IMMINGHAM EASTERN RO-RO TERMINAL NAVIGATION RISK ASSESSMENT

Immingham Oil Terminal Shipping and Navigation Support

Associated Petroleum Terminals (Immingham) Ltd

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CLIENT	Associated Petroleum Terminals (Immingham) Ltd
CLIENT ADDRESS	Queens Road | Immingham | N E Lincolnshire | DN40 2PN

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NASH MARITIME LTD, 2 CANUTE ROAD, SOUTHAMPTON, HAMPSHIRE, SO14 3FH, UK.

info@nashmaritime.com

+44 (0) 2380 381 681

EXECUTIVE SUMMARY

1. NASH Maritime Ltd have been contracted by Associated Petroleum Terminals (Immingham) Ltd operators of the Immingham Oil Terminal (IOT) to provide Shipping and Navigation subject matter expertise for the Immingham Eastern Ro-Ro Terminal (IERRT) Development which is proposed to be sited adjacent to the IOT and is being developed by Associated British Ports (ABP).
2. In relation to the proposed IERRT development then IOT is a piece of critical national infrastructure, and the Humber and Lindsey Oil Refineries account for 27% of the UK's refining capacity. Their operations are dependent upon the continued and safe operation of the: IOT river berths, IOT Finger Pier and IOT Trunkway flowing product from and to vessels and the refineries.
3. Due to the amount and type of product handled the IOT is classified as an Upper Tier site under the Control of Major Accident Hazards (COMAH) Regulations.
4. The IOT Operators have serious concerns with the shipping and navigation effects of the proposed IERRT Development which they do not consider have been adequately addressed by ABP as IERRT developers, particularly in relation to the adequacy of the IERRT Navigational Risk Assessment and the navigation safety effects on the IOT during both the construction and operational phases of the IERRT Development. These concerns, (see **Section 2**) have been raised with ABP but have yet to be satisfactorily addressed and relate to:
    a. A lack of clarity as to the NRA methodology, specifically how guidance documents and policies are used in the NRA and how the NRA meets the requirements of the named guidance and policies.
    b. Ambiguity as to why different AIS data sources were provided for the NRA than were provided for the HAZID workshops with stakeholders and a lack of quality checks having been undertaken for the IERRT NRA AIS data.
    c. Inaccuracies, overlooked key information and insufficient analysis within the description of the navigation baseline.
    d. A lack of clear definition of the proposed marine operations for IERRT.
    e. The absence of a future baseline specific to the berths at and around the IERRT.
    f. Concerns with the risk assessment methodology, particularly in relation to the lack of definition of likelihood parameters (which are entirely subjective in nature) and the calibration or risk appetite levels.
    g. The inclusion of insufficiently defined and overlapping additional risk controls that are either very similar to each other or very similar to embedded risk control measures (i.e., those measures that are already currently in place for the management of navigation risk in the area).
    h. An absence of detail describing the methodology, process used and outcomes of the Cost Benefit Analysis exercise, including the anticipated costs (quantitatively, or even qualitatively) and how these have been used to determine what could be considered appropriate.
5. IOT Berths 8 and 9, located to the south of the IOT Finger Pier are capable of handling vessels of 104m and 61m LOA respectively. Whilst smaller than the vessels on the main

river berths (which can be in excess of 300m), they are critical to the operation of the IOT and associated refiners handling refined products destined for England and Scotland. Access to Berth 8 is restricted to the flood tide only, requiring the ship's Master to balance the effects of wind and tide, and tankers may require the assistance of a workboat and/or tug to berth safely.

6. If developed, the IERRT would be a major 24hr 7 days a week Roll on – Roll Off ferry terminal with three berths handling vessels up to 240m LOA and with a beam of 35m. It is not clear what the detailed characteristics of these vessels would be, however, they will carry unaccompanied freight, accompanied freight and passengers. It is anticipated that there would be a minimum of one arrival (in the early morning) and one departure (in the early evening) per day per berth.
7. The space between the IOT Finger Pier and IERRT infrastructure would be 95m, within which a tanker of 104m, with associated tugs or workboats, will be required to manoeuvre with strong tidal flows and cross winds. Furthermore, up to three large RoRo vessels would be required to manoeuvre in close proximity to the IOT infrastructure and or vessels. A risk of contact of an IOT tanker or IERRT RoRo with the IERRT jetties, IOT finger pier and IOT Trunkway & pipetrack has therefore been highlighted as a credible and serious hazard.
8. To address these concerns IOT Operators have made it clear that specific mitigation (risk control) measures must be delivered as part of the IERRT development to address the shipping and navigation concerns raised including:
    a. The relocation of the IOT finger pier or a solution requiring the outer-most Immingham Eastern Ro-Ro Terminal Development berth (the northern berth of the northern pier) to be unused until such a time as alternative adequate arrangements have been put in place to reduce impacts on (safe) use by the IOT Operators of the Finger Pier;
    b. The provision of adequate vessel impact protection during the construction and operational phase of the proposed development (including ensuring the design of the IERRT Development can withstand impacts from vessels using the facility); and
    c. A detailed marine and liaison plan to be developed in conjunction with IOT Operators.
9. This report documents a shadow NRA (sNRA) to the IERRT NRA, focusing on addressing the shortcomings identified by the IOT Operators and navigation safety impacts brought about by the operation phase of the IERRT development (it does not deal with construction or construction / operation phases of the development).
10. IOT Operators have requested additional information and data from IERRT developers (e.g. the current navigation risk assessment for the area, design parameters of the IERRT infrastructure in relation to errant vessel impact design loadings, further details on historical incidents occurring in the area of the IERRT, etc.) which are necessary for an adequate risk assessment but were not included in the IERRT NRA and which have not been provided subsequently.
11. The following process was carried out in developing and documenting the findings of the sNRA:
    a. Review of IERRT NRA and Simulations.

b. Analysis of the marine operation of the IOT, particularly in relation to the Finger Pier.

c. Review of Legislation and Guidance related to Navigation Risk Assessments.

d. Presentation of the Navigation Risk Assessment process carried out for sNRA assessment which included:

   i. Specification of the risk assessment methodology;

   ii. Detailed analysis of the navigational baseline including:

      1. How vessel navigation in the area of the IERRT is currently managed.

      2. Vessel traffic analysis of current vessels in the area of the IERRT.

   iii. Historical incident analysis

e. Navigation Risk Assessments were undertaken as follows:

   i. Qualitative risk assessment for the proposed IERRT development to identify high risk hazards using IOT Operators risk matrix and descriptors.

   ii. Quantitative Risk Analysis for high-risk hazards derived from the qualitative risk assessment to mathematically quantify risk (this analysis is needed for a detailed cost benefit analysis to justify As Low As Reasonably Practicable (ALARP) requirements).

   iii. Review and determination of additional risk control measures over and above those that are embedded or proposed by IERRT Developers, to mitigate unacceptable risk levels.

   iv. Revised risk assessments (qualitative and quantitative) to determine the benefit of implementing the additional control measures.

   v. Cost benefit assessment using the results of the quantitative risk assessment for the additional risk control measures.

12. The results for the qualitative risk assessment shows that a total of 22 hazards were identified including collisions, contacts and breakaway hazard types. Based on a review of the collated data and taking information from Hazard Workshops conducted by IERRT and attended by IOT Operators, two of these hazards were scored as Intolerable risk, with the remaining 20 assessed as Tolerable if ALARP. Those scored as Intolerable were:

    a. Contact (Allision) - IERRT Ro-Ro Vessel with IOT Trunkway

    b. Contact (Allision) - IERRT Ro-Ro Vessel with IOT Finger Pier

13. The quantitative risk assessment focused on these intolerable hazards (identified as part of the qualitative navigation risk assessment) providing greater detail of the potential likelihood and consequences of their occurrence through use of event and consequence tree modelling. The modelling identified four scenarios with increasing magnitude of consequences and demonstrated that (the two) lower consequence scenarios fell within the high end of Tolerable if ALARP, and (the two) higher consequences scenarios breached the threshold for Intolerable risk.

14. A review of the additional risk controls provided both by IERRT NRA and by IOT Operators resulted in the three key IOT Operator risk control measures being assessed both in the qualitative and quantitative assessment of risk.
15. The results of the qualitative residual risk assessment with the three IOT Operators key risk controls in place resulted in 18 hazards being scored as Tolerable if ALARP, whilst four were scored as Broadly Acceptable. The two intolerable hazards were mitigated to a Tolerable if ALARP risk level.
16. Results for the residual quantitative risk assessment concluded that risk was reduced to below Intolerable limits with the IOT Operator control measures in place. Following this a cost benefit assessment of the three IOT Operator measures was undertaken with estimated costs for each mitigation related to the previously Intolerable hazards to determine whether they could be classified ALARP. The results of the cost benefit assessment are as follows:
    a. Impact protection has a relatively low-cost benefit ratio of 1.0 for low energy (consequence) strikes given the high cost and low benefit, however, for high energy (consequence) strikes this is significantly more effective, with ratios in excess of five. Therefore, the total benefit for impact protection is approximately 20 times the cost.
    b. Relocation of the finger pier is more expensive and therefore is only cost effective for preventing high consequence contacts of IERRT vessel with the IOT. Overall, this measure has a benefit of 2.7 times the cost.
    c. Marine operations and liaison plan is a low-cost risk control measure and therefore its modest benefits provide significant cost benefit, with a total benefit of more than 100 times the cost.
    d. On the basis of the findings of the cost benefit analysis. i.e. in the event of a high consequence hazard occurrence the benefits of the proposed measures out way the initial cost outlay, it is concluded that in order to reduce navigation risk levels to Tolerable (if ALARP) the three additional risk control measures assessed must be implemented.
17. In summary, this sNRA concludes, based on the information and data available, that the IERRT operations pose an unacceptable risk to IOT infrastructure (and consequently the refineries), although with the risk controls measures as specified by IOT in place the navigation risk to the IOT terminal (as critical national infrastructure) is mitigated to Tolerable (if ALARP) levels.

FIGURES

TABLES

APPENDICES

1. INTRODUCTION

1. NASH Maritime Ltd have been contracted by Associated Petroleum Terminals (Immingham) Ltd, operators of the Immingham Oil Terminal (IOT) to provide Shipping and Navigation subject matter expertise for the proposed Immingham Eastern Ro-Ro Terminal (IERRT) Development which is proposed to be sited adjacent to the IOT and is being developed by Associated British Ports (ABP).
2. The IOT Operators have raised concerns with the shipping and navigation effects of the IERRT Development which they do not consider have been adequately addressed. The IOT Operators' primary concerns relate to the:
    - Adequacy of the IERRT Navigational Risk Assessment (NRA) in relation to the:
        - Presentation of baseline and future navigation activities (during both construction and operation of IERRT);
        - Determination of safety thresholds / acceptability;
        - Risk assessment methodology (including risk matrix);
        - Identification and implementation of risk control / mitigation measures; and
        - Results and outputs of the assessment.
    - Actual navigation safety effects on the IOT during both the construction and operational phases of the IERRT Development include:
        - Allision (contact) of IERRT (and other) vessels with IOT infrastructure as a result of the development;
        - Collision between IERRT vessels (and other vessels including IOT vessels) as a result of the IERRT development; and
        - Impacts to the IOT Operators' Control of Major Accident Hazards safety case as a result if the IERRT development leading to unacceptable risk and associated need for mitigation;
3. In response to these concerns, the IOT Operators have requested that specific mitigation (risk control) measures must be delivered as part of the IERRT Development to address the shipping and navigation concerns raised. These are:
    - The relocation of the IOT finger pier or a solution requiring the IERRT Development's outer-most berth (the northern berth of the northern pier) to be unused until such a time as alternative adequate arrangements have been put in place to reduce impacts on (safe) use by the IOT Operators of the finger pier;
    - The provision of adequate vessel impact protection during the construction and operational phase of the IERRT Development; and
    - A detailed marine and liaison plan to be developed in conjunction with IOT Operators.
4. In reviewing the IERRT Developers Environmental Statement and NRA, none of the IOT Operators mitigation measures have been identified as necessary. As IOT Operators have concerns of the adequacy of the IERRT NRA and the IOT proposed mitigation measures are not mandated in the IERRT NRA, then IOT Operators contracted NASH Maritime Ltd

to undertake a shadow Navigation Risk Assessment (sNRA), to assess the actual navigation risk of the IERRT.

5. IOT Operators required that an independent sNRA is undertaken, as the location of the IERRT development falls within a Statutory Harbour Authority area owned and operated by ABP – Port of Immingham, a Competent Harbour Authority owned and operated by ABP, and that ABP is also the developer of the IERRT. Further the navigation risk consultants used by IERRT developers (ABP) are also a wholly owned subsidiary of ABP, ABPmer. IOT operators also required that the sNRA be conducted in line with the IOT risk assessment standards as the ABPmer IERRT NRA was not considered to comply with these standards.

6. This report documents the sNRA, which is focused on addressing the short comings identified by the IOT Operators of the ABPmer IERRT NRA and focuses on the operation phase of the IERRT development. This is because the IOT operators require that the navigational safety merits of the development should first address the intended operational phases of the project and also that insufficient information is available for assessing the construction phase and construction / operation phase.

1.1 BACKGROUND

7. NASH Maritime Ltd has been contracted to IOT Operators to provide Shipping and Navigation subject matter expertise and support to the IERRT project since April 2022, which corresponds to issue of the Preliminary Environmental Impact Report (PIER) Navigation Risk Assessment. Since April 2022 NASH Maritime have engaged with IERRT developers as follows:

   - Attended the following Hazard Workshops chaired by ABP:
     - IERRT Hazard Workshop 2: 7-Apr-2022.
     - IERRT Hazard Workshop 3: 16 & 17-Aug-2022.
     - Letters issued by the IOT Operators on 26-Aug-2022 and 16-Sep-2022 outlining their concerns with the ABPmer IERRT NRA methodology following Hazard Workshop 3 are appended to IOT Operators Written Representation.
   - Attended to observe the following elements of the ship bridge simulation sessions at HR Wallingford:
     - 11 April 2022 – arrivals and departures, IOT berth 8 (1 day)
     - 13 July 2022 - arrivals and departures IOT berth 8 (1 day)
     - 28-30 November 2022 – arrivals and departures IERRT berth 1 (1.5 days), arrivals and departures IOT berths 8 and 9 (1 day)
   - Attended the following ad hoc meetings:
     - Arranged a meeting with ABPmer to discuss concerns on the NRA methodology being employed on the project 25-May-2022. (Notes of the meeting can be viewed in Appendix A)
     - Met with IERRT developers to discuss IOT Operators mitigation measures and how they could be taken forward, either as part of the IERRT development or in the case of relocation of the IOT Finger Pier, as part of

another development ABP are pursuing, the Immingham Green Energy Terminal – 19-Oct-2022.

1.2 DOCUMENT STRUCTURE

8. The structure of this report is as follows:
   - Section 1: Introduction - Introduction to sNRA report and background to the assessment
   - Section 2: IERRT Navigation Risk Assessment
     - Review of ABPmer IERRT navigation report including the NRA and Ship Bridge Simulations
     - List of clarifications requested of ABPmer on the NRA
   - Section 3: Immingham Oil Terminal Operations - Overview of Terminal
   - Section 4: IERRT Development – Overview of IERRT development and operations
   - Section 5: Legislation and Guidance – Review of relevant NRA legislation and guidance
   - Section 6: Risk Assessment Methodology – details of the assessment methodology employed as part of this sNRA.
   - Section 7: Navigation Baseline – details of navigation in the area including vessel traffic analysis.
   - Section 8: Incident Analysis – review of incidents in the area and associated with Ro-Ro vessels.
   - Section 9: Qualitative Risk Assessment – IOT methodology using HSE / COMAH assessment.
   - Section 10: Quantitative Risk Analysis – Detailed likelihood and consequence assessment for IERRT ship contact.
   - Section 11: Additional Risk Control Measures – Review of ABP and IOT risk control measures
   - Section 12: Residual Assessment of Risk – With IOT risk controls in place including a detailed Cost Benefit Assessment
   - Section 13: Conclusions and Recommendations

2. IERRT NAVIGATION ASSESSMENT

9. The following sections provide a high-level review of the DCO Navigation Risk Assessment (NRA) (document TR030007-000369-8.4.10(b) and Vol3 Appendix 10.2: Navigation Simulation Study – Part 1). A list of clarification question issued to the IERRT developers, based on the review of documents, is then provided.

10. This section should be read in the context of Section 3 – Immingham Oil Terminal Operations and Section 7 – Navigational Baseline.

2.1 NAVIGATION RISK ASSESSMENT

11. The following review of the IERRT NRA is structured based on the contents of the report as follows:

- Introduction
- Data Sources
- Navigation Baseline Information
- Marine Development
- Future Baseline
- NRA Methodology
- Hazard Identification Workshop
- Risk Control Comments
- NRA Discussion
- Summary

12. For the reasons explained in the remainder of this section, it is judged that there are considerable issues with the ABPmer IERRT NRA that lead to a lack of clarity and consistency within the document making the document difficult for third parties to understand and assess.

2.1.1 Introduction

13. The proposed IERRT development is located within the Statutory Harbour Authority area of the Port of Immingham, and within the Competent Harbour Authority area of Humber Estuary Services. The relevant authority for navigation safety is therefore the Port of Immingham Harbour Master, commonly referred to as the Humber Dock Master (note - there is one Dock Master for the Humber, who is supported by local Deputy Dock Masters). It is not clear from the assessment whether the proposed IERRT terminal resides within the Vessel Traffic Services area for Humber Estuary Services or the Local Port Service area of the Port of Immingham.

14. The IERRT NRA details the Policy on which the assessment is based and identifies the National Policy Statement for Ports, the Port Marine Safety Code (PMSC), and two other guidance documents (IMO Formal Safety Assessment (FSA) guidelines and Maritime Coastguard Agency (MCA) Marine Guidance Note (MGN) 654 providing guidance to Offshore Renewable Energy installations). Where and how these policies and guidance documents are used in the NRA is not clearly stated (e.g., standards of acceptability are not defined for hazard risk scores), and it seems that various aspects from the different

guidance documents are drawn upon at various stages of the NRA with no overall coherent strategy. For example, Marine Guidance Note (MGN) 654 provides a checklist which can be used to ensure NRAs meet its requirements and this would be a helpful inclusion for the IERRT NRA.

15. The introduction also provides some commentary on As Low As Reasonably Practicable (ALARP) and Tolerability principles which are taken from the Guide to Good Practice on Marine Operations, a guide produced by the MCA, which accompanies the PMSC. This document is particularly focused on the requirement to undertake objective assessments, without being influenced by the financial position of the port.

16. The IERRT NRA documents the principle of Tolerability of risk, the point at which risk is acceptable, and defines what must be done to address intolerable risks. The IERRT NRA then identifies that for a level of risk to be acceptable, it must firstly be ALARP, and then it must be tolerable. The order this is presented is at odds with the PMSC, which identifies formal risk assessment should identify hazards / risks, access these against "standards of acceptability" and then where appropriate consider a cost benefit assessment of risk reduction measures (e.g., using ALARP) (through cost benefit) (See Section 2.7 of the PMSC - Use of Formal Risk Assessment):

17. The first test should therefore be whether risk is tolerable and only if not, then what can be done to mitigate it to tolerable levels using the ALARP principle.

18. A general comment on review of the NRA is that there is little in the way of standardisation of nomenclature and various terms are used in different context. A glossary is provided at section 13 but does not extend to common terms used throughout the assessment (e.g. "*Risk", "Risks", "Hazard(s)", "Embedded Controls" and "Further Controls", "Additional Controls*"). This makes the document difficult to follow and it falls short in terms of being transparent and clear to those seeking to read and understand it.

2.1.2 Data Sources

19. It is noted that the vessel traffic (AIS) data sources provided for the NRA are different to that provided to stakeholders for the HAZID workshops – it is not clear why this has occurred. It is not therefore possible to audit them or their comparability.

    - AIS data analysis provided in the PIER NRA and available for the hazard workshops was anonymised publicly available data from the Marine Management Organisation which is collected by the Maritime and Coastguard Agency from 2019 (see Section 2, Immingham Eastern Ro-Ro Terminal: Preliminary Environmental Information: Appendix 10.1: Preliminary Navigational Risk Assessment, January 2022).

    - AIS data sourced for the IERRT NRA is "from an in-house AIS database provided by Anatec Limited" a commercial provider, which covered 01 September 2021 to 31 August 2022

20. No quality checks on the IERRT NRA AIS data appear to have been undertaken (such as location of the receiving stations or details on any post-processing of data), or justification for the change in underlying data which was provided for use in the NRA by a third party, Anatec Ltd.

21. The authoritative source of information should be vessel data collected from Humber Estuary Services VTS (as the Vessel Traffic Services in the area of the proposed IERRT, which will be operated to IALA standards and hence data quality should be to the highest

standards) or confirmation/verification of third-party data sources against this where other data was necessary.

22. **Section summary**

    a. There is ambiguity as to why different AIS data sources were provided for the NRA than were provided for the HAZID workshops with stakeholders and a lack of quality checks undertaken for the IERRT NRA AIS data.

2.1.3 Navigation Baseline Information

23. The baseline information does not document or describe the marine infrastructure and associated vessel movements in the vicinity of the proposed IERRT; as such a clear baseline is not provided in the assessment on which a reader may make a judgement on the impacts on marine safety directly attributable to the proposed IERRT.

24. It is noted that the Port of Immingham and Humber Estuary Services have Marine Safety Management Systems (MSMS) in place that manage marine safety in the area, which are described as meeting the requirement prescribed by the PMSC. The PMSC mandates that MSMSs are based on a robust risk assessment conducted, and regularly reviewed / updated, with stakeholder consultation: see PMSC Para. 10 Bullet 6 & Section 2. It is understood that IOT Operators do not have records of attending hazard workshops for the Port of Immingham's PMSC-aligned NRAs and have no copies of the assessments that form the basis for managing navigation safety in the area or minutes relating to consultations on relevant port issues.

25. Further, under the requirement of the Pilotage Act 1987 and the MCA MGN 401 (Amendment 3 Navigation: Vessel Traffic Services (VTS) and Local Port Services (LPS) in the UK), risk assessments are required to determine the need and requirements of Pilotage and VTS.

26. Therefore, there are three requirements for the Port of Immingham to have a robust NRA in place for the area covering the IERRT, all of which require regular consultation with stakeholders such as the IOT Operators prior to and during the conceptual development of the IERRT. That consultation has not taken place.

27. In reviewing the baseline information, pilotage is noted as being provided. The Pilotage Act (1987) requires that Competent Harbour Authorities, in this case Humber Estuary Services, keep under consideration "*what pilotage services need to be provided to secure the safety of ships navigating in or in the approaches to its harbour*" (Section 2(1)(a)). As such, where pilotage is provided, it should be fit for purpose.

28. Generally, the analysis provided in the IERRT NRA (Section 3.7 Marine traffic analysis) shows only a high-level context of shipping and navigation for the area as a whole and does so primarily based on track plots (see Figure 1). The analysis presented also does not show the layout of the proposed IERRT development, making it more difficult to discern what the impacts to current vessel navigating in the area could be. Therefore the intricacies, complexities and details of how vessels currently navigate in close proximity to the proposed IERRT are not provided.

29. These track plots offer little in the way of context of sea room (swept path) currently used by vessels in this congested area, the dynamic / tidal nature of vessel transits in close proximity to the proposed IERRT, or the temporal disposition of navigation.

30. It is therefore unclear as to how vessels, of differing characteristics, may interact with the proposed IERRT infrastructure making it difficult to draw meaningful assumptions as to the navigational risks posed to baseline vessel traffic movements by the IERRT operation and infrastructure.

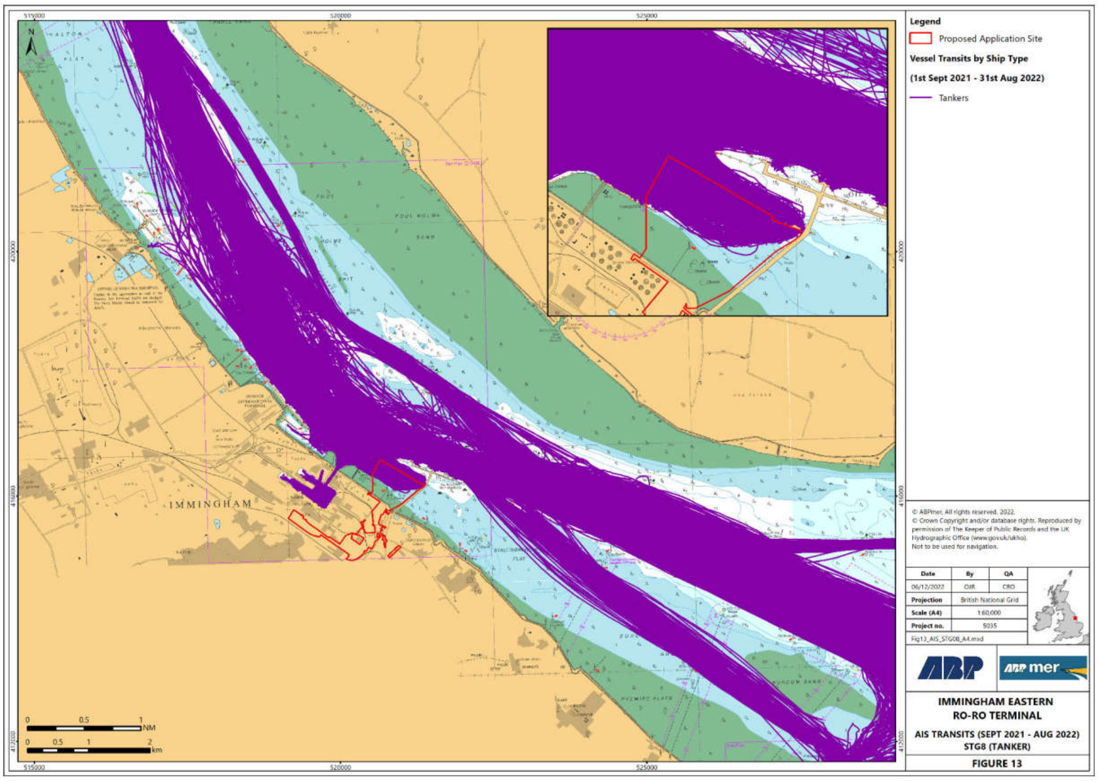


Figure 13 Vessel transits – Tankers

Figure 1: Figure 13 from the IERRT NRA showing track analysis of for Tankers.

31. Therefore, additional analysis is needed, focusing on the sea room currently used by vessels and their support craft (e.g., tugs) navigating in close proximity to the proposed IERRT development, particularly those vessels bound to/from the IOT Finger Berth, Immingham Eastern Jetty and other terminals in the area. This should be provided as individual and composite vessel swept path analysis by destination and vessel type and take into account adverse conditions such as high winds, restricted visibility and maximum water currents vessel may navigate in (e.g., tidal / fluvial water velocities).

32. The analysis and plots provided as part of the Navigation Baseline Information also do not show the proposed IERRT infrastructure, so even at the high level provided, impacts to passing vessels are difficult to discern. Such analysis was requested by IOT operators prior to both Hazard Workshops 2 & 3 (see Appendix A for meeting minutes and correspondence).

33. Incident analysis (see IERRT NRA Section 3.8 Marine accidents and incidents) provided is at a high level and fails to adequately provide context of incidents in the study area, particularly in relation to impacts with infrastructure and equipment failure on vessels, which are among the most frequent incident types and are of significant concern to IOT Operators for the ongoing safe operation of their terminal. No reference has been made to incidents elsewhere which may involve similar vessel types / navigation features (either nationally or internationally for the proposed class of vessel to use IERRT or incident data taken from Stena Line operations as the proposed operator of the facility), nor have the

magnitude of those incidents and the vessel types involved been identified in the NRA. This would be helpful in categorising incident likelihood and consequence for the IERRT. Similarly, historical incident analysis associated with ship collision/allision with oil terminals to ascertain hazard consequence has also not been provided and does not appear to have been undertaken.

34. **Section summary**

    a. There are inaccuracies, overlooked key information and insufficient analysis within the description of the navigation baseline information. It is therefore unclear as to how vessels, of differing characteristics, may interact with the proposed IERRT infrastructure making it difficult to draw meaningful assumptions as to the navigational risks posed to baseline vessel traffic movements by the IERRT operation and infrastructure.

    b. Further additional analysis is needed, focusing on the sea room currently used by vessels and their support craft (e.g., tugs) navigating in close proximity to the proposed IERRT development, particularly those vessels bound to/from the IOT Finger Berth, Immingham Eastern Jetty and other terminals in the area.

2.1.4 Marine Development

35. The proposed marine operations for the IERRT are not clearly defined in Section 4, which focuses on a cursory review of IERRT infrastructure and does not consider the marine operational concept for IERRT including sea room required and operational limitations (e.g., passage plan, tug use, berthing duration, metocean limits, etc.).

36. The inclusion of implicit impact protection in the IERRT design is not defined as part of the assessment and as such no designed-in impact protection is provided for within the IERRT infrastructure to protect the IOT and IOT Trunk Way.

37. Further, the details of the potential additional vessel impact protection provided to protect a section of IOT Trunk Way are not provided – e.g., design basis for vessel size, displacement and speed that the impact protection is designed to withstand.

38. There is also no clear design vessel specification provided within the NRA (e.g., vessel displacement, vessel windage, configuration such as propulsion type / engines / rudders / thrusters / machinery redundancy systems etc) provided. Given the complex nature of tide and challenging approach to the IERRT berths, then manoeuvring characteristics for the design vessel are necessary to assess likelihood and consequence of incident occurrence. Reference to vessel parameters is provided in the simulation reports, but these do not appear to be confirmed in the NRA. As such the specification of vessels visiting IERRT could well be less manoeuvrable and more difficult to handle than is inferred in the NRA and thus the likelihood of incident / accident occurrence could be more than the NRA depicts.

39. **Section summary**

    a. The IERRT NRA fails to provide a clear definition of the proposed marine operations for IERRT.

    b. Details of the potential additional vessel impact protection provided to protect a section of IOT Trunk Way are not provided.

    c. There is also no clear design vessel specification provided within the IERRT NRA.

d. The lack of clear definition limits an assessment of navigation risk as the complexities and nuances of the proposed operation and scheme design are not fully documented and understood.

2.1.5 Future Baseline

40. The future baseline contained within the NRA is generic and not specific to the berths at and around IERRT, and neither does it consider future developments such as Immingham Green Energy Terminal (IGET) – an ABP development in close proximity to IERRT (Scoping Report 30 August 2022) which is a Cumulative Tier 2 project[1] in the context of the IERRT.

41. The NRA should have undertaken an assessment of the cumulative effects of this project in relation to safety of navigation brought about by other proposed developments such as the Immingham Green Energy Terminal.

42. Projected increases in vessel traffic movements in the area over the life span of the IERRT infrastructure should be included in the assessment of navigation risk. The volume of future vessel movements, as presented in the NRA (Section 5) shows a marked increase across all vessel traffic in the study area and it is not clear how these increases in vessel traffic are considered within the assessment of risk for future scenarios and throughout the entire design life of the IERRT.

43. Construction of other facilities (noting that document *8.2.20 Environmental Statement - Volume 1 - Chapter 20 - Cumulative and In-combination Effects)* included only a superficial statement related to the Immingham Green Energy Terminal impact on the Shipping and Navigation Assessment and no identification of any relevant mitigation:

> *"Potential Significant Cumulative Effects: The only cumulative effect relevant from a commercial and recreational navigation perspective is the increased utilisation of the estuary as a result of greater vessel traffic. Existing embedded controls already in place for IMM [Port of Immingham] and HES [Humber Estuary Services] Marine Safety Management Systems mitigate risks associated with vessel movements on the estuary to an ALARP state already.*
>
> *Significance of Effect: Insignificant*
>
> *Residual Cumulative Effect: None / Insignificant."*

44. **Section summary**

a. The future baseline contained within the NRA is generic and not specific to the berths at and around IERRT, and neither does it consider future developments.

b. The volume of future vessel movements, as presented in the NRA (Section 5) shows a marked increase across all vessel traffic in the study area and it is not clear how these increases in vessel traffic are considered within the assessment of risk for future scenarios.

c. The NRA should have undertaken an assessment of the cumulative effects of this project in relation to safety of navigation brought about by other proposed developments.

[1] Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure projects | National Infrastructure Planning (planninginspectorate.gov.uk)

2.1.6 NRA Methodology

45. The NRA methodology is stated as complying with guidance provided in the PMSC, and that consideration had been given to MGN 654 and IMO FSA methods. However, the actual methodology deployed does not appear to be based on this or any other published NRA methodology relating to UK marine safety, and as such seems to have been developed for ABP specifically for the IERRT project.

46. The IOT Operators (as well as the UK Department for Transport as the government department with responsibility for the PMSC), consider that the basis of an NRA, both in terms of the overarching methodology and the provision of baseline understanding of risk (that is accurate, up-to-date and stakeholder-agreed), should be the NRA that the Port of Immingham already has in place as a requirement of the PMSC (and Pilotage and VTS provision) and underpins the Port of Immingham's MSMS.

47. Standards of acceptability (as mandated by the PMSC) have not been agreed with IOT Operators (and other stakeholders), and as such it is not clear what level of risk would be acceptable with the IERRT in place and operational. It is understood from the IERRT NRA that ABP, as Duty Holder for Port of Immingham, have determined what level of risk is acceptable, although the actual level is not documented within the NRA. As IOT Operators are a Control of Major Accident Hazards ("COMAH") site, it has HSE-imposed acceptability levels to risk which are referenced to clear likelihoods of occurrence for defined hazard consequences (e.g., fatality) – these have previously been provided to IERRT developers with the Standards of Acceptability to IOT Operators as a COMAH site under UK Health and Safety Executive regulations.

48. As set out in Section 6, the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) approach, is mandated by the UK PMSC as the appropriate methodology for marine operations in UK ports and harbours. A summary of PMSC Risk Assessment requirements relating to the IERRT NRA is provided in Table 1 (a copy of the Port Marine Safety Code is included in REP1-015)

Table 1: PMSC Risk Assessment requirements.

PMSC Section	Comments on IERRT NRA
Executive Summary Para 10 (pg 8) **Risk Assessment** 5. Ensure all marine risks are formally assessed and are eliminated or reduced as low as reasonably in accordance with good practice.	The focus on eliminated marine risk has not been prioritised and the NRA instead focuses on as low as reasonably in accordance with good practice.
6. Marine Safety Management System: Operate an effective MSMS which has been developed after consultation, is based on formal risk assessment and refers to an appropriate approach to incident investigation.	The Port of Immingham and Humber Estuary Services Marine Safety Management Systems are reference but not provided in the NRA. No formal details relating to consultation on the formal risk assessment has been shared with IOT Operators. Appropriate incident investigation should include notification to IOT Operators on findings of incident investigations related to IOT Operations / vessels (see Section 8.2.2 and 8.2.3 below.)
7. Review and Audit: Monitor, review and audit the risk assessment and MSMS on a regular basis – the independent designated person has a key role in providing assurance for the duty holder	The independent designated person has not attended IERRT hazard workshops or engaged with IOT Operators.
2. Key Measures to secure marine safety (pg 14) • **Use formal risk assessment:** Powers, policies, plans and procedures should be based on a formal assessment of hazards and risks and organisations should have a formal MSMS.	No details on the formal risk assessment Powers, policies, plans and procedures are provided for the Port of Immingham or Humber Estuary Services.
• **Implement a marine safety management system:** An MSMS should be in place to ensure that all risks are identified and controlled – the more severe ones must either be eliminated or reduced to the lowest possible level, so far as is reasonably practicable (that is, such risks must be kept as low as reasonably practicable or “ALARP”). Organisations should consult, as appropriate, those likely to be involved in, or affected by, the MSMS they adopt. The opportunity should be taken to develop a consensus about safe navigation. The MSMS should refer to the use of formal risk assessment which should be reviewed periodically as well as part of post incident/accident investigation activity.	Elimination of risk should be prioritised over application of the ALARP principle. Navigation risk associated with the IERRT development can be eliminated through implementation of impact protection and relocation of the IOT Finger Pier. Consultation with stakeholders such for the IERRT has been: • Hazard workshop 1: ABP only based on numerical NRA methodology. • Hazard Workshop 2: ABP and stakeholders based on numerical NRA methodology. • Hazard Workshop 3: ABP and Stakeholders based on a non-numerical NRA methodology.
• **Consensus:** The organisation should strive to maintain a consensus about	

PMSC Section	Comments on IERRT NRA
safe navigation. This can be achieved through formal programmes of stakeholder engagement a review of relevant risk assessments with users of the facility or harbour	No consensus on safe navigation was made, and the thresholds for acceptability of risk were not defined in hazard workshops.
Use formal risk assessment. 2.7 The risks associated with marine operations need to be assessed and a means of controlling them needs to be deployed. The aim of this process is to eliminate the risk or, failing that, to reduce risks as low as reasonably practicable. Formal risk assessments should be used to: • identify hazards and analyse risks; • assess those risks against an appropriate standard of acceptability; and • where appropriate consider a cost-benefit assessment of risk-reduction measures.	PMSC prioritises elimination of risk, which can be provided for IERRT through implementation of the impact protection and relocation of the IOT Finger Pier. Identification of hazards within the IERRT NRA does not follow a structured approach with hazards defined in an ad hoc manner. Analysis of vessel tack data and incident data is provided, but at a basic level, which does not adequately detail the types, sizes, and searoom taken up by vessel navigating to and from the IOT. The assessment *of risk against an appropriate standard of acceptability* has not been provided in the IERRT NRA. No quantitative details on the acceptability of risk to ABP is provided and no consultation with stakeholders, who will be impacted by the hazards, was undertaken in relation to acceptability of risk. Consideration of cost benefit assessment of risk reduction measures is provided in the IERRT, however no quantification of cost or benefit is provided.
Use formal risk assessment. 2.8 Risk assessments should be undertaken by people who are competent especially when deciding which techniques to use and when interpreting the results. Risks should be judged against objective criteria, without being influenced by the financial position of the authority, to ensure they are reduced to the lowest possible level, so far as is reasonably practicable (that is such risks must be kept as low as reasonably practicable or "ALARP"). The greater the risk, the more likely it is that it is reasonable to go to the expense, trouble and invention to reduce it. There is a hierarchy of risk control principles: a. minimise risks – by suitable systems of working; b. combat risks – by taking protective measures to prevent risk; and c. eliminate risks – by avoiding a hazardous procedure or substituting a less dangerous one.	The IERRT NRA has been undertaken by a team from ABPmer, a wholly owned subsidiary of ABP, who are also the developers of IERRT and the harbour authority charged with maintaining navigation safety in the area. The credentials of the ABPmer consultants who undertook the NRA have not been provided. The PMSC requires that risk assessments should not be influenced by the financial position of the authority and therefore the cost benefit assessment should be open and transparent, which is not the case in the IERRT NRA. The hierarchy of control principals indicate that elimination of risk should be prioritised.
Use formal risk assessment. 2.9 The process of assessment is continuous so that both new hazards to navigation and marine	The existing NRA undertaken by the harbour authority (Port of Immingham / Humber estuary

PMSC Section	Comments on IERRT NRA
operations and changed risks are properly identified and addressed. Where appropriate organisations should publish details of their risk assessments.	Services) for the area have not been published or shared with key stakeholders such as IOT Operators.
Use formal risk assessment. 2.10 Risk assessments should be reviewed on a planned periodic basis. The MSMS should prescribe the organisation's policy on review frequency as well as any related procedures or processes. The MSMS should also refer to a procedure which ensures that risk assessments are reviewed appropriately in the following circumstances: • on a planned periodic basis; • post-incident/accident; and • post-review of relevant marine accident or health check trend report.	MSMS procedures for the area have not been provided in the IERRT NRA. Neither is it clear that risk assessments have been reviewed and updated on a planned, post incident or post review/ audit report.
Use formal risk assessment. 2.11 Risk assessment reviews are best conducted by utilising user groups or representatives who use the harbour or facility regularly. This helps to ensure that practical and relevant experience can be captured, promotes good consultation and demonstrates the organisation's commitment to engaging with users.	No formal review of the harbour authority (Port of Immingham / Humber estuary Services) existing baseline NRAs has been undertaken with IOT Operators.

49. **Section summary**

   a. There is a lack of clarity within the ABPmer IERRT NRA as to the NRA methodology, specifically how guidance documents (e.g. PMSC) and policies are used in the NRA and how the NRA meets the requirements of the named guidance and policies.

   b. There is a lack of transparency and clarity in regard to the definition of Standards of acceptability (as mandated by the PMSC).

2.1.7 Risk Assessment methodology

50. Section 6 and 7 of the IERRT NRA details the risk assessment methodology, risk matrix and the Hazard Identification Workshops for the NRA .

51. It stated (at para. 6.3.4) that the consequence categorisation definitions used within the NRA are taken from ABP's MSMS – presumably the MSMS's baseline NRA for the Port of Immingham as mandated by the PMSC. These provide a range for each category, and it is not clear whether these have been calibrated to the risk appetite of ABP or stakeholders such as IOT Operators, e.g. the highest Consequence Descriptors: Port, which is defined as "Extreme" consequence relates to "*Major (Negative national and international publicity. Major damage to reputation. Major loss of revenue, > £8 M)*" – it is not clear whether this relates to IERRT operations (ABP or Stena Line) or IOT operations (see IERRT NRA Tabe 15: Consequence Descriptors).

52. The likelihood (termed "frequency") categorisation definitions (as presented in Table 16 and reference in para. 6.3.5 of the IERRT NRA) do not appear to have a source of reference and are specific to the IERRT project – i.e., they do not appear to be taken from

the existing Port of Immingham NRA or the reference guidance documents presented, or any other maritime guidance publication on navigation risk. The frequency and associated descriptions do not relate to specific mathematical probabilities (e.g., such as return periods) and are therefore entirely subjective in nature.

53. Further the IERRT PIER NRA used different likelihood descriptors, and whilst no definitive guidance is provided within the PMSC, the MCA MGN 654 does reference IMO Formal Safety Assessment Likelihood/Frequency Index likelihood descriptors at MGN 654 Annex 1 Methodology for assessing marine navigational safety & emergency response risks of OREIs.

54. In the context of the IERRT NRA then word-based frequency descriptors are used based on the lifetime of the operation being assessed which are then combined with consequence criteria to produce a risk classification using the tolerability matrix (see Figure 2). The frequency descriptors are as follows, and if related to the lifetime of the entity (e.g., the IERRT) then could be determined to have the following mathematical return periods (probabilities):

- Operation Phase – 50 years duration:
    - Rare – <1 in 1,000 years
    - Unlikely – 1 in 100 years 14to 1 in 1,000 years
    - Possible – 1 in 50 years to 1 in 100 years
    - Likely – 1 in 10 years to 1 in 50 years
    - Almost Certain – >1 in 10 years
- Construction phase - 2 years duration:
    - Rare - < 1 in 10 years
    - Unlikely – 1 in 4 years to 1 in 10 years
    - Possible – 1 in 2 years to 1 in 4 years
    - Likely – 1 in 2 years
    - Almost Certain – >1 in 1 years

55. As a result, the mathematical return periods (probabilities) for the IERRT Frequency Descriptors are not definitive and would likely be interpretated differently by different individuals.

56. Based on the IERRT NRA Figure 26 People Tolerability Matrix, multiple fatalities that occur for the operation phase as "Unlikely" Frequency are considered Tolerable – this could relate to a mathematical return period of between 1 in 100 years to 1 in 1,000 years per occurrence. However, for the construction phase the same likelihood, for multiple fatalities would be a 1 in 4 year to 1 in 10 year per occurrence.

57. Also, when reviewing the Tolerable area on the IERRT NRA Figure 26 People Tolerability Matrix for an "Unlikely" frequency hazard, then it would be scored as a "Medium risk" for a single fatality and the same for a multiple fatalities' consequence.

58. Thus, there appears to be variable tolerability to hazards between the construction, construction/operation and operation phases of the IERRT, and none of the tolerability thresholds appear to have been benchmarked to any Standards of Acceptability as required by the PMSC or as specified in MCA MGN 654.

Classification	Outcome
Very High Risk	Very High
Significant Risk	Significant
Medium Risk	Medium
Low Risk	Low
No Practicable Risk	No Practicable Risk

Descriptor	Frequency
The impact of the hazard is realised but should very rarely occur (within the lifetime of the entity)	Rare (1)
The impact of the hazard might occur but is unlikely (within the lifetime of the entity)	Unlikely (2)
The impact of the hazard could very well occur, *but it also may not* (within the lifetime of the entity)	Possible (3)
It is quite likely that the impact of the hazard will occur (within the lifetime of the entity)	Likely (4)
The impact of the hazard will occur (within lifetime of entity)	Almost Certain (5)

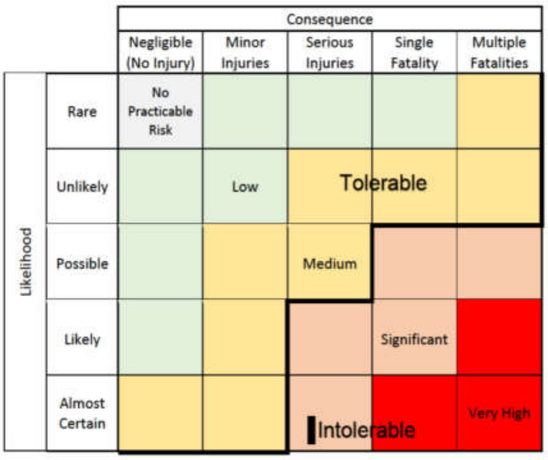


Figure 2: Extract from IERRT NRA report: Top left: Table 16 Frequency Descriptors, Bottom Left: Table 17 Risk classification and right Figure 26 People Tolerability Matrix.

59. Further a recent Navigation Risk Assessment for the Able Marine Energy Park Development Consent Order[2] provides different likelihood probabilities which are more closely aligned to HSE standards (see Section 5.2 below).

60. The IERRT NRA methodology approach also does not allow for an informed Cost Benefit Analysis (CBA) as required when using the ALARP principle (PMSC Section 2.7) as the effectiveness of risk controls cannot be quantified empirically against a change in likelihood. For example, using the IERRT Frequency descriptors (as specified in Table 16 Frequency Descriptors of the IERRT NRA), a risk control measure that reduces the likelihood of a hazard occurring from a "Possible" to "Unlikely" frequency level, corresponds to hazard likelihood change of "an impact of a hazard could occur" to the "impact of a hazard might occur". As there is no mathematical basis to the frequency descriptors it is not possible to undertake a cost benefit assessment and therefore hazards defined as Acceptable if ALARP using cost benefit cannot be determined using the methodology employed.

61. The risk matrix employed, which brings together consequence and likelihood classifications to determine a risk score, also has no source defined. For example, the PEIR for the Immingham Green Energy Terminal[3] shows a different risk matrix, albeit is only listed as an example risk matrix, but it does not align with that chosen for the IERRT NRA. The loose definitions of likelihood and the classification within the risk matrix allows for considerable flexibility in resulting risk scores, which has the potential to significantly underplay risk levels. The categorisation of risk is also questionable when considering it's alignment with ABP's tolerability threshold – for example, an "*extreme*" consequence that results in multiple fatalities that is *"unlikely*" (but still "might" occur in the 50yr-life of the project) is only regarded as a medium risk and is considered to be tolerable; and a "*serious*" damage to port reputation resulting in £8M loss of revenue that is "*quite likely*" to occur is regarded as a significant risk yet is still tolerable. In the context of HSE standards of acceptability the risk of these hazards would likely be interpreted as unacceptable (see Section 5 below). The lack of any quantitative analysis / modelling or numerical approach

2 https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030006/TR030006-000135-TR030006-APP-6A-14-1.pdf
3 https://imminghamget.co.uk/wp-content/uploads/2023/01/12_IGET-PEIR-Chapter-12-Marine-Transport-and-Navigation.pdf

to hazard likelihood means that the NRA cannot be benchmarked to any guidance on standards of acceptability as required by the PMSC.

62. **Section summary**

a. In general, the likelihood definitions used within the IERRT NRA are overly simplified, entirely qualitative/subjective in nature, are different for the construction, construction/operation and operation phases of the IERRT, are not referenced to IOT COMAH Safety Plan likelihood classifications (as previously provided to ABP), do not appear to be based directly on the current baseline risk assessment for the area as required by the PMSC and do not allow any meaningful quantified/probabilistic basis for assigning a category for the likelihood of hazard occurrence.

b. It is not clear from the IERRT NRA report how the tolerability / acceptability of risk for hazards using the ALARP has been defined. Although reference is made to a Cost-Benefit Analysis and Tolerability workshop held by ABP on 6 October 2022 (see para. 7.1.13 of the NRA) although no minutes or details are provided) and neither were Stakeholders (who would be impacted by the IERRT development) consulted or invited to attend.

c. Further, the tolerability workshop was undertaken retrospectively following the hazard workshops, so during the workshops no attendee was aware of whether the scoring they had applied would result in acceptable or unacceptable hazard outcomes, especially when considering the subjective and qualitative nature of the method employed, particularly the likelihood parameters.

2.1.8 Risk Control Comments

63. The risk control section of the IERRT NRA considers measures that can be put in place to minimise risk, either through a reduction in the likelihood of a hazard occurring, or a reduction in the magnitude of hazard consequences. The IERRT NRA, however, considers a number of further risk control measures that are either very similar to each other or very similar to embedded risk control measures (i.e., those measures that are already currently in place for the management of navigation risk in the area).

64. An example where further risk controls are similar to embedded risk controls is Additional Pilotage Training / Familiarisation (see Table 29 Construction-Operation - Further Applicable risk controls of the IERRT NRA) which is the same as provision of Pilotage – which should be an embedded risk control. IOT Operators consider that the assessment of risk undertaken for the IERRT hazard workshops considered the provision of pilotage for IERRT vessels (either in the form of an authorised pilot or Pilot Exemption Certificate (PEC) holder). The Pilotage Act requires that where pilotage is provided, it must do so to ensure safety and, as a result, additional training / familiarisation should be considered as an embedded measure – taken as a matter of course. This is because IOT Operators consider that pilotage (where provided) should already be to the requisite standard, and therefore don't consider that risk reduction applied to this control should be applied to hazards to reduce risk in the NRA.

65. An example of further risk control measures which are similar, the operational phase of the IERRT includes "Berthing Criteria (which includes implementing other potential weather limits (e.g. high winds), "Tidal Limitation / Weather Restrictions", and "Berth Specific Weather Parameters" (which also is assumed to relate to weather limits) – these are essentially the same risk control measure and IOT Operators would consider that they

should be embedded measures and not further measures. This is because all berths and terminals should have operational procedures in place which should include weather limits – which at this stage of the IERRT development should be well known as it impacts the design and operability of the terminal. It is also standard practise in risk assessments to have clearly defined measures which are commonly attributed to multiple hazards, this makes the NRA process more structured and easier to follow. The IERRT NRA instead relies on ad hoc requests and comments raised at the hazard workshops and judgement of the ABPmer consultants with little consolidation and refinement on risk control definition undertaken. This has the potential to both confuse the reader obfuscating the actual level of risk reduction applied by particular controls and may result in double accounting of risk reduction. Also, in attending the hazard workshops, it was not made clear to the IOT Operators that the risk was being assessed without some or all embedded controls in place.

66. In relation to the IOT Operators proposal to relocate the Finger Pier, then this is identified as a highly effective risk control listed as a "very substantial" control measure by eliminating risk completely; however, this further risk control has not been carried through during the assessment of residual risk and the reason given was to allow assessment of the other identified mitigations. Specifically, it is not shown for hazard O1 (Table C1) and is greyed out for Hazard O2 and O3 (Tables C2 and C3). The IERRT NRA states the Cost Benefit Assessment (CBA) and ALARP assessment considered this further risk control as "not reasonably practicable" (see Para. 9.9.21 of the IERRT NRA) and it was subsequently dismissed, however, there is no detail justifying this decision and no prior consultation was undertaken with IOT Operators to understand the nature and extent of the operations at the Finger Pier and if/how they could be maintained through other means. The justification of "not reasonably practicable" is therefore premature without detail being provided which can be reviewed by IOT Operators.

67. Impact Protection for the IOT Trunk Way is identified (see para. 9.9.24 of the IERRT NRA) to provide protection to a portion of trunk way south of the IOT Finger Pier. However, this does not provide protection against collision of an IERRT vessel with a tanker or barge berthed at the IOT Finger Pier, nor allision with the finger pier itself, which would require re-locating the finger pier. The Impact Protection risk control was also not considered as required within the IERRT NRA, and instead its construction is placed at the discretion of the ABP Harbour Master for the Port of Immingham – again, no details have been provided to justify the decision by IERRT developers.

68. **<u>Section summary</u>**

    a. The identification, specification and application of further risk controls proposed by the IERRT NRA is difficult to understand and flawed in many aspects. The justification for which further controls are adopted is also unclear and not documented.

    b. It is therefore difficult to assess the effectiveness of the proposed IERRT NRA risk controls and to quantify the impact of the proposed risk control measures in reducing levels of navigation risk.

2.1.9 NRA Discussion

69. There is discussion of a CBA having been conducted throughout the IERRT NRA but there is no detail describing the methodology and process used, nor the outcomes of the CBA exercise, including the anticipated costs (quantitatively, or even qualitatively) and how

these have been used to determine what could be considered appropriate. The judgement on CBA and tolerability is therefore highly subjective and determined solely by ABP as developer of the IERRT.

