Port Kembla Bulk Liquids Terminal

Navigation Assessment

Manildra Group

28 April 2022

311010-00294

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PROJECT 311010-00294 - MA-REP-0001: Port Kembla Bulk Liquids Terminal - Navigation Assessment

Rev	Description	Author	Review	Advisian approval	Revision date	Client approval	Approval date
0	Issue for Use	G. Tooker	D. Aubourg	P. McCallum	28.04.22		

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Executive Summary

Manildra Group are undergoing the NSW Department of Planning and Environment Secretary's Environmental Assessment Requirements (SEARs) for an ethanol export facility in Port Kembla to identify the specific environmental assessments for the Environmental Impact Statement (EIS). It is proposed to export beverage grade ethanol via Berth 206 in the Outer Harbour of Port Kembla. As a part of the SEARs, a study investigating the navigability of the port, required waterside infrastructure and impacts to existing operations is required.

Manildra Group are proposing to export ethanol in ships up to 155 m length overall (LOA), which is less than the port maximum and within the suitable vessel size for the existing infrastructure on Berth 206. The facility is proposed to have up to 30 shipments of 4-10 ML per year.

Port Kembla is designed to cater for Capesize bulk carriers, with a maximum size of 300 m LOA and 50 m beam, to be able to transit the port. The port also currently imports fuels and other dangerous goods as a part of standard operations. The existing and future tug fleet are suitable for ethanol loading operations as per Australian Standards, however a risk assessment reviewing the combined landside and waterside infrastructure should be conducted to determine the required safety and firefighting infrastructure.

Typical petrochemical facilities require a 40 m exclusion zone around the ship manifold during operations with a 25 m exclusions zone around the whole ship for unauthorised vessels. These two zones are not greater than what is currently in place at the berth and do not impact the existing public boat ramp or port entrance channel. However, this will need to be validated with a risk assessment.

It is not expected that the proposed facility will impact existing operations in the port or require any additional infrastructure at the berth to support waterside operations (Figure 1-1).

Acronyms and Abbreviations

Acronym/abbreviation	Definition
BLB	Bulk Liquids Berth
DUKC	Dynamic Underkeel Clearance
DWT	Deadweight Tonnage
EIS	Environmental Impact Statement
FiFi	Firefighting
LAT	Lowest Astronomical Tide
LBP	Length Between Perpendiculars
LOA	Length Overall
LPG	Liquefied Petroleum Gas
SEAR	NSW Department of Planning and Environment Secretary's Environmental Assessment Requirements
UKC	Underkeel Clearance

1 Introduction

Manildra Group are undergoing the NSW Department of Planning and Environment Secretary's Environmental Assessment Requirements (SEARs) for a beverage grade ethanol export facility in Port Kembla to identify the specific environmental assessments for the Environmental Impact Statement (EIS). It is proposed to utilise the existing Berth 206 bulk liquids berth (BLB) as the proposed export berth (Figure 1-1 and Figure 1-2).

The proposed export facility will have the ethanol tank storage on land, transfer the product via pipeline to the berth, and load ships via hoses. An estimated maximum of 30 ships will arrive per year.

Part of the SEARs require the completion of several studies outlined by the Department of Planning. These studies include, but are not limited to, a shipping hazard, risk, and navigation assessment.

Figure 1-1: Port Kembla Outer Harbour (Nearmap, 1/11/2021)

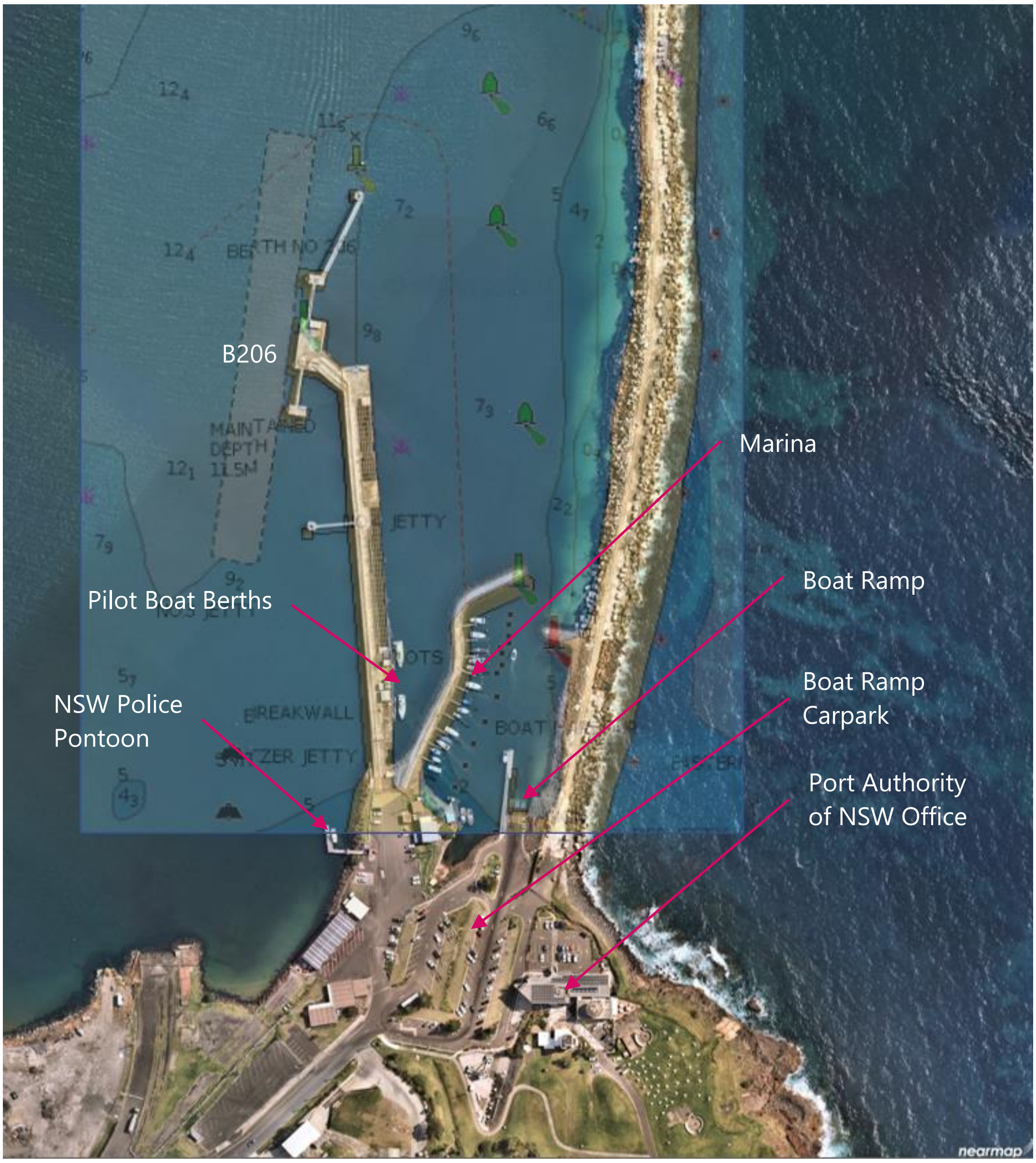

Figure 1-2: Port Kembla Berth 206 and public facilities (Nearmap, 9/02/2022)

1.1 Scope of Work

Listed below are the key areas investigated in this report.

