities observed during the operation could have either been eliminated, or reduced to ALARP levels.

10.4 Tug use at Taharoa

10.4.1 To our knowledge, the majority of SBM and FPSO operations around the world employ a pull-back tug on the stern of the off-take vessel. The tug itself would, typically, be an Anchor Handling and Tug Supply vessel (AHTS) of about 85-100 tonnes Bollard Pull. The purpose of such a tug is to prevent the vessel fish tailing or yawing while on the buoy, which is a major cause of snatch loading on the hawser. It provides a steady pull and keeps the buoy, export vessel and tug in a straight line.

10.4.2 It is acknowledged that significant fish-tailing has not presented a problem to date under the current Operational Limits. However, if the Operational Limits were to be

increased at some time in the future, then any tendency for fish-tailing and hence snatch loading would need to be reviewed.

10.4.3 With regard to the specific operation at Taharoa, the main problem with employing a pull-back tug would be the length of the tow from the SBM to the tug and its proximity to the shore. Since the prevailing conditions will tend to align the vessel inshore of the SBM, the likely length of the tow[64] would place the tug unacceptably close to the surf line during its normal operation. The tug would need to be large and powerful enough, to haul the stern of a fully loaded export vessel around into the prevailing swell and wind, before the export vessel sets down too far towards the 25m contour line.

10.4.4 The daily charter rate for a suitable tug would be very high due to world- wide demand for them. This type of tug would, in our opinion, not be available for sporadic short-term hire, even if one was available in the Taranaki/Auckland range. Any operator of these vessels would require a long term time charter or commitment.

10.4.5 The cost of keeping a tug of this type on permanent stand-by at Taharoa for one vessel would therefore be unjustified. However, with a second and third vessel due in 2015, we recommend that the Director of MNZ consider requiring NZS to undertake a viability and feasibility study on the use of a tug for emergency response purposes.

10.4.6 A suitable tug (of an ocean-going or AHTS type) would be equipped with a Fast Rescue Craft (FRC), with a crew trained in rescue techniques, including events like helicopter ditching, man overboard from a drill rig, and so on. The FRC's are constructed and fitted on these vessels for that purpose. They are fit for purpose, whereas in our opinion the 'zodiac' used by the "MJ" is not, as described in section 10.2.18 above.

10.4.7 The main consideration for using an emergency response tug at Taharoa, especially in view of three vessels using the facility, would be as an emergency towing vessel in case of deteriorating weather and vessel breakaway from the

[64] With a 75m hawser, a 290m vessel (overall length of the TD) plus a tug tow wire of several hundred metres (expected to be 300 – 400 metres minimum in order to be effective), the total tow length is likely to be at least 700 – 800 metres.

buoy, or incapacity of the vessel itself due to engine failure, fire or other emergency. The benefit of having a tug on standby in case of engine failure either during mooring or unmooring, parting of the mooring hawser should be considered in the context of possible preventative or mitigating steps. These would include operating within the weather limits, having the engine ready for use at short notice, and having both anchors ready for letting go at all times.

10.4.8 Although we consider that the probability of the vessel breaking away from the SBM to be very low, the outcome is potentially catastrophic[65] and the use of a tug for emergency response could further mitigate these risks, in addition to other mitigating steps such as adhering to the weather limits, testing of the main engine prior to mooring, having the engine on '10 minute' standby and having both anchors ready for letting go at all times.

[65] The term 'catastrophic' is used in the same context as that provided in para 5.3.8.

11 INTERVIEWS WITH KEY PERSONNEL

11.1 General

11.1.1 The following persons were interviewed during our attendance at Taharoa and MNZ's offices. Their comments have been considered in drawing our conclusions:

i) Captain Jim McMaster, McMaster Marine; Incumbent pilot at the time of the on-site audit;

ii) Captain John Ireland, Port of Taranaki; Former Harbour Master at Taharoa;

iii) Captain Richard Lough; Current Harbour Master at Taharoa;

iv) Helicopter Pilot, Helicopters New Zealand; Pilot for helicopter support and personnel transfer at Taharoa;

11.1.2 With regards to interviews with other key personnel, we make the following observations:

i) A formal interview with the Master of the Support Vessel was felt by the Auditors to be unnecessary, as the relevant matters were discussed during our visit to the vessel and the warehouse facility at Kawhia. We have reported elsewhere in this report any pertinent points that arose in these discussions.

ii) Considerable time was spent with NZS personnel at their Glenbrook facility and subsequently at Taharoa. Formal interviews were therefore not felt to be necessary as the relevant matters were discussed and points raised on a continual basis, which are reported throughout this report.

iii) In accordance with the Terms of Reference for the audit (Appendix A), our role on board the "TD" was as observers, not as auditors and therefore we did not formally interview the Master, crew or the NYK technical staff. Where appropriate, we have reported particular aspects of the discussions held during our visit on-board.

12 CONCLUSIONS AND RECOMMENDATIONS

12.1 The Port of Taharoa

12.1.1 The Taharoa SBM is exposed to the open sea and can experience hostile wind and wave conditions, including long period swells from the Southern Ocean. There is minimal infrastructure, support or emergency facilities available on-site (at sea or on land) and support would need to be sourced from other locations such as Hamilton or Taranaki.

12.2 The Export Vessel(s)

12.2.1 The TAHAROA DESTINY is a very capable and well-found vessel that provides considerable improvements and risk mitigations compared to the vessels previously employed for the export of Iron-sand from Taharoa.

12.2.2 The vessel appears to be well managed and within NYK, there is a considerable body of experience of the Taharoa operations.

12.2.3 However, the hardware and arrangements for the hawser and slurry pipe connection and disconnection needs improvement. The current arrangement for the whole connection and disconnection operation puts the crew at considerable risk of personal injury and potential fatality, due to the high level of manual intervention required and the need to work in close proximity to loaded lines and suspended loads.

12.2.4 The new vessels for the Iron-sand export trade from Taharoa are understood to be based on the design of the TAHAROA DESTINY. It is therefore likely, that the same mistakes will be repeated, unless the design of the mooring and slurry pipe connections are changed.

12.2.5 The second vessel, the TAHAROA EOS is to be operated by Cara Shipping, China. The crew and management of Cara Shipping do not have the previous experience of the Taharoa operation, s 9(2)(a) of the OIA [redacted] The arrival of this second vessel at Taharoa will present a significant additional risk to the safety of the operation until this experience is gained.

12.2.6 NZS have, as far as normal shipper-port-charterer-owner contractual relationships allow, been pro-active in engaging with Cara Shipping and NYK to mitigate this risk through training and incorporating lessons learnt into their procedures and some aspects of the vessel design. However, there is still an inherent heightened risk until sufficient experience is gained at Taharoa by the Cara Shipping crew.