70. Further, in the IERRT NRA what is reasonably practicable is not directly related to what is tolerable and the measure of practicability is not clear. It would be expected that tolerability and ALARP levels should already be established as part of the Port of Immingham's MSMS or it is determined / agreed in consultation with the relevant stakeholders in the same way that the NRA that underpins the MSMS would be and that this would precede and be known to stakeholders prior to the hazard workshop. In this way the appetite for risk between different stakeholders can therefore be considered in setting acceptable risk levels, this is commonly referred to as calibrating the risk matrix / appetite (e.g. see UK Government Risk Appetite Guidance Note [4]).

71. A fundamental issue within the IERRT NRA is that ABP/ABPmer have calibrated the assessment against their own risk appetite levels and have not considered the risk appetite of IOT Operators or other stakeholders, nor has the risk appetite level been based on accepted marine guidance or even the existing level used by ABP operationally for other PMSC NRAs. In consideration of acceptability of risk, then ABP, as IERRT developers, must consider the risk appetite of IOT Operators as a top tier COMAH site and critical national infrastructure site for distribution of fuels, operated/owned by oil majors with highly developed and detailed policies and procedures in place for the management of risk.

2.1.10 IERRT NRA Summary

72. The NRA report summary is brief and does not summarise what further risk control measures will be implemented for each of the Construction, Construction/Operation and Operation stages of the IERRT.

73. It also recommends that the IERRT NRA is used "to inform amendments to the Marine Safety Management System that is currently in place at the Port of Immingham to ensure that risks are appropriately captured, monitored, and updated as required based on the latest information available as time goes on." That Marine Safety Management System is not being made available as part of the DCO application. Nor is the Port of Immingham's NRA undertaken in compliance with the PMSC which informs the port's Marine Safety Management System. It is therefore impossible for stakeholders engaged in the DCO application (or the Examining Authority) to understand what those amendments should be, what their effect would be, and what all of that might mean for the remainder of the assessments which have been made by the Applicant in their DCO Application (including for example, their Environmental Statement).

2.2 IERRT SIMULATIONS

2.2.1 Background

74. ABP commenced IERRT feasibility simulations at HR Wallingford (HRW) during 2021 and continued these simulation studies periodically during 2022 to study tidal flow, design, orientation, and dredged area of the proposed Ro-Ro facility. A real time navigation simulation study was commenced with the objective of understanding the navigation operations and to ascertain the likely operating limits of design vessels using the facility. Supplemental to this, simulations also studied the potential effects of the presence of the

[4] Risk Appetite Guidance Note (publishing.service.gov.uk) accessed 24-Aug-2023

proposed terminal on the arrival and departure of ships using the adjacent IOT, in particular the IOT Finger Pier. Output from the simulations was used to inform the NRA. APT and NASH Maritime Ltd (NASH) representatives were invited to observe elements of the simulation sessions as follows:

- Session One: 11th April 2022 (1 day)
- Session Two: 13th July 2022 (1 day)
- Session Three: 28th to 30th November 2022 (2.5 days)

75. During all sessions, HRW staff plus employee representatives from ABP Humber, ABP Projects, ABPMer, Stena Line and SMS Towage were present. During sessions one and two, APT (Immingham) Ltd as IOT Operators and NASH were the only observers. For Session three, in addition to IOT Operators and NASH, ABP had also invited Brian Greenwood (specialist in planning law at Clyde & Co) and representatives from DFDS plus, at the request of IOT Operators, Captains from James Fisher Everard (JFE) and Rix Shipping, both holding a Humber Pilot Exemption Certificate (PEC).

2.2.2 Session One

76. The intention for Session One was to simulate vessel movements to and from the IOT Finger Pier berth 8 which, at 94m minimum distance from the closest point of the proposed IERRT infrastructure, was deemed to be potentially the worst affected of the IOT berths.
77. The orientation of IERRT jetties for this study was 298° with a four-berth configuration which has since been superseded with a three-berth configuration.
78. The proposed tanker vessel model was '*Thun Grace*', but this ship model was subsequently found not to respond accurately, therefore a model of '*Thames Fisher*' was used. A total of 10 arrival and departure manoeuvres were conducted by highly experienced, senior Humber Pilots in moderate and strong NE'ly and SW'ly beam winds.
79. It was concluded from these simulations (especially in some wind conditions) that the currently practiced departure manoeuvre(s) would need to be modified due to the presence of IERRT's linkspan and berth. Notwithstanding the constrained approach presented by IERRT Berth 1 and its alongside vessel, berthing and departure was possible with care, utilising the existing workboat and tug resources available for ships berthing at the IOT.

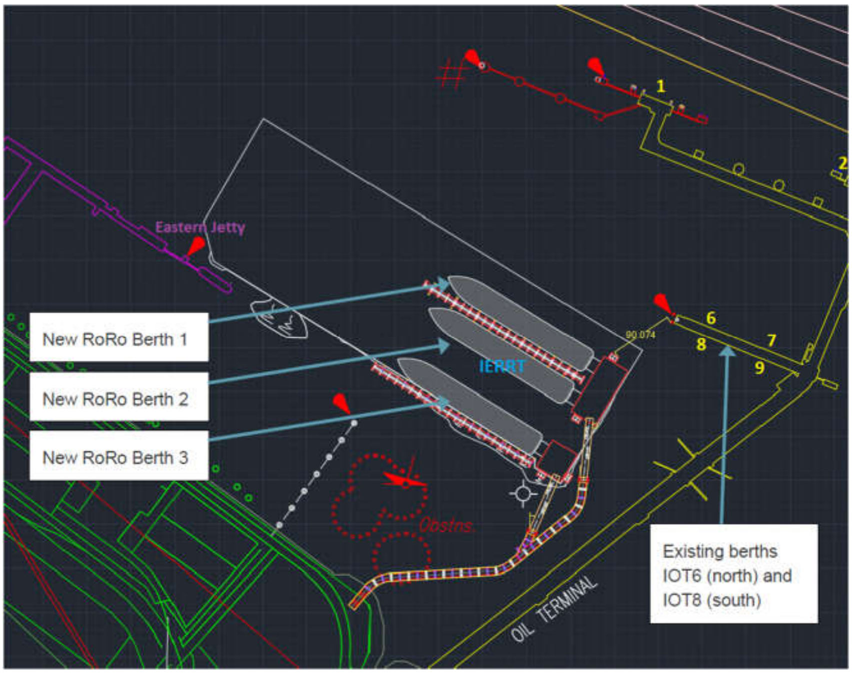


Figure 3: IERRT layout (from simulation report).

80. However, these simulations were undertaken without wind shielding enabled, and as a result the berthing scenarios are not realistic, because in real life there would be an added degree of difficulty and risk caused by rapid variations in forces acting on the vessel as a result of wind shielding, at a crucial time during the final approach to the berth. The April 2022 HRW report noted '*it is considered that during southerly winds, a combination of wind sheltering and funnelling could increase the complexity of berthing at berths 6 and 8'*.

81. Furthermore, the '*Thames Fisher*' class of ship is currently undergoing disposal and was more representative of a ship of the past visiting IOT, rather than a more modern ship with potentially larger Gross Tonnage and increased windage area (hence, many current and future vessels visiting the IOT Finger Pier will be significantly more susceptible to wind and wind shielding effects).

82. From hands-on knowledge, the '*Thames Fisher'* is known as a highly manoeuvrable vessel with a large ballast capacity (resulting in less windage area when approaching the berth) and a large bow thruster (resulting in increased manoeuvrability and response). Importantly, the ship's propeller transverse thrust acts 'left-handed' when the engine is operated astern whereas most ships act 'right-handed' (resulting in opposite vessel yaw rotations when propellor thrust in an astern direction is ordered), therefore its handling characteristics differ from the vessels which are expected to use the facilities it is therefore not a suitable model to use for a feasibility study, nor is it a conservative vessel suitable to be defined as a design vessel which should be reasonably worst case.

83. Furthermore, the ship's relatively small Gross Tonnage (GT) was not representative of a more modern, wide beamed vessel, neither is its shorter length (91m versus the longer Berth 8 design vessel length of 105m). For example, '*Wisby Teak'* and '*Wisby Argan'* regularly use the berths and are 4776 Gross Tonnage (GT) versus Thames Fisher's 2760 GT, hence are 'heavier' and larger vessels to manoeuvre, with higher windage and less able to be adequately controlled by the available workboat.

2.2.3 Session Two

84. For session two, the IERRT orientation had been changed from 298° to 300° and the minimum distance to IOT finger pier reduced from 94m to 90m, with a three-berth configuration (see Figure 3).

85. Again, highly experienced senior Pilots were used to conduct the simulation runs. The '*Thun Grace'* model had been corrected and was found to be broadly representative of the real ship. At 104m in length, the vessel is near design length for the IOT Finger Pier berths and has slightly higher GT than '*Thames Fisher*'. It is also a 'right-handed' acting ship, therefore more suitable (normal) for the study than the 'left-handed' '*Thames Fisher*'. It was also noted that the '*Thun Grace*' ship class is also old and currently being disposed of, therefore a larger tonnage model would still be preferable to assess the largest vessels likely to use the IOT Finger pier, which would also allow room for a small amount of future conservatism associated with the trend of vessel sizes increasing.

86. In total 11 arrival and departure runs were completed, of which all except one (run 10) proved to be feasible within the wind and tide limits simulated. Run 10 resulted in a heavy landing on Berth 8 which HRW described as '*Pilot error due to fatigue'*.

87. Again these simulations were not undertaken with wind shielding enabled, and therefore the study was not representative of the typical challenges of ship handling which actually occur.

2.2.4 Session Three

88. Session three was likely facilitated to try to appease other port users who had their own reservations regarding the feasibility of IERRT. At the request of ABP, Brian Greenwood (Clyde & Co) was present throughout. IOT Operators had requested ABP to invite an experienced James Fisher Everard (JFE) Master and Rix Shipping Master who hold a Pilot Exemption Certificate (PEC). At the suggestion of IOT Operators and NASH, ABP had requested HRW to model '*Wisby Teak'* and '*Rix Phoenix',* these simulating a larger tonnage vessel within the 104m IOT Finger Pier berth design length and an inland trading oil distribution (bunker) vessel, both of which are regular callers at IOT.

89. Day 1 and the morning of day 2 were dedicated to Ro-Ro manoeuvres to and from IERRT berth 1. DFDS had made comment regarding the inappropriate use of their highly manoeuvrable Jinling class ships which would never visit the proposed terminal (e.g. '*Humbria Seaways*'), therefore the existing Stena T class model '*Stena Transporter'* was used for IERRT runs during this session. Stena T class are 212m in length versus Jinling class 238m (the latter being design length for IERRT and thought to be the approximate length of the replacement generation of Stena T class ships) with considerably less beam and displacement, and therefore could be deemed easier to manoeuvre into IERRT than the larger ships that would be expected to service the proposed IERRT in the future.

90. Two highly experienced Stena Captains (also Humber PEC holders) conducted arrival and departure manoeuvres, one of whom had previously conducted some 70 simulated manoeuvres at IERRT during previous simulation sessions and was noticeably more practiced in the skills required than the other. It was clear that the approach angle and positioning of the vessel in relation to the tide and wind are critical to a safe and timely outcome. Run 11a was terminated due to the vessel's suboptimal positioning in the main channel and the time taken to manoeuvre clear of the main shipping channel, rather than letting the run complete. However, this aborted manoeuvre was recorded in the simulation report as 'no particular issues identified'.

91. Captains were pushed by the attending ABP HES Harbour Master, to vacate the main channel and lock bell mouth approach area as quickly as possible and manoeuvre within the confined water space between Immingham Lock approach, Eastern Jetty, IOT and the proposed IERRT. This additional pressure introduces an additional risk during poor weather or at a busy shipping period.

92. A total of 12 arrival and departure manoeuvres were concluded over 1.5 days which, despite the vessel being highly manoeuvrable, resulted in the model often being close to its engine and bow thrust operating limits. In addition, some manoeuvres, particularly departures during strong ebb tide, highlighted the vulnerability of tugs, especially the forward tug when secured to the vessel's bow. The combined effect of a 4 knot ebb and the vessel moving ahead at 3 knots over the ground results in a water speed of 7 knots. If a vessel is moving ahead through the water a tug needs to use a proportion of its power to match the speed of the ship, thus leaving only a proportion of its power to be available for manoeuvring the ship, therefore the tug is much less effective as speed increases and is of little or no effect once a large ship reaches 5 to 6 knots water speed. Additionally, water flow between a tug and the ship's bow causes a low-pressure area, which results in the tug getting sucked in towards a ship's bow, potentially losing control and colliding. This hydrodynamic effect is exponentially related to water speed. The effectiveness of a ship's bow thrust is similarly downgraded as the ship's speed increases.

93. Therefore the use of tugs in these situations needs to be considered in relation to how effective they would actually be; this further increases risk associated with manoeuvres in limit state conditions.

94. Two 'emergency' scenarios were conducted with a simulated total loss of power during the approach to IERRT Berth 1 on a spring ebb tide. In the opinion of NASH, APT and DFDS, these scenarios were scripted in detail prior to the run, conducted at too low a ground speed and commenced with the pre-planned response of dropping both anchors (using bridge control) within 15 seconds of alarm. This well-rehearsed and unrealistically quick response resulted in a successful simulated outcome whereby the anchors held, and the vessel's speed was arrested. The reaction time to these 'emergencies' was unrealistically fast compared to that likely in a real-life incident; additionally, most ships do not have the benefit of bridge control of anchors and are not manned to a level to be able to let go two anchors simultaneously. Due to the nature of the trade, RoRo ferries rarely use anchors, therefore it is reasonable to conclude that deploying them is likely to take longer than on a ship where they are regularly used.

95. Quick reaction time in loss of power scenarios is key to a good outcome, because the longer the vessel has to gain speed and momentum in a strong tidal current the longer and more difficult it is to stop and the less likely the anchors are to hold or quickly arrest the vessel. Kinetic energy, being related to speed, squared is exponential not linear – e.g. stopping power required at 2 knots is 4 times that required at 1 knot and at 4 knots is 4 times that required at 2 knots.

It can be concluded therefore that these brief 'emergency' scenarios cannot be regarded as a realistic representation of the likely outcome of real-life emergency and that the associated level of risk has not been adequately identified or addressed in the NRA.

96. During the afternoon of day 2 and the morning of day 3, simulations of tankers to IOT Finger Pier Berth 8 were conducted by a senior Humber Pilot using '*Wisby Teak'.* The wind shadowing feature of the simulator was switched on, which proved that the berthing manoeuvre in a strong SW'ly wind with a ship alongside IERRT berth 1 was indeed more challenging than without wind shadowing enabled. Despite good prediction of the timely need for assistance from the workboat and tug, berthing manoeuvres to Berth 8 during strong SW'ly winds resulted in landings which were heavier than would be routinely acceptable, leaving little margin for error or contingency. The ship's bow thruster was less able to cope with the additional windage caused by the wind funnelling effect introduced by the presence of nearby IERRT infrastructure and moored Ro-Ro. By using the larger 40t bollard pull tug on the bow rather than the stern and the workboat pushing aft, a lighter landing was achieved, however only one simulation was conducted using this tug allocation and therefore inconclusive without further trials. However, the availability of 40t bollard pull tugs is currently limited on the Humber Estuary.

97. Rix PEC Captain conducted runs using '*Rix Phoenix*'. A technical issue not apparent from the ship's bridge was discovered by HRW staff which explained why the first two runs had failed. Thereafter, although the model was not deemed fully representative of the handling characteristics of the real ship, two successful manoeuvres were conducted to Berth 9. The Rix PEC Captain observed that the reduction in manoeuvring space due to IERRT infrastructure would result in him being unable to carry out some of the manoeuvres that are currently routinely carried out during strong tides and winds.

2.2.5 Summary

98. There was discussion among the stakeholders attending the simulations during all sessions regarding the accuracy of the tidal modelling. For session three, the modelling had been further updated and it was stated by HRW that the updated tidal model better represented the actual tide experienced by Pilots and PEC holders. The complexities are enhanced because the spring and neap tide flows are not in exactly opposite directions - flood and ebb are not 180° opposed - plus, at differing states of the flood and ebb tides, flow directions differ due to whether water is flowing around mud banks (nearer low tide) or over them (nearer high tide). Flow around the IOT Finger Pier will be altered by the proposed dredged area of IERRT and the proposed infrastructure itself is likely to further impact what is currently experienced, particularly in way of the link span construction close to IOT berth 8.

99. It was stated by HRW that to add a conservative approach to the simulation studies, simulated tidal flows have been increased by about 15% compared to tidal flow modelling – this may not however be representative of the tidal flow directions and velocities experienced once the IERRT is constructed. Fluvial run down can also considerably increase the rate of ebb flow which has not been taken into account in simulations.

100. There was verbal agreement, during simulation attended by IOT Operators, from HRW and ABP Humber that the proposed IERRT design presents a challenging berthing scenario which would require careful planning and meticulous manoeuvring, especially in strong tide and/or wind. This theme was reflected in the simulation report. HRW in TR030007-000369-8.4.10(b) (Navigation Simulation Study – Part 2) concludes that IERRT should be subject to potentially onerous limiting wind parameters due to limited manoeuvring space and that operations would be challenging. Manoeuvres would require precise positioning of the vessel, tugs and their attitude to tidal flow and wind.

101. Therefore, if the development was to go ahead, there would be inherent risks which would result in a significant and ongoing training burden for Pilots and PEC holders as well as an increased risk to the IOT Finger Pier due to the proximity of IERRT infrastructure. This increased risk would be due to the increased technical difficulty of berthing ships at IOT 8 and 9 and the berthing of RoRo's at IERRT.

102. Spring ebb tide is generally seen as the main challenge for the IERRT berths particularly berths 2 and 3, where reduced wind parameters are recommended due to the reduced effectiveness of a ship's thrusters and tugs due to the vessel's headway through the water. In a strong (4 knot) ebb current when stationary over the ground or moving ahead the effects would require utmost caution.

103. It is envisaged that most vessels calling at IERRT will have regular masters who have Pilotage Exemption Certificates. This means that Humber pilots will seldom have the opportunity to gain experience of the berths. Given ship's staff turnover, the occasionally limited availability of ship's PEC holders and the potential use of unfamiliar chartered vessels, pilots will occasionally be required. The likely limited experience of individual Humber pilots to the proposed development is a risk.

104. The 'significant and ongoing' training burden referred to above is likely to be impractical, resulting in pilots insufficiently familiar or experienced with the IEERT berths and approaches being allocated to ships destined for the terminal, with the resultant risk of a failed or delayed manoeuvre.

105. The simulations observed (noting that these were to berth 1 only and not the more challenging berth 2 and 3) demonstrated that operations were technically feasible, within certain metocean limits, on a well-designed and well-resourced ship (e.g. Stena T class has 50t bow thrusters, twin propellers and flap rudders) but with propulsion equipment operating at 100% capacity for extended periods of time and minimal margin for error or redundancy.

106. Of course, not all ships likely to use IERRT during its lifetime are so well resourced. The DFDS Jinling class vessel model used for earlier simulations are also purpose designed, very powerful, highly manoeuvrable North Sea trailer ferries. TR030007-000369-8.4.10(b) states on page 3 that '*the proposed berths are acceptable for safe manoeuvring of a 240m long RoRo vessel*', however this general statement is flawed because it makes the incorrect assumption that all 240m RoRo vessels are similarly well resourced to the models used in simulations. Page 4 concluded that it would be necessary to run more specific simulations to identify the detailed procedures and limits for all future classes of vessel, in a wider range of environmental conditions. TR030007-000371-8.4.10(c) (Navigational Simulation – Stakeholder Demonstrations Report) amplifies this point further by concluding that '*any new class of vessel and potentially individual ships within a class will need operating limitations and procedures reviewed and developed*', which '*due to the precise navigation required, combined with strong currents at the site make this a particularly critical feature'*.

107. This highlights the marginal nature and viability of operations at IERRT, and therefore infers that significant unmitigated risk remains, which is the primary concern raised by IOT Operators.

108. In general, the conditions simulated were falsely sterile with the use of highly experienced, senior Pilots and Masters operating in a rehearsed, simulated environment, lacking dynamic variations, and having no other moving traffic, external time pressures, or the unpredictability and distractions regularly experienced on the bridge of a ship in a busy, fast flowing river. The conditions are falsely sterile because the human element and machinery reliability are not 'sterile' in practice.

109. Simulations were made with simulated mean winds up to 30 knots, without significant gusting. In practice, in mean winds of that strength, gusting occurs well above the 5 knot gusts said to be simulated; importantly it is not the mean winds which generally result in

damage to a jetty or loss of control of a vessel, it is the gusts. A gust is usually defined as lasting less than 20 seconds, but maybe longer, and is more than 10mph above the mean wind. This is critically important, because the force of wind acting on a ship is not linear but is exponential; the effect varying with the square of the wind speed. Using the formula [$F=(V^2/18,000)$ x windage area], where F is the wind force in tonnes/m^2, wind is m/s and area in m^2, it can be seen that if a ship is exposed to a mean wind of 30 knots and then a gust of 40 knots, this 33% increase in wind force results in a near doubling of the wind effect (30x30=900, 40x40=1600).

110. Therefore, if a ship's manoeuvre is marginal in a 30 knot mean wind, it is likely not to be feasible in a 40-knot gust and the limits should therefore be accordingly set as being the maximum gust and not the mean wind. It follows that the assumptions resulting from the simulations regarding feasibility and operational limits are flawed and do not demonstrate that worst case scenarios have been considered.

111. In addition, to further amplify the short comings of the simulation, it is usual for simulation software to use a recognised basis for wind gusting, for example the Davenport Spectrum, which uses randomised gusting with varying duration and intensities. There is no evidence regarding how gusting is applied in the simulations, further evidencing that the simulations are not fit for purpose. Simulation run telemetry shows a flat line wind strength and, even when the use of 5 knot gusting is said to have been applied, this is not shown in the wind graph of the simulation plots. It may be that only the mean wind set by the simulation operator is shown on the plots, however it is essential to be able to quantify the gusting speeds and durations actually experienced in simulation and then compare this to real wind data of the area to ensure that the increases used for gust speed and the duration are adequately realistic. Otherwise, all wind limitation assumptions based on simulation outputs are further flawed. It is considered that ABP's weather analysis has not been sufficiently thorough to understand what the actual gusting in that immediate area should look like and, again, the simulations cannot be relied on to accurately demonstrate the true windage.

112. As a result of global warming and increased sea temperatures, weather systems now have more energy, resulting in squalls which can be far more intense and prolonged than gusts, thus further increasing risk.

113. In summary, in a sanitised and predictable environment the simulations demonstrated that the vessels modelled are technically able to berth and depart IERRT berth 1. This is, however, inadequate and not reflective of the dynamic environment in which ships operate. As with the Finger Pier simulations, wind shielding was not enabled for all but a few simulation runs and the variation & duration of wind gusts is not recorded. It is therefore difficult to place any degree of confidence in the simulation results.

114. Even so, the simulations highlighted significant vulnerabilities, especially in reduced margin for error when considering the variabilities that real world and future scenarios will introduce such as, commercial pressure, additional traffic, limited availability of the specific size and type of tugs required, time pressures and vessel sizes. It is worth noting that the proposed operation involves vessels carrying in excess of 300 passengers (truck drivers) and time sensitive 'just in time' trailer cargos, therefore the commercial pressures for the vessels to berth on time, whatever the weather, will be enormous.

115. As a result, these simulations do not provide sufficient evidence that the IERRT development is inherently safe with any margin for error and are likely to be less so when considering the reality of berthing at the IERRT. There are significant risks that still exist which would require very robust controls in place to mitigate such risks to levels regarded

as acceptable to all stakeholders. The presence of IERRT would also introduce significant additional navigational risks to existing IOT infrastructure downstream of and adjacent to the development, to vessels alongside Immingham Eastern Jetty and to those vessels using Immingham lock.

116. Additionally, the arrival and departure manoeuvres to IOT Finger Pier Berth 8 and 9 would be compromised by the reduced available water space. In particular, the approach angle to IOT Berth 8 and 9 currently used by tankers in strong SW'ly winds would not be possible due to the structure of IERRT Berth 1, its Ro-Ro pontoon and associated ship alongside.

117. In a wind between S'ly and WNW'ly the presence of a ship on IERRT Berth 1 would provide a sheltered approach to IOT Finger Pier Berth 8 and 9, meaning that an approaching tanker would not have time to 'balance' the forces of true wind and tugs during the approach to the berth, nor would it have time once emerging into the wind to abort the approach if deemed necessary/unsafe. Once committed in the final stage of approach, particularly to IOT Finger Pier Berth 8, when a tanker emerges from the shelter of the vessel alongside IERRT, the full force of the wind is suddenly experienced close to the berth giving the Pilot no time to balance the forces of available thrusters and tugs, and no chance to abort the manoeuvre if the ship's manoeuvring characteristics or towage resources prove inadequate. This would lead to heavy landings on the berth, especially the upstream knuckle of berth 8, with significant risk of damage to the jetty, ship and causing downtime of the IOT facilities (immediate berth downtime and potential terminal downtime to facilitate repairs).

118. HRWs conclusion that navigation to and from berth 8 is not adversely affected is therefore incorrect.

119. The extent of commercial impact on other port users was also noted from other participants during the simulations. From commencement of the IERRT approach manoeuvre in the vicinity of IOT Berth 2, the time taken for a ferry to be in position alongside IERRT Berth 1 – the quickest and simplest operation – was in the region of 25 minutes.

120. If using tugs, this time would be increased significantly, not least due to the fact that the tugs would not be released until a ferry was fully secured, and then the same two tugs have to proceed to the main channel to await the next vessel. Assuming that if one ferry requires tugs, then the others bound for Berths 2 and 3 would also have a similar or greater need. The time window, assuming 3 consecutive ferry arrivals, whereby tankers could not approach or depart IOT Finger Pier due to water space congestion could in the order of 1.5 – 2 hours or more. It is possible that this could also impact on main berth operations, depending on where inbound ferries have to wait. Similarly, a mooring gang can only service one vessel at a time, meaning that one vessel must complete mooring before being able to depart for another vessel.

121. Given an operating window of low water + 1 hour to high water (about 5.5 hours) the impact on IOT vessel movements would, on days when flood tide coincided with IERRT vessel movements, be significant.

122. It is also likely that current operating parameters would have to be reduced for barge operations on Berth 9 due to the limited manoeuvring space presented with IERRT structure in place, resulting in commercial impact on both IOT and the berth users. This is not accurately reflected in HRW report.

2.3 IERRT NRA CLARIFICATIONS

123. The following requests for further information were made to assist the drafting of this NRA (reference to the document they relate to):

- Background / basis of assessment

  a. Provision of a copy of the Port of Immingham's Statutory Harbour Authority's (SHA) Marine Safety Management System (MSMS). *(Vol3 Appendix 10.1 Navigation Risk Assessment 3.2.5)*

  b. Provision of a copy of the Humber Estuary Services (SHA/CHA/VTS are) Marine Safety Management System (MSMS). *(Vol3 Appendix 10.1 Navigation Risk Assessment 3.2.5)*

  c. Provision of a copy of the Port of Immingham's Statutory Harbour Authority's (SHA) current baseline Navigation Risk Assessment (NRA) (according to PMSC requirements). *(Vol3 Appendix 10.1 Navigation Risk Assessment 3.2.5)*

  d. Provision of a copy of the Humber Estuary Services current baseline Navigation Risk Assessment (NRA) (according to PMSC requirements) which covers the IERRT DCO area and approaches to it. *(Vol3 Appendix 10.1 Navigation Risk Assessment 3.2.5)*

  e. Provision of a copy of the Humber Estuary Services Pilotage Operations Manual for berths in vicinity of proposed IERRT (e.g. Immingham Bellmouth & Lock Entrance, Immingham East / West Jetty, Immingham Outer Harbour, Immingham Oil Terminal). *Not referenced in Vol3 Appendix 10.1 Navigation Risk Assessment but should be contained within 3.5.2.*

  f. Provision of a copy of the Humber Estuary Services Towage Operations manual for berths adjacent to proposed IERRT (e.g. Immingham Bellmouth & Lock Entrance, Immingham East / West Jetty, Immingham Outer Harbour, Immingham Oil Terminal). *Not referenced in Vol3 Appendix 10.1 Navigation Risk Assessment but should be contained within 3.5.3.*

  g. Provision of a copy of the Basis of Design Documents for IERRT for design vessel specifications document (including limits of vessel size and manoeuvrability) for marine operations at IERRT, including operational profile for the IERRT in relation to throughput, vessel frequency, downtime, operational and leave-berth limits (weather, etc). – *Chapters 2 and 3 of Volume 1 of the ES for the IERRT project (Application Document Reference Number 8.2).*

  h. Provision of a copy of the Emergency Response Plan for IERRT (to include 3rd party emergencies) – not provided although reference is made in Vol3 Appendix 10.1 Navigation Risk Assessment Section 12 to HESMEP: Humber Estuary Serious Marine Emergency Plan.

  i. Provision of a tidal data assessment and any tidal flow modelling information or reports (such as those used to inform Basis of Design documents). *Only limited Tidal information is provided at Vol3 Appendix 10.1 Navigation Risk Assessment Section 3.3.4 related to levels, but not velocities or directions for various tidal states.*

j. Provision of full incident data in relation to "Local port marine accident incident reporting database (MARNIS)" to facilitate IOT Operators Navigation Risk Assessment. Vol3 Appendix 10.1 Navigation Risk Assessment Section 2.6.1.

- NRA Methodology

  a. Definitions

     i. Definitions for commonly used terminology within the report (e.g., "Risk", "Risks", "Hazard(s)", "Embedded Controls" and "Further Controls", "Additional Controls", etc. – not provided within Vol3 Appendix 10.1 Navigation Risk Assessment.

     ii. Information on the data source used for the NRA Vessel Traffic Analysis and any reviews of data quality undertaken. – not provided within Vol3 Appendix 10.1 Navigation Risk Assessment 2.2, only that it has been sourced from an in-house AIS database provided by Anatec – Section 2.2.1.

  b. Risk Control Options

     i. Basis of Design Documents for IOT Trunk Way impact protection. – no details provided except at Vol3 Appendix 10.1 Navigation Risk Assessment Section 4.2.7.

     ii. Basis of Design Documents in relation to implicit impact protection for IERRT infrastructure. – *no details provided in Vol3 Appendix 10.1 Navigation Risk Assessment*

     iii. Further details on risk controls including specification and parameters. Limited details are provided on risk control measures in terms of when and how they will be implemented.

  c. Cost Benefit

     i. Details of Cost Benefit Analysis (CBA) undertaken, including inputs methodology and findings. Vol3 Appendix 10.1 Navigation Risk Assessment Section 9.7.2 - 9.7.4 (e.g. minutes of the Risk Assessment Meeting held on 04 October 2022 and the Cost-Benefit Analysis meeting held 06 October 2022).

     ii. Definitions for and the Tolerability thresholds used in the NRA and equivalent thresholds previously used in development of the Port of Immingham and Humber Estuary Services baseline NRAs. – *not provided in the Vol3 Appendix 10.1 Navigation Risk Assessment.*

124. As at 05-Sep-2023, none of the documentation has been provided by IERRT developers, however correspondence was received indicating that the requests were "*Potentially misleading information*", "*Publicly available information"*, "*Premature information"*, "*Unnecessary information"* or "*Irrelevance".* Further requests, stating why they are necessary have been made to IERRT Developers, however in the meantime this assessment has progressed based on the best available information and not on the actual assumptions used by ABP and its consultants.

3. IMMINGHAM OIL TERMINAL OPERATIONS

3.1 OVERVIEW OF TERMINAL

125. The IOT Operators are joint venture companies owned equally by Phillips 66 Limited ("Phillips 66") and Prax Lindsey Oil Refinery Limited ("Prax"). Phillips 66 is the owner of the Humber Refinery and Prax is the owner of the Lindsey Oil Refinery.

126. The Humber Refinery is a nationally significant piece of infrastructure and is one of the most complex refineries in Europe. It provides highly skilled and high value roles for 1,100 employees and contractors and injects over £200 million on an annual basis into the region's economy.

127. The Lindsey Oil Refinery is one of the most advanced refining and conversion processes in Europe and is highly valuable to the region's economy and employs approximately 400 staff and another 400 contractors.

128. Together, the Humber Refinery and Lindsey Oil Refinery make up approximately 27% of the UK's refining capacity. The importance of the refineries to the region and wider country's economy is expressly acknowledged in a wide range of economic and development plan policy documents.

129. The activity of the IOT Operators is almost entirely in response to the requirements of Phillips 66 and Prax for marine movements of feedstock and products to and from the two refineries. The IOT Operators operate marine terminals and much of the pipeline system between the IOT and the refineries.

130. The marine components of the IOT include the following:

- Trunkway: Carries all product (via a pipe rack located on the upstream side of the trunk way (see Figure 4)) from and to vessels and provides access to Finger Pier and River Berths.
- Finger Pier: These berths mostly export refined product from the refineries in coastal product (coastal) tankers mostly exporting to UK and near European ports. Smaller bunker barges, servicing shipping on the Humber Estuary also visit the finger pier.
- River Berths: These berths are primarily used for the import of feed stock to the refineries.

Figure 4: Top left aerial view of IOT berths (source: humber.com), Top right: Nautical chart showing Trunkway, finger pier and river berths, and Bottom: close up aerial view showing the finger pier (showing berths 8 and 6 occupied by coastal tankers and berth 7 occupied by a bunker barge), Trunkway (pipe tracks are white/light grey) and small workboat berth opposite the finger pier.

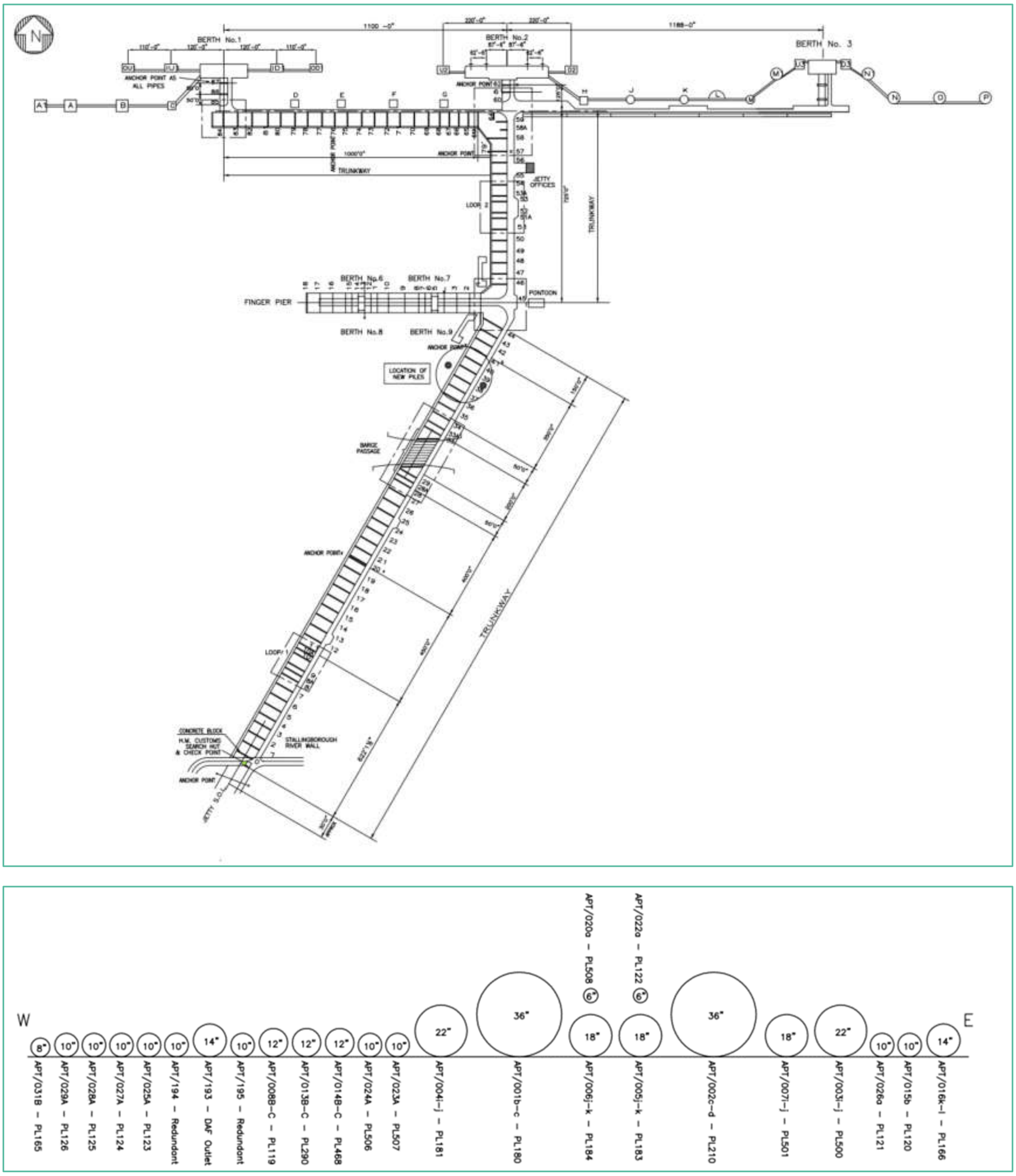


Figure 5: IOT layout (top, layout and bottom, pipe track on Trunkway).

131. The Trunkway is orientated across the tidal flows and extends first to the Finger Pier and then to the River Berths. The pipe rack carries 25 pipes of varying diameters to and from the Finger Pier and River Berths. The pipes contain the following types of products:

- Crude Oil;
- Kerosine;
- Motor Spirit;
- Gas Oil;
- Cracked Fuel Oil; and

- Heavy Fuel Oil.

132. Each IOT berth has a limit on the size and type of vessel that it can accommodate, which is as shown in Table 2.

Table 2: IOT Berth limits (* = Displacement, note Berths 6 and 8 are coastal tanker berths and 7 and 9 are estuarial barge berths only).

IOT Berth	1	2	3	6	8	7	9
	Main Berth	Main Berth	Main Berth	Finger Pier	Finger Pier	Finger Pier	Finger Pier
Minimum Summer Deadweight Tonnage	12,000	5,000	2,000				
Maximum Summer Deadweight Tonnage		284,480	80,000	8,500*	8,500*	1,000	1,000
Max Displacement on arrival (MT)	172,720	172,720	110,000	5,500	5,500		
Max Length Overall	350m	--	--	104m	104m	61m	61m
Minimum Ballast Flatside	73m	55m	42m				
Maximum Draft	14.0m	14.0m*	12.8m	7.0m	7.0m	5.0m	5.0m

133. Workboats, supplied by Briggs Marine, who are APT's current marine contractors, provide line handling and light towage duties to the IOT. They are all restricted to pushing duties only, no lines can be secured to the ship and therefore no pulling or towing can be provided. The service craft include:

- Bull Sand 1 (used the most)
- Spurn Sand
- Haile Sand
- Trinity Sand (not used for finger pier movements)
- Ross Point (not used for finger pier movements)

134. The workboats are the only craft that use the Mooring Pontoon (located immediately downstream/opposite of the IOT Finger Pier) or the Barge Mooring Buoy located upstream of the IOT Trunkway and inshore of the IOT Finger Pier. The workboats can also use the Barge Passage under the Trunkway to move around from upstream to downstream of the IOT Trunkway

3.2 BERTH OPERATIONS

135. All Finger Pier berths are used regularly, although berths 8 and 6 are the most heavily used berths. The Finger Pier is used by two types of vessels, coastal tankers and river trading (estuarial) barges.

136. Seagoing tankers of the size arriving and departing berths 6 and 8 are required to engage the services of a licensed ABP Humber pilot. Regularly trading ships with a Master familiar with the port may, subject to the requirements of the Humber Pilotage Directions, apply and be examined for a Pilotage Exemption Certificate and thereafter conduct the

pilotage themselves. Skippers of trading barges using berths 7 and 9 are required to hold a PEC, as they contain dangerous goods in bulk.

137. Under normal circumstances berthing will not be allowed if the “off-berth” mean wind speed is forecast to exceed 40mph or if the on-berth mean wind speed is forecast to exceed 30mph. There are occasions where a vessel may be berthed outside these criteria (e.g. it may be safer to allow the vessel to berth rather than return to an anchorage). The APT Berthing Master will make the decision in consultation with the vessel’s Master and/or Pilot.

138. Coastal Tankers are small product tankers, generally within the range 80m – 100m in length which trade predominantly to UK and near European ports distributing refined oil products and fuels. The largest vessel to visit the IOT recently was the WISBY ARGAN (see Figure 6) with the following parameters:

- Summer Deadweight Tonnage of 7,200t
- Length 99m
- Breadth 18m
- Year 2009
- Capacity 6,000MT of mineral oil.

139. The WISBY ARGAN is a regular visitor to IOT Finger Pier and visited as follows during a two week period this as follows:

- 07/06/2023
- 12/06/2023
- 16/06/2023
- 21/06/2023

140. The WISBY ARGAN berths at either berth 6 or berth 8 of the Finger Pier and generally stays alongside for approximately 24 hours per visit (note arrivals and departures are limited to flood tide only, which applies to all coastal movements on and off the Finger Pier).

Figure 6: Wisby Argan (Source fleetmon.com).

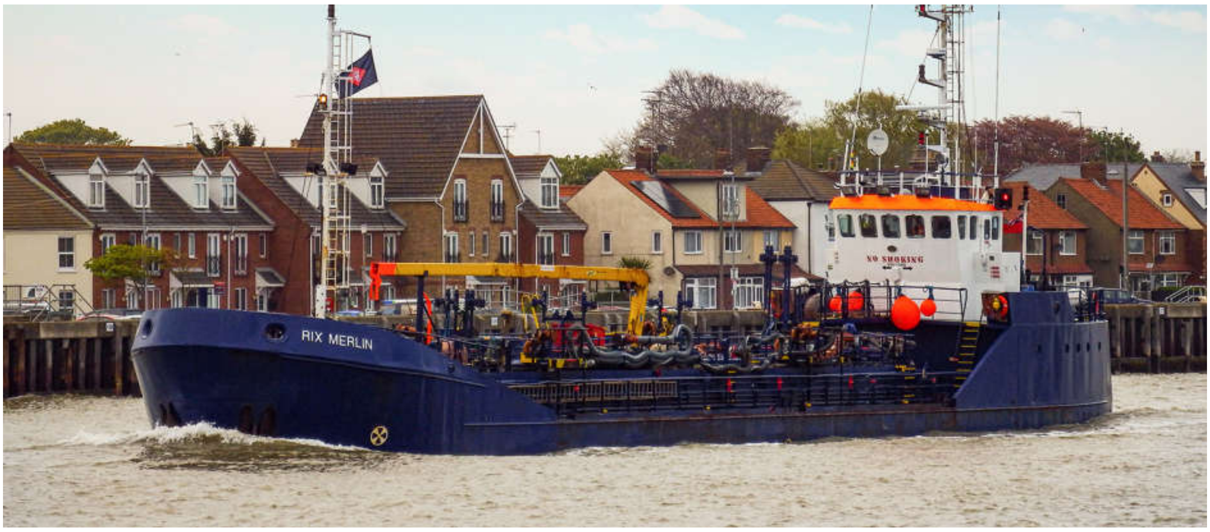


Figure 7: Rix Merlin (Source maritimebunkering.co.uk).

141. Estuarial Barges are frequent visitors and predominantly berth at berths 7 and 9 of the Finger Pier. These vessels are a mixture of estuarial barges which ply their trade on the Rivers Humber, Ouse and Trent, one of which can trade to coastal ports and harbours, subject to sea state limitations. Their trade comprises distribution of refined products to terminals further inland and direct delivery of bunker fuels to ships in Hull, Immingham and Grimsby. Rix Shipping provide the barges and their principal dimensions are as shown in Table 3.

Table 3: Rix Shipping Estuarial Barges.

Name	Length	Breadth	Capacity
RIX MERLIN	53.00m	7.9m	794 CuM
RIX PHOENIX	58.85m	7.6m	618 CuM
RIX OWL	60.80m	7.6m	777 CuM

3.2.1 Coastal Tanker Passage Plan

142. Historically, small tankers using berths 6 and 8 were allowed to berth on an outgoing (ebb) tide. However due to several incidents and near misses, the berthing and departure windows were (and remain) restricted to incoming (flood) tide only for vessels over 1,300t dwt; this being between the times of 'Low Water Immingham + 1hr through to the time of High Water Immingham. Vessels must berth bow to tide, therefore those mooring at berth 6 are starboard side to the jetty and those mooring at berth 8 are port side to the jetty. The restrictions were put in place by the harbour authority and agreed by IOT Operators.

143. The northwestern extremity of the Finger Pier houses a wheel fender which is designed to be used by arriving and departing vessels to 'slide' along the jetty. Arriving vessels transit the River Humber from sea, passing the IOT outer berths, rounding the northwestern end of berth 1 prior to setting their approach to the finger pier. The flood tide does not run parallel to the Finger Pier but runs with an approximate 6 to 10 degree offset, therefore the approach has to allow for a set off berth 6 and a set onto berth 8. An allowance for vessel drift due to wind also has to be factored into the approach course.

144. A small, terminal workboat tug is available 24 hours a day at IOT. The tug will be in attendance during all movements on and off the Finger Pier for use at the discretion of the tanker's Master, Pilot and APT Berthing Master. Due to manoeuvring and crew limitations, this small tug can only be used for pushing; it cannot be secured by a line to tow or pull.

145. For berth 6, tankers generally head for the jetty end knuckle and, when close, allow the vessel to set north, securing a forward spring line and a stern line as soon as possible. The small terminal tug stands by as directed by the Master/Pilot to push amidships and thereby hold the vessel onto the jetty.

146. For berth 8, tankers generally head slightly to the south of the knuckle endeavouring to keep head to tide so as not to be pushed onto the berth too early. In the event of a strong south westerly wind, the vessel will approach from a direction further to the south to allow for the effect of lateral drift during the approach. The small terminal tug is used on the port shoulder of the vessel to hold the bow up into the wind, sliding astern as the vessel's bow approaches the berth and allowing the vessel to land on the roller wheel fender. In strong winds where the power of the terminal tug is likely to be insufficient, tankers may contract the services of a 40t ASD tug in addition, usually from SMS Towage. This additional tug is generally secured to stern of the tanker by means of the tug's towing line and can be used for pushing or pulling/lifting as the Master/Pilot deems necessary.

147. During the approach to the berth, the Master/Pilot must balance the effect of tide and wind against the power available from the tug(s), leaving sufficient room to appraise the situation and abort the berthing if the prevailing weather proves to be beyond safe limits.

148. When departing berths 6 and 8, also on the flood tide only, tankers must proceed stern-first from the berth, turning around in a location of the Master/Pilot's choosing, normally dependent on the proximity of other traffic in the immediate area, the strength and direction of the wind. The small terminal workboat tug is available to be used to assist the departure and turn if required. In conditions of extreme wind, the services of a larger tug may be requested. Standard procedure is currently to turn using the water space proposed to be occupied by the IERRT development for vessels arriving and departing berth 8 and 9 of the finger pier.

3.2.2 Estuarial Barges Passage Plan

149. Barges using berths 7 and 9 are currently under 800t dwt, are highly manoeuvrable and are thereby permitted to berth on an ebb or flood tide. The regular Masters are used to the strong tidal flows, which can reach up to 4 knots on a spring ebb tide, pushing vessels towards the Trunkway, but they may avoid berthing on the strongest of tides, dependent on wind conditions. Barges usually berth 'head out', bow up river (i.e. stern to the Trunkway). Due to the minimal ballast capacity of the barges, their arrival draft is shallow, meaning that they are highly susceptible to the effect of wind. Therefore, current practice when arriving at berth 9 is to make a wide approach using the area of water between IOT finger pier and the river shore to turn and manoeuvre onto the berth, this being the area of water proposed to be occupied by IERRT. As with the larger coastal tankers at berths 6 and 8, the small terminal tug is available for barge arrivals and departures at berths 7 and 9.

150. When departing, barges are 'head out', therefore there is no need to turn after departure. Therefore, subject to weather and traffic, departures are generally relatively straight forward.

4. IERRT DEVELOPMENT

4.1 INTRODUCTION

151. The IERRT development is for a freight and passenger roll on / roll off (Ro-Ro/Ro-Pax) ferry facility, with a river terminal located immediately upstream of the IOT and downstream of Immingham Inner Docks bell mouth and Immingham East Jetty. Dedicated freight (truck) ferries with driver accommodation capacity over 12 are classed as passenger ships, even if they do not offer passenger only or car crossings. Drivers are not permitted to remain with their vehicles during a crossing. The current T-Class Stena ferries offer a driver passenger capacity of 300 in 150 twin berth cabins.

152. The physical characteristics of the development are detailed in the IERRT ES Chapters 2 and 3 (Environmental Statement: Volume 1 Chapter 2: Proposed Development - Document Reference: 8.2.2 and Environmental Statement: Volume 1 Chapter 3: Details of Project Construction and Operation - Document Reference: 8.2.3).

153. The IERRT marine facility comprises three in-river berths, orientated upstream and nominally in line with the tidal flows. It will operate 24 hours a day, seven days a week and it is understood (based on discussions at Hazard Scoring and Simulation meetings) that it will be operated by Stena Line. It is envisaged that Stena Line will operate a liner service from the IERRT to near European Ports (similar to that already provided from existing terminal berths in the River Humber).

154. The IERRT is designed to accommodate three vessels simultaneously (one at each berth) and it is understood that Stena Line will provide night crossings of the North Sea to the destination ports. This is similar to current Humber ferry operations where ferries have a similar scheduled arrival time on berth and means that the IERRT berths will likely be occupied during the day, with ferries arriving at set times in the morning and departing in the evening. It is also feasible that additional services could arrive in the evening and depart the following morning.

155. According to the ES IERRT berthing facilities have been designed to handle vessels with a length overall (LOA) of up to 240m, a breadth of 35m, and a draught of up to 8m. No further details on the specification of vessels have been provided including vessel:

- Number, type and rotation direction of propellers
- Engine Power;
- Thruster Power;
- Rudder Type;
- Windage area; and
- Displacement tonnage.

156. The IERRT vessels will carry accompanied freight (this includes goods vehicles and their drivers), unaccompanied freight (this includes heavy goods trailers) and passengers (this includes members of the public travelling in a motor vehicle – i.e., foot passengers will not be allowed). It is not clear what the limit of accompanied freight would be, although the ES states that there will be a limit of 100 members of the public embarking on any one day.

157. Based on numbers of members of the public known at 100 and the unknown limit for drivers of accompanied freight, the vessels servicing the IERRT will be passenger vessels

and should therefore follow the representative legislation for passenger vessels. Total passengers on board could therefore be in the order of 300.

4.2 LAYOUT

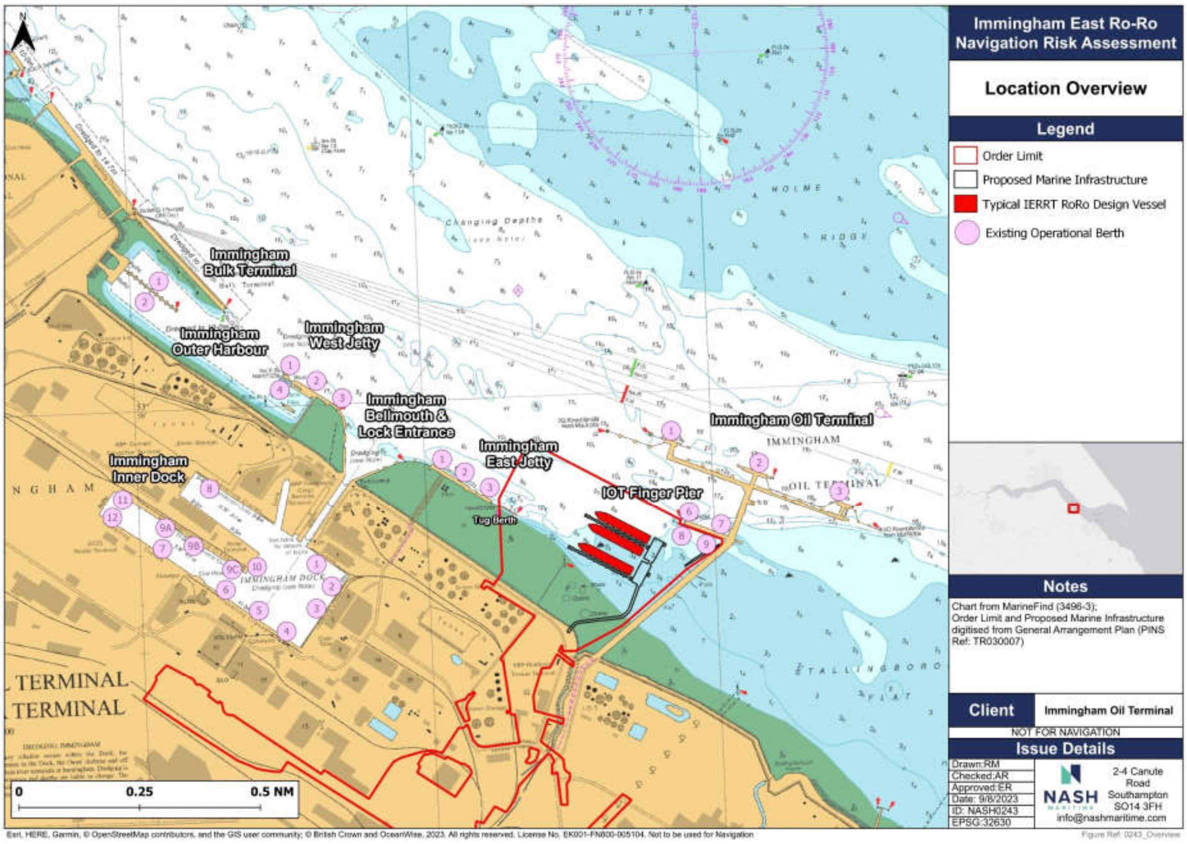
158. A detailed chart showing the location of the IERRT Marine Infrastructure is presented in Figure 8 which shows IERRT infrastructure geo-referenced manually on a navigation chart. The plot shows three 240m LOA and 35m breadth vessels alongside as would likely be the case during the day.