- Navigation Assessment
  - Desktop navigation assessment for the arrival, berthing (including berthing speed), and departure of ethanol ships, including impacts from the Port Kembla Gas Terminal and emplacement cell
  - Location of the loading arm/hose connection in relation to the existing berth face

  - Any plans to upgrade the fendering on the wharf and any other changes that may have an impact on the ships
- Impacts to existing Port Operations
  - Desktop assessment on the impacts of the proposed ethanol export facility on existing operations in the port, such as exclusions zones during operations
  - High level assessment of existing tug ship suitability based on other Australian ports handling similar sized ethanol ships
- Discussion of findings with Harbour Master
  - Prepare summary presentation
  - Workshop/meeting with the Harbour Master to determine if they have any comments or questions regarding the findings/outcomes of the studies.

2 Intended Operations

The ethanol export facility is intending to conduct approximately 30 shipments of beverage grade ethanol per year from Berth 206 in the Outer Harbour of Port Kembla. Each shipment will consist of between 4-10 ML of ethanol with a loading rate up to 1 ML per hour. The two design ships' particulars are presented in Table 2-1.

Table 2-1: Design ship particulars

Particular	Golden Leader	Golden Unity
Length Overall (LOA)	124.0 m	155.0 m
Length Between Perpendiculars (LBP)	116.1 m	145.0 m
Beam	20.0 m	24.8 m
Moulded Depth	11.2 m	13.35 m
Ballast Draught	4.83 m	6.27 m
Summer Draught	8.77 m	10.22 m
Ballast Displacement	8,384 t	17,847 t
Summer Displacement	16,270 t	30,122 t
Cargo Capacity	13,355 m^3	23,325 m^3
Bow to Centre of Manifold	61.1 m	74.85 m

3 Waterside Requirements of an Ethanol Facility

Ethanol as a bulk liquid cargo is not considered any different to other High Hazard Class Volatile Petrochemicals, and therefore follows the same guidelines and standards as a typical bulk liquids facility [1]. Outlined below are the typical waterside requirements:

- For preliminary planning purposes, an exclusion zone of at least 40 m from the manifold centre is required [1]
- No unauthorised small craft or ships within 25 m of the ethanol ship [2]
  - One or more warning signs with legible signage from at least 30 m distance in any direction that ships may approach from are required
- Class B firefighting capable tug boat [2]
- Number of tugs dictated by the difficulty in berthing and manoeuvrability of the ship
- Spill kits on standby in the event of a leak/spill to contain ethanol.

It is noted that only a review of other similar facilities, and the relevant standards and guidelines pertaining to waterside requirements has been completed. No risk assessment has been conducted considering both landside and waterside infrastructure, but a risk assessment should be undertaken as the project develops.

3.1 Examples of Existing Ethanol Facilities

3.1.1 Mackay

The Port of Mackay bulk liquids berth (Berth M1) is located north of the small craft harbour, as shown in Figure 3-1, and is used to export ethanol. Like Port Kembla Berth 206, Berth M1 has a public marina located to the south of the berth with the public access channel running in close proximity to the east of the BLB.

There are two tugs available for towage stationed in Mackay provided by Smit Lamnalco. The requirement for the number of tugs is related to the LOA and maneuverability of the tanker, such as having an operational bow thruster [3], and the discretion of the Harbour Master.

For the export of ethanol, no additional waterside provisions are outlined in the port procedures compared to general cargo operations. The berth has two firefighting towers installed either side of the manifold.

Figure 3-1: Port of Mackay bulk liquid terminal (Nearmap 02/10/2021)

3.1.2 Port Botany

Ethanol is imported into Sydney via the two BLBs in Port Botany (BLB1 and BLB2), and stored in tanks onsite as shown in Figure 3-2. The two berths handle several liquid commodities including chemicals, petroleum fuels and LPG.

These berths are located close to the international container terminals and approach channels. Port Botany has several firefighting capable tugs for towage provided by Svitzer and Smit Lamnalco. The two bulk liquids berths also have firefighting towers installed either side of the manifold. The required terminal firefighting capabilities are set by the transfer of LPG, which has higher volatility compared to other products.

The landside and waterside commercial areas of Port Botany are restricted access with no public access or facilities located near to the BLBs unlike Port Kembla.

Figure 3-2: Port Botany bulk liquid berths and tank farm

4 Impacts to Existing Operations

Port Kembla currently imports fuels into Berth 201 and acids into Berth 206 in the Outer Harbour. The port's maximum vessel size is a Capesize bulk carrier of 300 m LOA and 50 m beam and Berth 206 has a berth pocket length of 220 m and 50 m width [4]. Therefore, the design vessel sizes (Table 2-1) are within the berth and port limits.

The existing Svitzer tug fleet in Port Kembla is firefighting capable, with the Svitzer Ruby firefighting (FiFi) Class 1 compliant with up to 2,750 m^3/hr water capacity with up to 680 L/min foam discharge. Svitzer Ruby also meets the requirements for FiFi Class A as per [2], however is not currently carrying all the required equipment to be certified as Class A. The Svitzer Bass and Svitzer Flinders are FiFi capable with up to 600 m^3/hr water discharge each. However, a risk assessment is required to review both landside and waterside infrastructure and determine the requirements of the waterside FiFi capabilities.

Additionally, As discussed in Section 3, ethanol cargo is not considered any different to other High Hazard Class Volatile Petrochemicals which are currently imported via Berth 201 on the Northern Breakwater of Port Kembla Outer Harbour. Therefore, the ethanol cargo can be considered within the existing port cargo profile.