12.3 The Taharoa SBM

12.3.1 The Taharoa SBM is 38 years old and is of a standard CALM buoy design, typical of that used in the offshore oil and gas industry. The buoy has not been 'classed' and is operating beyond its original design life of 20 years.

12.3.2 The buoy has been subject to a number of recent upgrades in order to extend its life. An extensive package of work has been commissioned by NZS to assess the mooring loads and structural capacity of the buoy, as well as inspection by ABS Consulting to certify its Fitness for Purpose.

12.3.3 The mooring analyses conducted for the buoy were conducted to the applicable industry standards. However, in our opinion, there are a number of potentially critical flaws with the latest analysis (INTECSEA 2013) upon which NZS have relied. These are:

i) Use of sea-states that are un-representative of the actual conditions recorded on-site at Taharoa;

ii) The majority of the analysis was conducted for the wrong hawser specification;

iii) The use of the Survival condition (no vessel on buoy) to determine the maximum mooring loads, which gives lower loads than the design Operating condition (vessel on buoy).

We recommend that the sensitivity of the results to these factors be assessed, in order to provide confidence in the outcomes.

12.3.4 Based on the analyses presented, the majority of the components of the Taharoa SBM meet the required safety factors according to the API-RP-2SK standard. There are, however, two significant exceptions to this:

i) The four special, elongated D shackles used to join the tri-plate to the turntable are of unconfirmed Minimum Breaking Load, Safe Working Load, proof-loading and age. NZS have not located any certification for these components and have therefore been operating the SBM with un-certified critical equipment. NZS have committed to replace these items.

ii) The maximum mooring load values obtained from the mooring analysis were used to define the pull-test loading for the installation of the anchors. The error described above in para. 12.3.3 (iii) means that the anchors were not installed with the required proof loading to satisfy the applicable standards (API-RP-2SK and ABS Rules). There is therefore a risk, should the SBM experience higher anchor loads, that the anchors may drag until they embed deeper. This will allow the SBM buoy to move nearer the shore by a few metres, allowing for the prevailing conditions

12.3.5 The surveys and inspections of the SBM carried out since 2009 have shown that, in general, the buoy is in a fair condition for its age and usage. However, a number of specific areas have been identified in the various inspections as requiring specific attention and it has not been confirmed if all of these have been completed. The items still outstanding (or requiring ongoing efforts), to our knowledge, are:

i) Formal confirmation that the SBM complies with the damage stability requirements, considering the deviation from the original specification of foam filling 3 of its 6 compartments.

ii) Continued, regular, close-up inspection of the chain hawse box structures that showed evidence of cracking in 2012. We note that the inspections were carried out in the 2014 ABS surveys.

iii) Non-destructive examination (NDE) of specific fatigue sensitive areas as identified by INTECSEA and ABS (to be completed by 31st May 2015). This was also completed in 2014, but excluded some areas from NDE due to inaccessibility.

iv) Full close-up inspection and NDE of all fatigue sensitive areas and rectification of the 13 structural details listed by ABS by 31st December 2016. This includes items listed in the 2012 ABS survey.

12.3.6 The fatigue analysis conducted is, in our opinion, not valid as it is based on incorrect input data and assumptions. Specifically, it is based on the older, 21 inch hawser which gives lower loads, it did not assess critical equipment such as the tri-plate and is based on a single vessel operation, not three vessels. It therefore under-estimates the fatigue damage predicted and hence will over-predict the life of the relevant components.

12.3.7 The inspection regime of NZS that was presented to us is broad in its scope and provides defined intervals for particular inspections and maintenance. However, it specifies a longer interval than the industry best practice and some standards for offshore mooring systems in critical areas, such as the mooring chains, Kenter shackles and chain stoppers and associated structural details that are fatigue sensitive. The NZS inspection schedule states that a full chain inspection should be undertaken every 3 years, compared to a minimum of every 5 years as per API (API–RP-2I), but annually as recommended by OCIMF. In light of the fatigue sensitivity of these components and the future increased utilisation of the buoy, we consider that a more stringent inspection period should be considered for key components.

12.3.8 NZS have employed a sensible approach to management of the mooring hawser that is based on reasonable engineering principles. By testing the hawser after each retirement, they potentially have a unique data set from which to predict hawser life. However, in our opinion, the predictions must be used with caution as it is still early in the process of this approach.

12.4 NZS Risk Assessments

12.4.1 The Hazard Identification and Controls Adequacy Workshop complied with, and adhered to the principles and methodology equivalent to that set out in the 'Final Guidelines for Port & Harbour Risk Assessment and Safety Management Systems'.

12.4.2 The methodology used to identify the eleven (11) Risk Events which fall into the ALARP category complies with the 'Guidelines'.

12.4.3 The methodology used to identify the five (5) Risk Events which fall into the Heightened Risk category complies with the 'Guidelines'. However, we have a

number of comments on the descriptions of these risk events, which we have described in Section 5.2 of this report. Additionally, we have identified areas where the risk assessment has not, in our opinion, properly accounted for the actual operations as they are conducted and the risks generated. These are described in Section 5.2 of this report

12.4.4 The Risk Assessment Criteria and Risk Assessment Review were in compliance with the Port & Harbour Risk Assessment and Safety Management Systems Guidelines.

12.5 The Load Line Issue / Use of the Over-draft Condition

12.5.1 Although the Taharoa Offshore terminal is a port, there is no harbour, sheltered headland, estuary, river or port protected by breakwaters, with the nearest Place of Refuge some 12 hours steaming away. It is an exposed terminal and in our opinion, cannot be considered as a port in any practical sense.

12.5.2 The "Overdraft at harbour condition" Certificate issued by the Classification Society NKK is not a permission to overload the vessel, nor is it an Exemption Certificate. It is a statement regarding the vessel's structural integrity in the conditions defined on the Certificate.

12.5.3 The vessel's Flag State, Japan have acknowledged that the load line shall not be submerged at any time when the ship puts to sea and they have not issued an International Load Line Exemption Certificate, nor applied any endorsements to the vessel's standard Load Line Certificate.

12.5.4 The load line should not be submerged at any time during the operation at Taharoa, as this will contravene the International Convention on Load Lines, and would class the vessel as potentially unseaworthy[66].

12.5.5 For the export vessel to depart the SBM, it does not have to have completed loading, nor does it have to have commenced the voyage.

[66] 'Unseaworthy' in this context means in the legal sense.

12.5.6 The "Taharoa Destiny" is not of a special nature, nor is it of special service. It is classified by NKK and the Flag State, Japan as an 'Ore Carrier'.

12.5.7 Based on the information available to us, we do not consider that there is any safe and reasonable basis for submerging the Load Line at Taharoa, or any other exposed offshore terminal. To do so, would further erode safety margins.