159. The following key dimensions are noted in relation to vessels bound to and from IOT Finger Pier Berths 8 and 9:

- The shortest distance between the IERRT and the IOT Finger Pier is 95m and is between the outer berth (berth 1) pontoon pile and the IOT Finger Pier berth 8 knuckle.
- Whilst the shortest distance is 95m, the cross-track width (the available sea room for the swept path of a vessel to navigate within) available to vessels servicing berths 8 and 9 is reduced to 79m, this being complicated due to the alignment of the finger pier and IERRT being different (292 degrees versus 300 degrees).
- Should a vessel of 18m beam be alongside the IOT Finger Pier berth 8, then the cross-track width is further reduced to approximately 68.5m, as shown in Figure 9.
- Further, given prudent mariners would require a nominal buffer to a fixed object (generally 2 x breadth of a vessel as a minimum for slow speed manoeuvres such as approaching a berth under pilotage), then the cross-track width is further reduced. As such the cross-track margin for Coastal Tankers would be 20m and the cross track for Estuarial Barges would be 40m. There is no industry standard for lateral distance between vessels, but if close, a passing vessel can be liable to detrimental effect on the ability to maintain directional stability due to discharges from a moored vessel (e.g. cooling water outflows, ballast outflows). Additionally, water flow around vessels' hulls causes a high-pressure area around the bow and stern and a low-pressure area towards the centre. This can also result in difficulty maintaining directional stability, resulting in an unwanted sheer or loss of control of a passing vessel.

4.3 OPERATIONS

160. Freight ferries serve the 'just-in-time' distribution concept whereby minimal stock of produce is kept in the marketplace. Hence businesses rely on daily, predictable, on-time delivery of goods whether it be perishable fresh produce, furniture or manufacturing components. Generally, the system relies on freight arriving in UK early in the morning (e.g. 05.00 - 06.00), with drivers rested overnight during the crossing, to be offloaded very quickly and on the road to the UK destination. Some will use the UK as a land bridge and board a west coast ferry to Ireland. There is significant commercial pressure for ships to maintain a rigidly timed liner service and therefore to discharge the cargo on time, which can add to the pressure experienced by ship's Masters to keep to the schedule as planned, despite the potential disruption of high winds or poor visibility.



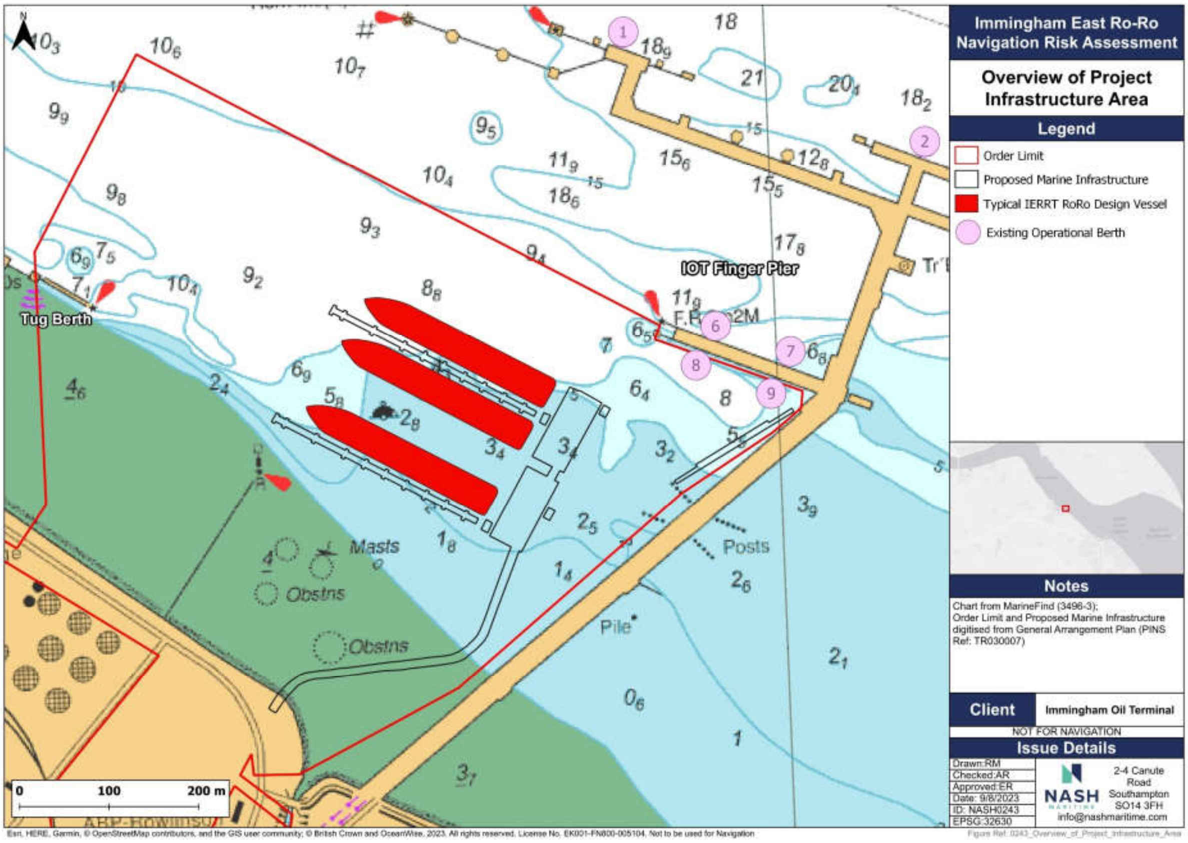


Figure 8: Overview of proposed IERRT Marine Infrastructure.

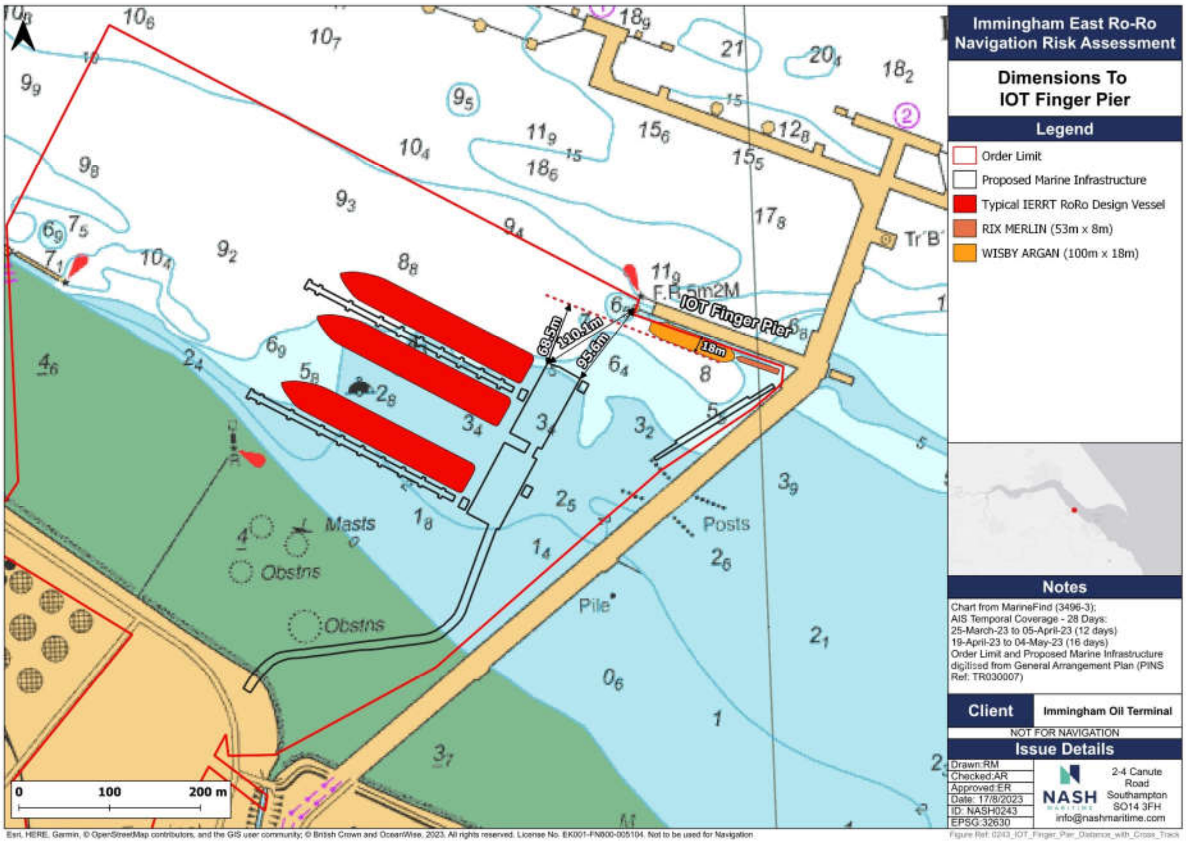


Figure 9: Dimensions of IERRT to IOT Finger Pier.

161. The River Humber is home to a large, busy and diverse port network including the enclosed docks of Hull, Immingham and Grimsby plus a multitude of river berths. Therefore, ferries engaged in daily liner services have to compete for slot times (and tugs/pilots where required) not only with ferry services operated by competitors, but with other commercial traffic. This ranges from very large tankers and bulk carriers which will be tidally constrained, to container ships, car carriers, chemical & gas carriers and various smaller commercial vessels, some of which will also be tidally constrained (e.g. small product tankers using IOT finger pier).

162. Given that inbound ferries arriving at IERRT and other similar ferry facilities elsewhere in the Humber would be required to be on berth at broadly the same time each day, congestion is a risk which would require careful co-ordination and deconfliction by VTS, especially when the river is busy with other traffic and/or during periods of high winds or poor visibility. The area immediately adjacent to IERRT, comprising Immingham Lock Bell Mouth, Eastern Jetty and the 9 berths comprising IOT is currently compact, extremely busy and often congested. The presence of IERRT would only add to this congestion and associated risk.

163. From the runs observed during simulation (noting that these only comprised simulations of ferries destined for IERRT berth 1, the simplest and quickest berthing operation of the three proposed jetties), a swift vacation of the main channel is required in vicinity of IOT Berth 1 in order to free up the main channel for the uninterrupted inward and outward passage of other shipping. The duration of the manoeuvre from IOT 1 area to being secured on the berth took approximately 30 minutes at best case. During periods of high winds, consecutive vessels would likely all require the assistance of tugs, meaning

that a second or third inward vessel would have to delay arrival to allow for the ferry ahead to complete mooring, to release the tugs and for the tugs to return to the main channel east of IOT to meet the next vessel. Given the time necessary for safely completing this scenario, a gap of at least 45 minutes between IERRT vessels would be prudent. Last minute delays would be difficult to manage and would add to main channel congestion.

164. The River Humber is well known for its 7-metre spring tidal range and the resulting exceptionally fast tidal flow, especially during the ebb tide. It is also openly exposed to the effects of wind. The jetties' vessel ramp pontoons would be designed to float, secured by piles, but the Finger Jetties at IERRT would be fixed structures. Moored vessels need to keep mooring winch brakes firmly secured and any required tending of moorings as the ship rises and falls with the tide must be undertaken with extreme care to avoid the vessel parting lines and/or the ship breaking away from the berth.

4.4 VESSELS

165. Ferries with driver/passenger accommodation capacity over 12 persons are classed as passenger ships, even if they do not offer passenger only or car crossings. Passenger ships are constructed under more stringent regulations to facilitate greater 'survivability' by the vessel in the event of fire or collision. Aboard any sea going ferry, drivers are not permitted to remain with their vehicles during a crossing. The T-Class Stena ferries currently operating to the Humber are envisaged to initially use IERRT prior to larger, replacement tonnage being delivered. The 212m x 27m T-Class currently offer a passenger accommodation capacity of 300 in 150 twin berth cabins. These are functional but the accommodation offers few facilities other than a 'embark, meal, sleep, meal, disembark routine.

166. Stena E-Flexer Class, 215 loa x 28 beam, the latest ferry design developed by Stena, currently in use by Stena on the Irish Sea, chartered to DFDS on the Dover Calais route, and Brittany Ferries on UK – Europe routes have a passenger capacity of 1,000.

167. DFDS Jinling Class at 238m loa x 34m is amongst the largest class of freight ferry currently used in UK-Europe North Sea trades and is more representative of the size of vessel envisaged for IERRT. Of broadly similar capacity, the largest current ferry operated by CLdN, a major North Sea operator, is the G9 class at 234m x 35m. Both the Jinling and G9 Class vessels are designed for unaccompanied freight (trailers) and therefore are classed as cargo ships with a maximum passenger capacity of 12.

Figure 10: Stena Transit - 'T' Class (Source: fleetmon.com).

Figure 11: Stena Estrid – E-flexer Class (Source: shipspotting.com).

Figure 12: Humbria Seaways – Jinling Class (Source: shipspotting.com).

Figure 13: Celine – G9 Class (Source: shipspotting.com).

4.5 PASSAGE PLAN

168. Given the proposed location of the IERRT jetties and the general agreement from simulations that ship handling at the proposed site would be challenging at best, the approach and departure manoeuvres would require precise initial positioning of the ferry in the river, the correct angle across the tide and highly accurate vessel manoeuvring. The differences in tidal set (the direction at which tidal vectors impacts on a vessel) between the strong flood and ebb tidal regime, would require a significantly different approach and departure plan and manoeuvres in strong winds would be increasingly complex. Given its more open location, arrival and departure from berth 1 would pose complex challenges and provide little margin for human misjudgement or a technical glitch, but berth 1 manoeuvres would be much less onerous than those at berths 2 and 3 where the room for manoeuvre and the margin for error is significantly less.

169. Arriving ferries would be required to reduce speed prior to passing the IOT outer berths such that speed over the ground when clearing IOT1 is less than 3 knots. Tugs, when required, would need to meet the vessel to seaward of IOT to allow adequate time for lines to be secured. Speed when securing and working with tugs should generally be less than 7 knots through the water.

170. Arrival and departure manoeuvres would require deconfliction from other traffic in the busy main channel and lock bell mouth area and there would be a need, due to commercial pressure and other vessel traffic, to vacate these areas as quickly as possible. Any delay in the arrival of tugs, for example, would add to the challenge in this busy but compact area of water.

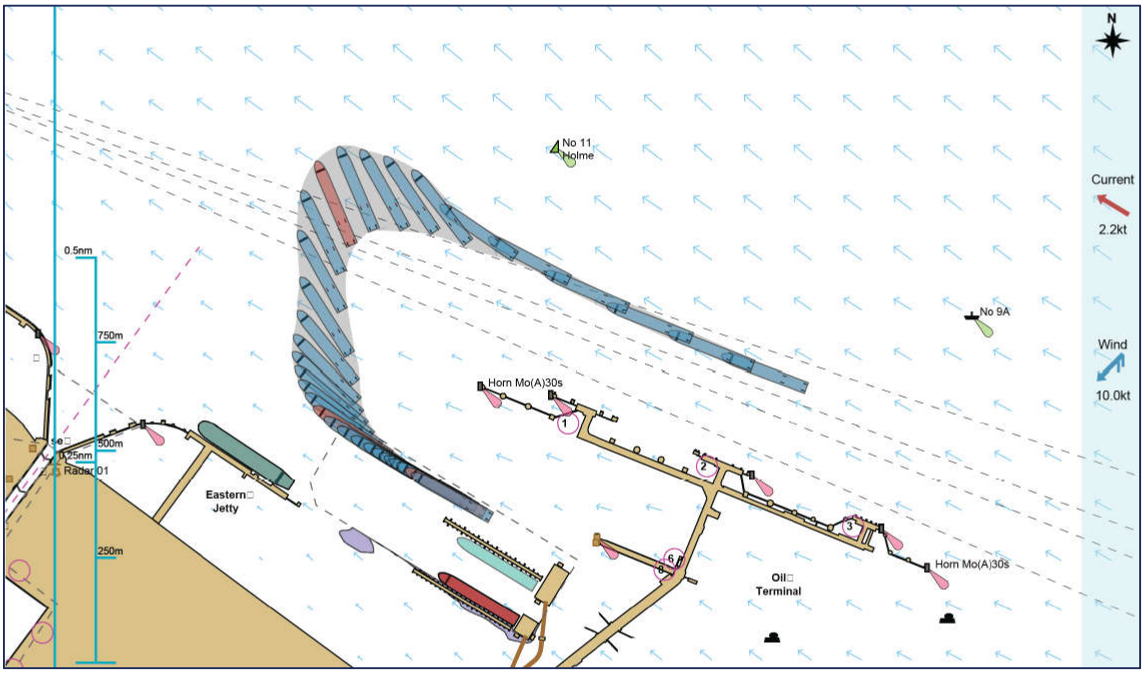


Figure 14: Flood tide berthing, 10kts NE'ly wind (extract from IERRT simulation report).

171. In this example (see Figure 14) of a flood tide arrival the ship obstructs the main channel for 15 minutes. It is essential to angle the vessel and keep the flood tide on the starboard side whilst operating propulsion astern. The resulting vector pushes the ship towards the berth. It can be seen that this arrival manoeuvre would be more challenging for berths 2 and 3, especially with a ship alongside the Eastern Jetty and/or when berthing with the additional footprint of tugs.

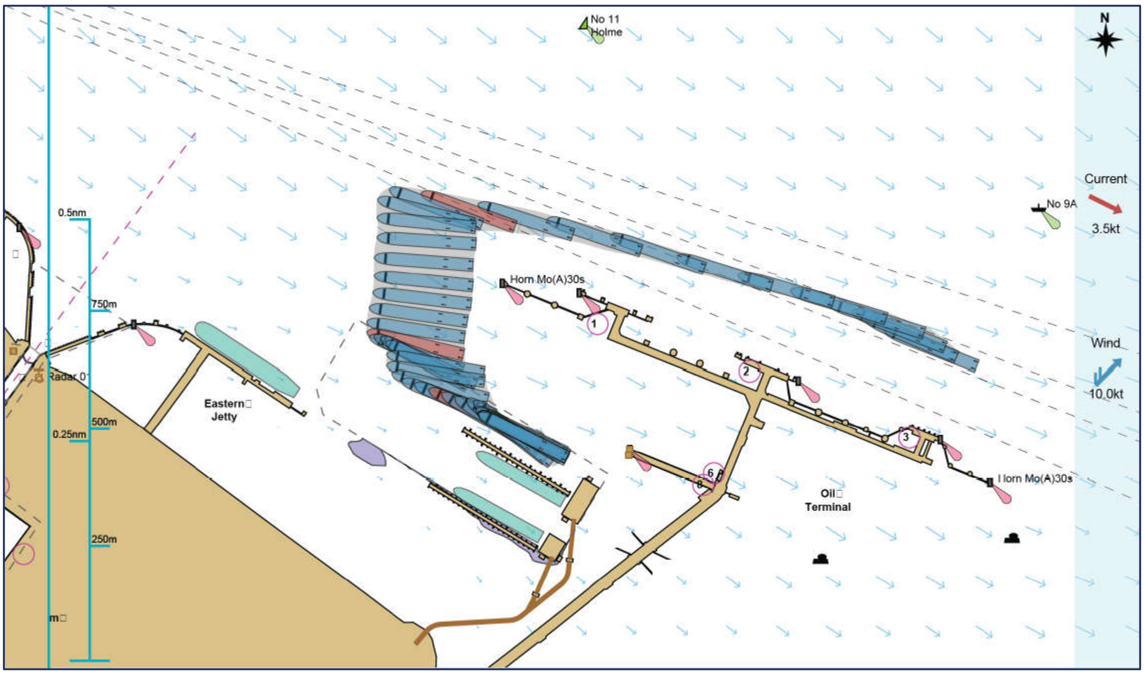


Figure 15: Ebb tide arrival berthing, SW'ly 10kts wind (extract from IERRT simulation report).

172. During an ebb tide arrival, loss of speed when approaching IOT 1 is easier than during a flood tide arrival (see Figure 15). In the ebb tide scenario, the IERRT ferry would need to be angled such that tidal flow remained on the vessel's starboard side, whilst operating propulsion ahead to stem the tide and therefore crab sideways in relation to the ground. Again, it can be seen that the manoeuvre would present more challenge when berthing at berths 2 or 3 because of the need to keep the tide just a few degrees off the bow and the distance between the NW end of IERRT and the SE end of Eastern Jetty being only marginally greater than the length of the ship (too great an angle would result in loss of control of the ship in the strong tide).

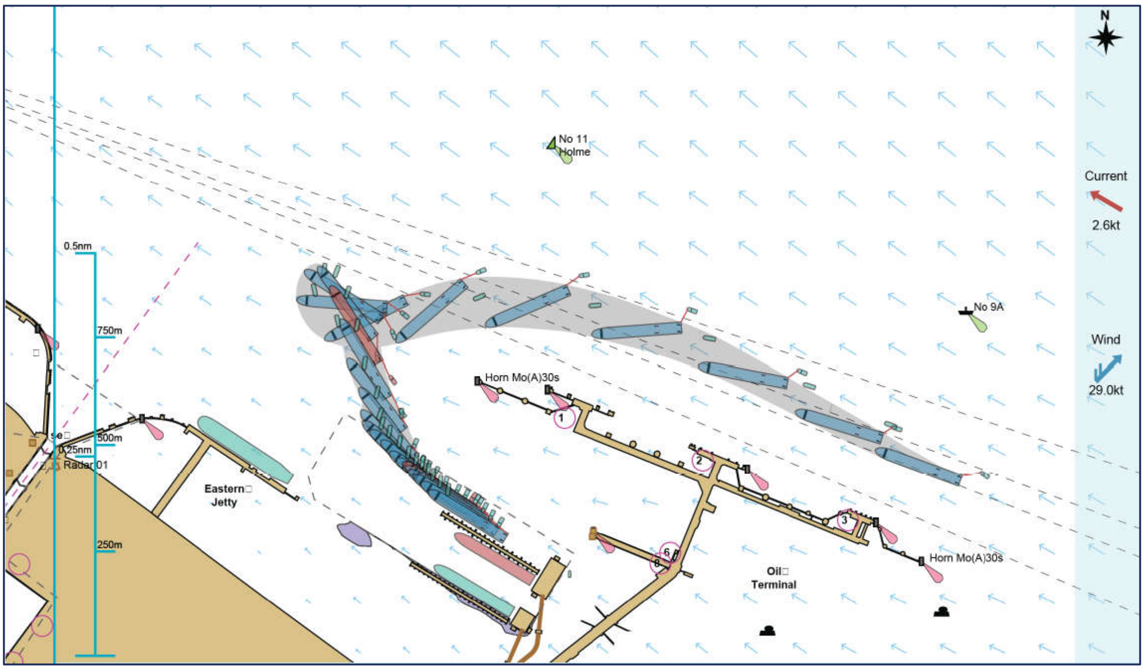


Figure 16: Flood tide arrival with tugs, SW'ly 30kts wind (extract from IERRT simulation report).

173. For an arrival scenario with 30kts SW'ly wind (see Figure 16), the vessel would require the services of 2 tugs. Due to the wind strength and direction it is necessary to drive the ship towards the jetty, into the wind, then align the flood tide on the ship's starboard side. The ship would then operate propulsion astern, with the tugs pushing or holding the ship up into the wind. It is a question of balancing the effect of wind and tide whilst delivering an appropriate force with tugs and the ship's bow thrusters in order to safely berth the ship. This is a highly skilled manoeuvre in which the Master or Pilot commence the approach by applying the forces which they intuitively feel are correct and then adjusting those forces to fine tune a delicate balance as the ship approaches the berth.

174. Departure on the flood tide (see Figure 17) is generally more challenging than on the ebb tide, especially in strong winds. In this example in a strong NE'ly wind, it proves difficult to lift the ship's bow into the wind as the ship moves ahead and the stern is taken through the wind using the aft tug. The ship is set north-west into the lock bell mouth by the flood tide during the manoeuvre. Again it can be envisaged that departure from berths 2 or 3 in such a scenario would be considerably more difficult.

175. During an on-berth wind it is necessary to keep a vessel up wind and gradually ease the vessel onto the berth with tug/workboat countering the effect of the wind (see Figure 18). It can be seen that during a strong SW'ly wind, even without a Ro-Ro berthed on IERRT 1, there is insufficient room for a tug to safely operate when in position to lift the stern, due to the presence of the planned IERRT linkspan infrastructure. When a Ro-Ro is in position on IERRT 1, it is necessary to leave a distance of approximately two ship's beam widths between a moored vessel and a passing ship due to hydrodynamic effects of increased water flow between vessels. The high-pressure areas around a ship's bow and stern, plus low-pressure area towards the centre when making way through the water or moored in a tidal flow can cause repulsion or attraction resulting in loss of directional stability of the passing vessel. It can therefore be seen that when passing at marginal distance from the Ro-Ro, there is insufficient room between vessels to allow a tug, whether used on the bow or stern, to be positioned ready to lift the tanker up into the wind.

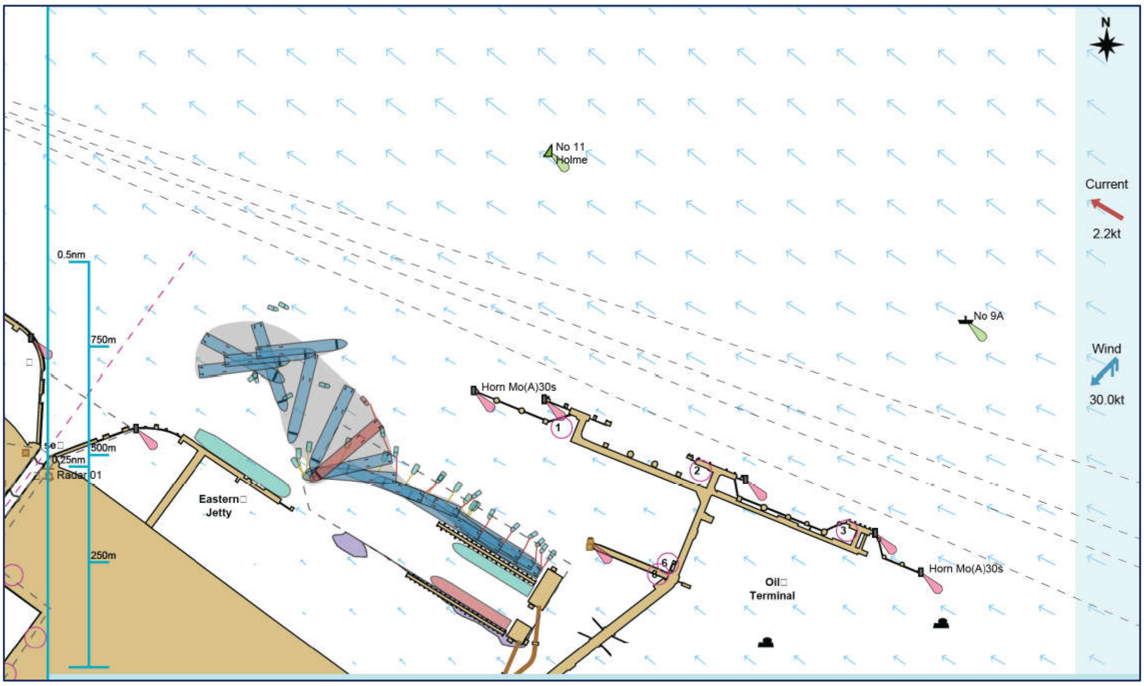


Figure 17: Flood tide departure, NE'ly 30kts wind (extract from IERRT simulation report).

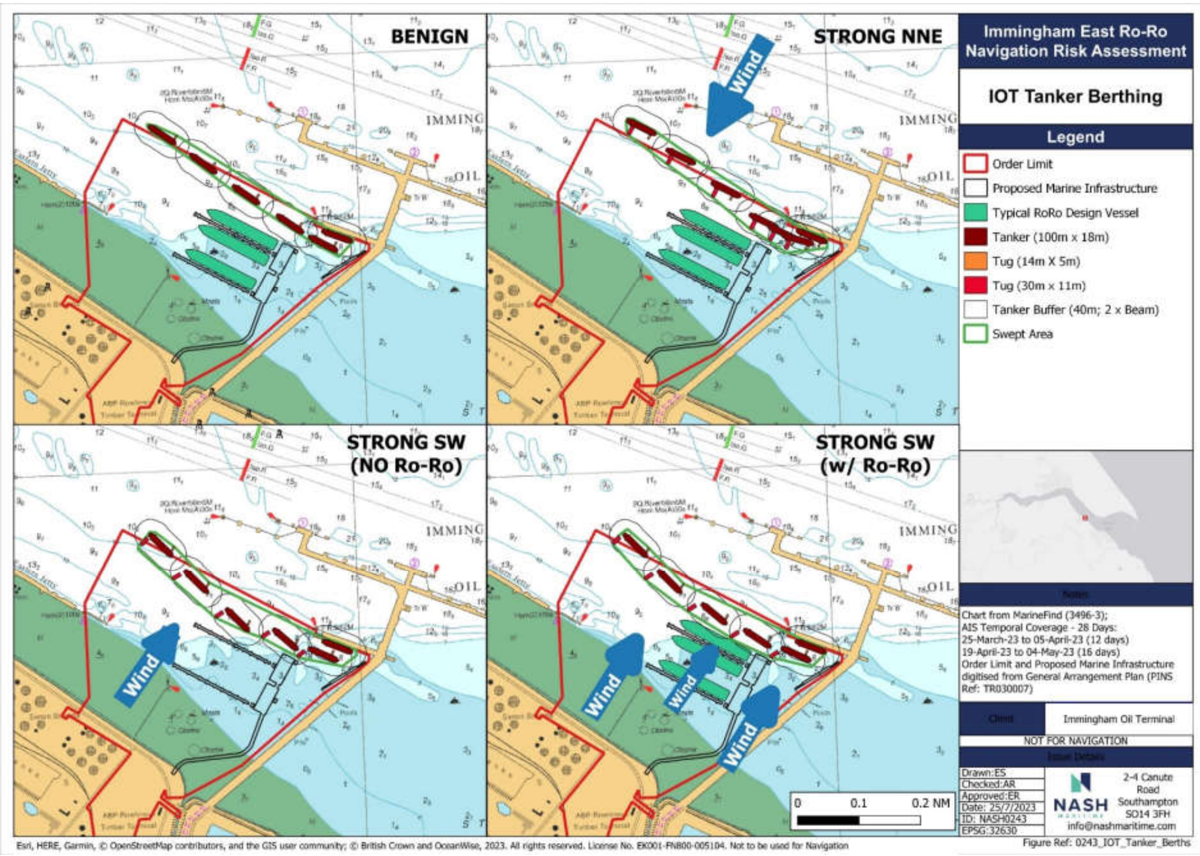


Figure 18: Berthing of Coastal Tanker with IERRT.

5. LEGISLATION AND GUIDANCE

5.1 INTRODUCTION

176. The following sections provides an overview of the legislation and guidance related to the IERRT development in close proximity to the IOT. This includes a high-level review of:

- Control of Major Accident Hazards (COMAH) Regulations 2015 Requirements.
- Port Marine Safety Code.
- Marine Guidance Note 654.

5.2 CONTROL OF MAJOR ACCIDENT HAZARD

5.2.1 Control of Major Accident Hazards (COMAH) Regulations 2015 Requirements

177. The Control of Major Accident Hazards (COMAH) Regulations 2015 aims to prevent and mitigate the effects of major accidents involving dangerous substances which can cause serious damage/harm to people and/or the environment. Regulation 4 of the COMAH Regulations requires Operators to "*take all measures necessary to prevent major accidents*". and limit the consequences to people and the environment of any major accidents which do occur.

178. IOT Operators are defied as an Upper Tier COMAH site and as required by Regulations 8 and 9 and Schedule 3 of the COMAH Regulations 2015 must have a:

- Major Accident Prevention Policy.
- Safety Report, which should include:
  - a description of the establishment and its environment including the geographical location, meteorological, geological, hydrographic conditions and, if necessary, its history;
  - a description of processes, in particular the operating methods, where applicable, taking into account available information on best practices;
  - a description of dangerous substances, including their classification under the Classification Labelling and Packaging Regulations and an inventory of dangerous substances;
  - a detailed description of the possible major accident scenarios and their probability or the conditions under which they might occur including a summary of the events which may play a role in triggering each of these scenarios, the causes being internal or external to the installation;
  - a policy on how to prevent and mitigate major accidents;
  - a safety management system for implementing that policy;
  - an effective method for identifying any major accidents that might occur;
  - measures (such as safe plant and safe operating procedures) to prevent and mitigate major accidents;

  - information on the safety precautions built into the plant and equipment when it was designed and constructed;
  - details of measures (such as fire-fighting, relief systems and filters) to limit the consequences of any major accident that might occur;
  - identification of neighbouring establishments, as well as sites that fall outside the scope of these Regulations, areas and developments that could be the source of, or increase the risk or consequences of a major accident and of domino effects;
  - information about the emergency plan for the site, which is also used by the local authority in preparing an external emergency plan;
- Prepare and test an internal emergency plan;
- Supply information to local authorities for external emergency planning purposes; and
- Provide certain information to the public about their activities.

5.2.2 IOT COMAH Safety Report: Ship Impact

179. The IOT Operators have provided the following information in respect of the IOT's COMAH classification:

- APT Immingham Oil Terminal is an upper tier COMAH establishment, due to the amount of hydrocarbon fuels stored on site. To comply with the COMAH regulations, APT must identify the major accident hazards that the site and its operations create.
- APT is also a COMAH "Domino site" define as those sites where the likelihood or consequences of a major accident may be increased because of the location and close proximity of other COMAH establishments and the dangerous substances present there.
- The level of risk that these hazards present to people and the environment must be assessed and compared to accepted tolerability criteria. This process is reviewed on a five yearly cycle by the Competent Authority (CA).
- At each cycle, the CA require APT to have thoroughly examined their operation and implement relevant safeguards to reduce operational risk to levels that are Broadly Acceptable or As Low As Reasonably Practical (ALARP).
- In the current cycle, APT has and is expected to spend significant resources on risk reduction measures identified as part of the COMAH process. This takes up a significant portion of the Safety and Projects teams time and effort, in addition to the financial costs associated.
- In operating a Marine Terminal for the transfer of fuels, there may be the risk of loss of oil from the infrastructure to the water. A ship collision has been identified as one of the potential causes of such an event. This could be a ship impacting on the jetty (allision) or a collision between vessels where one is berthed at the APT jetty.
- Ship collision leading to the loss of life or damage to the environment has been assessed as part of the COMAH process. The last submission was made to the

CA in 2019. From the data in that submission the chance of a spill capable of leading to a major accident hazard as a result of a collision can be calculated as 1.7E-02/yr, or about one in every 60 years.

- One of the major safety factors utilised to reduce this risk of allision with the IOT trunk way is that the coastal tankers using the Finger Pier are limited to a maximum displacement during arrival and departure tonnage of only 5000mt (compared to Ro-Ro vessels with a tonnage of 50,000mt). These coastal tankers are only permitted to berth or sail from the finger Pier during a "Flooding tide". This ensures that should an engine or manoeuvring failure occur during the berthing / sailing of these vessels, they are carried upstream by the tide- away from the finger Pier infrastructure.
- While APT already employ's various detailed measures to reduce the initial risk and consequence of any collision, there must still be an acceptance that a certain portion of the residual risk is outside of APT's control, i.e. other vessels operating in the Humber.
- Should the IERRT development proceed, without extensive and substantial modification and preventative barrier protection to the IOT finger Pier and main Trunk way, the proximity of the IERRT and the size of the vessels using it would significantly increase the chance of allision to vessels using the Finger Pier and Collision to the IOT jetty.
- As such, it would be necessary for APT to re-evaluate the level of risk that ship collision would pose to people and the environment. The results would shift APT's priorities on where to focus risk reduction effort and result in potentially significant time effort and financial resources being borne by the Terminal.

180. An extract of the IOT Operators COMAH Safety Report that details ship impact and collision risk to the IOT was provided to IERRT developers on 25 July 2022 (see Appendix B).

5.2.3 Guidance on ALARP Decisions in COMAH – Individual Risk

181. The Health and Safety Executive (HSE) document "*Reducing Risks Protecting People*"[5] was republished as an information document on the 13th December 2001. The purpose of the document is to address external stakeholders about HSE`s approach to regulatory decision making. The information document details the following statements of principle:

- Principle 1: "*HSE starts with the expectation that suitable controls must be in place to address all significant hazards and that those controls, as a minimum, must implement authoritative good practice irrespective of situation based risk estimates*".
- Principle 2: "*The zone between the unacceptable and broadly acceptable regions is the tolerable region. Risks in that region are typical of the risks from activities that people are prepared to tolerate in order to secure benefits in the expectation that*

[5] Reducing Risks: Protecting People - HSE's decision making process (Accessed 10-Jul-2023)

   - *the nature and level of the risks are properly assessed and the results used properly to determine control measures;*
   - *the residual risks are not unduly high and kept as low as reasonably practicable (the ALARP principle); and*
   - *the risks are periodically reviewed to ensure that they still meet the ALARP criteria, for example, by ascertaining whether further or new controls need to be introduced to take into account changes over time, such as new knowledge about the risk or the availability of new techniques for reducing or eliminating risks."*
- Principle 3: "*both the level of individual risks and the societal concerns engendered by the activity or process must be taken into account when deciding whether a risk is acceptable, tolerable or broadly acceptable' and 'hazards that give rise to …. individual risks also give rise to societal concerns and the latter often play a far greater role in deciding whether risk is unacceptable or not*".

182. In the context of COMAH sites "*Reducing Risks Protecting People"* is accompanied by a Semi Permanent Circular "*Guidance on ALARP Decisions in COMAH*" [6] (SPC/Permissioning/37), which aims to give guidance specifically on ALARP demonstrations.

183. The guidance identifies three levels of risk:

- ***Intolerable Risk****: Clearly, if the risk is in this region then ALARP cannot be demonstrated and action must be taken to reduce the risk almost irrespective of cost.*
- ***Tolerable if ALARP Risk****: If the risks fall in this region then a case specific ALARP demonstration is required. The extent of the demonstration should be proportionate to the level of risk.*
- ***Broadly Acceptable Risk****: If the risk has been shown to be in this region, then the ALARP demonstration may be based on adherence to codes, standards and established good practice. However, these must be shown to be up-to-date and relevant to the operations in question.*

184. The Semi Permanent Circular shows types of ALARP demonstrations and associated risk of death per annum (see Figure 19). This reiterates the HSE "*Reducing Risks Protecting People"* definition relating to be acceptable levels of risk; "**Broadley Acceptable**" - fatality rate of less than 1 x 10^{-6}, "**Tolerable if ALARP**" – fatality rate of less than 1 x 10^{-4} (public) and 1 x 10^{-3} (workers), and "**Intolerable**" risk is greater than these. It relates however to risk to individuals and not societal risks.

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[6] Guidance on ALARP Decisions in COMAH - SPC/Permissioning/37 (hse.gov.uk) (Accessed 10-jul-2023)

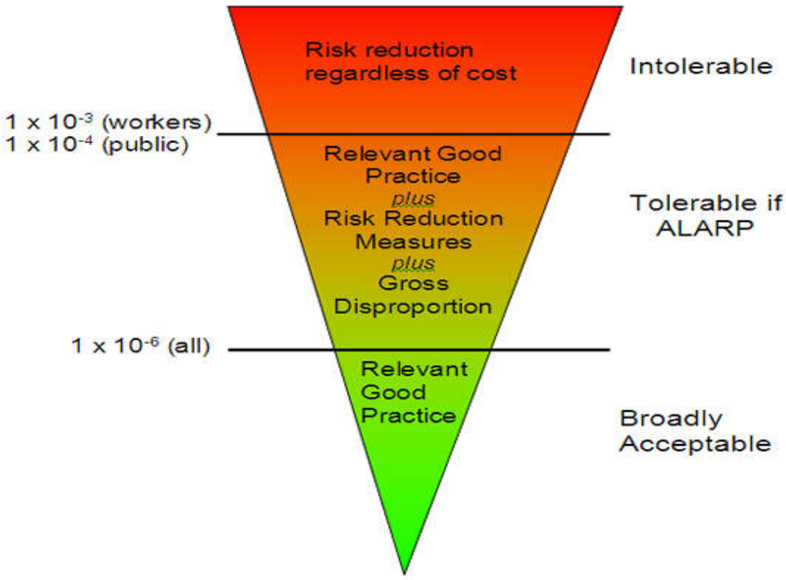


Figure 19: Types of ALARP Demonstration (Figure 1: Guidance on ALARP Decisions in COMAH - SPC/Permissioning/37).

5.2.4 Guidance on ALARP Decisions in HSE – Societal Risk

185. The HSE guidance notes that some risks give risk to societal concerns, which might take the form of a single event with multiple fatalities. Societal risk is particularly relevant for transportation activities which have the potential for multiple fatalities, but which spread their risks over a constantly changing population of passengers and people and therefore the individual risks to any specific person is relatively low.

186. Societal risk is often displayed through the use of so-called FN-curves which are obtained by plotting the frequency at which such events might kill N or more people). Whilst no FN curve is given within the HSE guidance HSE's (2001) Reducing Risks, Protection People states that "HSE proposes that the risk of an accident causing the death of 50 people or more in a single event should be regarded as intolerable if the frequency is estimated to be more than one in five thousand years". Translating this to the acceptability of societal risk for an individual fatality then it would relate a single fatality in one hundred years.

5.3 PORT MARINE SAFETY CODE

187. The Port Marine Safety Code(PMSC) [7] provides a national standard for marine safety in ports, harbours, marine terminals and marine facilities. Its aim is to enhance safety for everyone who uses or works in the UK port marine environment. The PMSC notes that the responsibility for maintaining port marine safety is governed not only by marine legislation, such as the Pilotage Act 1987 and Merchant Shipping Act, but also by general legislation, such as the Health and Safety at Work Act 1974 (which includes COMAH Regulations) and the Corporate Manslaughter and Corporate Homicide Act 2007.

188. Of the 10 keys measures of the port marine safety code three are recommended as the very minimum requirement for compliance, these are

[7] Port Marine Safety Code (publishing.service.gov.uk) (Accessed10-Jul-2023)

- **Measure 4:** Duties and Powers: Comply with the duties and powers under existing legislation, as appropriate.
- **Measure 5:** Risk Assessment: Ensure that marine risks are formally assessed and are eliminated or reduced to the lowest possible level, so far as is reasonably practicable, in accordance with good practice.
- **Measure 6:** Marine Safety Management System: Operate an effective MSMS which has been developed after consultation, is based on formal risk assessment and refers to an appropriate approach to incident investigation.

189. Through implementation of "Measure 5: Risk Assessment" and "Measure 6: Marine Safety Management System" the PMSC requires "all risks are identified and controlled – the more severe ones must either be eliminated or reduced to the lowest possible level, so far as is reasonably practicable (that is, such risks must be kept as low as reasonably practicable or "ALARP"). Organisations should consult, as appropriate, those likely to be involved in, or affected by, the MSMS they adopt. The opportunity should be taken to develop a consensus about safe navigation. The MSMS should refer to the use of formal risk assessment which should be reviewed periodically as well as part of post incident/accident investigation activity."

190. At section 2.7 of the PMSC formal risk assessments are required to:

- *identify hazards and analyse risks;*
- *assess those risks against an appropriate standard of acceptability; and*
- *where appropriate consider a cost-benefit assessment of risk-reduction measures.*

191. The PMSC requires that risks are assessed against an appropriate standard of acceptability, and in this context then IOT Operators are required by the Health and Safety at Work Act to defer to the standards defined in the COMAH regulations (see Figure 19), which put the threshold of "Broadley Acceptable" of a fatality rate per year of less than 1 x 10^{-6}, and the threshold for "Tolerable if ALARP" at a fatality rate per year of less than 1 x 10^{-4} (defined as the limit for members of the public, as IERRT vessels will be carry up to 120 passengers). This relates to individual risk, however for societal risk then a figure of one fatality in 100 years could be adopted (see above).

5.4 MARINE GUIDANCE NOTE 654 (M+F)

192. MGN654, and its associated annexes, was developed by the MCA (2021) as the primary guidance for developers conducting NRAs of offshore renewable energy installations. The guidance clearly sets out the expectations of data gathering, consultation, analysis and assessment of these NRAs. Much of the underlying assessment approach is consistent with the IMO's Formal Safety Assessment. Failure for developers to follow the guidance principals of MGN654 may result in delays and objections from stakeholders within the licensing and consenting process.

193. Whilst MGN654 is not explicitly developed for use in NRAs in other applications, the MCA have consistently accepted the use of MGN654 for undertaking NRAs on a wide range of topics (such as oil and gas, offshore infrastructure, and port infrastructure).

5.5 LEGISLATION AND GUIDANCE SUMMARY

194. In summary, there is adequate existing legislation and guidance to enable a robust and evidence-based navigation risk assessment of IERRT to be undertaken. Based on a

review of the available legislation then an appropriate standard of acceptability for societal risk, in relation to harm to people is a figure of one fatality in 100 years could be adopted, which is the limit between Tolerable subject to ALARP and Intolerable. An appropriate and robust Navigation Risk Assessment should therefore adopt these parameters.

6. RISK ASSESSMENT METHODOLOGY

6.1 FSA METHODOLOGY

195. The scope for this sNRA commissioned by IOT Operators is to address the shortcomings identified in the ABP provided IERRT NRA. The underlying methodology for the sNRA is the International Maritime Organisation (IMO) Formal Safety Assessment (FSA) approach, which is referenced (PMSC Para. 4.3.20) by the UK PMSC as the appropriate methodology for marine operations in UK ports and harbours. It is also the same approach as is mandated by Maritime Coastguard Agency in MGN 654 (M+F).

196. This methodology involves a structured process for identification and analysis of hazards and scenarios with scoring of risk, before taking action to reduce intolerable risk to 'As Low As Reasonably Practicable (ALARP)' and to a level that is acceptable to stakeholders, (see Figure 20)

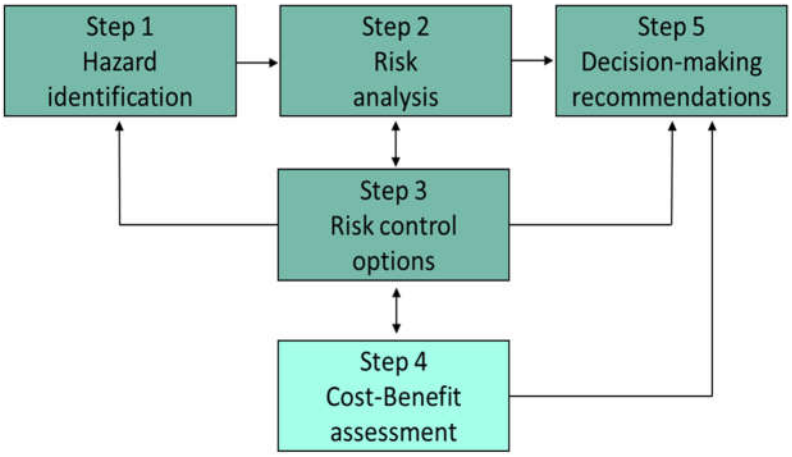


Figure 20: IMO Formal Safety Assessment process

197. The individual steps of the sNRA are as follows:

- **Step 1:** Hazard identification based on detailed description of current and future navigation baseline for the area of the proposed IERRT (see Sections 7, 8 and 9), based on:
  - Quantification of current baseline navigation disposition including:
    - Use of composite swept path analysis from AIS data collected at IOT.
    - Review of historical incidents (both in the area, with similar vessel types elsewhere, and to oil terminal infrastructure).
  - Future navigation disposition:
    - Cross reference to the IERRT NRA documentation.
  - Consultation with stakeholders (and regulators such as Harbour Master for the port of Immingham); and
  - Detail a robust sNRA methodology appropriate to IERRT and IOT operations based on accepted guidance. This includes review of current baseline NRAs for the area (yet to be provided by ABP) – principally, the current MSMS NRA.

- **Step 2:** Risk analysis (see Section 10) to inform hazard scoring including quantitative:
  - Likelihood modelling; and
  - Consequence modelling.
- **Step 3:** Identification and specification of risk control measures (see Section 11.
- **Step 4:** Cost benefit assessment using ALARP principles for intolerable hazards (see Section 12).
- **Step 5:** Decision making recommendations (see Section 13).

6.1.1 Consultation

198. Consultation with stakeholders is included in this assessment based on the attendance at and outputs of the second and third hazard workshops undertaken by IERRT developers and attended by the IOT operators, giving particular regard to information raised by navigation users of the area. The first hazard workshop was conducted by ABP personnel only and IOT operators were not invited to attend, so no consultation results are drawn from this workshop.

199. The following hazard workshops were as follows:

- Hazard Workshop 1: 29 October 2022

  ABP personnel only to inform the Preliminary Environmental Impact Report Navigation Risk Assessment;
- Hazard Workshop 2: 7 April 2022

  IOT Operators and other stakeholders in attendance,
- Hazard Workshop 3: 16 - 17 August 2022

  IOT Operators and other stakeholders in attendance.

6.2 QUALITATIVE ASSESSMENT (HSE / COMAH)

200. The following section outlines the parameters of the risk assessment methodology which has been adopted as the qualitative NRA methodology for this assessment in order to determine the baseline and residual navigation risk posed by the IERRT. It uses the same risk matrix as adopted by IOT operators for their COMAH safety plan.

201. As the IOT is a COMAH site, it has HSE-imposed acceptability levels to risk which are referenced to clear likelihoods of occurrence for defined hazard consequences (e.g. a fatality) – these have previously been provided to IERRT developers with the Standards of Acceptability to IOT Operators as a COMAH site under UK Health and Safety Executive regulations.

202. The IOT Operators COMAH risk assessment methodology was utilised to establish a benchmarking basis for navigation risk posed by the IERRT development which is consistent with how the IOT Operators currently assess and understand risk.

203. In this sNRA the following definitions apply:

- **Hazard** - an unwanted event resulting in adverse consequences;
- **Likelihood** - a determination of how likely a hazard is to occur;

- **Consequence -** the magnitude of adverse outcomes should a hazard occur;
- **Risk** – a non-dimensional measure of hazard frequency and consequence based on a qualitative risk matrix;
- **Embedded risk control measures** – a risk control measure that is already in place;
- **Additional risk control measures** – a risk control measure that is put in place specifically for the project scheme under consideration;
- **Baseline Assessment of Navigation Risk** – an assessment of hazard risk with the proposed operation occurring including existing ("Embedded") risk control (or mitigation) measures.
- **Residual Assessment of Navigation Risk** – an assessment of hazard risk with the proposed operation occurring including existing ("Embedded") risk control (or mitigation measures), and "additional" project / risk control (or mitigation) measures.

204. The risk assessment methodology requires that marine hazards are identified and assessed in relation to likelihood and hazard consequence to generate a hazard risk score. The likelihood classification is assigned based on the likelihood of the occurrence of the level of harm (severity) specified e.g. injury, not the likelihood of an initiating event e.g. adverse weather.

205. The hazard likelihood categories are summarised in Table 4 which are the same as the IOT COMAH safety plan. A cross reference is also included to IERRT Frequency Descriptors based on the mathematical likelihoods.

Table 4: IOT COMAH Hazard Likelihood Categories.

Rank	Description	Typical Frequency Range (of specific scenario being considered on the site)	Cross reference to IERRT Hazard Frequency for Operations
1	Very unlikely	< 1 in a million chance per year	Rare
2	Unlikely	1 in 1,000,000 to 1 in 10,000 chance per year	Rare
3	Reasonably likely	1 in 10,000 to 1 in 1,00 chance per year	Unlikely / Rare
4	Likely	1 in 1,00 to 1 in 1 chance per year	Likely / Possible
5	Very likely	> 1 in 1 chance per year (> 1 per plant year)	Almost certain

206. Hazard consequence classifications are shown in Table 5 and relate to hazard outcomes to people, property, environment and Port Business.

207. The IOT COMAH risk assessment methodology outlines consequences in terms of people and environment as follows:

- Consequences to people are derived from HSE imposed acceptability levels.
- Consequences to the environment are defined in terms of potential to cause a Major Accident to the Environment (MATTE). For a MATTE to occur there must be a release of material from site that causes sufficient environmental damage to

one or more environmental receptors. The severity of damage and the length of time the damage occurs are significant in determining a MATTE.

208. Consequences to property and business are not outlined in the COMAH risk assessment methodology. The NASH Maritime team therefore undertook a benchmarking exercising utilising internationally recognised consequence classifications used in NRA methodologies, such as MCA MGN 654, and methodologies utilised by UK SHAs to determine appropriate consequence classifications for property and business.

Table 5: Hazard Consequence Classifications.