As discussed in Section 3, the recommended exclusion zones are 40 m from the ship's manifold location and 25 m around the perimeter of the vessel as shown in Figure 4-1. This is approximately within the existing exclusions zones as noted in [5], therefore no change with the existing berth exclusion zone is required. Additionally, the public boat ramp and moorings are at least approximately 200 m away from the vessel and will pass at a greater than 50 m distance to the berth, similar to Port of Mackay. The pilot vessel berths are also located outside the 40 m exclusions area.

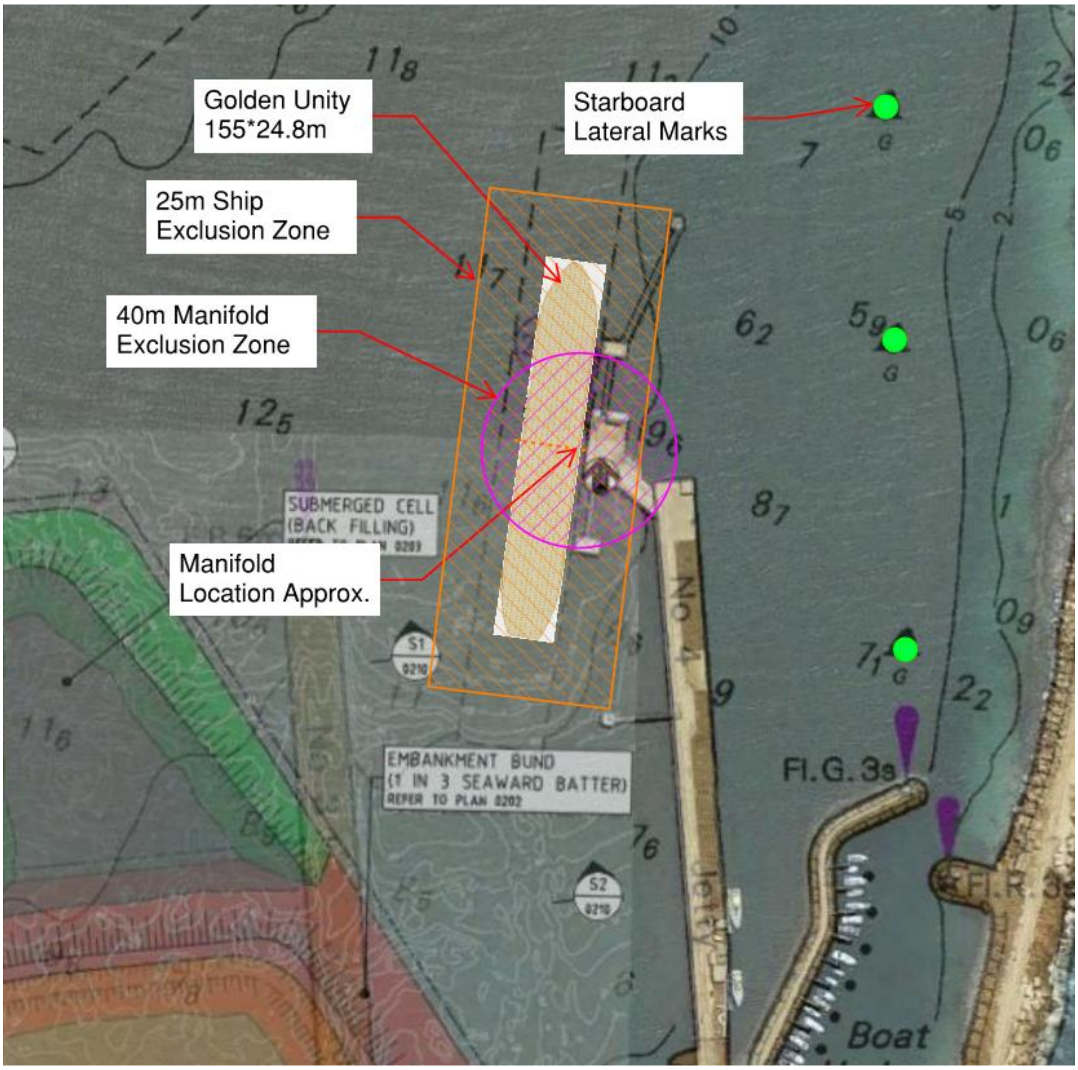

Figure 4-1: Map showing Berth 206 exclusions zones when the Golden Unity is alongside with the existing marked channel from the boat ramp to the harbour entrance

Currently, Berth 206 has a utilisation of approximately 1.3%, which is one service that imports acid. The proposed ethanol facility will have approximately 30 shipments of 4-10 ML of ethanol per year with a maximum design loading rate of 1 ML/hr, depending on the vessel capacity. This results in the proposed ethanol export facility requiring up to 10% utilisation, or a total of up to 11.3% utilisation which will not result in over-utilisation of the berth.

As shown in Figure 4-2, Berth 206 is located approximately 200 m from the Outer Harbour swing basin and at least 700 m from other berths. Therefore, the proposed ethanol facility should pose minimal risk to visiting cruise vessels transiting to the Inner Harbour and passing cargo vessels.