12.5.8 We are aware of a 'compromise proposal' put forward by NZS with regard to the issue of submergence of the Load Line. It is beyond the scope of this report to comment on the proposal. However, we would highlight that any potential submergence of the Load Line requires the necessary formal approvals from the vessel's Flag State, the Coastal State and the vessel's insurers. We note that the current Harbour Master has exercised his powers to prohibit submergence of the load line in NZ waters and as such, no approval exists.

12.6 The Harbour Master's Operating Limits

12.6.1 We consider that the Harbour Masters direction should use definitive and tight language and be based around operating limits rather than parameters. It should also allow for the Harbour Master, Master and Pilot to, at their discretion, reduce the operating limits should they feel it appropriate to do so. The Harbour Master should also have the power to approve a temporary increase in limits if the vessel is already on the SBM and if the Harbour Master, Master and Pilot agree that it would be safer to remain on the SBM for a short period of exceedance than to depart the SBM.

12.6.2 We consider that the operating limits set out at Annex A of the current Exemption Certificate issued by the Director of MNZ on 2nd February 2015, were valid and reasonable for the period when no licensed pilot was available.

12.6.3 Due to the issues we have identified regarding integrity of the SBM and described in this report, we cannot see any compelling reasons to increase the current operating limits from the perspective of the integrity of the buoy. For any increase in operating limits to be justifiable, we consider that a more rigorous inspection and planned maintenance regime would need to be in place, or preferably a new SBM be installed in light of the significantly increased future usage of the SBM expected.

12.6.4 Based on the high degree of manual handling and human intervention required for the mooring and slurry pipe operations observed during the audit (September 2014), we believe that the current operational limits are already at the higher end of the acceptable range and cannot justify any increase from the perspective of personnel safety.

12.6.5 An increase in the operational limits could be justified in the future on the basis of considerable improvements made to the equipment on the export vessels and the support craft, such that the risk to personnel is considerably reduced.

12.6.6 The Exemption Certificate (no. 18-EX-15) issued by the Director of MNZ defined the operating limits during the period where no licensed pilot was in place. Now that a licensed pilot is in place, we consider that the same operational limits should be maintained. Any further increase in operational limits would only be justifiable on the basis of a more rigorous inspection and planned maintenance regime and improvements to the mooring and slurry pipe operations on board the export vessel, in addition to the licensed pilot being in place.

12.6.7 Therefore, any future increase in the operational parameters should be on the basis of improvements in all three key areas; integrity of the SBM, safety of personnel and pilotage arrangements in place.

12.6.8 Hence, we consider that the current operational limits, should remain as follows with a licensed pilot in place:

- Mooring: Max. Hs = 2.6m, Max Wind = 30 knots, Daylight only;
- Unmooring: Max Hs = 2.9m, Max Wind = 40 knots, Night or day;
- No submergence of the Load Line;

12.6.9 The strain gauge should, in our opinion, be used as a guide to the hawser loads and in turn as a guide to the loads on the entire mooring system. The strain gauge has minimal scope for managing crew safety and navigational risks and should not be used as the absolute and only guide to safe operating conditions.

12.7 NZS Safety Management System and Approach

12.7.1 The NZS Safety Management System complies, where appropriate, with the New Zealand Port & Harbour Marine Safety Code.

12.7.2 There is and has been an apparent lack of engagement with the wider shipping and offshore industry as to accepted standards and best practices regarding the operation and maintenance of the SBM. NZS should consult with and be guided by the offshore oil and gas industry with regards to operating limits, inspection and maintenance regimes and emergency procedures.

12.7.3 Whilst NZS have stated their commitment to safety, there are several issues that appear to be in contradiction to that commitment including:

i) A failure to implement a sustainable solution for pilot training and succession in a timely manner, and reliance over many years on a one-Pilot operation resulted in the port having no licensed Pilot available for approximately 8 months (section 7.3 discusses this in more detail). We now understand that a licensed pilot is in place and the Pilot Training Programme has been approved.

ii) Submerging the load line as proposed by NZS, would in our opinion be an erosion of safety margins, as this reduces the under-keel clearance, freeboard and reserve buoyancy of the vessel.

iii) Operating the SBM with uncertified, critical components over a long period of time.

iv) A maintenance and inspection schedule that does not meet current industry best practice 'standards' for critical components (e.g. OCIMF), such as the mooring chains and associated equipment and structural details, noting however, that they do comply with the API-RP-2I maintenance and inspection standard. This is particularly important with respect to the future usage profile of the SBM.

12.7.4 We have reviewed NZS's Safety Management system and have made a number of recommendations, which are described in Section 8 of this report. In particular Procedure TM-6000-088, sub section 7.3, Contingent Manoeuvring Area should

be revised to reflect the safe distance from the stern of the vessel to the appropriate depth contour line, accounting for vessel motions.

12.8 General Concluding Comments

12.8.1 Based on our observations, the Taharoa operations have a number of 'single point failures' throughout the operation. At the time of our attendance, there was no back up pilot and there was no licensed pilot for a period of approximately 8 months, no back up support vessel, or line-handling boat. We found that the operation was too heavily reliant on the experience and skills of a few key personnel, i.e. the pilot and support vessel crew operating the support 'zodiac' dinghy. During the period that the Exemption Certificate was in force, there was an increased burden placed on the Master due to there being no pilot, although this has now been mitigated by the licensing of a pilot and commencement of the approved Pilot Training Programme.

12.8.2 In the past, NZS appear to have operated the Taharoa terminal by delegating to the Pilot and Master, actions and responsibilities that are clearly the responsibility of the port. We do note however, that NZS have accepted that this was the case and have made a number of changes to the operation and its management to rectify this, including accessing expert marine advice from other organisations. In addition we would recommend that NZS consider the employment of a full, or part time (as appropriate), Port Captain.

12.8.3 A significant body of engineering analysis has been conducted to assess whether the buoy is fit for its current purpose and presumably also, for its future intended usage profile. Notwithstanding our comments on the validity of some of this analysis, there are examples of the recommendations from this body of analysis and inspections not yet being actioned, including critical areas such as fatigue damage inspections.

12.8.4 Further, the engineering analysis has, in our view, been used in isolation in an attempt to justify an increase in the operating limits, apparently without considering the wider issues (such as personnel safety). A holistic approach must be taken in defining the operating limits to ensure the safety of life, environment and property and we note that the documents presented to us by NZS during the audit indicate cognisance of and positive change toward this more holistic approach.

12.9 Summary of Recommendations for the Director of MNZ

12.9.1 Table 12.1 lists our recommendations to the Director of MNZ made in this report, following our review of the available documentation and audit of the Taharoa Port operations.

12.9.2 We are aware that, since the on-site audit and various communications on aspects of the audit, that a number of these recommendations have been implemented or are on-going.