Rank	Description	Definition			
		People	Property	Environment	Business
1	Moderate	Potential for minor injury on site.	£10,000-£100,000	Environmental impact but below the major accidents to the environment (MATTE) threshold	Local negative publicity, short term loss of revenue to port / ship register £10,000-£100,000
2	Serious	Potential for serious injury / injuries on site.	£100,000-£1million	Department of the Environment, Transport and the Regions (DETR)[8] criteria – the lowest level of harm that can be considered a MATTE	Widespread negative publicity, temporary suspension of activities at port / ship register £100,000 Local publicity -£1million
3	Major	Potential for some (one/few) fatalities / many serious injuries on site, some potential for minor injury off site.	£1million-£10million	Catastrophic environmental impact on 2 or more MATTE categories over the designated threshold and for greater than 1 year (widespread, requires long term additional resources considered a MATTE on 2 or more environmental receptors	National negative publicity, prolonged closure or restrictions to port / ship register £1million National publicity -£10million
4	Catastrophic	Potential for many fatalities on site or potential for serious injury or fatality off site	>£10million	DETR criteria – the highest levels of harm to the receptor (long term/permanent/widespread damage)	International negative publicity, serious disruption to operations to port / ship register >£10million International publicity

[8] Department of the Environment, Transport and the Regions (DETR), 1999, Guidance on the interpretation of Major Accident to the Environment for the purposes of COMAH regulation.

209. A risk matrix is then used to combine the likelihood and consequence scores for each identified hazard to generate a baseline assessment or risk. Based on the evaluation of the impact of the proposed IERRT operation, each hazard is scored using the matrix as defined in Table 6. This is the same risk matrix as used by IOT in its safety plan.

Table 6: Risk Matrix.

Risk Matrix						
Likelihood	Very likely	5	**5**	**6**	**7**	**8**
	Likely	4	**4**	**5**	**6**	**7**
	Reasonably unlikely	3	**3**	**4**	**5**	**6**
	Unlikely	2	**2**	**3**	**4**	**5**
	Very unlikely	1	**1**	**2**	**3**	**4**
			1	2	3	4
			Moderate	Serious	Major	Catastrophic
			Consequence			

210. Hazard risk scores are assessed for the "worst credible" outcome of an individual hazard. The following classifications for consequence are:

- People;
- Property;
- Environment; and
- Port business.

211. Hazard risk scores for each individual hazard consequence score are then brought together using a weighted averaging formula to give a single overall risk score. The averaging formula, which generates a single risk score on a scale of 1 to 8 is generated by taking the average of the four assigned consequence scores plus the maximum consequence scores divided by two. This provides a weighing towards the more riskier consequence classifications. An example calculation is as proved below:

- Hazard Likelihood Category "*Reasonably unlikely - 1 in 10,000 to 1 in 1,00 chance per year* " = 3
- Hazard Consequence Category

    - People: “Serious” = 2
    - Property: “Major" = 3
    - Environment: “Major” = 3
    - Port business: “Catastrophic” = 4
- Risk Score (using the risk matrix)
    - People: Risk Score 4
    - Property: Risk Score 5
    - Environment: Risk Score 5
    - Port business: Risk Score 6
    - Overall risk score 5.5 (which is average risk score (5) plus maximum risk score (6), divided by 2)

212. Based on the resulting risk scores, hazards are defined as either “Broadly Acceptable”, “Tolerable if ALARP” or “Intolerable” (corresponding to the red / yellow and green colouring in the risk matrix at Table 6). As described in **Section 5.2.4**, HSE (2001) guidance states that risks are intolerable if the hazard could result in more than 50 fatalities and would occur more than once in 5,000 years. This equates approximately to a consequence score of 4 and a frequency score of 3, and therefore a risk score on the matrix of 6. Risk matrices assume that likelihood and consequence scale comparatively across the matrix and so a threshold of 6 is defined as the threshold for intolerable risk. Following a review of risk matrices, it was concluded by the project team that the same hazard could be defined as Broadly Acceptable if it was more than two orders of magnitude lower in likelihood than an Intolerable hazard, and as such any hazard which scores a 3 or below is deemed to be Broadly Acceptable. Any hazard which falls between 3 and 6 is therefore Tolerable, provided that the risk is As Low As Reasonably Practicable (ALARP).

213. Hazards with risk scored at “Broadly Acceptable” would be deemed acceptable, which puts the acceptability threshold at risk scores lower than 4 (see Table 7 for risk score classifications). Where hazards are scored between 4 and 5.99 (Tolerable if ALARP) then additional control measures are necessary unless their cost is disproportionate to their benefit – e.g. following the As Low As Reasonably Practicable (ALARP) principle. Where hazard risk scores are greater than or equal to 6 (“Intolerable”), additional risk controls must be identified and allocated to hazards to reduce risk. Hazard risk scores are then recalculated using the same method as above and a residual assessment of risk determined.

Table 7: Hazard Risk Score Classifications.

Risk Scores	Tolerability
0 to 3.99	Broadly Acceptable
4 to 5.99	Tolerable if ALARP
Greater or equal to 6	Intolerable

6.3 QUANTITATIVE ASSESSMENT

214. Having identified the list of hazards and prioritised the key scenarios by risk level, detailed risk analysis is undertaken to investigate the likelihood and consequences of the highest priority hazards. A Quantitative Risk Assessment (QRA) is undertaken to provide evidence-based, numerical values to the causes and consequences in each scenario.

215. The primary method of undertaking this is through an event tree, whereby the causal sequence of events which might cause a hazard to occur are mapped, with the probabilities that certain branches occur estimated. Following this, consequences to people, property, environmental and the economy are modelled for each scenario.

216. The resulting risk scores are then benchmarked against published acceptability criteria established by the HSE (2001), IMO (2008) and other industry sources.

217. The details of the QRA are contained in Section 10.

7. NAVIGATION BASELINE

7.1 INTRODUCTION

218. The Humber Estuary is located on the east coast of the UK between Yorkshire and Lincolnshire. It is currently the busiest shipping estuary in the UK according to Department of Transport UK data on port ship arrivals by port[9].

219. The location of the IERRT development is approximately 0.5nm from the entrance to Immingham impounded dock system, immediately upstream of the IOT Trunkway. The Department for Transport data shows that the Port of Immingham and Grimsby (accounted for together due to historical reasons), is the busiest port for ship arrivals in the UK except for the Port of Dover, which has higher numbers due to it ferry operations.

220. The Admiralty Sailing Direction: (North Sea (West) Pilot notes that tidal streams off Immingham have a spring rate for the in going stream of 3.5kn and for the outgoing stream 4.5kn, and that whilst rates off the jetties and terminals in the area are similar, they can at times reach 4kn for incoming tides and 7kn for outgoing tides.

221. Essentially the area around the Immingham is amongst the busiest in the UK and has arduous and complex tidal flows, which makes navigating vessels in the area difficult. To a degree this is brought out in the incident rates for the Humber Estuary, and Immingham in particular, which are also amongst the highest in the UK.

222. The following section provides context on the navigation baseline for the area close to the proposed IERRT development, in terms of the

- Marine environment;
- Management of Navigation;
- MetOcean data;
- Vessel Traffic Movement Analysis;
- Vessel frequency analysis; and
- Berth utilisation at IOT finger pier.

7.2 OVERVIEW OF MARINE ENVIRONMENT

223. The location of the IERRT is shown on an Admiralty navigation chart in Figure 8. The figure also shows nearby terminals. Of particular interest to IOT Operators is the proximity of the proposed IERRT infrastructure in relation to the IOT Finger Pier (Berths 6, 7, 8 and 9), Trunkway and for IERRT vessels on transit to the IOT river berth.

7.3 MANAGEMENT OF NAVIGATION

224. The management of vessel navigation on the Humber Estuary, and in the area of the proposed IERRT is undertaken by ABP as follows:

- Statutory Harbour Authority for IERRT Development – ABP Port of Immingham;
- Statutory Harbour Authority for Humber outside of ABP Port of Immingham area including the Humber Estuary – ABP Humber Estuary Services;

[9] port0602.ods (live.com) Accessed 21-07-2023.

- Competent Harbour Authority (provision of pilots) – ABP Humber Estuary Services;
- Vessel Traffic Services / Local Port Service – ABP Humber Estuary Services / ABP Port of Immingham; and
- Local Lighthouse Authority – ABP Port of Immingham

7.3.1 Statutory Harbour Authority

225. SHAs are Statutory Bodies responsible for the management and running of a harbour. The powers and duties in relation to a harbour are set out in local Acts of Parliament or a Harbour Order under the Harbours Act 1964[10]. The Port of Immingham under the Harbours Act 1964 and various Harbour orders is responsible for management of navigation in the area proposed for the IERRT development.

226. All UK SHA's (and other types of marine facilities) are requested by the Department for Transport to follow the UK PMSC (see Section 5.3) which requires SHAs to have a number of key requirements in place including a Marine Safety Management System based on a formal assessment of risk. According to the IERRT NRA the Port of Immingham has a Marine Safety Management System in place:

227. "Section 10.1.3 It is recommended that this risk assessment is used to inform amendments to the Marine Safety Management System that is currently in place at the Port of Immingham to ensure that risks are appropriately captured, monitored, and updated as required based on the latest information available as time goes on."

7.3.2 Competent Harbour Authority

228. The PMSC states that Under the Pilotage Act 1987, a Competent Harbour Authority (Humber Estuary Services) has a duty to assess what, if any, pilotage services are required to secure the safety of ships, and to provide such services as it has deemed necessary, and that Competent Harbour Authorities should determine these matters through risk assessment.

229. The Competent Harbour Authority for vessels bound to and from the IERRT and adjacent berths is ABP Humber Estuary Services, who have published "*Pilotage Directions For Ships To Be Navigated Within The Humber Pilotage Area*"[11]. Pilots are assigned to vessels based on the size of vessel (e.g. there are four classes of pilot; 3rd, 2nd, 1st and Very large Ship) and whether they are authorised for a particular berth or terminal.

230. Humber Pilotage Directions also allow for Pilotage Exemptions Certificates (PECs) to be issued which allow vessels not to take a pilot. PECs are issued to deck officers of vessels who frequently visit the estuary and are generally restricted to specific vessels and specific berths / terminals. The PECs are issued to specific deck officers who "*must satisfy ABP by examination that they have a sufficiently high level of skill, experience and local knowledge for them to be capable of piloting that ship*" and must also demonstrate that they have undertaken a number of trips in and out over the part of the pilotage area that the certificate covers.

231. It is anticipated that due to the repeat nature of specific vessels arriving and departing the proposed IERRT that a PEC will be mostly used rather than a Humber Estuary Services pilot.

[10] Harbour Orders - GOV.UK (www.gov.uk) Accessed 21/07/2023
[11] ASSOCIATED BRITISH PORTS (humber.com) Accessed 21/07/2023

7.3.3 Vessel Traffic Services / Local Port Services

232. Humber Estuary Services provides a Vessel Traffic Service (VTS) to the requirements of competent authority - Maritime Coastguard Agency Marine Guidance Note 401. A VTS is defined as service designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and respond to traffic situations developing in the VTS Area.

233. The Port of Immingham provide a Local Port Service (LPS), a lower level of service compared to a VTS, which covers the SHA area. Where the requirements of a VTS are specified internationally and cascaded through national competent authorities to VTS areas (such as the Humber VTS area managed by Humber Estuary Services), the specification and requirements for LPS are defined by the organisation that has set it up (e.g. Port of Immingham). The overlap and interface between the Humber Estuary Services VTS and the Port of Immingham LPS is not clearly defined in available literature / documents.

7.4 METOCEAN DATA

234. Wind information in the IERRT NRA was derived from Humberside Airport, which is located some distance from the proposed IERRT development at a location chosen for the construction of an airport (which presumably has constant and manageable wind speed). In ABP's Written Summary of the Applicant's Oral Case at Issue Specific Hearing 2 For Deadline 1: 15 August 2023, a wind rose from June 1999 – June 2000 was provided for Immingham Dock. Whilst the Immingham Dock wind rose is over 20 years out of date, it does show differences between that provided in the IERRT NRA (such as the IERRT site having high wind speeds when wind is from the NE - perpendicular to the IERRT infrastructure - and the prevailing wind being more from the south than the south west), albeit it the legend in the Immingham Dock wind rose is largely eligible.

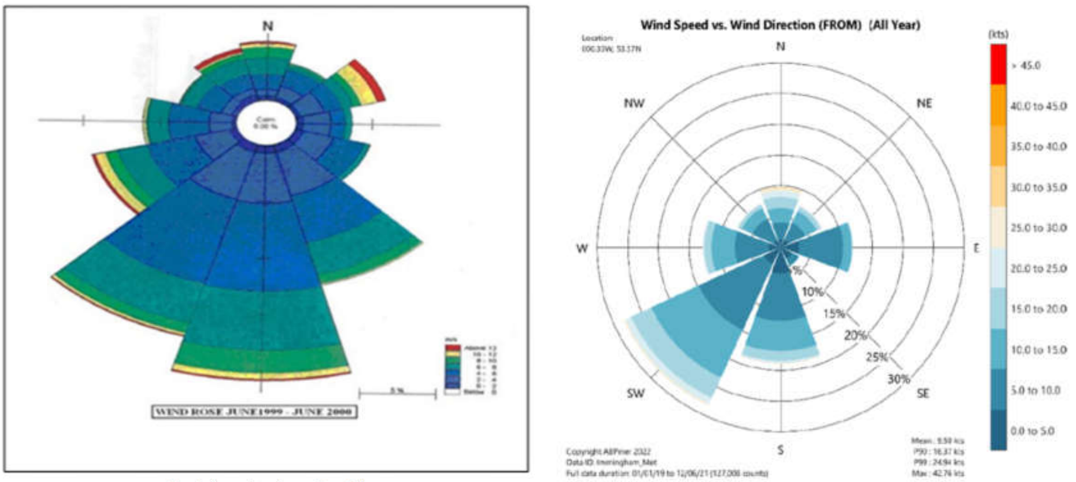


Fig 1 (Immingham Dock)

Figure 2 **Wind Speed and Direction at 10 m Above Sea Level, Rose Plot**

Figure 21: Left Immingham Dock wind data from 1999 to June 200 and Right. Wind Rose from Humebrside Airport as presetned in IERRT NRA.

235. Tidal velocities and directions are complex in the vicinity of the IERRT development, however no detailed high resolution stream atlas's are provided in the IERRT NRA which show the direction and strength of the tide at incremental stages through the tidal cycle.

7.5 VESSEL TRAFFIC ANALYSIS

7.5.1 Data

236. AIS is an automatic tracking system fitted to vessels which broadcasts information about the vessel and its activities through VHF to other vessels and shore stations. AIS broadcasts includes dynamic information (location, speed, course etc.) and static information (name, size, type etc.). AIS is required on all commercial vessels over 300 gross tonnage and may be carried by smaller craft such as fishing boats and recreational craft. The transmission rate of the dynamic information varies best on activity but is in the region of two to 10 seconds for a navigating vessel and up to three minutes for a vessel moored or at anchor.

237. The following section describes vessel traffic analysis based on AIS data collected from an AIS receiving station located on the IOT from March to June 2023. The receiver was positioned in a location with good coverage and line of sight of the study area and therefore the data quality is considered to be high.

7.5.2 Overview

238. The area close to the IERRT is primarily used by commercial vessels including cargo, tanker, and tug & service vessels. The Humber River is transited by vessels travelling on an east/west route. The total Humber transits at this section of the river was 1,439 in 28 days, with 1067 of these transiting within 0.5nm of the Immingham IOT (74%).

7.5.3 Cargo Vessels

239. Figure 22 shows the AIS tracks of cargo vessels operating in the study area. The majority of cargo vessels visiting the Immingham site are using either the Immingham Dock or the Outer Harbour, as seen in the southwest and west region of the plot, respectively.

240. Over the 28 days of AIS data coverage, the Immingham Dock experienced 286 cargo vessels transits (arrival and departure), this consisted of all vessels of <= 100m (75 transits) and 101m – 150m (109 transits). Cargo vessels of 151m – 200m use both the Immingham Dock (103 transits) and Outer Harbour (54 transits). All 68 transits of vessels 201m-260m visiting Immingham use the Outer Harbour.

241. Figure 23 illustrates that the areas with highest vessel traffic are in the approaches to both the Immingham Dock and Outer Harbour, and the region to the north of the IOT where vessels are transiting East / West. With 47 transits the cargo vessel with the most frequent visits is the bulk carrier FEDERAL DART (MMSI: 538007827).

7.5.4 Tankers

242. Figure 24 shows AIS data of tanker vessels transiting close to the proposed IERRT. There are currently three areas of primary use: the eastern side of the Outer Harbour, the existing IOT Finger Pier, and the access of the IOT river berths. Tanker vessels of <=100m are the most common, generally visiting either the existing IOT Finger Pier (79 transits) or the eastern side of the Immingham East Jetty (18 transits).

243. There are also sporadic uses of other areas, with four transits at the West Jetty, six transits at the Eastern Jetty, and 2 uses of the Immingham Dock. Tanker vessels of 101-150m are more evenly distributed amongst the available berths, with 25 transits using the

IOT river berths; 20 transits at the Immingham West Jetty; 10 transits at the Eastern Jetty, and six using the Immingham Dock.

244. All 151m – 200m tankers use one of the three IOT river berths, consisting of 20 transits in the recorded 28 days. Similarly, vessels of 201m-260m also only use the IOT river berths, accounting for all 18 transits. Figure 25 shows the density of tanker vessel transits in the study area, the two areas exhibiting the most concentrated traffic are just north of the IOT, and either side of the existing Finger Pier. With 33 vessel transits, the Oil Tanker SHANNON FISHER (MMSI: 30839000) is the most frequent user of the Immingham site. The EAGLE BRISBANE (MMSI: 563053500) has a length of 250m, making it the largest vessel that entered the study area.

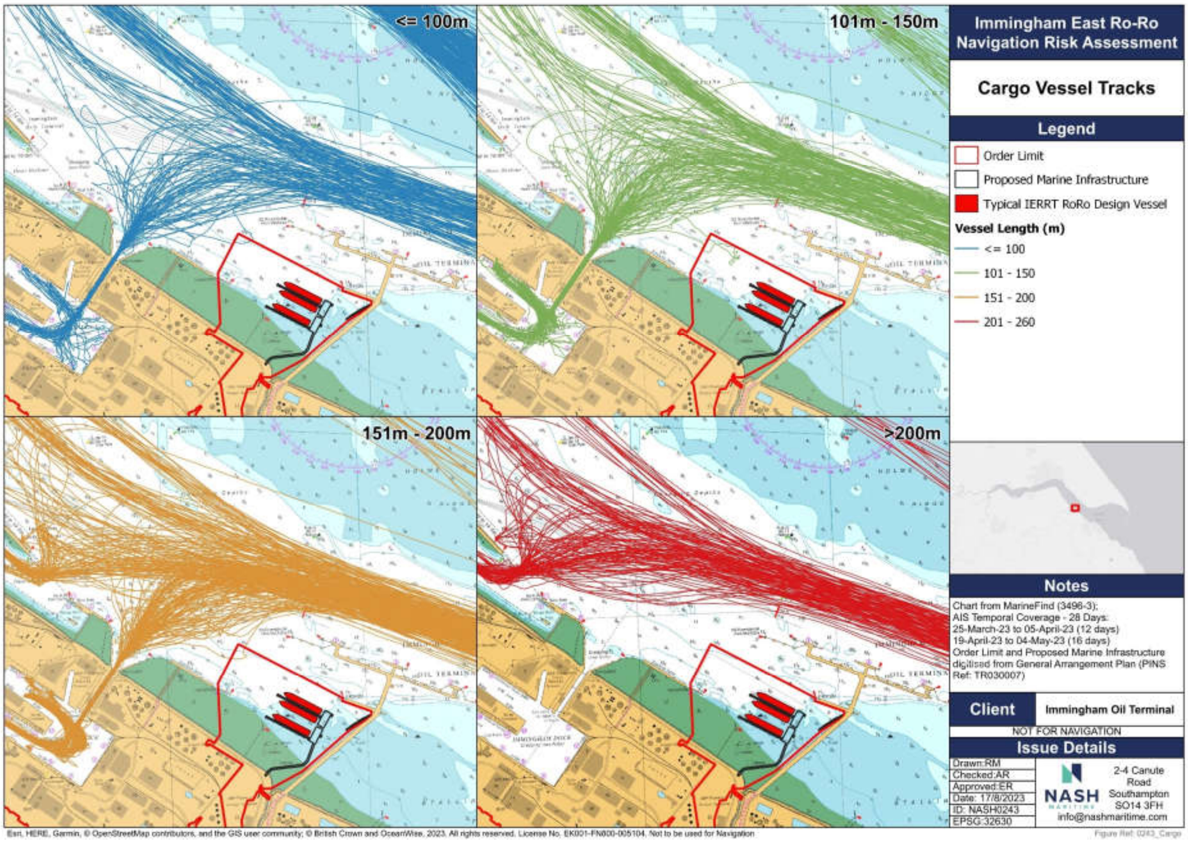


Figure 22: Cargo vessel tracks.

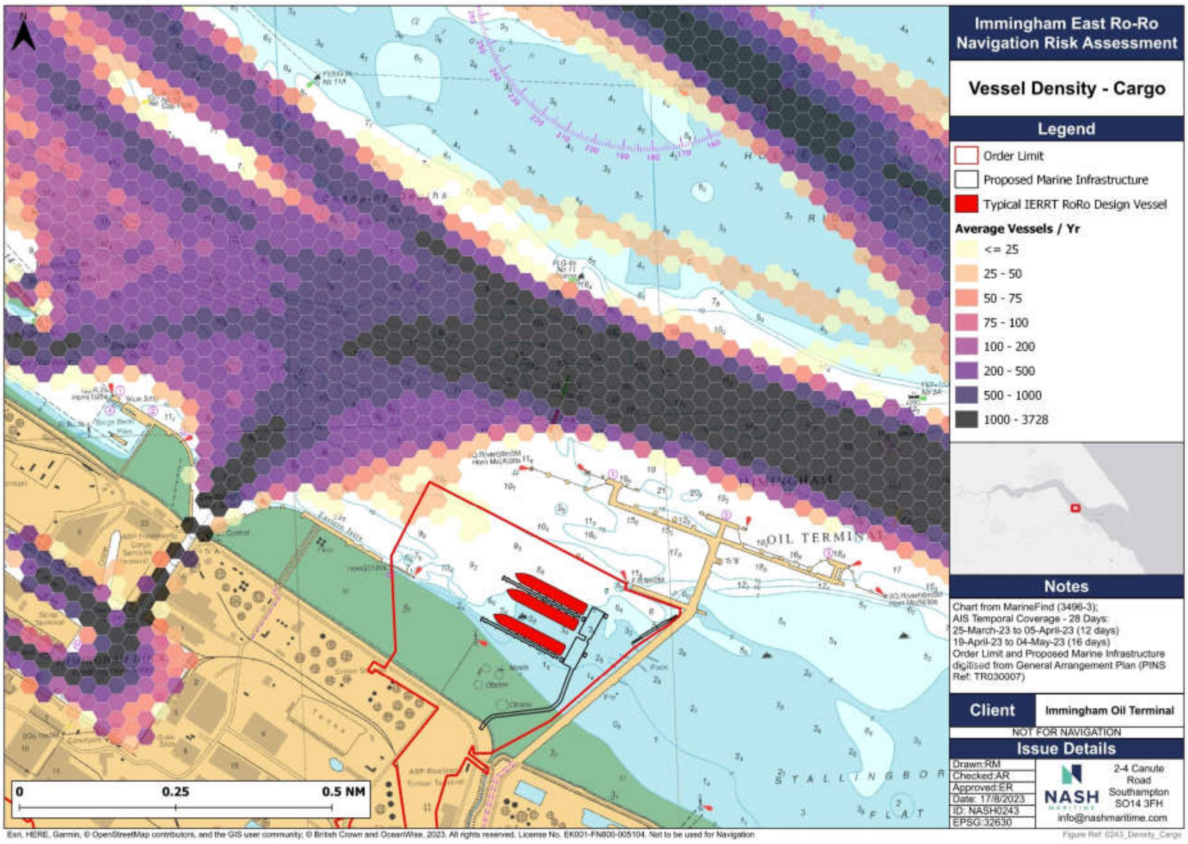


Figure 23: Cargo track density (28 days).

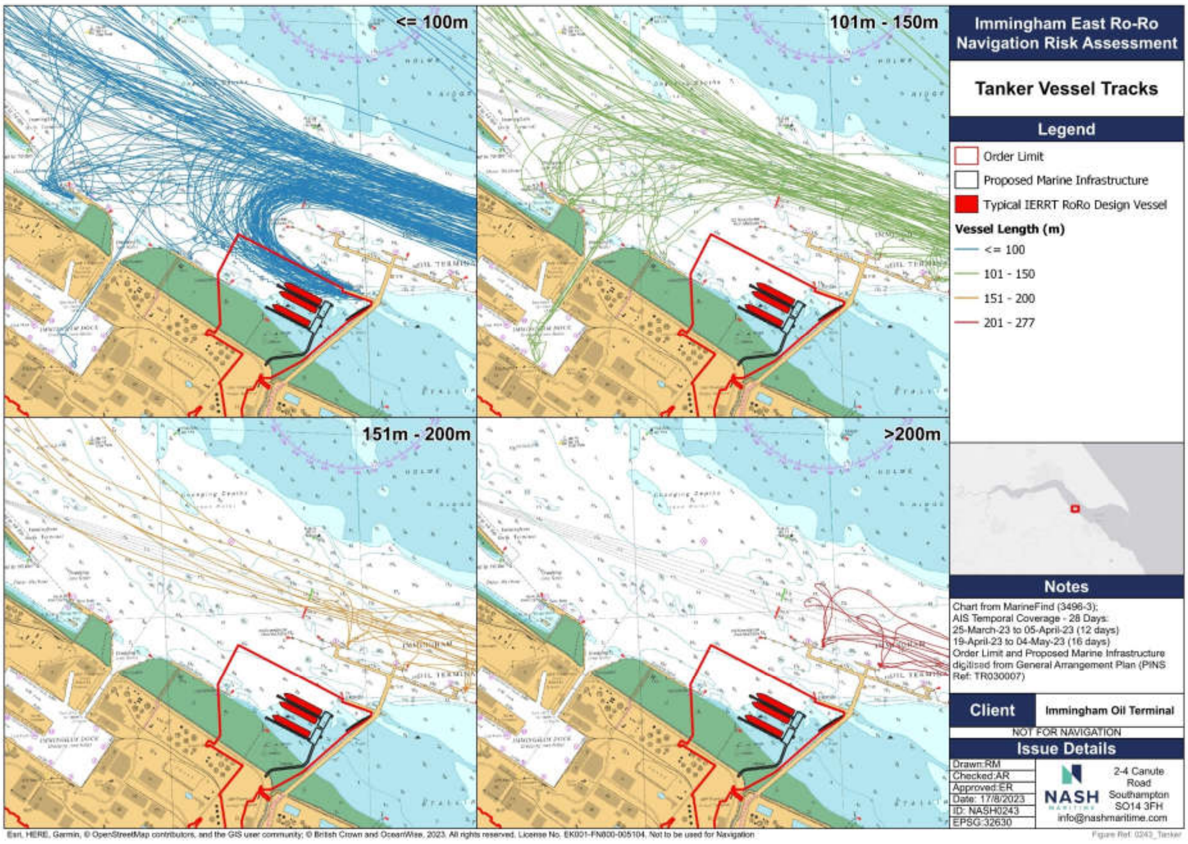


Figure 24: Tanker vessel tracks.

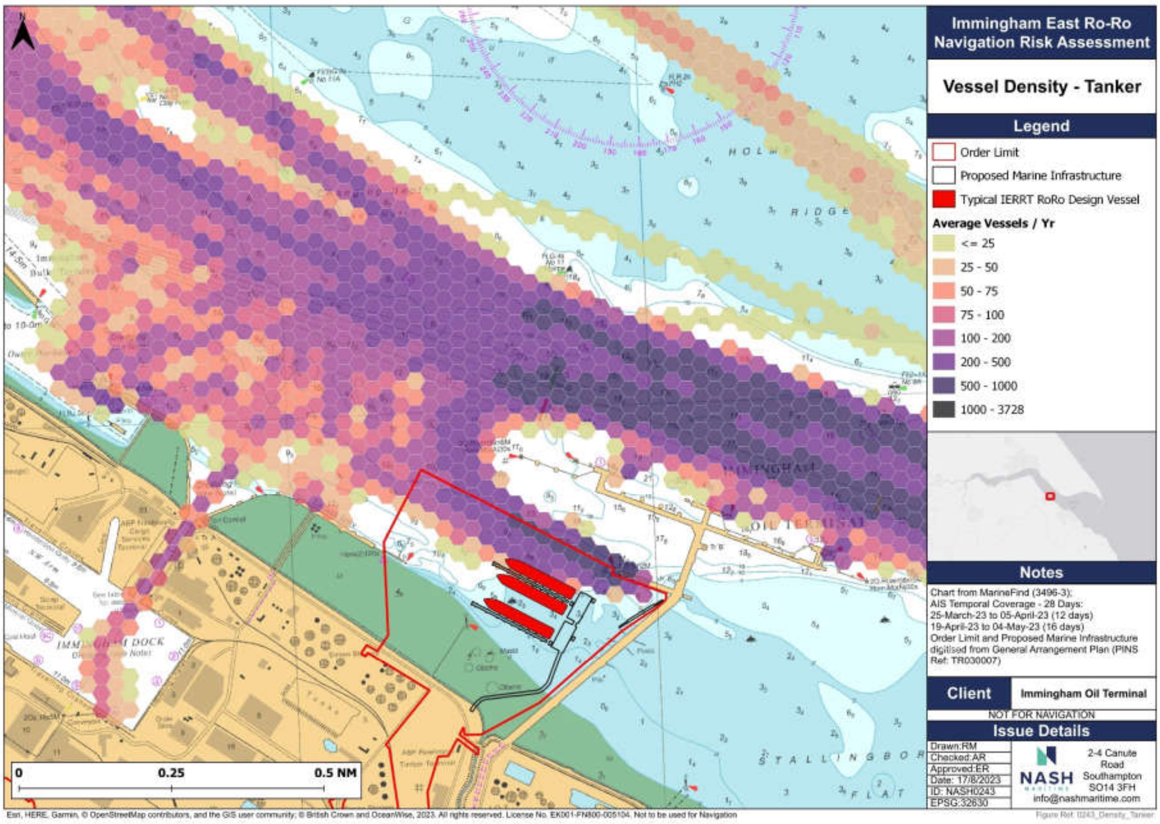


Figure 25: Tanker track density (28 days).

245. Figure 26 and Figure 27 show swept path analysis of the WISBY ARGAN, the largest Gross Tonnage coastal tanker visiting the IOT Finger Pier during the data period. The swept path analysis shows the sea room taken up by a vessel's outline as it navigates, which is more detailed than the presentation in a track plot which shows only the line taken by the ship's AIS antenna. The analysis demonstrates the approach to the berth on two separate days, 25 April 2023 and 6 May 2023. The weather conditions on these days were benign with wind speeds of less than 12 knots and good visibility reported at Humberside Airport. For these swept path plots the IOT workboats are not included. For both arrivals, even in benign conditions, it is evident that the WISBY ARGAN transits close to or through the proposed IERRT location. In more challenging weather conditions, especially when requiring the use of the workboat (and possibly tug) the combined swept path is likely to be significantly greater further to the south than that shown.

246. Swept path plots of other coastal tankers THUN BLYTH and DEE FISHER arriving at IOT Finger Pier berth 8 are provided in Figure 28 and Figure 29.

247. A compositive swept path plot are presented in Figure 30 and Figure 31, which shows the cumulative swept paths for all tankers using berths at the IOT Finger Pier. This plot shows the sea room currently used by tankers arriving and departing the IOT Finger Pier. It is evident from this analysis that the footprint proposed to be taken up by the IERRT is commonly used during the approach to and departure from the IOT Finger Pier. When considering the requirement for the master to use a safe distance of minimum two ships' beam widths clear from a moored vessel, then the available sea room for manoeuvring on and off the IOT Finger Pier is reduced significantly more.

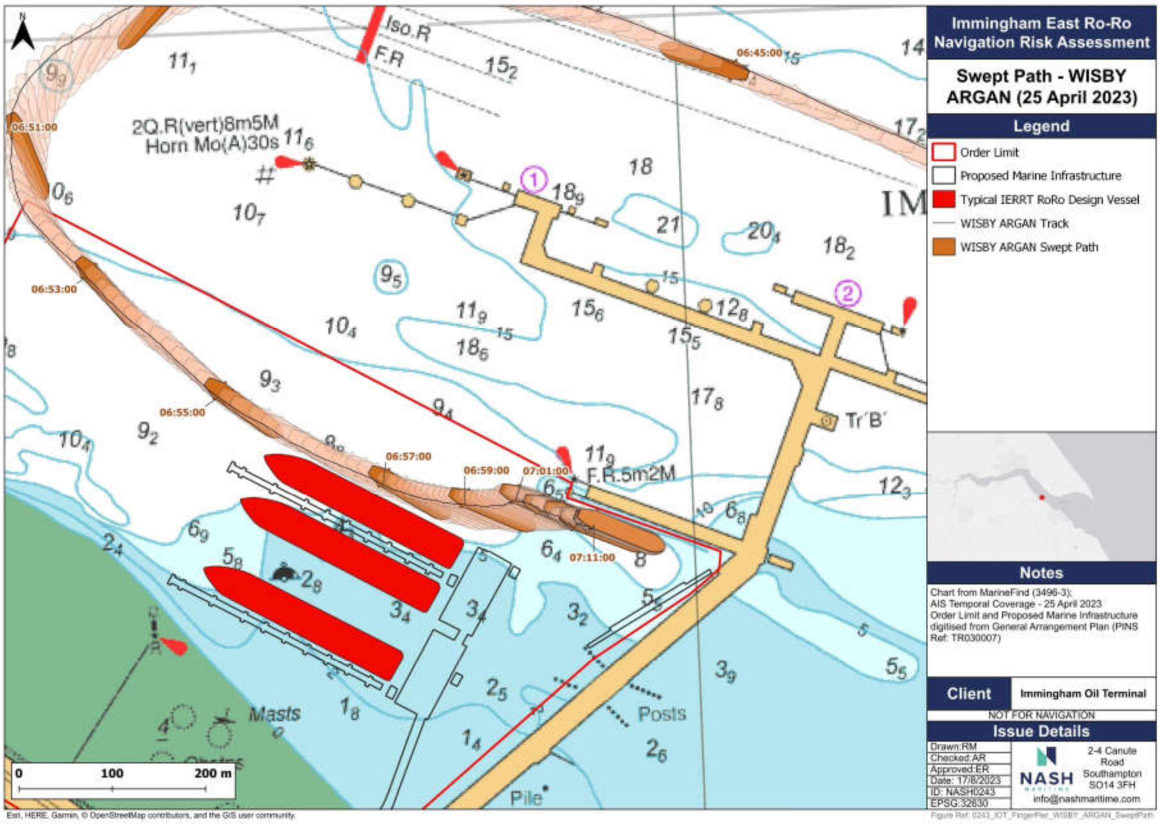


Figure 26: WISBY ARGAN swept paths (25-Apr-2023).

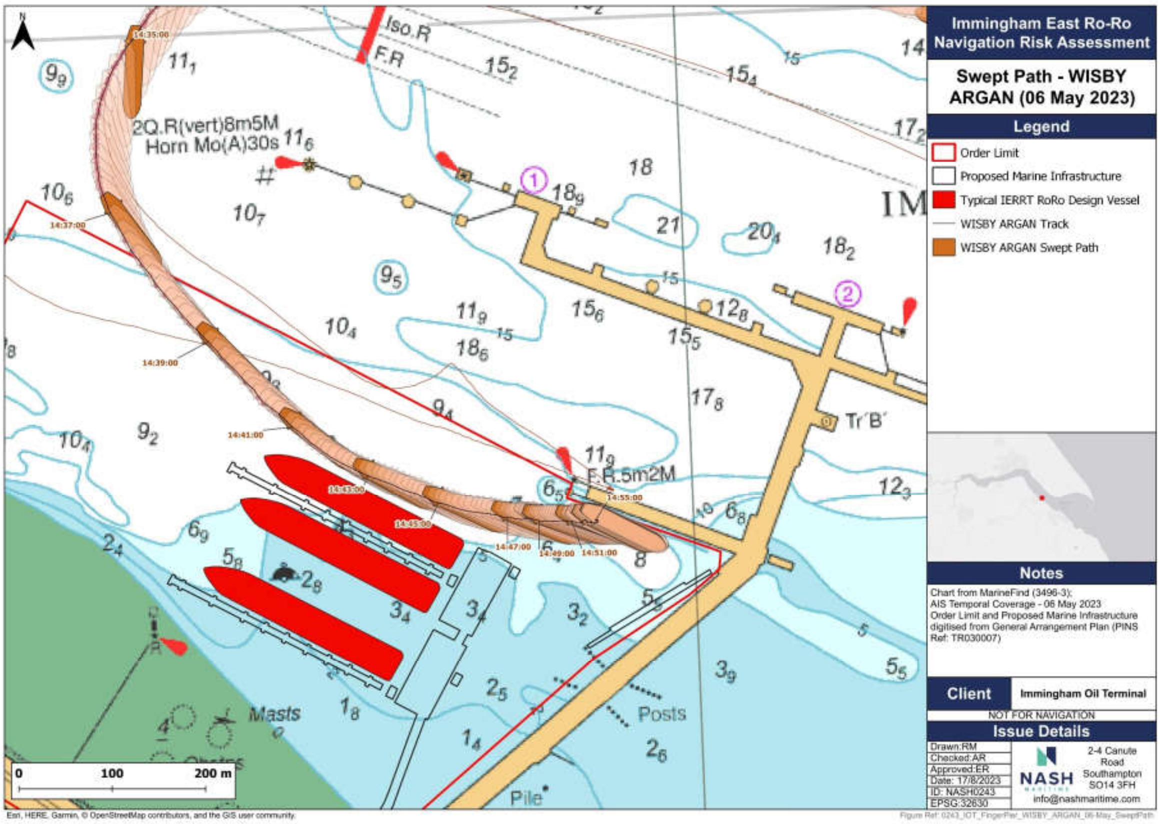


Figure 27: WISBY ARGAN swept paths (06-May-2023).

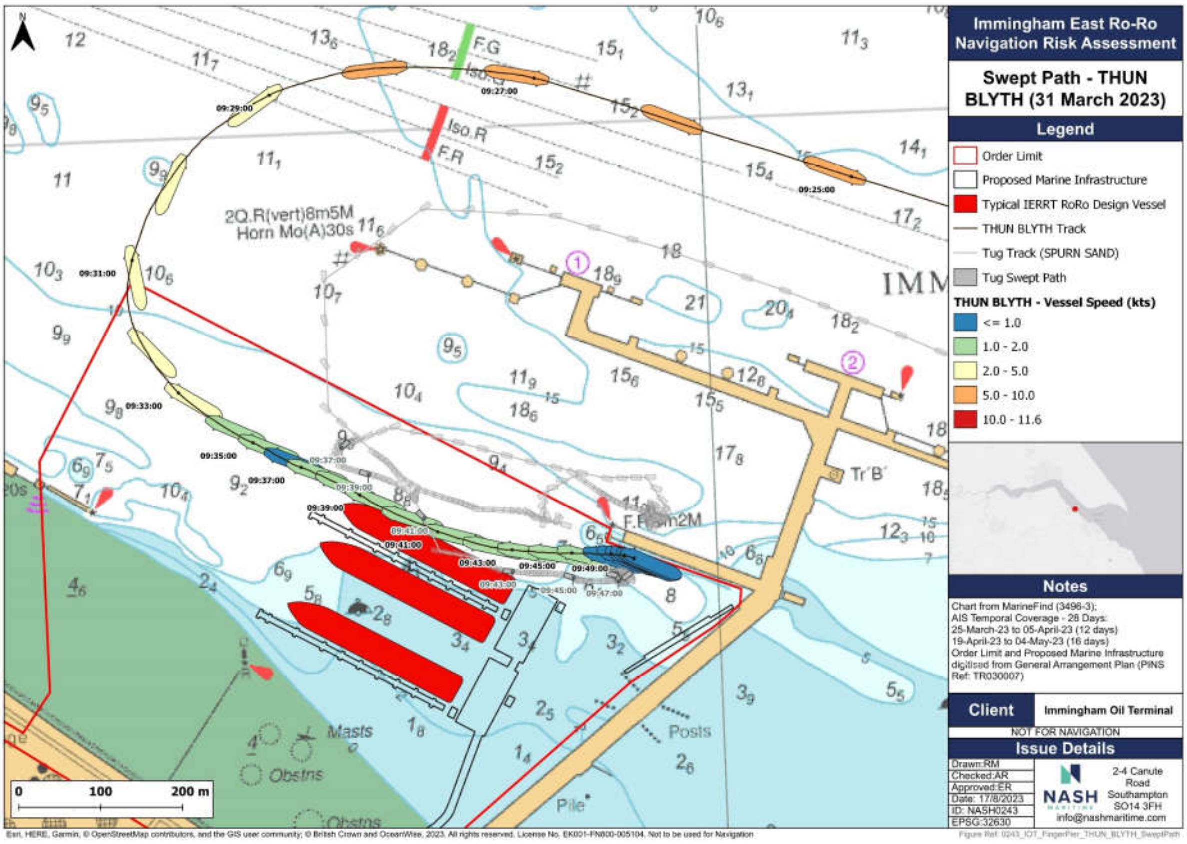


Figure 28: Thun Blyth swept paths (31-Mar-2023).

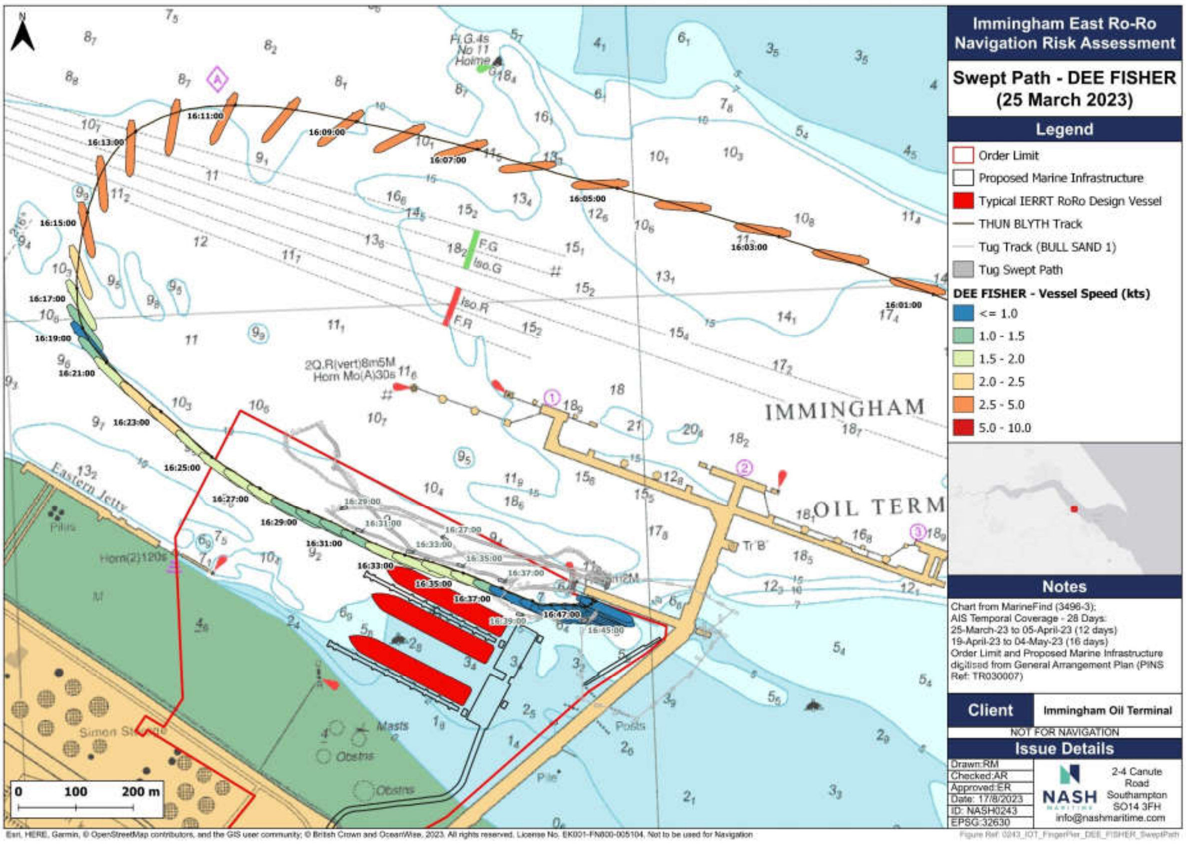


Figure 29: Dee Fisher swept paths (25-Mar-2023).

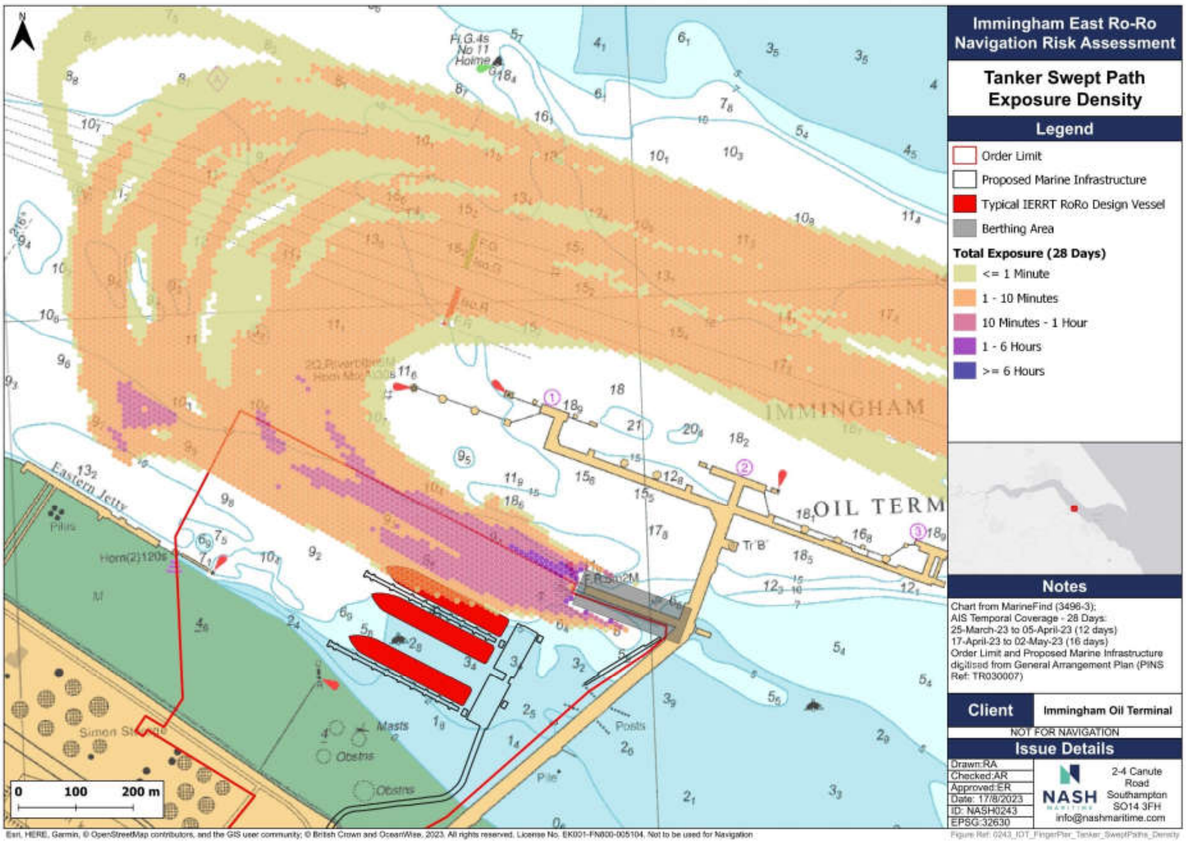


Figure 30: Tanker swept path exposure density (28 days).

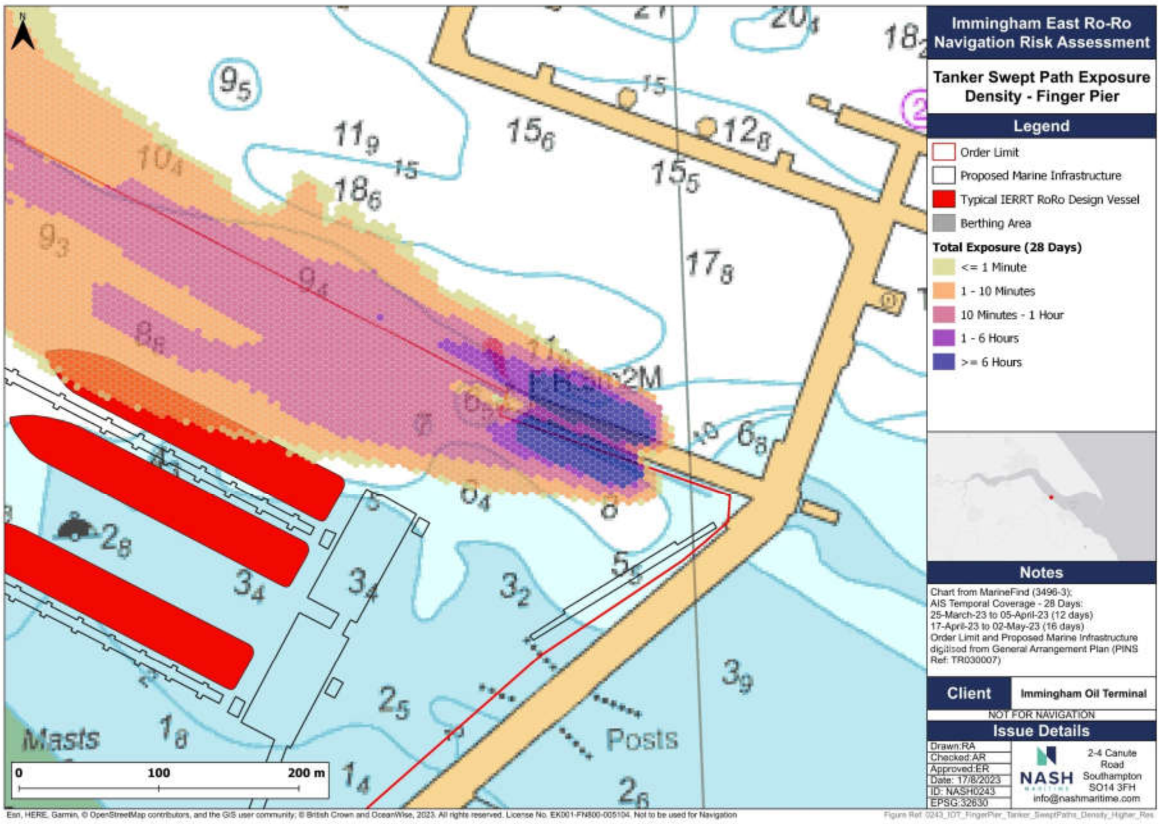


Figure 31: Tanker swept path exposure density (28 days) (zoomed in).

7.5.5 Barges

248. Figure 32 shows that barges primarily use the current IOT Finger Pier and the Immingham Dock. The barges using the IOT Finger Pier are the Rix Merlin (MMSI: 235030851)(8 transits), Rix Owl (MMSI: 235030995) (14 transits), and the Rix Phoenix (MMSI: 232003150) (8 transits). These same vessels operate in the Immingham Dock but with greater frequency, with 21 transits by the Rix Merlin, 21 by the Rix Owl, and 31 by the Rix Phoenix. As shown in Figure 33, the area that experienced the most transits by these estuarial barges is the entrance to the Outer Harbour.

249. To demonstrate the manoeuvring of barges using the current IOT Finger Pier, the RIX MERLIN was selected for swept path analysis (see Figure 34, Figure 35and Figure 36).

250. The RIX MERLIN is a "*class B.V. I + Hull, + Mach, Oil Tanker ESP, Unrestricted Nav, Aut— UMS, Strengthened bottom*" (Rix Shipping, 2023). The vessel has a LOA of 53m, a beam of 7.9m and a draft of 7.9m. The RIX MERLIN was assisted in this manoeuvre by the mooring vessel, BULL SAND 1 (MMSI: 235030851).

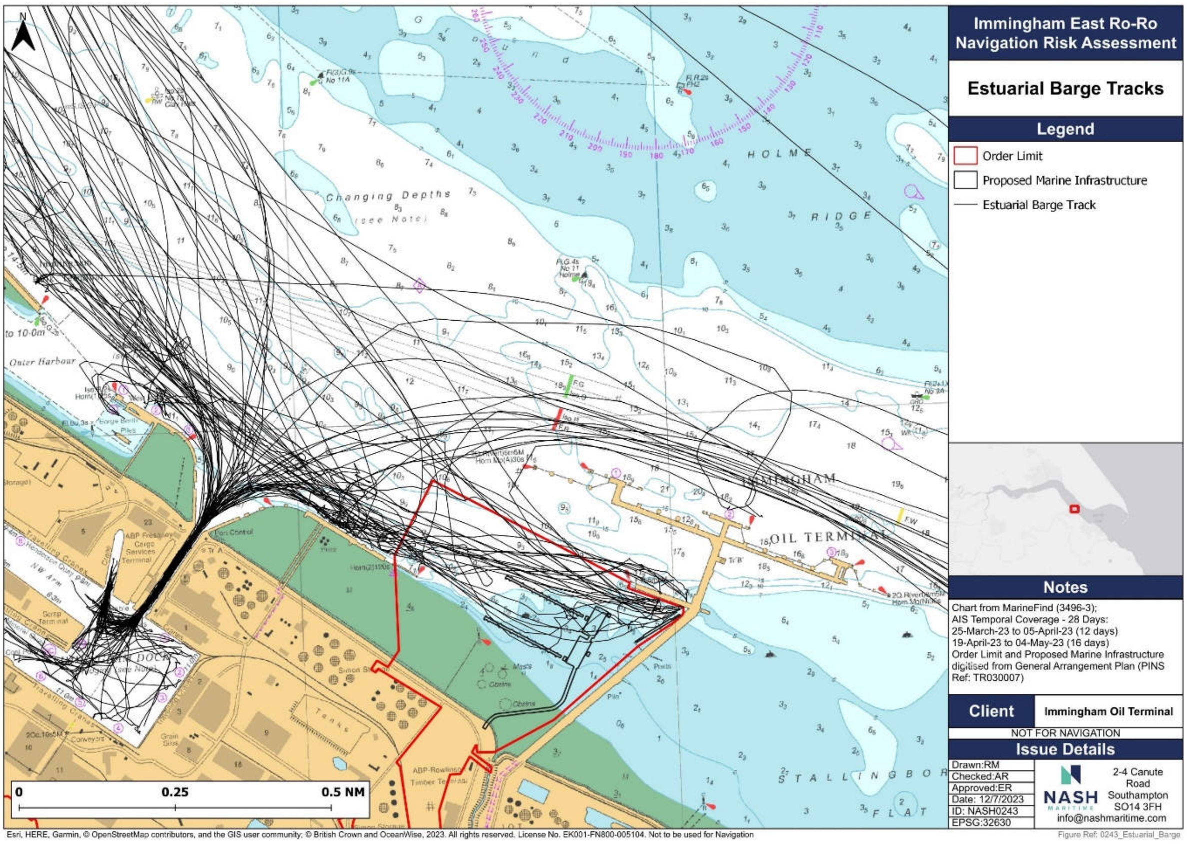


Figure 32: Estuarial barge vessel tracks.