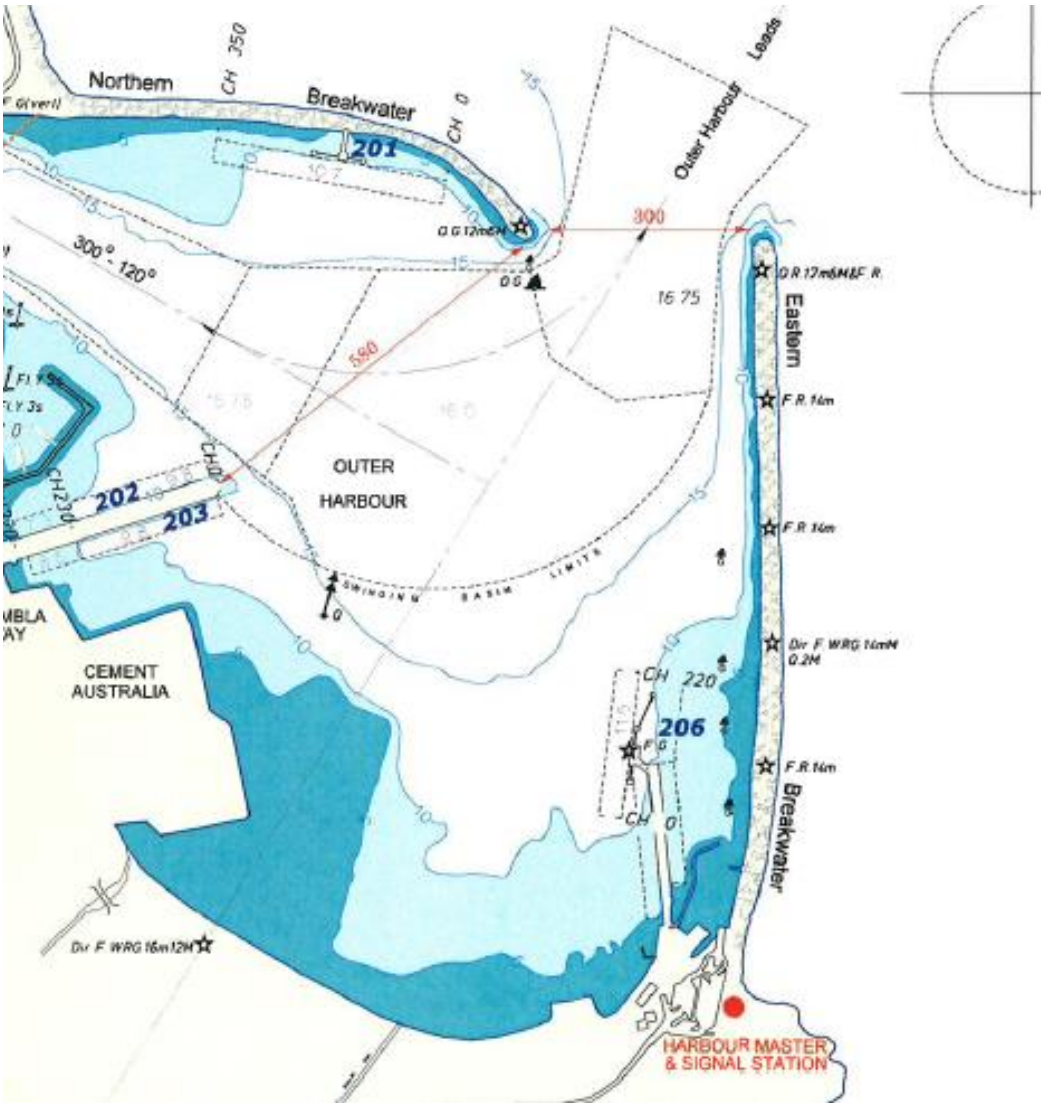

Figure 4-2: Port Kembla port passage plan [4]

5 Berthing Assessment

A berthing assessment was conducted on the two design vessels shown in Table 5-1 using the design berthing conditions outlined on the For Construction Drawing 5782DECP-D002-B [6] (Figure 5-1). The berthing energy calculations are shown in Appendix A utilising the methodology outlined in [7].

Table 5-1: Design ship particulars and berthing conditions

Particular	Golden Leader	Golden Unity
Length Overall (LOA)	124.0 m	155.0 m
Length Between Perpendiculars (LBP)	116.1 m	145.0 m
Beam	20.0 m	24.8 m
Moulded Depth	11.2 m	13.35 m
Summer Draught	8.77 m	10.22 m
Summer Displacement	16,270 t	30,122 t
Berthing Angle	7	7
Berthing Velocity	0.17 m/s	0.17 m/s
Abnormal Berthing Factor	1.75	1.75
Berthing Type	Quarter Point	Quarter Point
Abnormal Berthing Energy	395 kNm	791 kNm

C. DESIGN BERTHING CONDITIONS
1 DESIGN VESSEL FULLY LADEN = 35,000 DWT
2 DESIGN APPROACH VELOCITY = 0.175m/sec
3 DESIGN BERTHING ENERGY = 792 kNm
4 ANGLE OF APPROACH TO BERTH = 7°

D. FENDER DESIGN LOADS
1 BERTHING DOLPHINS — BERTHING ENERGY = 792kNm; REACTION FORCE = 150 TONNES
2 CENTRAL WORKING PLATFORM — BERTHING ENERGY = 396kNm; REACTION FORCE = 100 TONNES

Figure 5-1: Design berthing conditions and loads as presented on the Issued For Construction drawings [6]

As shown in Table 5-1, the calculated fully loaded abnormal berthing energies are less than the fender design limits as specified on the design drawings. This assumes that due to ship and berth geometry the Golden Leader berths alongside the central platform fenders and the Golden Unity berths alongside the berthing dolphins. It is noted that no structural assessment of the wharf infrastructure has been conducted to confirm the values presented in Figure 5-1 are correct.

The fender panel area for both the berthing dolphins and the central working platform dolphins are 12 m^2 as shown on [6]. Therefore, the maximum hull pressure that can be applied on a moored ship is approximately 120 MPa as the design reaction force is 150 t (Figure 5-1). As this pressure is less than the typical allowable hull pressure of 300 MPa for a tanker as outlined in [7], it is suitable to moor the two design ships alongside Berth 206.

6 Navigation Assessment

6.1 Existing Channel and Turning Basin

The existing channels and turning basins in Port Kembla are designed for Capesize bulk carriers (300 m LOA and 50 m beam) with a maintained depth of 15.7-16 m in the Outer Harbour. The water depth between the Outer Harbour turning basin and Berth 206 is greater than 12 m. Therefore, the existing channel and turning basin are sufficient for the design ships to navigate at a laden draught through the port to Berth 206 with a 10% static underkeel clearance (UKC).

Port Kembla utilises a Dynamic Underkeel Clearance (DUKC) system to monitor the dynamic UKC during transit and loading. This system accounts for real-time water levels, environmental conditions and ship hydrodynamics to ensure sufficient UKC.

Figure 6-1 shows the Outer Harbour channel and turning basin with the Golden Unity assumed travel path to the berth. It has been assumed that the ship will be turned upon arrival into to allow starboard-side-to berthing, allowing for quick egress in case of an emergency.