ID	Recommendation	Timescale	Section Ref
1	Any reference to 'Operational Parameters' should be termed as 'Operational Limits'	Immediate	6.6
2	The Operational Limits to be endorsed with the wording; "The decision to berth at or depart the SBM is always at the sole discretion of the Master in consultation with the Pilot, provided that they are within the Harbour Master's limits"	Immediate	6.6
3[67]	For the TAHAROA DESTINY, in the absence of a licensed pilot, the operational limits as detailed in Annex A of the Certificate issued by the Director of MNZ on 2nd February 2015 to be applied.	Immediate	6.6
4	For the new vessels, without a licensed pilot, for the first three calls, the 'Training Voyages' operational limits as per Annex A of the Exemption Certificate of 2nd February 2015 to be applied.	When appropriate	6.6
5	Use of the 'over-draft' condition / submergence of the Load Line not to be permitted.	Immediate	6.6
6	When a licensed pilot is in place, maintain the current operational limits.	When appropriate	6.6
7	Include the additional notes as defined in section 6.6.22 in the Operational Limits	Immediate	6.6

Table 12.1 – Recommendations to the Director of MNZ

12.9.3 Table 12.2 lists the recommendations made in this report to the Director of MNZ for action by NZS, following our review of the available documentation and audit of the Taharoa Port operations.

67 Recommendations #3 and 4 refer to the period when the Exemption Certificate was in place. Now that the Exemption Certificate has expired, the recommendations are documented here for reference and completeness.

ID	Recommendation	Priority	Section Ref
8	Undertake a sensitivity analysis for the effect on the mooring analysis results of wave periods, wave spectrum and hawser size.	Med	4.2
9	Recalculate safety factors using correct maximum mooring loads for intact and single line damage cases.	Med	4.2
10	Provide confirmation that the damaged stability analysis has been completed for the buoy, including 1 and 2 compartment flooding and effect on mooring legs, as per INTECSEA 2012 recommendation.	Med	4.2
11	Undertake study into sea-bed properties with respect to anchor holding power and potential for further bedding in.	Med	4.3
12	Confirm if close-up inspections made of chain hawse box structures as per INTECSEA 2012 recommendation.	High	4.4
13	Confirm if shackle pins in tri-plate were replaced as per INTECSEA 2012 recommendation.	High	4.4
14	Confirm when the requirements for rectification defined by ABS in 2014 will be completed	High	4.4
15	Confirm if recommendations of INTECSEA fatigue analysis report for inspection of fatigue sensitive details were or are planned to be carried out as per recommendations.	High	4.5, Table 4.5
16	Re-assess the fatigue damage predictions for the critical components of the mooring system, including the tri-plate, link plate and associated shackles, using the correct inputs (23 inch hawser loads, 3 vessel usage profile)	Med	4.5
17	Review and use the considerable body of industry research and knowledge on fatigue failures of mooring systems to inform risks and requirements for Taharoa	On-going	4.5
18	Develop and implement a more rigorous inspection and maintenance regime in line with industry best-practice inspection schedules and practices (e.g. OCIMF). Regime should consider future usage profile and should specifically include fatigue sensitive details.	High	4.6
19	Maintain the approach for hawser life management and prediction, but with caution. Disseminate results to improve knowledge.	On-going	4.7

	Replace the special, elongated D shackles on the turntable to tri-plate connection with industry standard, proof loaded units.	V. High	4.8
21	Review the mooring leg design, as to whether use of multiple Kenter shackles 'in-line' is suitable from a fatigue perspective.	Med	4.8
22	Consider the acquisition of a new buoy to support the 3 vessel operation, utilising the current buoy as spare.	High	4.8
23	The Risk Assessment and Safety Management System should be brought into line with the Port and Harbour Marine Safety Code, where appropriate, and finalised, reviewed and signed off.	Med	5
24	Consider the inclusion of the suggestions to the naming and rating of the 'Heightened Risk Events' as described in section 5.3 herein.	Med	5.2
25	Engage with and utilise the oil and gas industry to help inform the Taharoa operation with regard to operational limits, procedures, emergency response.	On-going	6.6
26	Separate the Taharoa port procedures from the Taharoa Mine site procedures	High	7.1
27	Engage with RCC Wellington, including lodging of emergency and pollution response plans	Med	7.1
28	Revise the Helicopter Emergency Response Procedure to include the function of RCC wellington and to include medevac situations.	Med	7.1
29	All SBM hardware material and test certificates to be centrally located and referenced appropriately to relevant components.	High	7.1
30	Consider the possibility and discuss with HNZ, to include medevac operations in the contract with HNZ.	Med	7.1
31	Recruit a suitable person with marine experience to take role as Port Captain / Marine Manager.	High	7.1
32	As per NZPMSC, section 2.5.3, develop and obtain approval of the pilot training programme from ETL.	High	7.3
33	Ensure more than one pilot is trained, to provide redundancy	High	7.3
34	Consider the use of simulator and manned model training as part of the pilot training program.	Med	7.3
35	Consider the inclusion of the suggestions made herein at section 8.2 for the TM-6000 and TM-7000 series of procedures	Med	8.2
36	Undertake an assessment of the safe depth contour line accounting for vessel motions and acceptable under-keel clearance allowances, in accordance with ABS Rules 2014.	Med	8.7

37	Consult with MMC to resolve the crewing of the Margaret J during mooring / disconnection operations to maintain compliance with the MSCD and ensure safe operation.	High	9.1
38	Replace the 'zodiac' support boat with a more suitable offshore line-handling craft.	High	10.2
39	Critically examine the export vessel end mooring arrangements to minimise the risk to crew and support boat crew. Determine short and long term solutions and implement.	High	10.3
40	Critically examine the export vessel end slurry pipe lifting, connection and disconnection arrangements to minimise the risk to crew and support boat crew. Determine short and long term solutions and implement.	High	10.3
41	Consider the options for chartering a suitable pull-back tug for the 3 vessel operation.	Low	10.4
42	Maintain engagement with Cara Shipping and ensure lessons learnt are disseminated to all parties (incl. NYK). A regular Taharoa port user's group meeting would be beneficial.	Med	12.2

Table 12.2 – Recommendations to the Director of MNZ for NZS

N. Cooper

Captain Nicholas Cooper, F.N.I. M.N.M.

Simon Burnay

Simon Burnay, MEng (Hons) MRINA

APPENDIX A

Terms of Reference

TERMS OF REFERENCE FOR AN INSPECTION AND AUDIT OF PORT TAHAROA OPERATIONS PURSUANT TO SECTION 33T OF THE MARITIME TRANSPORT ACT 1994

Background

In October 2013 a new Part 3A was inserted into the Maritime Transport Act 1994. This clearly established the legal responsibility of port operators for port safety. In addition, new statutory powers are given to the Director of Maritime New Zealand to conduct inspections and audits of port operations and to impose prohibitions and conditions on the use or operation of port facilities.