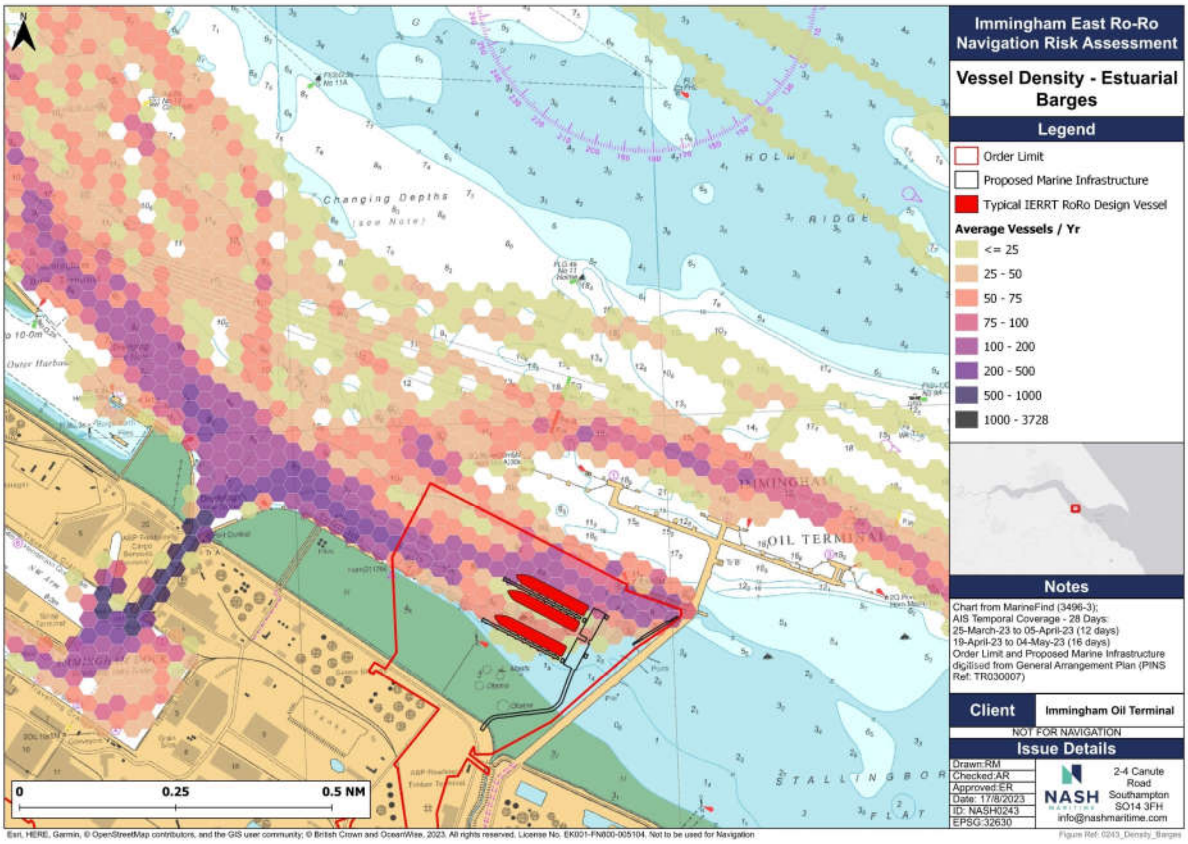


Figure 33: Estuarial barge track density (28 days).

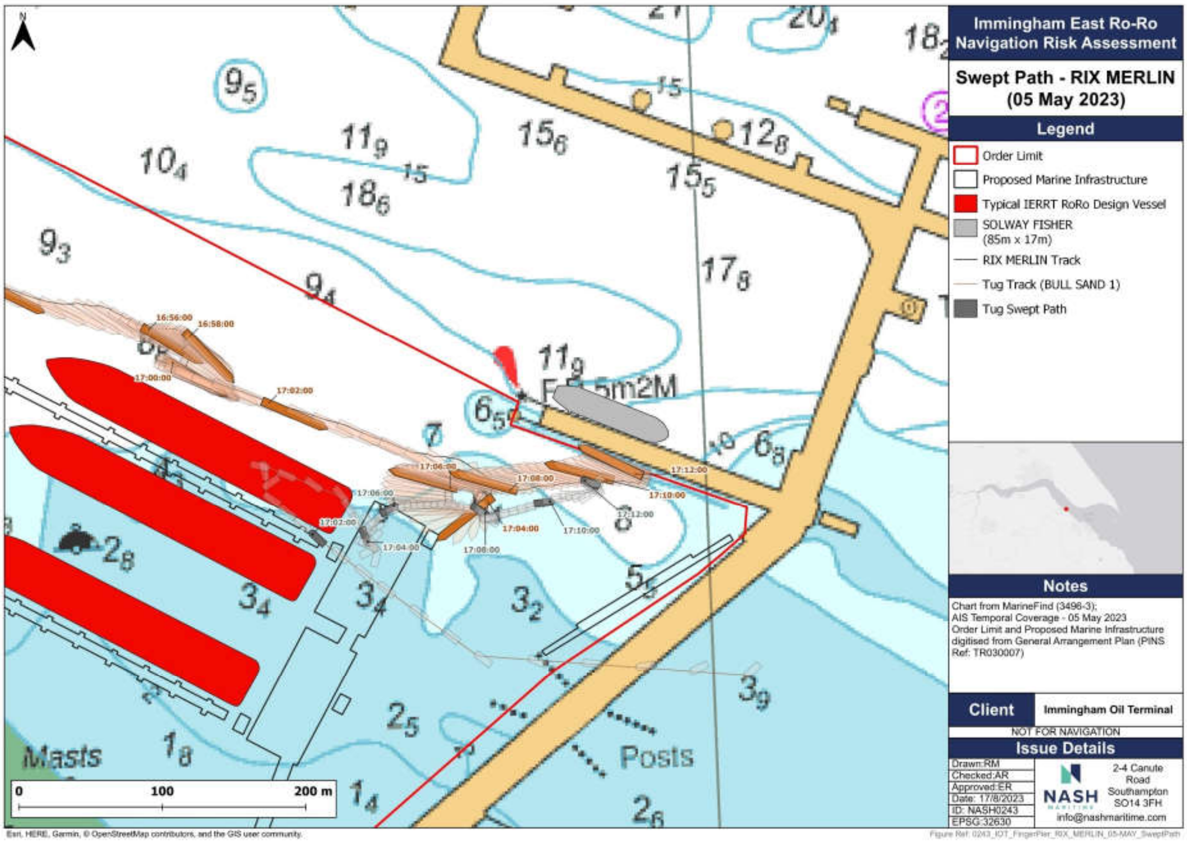


Figure 34: RIX MERLIN swept paths (05-May 23).

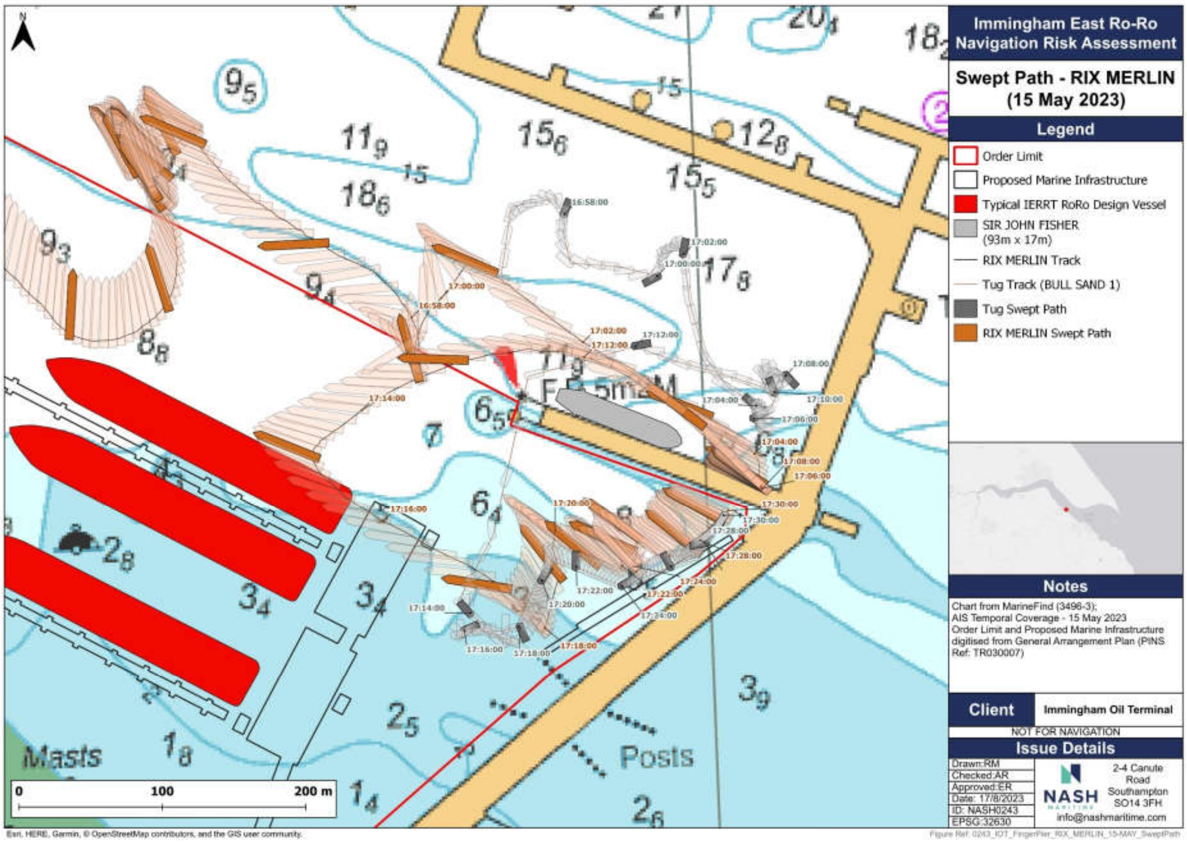


Figure 35: RIX MERLIN swept paths (15-May 23).

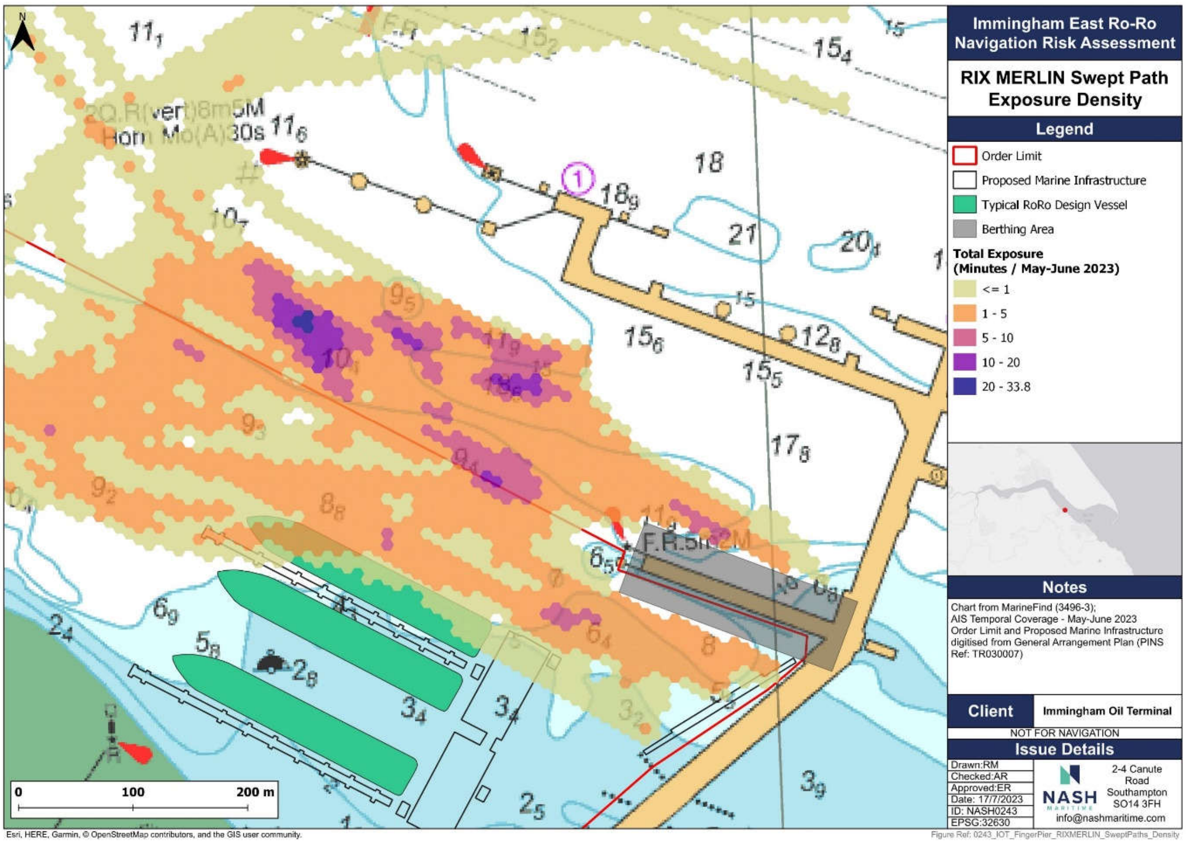


Figure 36: RIX MERLIN swept path exposure (May-June 23).

7.5.6 Tug and Service

251. Figure 37 shows the distribution of vessel transits by tug & service vessels. Tug & Service activity is present across all berths at the Immingham site and is mostly characterised by tug boats supporting the arrival and departure of cargo and tanker vessels. Figure 38 shows the density of tug & service vessels, indicating that the most densely transited areas are just north of the IOT (435 transits), the Immingham Dock (393 transits), and the eastern side of the Outer Harbour (295 transits). The most regular tug & service vessels using the Immingham site are the tug boats MANXMAN (58 transits), PULLMAN (49 transits), and SVITZER LAURA (48 transits).

7.5.7 Passenger

252. Passenger vessel activity is shown in Figure 39. Other than five transits by the Ro-Ro/ Passenger vessel PATRIA SEAWAYS (MMSI: 277291000) entering the Immingham Dock, all passenger vessels transited on an east-west route, north of the Immingham site. The 112 transits were made by four Ro-Ro/ Passenger vessels. The PRIDE OF HULL and the PRIDE OF ROTTERDAM are P&O ferries, currently operating between Hull port and Rotterdam port, each vessel transited north of the Immingham site once a day for the 28 day period. The STENA TRANSPORTER and STENA TRANSIT are ferries operated by Stena Line. Currently these vessels are operating between the port of Killingholme and the port of Hoek Van Holland. Similar to the P&O ferries, these vessels transited north of the IOT once a day for the duration of the time extent. As shown in Figure 40, the area most travelled by passenger vessels was approximately 0.8nm from the north of the IOT.

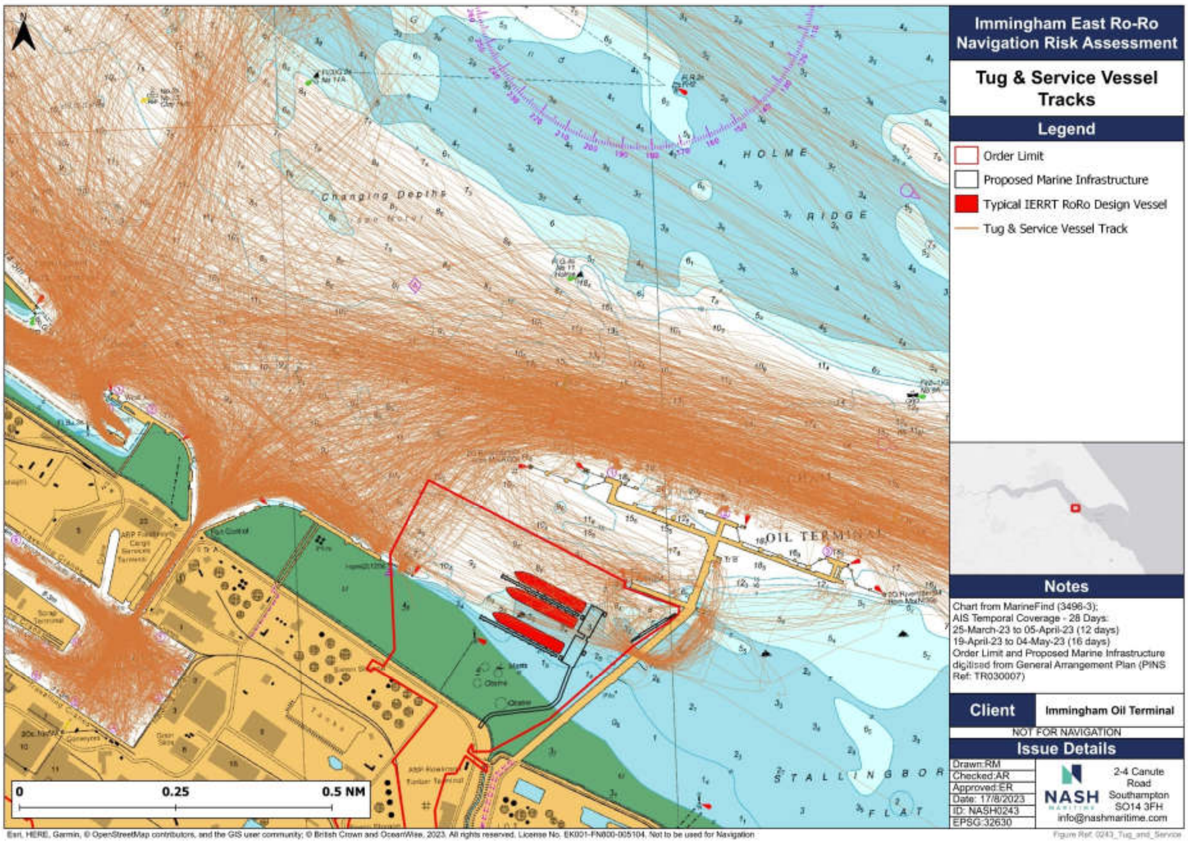


Figure 37: Tug and Service Craft Tracks.

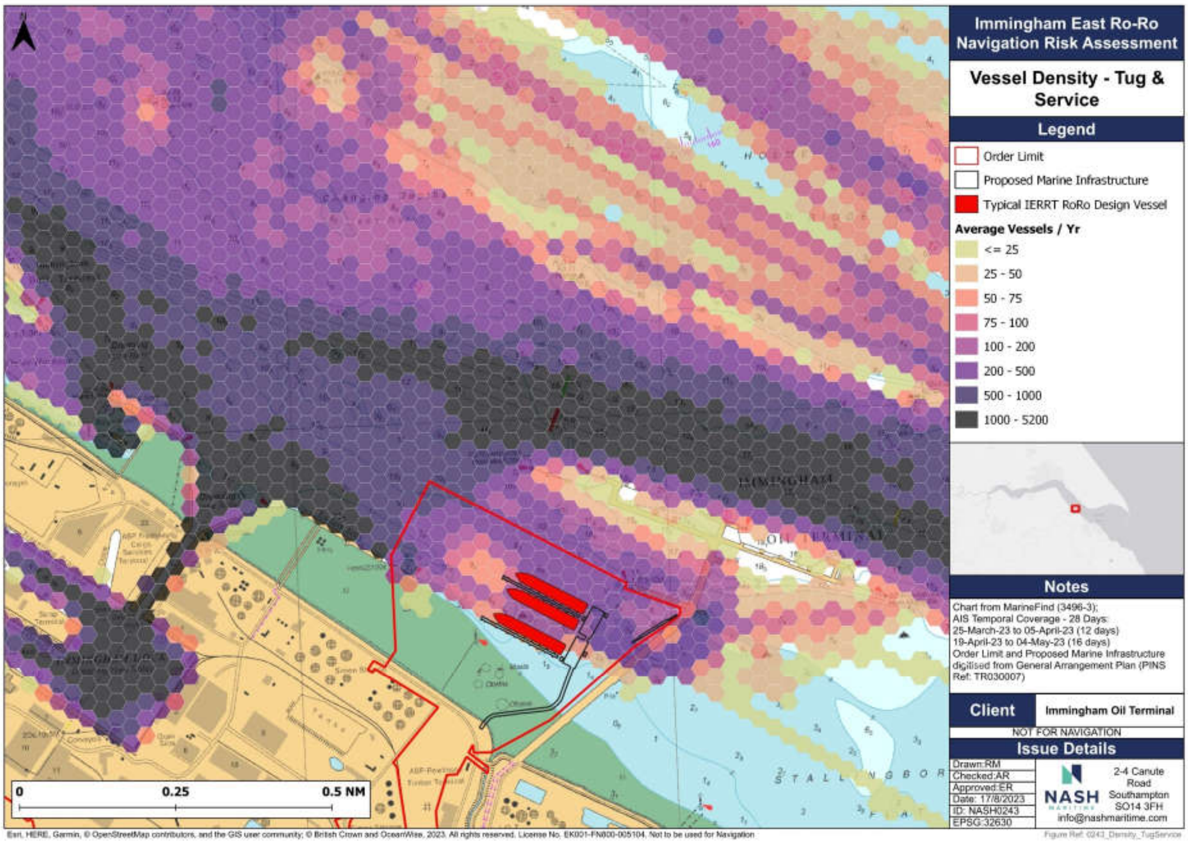


Figure 38: Tug and Service Craft Density.

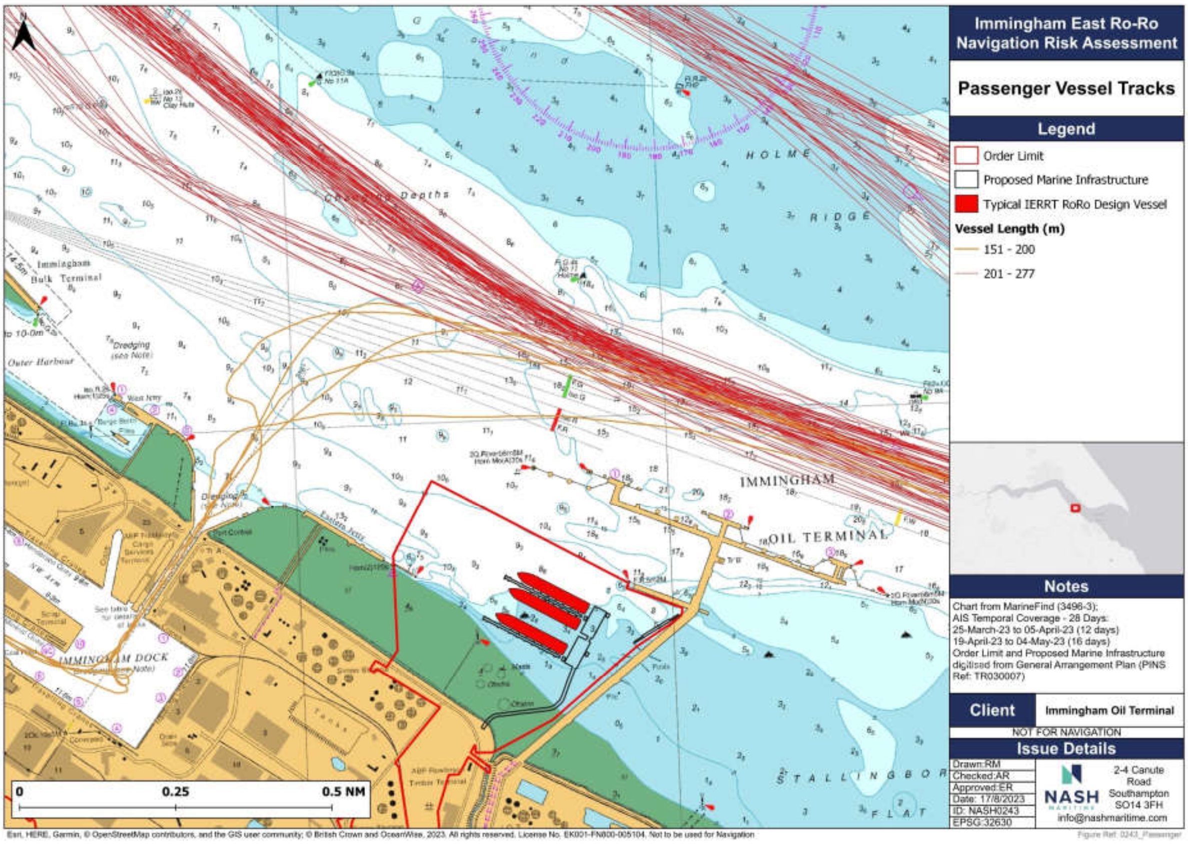


Figure 39: Passenger Tracks.

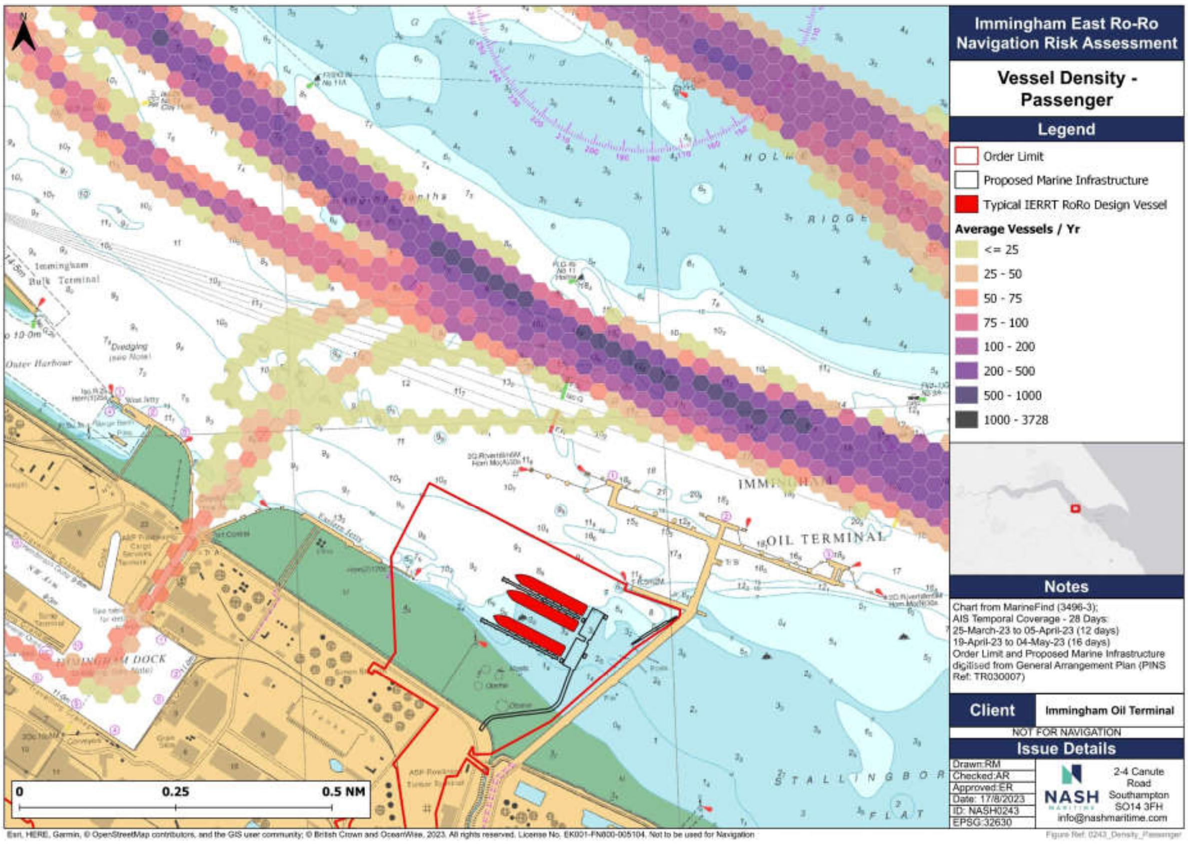


Figure 40: Passenger Density.

7.6 GATE ANALYSIS

253. Gate analysis was undertaken to develop an understanding of the lateral distribution of vessel transits across the various identified locations. Figure 41 shows the count of vessel tracks crossing between the Immingham Bulk Terminal -(IBT) and the IOT per day during May and June for each vessel type. The exact location of the gate is shown alongside the direction and weekly count of cross-gate transits in Figure 40.

254. A total of 3719 vessel tracks crossed the gate over the 2-month period, 1,912 in May and 1,807 in June, giving an average of 62 transits per day during May and 60 transits per day during June.

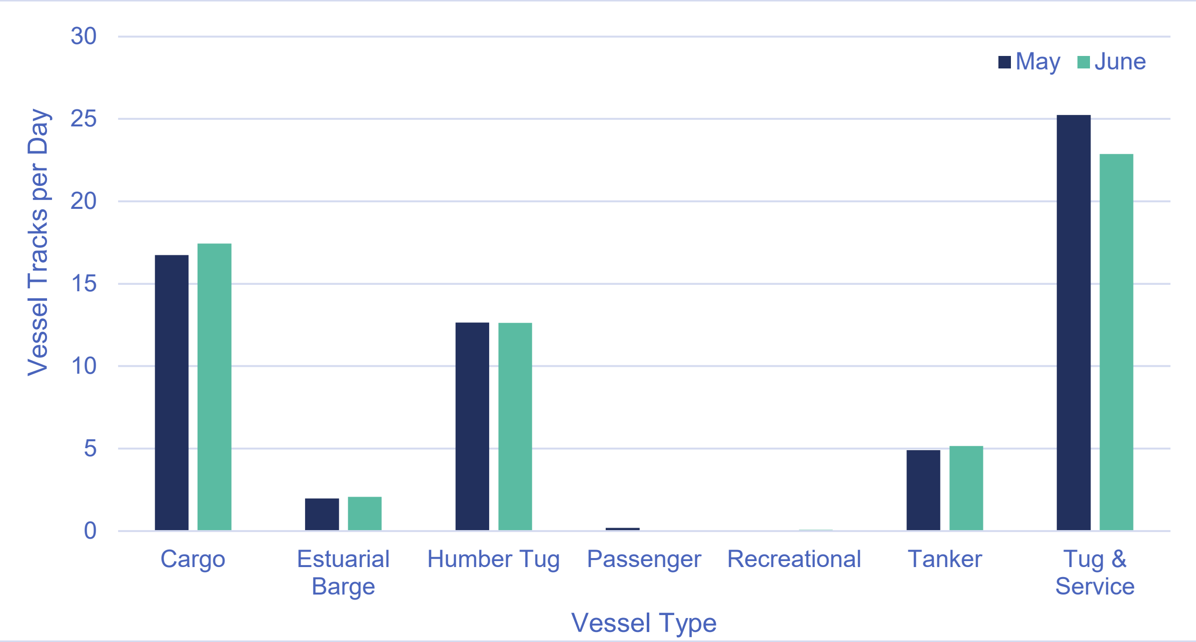


Figure 41: Count of Vessel Tracks Across Gate (may and June 2023).

Table 8: Vessel Counts by time of day.

	COUNTS BY VESSEL TYPE					
TIME OF DAY	**Cargo**	**Estuarial Barge**	**Humber Tug**	**Pax.**	**Tanker**	**Grand Total**
07:00:00 - 07:30:00	23	0	24	0	11	**58**
07:30:00 - 08:00:00	22	4	22	0	6	**54**
08:00:00 - 08:30:00	16	6	19	0	13	**54**
19:00:00 - 19:30:00	68	3	14	0	8	**93**
19:30:00 - 20:00:00	50	4	26	0	7	**87**
Grand Total	**179**	**17**	**105**	**0**	**45**	**346**

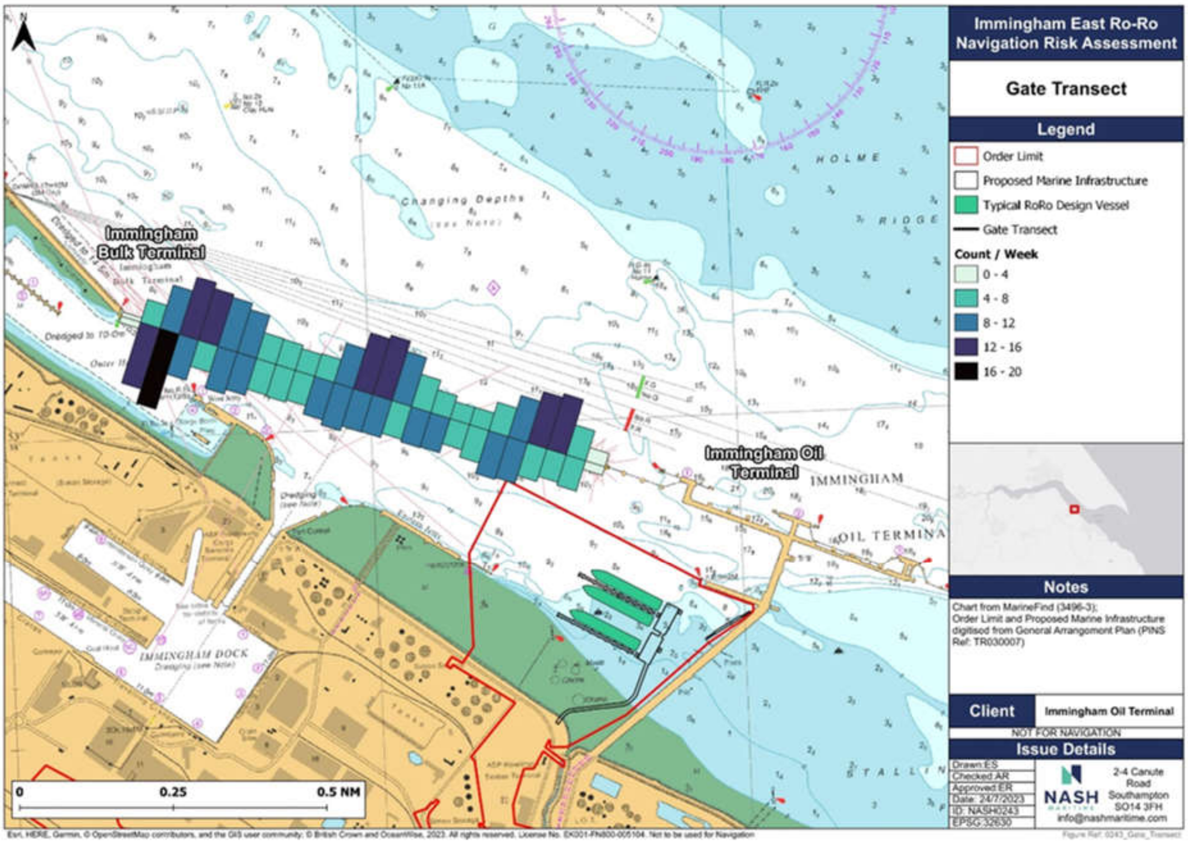


Figure 42: Gate Transect.

255. These transits were further investigated to identify how many significant vessel tracks crossed between the IBT and IOT during 1 hr time slots for the arrival and departures of Ro-Ro vessels to the proposed IERRT (from 07:00 to 08:30 and between 19:00 and 20:00), during which times the area would be closed to other vessels. The number of vessel tracks that crossed the gate between these times during May and June are provided in Table 8.

256. In total 166 significant vessel tracks crossed the gate between 07:00 and 08:30 and 180 between 19:00 and 20:00. Given that 2,249 tracks of these vessel types crossed the gate over the time of a whole day (00:00:00-23:59:59), approximately 15.4% of the usual vessel activity through this area during May and June would be unable to occur as a result of the closure during Ro-Ro arrival and departure times.

257. Most of the impacted vessels transiting in the evening are Cargo vessels heading toward Vlaardingen and Esbjerg, two main freight shipping routes. Between 19:00-20:00, the activity is heavily concentrated on the western side of the gate, nearer the IBT with fewer transits near the IOT. Those near the bulk terminal are nearly all Cargo and Humber Tug Vessels, whereas all the Barges and Tanker vessels transit within 371m of the IOT during these hours. However, the vessel activity in the morning, between 07:00 and 08:30 is more equally distributed along the gate.

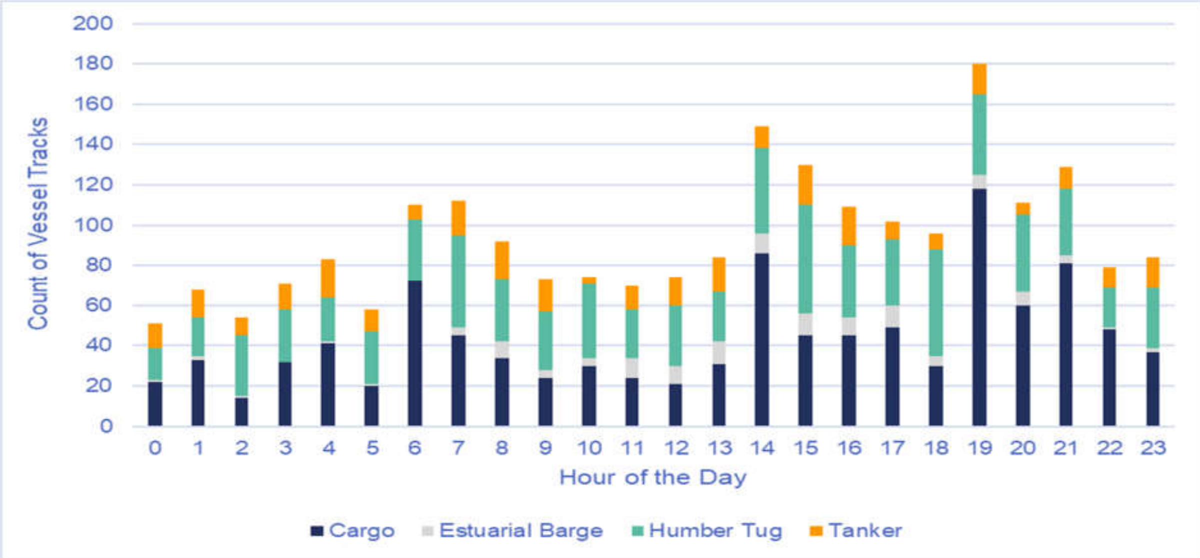


Figure 43: Count of Vessel Tracks per Hour of the Day.

258. Figure 43 shows the vessel track count per hour for each of the main vessel types during May and June. From the analysis it is evident that there were higher numbers of cargo vessel transits across the gate in the mid-morning (between 06:00-07:00) and in mid to late afternoon (14:00 and 19:00-21:00), during which times there were an average of 111 and 126 transits across the gate per hour, respectively. Otherwise, the activity is relatively consistent with an average of 73 transits per hour, across the gate.

7.7 BERTH ANALYSIS

259. Analysis of berth usage for the IOT Finger Pier was undertaken based on information provided by IOT covering March, April, May and June 2023. Analysis of the total number of vessels using the Finger Pier (see Figure 44) shows that there is little variation in vessel numbers with between 42 to 49 coastal tanker arrivals per month, and between 16 to 21 estuarial barge arrivals month.

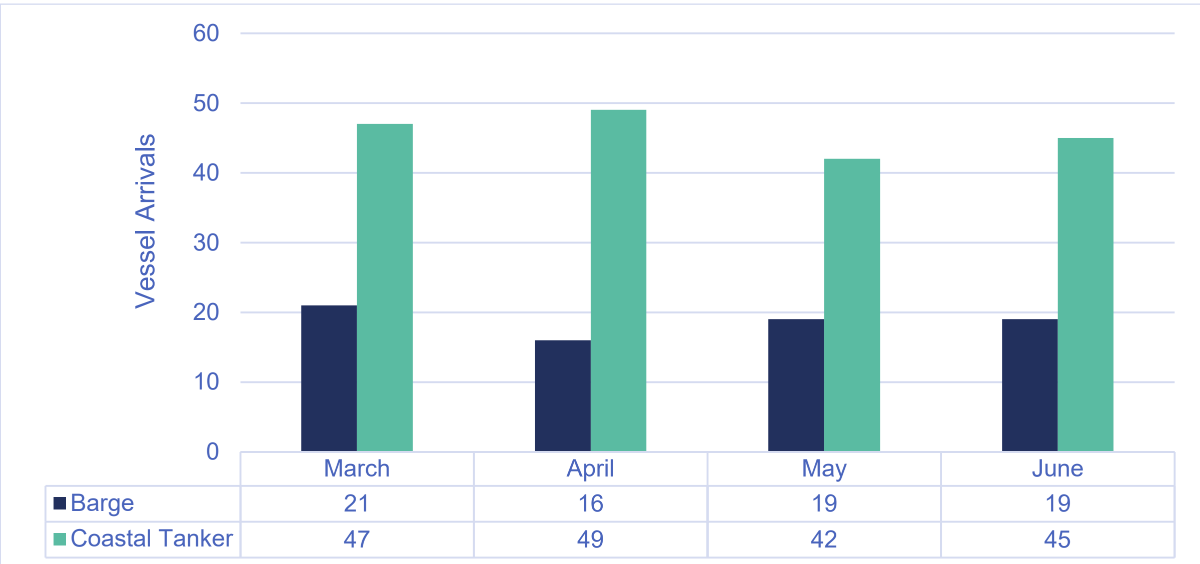


Figure 44: Total Number of vessels arrival at IOT Finger Pier (Mar 23- Jun 23).

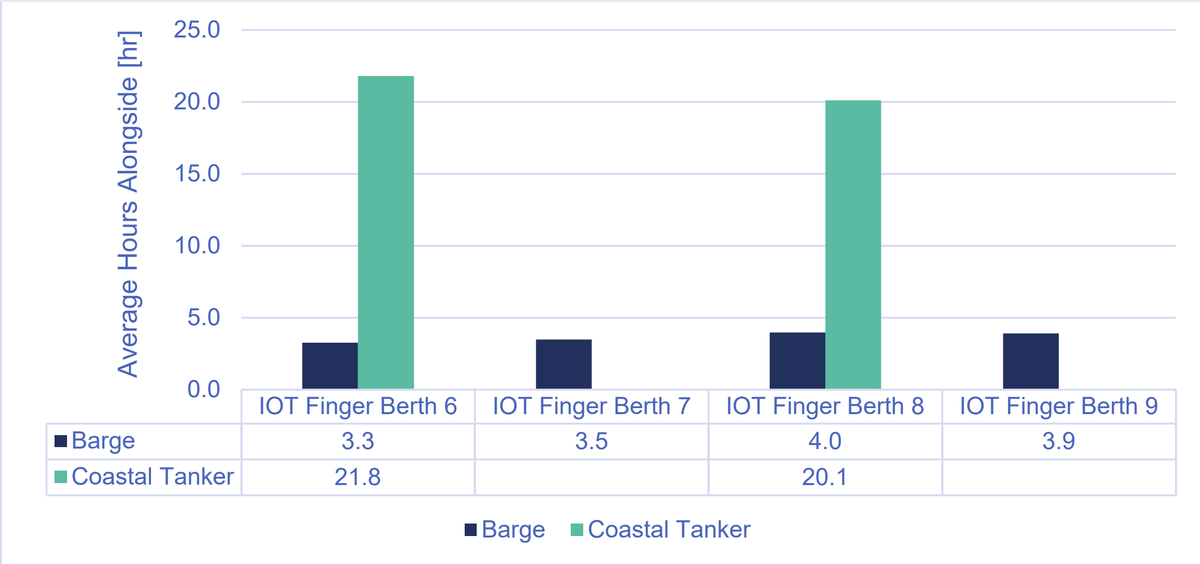


Figure 45: Average Time Spent at Berth (Mar 23- Jun 23).

260. On average Coastal Tankers remain alongside for 20 to 21 hours (see Figure 45), and estuarial barges on average remain alongside for 3.3 to 4.0 hours. As coastal tankers are limited to berthing only on flood tides, and due to the frequency of use of Finger pier berths 6 and 8, then it is evident that the berths are highly utilised (see Figure 46).

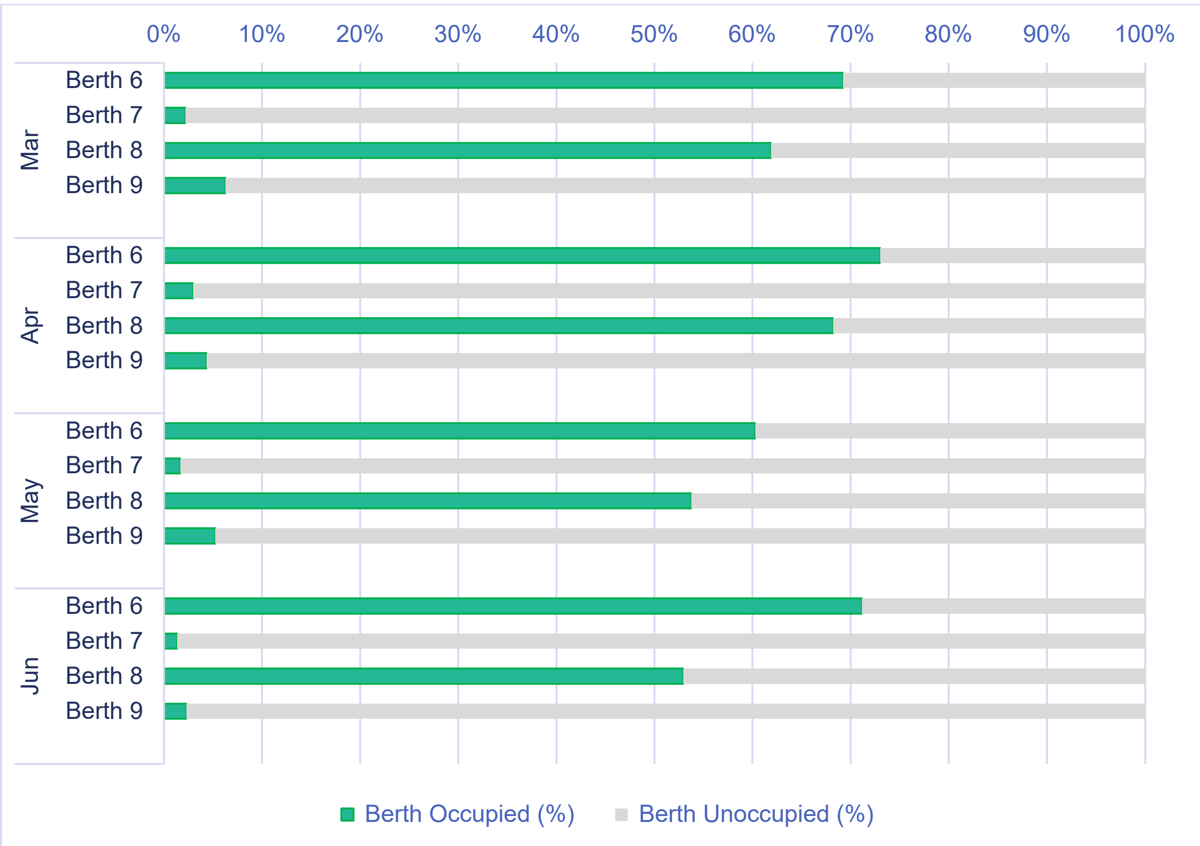


Figure 46: Percentage of Time Berths are occupied.

8. INCIDENT ANALYSIS

8.1 INTRODUCTION

261. To support the sNRA, particularly in relation to the likelihood and consequence of navigation hazard occurrence, analysis of historical incident data has been undertaken from a variety of sources which are outlined in Table 9.

Table 9: Incident data sources.

Source	Coverage	Notes
MAIB	1992-2021	Analysis of MAIB data nationally, with particular reference to incidents around Immingham and incidents involving RoRo vessels.
IMO (2008)	1994-2004	Review of IMO's FSA for RoPax Ships.
MarNIS	2011-2020	Whilst the raw data was not made available, reference is made to the analysis contained in the IERRT NRA (ABPMer, 2022).
EMSA (2018)	2011-2018	Review of report "Safety Analysis of Data Reported to EMCIP: Analysis of Marine Casualties and Incidents Involving Ro-Ro Vessels"

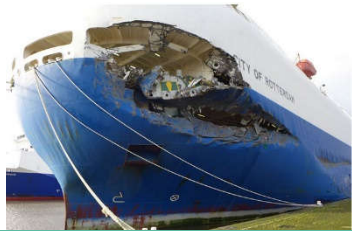
8.2 INCIDENTS OCCURRING ON HUMBER / IMMINGHAM

8.2.1 MAIB Data Analysis

262. Table 10 identifies significant incidents in the vicinity of the study area which resulted in MAIB reports. These include five collisions and three allisions. This includes three incidents whereby vessels collided with the IOT infrastructure or moored vessels. All three of these incidents involved vessels which were not bound for IOT but for other berths along the Estuary. The accident reports also emphasise the challenging navigation of the Humber and the effect of the tidal streams.

Table 10: Summary extracts of MAIB Immingham / River Humber Incidents.

Date	Type	Description
06/07/2008	Collision	General cargo vessel Fast Filip was heading down river from Goole on an ebb tide during hours of darkness, destined for Immingham Dock. ABP Pilot onboard, good visibility. Vessel commenced a turn around the stern of an inbound ferry, resulting in **colliding with a tanker berthed at IOT1**. Alongside vessel sustained a hole in the hull plating. Cause identified as **Pilot's lack of planning and situational awareness, plus poor awareness of the effect of tidal stream and speed**. Poor bridge resource management also identified.
12/12/2000	Collision	Bulk carrier Xuchanghai, inward to Immingham Dock, **collided with the moored shuttle tanker** Aberdeen, berthed at IOT3. Aberdeen sustained holes in her hull plating above the waterline. A contributing cause was **poor safety arrangements and procedures in respect of ABP for vessels proceeding to Immingham Dock and other vessels in the vicinity of Immingham Oil Terminal**. NtM09/2001 was retrospectively published in which a minimum passing distance and a location by which tugs should be secured was outlined.
19/01/2010	Allision	Fast Ann, an unmanned cargo ship, broke free from its moorings and **collided with IOT infrastructure**. Despite VTS endeavouring to identify the radar target and a tug endeavouring to secure a line to the vessel,

Date	Type	Description
		efforts were hampered by a 4-knot spring ebb tide and dense fog. Risk assessments and procedures were reviewed, particularly regarding unmanned vessels during spring tides.
03/12/2015	Collision	The car carrier City of Rotterdam collided with the ferry Primula Seaways in dense fog after the **pilot became disorientated** (due to relative motion  illusion) and failed to correct the carrier's path which had been set toward the path of inbound ferry. Both vessels were sustained major damage but made their way to Immingham without assistance. There were no serious injuries or pollution.
19/05/2016	Collision	Petunia Seaways collided with the historic motor launch Peggotty after the skipper of Peggotty became **disorientated in the dense fog** and took the motor launch into the shipping channel and the path of Petunia Seaways, which was **not sounding a regular fog signal** at the time of incident. The motor launch suffered severe structural damage and began to take on water but a local pilot launch crew were able to rescue the skipper and other person on-board so that there were no injuries or significant pollution.
02/04/2002	Allision	During hours of darkness, Ro-Ro vessel Stena Gothica **struck the eastern jetty**, during a spring ebb tide, while approaching Immingham lock. A 3-metre gash was sustained in the port side shell plating below  the waterline, leading to a large ingress of water into the lower cargo hold. Cause was identified as the **master's decision to take the con** prior to the lock, **his under estimation of the strength of the tide**.
29/08/2010	Allision	The general cargo vessel CFL Patron suffered a **controllable pitch propeller (CPP) control power failure** while manoeuvring at 1.6 knots in the lock at Immingham docks. Despite the master's attempts to recover control of the CPP system, the pitch remained at approximately 40% ahead, causing the vessel to accelerate. Although a forward spring was deployed and the tug Guardsman attempted to slow the vessel's progress by pushing, the vessel **impacted heavily with the outer lock gates at 3.7 knots**. Minor damage was sustained to vessel and tug. Significant damage was sustained to lock gates. Ship owner was encouraged to tight up pre-departure checks and preparedness for propulsion failure. Cause of failure not able to be identified.
23/01/2015	Collision	**Tanker Audacity collided** with cargo vessel Leonis in the Humber Estuary precautionary area during dense fog. Cause attributed to **Pilots on both vessels not making a full assessment of risk of collision** and **poor VTS procedures**.