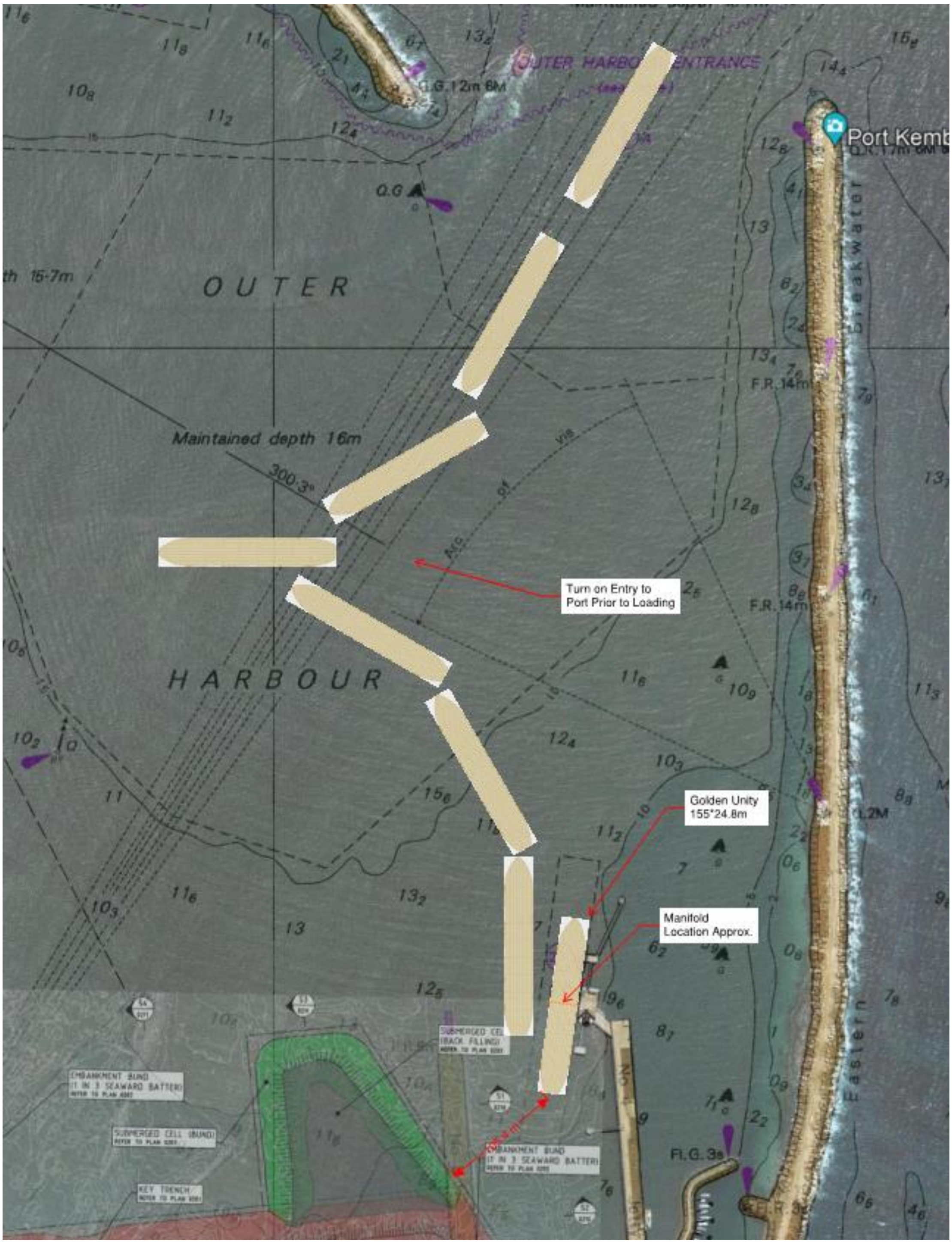

Figure 6-1: Port Kembla Outer Harbour turning basin and assumed approach

6.2 Existing Berth Box

The existing Berth 206 berth box dimensions are 220*50*11.1 m centred about the centre of the loading platform. The ship manifold is located at approximately midships for both design ships and therefore will be located central to the loading platform.

The Outer Harbour berths require a minimum UKC of 10% of the vessel draught. The summer draught of the Golden Unity is 10.22 m which will require a depth alongside the berth of 11.2 m which is 0.1 m deeper than the declared depth. Therefore, the Golden Unity will be tidally restricted to tides 0.1 m above lowest astronomical tide (LAT) water level, when loaded to summer displacement.

6.3 Outer Harbour Development

The construction of an emergent and submerged emplacement cell in the Outer Harbour has been approved for development as a part of the Port Kembla Gas Terminal and is shown in Figure 6-2. The green shaded area is submerged emplacement, and the red area is emergent reclamation. The toe of the bund is approximately 60 m clear of the berth box, however as the Golden Unity is smaller than the existing maximum design vessel for Berth 206, there is approximately 105 m clearance when berthed alongside.

It is not expected that the Outer Harbour emplacement cell will impact navigability in the Outer Harbour for the export of ethanol, for the proposed ships (Table 2-1).