For many years New Zealand Steel Ltd, as a subsidiary of Bluescope Steel Pty Ltd of Australia, has been operating a bulk carrier iron sands loading operation at Port Taharoa on the west coast of the North Island of New Zealand. This is a unique operation in which the vessel is secured to a single mooring buoy (SMB) located some 1.8 nautical miles off an exposed coast while iron sands are loaded as a slurry through two undersea pipes that emerge at the SMB.

The current bulk carrier which commenced service in 2012 is the *Taharoa Destiny*. It is a purpose-built Cape sized ship of some 175,000 tonnes DWT owned by NYK Tokyo and operated by NYK Singapore. Port Taharoa is a pilotage area and no tug services are available.

The history of operations at Port Taharoa has been marked by several serious and potentially serious safety incidents involving the vessels in use prior to the *Taharoa Destiny*. Some of the risks are now mitigated by the purpose-built features of the *Taharoa Destiny*. However, the SBM is some 30 years old. It was taken out of the water for the first time and refitted in 2009 but it is not in Class. It is secured in place by six anchors buried in the seabed.

At present, the safety of the operation is regulated in part by the Port Taharoa Harbourmaster. The Harbourmaster has promulgated maximum wave and wind parameters for berthing (Hs 2.6 metres and 30 knots) and for loading (Hs 2.9 and 40 knots). In addition, the Harbourmaster has prohibited submerging of the load lines at any time during the loading and dewatering procedures. The safety of the operation is also subject to the voluntary application of the New Zealand Port and Harbour Marine Safety Code administered by Maritime New Zealand.

The inspection and audit is to be carried out by two independent experts as delegates of the Director of Maritime New Zealand. One expert is to be a master mariner with extensive experience in command of Cape Size ships. The other expert is to be a highly qualified marine engineer and naval architect.

Work Requirement

1. Develop a sound understanding of the nature and recent history of the Port Taharoa operations based upon a review of all relevant and available documents and interviews with the Port Taharoa Harbourmaster and Maritime New Zealand personnel;

2. Review the development of a risk assessment of Port Taharoa operations under the New Zealand Port and Harbour Marine Safety Code and in particular the risk assessment report prepared by Arriscar dated 14 November 2013;

3. Review the development and imposition of the Harbourmaster's current operational safety parameters for the *Taharoa Destiny* at Port Taharoa and the technical basis for those parameters;

4. Review the total mooring system provided for the *Taharoa Destiny* including detailed engineering assessments of the following reports:

   (a) Mooring Analysis report for CALM S010790 by Single Buoy Moorings Inc (SBM Offshore) dated 23 February 2004;

   (b) MNZ's letter to SBM Offshore dated 20 September 2011 and SBM Offshore's Technical Response dated 3 October 2011;

   (c) ABS Consulting Installation and Pull Test report dated 14 March 2011;

   (d) Note by [redacted], Principal Naval Architect, Rev 3 dated 18 May 2013 relating to original SBM anchor setting tension;

   (e) WorleyParsons Inspection Report – Taharoa Calm Buoy dated 21 May 2009;

   (f) Bridon Customer Test Report of 21 inch nylon Braidline hawser dated 23 December 2010;

   (g) Intecsea Taharoa Buoy Modifications In-water Inspection Report dated 31 March 2012;

   (h) Intecsea letter certifying loads and operation parameters for Taharoa CALM buoy dated 2 July 2012;

   (i) McConnell Dowel Constructors Ltd wave forecast accuracy analysis dated January 2012;

5. Carry out a statutory inspection and audit of the Port Taharoa operations including:

   (a) obtaining and reviewing the Port operator's SMS documents including all operational manuals;

   (b) interviewing the Port operator's key personnel involved in operating the Port;

   (c) interviewing the licensed pilot(s) for the Port and assessing the effectiveness of pilotage for these operations;

   (d) interviewing the contracted helicopter and support vessel key personnel;

   (e) interviewing the Port Taharoa Harbourmaster and accompanying him on the bridge of the *Taharoa Destiny* to observe the vessel's mooring, loading and departure procedures including the work of the line crews on the ship and its support vessel;

   (f) consideration of safety and risk issues that will change as a result of the Port operator's intention to increase operations at the Port by introducing two additional Cape size ships;

6. Prepare a comprehensive final report for the Director of Maritime New Zealand summarising the work carried out and setting out all findings and expert opinions

encompassing paragraphs 1-5 above. The report is to include recommendations to the Director about:

(a) any appropriate prohibitions or conditions that the Director should impose in substitution for the Harbourmaster's current operational safety parameters and any other prohibitions or conditions that would be appropriate for safety and environmental protection purposes;

(b) the improvements if any required to the Port operator's current risk assessment and safety management system to satisfy all requirements of the New Zealand Port and Harbour Marine Safety Code;

7. The final report is to be submitted in draft form initially for review and approval by the Director before final completion.

APPENDIX B

List of Documents Reviewed

TAHAROA PORT SAFETY AUDIT

LIST OF DOCUMENTS REVIEWED

NZS Taharoa Harbour Risk Assessment Review
SBM Mooring Analysis by Ship & Offshore 2004 & various emails
Hawser Strain Gauge Readings 2012
Taharoa Destiny Harbour Master's Directions 21st March 2013
Harbour Master's Directions at Port Taharoa/Taharoa Destiny 19th July 2013
Harbour Master's Directions – Taharoa Destiny 28th May 2013
ABS tension Pull Test STEVPRIS MK6 Anchors
INTECSEA SBM Mooring Analysis18th May 2013
INTECSEA Mooring Analysis Survival Condition
INTECSEA Mooring Analysis Operating Condition
INTECSEA SBM Certificate
NKK Overdraft Certificate for Taharoa Destiny 26 June 2012
Worley Parsons SBM Inspection Report 21 May 2009
SBM Technical Response Sheet (Invalid – Bruce Anchors)
SBM Mooring Analysis for SBM 23rd February 2004 (Invalid – Bruce Anchors)
Appeal – New Zealand Steel v Harbour Master 9th May 2014
Taharoa Mining and Ship Loading Operation – Overview
Plan View Taharoa Offshore Operations Areas
Taharoa Port Operating Parameters
Taharoa Loading parameters Timeline
NZS letter Harbour Master's Directions – Taharoa Destiny 28th May 2013
ABS Tension pull Test Stevpris MK6 Anchor
INTECSEA Mooring Analysis with Stevpris Anchors
Applying the Harbour Master's Logic 17 May 2013
Worley Parsons Inspection Report – SBM 21 May 2009
INTECSEA SBM Analysis – Survival and Operating Condition
The Theory and Practice of Seamanship
BRIDON Hawser Analysis + Strain Gauge Readings + Proposed Parameters
NKK Overdraft Certificate with Japanese Government stamp
INTECSEA SBM Certificate 2 July 2012
Email from NYK Line re Overdraft
Flag State email confirming Overdraft
Met Ocean Taharoa Upgrade Wave Forecast Accuracy Analysis
NZS – Submission on the Marine Legislation Bill 12 October 2012
Email Letter Izard Weston NZS Lawyers to MNZ – Load Lines 15th June 2012
NZS letter to Harbour Master - Over Draft Certificate 19th July 2012
Taharoa Upgrade – Wave forecast accuracy analysis by Met Ocean
NZS Submission on the Marine Legislation Bill – Executive Summary