263. More recently the IOT Operators are aware of two incidents involving pilot error associated with tankers departing the IOT in the last year, including:

- Coastal Tanker SELIN S near miss; and
- HEINRICH Line Parting.

8.2.2 SELIN S

264. On 28 July 2022, 'SELIN S', a 93m loaded chemical tanker was moored starboard side to the IOT finger pier, berth 6. The vessel departed the berth bound for sea and had a pilot onboard. During the vessel's daylight departure manoeuvre, which involved the vessel turning around to head out, the pilot misjudged the effect of the tide and collided with a mooring buoy located in the river. There was no apparent damage to the buoy or to the vessel, therefore the incident was latterly revised to being either a near miss or very light contact.

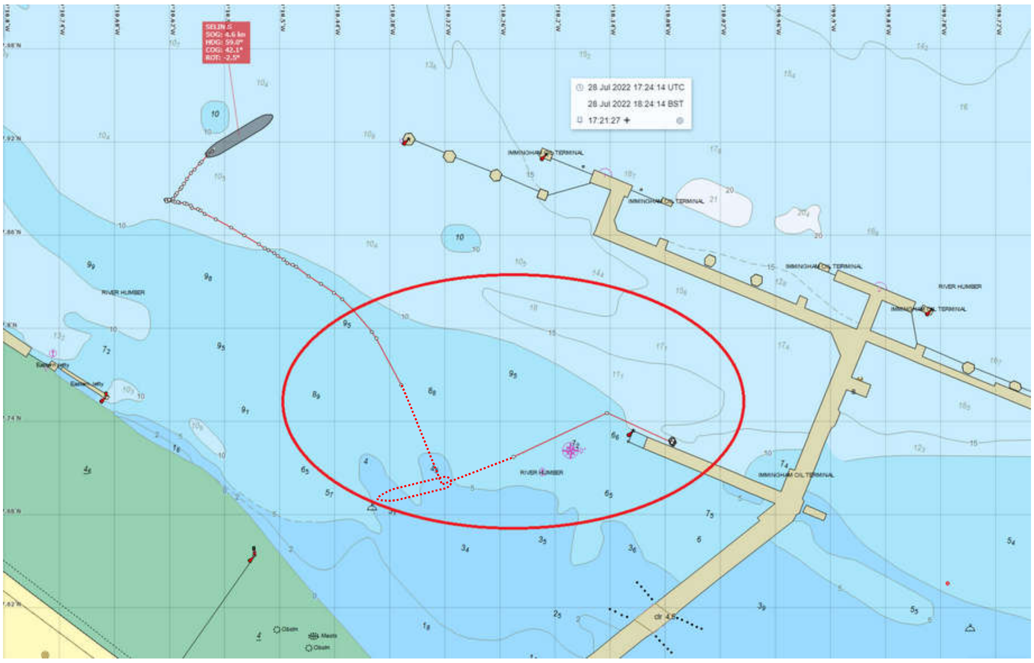


Figure 47: Commercially available AIS showing the AIS antenna position during the manoeuvre (actual track red line and vessel outline grey). Position of mooring buoy within red ellipse but not precisely shown, and indicative track of vessel and outline in dashed red.

8.2.3 HEINRICH

265. On 19 March 2023, the loaded tanker HEINRICH was making a routine departure from IOT berth 2, port side alongside. During the departure from the berth, three of the vessel's mooring lines parted, one of which snapped back close to line handlers. The subsequent internal investigation showed an inadequate Master/Pilot Information Exchange prior to departing, failure to adopt an effective unmooring sequence, misjudgement of the effect of the tide and suboptimal use of the allocated tug. The Pilot's authorisation was downgraded to smaller ships. Tide was HW minus 1.5h, wind light SW'ly, daylight conditions.

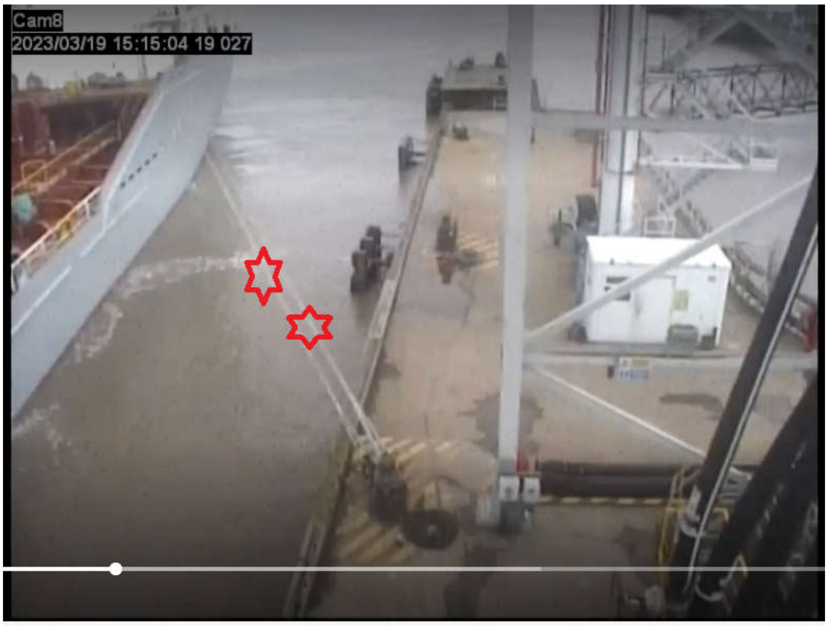


Figure 48: Extract of CCTV showing line parting of HEINRICH.

8.3 STATISTICAL INCIDENT ANALYSIS

266. The analysis contained within the IERRT NRA (ABPMer, 2022) was limited to 2011 to 2020, and has been reproduced in Figure 48. This has been extended based on a longer-term MAIB dataset to show 1992 to 2021 in Figure 50, although noting that the study area extents are not exactly aligned. It can be seen that there is a fluctuation in the total incident numbers reported to the MAIB, likely associated with changes in reporting formats. The analysis suggests that impacts with structures are the most likely incident type reported to the MAIB, followed by equipment failures.

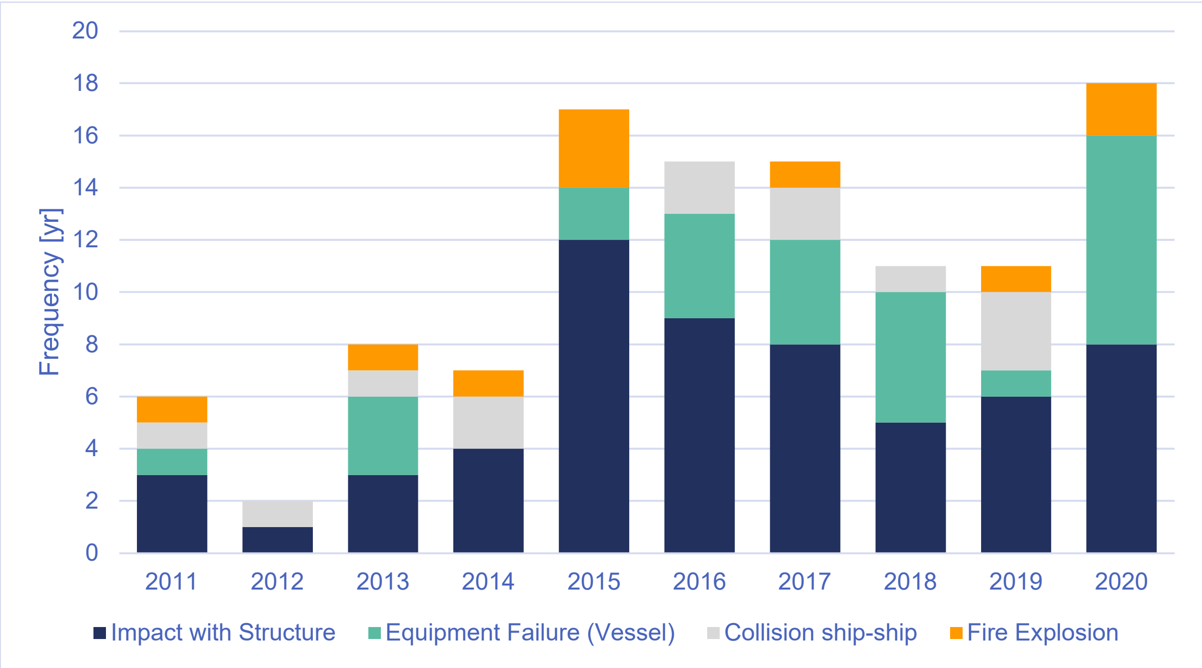


Figure 49: Chart showing ABP MAIB Accidents / Incidents per year (extracted from Table 6 ABPmer IERRT NRA).

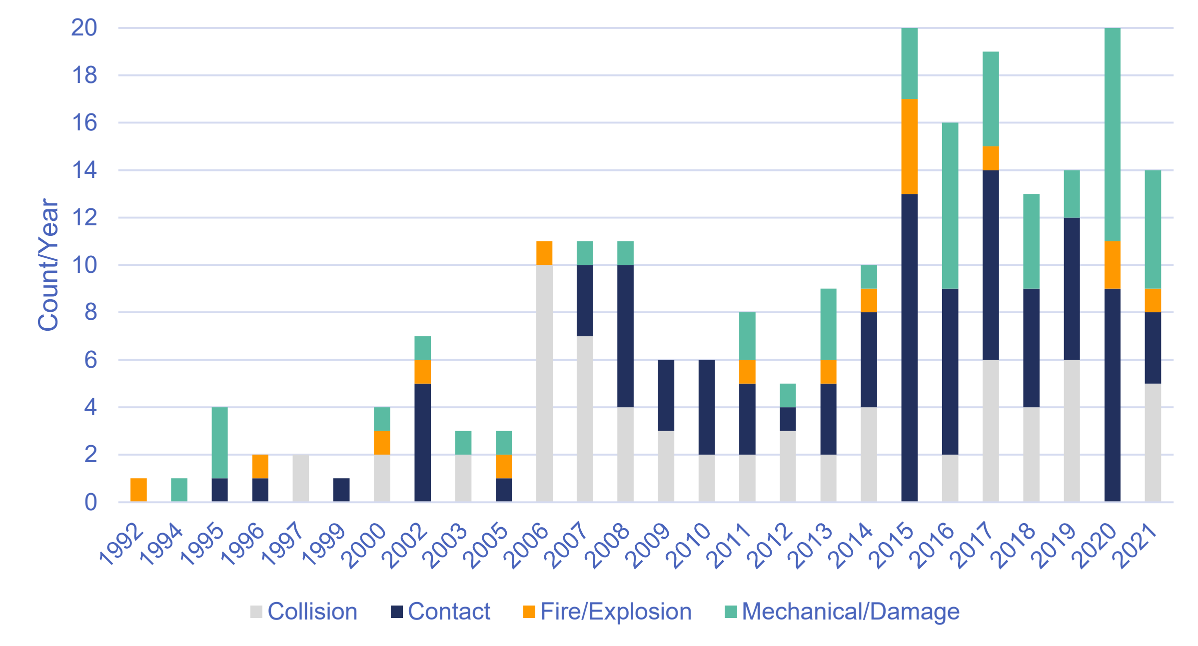


Figure 50: Extended MAIB Analysis.

8.3.1 Review of MARNIS Data

267. Whist the MARNIS data was not provided, a review has been conducted of the data presented in the IERRT NRA (see Figure 51). The IERRT NRA notes that there was on average 183.4 incidents per year in the study area. Given that the MARNIS data shows that equipment failure is the most frequent incident type, it demonstrates that the MAIB dataset analysed above underestimates these minor incidents, but which have the potential to escalate into serious incidents. Figure 52 compares the average number of incidents per year reported in the IERRT NRA between the MARNIS and MAIB datasets. It shows that approximately 13.1% of impacts and 3.6% of mechanical failures reported in the MARNIS dataset are contained within the MAIB dataset.

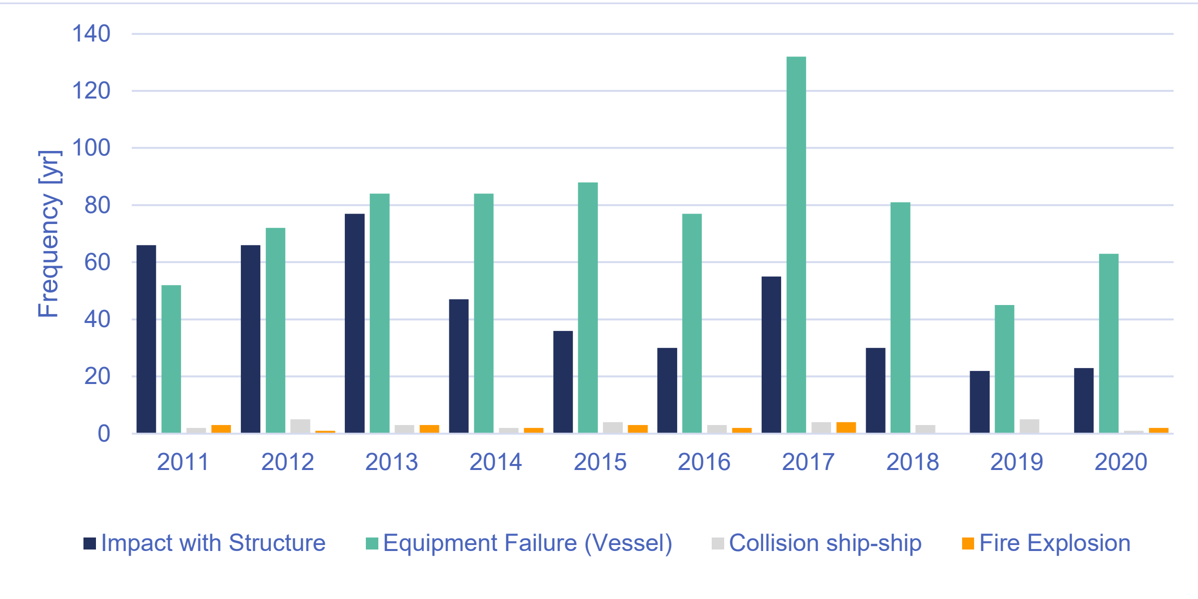


Figure 51: Chart showing ABP MARNIS Accidents / incidents per year (extracted from Table 5 ABPmer IERRT NRA).

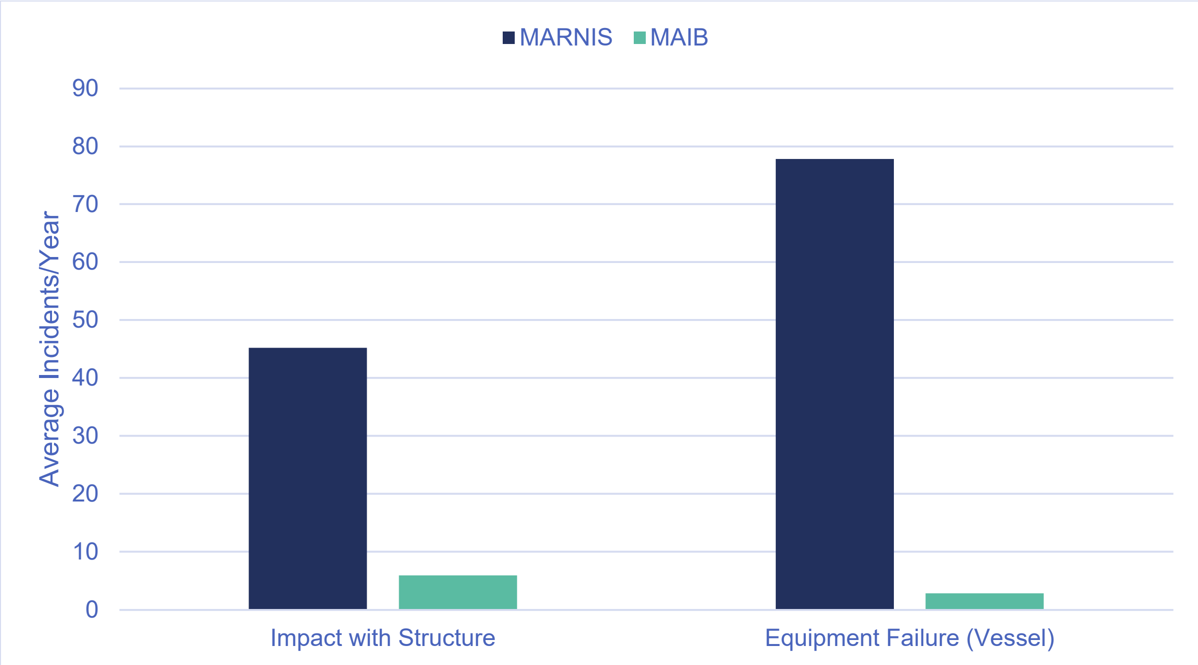


Figure 52: Comparison of MARNIS and MAIB Incident Counts in IERRT NRA.

268. Figure 53 and Figure 54 clearly demonstrate a higher number of equipment failures and impacts with structures around the existing IOT, Eastern Jetty and Killinghome Jetties as well as the proposed location of IERRT. Whilst it is not possible to analyse the frequency of occurrence without access to the underlying data, it demonstrates that the MAIB analysis conducted above is highly conservative on actual incident frequencies.

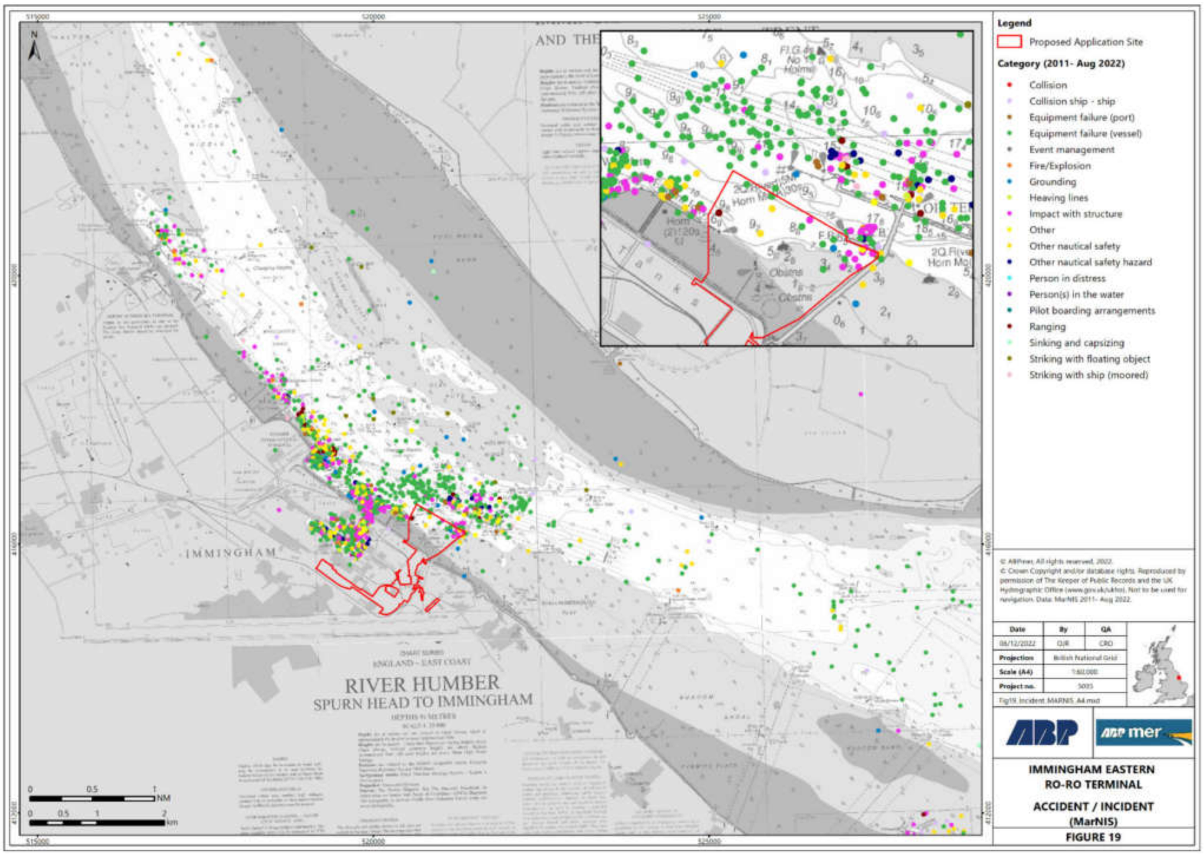


Figure 53: MARNIS accident/incident reports (Figure 19 from ABPmer IERRT NRA).

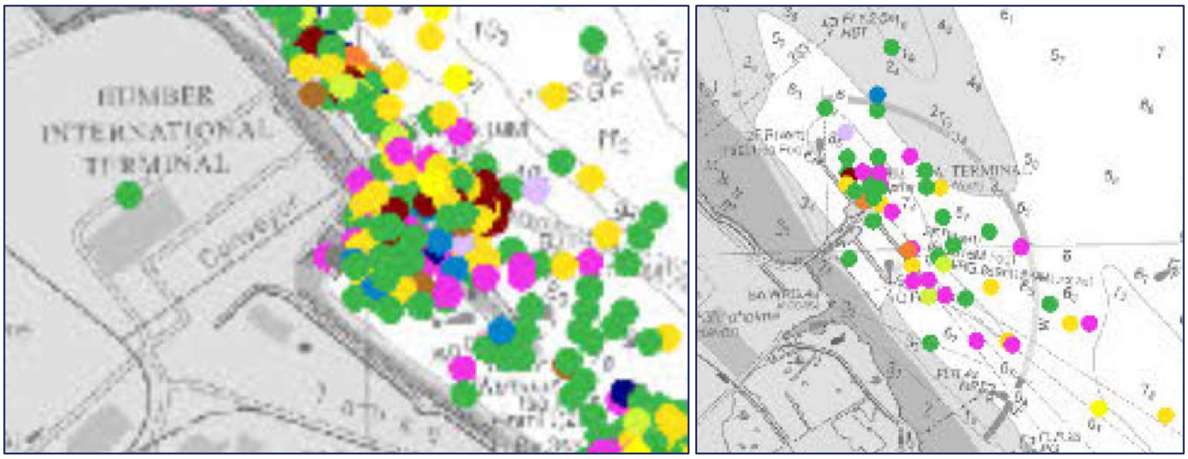


Figure 54: Extract from MARNIS accident/incident reports (Figure 19 from ABPmer IERRT NRA) Killinghome Ro-Ro Terminal and DFDS Ro-Ro terminal.

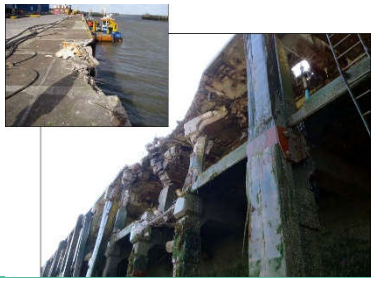
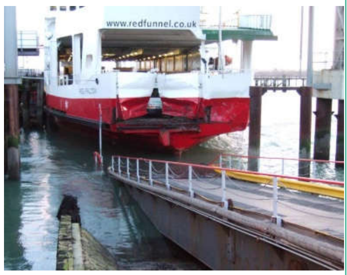
8.4 INCIDENTS OCCURRING ELSEWHERE IN THE UK

269. A summary of MAIB incident / accident reports on Ro-Ro vessels is presented in Table 11. The reports demonstrate that incidents involving Ro-Ro vessels occur and are often caused by equipment failure and human error, which are exacerbated by adverse weather. None of these incidents occurred with an oil terminal due to current locations of Ro-Ro vessel berths not being location in close proximity to such infrastructure.

Table 11: Summary of MAIB Ro-Ro Incidents.

Date	Type	Description
10/07/2023	Grounding	RoRo ferry Mazarine **lost all power** and grounded, after being adrift for 1.5 hour, adjacent to Wolf Rock lighthouse, causing significant damage to the vessel's portside keel area and bottom plating. 
25/06/2020	Grounding	Arrow grounded in thick fog, as a result of the **bridge team being under-prepared for pilotage in restricted visibility and poor Bridge Resource Management**. The ferry began to list significantly in the falling tide after the grounding and there was significant damage to the port side of the underwater hull, including holing and splitting of several water ballast tanks and damage to the port propeller and rudder, meaning the vessel was out of service for four weeks. However, there were no injuries or pollution, and the vessel was successfully re-floated 45 minutes later after grounding.
08/05/2019	Grounding	Seatruck Performance **grounded** while turning into a narrow, buoyed channel as a result of its heading being changed later than intended after entering the Greenore Channel, likely due to **nervousness and/or lack of confidence of the master and lack of bridge team support**. The ferry returned to Warrenpoint with no tug assistance and there was no damage to passengers, crew, or environment. However, it was later identified that a tank and a void space on the ferry's port side had been breached. The ferry was out of service for 3 weeks.
16/04/2018	Fire On-board	A fire broke out in the engine room of Finlandia Seaways following a catastrophic **main engine failure** that also resulted in significant structural damage to the engine. Engine failure was due to breaking of the engine's connecting rods, likely due to **poor maintenance**

Date	Type	Description
		management standards. The fire-fighting system was successfully activated but the third engineer suffered serious smoke-related lung, kidney and eye injuries and was recovered by coastguard helicopter to hospital.
25/09/2016	Allision / Grounding	As a result of **lost control of the ferry's port controllable pitch propeller following a mechanical failure**, the master was unable to prevent Hebrides from running over several mooring pontoons and briefly grounding. There were no injuries among persons on board, but the ferry was damaged and had to be repaired in dry dock.
09/11/2014	Allision	The ferry collided with the end of the breakwater while departing Dover. The **collision** was due to loss of directional control (as a result of an **unintentional change in the mode the steering control system** was operating) as the ferry turned towards the harbour's eastern entrance. The attempted corrections failed to prevent contact and the several minor injuries were suffered by passengers and crew as well as damage to the ferry's bow. There was no pollution.
29/09/2014	Fire On-board	A major fire broke out in the engine room of Pride of Canterbury while berthing. This occurred due to a series of events: unresponsive starboard pitch propeller; **master's decision to proceed with only one propeller shaft and one bow thruster;** a rupture of a pipework joint in the system, and a lack of shielding of the  joints which resulted in oil spraying onto exhaust uptakes. There were no injuries and the ferry berthed safely but the engine room was significantly damaged.
22/06/2013	Allision	**Heavy contact was made with berth** 3 at Harwich International Port, likely as a result of **inadvertent pressing of the button** which activates the back-up control system **for the starboard propulsion system** (which bypasses normal control). The error went unnoticed by bridge  team which meant it remained at 63% ahead throughout accident. Considerable damage occurred to the fore-end of the vessel and the linkspan collapsed into the water. There were no injuries or pollution.
16/02/2013	Allision	The port fin stabiliser of Finnarrow made contact with the berth during arrival into Holyhead. As a result, the hull was punctured, and the pump room subsequently flooded. The cause was concluded to be **inadequate procedures for pre-arrival checks** and a **lack of familiarity of the crew with the vessel's equipment** and emergency procedures.
22/10/2011	Allision	Heavy contact was made with the No 6 berth in Calais by the Pride of Calais as a result of **failure of the vessel's main propulsion** as the vessel approached the berth. The vessel suffered minor damage to the bow but there were no serious injuries and no pollution.

Date	Type	Description
24/05/2011	Allision	Clipper Point made heavy contact with the quay, two ro-ro ferries and another vessel while manoeuvring to berth, due to the wind increasing to 34knots during arrival into port meaning the ship was set closer to the port's South Quay than intended. The **master then made the poor decision** to attempt to turn to port as usual, with **one Un operational bow thruster,** meaning the starboard quarter of the ferry made contact with South Quay and sustained damage. The ferry's steering  compartment was also holed below the waterline. South Quay sustained damage to the upper edge and lower level and supporting structure. Scotia Seaways' port bow bulwark plating and two internal frames were damaged and Clipper Ranger's port bow sustained minor damage to port bow bulwark plating.
06/02/2010	Allision	The Isle of Arran passenger ferry hit the linkspan in Kennacraig at over 8 knots. The collision occurred due to a **mechanical failure that led to loss of control of the starboard propeller pitch** so the starboard propeller remained at full ahead during the approach to berth. There were no injuries but the vessel and linkspan were both damaged. 
13/11/2007	Collision	Ursine made contact with the passenger ferry Pride of Bruges as a result of **ineffective communication between the master and the PEC holder** and failure to clarify who would be in control of the vessel. Formal berth allocation was also absent which led to Ursine being directed toward a berth already allocated by Pride of Bruges until contact was made. Damage was caused to both vessels, including to the stern door, stern light and bracket. There were no injuries.
10/03/2006	Allision	Heavy contact was made with the linkspan at Town Quay, Southampton as a result of **miscommunication between the master, the AB and the Chief Officer**, which caused the chief officer to reduce speed on only the aft unit and not both Voith units. Hence, the vessel's speed was not sufficiently reduced and collision with the linkspan was made. 11 people were minorly injured and some vehicles on-board were damaged, as well as the vessel and linkspan. 
23/01/2005	Collision	As a result of an **incorrect assumption being made by the master** of Amenity (that Tor Dania had turned onto a collision course), Amenity turned to port and hit Tor Dania close to midships on the port side at a speed of ~7 knots. Both vessels suffered significant damage but there were no injuries or pollution and both vessels were able to continue to berth un-aided before being withdrawn from service for repairs.
29/12/2004	Allision	Isle of Mull glanced off Lord of the Isles (moored alongside) and subsequently made contact with Oban Railway Pier bow on at around 4 knots. This was due to **human error, where the master forgot to start the bow thrusters at the centre control before moving to starboard wing control console**. The realisation and attempt at correction was too late so the ferry did not slow or turn sufficiently.

Date	Type	Description
		There were no passengers onboard and no injuries were sustained as a result of the impact. The bow visor and port side of the fo'c'sle were substantially damaged and the vessel was withdrawn from service for repairs.
30/07/2004	Allision	Daggri made **contact** with the Ulsta breakwater at around 3knots. This was due primarily to the **visibility becoming significantly reduced** near to Yell shore. As a result of the breakwater collision, the forward azimuth thruster blades of the propellers were distorted, and the hull was indented but not breached and there were no injuries or pollution.
18/04/2003	Allision	Pride of Provence, a ro-ro passenger ferry with 641 persons on board, made heavy contact with the end of the southern breakwater at the eastern entrance to Dover Harbour on 18 April 2003 at 1724. It was daylight, the weather was good and the visibility clear. There was a strong north-easterly wind and a southerly flowing tidal stream across the entrance. Twenty-eight passengers and crew suffered minor injuries, and two suffered major injuries in the accident, and the vessel was extensively damaged above the waterline.
14/03/2001	Grounding	Finnreel grounded after sheering to starboard out of the channel. This was as a result of the **main engine automatically shutting down following the main engine oil mist detector alarm activating**. As a result of the grounding, the vessel's fore peak, No 1 centre and No 2 port and starboard ballast tanks and the bow thruster space were all holed but there were no injuries or pollution.
27/04/2000	Allision	The master of Aquitaine put the two combinators to select astern pitch on both propellors after passing through the Calais port entrance faster than normal. However, the **port propellor failed to respond** and this was not noted by the bridge team. As a result, the master could not prevent the vessel from colliding with the berth at a speed of ~7 knots. 180 passengers and 29 crew were injured and the vessel was taken out of service and dry docked for 2 months.
22/10/1998	Grounding	The course selection that was made on-board Octogon 3 made **no allowance for the strong south-westerly winds or the tides** and, as a result, the **ship was set to starboard** until she grounded. There was no damage to the hull and no pollution or injuries.
19/09/1995	Grounding	Stena Challenger ran aground in the approach channel to Calais after the north-north-easterly gale force wind caused the vessel to drift southward and, despite more power being applied and the bow thrusters activated, fail to turn head to wind and ground on a sandy beach. A substantial amount of bottom plating was damaged in the accident but the hull was not pierced and no pollution occurred. There were no injuries. The primary cause was found to be **insufficient monitoring of the vessel's position during the approach** to Calais. 

8.5 STATISTICAL ANALYSIS OF INCIDENTS INVOLVING RO-RO VESSELS

270. The 1992-2021 MAIB incident data was analysed, extracting all Ro-Ro categorised vessels. This included 6,762 incidents, of which 416 were contacts/impacts and 949 were mechanical failures.

271. Figure 55 categorises the incidents by their reported severity using MAIB classifications. 34% of contacts are Marine Incidents (minor), whilst 36% are Less Serious and 30% are Serious. Figure 56 demonstrates that there is a 45% probability that a

contact/impact would result in material damage to the RoRo vessel, and that this is the highest of any incident category recorded. Fatalities resulting from RoRo incidents are generally rare, with none of the 416 contacts resulting in fatalities, albeit eight resulting in injuries (2%). Several of these incidents are described in Table 11.

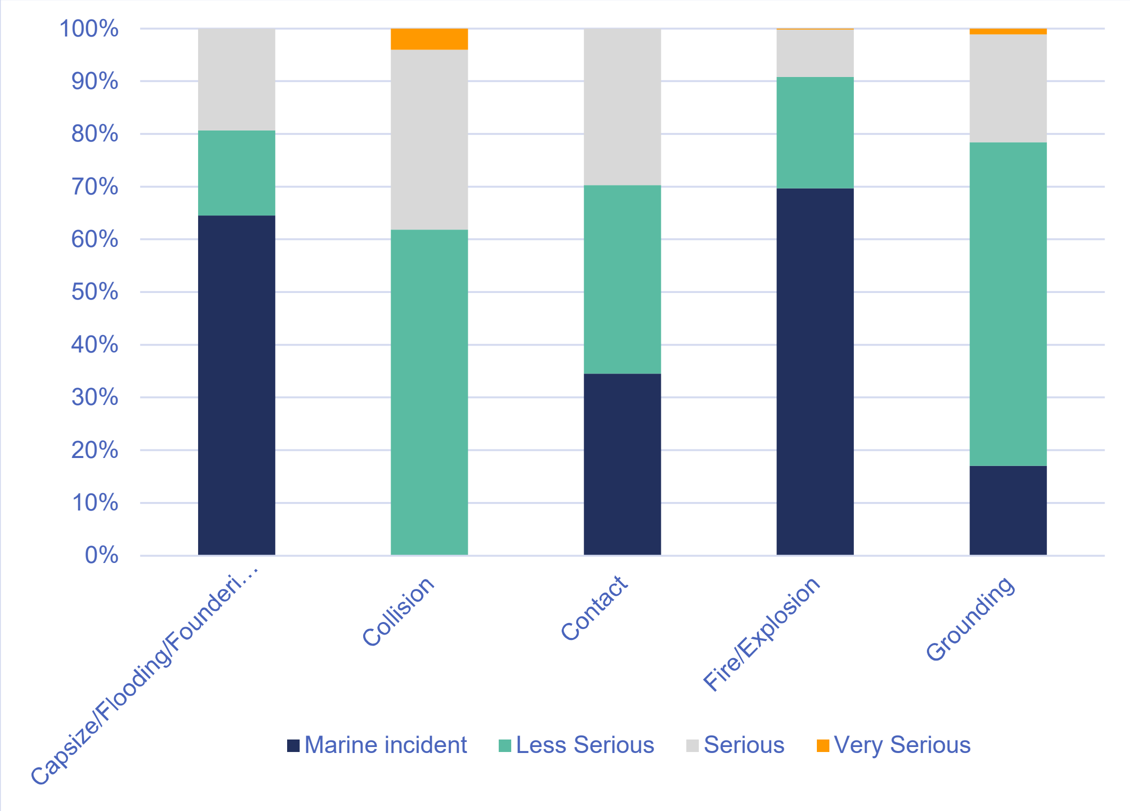


Figure 55: RoRo Incidents by Severity.

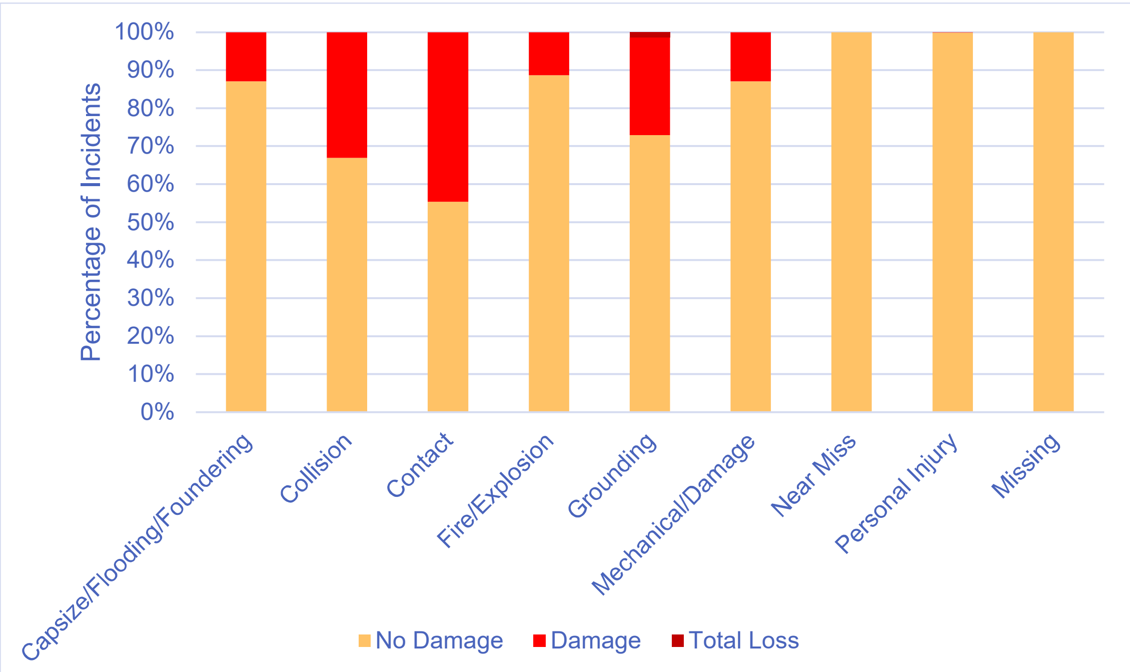


Figure 56: MAIB RoRo Incident Outcomes: Damage.

272. A study by Ciria (1999) reviewed a sample of 177 linkspans and identified that 34% had experienced significant incidents. Of these approximately 30% were the result of ship impacts.

273. A study by EMSA (2018) reviewed Ro-Ro incidents reported to EMCIP between 17/06/2011 and 26/04/2018. This included 3,236 occurrences, of which 523 were contacts, and 353 occurred on arrival and 81 on departure.

8.6 INCIDENT RATES

274. Analysis was undertaken of the MAIB Ro-Ro dataset and compared with the number of movements into different ports around the UK. This enabled determination of the incident rate per movement for use in the QRA (Section 10). Department for Transport Port and Domestic Waterborne Freight Statistics: data table PORT0601 (DfT, 2023) contains annual numbers of ship arrivals by vessel type per UK port. By extracting the number of MAIB incidents for the approximate approaches and berthing areas for each port, a rate per movement can be calculated.

275. Figure 57 shows the incident rate per movement for 11 selected RoRo ports in the UK. The average annual incident rate (for all incidents) varies between 1.4×10^{-3} to 3.41×10^{-4}, or one incident per 714 to 2,933 movements respectively. For contacts (impact / allision) incidents, this varies from between 2.85×10^{-4} to 4.85×10^{-5}, or one incident per 3,508 and 20,612 movements respectively. It is notable that Immingham/Grimsby have the highest contact incident rate (e.g. one contact per 3,508 movements), likely reflecting the challenging navigational conditions in the Estuary.

276. Much of the research into accident rates for vessels has been applied on the basis of a "ship year", which includes the full range of conditions and environments in which a ship operates and therefore cannot be directly compared to specific berthing manoeuvres in ports/harbours. Other work has provided estimated failure rates, such as a ship black out frequency of 1.14×10^{-5} per hour (Friis-Hansen et al. 2008), a human error rate of 4.9×10^{-5} (Goerlandt and Kujala, 2014) or a striking frequency per transit in a narrow waterway of 4.2×10^{-5} (DNV, 2013). Many of these rates are approximately an order of magnitude less likely that the Immingham contact rate of 2.85×10^{-4} per movement as derived above.

277. As has been identified above in Section 8.2, it is known that minor incidents are under-reported with approximately only 1 in 10 and 1 in 20 contacts and mechanical failures reported to the MAIB respectively. Therefore, it is likely that these figures are conservative in nature and the actual incident rate may be higher. Furthermore, given the significant difference for mechanical failures, this analysis has not been repeated for these incident types.

8.7 SUMMARY

278. Analysis of historical incidents is a very useful tool to assist in the development of NRAs. The historical analysis of MAIB incidents for the Humber Estuary show that the estuary has a high incident rate for contacts. A qualitative review of the MarNIS incidents, presented in the ABPmer IERRT NRA report, show high numbers of contact, equipment, and mooring incidents in close proximity to existing Ro-Ro berths on the river. The consequences of incidents analysed shows that contacts with linkspans and berths can have high costs and result in major injury. The consequences from historical incidents have generally been lower that would be expected at the IERRT, due to both the proximity of the IOT and also the navigational complexity of the IERRT location, which has strong

tidal velocities, frequent high winds and limited room for manoeuvring making the margin for error limited.

279. The statistical analysis of incidents enables probabilities of incident occurrence to be derived, which can be used to both inform a qualitative (see Section 9) and quantitative (see Section 10) assessment of risk.

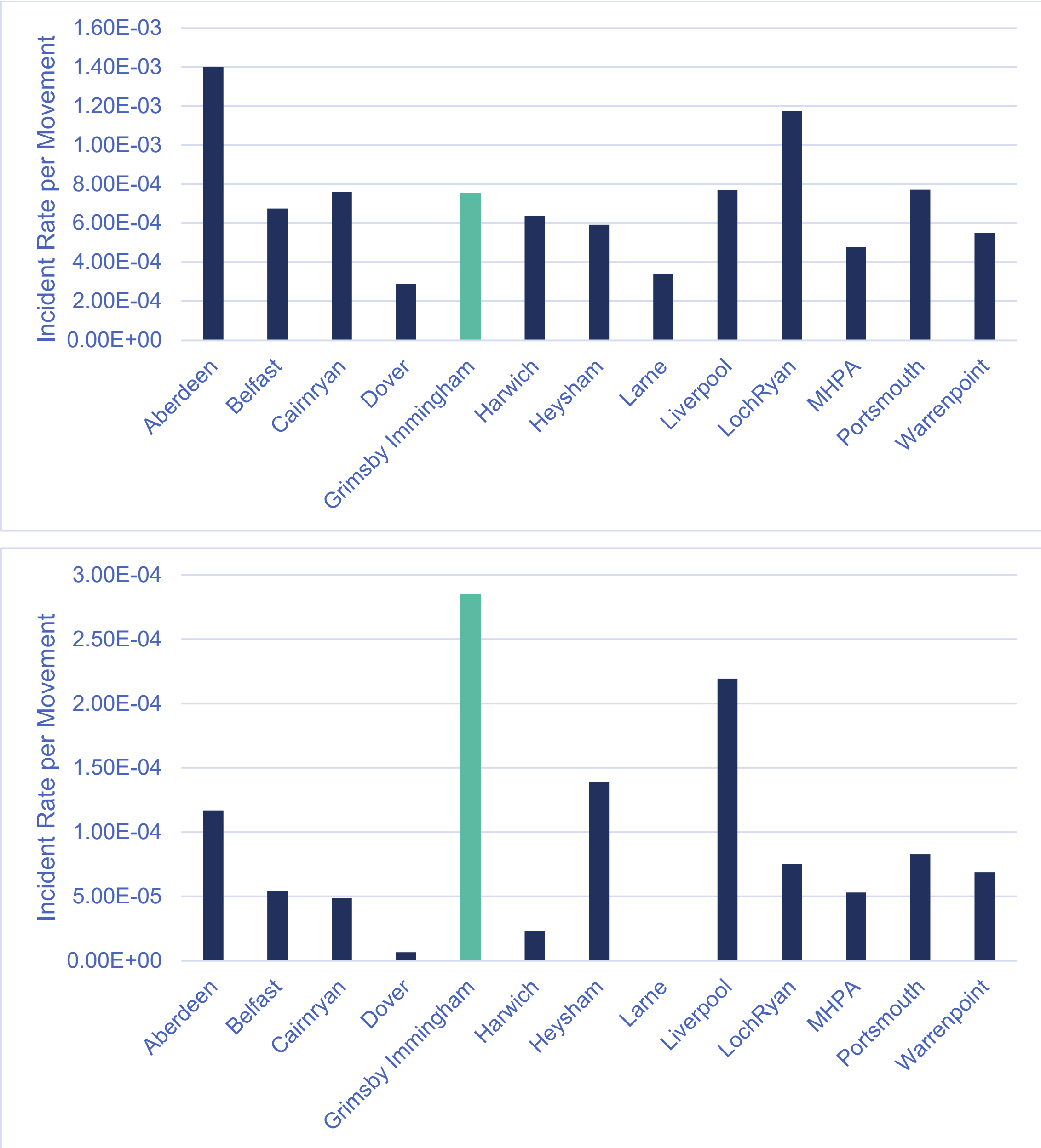


Figure 57: Incident Rates per Movement (Top: All incidents, Bottom: Contacts).

9. QUALITATIVE RISK ASSESSMENT

280. This section summarises the formal risk assessment process for the qualitative risk assessment for the operational phase only of the IERRT, including the identification of:

- Hazard types;
- Vessel types;
- Contact scenarios; and
- Identified hazards.

9.1 HAZARD IDENTIFICATION

281. The project team combined the findings of a review of the proposed IERRT NRA, with analysis presented in Sections 2, 3, 4, 5, 6, 7 and 8 of this report, to identify hazard types associated with the IERRT development, which were pertinent to IOT Operators. This resulted in three hazard types being identified which are summarised in Table 12. A commentary giving further context to the possible scenarios associated with each hazard type is included in the remainder of this section.

Table 12: Identified Hazard Types.

Hazard ID #	Hazard Types	Definition
1	**Collision**	Collision between two vessels underway (also includes striking of an anchored vessel).
2	**Contact (Allision / Impact)**	Vessel makes contact with Fixed or Floating Object (FFO) (e.g. quay, pile, shoreline, buoy, moored vessel)
3	**Breakaway**	Vessel breaks away from securely moored position may result in damage to non-vessel objects

9.1.1 Vessel Categories

282. A review of the baseline vessel traffic analysis was also undertaken to define vessel type categorisations. The following vessel categories were identified:

- **IERRT Ro-Ro vessels** – T -Class Stena ferries, (see Section 4.4)
- **Bunker Barge** – estuarial barges undertaking distribution of refined products to terminals further inland and direct delivery of bunker fuels to ships in Hull, Immingham and Grimsby, (see Section 3.2). Barges predominantly berth at IOT berths 7 and 9.
- **Tanker** – Commercial vessels larger than 100m in length carrying liquid cargo such as LPG, oil or chemicals between two ports. These vessels utilise the main river facing IOT berths and Immingham Dock.
- **Coastal Tanker** - product tankers, generally within the range 80m – 100m in length which trade predominantly to UK and near European ports distributing refined oil products and fuels. Coastal tankers berth at either IOT berths 6 or 8.

- **Cargo -** commercial vessels carrying dry cargo such as containers, bulk cargo or automobiles between two ports. Cargo vessel activity is predominantly associated with transits to and from Immingham Dock of the Outer Harbour.
- **Tug, service and other small vessels** – Tugs, workboats, port service, law enforcement and survey vessels.
- **Third Party Passenger** – Ro-Ro vessel entering Immingham Dock and transiting north of IOT.

9.1.2 Contact Scenarios

283. A number of contact (allision / impact) scenarios were identified for vessels navigating to and from the IERRT and IOT. Separate contact scenarios are considered because the severity of a contact occurrence not only depends on the vessel type(s) involved but the nature of the infrastructure contacted. For example, a contact hazard occurrence between a IERRT Ro-Ro vessel and the IERRT berth may result in significant damage to property but will likely have minimal consequences for the environment. In contrast a contact occurrence between a IERRT Ro-Ro vessel and the IOT Trunkway will not only result in significant damage to property but may also have catastrophic environmental impacts. The magnitude of risk is therefore influenced by the type of vessel and the nature of the infrastructure contacted. The contact scenarios are summarised in Table 13.

Table 13: Identified Contact Infrastructure Scenarios.

Contact Scenarios	Detail
IOT Trunkway	IOT Trunkway from shore to IOT Finger Pier and river berths
IOT Finger Pier	IOT Finger Pier including berths 6, 7, 8 and 9 and vessel moored alongside.
IOT River berths	IOT River Berths including berths 1, 2 and 3 and vessel moored alongside.
IERRT Jetty	IERRT including berths 1,2 and 3 and vessels moored alongside.

9.1.3 Identified Hazards

284. The identified hazard types, vessel types and contact scenarios were then combined to create a list of potential navigation hazards. The project team reviewed each hazard iteration to check whether the occurrence of each identified hazard was credible. Those hazards not deemed to be credible were removed from the final identified hazard list, (see Table 14).

285. The project team then reviewed each identified hazard to ascertain the relevance of the hazard to the sNRA. For example, Third party passenger vessels are not observed navigating in proximity to either the IERRT or IOT, therefore, a third party passenger vessel making contact with the IERRT or IOT was not deemed to be an appropriate hazard to consider in this sNRA. The identified hazards are therefore associated with vessels undertaking operations at either the IERRT, IOT or navigating to Immingham terminals. A commentary relating to the hazards applicable to each of the operations is outlined below.

Table 14: identified Navigation Hazards (ICW – In Collision With).

Hazard Id #:	Hazard Type	Hazard Title
1	Collision	Collision - IERRT Ro-Ro vessels (Passenger) ICW IERRT Ro-Ro vessels (Passenger)
2	Collision	Collision - IERRT Ro-Ro vessels (Passenger) ICW Coastal Tankers
3	Collision	Collision - IERRT Ro-Ro vessels (Passenger) ICW Bunker Barge
4	Collision	Collision - IERRT Ro-Ro vessels (Passenger) ICW Cargo
5	Collision	Collision - IERRT Ro-Ro vessels (Passenger) ICW Tanker
6	Collision	Collision - IERRT Ro-Ro vessels (Passenger) ICW Tug, Service and Other Small Vessel
7	Collision	Collision - IERRT Ro-Ro vessels (Passenger) ICW 3rd Party Passenger
8	Contact (Allision)	Contact (Allision) - Bunker Barge with IOT Trunkway
9	Contact (Allision)	Contact (Allision) - Coastal Tanker with IOT Trunkway
10	Contact (Allision)	Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IOT Trunkway
11	Contact (Allision)	Contact (Allision) - Bunker Barge with IOT Finger Pier
12	Contact (Allision)	Contact (Allision) - Coastal Tanker with IOT Finger Pier
13	Contact (Allision)	Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IOT Finger Pier
14	Contact (Allision)	Contact (Allision) - Tug, Service and Other Small Vessel with IOT Finger Pier
15	Contact (Allision)	Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IOT River berths
16	Contact (Allision)	Contact (Allision) - Bunker Barge with IERRT Jetty
17	Contact (Allision)	Contact (Allision) - Coastal Tanker with IERRT Jetty
18	Contact (Allision)	Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IERRT Jetty
19	Contact (Allision)	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty
20	Breakaway	Breakaway - Bunker Barge at IOT Finger Pier
21	Breakaway	Breakaway - Coastal Tanker at IOT Finger Pier
22	Breakaway	Breakaway - IERRT Ro-Ro vessel (Passenger) at IERRT Jetty

9.1.3.1 IERRT Operations: Collision

286. Encounters between IERRT vessels and other vessel types will occur as they navigate to and from the IERRT berths. It is possible that these encounters could result in a collision occurrence. Collisions between IERRT vessels and other vessels could occur when

navigating past the IOT, as they swing to align with IERRT and on final approach to the berth.

287. When passing the IOT, IERRT vessels could be involved in a collision with vessels utilising the main navigable channel, tug and workboat vessels assisting tankers in berthing at the IOT river berths and tankers arriving / departing the river berths.

288. As IERRT vessels depart / join the navigable channel and manoeuvre to the IERRT they will obstruct the main channel, (see **Section 4.5**). During this manoeuvre IERRT vessels will be in a state of relative vulnerability as the ability of the master to take any avoiding action will be restricted. A collision occurrence could occur between other vessels utilising the main channel, vessels navigating to Immingham terminals and coastal tankers and bunker barges approaching the IOT Finger Pier.

9.1.3.2 IERRT Operations: Contact

289. IERRT vessels approaching / departing the IERRT will navigate in close proximity to IOT and contact incidents could occur between a IERRT vessel and:

- IOT Finger Pier (including tanker moored alongside);
- IOT Trunkway;
- IOT River Berths; and
- IERRT.

290. Contact between an IERRT vessel the IOT Finger Pier and Trunkway will be most likely to occur when approaching / departing IERRT on an ebb tide, particularly IERRT Berth 1. Berth 1 is positioned in close proximity to the IOT Finger Pier and the navigable width will be further reduced should a coastal tanker or bunker barge occupy berths 8 and 9. In addition, the ebb tide will set IERRT vessels on to IOT. Precise vessel handling will be required to manoeuvre a IERRT vessel alongside and there will be minimal margin for error, particularly in adverse conditions.

291. In addition to contact with the Finger Pier there is also the possibility that an IERRT vessel may either pass between the Finger Pier and IERRT berth 1 thus making contact with IOT Trunkway or pass through the IERRT infrastructure to make contact with the IOT Trunkway.