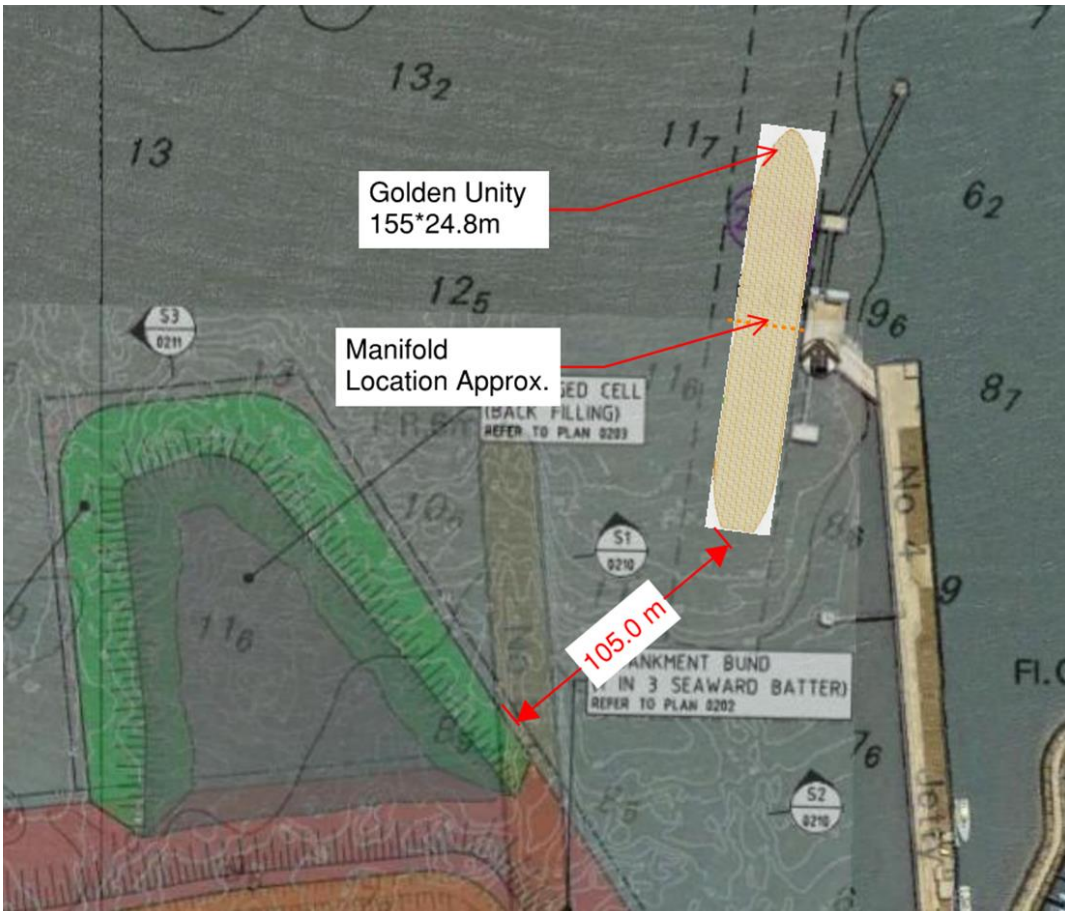

Figure 6-2: Outer Harbour emplacement cell proximity to Berth 206, where the green shaded area is submerged, and the red is emergent reclamation

7 Conclusions

Based on the above assessment, the proposed ethanol export facility operations are similar to operations currently undertaken in the port. Berth 201 and 206 currently import fuels and acids respectively with ships of similar sizes to the design ethanol export ships.

Exclusion zones are required around both the manifold and vessel of 40 m and 25 m respectively. These zones are within the existing boundaries at Berth 206. Therefore, the proposed facility will not cause additional impact on existing operations in the port and the surrounding waters.

The existing and future tug fleet of Port Kembla has sufficient bollard pull and FiFi capabilities to service the ethanol ships and operations, however a risk assessment should be conducted to review the whole facility, including landside infrastructure.

The existing fenders at Berth 206 are sufficient to safely berth both the Golden Leader and Golden Unity at summer displacement. No structural assessment of the wharf has been conducted to confirm the provided design loads for the berth.

The existing channel, turning basin, and berth pocket are sufficient to service the maximum design ship. Additionally, the approved Outer Harbour emplacement cell development will not impact the navigability to and from Berth 206.

Based on the above assessment, the proposed ethanol export facility operations can be safely conducted at Berth 206 in Port Kembla Outer Harbour with minimal impact to existing port operations.

8 References

[1] PIANC, "Recommendations for the Design and Assessment of Maine Oil and Petrochemical Terminals - WG 153," PIANC Secrétariat Général, Bruxelles, 2016.

[2] Australian Standard, "3846-2005 The Handling and Transport of Dangerous Cargoes in Port Area," Standards Australia, 2005.

[3] Maritime Safety Queensland, "Port Procedures and Information for Shipping - Port of Mackay," 2019.

[4] Port Authority of New South Wales, "Port Kembla Harbour Master Directions," 2021.

[5] Department of Primary Industries, "Re: SSD-33042483 – Manildra Port Kembla Bulk Liquid Terminal - Request for Secretary's environmental Assessment Requirements (SEARs)," 2021.

[6] Connell Wagner, "Contract No. PK 98/24 Jetty No. 4 Bulk Liquids Berth - 5782DECP," 1999.

[7] PIANC, "Guidelines for the Design of Fender Systems - WG 33," PIANC Secrétariat Général, Bruxelles, 2002.

Appendix A
Berthing Energy Calculations

Calculation Cover Sheet

Customer	Manildra Group	**Proj No**	311010-00294
Project Title	Port Kembla Bulk Liquids Terminal	**Calc No**	00-MA-CAL-0001
Calculation Title	Berthing Energies Summary	**Phase/CTR**	
Elec File Location	https://worleyparsons.sharepoint.com/sites/PK Nav Asses/Shared Documents/11.0 Engineering/Berthing Energies/311010-00294-00-MA-CAL-0001_Berthing_Summary.xlsx		
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Calculation Objective

The purpose of this calculation is to determine if the existing fenders on Berth 206 can safely berth the design ethanol ships, or if any berthing controls are required

Calculation Method

- Utilising PIANC and AS4997 method

Assumptions

- Ignores energy absorbed by wharf structure and vessel hull
- The fender design loads noted on the Berth Number 4 construction Drawings include energy reduction factors for temperature, angle, manufacturing tolerances and velocity

Software Used

Title	Version	Validation (Y / N / N/A)
N/A		

References

- PIANC WG 153 and WG 33
- Trelleborg Fender Brochure

Conclusions

- Existing cell fenders located on the central working platform are suitable to berth the laden Golden Leader at a 7deg berthing angle at the specified 0.17m/s berthing velocity
- Existing cell fenders located on the berthing dolphins are suitable to berth the laden Golden Unity at a 7deg berthing angle at the specified 0.17m/s berthing velocity

Related to a Safety Critical System?	*No*	*Status of Supplier Data used*	*N/A*

HOLDS

Rev	Date	Description	By	Checked	Approved
Rev 0	19-04-22	Issue for Use	G. Tooker	D. Aubourg	P. McCallum

Calculation Checklist

Customer	Manildra Group	**Proj No**	311010-00294
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		Page	2 **of** 5

Please check boxes for all applicable items checked or mark as "N/A" if not appropriate:

Calculations:

Originator	Checker	
X	X	Calculation number assigned and registered. refer to project numbering system or Document Number Standard (DPP-0031-COR-EN) for format.
X	X	All required information on Cover Sheet provided.
X	X	Revision history box complete and signed. (Typed names (minimum of first initial and last name e.g. A. Wood) of Originator, Checker, Approver; to be initialled beside at sign-off) (Dates in standard format (DD-MM-YY)
X	X	Table of Contents.
N/A	N/A	Appropriate stamp for preliminary issues.
X	X	Source of input data stated (with revision number and date if relevant).
X	X	Customer's requirements included/addressed.
X	X	Approach used is appropriate for problem being solved.
X	X	Method clear and easy to follow.
X	X	Input data correct.
X	X	Calculation arithmetically correct OR software previously verified and reference to verification checked.
X	X	Calculation result within expected limits.
N/A	N/A	Calculation tolerances stated if significant.
X	X	Units used as required by customer. Unit conversions correctly performed.
X	X	Appropriate cross-references.
N/A	N/A	Sketches included and clearly labelled, where required.
X	X	Appendices included and referenced, as required.
N/A	N/A	Considered design reviews, Hazop actions, customer input, safety and environmental issues, etc.
N/A	N/A	Safety in Design (SID) and Sustainable Design are addressed. Refer relevant SID Discipline Standard.
X	X	Conclusions and recommendations are appropriate.