Email Harbour Master – New Zealand Steel – Operating Limits 28 June 2013
NZS - Harbour Master's Directions at Taharoa/Taharoa Destiny 19th July 2013
Legal loading issues and judgements
Various emails and letters – Harbour Master and NZS
MNZ Appointment of Harbour Master 22 May 2012
ABS Certificate Fit for Purpose SBM 29th March 2013
Worley Parsons Chain Fatigue Testing Discussion Meeting
Press cuttings
Strain Gauge readings 2012 – 2013 against Wave height
Various emails MNZ - NZS
NZS Response to Harbour Master's Concerns 03 November 2012
Izard Weston to Kenny Crawford – Taharoa Destiny Load Line 11 July 2012
NZS Harbour Master's Directions - Taharoa Destiny 28 May 2013
NZS Harbour Master's Directions – Taharoa Destiny 19 July 2013
NZS Response on proposal to remove strain gauge limits
NZS Taharoa Port Operational Parameters, History, Derivation and Recommendation 12 September 2014
Waikato Council Resource Consent Certificates
Maritime Safety Authority of NZ – Permission to overload 16 April 2004
NKK Overdraft certificate in Harbour Condition Copy
Email from Flag State – overdraft & Load Lines 5 October 2012
INTECSEA – SBM Certificate 2 July 2012
Taharoa Destiny Particulars
MNZ "Margaret J" Safe Crewing Certificate
Charts of Taharoa
TAIB "Taharoa Express" Enquiry
Australian Maritime College Simulation Model Testing October 2007
Discovery Marine Ltd Hydrographic Survey June & August 2005
NZS Risk Assessments and Risk Assessment Review
NZS SMS Procedures
NZS Load Line & Legal
Pilotage, ARP Pilot Training Programme
Met Ocean Wave Forecast Accuracy Analysis 09 January 2012
BRIDON Hawser Inspections and data, Trelleborg
Ironsand Cargo Stability
SBM Reports, Analysis, Correspondence
Worley Parsons Inspection Report 21 May 2009
Worley Parsons SBM – Met Ocean Calculation
INTECSEA SBM In-Water Inspection Report 31 March 2012
INTECSEA Fatigue Analysis Report 24 April 2013
INTECSEA Mooring Analysis Report – Taharoa Destiny 10 September 2013
SBM Mooring Analysis 23 February 2004

ABS Inspection Report & "Fit for Purpose" Certificate 31 May 2014
NZ Port & Harbour Marine Safety Code
NZ Port & Harbour Marine Safety Code Guidelines
UK Port Marine Safety Code
UK Port Marine Safety Code Guidelines
Guidelines for IACS Auditors to the ISM Code
MARICO Marine Port Safety Audit
MCA Port Safety Audit Guidelines
Taharoa & Waikato North Head Ironsand Brochure
Taharoa Port Information Booklet
Waikato Council Navigation Safety Bylaw
RCC Wellington Handbook
Report of Captain [redacted] of Brookes Bell
Report of Mr [redacted]

APPENDIX C

CV's of the Authors

CURRICULUM VITAE **Page 1**

CAPTAIN NICHOLAS COOPER, FNI, MASTER MARINER

DATE OF BIRTH:	30 December 1941
QUALIFICATIONS:	Master Mariner's Certificate of Competency (FG) GDMSS general certificate Fellow of the Nautical Institute (FNI)
MEMBERSHIP:	Past President of the Nautical Institute Council of the Nautical Institute Member of the International Federation of Shipmasters' Associations Member of Nautilus International
EXPERT WITNESS:	Appearance as expert witness at arbitration hearings and at the High Court in the U.K.
MARINE CONSULTANT:	Cases include Charter Party disputes; Unsafe Berths and Ports; Groundings; Cargo Damage and wetting; Cargo Quantity and Draft Limitations; Personal Injuries; application of the ISM Code; North Pacific Ocean routing disputes; Indian Ocean Piracy routing disputes; the role of the prudent mariner.
EMPLOYMENT HISTORY:	2010 to date Cwaves Ltd - Master Mariner Consultant
	2000 to 2009 Maersk/AP Moller - Master of container ships and bulk carriers
	1995- 2000 Safmarine - Master of Cape size bulk carriers
	1993 - 1995 Pentow Marine - Master of salvage tugs and supply vessels
	1979 - 1993 Various employers - Consultant, Surveyor, Port Captain
	1960 - 1979 Various employers - Seagoing Deck Officer General cargo, Reefer, Ro-Ro, Luxury Yacht

Seagoing Deck Officer

Served on general cargo ships, Reefer vessels, luxury yacht, oceanographic survey, container ships, salvage and supply tugs, Cape size, handy-size geared and Panamax gearless bulk carriers.

Experience with a variety of cargoes, including: -

General break-bulk cargoes, including Heavy Lifts; Containers; Grain; Coal; Iron Ore; Cement; Rice; Timber; Steel - sheet, plate, coil, scrap, etc.

Traded to most parts of the world - NW Europe; Mediterranean, including Black Sea; Middle East; North, East, West and South Africa; Australia and most parts of the Far East; East, Gulf and West coasts of North America; North and East coasts of South America; Transits of the Suez and Panama Canals.

Experienced with crews of various nationalities including Western and Eastern European, Filipino, West African, Indian, Pakistani, Latin American, Egyptian and West Indian.

Casualty Investigation -
Collisions, groundings, contacts, total loss, speed + angle of blow surveys, cargo damage.

Navigation and Ship-handling –
Extensive personal experience, including training and investigation of all aspects of seamanship. Extensive ship handling experience all types of vessel including oceanographic surveys. Delivered fully loaded Cape size bulk carrier from Mauritius to Brixham under own power with lower half of rudder missing, and Brixham/Rotterdam/Setubal under tow. (Lloyd's List 08 August & 30 October 1997).

Container Operations –
Extensive experience of operating large feeder vessels in Eastern Mediterranean, Black Sea and West Africa.