9.1.3.3 IERRT Operations: Breakaway

292. IERRT vessels could breakaway from their berths in adverse weather conditions or if berthing infrastructure failure e.g. parting mooring line. If an IERRT vessel does breakaway from the berth then there is the possibility that contact could be made as outlined above, the consequences of a breakaway would likely be more severe during a strong ebb tide as the tide will set the vessel back toward the IOT Finger Pier and Trunkway.

9.1.3.4 IOT Operations: Collision

293. Vessels utilising the IOT terminal include tankers utilising the IOT River Berths, Coastal tankers utilising berths 6 and 8 on the IOT Finger Pier, bunker barges utilising berths 7 and 9 on the IOT Finger Pier and, tug and workboats that assist in berthing operations.

294. Coastal tankers and bunker barges approaching the IOT Finger Pier will navigate in close proximity to IERRT vessels. Encounters between such vessels are likely and therefore there is a heightened risk of collision.

295. Tugs and workboats assisting in berthing IOT bound vessels are also likely to navigate in proximity to vessels arriving / departing IERRT berths.

9.1.3.5 IOT Operations: Contact

296. When an IERRT vessel is alongside berth 1, navigable width between IERRT berth 1 and berths 8 and 9 of the IOT Finger Pier will be significantly reduced. This will reduce the margin of error for IOT berthing manoeuvres and there is a possibility that IOT vessels could make contact with the moored IERRT vessel, IOT Finger Pier (including vessel alongside) or the Trunkway.

297. Coastal tankers, bunker barges, tugs and workboats could also make contact with the IOT Finger Pier as a result of the reduced navigable width.

9.1.3.6 Breakaway

298. IOT vessels (coastal tankers or bunker barges) moored at berth 7 and 9 could breakaway from the berth in adverse weather conditions or if there is a berthing infrastructure failure. If an IOT vessel does breakaway from the berth then there is the possibility that contact could be made with a IERRT Ro-Ro vessel moored at IERRT berth 1, the IERRT jetty or the IOT Trunkway. The consequences of a breakaway would likely be more severe during a strong ebb tide as the tide will set the IOT vessel toward the IOT Finger Pier.

9.2 HAZARD SCORING

299. Hazards scoring was based on the data and analysis contained within this report and a review of the IERRT operational phase NRA hazard likelihood and consequence scores. For the hazard consequence scoring, direct benchmarking with IERRT hazard consequence scores was undertaken. In effective hazard consequence scores for this sNRA are therefore considered to be the same or similar to those derived from the hazard workshops.

300. Due to the problems with the IERRT Frequency Descriptors (as detailed in Section 2.1.7) hazard likelihood scores were derived from analysis contained with this report at Sections 3, 4, 5, 6, 7 and 8.

9.3 BASELINE QUALITATIVE RISK ASSESSMENT

301. The results of the baseline assessment of risk (which includes the embedded risk controls) are presented in Table 15. The results of the baseline sNRA are contained in full in the "*Risk Assessment Logs*" which can be viewed in Appendix C.

302. Of the 22 identified hazards:

- Two are scored as "Intolerable":
    - Haz ID # 10 - Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IOT Trunkway; and

- Haz ID # 13 - Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IOT Finger Pier.

- 20 are scored as "Tolerable if ALARP".

9.3.1 Intolerable Hazard Commentary

303. This section includes a short commentary expanding on the circumstances that combine to influence the relative high-risk scores attributed to those hazards classified in the baseline assessment of risk as intolerable.

9.3.1.1 Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IOT Trunkway

304. The proximity of berth 1 to the IOT Trunkway and the fact that berthing operations will take place on ebb tides combine to result in a relative high likelihood score for hazard occurrence.

305. In combination with relative high consequence scores, this results in this hazard being classified as intolerable.

306. High consequence scores are assigned on the following basis:

- People - IERRT Ro-Ro vessels are passengers vessel carrying hundreds of passengers, in a worst case scenario the IERRT Ro-Ro vessel could capsize / sink as a result of contact resulting in multiple fatalities;
- Property – a contact event between the IERRT Ro-Ro vessel and the IOT Trunkway would likely damage the Trunkway beyond repair with the IERRT Ro-Ro vessel also likely to sustain significant damage.
- Environment – should a contact occur and the Trunkway pipelines be compromised, there would be an oil / product spill resulting in catastrophic long lasting impact to the environment; and
- Business – such a contact event (involving multiple fatalities, catastrophic damage to property and the environment) would result in widespread international negative publicity and would result in significant loss of revenue to the port.

Table 15: Baseline Risk Assessment Results.

ID	Baseline Rank	Hazard Title	Baseline Risk	
			Score	Rating
10	1	Contact (Allision) - IERRT Ro-Ro Vessel with IOT Trunkway	6.0	Intolerable
13	1	Contact (Allision) - IERRT Ro-Ro Vessel with IOT Finger Pier	6.0	Intolerable
2	3	Collision - IERRT Ro-Ro Vessel ICW Coastal Tankers	5.9	Tolerable if ALARP
12	4	Contact (Allision) - Coastal Tanker with IOT Finger Pier	5.8	Tolerable if ALARP
3	5	Collision - IERRT Ro-Ro Vessel ICW Bunker Barge	5.5	Tolerable if ALARP

ID	Baseline Rank	Hazard Title	Baseline Risk	
			Score	Rating
18	6	Contact (Allision) - IERRT Ro-Ro Vessel with IERRT Jetty	5.1	Tolerable if ALARP
5	7	Collision - IERRT Ro-Ro Vessel ICW Tanker	5.0	Tolerable if ALARP
11	7	Contact (Allision) - Bunker Barge with IOT Finger Pier	5.0	Tolerable if ALARP
15	7	Contact (Allision) - IERRT Ro-Ro Vessel with IOT River berths	5.0	Tolerable if ALARP
7	10	Collision - IERRT Ro-Ro Vessel ICW 3rd Party Passenger	4.9	Tolerable if ALARP
8	10	Contact (Allision) - Bunker Barge with IOT Trunkway	4.9	Tolerable if ALARP
9	10	Contact (Allision) - Coastal Tanker with IOT Trunkway	4.9	Tolerable if ALARP
20	13	Breakaway - Bunker Barge at IOT Finger Pier	4.8	Tolerable if ALARP
21	13	Breakaway - Coastal Tanker at IOT Finger Pier	4.8	Tolerable if ALARP
16	15	Contact (Allision) - Bunker Barge with IERRT Jetty	4.6	Tolerable if ALARP
17	15	Contact (Allision) - Coastal Tanker with IERRT Jetty	4.6	Tolerable if ALARP
22	15	Breakaway - IERRT Ro-Ro Vessel at IERRT Jetty	4.6	Tolerable if ALARP
1	18	Collision - IERRT Ro-Ro Vessel ICW IERRT Ro-Ro Vessel	4.5	Tolerable if ALARP
4	19	Collision - IERRT Ro-Ro Vessel ICW Cargo	4.4	Tolerable if ALARP
14	20	Contact (Allision) - Tug, Service and Other Small Vessel with IOT Finger Pier	3.6	Tolerable if ALARP
19	20	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty	3.6	Tolerable if ALARP
6	22	Collision - IERRT Ro-Ro Vessel ICW Tug, Service and Other Small Vessel	3.5	Tolerable if ALARP

9.3.1.2 Contact (Allision) - IERRT Ro-Ro vessel (Passenger) with IOT Finger Pier

307. The proximity of berth 1 to the IOT Finger Berth (and / or coastal tanker / bunker barge moored alongside) and the fact that berthing operations will take place on ebb tides combine to result in a relative high likelihood score for hazard occurrence.

308. In combination with relative high consequence scores, this results in the hazard being classified as intolerable.

309. High consequence scores are assigned on the following basis:

- People - IERRT Ro-Ro vessels are passengers vessel carrying hundreds of passengers, in a worst case scenario the IERRT Ro-Ro vessel could capsize / sink as a result of contact resulting in multiple fatalities;

- Property – a contact event between the IERRT Ro-Ro vessel and the IOT Trunkway and or vessel berthed alongside would likely damage the IOT Finger Pier beyond repair with the IERRT Ro-Ro vessel and IOT vessel also likely to sustain significant damage.
- Environment – should a contact occur and the IOT / IERRT Ro-Ro vessel be holed there would be an oil / product spill resulting in catastrophic long lasting impact to the environment; and
- Business – such a contact event (involving multiple fatalities, catastrophic damage to property and the environment) would result in widespread international negative publicity and would result in significant loss of revenue to the port.

9.4 SUMMARY

310. The hazard identification for the Qualitative Risk Assessment identified 22 unique hazards. Of these hazards two were identified as “Intolerable” in the baseline assessment of navigation risk. The remaining hazards were classified as “Tolerable if ALARP”.

10. QUANTITATIVE RISK ANALYSIS

10.1 INTRODUCTION

311. Following the identification of a potentially high-risk hazard associated with an impact between an IERRT Ro-Ro and the IOT infrastructure, a detailed Quantitative Risk Assessment (QRA) has been undertaken. This consisted of modelling of incident likelihood and consequences.

10.2 LIKELIHOOD MODELLING

312. The primary methodology utilised in the QRA are event trees, whereby high-level event sequences are identified which represent the causal chain which may lead to a certain outcome. For the basis of this assessment, the causal chain of events contains the following stages:

- A vessel arrives or departs the IERRT.
- There is a mechanical or human failure aboard which results in loss of control.
- The vessel fails to rectify the issue through taking some action (e.g. dropping anchor, availability of a tug etc.).
- An impact occurs sufficient to cause significant damage.
- The impact vector results in the vessel striking the IOT Trunkway.
- The impact causes a catastrophic outcome (such as rapid capsize of the Ro-Ro or ignition of fuel).

313. For each stage in this assessment, assumptions were made that drew upon published academic literature, accident reports and the expertise of the project team. Table 16 describes the assumptions used to construct the event tree.

Table 16: QRA Likelihood Values

Node	Value	Source and Notes
Movements/ Year	2,190	ES Volume 3 Appendix 101: Navigation Risk Assessment (Document Reference 8.4.10a).
Failure Rate	True: 2.85×10^{-4} False: 9.997×10^{-1}	A review of the literature identified failure rates per movement of between 1.14 x 10-5 to 4.2 x 10-5 (see Section 8.6). However, the approximate Ro-Ro incident rate for Immingham is in the order of 2.85 x 10-4. Recognising the challenging navigation conditions, this value was applied for Ro-Ro berthing failure rates.
Probability of Intervention	True: 0.5 False: 0.5	It is reasonable that the vessel might be able to deploy contingency action to mitigate any impact. Given the relative urgency of any action this was assumed at 50%.
Impact Speed	High: 0.1 Low: 0.9	It is likely, given the location at activities the vessel is undertaking, that the vessel would be travelling at low speed when the incident occurs. However, given the potential for significant tidal flows and strong winds, coupled with the movement of the vessel, it is feasible that a higher impact speed could occur. A ratio of 0.1 to 0.9 was chosen based on the following information: To approximate the ratio of minor to serious incidents given in the IMO's FSA for RoPax Vessels of 0.86 to 0.14 (IMO, 2008).

Node	Value	Source and Notes
		The MAIB 2022 Annual Report shows ratio of Less Serious and Serious to Very Serious incidents of 221 to 13 or 0.94 to 0.06 (MAIB, 2023).
Striking Trunkway	True: 0.3 False: 0.7	It is possible that the vessel would strike another object other than the Trunkway, given the metocean and tidal conditions at the time, so striking the Trunkway is given as a 30% chance for this node.
Catastrophic Outcome	True: 0.1 False: 0.9	A catastrophic outcome likelihood was estimated as a 10% chance, given a high-speed impact of the Trunkway. This likelihood would be subject to further study to determine the potential for ignition sources following a strike of the Trunkway.

314. Figure 58 shows the event tree and associated probabilities and return period. A total probability of striking infrastructure of 3.12 x 10^{-1} or once in 3.2 years was determined. In particular, it identified four scenarios of significance:

- **Scenario 1: Low Speed Impact - moderate consequence**: 2.89 x 10^{-1} or once in 3.6 years.

  This could include impact of a tanker moored at berth 8 or 9 or impact with the Finger Pier or main jetty structure. Impact likely at speed less than 2 knots over ground, resulting from residual speed after a power failure, speed due to the effect of wind, speed due to tidal flow or any combination of these. A low speed impact could have a significant short term effect on the ability of IOT Finger pier berths to continue operating, and could potentially extend to explosion risk and pollution, including pipe rupture on the jetty, pipe use suspension pending survey and testing, ignition source during impact, breaking adrift a moored coastal tanker from berth 8 or estuarial barge from berth 9, and resultant damage to IOT Finger Pier.

- **Scenario 2: High Speed Impact (but not with Trunkway) - high consequence**: 2.19 x 10^{-2} or once in 46 years.

  This would include a substantial impact with the finger pier or the landward side of the main jetty at a speed in excess of 2 knots over ground, resulting from residual speed after a power failure, speed due to the effect of wind, speed due to ebb tidal flow or any combination of these. At worst case, speed could be up to approximately 6 knots (spring ebb tide, fluvial run down and residual momentum). Serious damage likely, resulting in IOT Finger Pier berths being out of use for an indeterminate period, potential for explosion and pollution. Coastal Tankers and estuarial barges alongside berths 8 and/or 9 could break adrift with consequent further damage.

- **Scenario 3: High Speed Impact (with Trunkway) - high consequence**: 8.43 x 10^{-3} or once in 119 years.

  Impact speed in excess of 2 knots and up to 6 knots over ground, resulting from residual speed after a power failure, speed due to the effect of wind, speed due to ebb tidal flow or any combination of these. Major damage to Trunkway pipeline infrastructure and possibly Trunkway itself resulting in temporary shutdown of IOT and consequent impact on refineries and unplanned shortage of refined products available for UK:

- **Scenario 4: High Speed Impact (with Trunkway and catastrophic outcome) - high consequence**: 9.36 x 10^{-4} or once in 1,068 years.

As above Scenario 3 but with the addition of explosion and multiple fatalities, resulting in long term shut down and IOT and consequence impact to refineries leading to shortage of refined products for the UK.

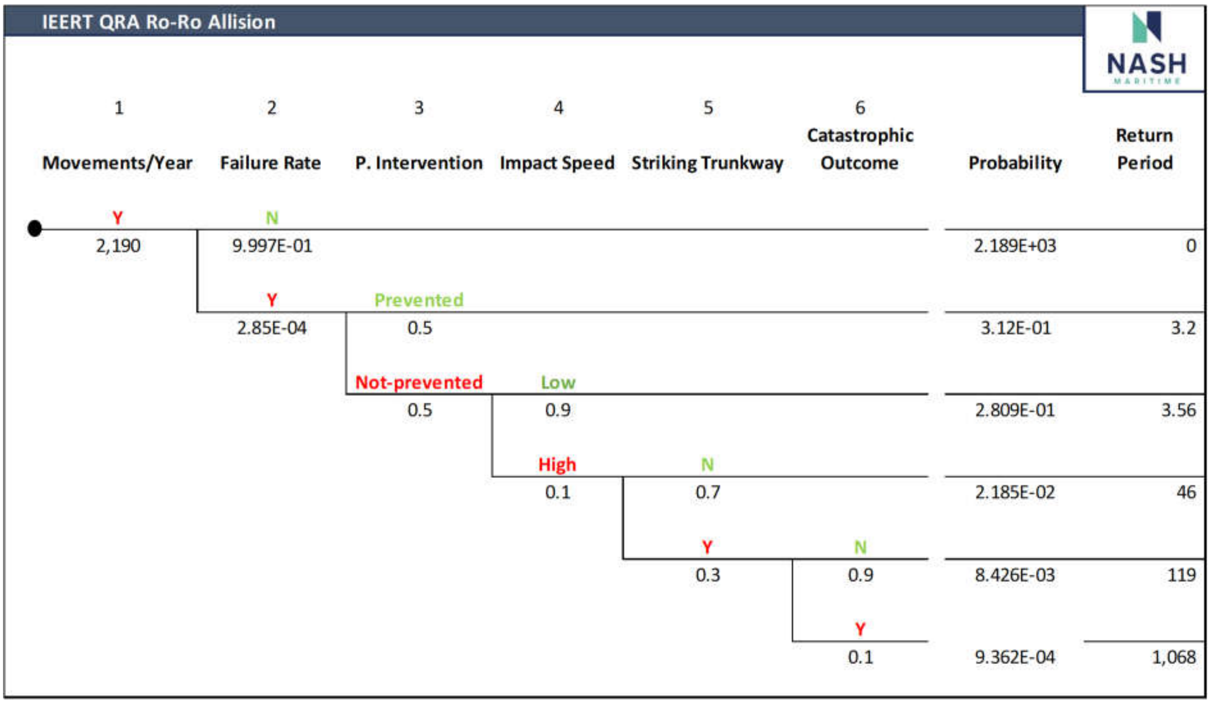


Figure 58: Event tree for Ro-Ro Allision.

10.3 CONSEQUENCE MODELLING

10.3.1 Potential Loss of Life

315. Based on the four scenarios, identified above, the potential loss of life was calculated per incident in Table 17**.** It has been assumed that a 300 passenger capacity vessel with 25 crew would have the following normalised distribution of persons on board of 244 (based on the assumptions set out in the IMO's 2008 FSA for RoPax Vessels):

- 25% of the time it would be full (325)
- 25% of the time it would be half full (162.5)
- 50% of the time it would be three quarters full (244).

316. For each of the four scenarios, a proportion of the persons on board who might be killed has been estimated. Previous studies have shown a range of outcomes, with, for example, the IMO's FSA for RoPax vessels ranging from 0.2% for minor slow sinking incidents (namely the Presidente Diaz Ordaz) through to 23% for incidents leading to rapid capsize in shallow water (average of European Gateway and Herald of Free Enterprise) and 87% for rapid capsize in deep water (Estonia) (IMO, 2008). For the purposes of this assessment, it has been assumed that minor incidents would cause between 0.01% and 0.1% fatalities given the modern safety standards of RoRo vessels and the immediate availability of assistance. Based on the historical analysis underpinning the IMO's work, a 25% catastrophic outcome has been utilised, however, recognising that were the vessel to become pinned or catch fire following a striking of the Trunkway, the figures of 80%/90% casualties could be possible. The determination of realistic catastrophic outcomes would be subject to further review.

Table 17: Potential Loss of Life.

Scenario	Likelihood / Year	Proportion of Fatalities	Fatalities per Incident	Potential Loss of Life/Year
1: Low Speed	2.89 x 10-1	0.01%	0.024	0.007
2: High Speed (not Trunk)	2.19 x 10-2	0.1%	0.244	0.005
3: High Speed (Trunk)	8.43 x 10-3	1%	2.24	0.021
4: High Speed (Trunk + Catast.)	9.36 x 10-4	25%	60.94	0.057
Total	3.11 x 10-1	N/A	N/A	0.09

317. Societal risk is defined in the FSA (IMO, 2018) as the "average risk, in terms of fatalities, experienced by a whole group of people (e.g. crew, port employees or society at large) exposed to an accident scenario." It is usual to express societal risk as the potential loss of life against the likelihood of occurrence on FN curves, shown with logarithmic scales.

318. It is possible to map onto the FN curves the acceptability criteria of Acceptable, ALARP and Intolerable. These have been derived from the following sources:

- HSE's (2001) Reducing Risks, Protection People states that "HSE proposes that the risk of an accident causing the death of 50 people or more in a single event should be regarded as intolerable if the frequency is estimated to be more than one in five thousand years".
- The IMO's FSA (2018) guidance shows an FN curve in Figure 1 which has an Negligible-ALARP slope running from approximately 2×10^{-4} for 1 fatality to 2×10^{-6} for 100 fatalities.
- Various academic studies (see for instance Stanley et al. 2018).

319. The resulting FN curve formed by each of the four scenarios is shown in Figure 59. As can be seen, as the severity of the scenario outcome increases, the likelihood of occurrence decreases.

a. For Scenarios 1 and 2, the risk lies within Tolerable if ALARP, albeit close to the limits of Intolerable.

b. For Scenarios 3 and 4, with the potential for mass casualties, the risk exceeds the limits of Tolerability and is therefore Intolerable.

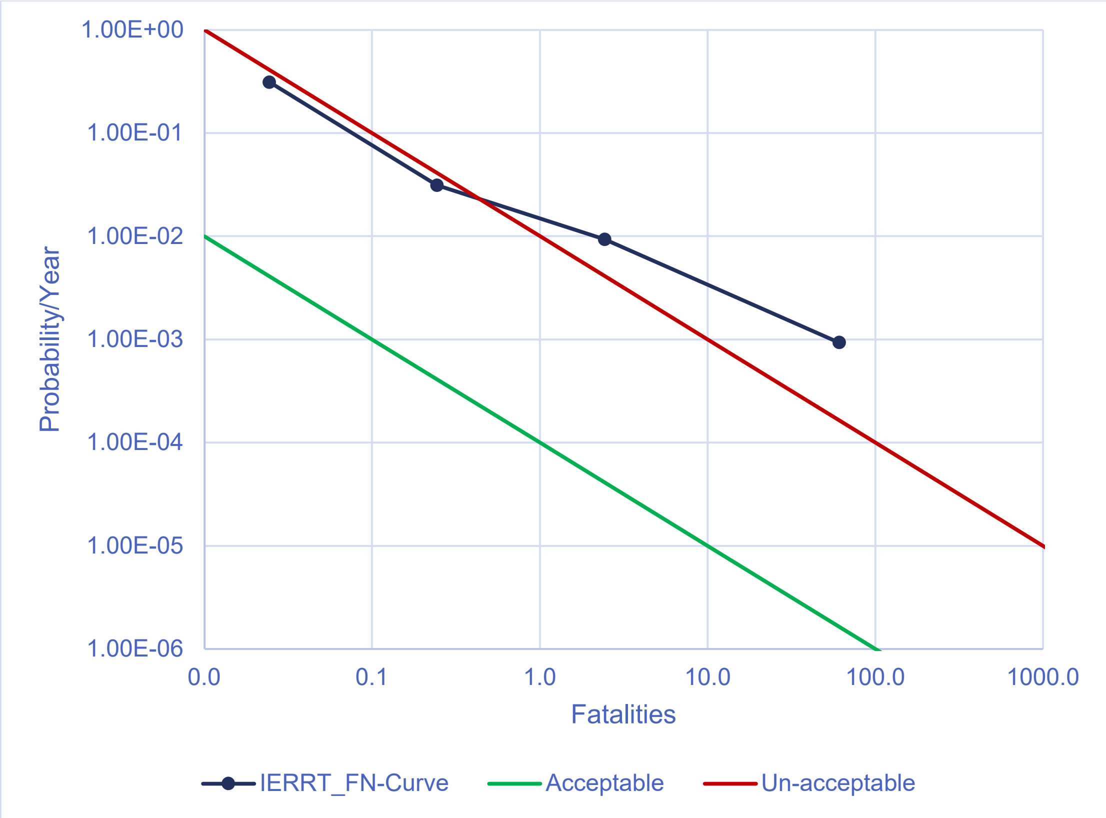


Figure 59: FN Curve.

320. In addition to the societal risk, individual risk is calculated based on the risk to any one individual aboard the ferry. This is the result of dividing the potential loss of life per year (from Table 17) by the average number of persons on board derived above (244). For all four scenarios combined, this results in a figure of 3.68 x 10^{-4}. This is greater than the maximum acceptable individual risk of 1 x 10^{-4} for members of the public given in HSE's Reducing Risks, Protecting People (HSE, 2001).

321. Finally, for comparison with other consequence types it is necessary to convert the potential loss of lives to monetary values using the principal of the Cost of Averting a Fatality/Value of a Prevented Fatality. For the purposes of this assessment a value of £2M has been utilised which is utilised by the UK Treasury (LSE, 2020). This is notably lower than has been used in other comparable studies such as GOALDS of 7.45M (Wang et al. 2020) and IMO's FSA of $3M (IMO, 2008) and is therefore considered conservative.

10.3.2 Potential Pollution

- For each of the four scenarios, the following worst credible oil outflows have been estimated:
- **Scenario 1**: 0.1 tonne of fuel spillage.
- **Scenario 2 and 3**: 500 tonnes of potential spillage. This represents approximately a 50% loss of fuel from a representative RoRo with carriage of >1000 tonnes of fuel.
- **Scenario 4**: This includes both the spillage contained in Scenario 2/3 as well as a further 1,000 tonnes of spillage from the Trunkway before it could be shut off.

322. A cost of cleanup has been derived using research by Kontovas et al. (2010) which proposes a relationship of $51,432 * $V^{0.728}$, where V is the spill size in tonnes. Whilst this figure is dated, and uses US$, it has been used as a conservative value in this assessment.

10.3.3 Potential Damage

323. The potential damage to property caused by the four scenarios are outlined below in Table 18. The asset value is representative of comparative assets and is multiplied by an impact factor for each scenario. For example, in Scenario 2 a 0.25 factor for a ferry (which costs £110M) allision would result in £27.5M damage.

Table 18: Potential Damage Criteria.

Scenario	Ferry Value	Ferry Impact	RoRo Terminal Value	RoRo Terminal Impact	IoT Terminal Value	IoT Terminal Impact	Total Cost
1: Low Speed	£110M	0.01	£90M	0.01	£100M	0	£3M
2: High Speed (not Trunk)		0.25		0.25		0.25	£75M
3: High Speed (Trunk)		0.5		0.5		0.5	£150M
4: High Speed (Trunk + Catast.)		1		1		1	£300M

10.3.4 Potential Economic Impact

324. The economic impact is a combination of loss of business to the ferry and loss of business to the IOT Terminal and shareholder refineries.

325. The loss of business to the ferry is represented by a loss of ticket sales. Assuming a ticket price of c.£500, up to 244 passengers and the ferry/berth out of action for one day (in a minor incident) or an extended period (weeks to months) across all three IERRT berths (in a major incident).

326. The analysis uses indicative figures to illustrate the range of likely economic impacts as a result of business interruption and demurrage to the refineries which might arise from a range of possible impact scenarios. The precise economic impacts will be driven by the specific nature of any impact event, associated duration of interruption in use of the IOT, associated ship demurrage and the refining margin environment at the time. The indicative figures used in this analysis provide an indication of the likely order of magnitude of the economic impacts of potential scenarios. However the impact on individual shareholder refineries are likely to differ greatly depending on scenarios so a generalised range has been used.

327. The range of impact scenarios could include.

- Minor severity collision by an IERRT vessel with the IOT Finger Pier: This would include collision of IERRT vessel with the finger pier structure or a vessel moored at berth 8 or 9. Whilst remedial actions are taken and repairs are made to the infrastructure with reduced berths operation, this could lead to short delays in servicing vessels. It is anticipated that this would have a minimal impact on refinery operations as sufficient stocks and contingency would be in place, however it could still result in losses as a result of demurrage of approximately £100K.

- Moderate severity collision by an IERRT vessel with the IOT Finger Pier: This would include a substantive impact with the finger pier or vessel alongside any of the berths, by an IERRT vessel, resulting in berths being out of use for indeterminate period whilst remedial actions are taken and repairs or alternative means of supply are made. It is estimated that the effect on refinery operations could result in a loss of at least £2 Million.
- Major consequence collision by an IERRT vessel with the IOT Trunkway. This would include major damage to the IOT Trunkway pipeline infrastructure including some or all of the pipelines, resulting in possible temporary refinery shutdown, sub optimal operation and or unplanned temporary shortage of refined products in the areas of the UK supplied by the refineries. Operations at the IOT as a whole (finger and river berths) would be shut down for a prolonged period (weeks to months). It is estimated that the effect on refinery operations could result in loss of at least £100 Million.
- Catastrophic consequence collision by an IERRT vessel with the IOT Trunkway. This would include catastrophic damage to the IOT Trunkway pipeline infrastructure including all the pipelines, resulting in sustained refinery shutdown and long-term supply interruption off refined products available within the UK supplied by the refineries. Operations at the IOT as a whole (finger and river berths) would have a prolonged shutdown (greater than several months). It is estimated that the effect on refinery operations could result in loss of at least £200 Million.

Table 19: Potential Economic Criteria.

Scenario	Ro-Ro Business	IOT Terminal Vessels	Total
1: Low Speed	£121,875	£100,000	£221.9k
2: High Speed (not Trunk)	£18.28M	£2M	£20.28M
3: High Speed (Trunk)	£18.28M	£100M	£118.28M
4: High Speed (Trunk + Catast.)	£18.28M	£200M	£218.28M

10.3.5 Summary

328. Table 20 presents the likelihood of occurrence per year multiplied by the cost per incident to show the annualised risk costs.

Table 20: Summary of Annualised Risk Costs.

Scenario	Likelihood	People	Property	Environ.	Economic	Total
1: Low Speed	2.89×10^{-1}	£13,692	£842,603	£2,702	£62,317	£921,315
2: High Speed (not Trunk)	2.19×10^{-2}	£10,650	£1,638,394	£103,619	£443,049	£2,195,712

Scenario	Likelihood	People	Property	Environ.	Economic	Total
3: High Speed (Trunk)	8.43×10^{-3}	£41,077	£1,263,904	£39,967	£996,641	£2,341,589
4: High Speed (Trunk + Catast.)	9.36×10^{-4}	£114,102	£280,868	£11,796	£204,360	£611,127
Total	3.11×10^{-1}	£179,521	£4,025,768	£158,085	£1,706,368	£6,069,742

11. ADDITIONAL RISK CONTROL MEASURES

11.1 ABPMER RISK CONTROL MEASURES

329. The ABPmer NRA for the IERRT provides three definitions of risk control measure:

- Embedded Risk Controls – existing measures in place to manage navigation safety (see ABPmer IERRT NRA Tables 24, 25 and 26)
- Further Applicable Risk Controls – possible future measures that could be put in place to manage navigation safety (see ABPmer IERRT NRA Tables 28, 29 and 30)
- Applied Risk Controls – proposed future measures that will be put in place to manage the navigation safety (see ABPmer IERRT NRA Section 9.9).

330. The Applied Risk Controls for the operational phase of the project listed in ABPmer IERRT NRA Section 9.9 and Annex C Navigation Risk Assessment: Operation are provided in Table 21 linked to individual IERRT NRA hazards.

331. The Port of Immingham and Humber Estuary Services Marine Safety Management System and baseline NRA for the area has not been supplied by ABP, even after an express request to do so, and therefore the extent and detail of Embedded risk control measures is limited to the details provided in the IERRT NRA.

332. For example, the IERRT NRA "Table 26 for Operation – Embedded Risk Controls" provides a generic list of Embedded risk control measures and only provides a title for each. It also does not include the detail of procedural controls that are in place in the area at the moment, such as the limit for flood tide only berthing of Coastal Vessels onto the IOT Finger Pier or the wind limits that IOT currently work to for vessel arrival. As such no detailed review of the current Embedded Risk Controls can be carried out.

333. For the operational phase of the IERRT project NRA the following Further Risk Controls were taken forwards by ABPmer and therefore are defined as Applied Risk Controls. This assessment therefore concludes that that they are committed to by the IERRT Developers (note that for ease of referencing a Risk Control number (RC#) has been applied to the Further Applicable Risk Controls):

- ABPmer RC1: Berthing criteria
- ABPmer RC2: Additional pilotage training/ familiarisation (Amalgamated into adaptive procedures)
- ABPmer RC3: Charted safety area, berthing procedures
- ABPmer RC5: Additional Training
- ABPmer RC7: Berth specific weather parameters
- ABPmer RC8: Marking safe water with AtoN
- ABPmer RC12: Risk assessed against relevant MSMS (HES/IMM)
- ABPmer RC13: ALARP with embedded controls

334. As noted in Section 2.1.8, IOT operators do not consider many of the IERRT developer's Further and Applied Risk controls measures to be additional to what is already in place, or what should be included as embedded within the proposed IERRT

development – with such risk controls considered as good industry practise and therefore should be embedded within the design of the IERRT.

335. In relation to "*ABPmer RC1: Berthing criteria*", "*ABPmer RC4: Tidal limitations / weather restrictions*" and "*ABPmer RC7: Berth specific weather parameters*", then these are all considered to be nominally the same control and represent good practise as they are commonly in place across in most terminals and berths in the UK. For example, there are already berth limits in place for Coastal Tankers and Estuarial Barges berthing and departing the IOT Finger Pier. For these controls (ABPmer RC1, RC4 and RC7) then to have a level of effectiveness, over and above an Embedded risk control, and therefore be considered as Further Applicable Risk Controls or Applied Risk Controls, then they must relate to specific and conservative limits for the IERRT vessels using the IERRT berths, that must relate to actual weather or tidal state limits which are more onerous than the limits generally in place.

336. However, no limits have been specified in the IERRT NRA and therefore classification as Additional Risk Control Measures and their associated effectiveness at reducing risk is not defined. Therefore their status cannot be considered as over and above Embedded Risk Controls.

337. Further it is not clear what risk reduction is provided by the ABPmer RC12: Risk assessed against relevant MSMS (HES/IMM) and ABPmer RC13: ALARP with embedded controls – both these controls seem to suggest that conducting an assessment reduces the risk of hazard occurrence, with the formed referencing the Marine Safety Management systems of Humber Estuary Services (HES) and the Port of Immingham (IMM), neither of which are supplied.

338. For these reasons the IOT Operators have identified that a Marine and Liaison Plan should be developed which would detail specific procedural controls associated with weather and tidal limits, or training needs etc., which should be built up based on a precautionary approach.

339. Furthermore, given that IOT Operators are a significant receptor that would be seriously impacted should a hazard occur (e.g. allision with the Trunkway) then such a plan should be developed in consultation with, and agreed by, IOT operators.

11.2 IOT OPERATORS RISK CONTROL MEASURES

340. As noted at Section 1, IOT Operators have requested three specific risk controls for the IERRT project to ensure that navigation safety is maintained and safety impacts to IOT operations are mitigated to acceptable levels. The three risk controls are:

- IOT RC 1: Relocation of the IOT Finger Pier Berths;
- IOT RC 2: Installation and design of appropriate impact protection to protect the IOT Trunkway; and
- IOT RC 3: Implementation of a Marine and Liaison Plan

341. The IERRT NRA documented "IOT RC 1: Relocation of the IOT Finger Pier Berths" and "IOT RC 2: Installation and design of appropriate impact protection to protect the IOT Trunkway" as Further Applicable Risk Controls, but discounts them both on the grounds of cost benefit. As previously noted, the process / methodology utilised for the cost benefit assessment was not defined within the IERRT NRA (except for noting that meetings were held with ABP to discuss the relative cost benefit of each IOT measure proposed) and the

IOT Operators have serious concerns over the cost benefit methodology employed. Therefore, this assessment herein considers these controls in more detail.

342. IOT Operators have reviewed options for "IOT RC 1: Relocation of the IOT Finger Pier Berths" and "IOT RC 2: Installation and design of appropriate impact protection to protect the IOT Trunkway" with regard to minimising the costs associated with their implementation.

343. By relocating IOT Finger Pier berths 8 and 9 only to the inside of the IOT river berths (i.e. inside of IOT berth 1), then a total relocation of the IOT Finger Pier could likely be averted, and a smaller additional impact protection structure for IERRT vessels could be constructed adjacent to the IERRT Berth 1 and the end of the IOT Finger Pier (see Figure 60).

344. As it is not clear from the documentation provided by IERRT developers whether the IERRT itself would be able to withstand impact from an errant IERRT vessel, then impact protection is also included within this risk control measure for the IERRT infrastructure. In order to refine the Impact protection, IOT Operators commission a review by specialist marine civils engineers Beckett Rankine which is appended to this assessment at Appendix D This would be contingent on an effective and agreed "IOT RC 3: Implementation of a Marine and Liaison Plan" being in place.

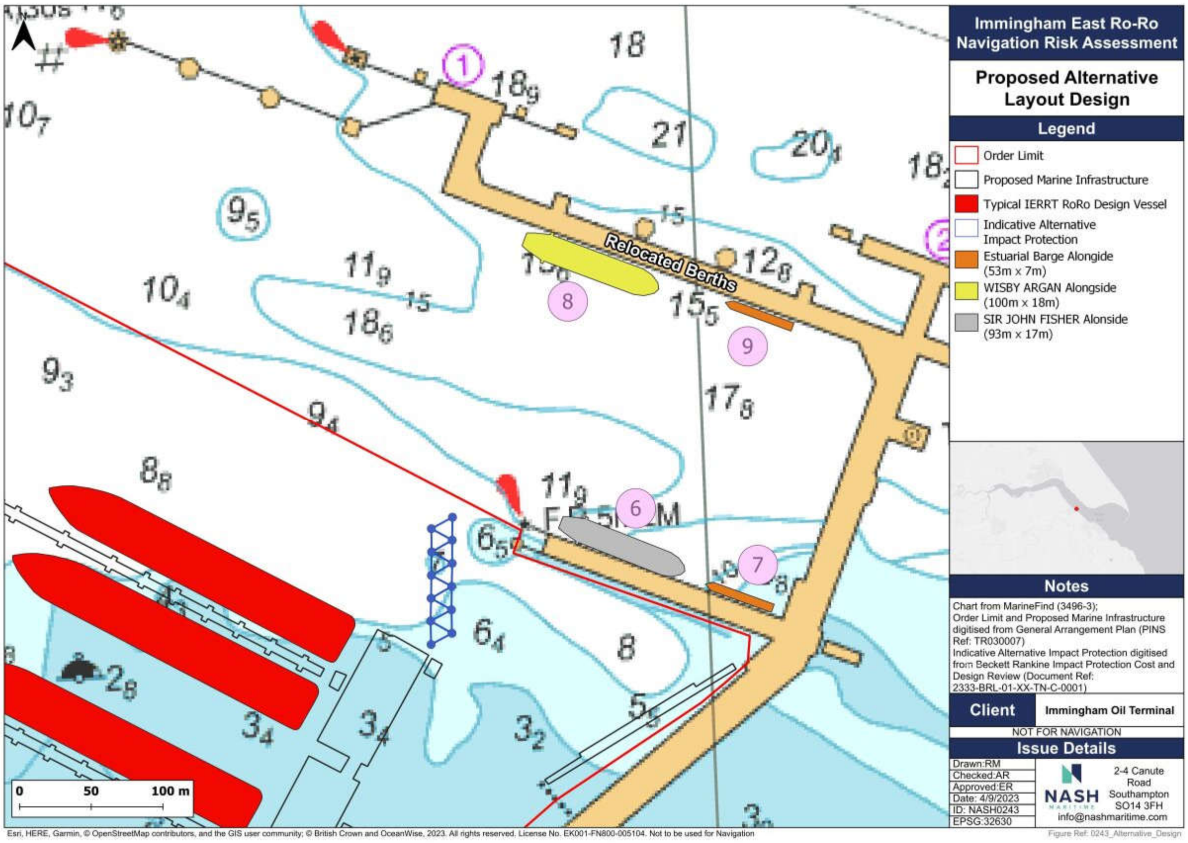


Figure 60: IOT Proposed Layout for Impact Protection and Relocation of Finger Pier.

11.2.1 Relocation of Finger Pier berths

345. "*IOT RC 1: Relocation of the IOT Finger Pier Berths*" has been defined by IOT Operators as the relocation of Finger Pier Berth 8 which is a Coastal Tanker berth and Berth 9 which is a Estuarial barge berth. By relocating these berths to a position inside

IOT River Berth 1, then construction of a replacement Finger Pier is not required, making a significant reduction to the capital cost of construction. It is generally understood that in-river works, such as piling, are considerably more expensive than pipework.

346. There may also be other cost saving measures which could be identified, such as relocation of the existing berth equipment, over procurement of new equipment / systems. The IOT Operators would require a ship manoeuvring study to confirm that the relocation of these berths does not create any unacceptable navigation safety concerns, and that operational relocation of the berths does not unacceptably impact IOT Operations.

347. A high level and indicative only cost, for the purposes of this risk assessment, to relocate the Finger Pier berths has been estimated as £25M - although further work should be undertaken to provide a more accurate costing. IOT Operators also consider that if relocation of Finger Pier berths 8 and 9 is not possible prior to completion of the IERRT, that a solution requiring the IERRT Development's outer-most berth (the northern berth of the northern pier) to remain unused until relocations have taken place have may provide the requisite mitigation / risk reduction, when combined with the other IOT identified risk control measures.

Table 21: ABPmer and IOT Risk Control applied to IERRT NRA Operation Hazards

Haz. ID	Hazard Title	ABPmer RC1: Berthing criteria	ABPmer RC2: Additional pilotage training/ familiarisation	ABPmer RC3: Charted safety area, berthing procedures	ABPmer RC4: Tidal limitations/ weather restrictions	ABPmer RC5: Additional Training	ABPmer RC6: Increased use of tugs/ Additional tug provisions	ABPmer RC7: Berth specific weather parameters	ABPmer RC8: Marking safe water with AtoN	ABPmer RC9: Increase size of dredge pocket	ABPmer RC10: Additional storm bollards	ABPmer RC11: Hooks with load monitoring	ABPmer RC12: Risk assessed against relevant MSMS (HES/IMM)	ABPmer RC13: ALARP with embedded controls	IOT RC1: Impact protection	IOT RC2: Relocation Finger Pier	IOT RC3: Marine and Liaison Plan	Notes
O1	Allision: Vessel Proceeding to/from Immingham Eastern Ro-Ro with tanker moored at IOT Finger Pier	✓	✓	✓												×	✪	
O2	Allision: Tanker manoeuvring on/off IOT Finger Pier (flood tide)		✓		×		?									✪	✪	Annex C: Table C2 doesn't include increased use of tugs / additional tug provisions
O3	Allision: Barge manoeuvring on/off IOT Finger Pier (flood tide)		✓		×											✪	✪	Annex C: Table C3 doesn't include Tidal Limitations
O4	Allision: Ro-Ro allision with IOT trunk way	✓	✓				×								×✪		✪	Annex C: Table C4 includes Additional pilotage training/ familiarisation (Amalgamated into adaptive procedures)
O5	Allision: Ro-Ro contact with IERRT infrastructure	✓				✓									✪		✪	
O6	Collision: Ro-Ro on passage to/from Immingham Eastern Ro-Ro Terminal with another vessel												✓	✓			✪	
O7	Grounding: Ro-Ro manoeuvring to south-western berth	✓							✓	×							✪	
O8	Other (Mooring): Ro-Ro vessel breaks free of moorings							✓			×✪	×✪						
O9	Allision: Ro-Ro arriving/departing Immingham Eastern Ro-Ro terminal berth 2-3 with a tanker berthed on eastern jetty	✓	✓	✓													✪	

Legend							
✓	Applied Risk Controls (post Cost Benefit Analysis)	×	Further Applicable Control (Identified but not taken forward)	✪	IOT required Risk Controls	?	Status not clear

11.2.2 Impact protection

348. Impact protection for critical infrastructure is a common mitigation measure employed for many types of infrastructure such as bridges, tunnels, riverside infrastructure, temporary works, etc. Design codes such as Eurocode 1[12] and ASHTO (2009) provide detailed design requirements for impact protection. A detailed impact assessment for the IERRT impact protection has not been provided by IERRT developers, however it is assumed that where impact protection has been identified (as a Further Applicable Control and not an Applied Risk Control) that it meets the intended purpose.

349. The impact protection provided by the IERRT structure itself has not been defined, however IOT Operators have assumed that the structure is designed to withstand impacts from IERRT vessels, e.g. IERRT vessels at 4kn. It should also be noted that the depths of water immediately behind the IERRT shelve towards the shore, and so designed in impact protection could take this into account. If this assumption is not correct, then additional impact protection located immediate behind the IERRT should be put in place.

350. The Oil and Pipeline Agency have recently constructed a new Oil Fuel Depot (oil terminal) at Thanckes in the Dockyard Port of Plymouth which has impact protection in place to protect the terminal Trunkway from naval fuel barges (of circa. 200t fuel capacity) which berth nearby on an inside berth (see Figure 60). This impact protection is similar to the design provided by IERRT developers.

Figure 61: Top: example impact protection installed 2022 at Oil Fuel Depot Thanckes, Dockyard Port Plymouth. Bottom Serco tug towing fuel barge. Source NASH Maritime.

12 Eurocode 1: Actions on structures | Eurocodes: Building the future (europa.eu) Accessed 23-Jul-23

351. In relocating IOT Finger Pier berths 8 and 9 then the amount of impact protection for the Trunkway (subject to the IERRT infrastructure having sufficient implicit impact protection designed in) would have a smaller footprint than that identified by the IERRT.

352. The key requirement for the impact protection is to avert an IERRT Ro-Ro vessel from being able to make contact with the IOT Trunkway and pipelines. As such an impact protection island could be installed in place of a fixed longitudinal structure which would close access.

353. Impact protection structures for oil terminals and associated trunkways are not a common occurrence, as it is unusual for Ro-Ro (or other) terminals to be located close to them in a strongly tidal river. There are also few oil terminals in the UK which are individually responsible for handling such a high percentage (27%) of the UK's refined oil import/export. However, there are examples in the UK where impact protection has been put in place for the purpose of protecting oil related infrastructure. For example, the Thanckes Defence Infrastructure Organisation fuel jetty in Plymouth recently had walkway and pipeway protection installed to protect from allision by marine service craft operating in the River Tamaran oil jetty.

11.2.3 IERRT Marine Liaison Plan

354. The IOT Operators have requested that a detailed IERRT Marine and Liaison plan be developed in conjunction with IOT Operators and other applicable stakeholders to develop and manage procedural controls related to the IERRT development. It is envisaged that this control measure will bring together several procedural controls, for the operational phase of the IERRT identified during the hazard workshops as follows:

- Berth limits
    - Detailed wind limits by vessel type / specification for IERRT Berths 1, 2 and 3 should be developed. A review of limits for the relocated IOT Finger Pier Berths 8 and 9 should also be considered. It is considered by IOT Operators that limits should be conservative in nature, with the option to review and relax as operational familiarisation is gained. The limits should be related to wind direction as well as speed. To this end, wind data should be collected at the IERRT to assist with operational planning. Where limits are exceeded the use of tugs should be considered and documented (see below).
    - Detailed tidal limits should be defined by vessel type specification for IERRT Berths 1, 2 and 3 particularly strong ebb tide berthing and departures. It is envisaged that the current limit on flood tide berthing only for IOT Coastal tankers should remain. It is considered by IOT Operators that limits should be conservative in nature, with the option to review and relax as operational familiarisation is gained. Where limits are exceeded the use of tugs should be considered and documented (see below).
- Towage requirements
    - Towage requirements for IERRT vessels should be defined both for normal operations, when wind and tidal restriction are in place (see above) and if IERRT vessels have defects. Towage assets should be appropriate for the size and types of vessels (both IERRT and IOT vessels) and the geometry / layout of the IERRT berths.

- Currently a standby tug is available to IOT vessels as prescribed in the IOT COMAH report and the also Humber Estuary Services Operational procedures. Extending this provision to IERRT vessels should be considered.

- Operational Deconfliction
  - The introduction of the IERRT significantly increases the frequency of vessel vessels navigating between the IOT and the Immingham dock, with a commensurate increase in collision and allision risk in the area. A procedural control limiting the number of vessels navigating in the same water space is therefore necessary to mitigate collision risk between IERRT vessel, IOT vessel and other 3rd party vessels as well. It is anticipated that this should be put in place by the SHAs (Port of Immingham and Humber Estuary Services) and monitored policed by the Humber Estuary Services Vessel Traffic Service / Port of Immingham Local Port Service. IOT Operators require that vessels bound for IOT have operational priority due to the limited tidal states at which they can currently berth.

355. It is envisaged the Marine and Liaison plan will also capture, document and mandate measures required for the construction phase of the IERRT, once construction methodology, timings and plant requirements have been defined.

The provision of the Marine and Liaison Plan therefore considers the following IERRT Risk controls:

- ABPmer RC1: Berthing criteria
- ABPmer RC4: Tidal limitations/ weather restrictions
- ABPmer RC7: Berth specific weather parameters
- ABPmer RC6: Increased use of tugs/ Additional tug provisions

11.3 EMERGENCY VALVES

356. Emergency cut off valves for the IOT pipework were considered by IOT Operators to mitigate the effects of catastrophic outcomes from IOT Trunkway by contact by IERRT Ro-Ro vessels. However, this control measure was discounted as:

- It was primarily only effective at mitigating the consequence of hazard occurrence to the environment (e.g. spill occurrence) but could also have a small effectiveness in damage to people due to lower amounts of volatile product being released. It did not mitigate effects associated with cost of infrastructure and business and therefore was only partially effective.
- To install such a system, IOT Operators consider it likely there would be a need to replace all IOT pipework, possibly to and from the refineries, which would make it considerably more expensive than the other IOT Operators measures, which are more effective at mitigating the likelihood and consequence of hazard occurrence.

12. RESIDUAL ASSESSMENT OF RISK

12.1 INTRODUCTION

357. Section 11 has identified several risk controls which have the potential to be effective at reducing the risk associated for the IERRT development. The following sections provide:

- An update to the qualitative assessment by rescoring the baseline hazard log (provided in Section 9) with the IOT Operators Risk Control Measures in place.
- An update to the quantitative risk assessment (provided in Section 10) by applying percentage reductions from implementation of the IOT Operators Risk Control Measures to the QRA results.
- A cost benefit assessment using the IOT Operators Risk Control Measures against the benefits of the residual QRA.

12.2 RESIDUAL QUALITATIVE NRA

358. The risk control measures identified in Section 11 were applied to the 24 identified hazards to reduce hazard risk. Table 22 shows the following information for each hazard:

- Baseline assessment hazard score and risk rank;
- Residual assessment hazard score and risk rank; and
- The risk controls applied to the hazard to reduce risk.

359. The residual assessment of navigation risk results in:

- 18 hazards scoring as "Tolerable if ALARP"; and
- 4 hazards scoring as "Broadly Acceptable".

360. The two intolerable hazards identified in the baseline assessment of navigation risk are reduced to "Tolerable if ALARP".

361. The risk controls have the following impacts on the navigational risk profile that combine variously to reduce hazard likelihood and consequence scores:

12.2.1 Relocation of the Finger Pier Berths

362. The relocation of berths 7 and 9 on the IOT Finger Pier reduces the likelihood of a collision occurrence between IOT vessels bound for the berths and the IERRT Ro-Ro vessels by naturally deconflicting arriving and departing vessels. The relocation of the berths also means IOT vessels will not be moored alongside berths 7 and 9, reducing the consequences of any contact occurrence as a IERRT Ro-Ro vessel would collide with the Finger Pier only, and not as well as a vessel moored alongside.

12.2.2 Impact Protection

363. The installation of impact protection (and design of the IERRT to withstand errant vessels) significantly decreases the likelihood of a IERRT Ro-Ro vessel making contact with the IOT Trunkway. The impact protection would be positioned in such a manner as to prevent a IERRT Ro-Ro vessel from being able to make contact with the IOT Trunkway. Therefore, the likelihood of such a hazard occurrence is reduced.

NASH MARITIME

Table 22: Application of Risk Controls and Residual Risk Assessment

ID	Baseline Rank	Residual Rank	Hazard Title	Baseline Score	Baseline Rating	IOT RC1: Impact protection	IOT RC2: Relocation Finger Pier	IOT RC3: Marine & Liaison Plan	Residual Score	Residual Rating
15	7	1	Contact (Allision) - IERRT Ro-Ro Vessel with IOT River berths	5.0	Tolerable if ALARP				5.0	Tolerable if ALARP
22	15	1	Breakaway - IERRT Ro-Ro Vessel at IERRT Jetty	4.6	Tolerable if ALARP				5.0	Tolerable if ALARP
13	1	3	Contact (Allision) - IERRT Ro-Ro Vessel with IOT Finger Pier	6.0	Intolerable	Yes	Yes	Yes	4.0	Tolerable if ALARP
2	3	3	Collision - IERRT Ro-Ro Vessel ICW Coastal Tankers	5.9	Tolerable if ALARP		Yes	Yes	4.0	Tolerable if ALARP
12	4	3	Contact (Allision) - Coastal Tanker with IOT Finger Pier	5.8	Tolerable if ALARP	Yes	Yes		4.0	Tolerable if ALARP
3	5	3	Collision - IERRT Ro-Ro Vessel ICW Bunker Barge	5.5	Tolerable if ALARP		Yes	Yes	4.0	Tolerable if ALARP
5	7	3	Collision - IERRT Ro-Ro Vessel ICW Tanker	5.0	Tolerable if ALARP			Yes	4.0	Tolerable if ALARP
11	7	3	Contact (Allision) - Bunker Barge with IOT Finger Pier	5.0	Tolerable if ALARP	Yes	Yes		4.0	Tolerable if ALARP
20	13	3	Breakaway - Bunker Barge at IOT Finger Pier	4.8	Tolerable if ALARP		Yes		4.0	Tolerable if ALARP
21	13	3	Breakaway - Coastal Tanker at IOT Finger Pier	4.8	Tolerable if ALARP		Yes		4.0	Tolerable if ALARP
1	18	3	Collision - IERRT Ro-Ro Vessel ICW IERRT Ro-Ro Vessel	4.5	Tolerable if ALARP			Yes	4.0	Tolerable if ALARP
4	19	3	Collision - IERRT Ro-Ro Vessel ICW Cargo	4.4	Tolerable if ALARP			Yes	4.0	Tolerable if ALARP
10	1	13	Contact (Allision) - IERRT Ro-Ro Vessel with IOT Trunkway	6.0	Intolerable	Yes			3.5	Tolerable if ALARP
18	6	13	Contact (Allision) - IERRT Ro-Ro Vessel with IERRT Jetty	5.1	Tolerable if ALARP		Yes	Yes	3.5	Tolerable if ALARP
7	10	13	Collision - IERRT Ro-Ro Vessel ICW 3rd Party Passenger	4.9	Tolerable if ALARP			Yes	3.5	Tolerable if ALARP
17	15	13	Contact (Allision) - Coastal Tanker with IERRT Jetty	4.6	Tolerable if ALARP		Yes		3.5	Tolerable if ALARP
16	15	17	Contact (Allision) - Bunker Barge with IERRT Jetty	4.6	Tolerable if ALARP		Yes		3.0	Tolerable if ALARP
6	22	17	Collision - IERRT Ro-Ro Vessel ICW Tug, Service and Other Small Vessel	3.5	Tolerable if ALARP			Yes	3.0	Tolerable if ALARP
9	10	19	Contact (Allision) - Coastal Tanker with IOT Trunkway	4.9	Tolerable if ALARP	Yes	Yes		2.5	Broadly Acceptable
14	20	19	Contact (Allision) - Tug, Service and Other Small Vessel with IOT Finger Pier	3.6	Tolerable if ALARP	Yes	Yes		2.5	Broadly Acceptable
19	20	19	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty	3.6	Tolerable if ALARP		Yes	Yes	2.5	Broadly Acceptable
8	10	22	Contact (Allision) - Bunker Barge with IOT Trunkway	4.9	Tolerable if ALARP	Yes	Yes		2.0	Broadly Acceptable

12.2.3 Marine and Liaison Plan

364. The introduction of a Marine and Liaison Plan ensures deconfliction between the IERRT operation and IOT operation and puts in place other procedural control measures to mitigate collision and contact risk. This decreases the likelihood of collision hazard occurrences between vessels associated with the respective operations.