Checking Records:

		Checked and annotated copy of calculation filed (use "Doc Check Print" stamp).
		Corrections made as required and calculation dated and signed on cover sheet by checker.
		Alternative method calculation and/or representative check performed and filed, as required.

Revisions:

		Changes clouded.
		Revision history block updated.
		Calculation re-checked if required.

Rev 0	19-04-22	Issue for Use	G. Tooker	D. Aubourg	P. McCallum
Rev	**Date**	**Description**	**By**	**Checked**	**Approved**

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Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
Rev 0	19-04-22	G. Tooker	D. Aubourg								

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Rev	**Date**	**By**	**Checked**	**Rev**	**Date**	**By**	**Checked**	**Rev**	**Date**	**By**	**Checked**
Rev 0	19-04-22	G. Tooker	D. Aubourg								

Berthing Energies Calculations in Appendix A and B

1.0 Background

Drawings

5782DECP - Jetty No 4 Bulk Liquids Berth Construction Drawings

1.1 Summary of Provided Information

Drawing notes below outlined the limiting design berthing conditions and fender design loads

B. GENERAL
1. LOAD PER BOLLARD = 1000 kN AT MAXIMUM ANGLE OF 30°
2. CURRENT ON BERTHED VESSEL = 2.9 KNOTS APPLIED IN ACCORDANCE WITH BS6349, PART1, 1984.
3. LIMITING WIND VELOCITY AT BERTH = 40 KNOTS

C. DESIGN BERTHING CONDITIONS
1. DESIGN VESSEL FULLY LADEN = 35,000 DWT
2. DESIGN APPROACH VELOCITY = 0.175m/sec
3. DESIGN BERTHING ENERGY = 792 kNm
4. ANGLE OF APPROACH TO BERTH = 7°

D. FENDER DESIGN LOADS

1	BERTHING DOLPHINS	BERTHING ENERGY = 792kNm REACTION FORCE = 150 TONNES
2	CENTRAL WORKING PLATFORM	BERTHING ENERGY = 396kNm REACTION FORCE = 100 TONNES

Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
Rev 0	19-04-22	G. Tooker	D. Aubourg								

Berthing Energies Calculations in Appendix A and B

2.0 Fender Details

2.1 Dolphin Fender

As stated on Drawing 5782DECP-D031, the central loading platform fender energy capacity is 396 kNm and the dolphin fender is 792 kNm which has been assumed to be factored

Therefore, the berthing energy has to be less than 396 kNm and 792 kNm for the central working platform and berthing dolphins respectively

3.0 Vessel Berthing Energies

3.1 Golden Leader

Name	=	Golden Leader		
loaded displacement tonnage	=	16270	tonnes while berthing	
length	=	124.0	m	
length between perpendiculars	=	116.0	m	
beam	=	20.0	m	
draught on arrival	=	8.8	m	
mean depth of water	=	11.1	m	
berthing velocity	=	0.17	m/s	As stated on Drawing 5782DECP-D031
berthing angle	=	7.0	degrees	As stated on Drawing 5782DECP-D031
Normal Berthing Energy 7º, E_N	=	225.4	kNm	
Abnormal Berthing Energy 7º, E_A	=	394.5	kNm	Factor of 1.75 as per PIANC

The abnormal berthing energy for the Golden Leader for the design conditions of the berth is 395 kNm which is less than the design limits

Therefore, the design ship can berth at Berth 206 with no additional restrictions

3.2 Golden Unity

Name	=	Golden Unity		
loaded displacement tonnage	=	30122	tonnes while berthing	
length	=	155.0	m	
length between perpendiculars	=	145.0	m	
beam	=	24.8	m	
draught on arrival	=	10.2	m	
mean depth of water	=	11.1	m	
berthing velocity	=	0.17	m/s	As stated on Drawing 5782DECP-D031
berthing angle	=	7.0	degrees	As stated on Drawing 5782DECP-D031
Normal Berthing Energy 7º, E_N	=	452.1	kNm	
Abnormal Berthing Energy 7º, E_A	=	791.1	kNm	Factor of 1.75 as per PIANC

The abnormal berthing energy for the Golden Unity for the design conditions of the berth is 791 kNm which is less than the design limits

Therefore, the design ship can berth at Berth 206 with no additional restrictions

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Appendix

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		Appendix	**A**

Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
Rev 0	19-04-22	G. Tooker	D. Aubourg								

Appendix A

311010-00294-00-MA-CAL-0002_Energy_Leader

2 Pages

Method 1 - PIANC - Guidelines for the Design of Fenders Systems : 2002

(Recommended for use in AS4997-2005)

VESSEL DATA:

Vessel type / size *(from Data Input Sheet)*

type	=	Ethanol	
loaded displacement tonnage	=	16270	tonnes
length	=	124.00	m
length between perpendiculars	=	116.00	m
beam	=	20.00	m
full draught	=	8.77	m
mean depth of water	=	11.10	m
berthing velocity	=	0.17	m/s
berthing angle	=	7	degrees

BERTHING ENERGY:

Ed = ½ M * v^2 * C_e * C_m * C_s * C_c *Cl 4.2*

where
- Ed = design energy under normal conditions to be absorbed by fender system (kNm)
- M = mass of design vessel (displacement in tonnes) at chosen confidence level (usually 95%).
- v = approach velocity of the vessel perpendicular to berth (in m/s) (use 50% confidence level).
- C_e = eccentricity factor
- C_m = virtual mass factor
- C_s = softness factor
- C_c = berth configuration factor or cushion factor

COEFFICIENTS:

C_m : Transverse approaches:
For very large keel clearances i.e. 0.5D, C_m = 1.5
For small keel clearances ie 0.1D, C_m = 1.8
For keel clearances between 0.1D and 0.5 D linear interpolation is used.