Dry bulk cargo Operations –
Wide experience of various grains, iron ore, sand, cement clinker, manganese and coal.

Project cargoes –
Planning, loading, stowing and securing heavy lift, offshore oil equipment and project and break-bulk cargoes. Responsible for port operations and heavily involved in commercial and financial aspects of shipping company operations.

Quality & Safety Management Systems –
The practical operation of ISM systems. Incident investigation from the ISM perspective. Detailed experience with all aspects of the ISPS Code. Set up and implemented Lloyds Enhanced Survey Programme on two Cape size bulk carriers and other bulk carriers in the Safmarine fleet. Full implementation of the ISM. Code on same two bulk carriers including internal and external audits and attained full DNV ISM/SEP certification.
Implemented the ISPS Code on a container vessel, including training and familiarisation for all officers and crew, reviewing the Risk Assessment and Ship Security Plan, attending the verification audit and gaining International Ship Security Certificate in June 2004

Vessel Surveys –
On and Off Hire Surveys on behalf of Owners and Charterers. Damage surveys on behalf of Owners, Charterers and Cargo Underwriters. Cargo suitability inspections. Draft surveys. Condition surveys on behalf of P & I Clubs for Entry.

General Surveys –
Wide experience of cargo surveys and investigation of cargo loss including General Average.
Investigations into casualties, including strandings, groundings, sinking/unexplained losses at sea.
Crew interviews to ascertain the causes of casualties.
Angle of Blow Surveys.
Cargo damage surveys on behalf of Cargo Owners/Interests, P & I Clubs, Salvage Association, Admiralty Lawyers, Owners and General Average Interests.
Oil cargo surveys. Arrangement of sale/disposal of damaged cargo on behalf of principals.
Condition surveys on behalf of P & I Clubs for Entry.

CURRICULUM VITAE

NAME	Simon Burnay
DATE OF BIRTH	24th September 1975
PRESENT POSITION	Naval Architect
NATIONALITY	British
HIGHER EDUCATION	University of Southampton

QUALIFICATIONS

M.Eng (Hons) Ship Science; First Class;

Member Royal Institution of Naval Architects (MRINA)

SUMMARY

Simon is a Naval Architect with over 15 years' experience as a marine consultant. He assists a range of clients, including Solicitors, P&I Clubs, H&M insurers, Government bodies, Vessel Owners, Charterers and Cargo Owners / Insurers, providing expert opinion, detailed analysis and expert reports on a range of naval architecture and marine matters.

Simon holds a First Class Master's degree in Naval Architecture (Ship Science). He is a member of the Royal Institute of Naval Architects, a former member of the SNAME H-10 Ship Controllability Panel on ship pilotage, manoeuvring and navigation and has acted as a technical advisor to both national delegations and NGO's at IMO.

Simon specialises in mooring systems, marine operations and vessel motions. When employed at BMT (formerly the National Maritime Institute and British Ship Research Association), Simon was responsible for the development of a leading ship simulator which was and continues to be widely used and accepted by the industry for ship simulation. During this period, Simon was invited to join the SNAME H-10 Ship Controllability Panel which studies ship manoeuvring, ship-handling and pilotage. Simon's primary focus during this time was the development of the simulator mathematical model and he led a large number of projects examining the navigation and mooring aspects of existing and proposed terminals, both offshore and 'in-port'. This included a large number of mooring analysis and related studies to establish safe operating limits for a range of terminals, including F(P)SO's, FSU's, FLNG terminals, offshore islands and SBM's, spread and turret moorings.

Simon has also undertaken projects concerning the assessment of mooring system integrity and has experience of analysing mooring system failures.

EMPLOYMENT HISTORY

2013 to Date	Cwaves Limited, Consultant Naval Architect
2010 - 2013	Braemar Technical Services Ltd, Director / Naval Architect

cwaves

2009 - 2010 BMT ARGOSS Ltd, Managing Director / Naval Architect

1998 – 2009 BMT SeaTech Ltd, Naval Architect / Senior Naval Architect

SPECIALIST KNOWLEDGE AND EXPERIENCE:

- Mooring loads and analysis, anchoring and berth / fender loads;
- Tug usage, forces and towing aspects;
- Marine operations analysis including offshore installations, towage, SPM's, FPSO's and similar;
- Mooring systems, integrity and failures;
- Manoeuvring and motions of vessels and assets;

NAVAL ARCHITECTURE EXPERIENCE

- Marine Casualty Investigations into nature, cause and extent of damages / loss including total losses, structural failures, collisions, groundings, FFOD and cargo damages;
- Naval Architecture including intact / damaged stability, longitudinal and local strength, residual strength following damage, motions analysis;
- Salvage and Wreck Removal: Live / post assessment of stability, strength, grounding, cargo removal;
- Cargo Matters including analysis of cargo securing and lashing, the IMO CSS Code, Cargo Securing Manuals. Project cargo securing including attendance as MWS. Container stack collapse, damage and losses.
- Hull & Machinery damages including survey of structural damages and failures. Advice on temporary and permanent structural repairs, including hull damage, propeller damages.
- Marine Warranty Surveys including review / approval of load-out, off-load, installations for project cargo and marine installations;

PREVIOUS WORK EXPERIENCE

2010 - 2013 Braemar Technical Services Ltd; Director / Naval Architect

Marine consultant for P&I Clubs, Legal firms, H&M underwriters, owners, charterers and Government Authorities. Case experience included:

- Structural failures;
- Total loss investigations;
- Heavy weather damage;
- Collisions and allisions;
- Un-safe port claims;
- Mooring failures;
- Hull & Machinery damage;
- Propeller damages;
- Groundings, salvage assistance and disputes;
- Towage cases;
- New-build disputes;
- Cargo shifting, sloshing and liquefaction;
- Container damages/loss and lashing failures.

cwaves

Project management of and engineering / naval architecture reviews for Marine Warranty Surveys (MWS), marine tows, project cargo transportation, offshore installations, sea-fastening analyses and heavy lifts. Attended project cargo transports as MWS.

1998 - 2010 BMT SeaTech Ltd; Naval Architect / Senior Naval Architect / Director
Working as a marine consultant on projects / cases relating to ship manoeuvring, ship performance and specialist analysis for incidents. Particular experience includes:

- Incident investigations including structural failure analysis, cargo shifting and securing failures, collisions, allisions, un-safe port claims.
- Offshore projects included rig moves, FPSO / FSU / FLNG installations; GBS tows and set-downs.
- Led the technical development and mathematical modelling of the PC Rembrandt ship simulator used extensively by 'blue-chip' industry clients (incl. oil majors) for ship-handling training, port development assessments and incident investigations.
- Personally conducted / led numerous studies into ship-handling, mooring assessments and marine operations (incl. FPSO's, SPMs), including numerous port / ship surveys.
- Led the conduct and organisation of various manoeuvring and speed trials.
- Responsible for hull stress monitoring systems and analysis of hull stress data.
- Project management of naval architectural aspects for vessel conversion studies, including assessments of stability, strength, classification requirements and manoeuvrability.