Longitudinal approaches:
C_m = 1.1

Keel Clearance = 2.33 m
= 0.27 D
Therefore C_m = **Transverse approach**
= 1.676

$$C_e = \frac{K^2 + R^2 * \cos^2\phi}{K^2 + R^2}$$ *Cl 4.2.4*

where K = radius of gyration of the vessel
= $(0.19C_b + 0.11)L$

and C_b = the block coefficient *(usually between 0.5 -0.9)*
= diplacement/(length of vessel x beam x draught x density of water)
= 0.73

Therefore K = 30.82 m
ϕ = angle between velocity vector and the line between the point of contact and the centre of mass
= 66.1
R = distance of point of contact from the centre of mass in metres (measured parallel to the wharf)
= **1/4 Point Berthing**
= 31.5 m

therefore $C_e = \dfrac{K^2 + R^2 * \cos^2\phi}{K^2 + R^2}$

$= \dfrac{(950 + 163)}{(950 + 994)}$

= **According to PIANC**

= 0.572

Note: Cl. 4.2.6 in NSW Maritime Authority's 'Engineering Standards & Guidelines for Maritime Strcutures', states "In deriving the berthing energy of a vesel, the eccentrcity factor Ce shall be taken as 1.0"

C_s = softness coefficient

The following values are usually used:

- for soft fenders and for smaller vessels C_s is generally taken as 1.0
- for hard fenders and larger vessels C_s lies between 0.9 and 1.0

take C_s = **1.0**

C_c = 1.0 for open piled jetty structures

= between 0.8 and 1.0 for solid quay wall

take C_c = **1.0**

ENERGY CALCULATION:

Ed = 0.5 * M * v^2 * C_e * C_m * C_s * C_c

= 0.5 * 16270 * 0.0289 * 0.57 * 1.68 * 1.00 * 1.0

= **225.42 kNm (kJ)**

For abnormal impact a factor should be applied to the design energy.
The following tables provides general guidance on the selection of the factor

Type of Berth Impact	Vessel	Factor for Abnormal Impact Applied to Berthing Energy (Cab)
Tanker and Bulk	Largest	1.25
Container	Smallest	1.75
Container	Largest	1.5
	Smallest	2.0
General Cargo		1.75
Ro-Ro and Ferries		2.0 or higher
Tugs, Work Boats, etc.		2.0

Abnormal factor = **1.75**

Therefore

Abnormal Ed = **394.48 kNm (kJ)**

NORMAL BERTHING ENERGY:

E_{normal} = **225.4 kNm (kJ)**

ABNORMAL BERTHING ENERGY:

$E_{abnormal}$ = **394.5 kNm (kJ)**

Customer	Manildra Group	**Proj No**	311010-00294
Project Title	Port Kembla Bulk Liquids Terminal	**Calc No**	00-MA-CAL-0001
Calculation Title	Berthing Energies Summary	**Phase/CTR**	
Elec File Location	https://worleyparsons.sharepoint.com/sites/PK Nav Asses/Shared Documents/11.0 Engineering/Berthing Energies/311010-00294-00-MA-CAL-0001_Berthing_Summary.xlsx		
		Appendix	B

Rev	Date	By	Checked	Rev	Date	By	Checked	Rev	Date	By	Checked
Rev 0	19-04-22	G. Tooker	D. Aubourg								

Appendix B

311010-00294-00-MA-CAL-0003_Energy_Unity

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(Recommended for use in AS4997-2005)

VESSEL DATA:

Vessel type / size *(from Data Input Sheet)*

type	=	Ethanol	
loaded displacement tonnage	=	30122	tonnes
length	=	155.00	m
length between perpendiculars	=	145.00	m
beam	=	24.80	m
full draught	=	10.22	m
mean depth of water	=	11.10	m
berthing velocity	=	0.17	m/s
berthing angle	=	7	degrees

BERTHING ENERGY:

$Ed = \frac{1}{2}\ \underline{M} * v^2 * C_e * C_m * C_s * C_c$ *Cl 4.2*

where
Ed = design energy under normal conditions to be absorbed by fender system (kNm)
$\underline{M}$ = mass of design vessel (displacement in tonnes) at chosen confidence level (usually 95%).
v = approach velocity of the vessel perpendicular to berth (in m/s) (use 50% confidence level).
C_e = eccentricity factor
C_m = virtual mass factor
C_s = softness factor
C_c = berth configuration factor or cushion factor

COEFFICIENTS:

C_m : Transverse approaches:
For very large keel clearances i.e. 0.5D, $C_m = 1.5$
For small keel clearances ie 0.1D, $C_m = 1.8$
For keel clearances between 0.1D and 0.5 D linear interpolation is used.

Longitudinal approaches:
$C_m = 1.1$

Keel Clearance = 0.88 m
= 0.09 D
Therefore C_m = **Transverse approach**
= 1.800

$$C_e = \frac{K^2 + R^2 * \cos^2\phi}{K^2 + R^2}$$ *Cl 4.2.4*

where K = radius of gyration of the vessel
= $(0.19C_b + 0.11)L$

and C_b = the block coefficient *(usually between 0.5 -0.9)*
= diplacement/(length of vessel x beam x draught x density of water)
= 0.75

Therefore K = 39.06 m
ϕ = angle between velocity vector and the line between the point of contact and the centre of mass
= 66.3
R = distance of point of contact from the centre of mass in metres (measured parallel to the wharf)
= **1/4 Point Berthing**
= 39.4 m

therefore C_e = $\dfrac{K^2 + R^2 * \cos^2\phi}{K^2 + R^2}$

= $\dfrac{(1526 + 252)}{(1526 + 1555)}$

= **According to PIANC**

= 0.577

Note: Cl. 4.2.6 in NSW Maritime Authority's 'Engineering Standards & Guidelines for Maritime Strcutures', states "In deriving the berthing energy of a vesel, the eccentrcity factor Ce shall be taken as 1.0"

C_s = softness coefficient

The following values are usually used:

- for soft fenders and for smaller vessels C_s is generally taken as 1.0
- for hard fenders and larger vessels C_s lies between 0.9 and 1.0

take C_s = **1.0**

C_c = 1.0 for open piled jetty structures

= between 0.8 and 1.0 for solid quay wall

take C_c = **1.0**

ENERGY CALCULATION:

Ed = 0.5 * M * v^2 * C_e * C_m * C_s * C_c

= 0.5 * 30122 * 0.0289 * 0.58 * 1.80 * 1.00 * 1.0

= **452.06 kNm (kJ)**

For abnormal impact a factor should be applied to the design energy.
The following tables provides general guidance on the selection of the factor

Type of Berth Impact	Vessel	Factor for Abnormal Impact Applied to Berthing Energy (Cab)
Tanker and Bulk	Largest	1.25
Container	Smallest	1.75
Container	Largest	1.5
	Smallest	2.0
General Cargo		1.75
Ro-Ro and Ferries		2.0 or higher
Tugs, Work Boats, etc.		2.0

Abnormal factor = **1.75**

Therefore

Abnormal Ed = **791.11 kNm (kJ)**

NORMAL BERTHING ENERGY:

E_{normal} = **452.1 kNm (kJ)**

ABNORMAL BERTHING ENERGY:

$E_{abnormal}$ = **791.1 kNm (kJ)**