Pre 1998 Various
Sea-going experience as "Skipper" for commercial charter yacht; Deck-hand on commercial deep sea fishing vessels and experience on cross-channel ro-pax ferries.

APPENDIX D

E-mail from NZS on Special D Shackles

Simon Burnay

From:	[redacted]@bluescopesteel.com>
Sent:	10 November 2014 03:10
To:	Simon Burnay; Nicholas Cooper
Cc:	[redacted]MJ; NZSAKL Mailstore Taharoa Port
Subject:	RE: Taharoa Port Audit - Additional Documents
Attachments:	NZC815-07-MEM-020 R1 Equipment in Service Certificates.pdf

Dear Simon,

Further to point 2 in your email below, please find attached a report that contains the certificates and load information for each of the SBM mooring components.

Please note the following:

- We were unable to find certificates for the 4" special shackles.
- The SWL of the hawser shackle is 200 tonnes.

In response to these findings, NZSM plans to replace the 4" special shackles and the hawser shackle with equivalent units that have SWLs of 250 tonnes. For the next visit of the Taharoa Destiny, we will amend our SOPs and mooring parameters (strain gauge limits) to reflect a 200 tonne SWL for the SBM.

Once the new components have been installed, we will lift the SWL of the SBM to 250 tonnes.

Best regards,

[redacted]

NEW ZEALAND STEEL

[redacted]
New Zealand Steel Limited
[redacted] | W www.nzsteel.co.nz
A 131 Mission Bush Road | Glenbrook | Private Bag 92121 | Auckland 1142

APPENDIX E

Offshore Hawser and Operational Limits

The Offtake Tanker is moored using a 90 meter x 533 mm Nylon hawser with a breaking load of 581 tonnes attached to the FPSO by a hydraulically operated Pusnes winch with built in release mechanism. At the Offtake Tanker end a 'chafe' chain is provided for connection to the OCIMF approved chain stopper. The chafing chain consists of 8 metres of 83 mm chain connected to the hawser followed with a 3.5 metres x 76 mm stud link chain as rated at 470 tonnes breaking strain. At the FPSO end of the chafe chain a buoy is attached (Appendix 18)

Hawser Tension, MFSV Control and Fishtailing

Hawser tension	• OIM, Mooring Master and Offtake Tanker Master to review loading operations if hawser pull exceeds 100 Tonnes • **Suspend** loading operations and release Offtake Tanker if hawser pull exceeds 100 tonnes x 5 times in one hour or exceeds a maximum pull of 160 Tonnes
Differences between Attitude of Offtake Tanker and FPSO	• Due to the large number of concurrent vectors (wind, wave and current) and the dynamics of displacements of either vessel during the offloading operations it is anticipated to be differences between the attitudes of the Offtake Tanker and the FPSO. The equilibrium of hawser tension between the OTT, FPSO, and MFSV should be monitored at all times • **Suspend** loading operations where the MFSV cannot maintain the equilibrium at 50% power or a 40 ° offset is approached, between hawser and centerline of FPSO
Fishtailing	• OIM, Mooring Master and Offtake Tanker Master to review loading operations if fishtailing the Offtake Tanker exceeds 20 degrees each direction (port and starboard) • **Suspend** loading operations if the assistance of the MFSV is not adequate at 50% power to control fishtailing, or if fishtailing the Offtake Tanker exceeds 40 degrees each direction (port and starboard) and / or a 40 ° offset is approached, between hawser and centerline of FPSO. Disconnect the hose and un-moor

<u>Mooring Hawser</u>

The OTT is moored using an 80 m 21-inch braided nylon grommet hawser with a MBL of 1105 tonnes, terminating in a 76 mm chafe chain 'B', rated at 440 tonnes breaking strain. The FPSO end of the hawser is similarly fitted with a 76 mm chafe chain, secured in a hydraulically operated Hi-Tec stopper.

Both chafe chains are buoyed to prevent the chain from sinking and thereby aid recovery and to avoid causing damage to the sub sea pipelines.

OTT and Equipment

Hawser High Tension Alarm	OIM, Master and Pilot to assess weather conditions and discuss advisability of continuing loading operations if two hawser pulls of 100 tonnes or more are experienced within 30 minutes. *This limit is below the advised 15% of MBL of the hawser in the UKOOA Guidelines for tandem mooring*
Hawser High High Tension Alarm	Suspend loading operations and release OTT if a single hawser pull of 150 tonnes is experienced *This limit is below the advised 19% of MBL of the hawser in the UKOOA Guidelines for tandem mooring*
Fishtailing	Suspend loading operations if the assistance of the FSV is not adequate at 50% of available power (considering SWL of OTT deck fittings) to control fishtailing, and the difference between headings of the OTT and the FPSO reaches 40 degrees. Consider disconnecting the hose and un-mooring if the situation persists

13.2.1 Mooring Hawsers

The OTT is moored using two 90m, 15in double-grommet ultraline hawsers with a wet breaking load of 580 tonnes each. They are attached to the SPM via steel chains. At the offtake tanker end a similar buoyed 'chafe' chain of 76mm OCIMF Type 'B' is provided for connection to the OCIMF approved chain stopper

14.6 Suspension of Cargo and Unberthing in an Emergency

Under certain conditions, the Master in consultation with the Mooring Master and the OIM shall ensure that loading and/or deballasting operations are stopped. If the circumstances so require, the Master may be requested to disconnect and blind flange the floating hoses, and lower them into the sea. In order to prevent the possibility of fouling the propeller of the ship, the Master must secure the hose ends when lowered with slip-ropes attached to some suitable point on board. Should conditions deteriorate further, the tanker will unmoor and depart the SPM until conditions abate

Cargo will be stopped under the following circumstances

- A wind speed of 30 knots is recorded, or significant sea height of more than 3m is experienced
- If storms are forecast for the terminal area
- On the approach of or during electrical storms or disturbances, strong winds or heavy rain
- If an oil spill occurs either on or from the vessel
- If an oil spill occurs either on or from the terminal
- If a fire occurs in the vessel or terminal
- If the tension in either of the mooring hawsers, as indicated on the portable display unit on the tanker, exceeds a force of 100 tonnes

In addition, hoses will be disconnected under the following circumstances

- If the tension in either mooring hawser exceeds 120 tonnes
- If either of the mooring hawsers appear damaged
- If the tug on static tow is unable for any reason to prevent the possibility of the vessel from riding up onto the SPM
- Any other conditions which in the opinion of the Master, the Mooring Master and the Terminal Manager present a risk to life, the environment or property