365. The plan also defines appropriate operational limitations for the IERRT operation as well as minimum and additional towage requirements along with a suite of other procedural risk controls. The controls again combine to reduce the likelihood and consequences of hazard occurrence.

12.2.4 Residual Assessment Summary

366. With the implementation of the identified three additional risk control measures 22 identified hazards score as “Tolerable if ALARP” or “Broadly Acceptable” risk.

367. As such, with the implementation of the identified additional risk control measures, IERRT operations and activities, would be deemed to be Tolerable providing that all hazard risk score are reduced to ALARP.

12.3 RESIDUAL QRA

368. Based on the risk analysis performed in Section 10 and the identified additional risk controls in Section 11, the QRA was repeated accounting for risk reduction. Each of the three key measures was assessed with potential effectiveness at reducing the scenario likelihood put in place. These are shown in Table 23.

Table 23: Risk reduction effectiveness.

Measure	1: Low Speed	2: High Speed (not Trunk)	3: High Speed (Trunk)	4: High Speed (Trunk + Catast.)
Impact Protection	20%	50%	75%	95%
Relocation of Finger Pier	25%	50%	0%	0%
Marine Operations Plan	5%	10%	10%	10%

369. Impact protection is deemed to be of modest effectiveness against low speed impacts given that the potential damage from such an event is low. For high speed impacts, this measure is far more effective, estimated to reduce the risk by 50%. Notably, with impact protection in place the likelihood of striking the Trunkway reduces significantly, by up to 95%.

370. Relocation of IOT Finger Pier reduces the proximity of a hazard from the berthing RoRo and therefore would reduce the risk by 25% to 50% for low speed and high speed allisions respectively. This would have no effectiveness at reducing the risk of striking the Trunkway.

371. Marine and Liaison plans are softer procedural control measures, and would also have a limited effectiveness, so have been classified as being between 5% and 10% at reducing the likelihood of occurrence for this hazard.

Table 24: Residual likelihoods per annum / return rates per year.

Measure	1: Low Speed	2: High Speed (not Trunk)	3: High Speed (Trunk)	4: High Speed (Trunk + Catast.)
No Additional Controls	2.81 x10^{-1} 1 in 3.6y	2.18 x10^{-2} 1 in 45.8y	8.43 x10^{-3} 1 in 118.7y	9.36 x10^{-4} 1 in 1,068y
Impact Protection	2.25 x10^{-1} 1 in 4.5y	1.09 x10^{-2} 1 in 91.6y	2.11 x10^{-3} 1 in 474.7y	4.68 x10^{-5} 1 in 21,362y
Relocation of Finger Pier	2.11 x10^{-1} 1 in 4.7y	1.09 x10^{-2} 1 in 91.6y	8.43 x10^{-3} 1 in 118.7y	9.36 x10^{-4} 1 in 1,068y
Marine Operations Plan	2.67 x10^{-1} 1 in 3.7y	1.97 x10^{-2} 1 in 50.9y	7.58 x10^{-3} 1 in 131.9y	8.43 x10^{-4} 1 in 1,186y
Combined Risk Controls	1.60 x10^{-1} 1 in 6.2y	4.92 x10^{-2} 1 in 203.5y	1.90 x10^{-3} 1 in 527.5y	4.21 x10^{-4} 1 in 23,736y

372. Based on these effectiveness's, the likelihood scores derived in Section 10 were rescored and are shown in Table 24 and then remapped onto the FN curve in Figure 62. Notably, the application this reduces the Scenario 1 likelihood from one in 3.6 years to one in 6.2 years, and the Scenario 4 likelihood from one in 1,068 years to one in 23,736 years.

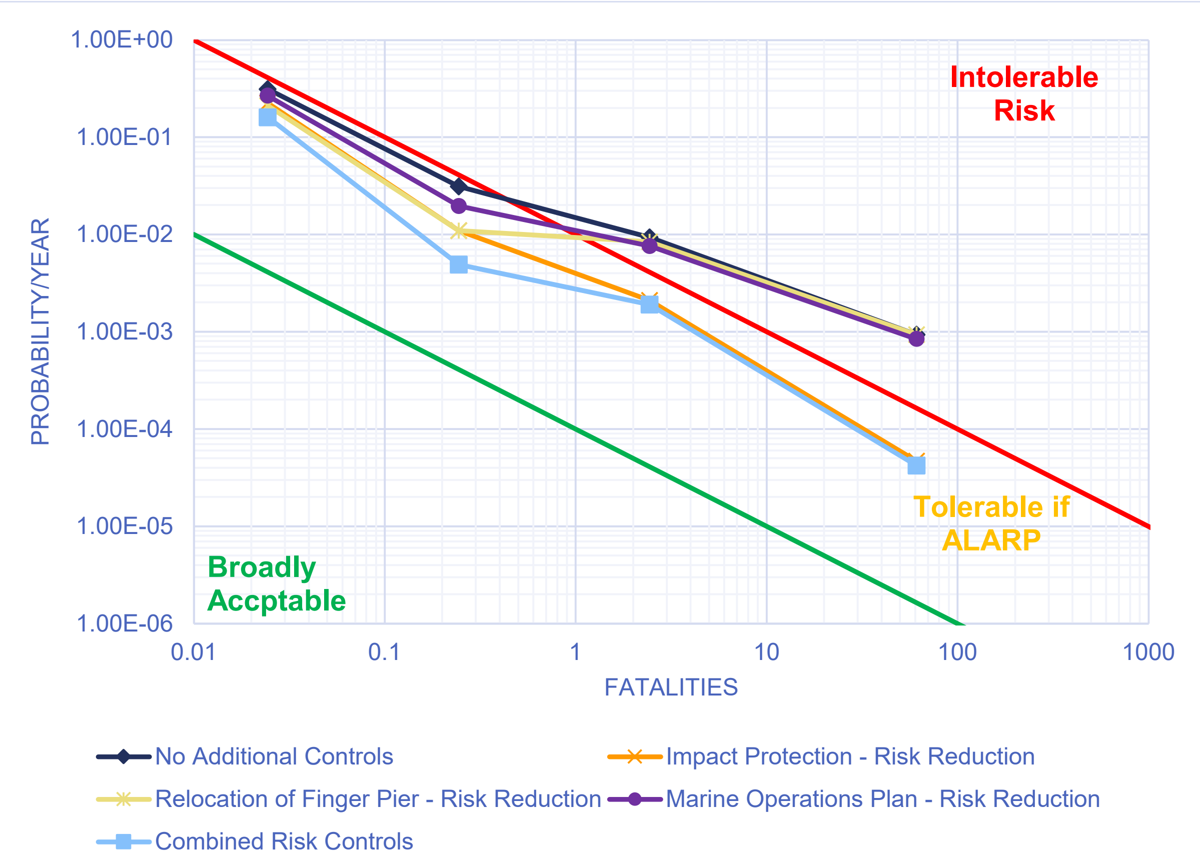


Figure 62: Residual FN Curve.

373. It is notable that the only means through which Scenario 3 and Scenario 4 fall below the Intolerable risk threshold is through implementation of Impact Protection and that the combination of other risk controls are not sufficient.

374. Furthermore, the combination of risk controls would reduce the individual risk from 3.68 x 10^{-4} to 5.04 x 10^{-5}, below the HSE's threshold of 1.0 x 10^{-4} (HSE, 2001).

12.4 COST BENEFIT ASSESSMENT

375. It has been demonstrated the three risk controls are capable of reducing the intolerable risk to Tolerable if ALARP and therefore a cost benefit assessment has been undertaken to determine if they are ALARP. For the purposes of the assessment, the three risk controls have been estimated to cost as follows to implement and maintain over a 50-year project duration:

- Impact Protection: £9M
- Relocation of IOT Finger Pier berths 8 and 9: £25M
- Marine Operations Plan: £250k

376. Table 25 shows the baseline consequence costs/year, the residual consequence costs/year with each mitigation measure in place and the ratio of the mitigation cost to the reduction in risk. A ratio greater than 1.0 indicates that the reduction in risk is greater than the cost to implement the risk control. The results demonstrate that almost all scenario-risk control combinations have greater benefits of implementation that costs.

Table 25: CBA Results.

	Risk Control	Low Energy Striking	High Speed Striking (Not Trunkway)	High Speed Striking Trunkway	High Speed Striking Trunkway w/ Catastrophic Outcome	Total Cost/Year
Baseline Consequence Cost per Year		£921,315	£2,195,712	£2,341,589	£611,127	£6,069,742
Residual Consequence per Year	Impact Protection	£737,052	£1,097,856	£585,397	£30,556	£2,450,861
	Relocation of Finger Pier	£690,986	£1,097,856	£2,341,589	£611,127	£4,741,557
	Marine Operations Plan	£875,249	£1,976,140	£2,107,430	£550,014	£5,508,833
	Total	£525,149	£494,035	£526,857	£27,501	£1,573,543
Ratio of Mitigation Cost (per Year) to Reduction in Risk	Impact Protection	1.02	6.10	9.76	3.23	**20.10**
	Relocation of Finger Pier	0.46	2.20	0.00	0.00	**2.66**
	Marine Operations Plan	9.21	43.91	46.83	12.22	**112.18**
	Total	**0.58**	**2.48**	**2.65**	**0.85**	**6.56**

377. The Impact protection has a relatively low-cost benefit ratio of 1.0 for low energy strikes given the high cost and low benefit, however, for high consequence events this is significantly more effective, with ratios in excess of 5 for Scenario 2 and Scenario 3. Therefore, the total benefit for impact protection is approximately 20 times the cost.

378. The relocation of the finger pier is more expensive and therefore is only cost effective for preventing high speed impacts with the Finger Pier. Overall, this measure has a benefit of 2.7 times the cost.

379. The marine operations plan is a low-cost risk control and therefore its modest benefits provide significant cost benefit, with a total benefit of more than 100 times the cost.

13. ASSESSMENT FINDINGS

13.1 CONCLUSIONS

380. This sNRA has been undertaken by NASH Maritime Ltd on behalf of the IOT to review the impacts of the IERRT on navigational safety.

381. The assessment has reached the following conclusions:

- The River Humber is a major estuary, with numerous ports and has in excess of 70 million tonnes of freight per year and approximately 10,000 ship arrivals per year. There is a 7-metre spring tidal range which results in significantly fast tidal flows and much of the study area is exposed to the effects of wind.
- IOT is a piece of critical national infrastructure and the Humber and Lindsey Oil Refineries account for 27% of the UK's refining capacity. They are dependent upon the continued and safe operation of the IOT river berths, finger pier and Trunkway flowing product from and to vessels. IOT is an Upper Tier COMAH site.
- Berths 8 and 9 located to the south of the Finger Pier are capable of handling vessels of 104m and 61m LOA respectively. Whilst smaller than the vessels on the main river berths (which can be in excess of 300m), they are critical to IOT operations and the flow of refined products destined for England and Scotland. Access to Berth 8 is restricted to the flood tide, requiring the ship's Master to balance the effects of wind and tide, and may require a workboat and/or tug.
- If developed, the IERRT would be a major 24-7 Ro-Ro terminal with three berths handling vessels up to 240m LOA and a beam of 35m. It is not clear what the detailed characteristics of these vessels would be, however, they will carry unaccompanied freight, accompanied freight and passengers. It is anticipated that there would be a minimum of one arrival (in the early morning) and one departure (in the early evening) per day per berth.
- The space between the IOT and IERRT infrastructure would be 95m, within which a tanker of 104m, with associated tugs or workboats, will be required to manoeuvre with strong tidal flows and cross winds. Furthermore, up to three large RoRo vessels would be required to manoeuvre in close proximity to the IOT infrastructure and or vessels. A potential risk of contact of an IOT tanker or IERRT RoRo with the IERRT jetties, IOT finger pier and IOT Trunkway has therefore been highlighted.
- A review of the IERRT developers NRA noted the following areas of concern:
  - The underlying data supporting the NRA is not well defined of suitably focused to aid / facilitate determination of navigation risk and nor were detailed characteristics of the IERRT vessels and the MARNIS incident data provided.
  - The operations and design of IERRT are not well defined including proposed tug use, berthing duration, metocean limits, and the detail of risk controls measures.
  - The standards and limits of acceptability/tolerability were not well defined and do not align with HSE/COMAH standards. As such there is a disconnect between the limits of tolerability between IOT and ABP.

    - The hazard workshops did not facilitate the input of all stakeholders and no attempt was made to reach a consensus on tolerability.
    - Additional risk controls were identified and considered effective, which were already included within the baseline (normal operations). Other risk controls were poorly defined and therefore their effectiveness cannot be determined. Several key risk controls, such as impact protection, were identified but discounted without undertaking any empirical cost benefit analysis.
    - Whilst the navigational simulations undertaken were useful to build an evidence base to contribute to the NRA, the omission of wind shielding of a berthed RoRo, gusting, unrealistic emergency scenario responses and technical issues undermined the credibility of their conclusions.
- This sNRA has been undertaken utilising the HSE approved IOT Operators COMAH methodology to qualitatively assess risk followed by quantitative risk modelling for high risk hazards based on the IMO's Formal Safety Assessment.
- Vessel traffic analysis was undertaken which provided greater detail on the existing manoeuvring patterns, swept paths and routes taken by vessels in the study area than that provided by IERRT.
- Berth analysis shows that IOT Berth 8 were occupied approximately 50-60% of the time between March and June 2023.
- A detailed analysis of historical incidents was undertaken from various data sources which highlighted several important findings:
    - There are on average six contacts and three equipment failure MAIB reportable incidents each year in the study area. This compares to an average of 45 and 78 impacts with structures and equipment failures per year recorded in the ABP MarNIS database.
    - It is notable that of eight MAIB reports in the study area, three involve impacts between navigating vessels and IOT infrastructure.
    - Several near misses were also highlighted (including in July 2022), however the detailed MarNIS data was not provided to the project team.
    - A review of national Ro-Ro incidents contained within the MAIB dataset noted that impacts with structures are defined as Less Serious in 36% of cases and 30% are Serious, with 45% resulting in Material Damage.
    - A calculation of incident rates was made by comparing the number of incidents per port within the MAIB dataset with the DfT ship arrival data. It concluded that RoRo vessels have one incident between every 714 and 2,933 movements, or a contact between 3,508 and 20,612 movements. Notably Immingham and Grimsby have the highest calculated Ro-Ro contact rate (e.g. one contact per 3,508 movements) of any sample port studied.
- Within the IOT sNRA, a total of 22 hazards were identified including collisions, contacts and breakaway incidents. Based on a review of the collated data and taking information and results from Hazard Workshops conducted by IERRT and

attended by IOT Operators, two of these were scored as Intolerable, with the remaining 20 assessed as Tolerable if ALARP. Those scored Intolerable were:

  - Contact (Allision) – IERRT Ro-Ro vessel (Passenger) with Finger Pier.
  - Contact (Allision) – IERRT Ro-Ro vessel (Passenger) with IOT Trunkway.

- A QRA was undertaken on the Intolerable hazards identified as part of the qualitative risk assessment to provide a more detailed and empirical assessment of risk The QRA included the following scenarios:
  - Scenario 1: Low Speed Impact with IOT infrastructure or vessel alongside - moderate consequence.
  - Scenario 2: High Speed Impact with IOT infrastructure or vessel alongside (but not with Trunkway) - high consequence.
  - Scenario 3: High Speed Impact with Trunkway - high consequence.
  - Scenario 4: High Speed Impact with Trunkway resulting in catastrophic outcome - high consequence.
- Based on these incident likelihoods and loss of life, an FN curve demonstrated that whilst Scenarios 1 and 2 fell within the high end of Tolerable if ALARP, the Scenarios 3 and 4 breached Intolerable levels. Furthermore, the risk to any individual would exceed the HSE's maximum allowable limit of 1 $x10^{-4}$.
- Additional risk controls were reviewed, with the three key risk controls discussed:
  - Relocation of Finger Pier berths: This would remove the potential risk of tankers striking the IERRT infrastructure and make the manoeuvre to Berth's 8 and 9 easier, significantly reducing this risk.
  - Impact protection: Whilst impact protection has not been defined within the IERRT, substantial protection would be required in order to prevent a vessel striking the Trunkway. Crucially this would significantly reduce the likelihood of a catastrophic event.
  - IERRT Marine and Liaison Plan: Definition of berth limits, towage requirements and operational deconfliction would further reduce the likelihood of conflicts between IERRT and IOT.
- A qualitative residual risk assessment was undertaken with the three key risk controls in place. The results identified that of the 22 hazards, 18 were scored as Tolerable if ALARP, whilst 4 were scored as Broadly Acceptable. All Intolerable hazards were mitigated.
- A residual QRA was also undertaken, which concluded that with all risk controls implemented:
  - Scenario 1: Low Speed Impact with IOT infrastructure or vessel alongside - moderate consequence - mitigated from once in 3.6 years to once in 6.2 year.
  - Scenario 2: High Speed Impact with IOT infrastructure or vessel alongside (but not with Trunkway) - high consequence - mitigated from once in 46 years to once in 204 years.

    - Scenario 3: High Speed Impact with Trunkway - high consequence - mitigated from in 119 years to once in 528 years.
    - Scenario 4: High Speed Impact with Trunkway resulting in catastrophic outcome - high consequence - mitigated from once in 1,068 years to once in 23,736 years.
- As a result, the QRA concluded that both the FN curve and individual risk were reduced below the Intolerable limits with the risk controls in place.
- A cost benefit assessment of these three measures was undertaken with estimated costs for each mitigation.
    - The Impact protection has a relatively low cost benefit ratio of 1.0 for low energy strikes given the high cost and low benefit, however, for high consequence events this is significantly more effective, with ratio's in excess of five for Scenario 2 and Scenario 3. Therefore, the total benefit for impact protection is approximately 20 times the cost.
    - The relocation of the finger pier is more expensive and therefore is only cost effective for preventing high speed impacts with the Finger Pier. Overall, this measure has a benefit of 2.7 times the cost.
    - The marine operations plan is a low cost risk control and therefore its modest benefits provide significant cost benefit, with a total benefit of more than 100 times the cost.

382. In summary, the sNRA concludes that the IERRT operations, in combination with the IOT operations, posed an unacceptable risk of contact and collision with existing mitigation in place. Additional risk controls are required to reduce this risk to Tolerable levels. A cost benefit assessment concluded that by implementing such measures, the risk could be deemed to be ALARP.

13.2 RECOMMENDATIONS

383. The following recommendations are made in order to manage risk properly and proportionately:

- IERRT developers to respond to clarification questions and provide requested information contained within Section 2.3 to enable finalisation of this assessment.
- Update QRA inputs (likelihood/costs/consequences) following review of requested data.
- IERRT developers to implement the IOT risk controls identified within this report, in consultation and agreement with navigation stakeholders (including IOT).
- IERRT developers to undertake a revised assessment of navigation risk for the construction and construction / operation phase of the IERRT addressing the deficiencies contained within this report in consultation and agreement with navigation stakeholder (including IOT).

384. Failure to implement the IOT risk controls identified in this report will result in an intolerable level of navigation risk arising as a result of the IERRT infrastructure and proposed marine operation.

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Appendix A
Correspondence following NRA Methodology Meeting

Edward Rogers

From: Edward Rogers
Sent: 06 July 2022 09:12
To: Timothy Aldridge
Cc: Montgomery Smedley; Nigel Bassett
Subject: RE: Minutes comments
Attachments: AC22-NASH-0243-NRA-Methodology-ABPmerMeetingMinutes-250522-R03-00.docx

Hi Tim,

I am slightly perplexed by changes to the meeting minutes proposed, as you had previously agreed the them, and my queries related to the post meeting notes. We generally feel that some of the proposed changes reflect where the project is now and not the discussion that took place in the meeting, though most changes don't materially affect the nature of the discussion so we have no objection to them.

The exception is the removal of the Action 2 - This was a request from APT, for ABP/ABPmer to consider using an approved NRA methodology, which during the meeting ABPmer had agreed to consider? I'm more than happy for you to put the action to "Closed" if you have considered this and decided to retain the current methodology.

Please find attached track changed version of the minutes. If you have any further changes please can you do them with track changes selected.

Many thanks

Ed

Dr Ed Rogers | Director
[redacted]

From: Timothy Aldridge <[redacted]
Sent: 30 June 2022 09:53
To: Edward Rogers [redacted]
Cc: Montgomery Smedley <[redacted]
Subject: RE: Minutes comments

Good morning Ed,

Please find attached the minutes as checked and amended by Monty as well now. Nil changes to the post meeting elements captured.

We did not agree with action item 3 in the meeting and as such it stricken through for removal.
All other amendments in blue for your convenience.

Kind regards, Tim

Timothy Aldridge | Senior Maritime Consultant | ABPmer
Quayside Suite | Medina Chambers | Town Quay | Southampton | SO14 2AQ

[redacted] eb: www.abpmer.co.uk | www.portriskmanagement.com

From: Edward Rogers [redacted]
Sent: 29 June 2022 14:57
To: Timothy Aldridge <[redacted]
Cc: Montgomery Smedley <[redacted] Nigel Bassett <[redacted]
Subject: RE: Minutes comments

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Good afternoon Tim,

Further to my email below, can you advise if you have any proposed changes to the 'POST MEETING NOTE' section of the meeting minutes?

If not, then I'll issue as a final on Friday.

Many thanks

Ed

Dr Ed Rogers | Director
[redacted]

From: Edward Rogers
Sent: 17 June 2022 16:38
To: 'Timothy Aldridge' <[redacted]
Subject: RE: Minutes comments

Hi Tim,

Please see updated meeting minutes – please can you review the 'POST MEETING NOTE' section at the end, and add in /edit what you want.

I will then issue as a final. Give me call if you wish to clarify anything?

Regards

Ed

Dr Ed Rogers | Director
[redacted]

From: Timothy Aldridge <[redacted]>
Sent: 13 June 2022 09:51

To: Edward Rogers <[redacted]
Subject: RE: Minutes comments

Hey Ed,

Sorry I missed your call on Friday I was in meetings all afternoon, which just isn't cricket for a Friday.

More than happy to discuss the finer points of the reply, I think the only thing we were unclear on was the terminology and implications around commercial implications for other stakeholders of Immingham (which falls outside the scope of the NRA in this proposal).

Kind regards, Tim

Timothy Aldridge | Senior Maritime Consultant | ABPmer
Quayside Suite | Medina Chambers | Town Quay | Southampton | SO14 2AQ
[redacted] **Web:** www.abpmer.co.uk | www.portriskmanagement.com

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From: Edward Rogers <[redacted]>
Sent: 10 June 2022 14:29
To: Timothy Aldridge <[redacted]
Cc: Montgomery Smedley <[redacted]>; Nigel Bassett <[redacted]
Subject: RE: Minutes comments

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Hi Tim,

I've just got round to reviewing your email below (apologies it's been a busy week back in the office) and updating the minutes to reflect your comments.

I think it may be simplest to have a call to discuss (just tried your land line) so I can update the minutes and issue as a final – but have put some notes against your items below.

Thanks

Ed

Dr Ed Rogers | Director
[redacted]

From: Timothy Aldridge <[redacted]>
Sent: 30 May 2022 17:24
To: Edward Rogers <[redacted]
Cc: Montgomery Smedley <[redacted]>; Nigel Bassett <[redacted]
Subject: Minutes comments

Good afternoon Ed,

Hope you had a good weekend.

Thank you for the minutes, by in large we agree with the elements they represent however I have made a couple of comments below to clarify/address.

Firstly, in respect to point 1.1.1 of the minutes: To clarify, no assessment has been made on commercial vessel assessment from a utilisation perspective across the whole estuary, MS and TA stated this was outside the scope of the NRA for the development but that we would relay the message to the ABP Project Team. MS and TA were under the impression that this point was more around the business/financial effects to the operator. Could you please define 'commercial shipping assessment' in a port context/ further than has been done so in the brackets of point 1.1.1 so that we can be clear on this term?

I would define the scope of a "commercial shipping assessment" as identifying, quantifying and determining mitigation in relation to commercial impacts to APT/IOT (including its customers) from Construction, Operation and Decommissioning of the IERRT – e.g. this may include delays to arrivals or sailings of IOT vessels, impacts on land side access, etc.

Secondly, we are very grateful to APT for their correspondence dated 29 Apr 22 and all of the comments and concerns captured within. Within the HAZID workshop, all of APTs concerns relating to hazard identification and the risks discussed were documented within the context of the hazard log. However, comments that were outside of this scope were not documented whilst conducting the HAZID assessment. As stated above ABPmer is genuinely thankful to APT for providing a detailed list of their concerns in this correspondence to ABP.

Shall I add this into the minutes as a post meeting note?

With respect to the action items the following comments are offered:

1) Asked for clarity around terminology of a commercial shipping assessment in a port context – will update to "Closed" and include a statement saying no commercial shipping assessment has been undertaken?
2) Project team at ABP has been informed – noted – will keep as "Open".
3) Acknowledge this is under consideration – noted – will keep as "Open".
4) As related to 3 this is under consideration– noted – will keep as "Open".
5) The requested information is noted and it is ABPmer's intent to provide as much information as possible, within good time, prior to the rescheduled date of HAZID Workshop III which is yet to be determined. – noted – will keep as "Open" – unless you are agreeing to provide the information as requested in 4.1?
6) N/A – NASH action – this remains "Open" as APT/IOT are currently reviewing what can be issued.

Thank you very much for the Terminal Layout figure provided too.

All the best for the upcoming long weekend, I hope you all have something nice planned to do.

Kind regards, Tim

Timothy Aldridge | Senior Maritime Consultant | ABPmer
Quayside Suite | Medina Chambers | Town Quay | Southampton | SO14 2AQ
[redacted] | **Web:** www.abpmer.co.uk | www.portriskmanagement.com

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From: Edward Rogers <[redacted]>
Sent: 27 May 2022 15:53
To: Timothy Aldridge <[redacted]
Cc: Montgomery Smedley <[redacted]>; Nigel Bassett <[redacted]>; Matt Dearnley <[redacted]>; Neal Keena <[redacted]
Subject: RE: Plan for Wednesday

CAUTION: This email originated from outside of the organisation. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Good afternoon Tim,

Many thanks to you and Monty for coming into our offices on Wednesday to discuss the Pre.NRA methodology for IERRT and APT's concerns.

Please find attached draft meeting notes for your records. You'll notice that we have included a list of pre-read material for the Hazard Workshop III that APT (have already requested from the project) which we think would be particularly useful. Can I ask you to review the meeting notes and revert with any comments or queries by 6th June 22 (in the absence of comment we'll assume it to be agreed)? We've also taken the latest IERRT drawing we have, issued on 01-03-22, and superimposed / georeferenced it onto a nautical chart (this is also attached for information) which we are happy to circulate to other attendees prior to the workshop. If you're able to provide the .dwg file we can update and improve accuracy.

Please note that I'm on leave next week, but look forward to meeting with you again at the Hazard Workshop III in Immingham on 7th June.

Regards

Ed

Dr Ed Rogers | Director
[redacted]

From: Timothy Aldridge <[redacted]>
Sent: 24 May 2022 15:12
To: Edward Rogers <[redacted]
Cc: Montgomery Smedley <[redacted]
Subject: RE: Plan for Wednesday

Hey Ed,

We can certainly discuss the Preliminary NRA tomorrow too. However the methodology section has been updated since the PreNRA's release in Jan - we can also discuss the updates to the methodology. I cant share them with you yet however, as it is in draft and not yet releasable sorry.

More than happy to listen the concerns and work to resolve them, we can certainly focus more on the NRA for the IERRT than in general too.

Looking forward to visiting tomorrow.

Kind regards, Tim

Timothy Aldridge | Senior Maritime Consultant | ABPmer
Quayside Suite | Medina Chambers | Town Quay | Southampton | SO14 2AQ
[redacted] **Web:** www.abpmer.co.uk | www.portriskmanagement.com

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From: Edward Rogers <[redacted]>
Sent: 24 May 2022 13:37
To: Timothy Aldridge <[redacted]
Cc: Montgomery Smedley <[redacted]>; Nigel Bassett <[redacted]>; Sam

Anderson-Brown <[redacted]
Subject: RE: Plan for Wednesday

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Hi Tim,

Thanks for the proposed agenda.

I think it would be better to focus our time on the Pre.NRA methodology (which presumably is unchanged – please can you confirm this?) and park discussion on how this is integrated into the ES. With discussion therefore focusing on the contents of the letter APT issued. We'd be happy to talk you through our concerns in more detail and hope you will be able to respond appropriately. Note our concerns also includes the data, analysis and modelling that should underpin a qualitative assessment of hazard risk and determination risk control effectiveness's.

I'd also note that our interest is more about how risk assessment is applied to infrastructure development, rather than how it is applied for day-to-day PMSC compliance in ports.

We can then talk specifically discuss the concerns APT have with the development and what has, and/or will be done to address them, including a review of the mitigation measures identified to date.

Look forward to seeing you tomorrow.

Regards

Ed

Dr Ed Rogers | Director
[redacted]

From: Timothy Aldridge <[redacted]>
Sent: 23 May 2022 14:32
To: Edward Rogers <[redacted]
Cc: Montgomery Smedley <[redacted]
Subject: Plan for Wednesday

Good afternoon Ed,

Hope you are well. Just wanted to touch base on the plan for Wednesday at 1400 at your offices.

Monty and I will discuss how we conduct a HAZID workshop and NRA from a port/harbour perspective holistically and how we find adherence with the code in so doing as previously mentioned. This should only take around 15 minutes, 20 if we allow for some discussion too.
We can then go over the attached methodology specific to the IERRT Navigation ES chapter for 20 minutes (including discussion), this will hopefully leave us with the last 20min or so to discuss concerns raised by APT in correspondence to see if/how the planned methodology might mitigate any significant concerns.

Agenda:
1400-1420; HAZID/NRA Port/Harbour general principles
1420-1440: IERRT Methodology from draft ES Chapter (ES Methodology attached)
1440-1500: APT concern mitigation

Please let me know any concerns if you have them.

Kind regards, Tim

Timothy Aldridge | Senior Maritime Consultant | ABPmer
Quayside Suite | Medina Chambers | Town Quay | Southampton | SO14 2AQ
[redacted] **Web:** www.abpmer.co.uk | www.portriskmanagement.com

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We are taking a number of actions to reflect this priority while ensuring, as far as possible, minimal disruption to service.

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IERRT NAVIGATION RISK ASSESSMENT

Project Title	IERRT Navigation Risk Assessment
Project Number	AC22-NASH-0243
Meeting subject / purpose	NRA Methodology Meeting
Revision	R03~~1~~-00
Date of meeting	25-May-2022
Start time	14:00 GMT
Finish time	15:30 GMT
Client	APT
Location	NASH Offices - Southampton

DOCUMENT CONTROL

Revision	Date of Issue	Description	Approved
R01-00	27-May-202~~1~~2	Issued to attendees for comment	EJR
R02-00	17-Jun-2022	Updated and re-issued	EJR
R03-00	06-Jul-2022	Updated and re-issued	EJR

ATTENDEES

Organisation	Attendee	Role	Initial
NASH Maritime	Capt. Nigel Bassett Dr Ed Rogers		NB ER
ABPmer	Monty Smedley Timothy Aldridge		MS TA

APOLOGIES

Organisation	Attendee	Role	Initial
N/A			

AGENDA

1. Introductions
2. Review of IERRT Preliminary Navigation Risk Assessment Methodology
3. Review of APT navigational concerns

NOTES OF MEETING

1	Introductions	Action
1.1	Introductions were had by all. A discussion was had on aspects not directly relevant to the Pre.NRA Methodology. This included: 1. ~~It was noted by MS that a~~ER asked if the NRA contained an assessment of commercial implications for shipping, MS commented that an assessment ~~(which should identify the non-safety impacts from~~of commercial considerations was not part of the ~~project to shipping and navigation) is not included in the NRA~~ NRA scope and thought ~~to~~it would be included in the socio-economic section of the ES. This assessment is not being undertaken by the Maritime ~~team~~Team (MS / TA) at ABPmer, but MS agreed to ~~find out who is responsible for~~pass this ~~and make contact~~enquiry to the ABP project team. 2. ~~MS~~ER asked MS if he knew whether a formal response had been ~~received from~~made to the Section 42 consultation response from APT – ~~ER~~MS responded saying he did not know. MS agreed to ~~check~~pass this enquiry to the ABP project team. 3. ER questioned the "Preliminary" nature of the Pre.NRA, and MS noted that the assessment is based on ~~currently available~~current scheme information (e.g. site layout, marine operations and construction methodology) and that the Pre.NRA would be updated based on finalised construction methodology and design / marine operations. ER noted this, which is common for DCO submissions, but noted the importance of sufficient scheme details ~~in determination of~~when determining navigation risk. ER also noted the need for engagement with APT when the NRA is updated was necessary to ensure safety of IOT infrastructure and operations. MS commented that this would be part of normal port/stakeholder engagement conducted by the Port of Immingham and Humber Estuary Services (HES). 4. ER requested details on the project schedule – MS noted that at this ~~but was~~time, further scheme details past that already published, were not ~~able to provide an update on schedule~~available. 5. ER provided an explanation of APT concerns, particularly in relation to the trunk way (a piece of critical national infrastructure) and IOT finger berth, in additional to other more generic concerns around increase in risk on the Humber Estuary, impact on IOT COMAH plan and commercial considerations.	Action number 1. 2.
2	**Pre. NRA Methodology**	
2.1	A detailed discussion was then had on the contents of APT letter dated 29 April 2022, in which ER articulated the issues and concerns raised with the Pre.NRA methodology. This included an explanation of APT concerns in relation to: • Actions from HAZID Workshop II (held on 7 April 2022) – primarily that ~~APT~~all of APT's concerns were not noted or minuted / documented as part of the Hazard Workshop. TA commented that navigational and marine safety concerns were incorporated into the RAs. • Navigation Risk Assessment Methodology	

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- Risk Assessment Matrices – it is understood that the matrix and methodology of assessing risk and determination of tolerability is propriety to ABP and limited details are available on the mechanics of the risk algorithms. ~~It was also noted~~ER commented that the risk appetite is set by ABP only, which may not align with that of the stakeholders. TA commented that the NRA is written for the Harbour Authority (ABP). ER noted that the NRA should be written for the DCO application and not the Harbour Authority. ER requested that further details are provided, or that an approved methodology is used. MS agreed to ~~consider this~~include further detail on the methodology in the next iteration of the NRA. 4.
- Port Wide Risk Assessment – ~~it is understood~~ER asked if a port wide risk assessment ~~for the area has been completed, but is not~~was available, which should form the basis for the IERRT risk assessment ~~to inform current baseline~~. MS commented that both the Port of Immingham and HES has PMSC compliant risk~~.~~ assessments and that~~. T~~ the IERRT NRA presents the assessment relevant to the IERRT scheme.
- Incident Data – ER asked about incident details and if further analysis would be presented in the updated NRA. MS noted that ~~,~~ additional details are available for the incident analysis, and would be provided in the updated Pre.NRA.
- Vessel Traffic Analysis – ER asked if additional vessel traffic analysis, such as swept path analysis to identify water space used by vessels bound for and departing IOT, ~~is unlikely to be provided.~~would be made available. MS/TA commented that AIS data has been used to assess other vessel movements holistically as it provides a high level view as to vessel movements which is sufficient for the covered area. The simulation report (HR Wallingford) will present swept path for vessels.
- Full Bridge Simulations – draft simulation report(s) from the HR Wallingford Ship Bridge Simulations have been provided to ABP/ ABPmer, but final reports are outstanding, hence they can not be shared. ER noted this, but felt it would be useful to have swept paths of vessel arriving / leaving the IERRT / IOT finger berth for the hazard workshop, which are factual records of the simulations undertaken and should not be subject to comment ~~-~~or analysis. NB noted that simulations undertaken for vessels using IOT berth 8 did not include the effect of wind shielding from vessels berthed at IERRT and were conducted using a vessel model significantly smaller than the IOT finger pier design vessel size.

- Scheme Design
  - A scheme design was presented in A3 paper format by MS / TA which with last issue dated March 2022. ER requested the scheme design be supplied on a nautical chart – MS would take this back to the project team.
  - Details of construction schedule and design vessel were requested by ER and MS / ~~TO~~TA noted this.

3	Review of APT navigational concerns and proposed risk controls / mitigation
3.1	MS questioned what APT felt would be suitable mitigation for the scheme. ER noted that APT do not mandate any particular risk control measure, but are currently seeking to understand the detail of the assessment of risk and the resulting need for control measures.

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However, APT have identified that the Pre.NRA does not consider the following possible additional risk control measures:

- Operational controls
  - Relocation of the IOT Finger berth to downstream of the trunk way
  - Installation of appropriate impact protection for the trunk way
- Construction controls
  - Installation of temporary ship impact protection
  - Temporary closing of IOT Berth 8

4 Hazard Workshop III

MS / TA noted that a further hazard workshop (Hazard workshop III) had now been provisionally scheduled for 7 – 8 June 2022, due to the ~~inclusion~~possibility of ~~a third possible phase~~combined construction/operation option to the scheme – ~~a "partially constructed phase",~~ with construction occurring concurrently with operations. ER asked whether ~~a further phase~~this ~~option~~phase would be considered in the Pre.NRA and TA noted that this ~~phase~~ would ~~likely~~ be considered ~~within the current hazard tables.~~in 'construction', 'construction/operation' and 'operation'. ER considered that as a separate phase this would need to be considered separately.

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TA then noted that the focus of Hazard Workshop III will be the determination of risk control effectiveness scores, which have to date been provided and scored in terms of effectiveness by ABP/ABPmer. ER noted that this aspect of the methodology is not well understood by APT and requested further details on how it works.

In preparation for the next Hazard workshop ~~II~~3, ER iterated the previous requests from APT that the following information be provided in good time (noting Jubilee celebration holidays next week) for APT to consider prior to the workshop: 5.

1. Provision of scheme design parameters for:
   a. ~~**Phase 1:**~~ **Construction** ~~**phase**~~ (outline construction methodology / plan against a schedule – assume 3 phases dredging / piling / pontoon & deck ways)
   b. ~~**Phase 2:**~~ **Construction / Operation** ~~**phase**~~
   c. ~~**Phase 3:**~~ **Operation** (Operation (specific details of maximum design vessel and frequency of operation and any embedded (designed in mitigation)

   APT identified a key requirement is the scheme design (construction sequences and scheme layout) to be provided on a nautical chart.
2. Provision of an explanation of the methodology, specifically:
   a. Risk matrix (APT propose adoption of an approved risk matrix (e.g. same as APT COMAH plan which include errant vessel collision with the IOT which is based on an HSE matrix.
   b. Determination on scheme risk appetite (to include stakeholders / societal expectations)
   c. Details on how the risk reduction calculations work.
3. Any port wide risk assessments which are appropriate for this area, which will provide context in how ABP currently manage the area and document what embedded risk control are in place~~(~~(APT note that this is a PMSC requirement and should be shared with stakeholders anyway).
4. APT will give consideration to sharing details on the IOT infrastructure and operations, e.g. 6.

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a. Design of pipelines on the trunk way and existing impact protection in place for IOT Finger berths 6/8
b. Share non-sensitive aspects of the "errant vessel assessment" as part of APT HSE approved COMAH plan
c. Share details of the maximum design vessel for the IOT finger berths (with an expectation the same level of detail would be provided for the IERRT maximum design vessel).

5. The following underlying data analysis is requested prior to the workshop:
    a. Tidal stream detail for the area
    b. Swept path analysis (showing footprint of area/water used by vessels) on approach to IOT finger berths.
    c. Swept path analysis for IERRT scheme vessels during operational phase approaching / departing IERRT – this should be available from the simulations already undertaken by ABP.
    d. Vessel simulation reports would be very helpful.
    e. More details on historic incidents in the area.
    f. Details / specifications of the currently defined "further additional risk control measures".

MS commented that information for the workshop will be released in advance for attendees. ABP would review the APT request for further information to inform Hazard Workshop.

MEETING ACTIONS

Number	Owner	Action	Status
1	MS	~~Commercial shipping Assessment – ABPmer to sign post to where this is considered in the PEIR EIA.~~Offered to pass the question about scheme assessment of commercial implications for shipping to the ABP project team.	Open
2	MS	~~MS~~Offered to ~~check status of~~pass the question about Section 42 response from ABP to APT consultation~~.~~ to the ABP project team.	Open
~~3~~	~~MS / TA~~	~~ABPmer to consider adoption of standard risk matrix.~~	~~Open~~
4	~~MA~~MS / TA	Provision of further details on the risk assessment methodology, particularly around the risk control effectiveness calculations.	Open
5	~~MA~~MS / TA	Review the APT request for further information to inform Hazard Workshop III.	Open

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Commented [A1]: Please retain the action and put to "Closed" if it has been considered and will retain the same methodology?

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6	ER	APT to review what can be shared on IOT infrastructure and operations to inform Hazard Workshop III.	Open

POST MEETING NOTE

The following Post Meeting Note was received from ABPmer and is provided with a response by NASH Maritime.

- In respect to point 1.1.1 of the minutes: To clarify, no assessment has been made on commercial vessel assessment from a utilisation perspective across the whole estuary, MS and TA stated this was outside the scope of the NRA for the development but that we would relay the message to the ABP Project Team. MS and TA were under the impression that this point was more around the business/financial effects to the operator. Could you please define 'commercial shipping assessment' in a port context/ further than has been done so in the brackets of point 1.1.1 so that we can be clear on this term?

  NASH response: The scope of a "commercial shipping assessment" is related to identifying, quantifying and determining commercial impacts as a result the Construction, Operation and Decommissioning of the IERRT. They may occur as a result of presence of the IERRT and associated vessel activity, or as a result of implementing IERRT risk control measures.

  Commercial impacts may for example include delays to arrivals or sailings of IOT bound vessels as a result of increased vessel traffic activity from IERRT (particularly the IOT Finger ~~beths~~berths), impacts to IOT operations as a result implementing IERRT mitigation measures, etc~~..~~. APT / IOT are not clear whether these impacts have been quantified in the PIER – especially where they relate to commercial impacts which may not involve a safety component.

- Secondly, we are very grateful to APT for their correspondence dated 29 Apr 22 and all of the comments and concerns captured within. Within the HAZID workshop, all of APTs concerns relating to hazard identification and the risks discussed were documented within the context of the hazard log. However, comments that were outside of this scope were not documented whilst conducting the HAZID assessment. As stated above ABPmer is genuinely thankful to APT for providing a detailed list of their concerns in this correspondence to ABP.

- NASH Response: It is not clear where in the hazard logs provided that APT concerns have been "documented". Noted that ABPmer is genuinely thankful for the input from APT.

Appendix B
Extract from IOT COMAH Plan

[redacted]

8.3.3 Risk Ranking Evaluation

8.3.3.1 Severity (S)

(a) Impact on personnel;

S1. Potential for minor injury on-site – not a Major Hazard;

S2. Potential for serious injury/injuries on-site – borderline Major Hazard;

S3. Potential for some (one/few) fatalities/many serious injuries on-site, some potential for minor injury off-site – Major Hazard;

S4. Potential for many fatalities on-site or potential for serious injury or fatality off-site – Major Hazard.

(b) Impact on the surrounding environment;

Scenarios thought to have potential to cause a Major Accident to the Environment MATTE are not indicated in this section but risk ranking is detailed further in *Section 11* – Environmental Risk Assessment where the methodology for determining if a scenario has potential to create a MATTE is described.

8.3.3.2 Likelihood (L)

Table 8.1 Likelihood Categories

Rating	Description	Typical Frequency Range (of specific scenario being considered on the site)
L1	Very unlikely	< 1 in a million chance per year
L2	Unlikely	1 in 1,000,000 to 1 in 10,000 chance per year
L3	Reasonably likely	1 in 10,000 to 1 in 100 chance per year
L4	Likely	1 in 100 to 1 in 1 chance per year
L5	Very likely	> 1 in 1 chance per year (> 1 per plant year)

Note – the likelihood classification is assigned based on the likelihood of occurrence of the level of harm (severity) specified e.g. injury, not the likelihood of the initiating event e.g. a leak, process fault, impact, human error.

8.3.3.3 Risk Ranking

a) Impact on personnel and/ or the plant/site:

Table 8.2 Risk Matrix

Risk Ranking Classification					
Likelihood	**L5**	RP7	RP8	RP9	RP10
	L4	RP5	RP6	RP8	RP9
	L3	RP3	RP5	RP7	RP8
	L2	RP2	RP4	RP5	RP7
	L1	RP1	RP3	RP4	RP6
		S1	**S2**	**S3**	**S4**
	Severity	Personnel			

Events that do not present any risk to personnel are assigned a RP0 risk ranking.

Events can have both safety and environmental impacts and severity/risk classifications (see *Section 11* Environmental Assessment for further analysis of scenarios with a potential for environmental impacts.

The shading broadly indicates the tolerability of the risks, with the red indicating that the risk may be Intolerable, the yellow indicating the Tolerable region, where risks should be reduced so far as is reasonably practicable (ALARP) and the green area indicating where the risks are low enough to be Broadly Acceptable.

8.4 HAZID RECORD TABLE

The following tables present the records of the APT HAZID study.

9.8 REPRESENTATIVE SCENARIO RP1 - SHIP COLLISION WITH THE JETTY/BERTHS

9.8.1 APT Bowtie Diagrams

- B01 – loss of containment from jetty loading equipment;
- B02 – loss of containment from pipelines.

9.8.2 Definition

Ship collision with the jetty or berths could arise as a result of an errant vessel or gross manoeuvring error causing damage to the facilities leading to leaks from the ship(s) involved and or the jetty, pipelines/berths.

9.8.3 Hazard Assessment

An assessment of the potential for an impact from an errant vessel/tanker with the jetty/berths has been undertaken.

The historical record at APT has been compared with the generic ship collision frequency data derived from:

- Marine Incidents in Ports and Harbours in Great Britain, 1988 -1992, RG Robinson and AN Lelland, AEA/0253, AEA/CS/HSE-R1051, March 1996

- An assessment of oil tanker spills (1974 - 2000), Accidental Tanker Oil Spill Statistics, International Tanker Owners Pollution Federation Ltd, 2001. (ITOPF)

Collisions causing small spills have been ignored as these are not likely to cause major damage and are already accounted for in the berth spill frequencies i.e. bumps during mooring/manoeuvring, See Representative Scenario 2. The contribution of collision events to all events causing small releases (<7 te) is negligible (see *Table 9.1*). However, the likelihood of collisions can significantly affect the overall spill distribution for the larger leak categories, where ship collisions account for approximately ¼ of all major events.

The ship collision data derived from the ITOPF and Marine Incidents reports has been compared with historical experience at APT. The berths/jetty has experienced three serious collisions, one which caused the major spill in 1983, a more recent event, not involving an oil tanker but a passing bulk carrier, which damaged an unoccupied berth and did not lead to a spill and the most recent incident where an unmanned vessel due to be scrapped broke away from its moorings upstream of IOT before colliding with the jetty again no loss of containment was experienced during this incident. Over the 30 year period this equates to a 0.1 chance per year of a serious ship collision event. The frequency of spills for the jetty/berths area based upon the ITOPF/ Marine Incidents vessel collisions data has been estimated as:

Table 9.20 RP1 Spill Frequencies

Summary of Spill Frequencies for Representative Scenario RP1 (Spills per year)					
Description	Spill Quantity				
	0.1 - 1 te	1 - 10 te	10 - 1000 te	> 1000 te	All Spills
Impact from Docking or Errant Vessel	Low impact	Low impact	7.7×10^{-2}	2.7×10^{-2}	1.0×10^{-1}

It can be seen that the APT historical experience is in-line with the derived spill distribution for ship collisions, both indicating a 0.1 chance per year of a serious collision.

It should be noted that the spill distribution used for the berth spill scenarios RP2 already includes this ship collision contribution and as such no additional analysis is proposed here.

The consequences of such releases are also included as part of Representative Scenario RP2. In a serious collision there is a potential for some injuries to any person on the jetty/berth or on board the ship. Persons working on the berth are likely to see any approaching vessel on an impact course and escape along the berth/ jetty. The size of ships likely to be involved means that serious injury to those on board is unlikely.

9.8.4 Effects on People

The effects on people of this scenario are considered to be the same as those detailed in *Section 9.8.3.*

9.8.5 Effects on the Environment

An unignited spill would result in hydrocarbons being deposited into the estuary of the Humber. The rate of evaporation would be low as the substance is in contact with the sea.

Effects have been presented in *Section 11* – Environmental Risk Assessment, which includes oil spill modelling.

9.8.6 Escalation Potential

Should a release of hydrocarbon from any of the identified threats ignite, it has the potential to spread to the tanker. However, the tanker has fire-fighting equipment on board and there are fire fighting tugs on call to support both the berth's and the tanker's capabilities in suppressing a fire. The open nature of the jetty/berth areas and the nature of the liquid being handled means that a vapour cloud explosion (VCE) is not considered a credible hazard.

A spray release of sour crude oil could result in small quantities of H_2S being liberated. However the distances to DTL from such a release are less than the distance to the shoreline.

A large un-ignited hydrocarbon liquid spill could have a short-term environmental impact in the area.

9.8.7 Hazard Management Assessment

The berthing of all vessels at IOT is controlled by a well-established set of regulations, which include berthing and sailing "windows," mooring patterns and ship to shore communications with the Berthing Masters. All movements involving ships having a summer deadweight of 40,000 tonnes or over, or having a declared draft of 11.0 metres or more are subject to the Humber Passage Plan requirements, which in essence, stipulates when these vessels can arrive or sail from the IOT. Vessels navigating within the port limits of the Humber Estuary are required to have a local pilot, unless the Master is specifically exempt from this requirement for the actual vessel under his command. The Harbour Authority issues pilot Exemption Certificates for this purpose by examining candidates for specific areas of operation. Mooring Masters are also put on board larger vessels prior to berthing to assist with the mooring operation (local knowledge). The Harbour Authorities operate a Vessel Traffic Service (VTS) control system, similar in some respects to an airport air traffic control system. The berths are also fitted with all the required navigational aids e.g. lights, foghorns, etc., which are inspected by Trinity House with fenders and breasting dolphins to cushion any impacts.

Passing distances from the berth are specified in official “Notice to Mariners.” This should ensure passing vessels do not get too close to the berths and the jetty infrastructure.

Harbour tugs are available to assist with the mooring and let go of larger vessels while a small work boat with pushing capability is used for the smaller vessels using the IOT Finger Pier. A stand-by tug is also available 24 hours a day 365 days a week should it be required in an emergency or during an abnormal situation where further tug assistance is required.

Tidal and weather restrictions are in place to ensure mooring and let-go of vessels is completed in suitable conditions.

APT has regular safety meetings with Humber Pilots and liaison meetings with the Harbour Authority giving an opportunity to share safety related information and concerns.

Charterers (the oil companies) also carry out vessel vetting procedures to ensure the vessel and its management meet acceptable requirements before they arrive.

APT has oil spill response equipment and contingency arrangements, which include shared local and national resources to deal with oil spills.

Overall, it is considered that APT have met all relevant marine standards and implemented sufficient checks and controls to reduce the risk of ship collision either due to mooring error or errant vessel, as is reasonably practicable and within their direct control.

Appendix C
Qualitative Risk Assessment Hazard Logs

				Baseline Risk											Additional Risk Control Measures			Residual Risk										
				Realistic Worst Credible Scores							Worst Credible Results				1	2	3	Realistic Worst Credible Scores							Worst Credible Results			
ID	Baseline Haz. Rank	Residual Haz. Rank	Hazard Title	People	Property	Environment	Business	Frequency	Baseline Risk Score	Baseline Risk Rating	People	Property	Environment	Business	IOT RC1: Impact protection	IOT RC2: Relocation Finger Pier	IOT RC3: Marine & Liaison Plan	People	Property	Environment	Business	Frequency	Residual Risk Score	Residual Risk Rating	People	Property	Environment	Business
1	18	3	Collision - IERRT Ro-Ro Vessel ICW IERRT Ro-Ro Vessel	4	3	2	3	2	4.5	Tolerable if ALARP	5.0	4.0	3.0	4.0			Yes	4	3	2	3	1	4.0	Tolerable if ALARP	4.0	3.0	2.0	3.0
2	3	3	Collision - IERRT Ro-Ro Vessel ICW Coastal Tankers	4	4	3	4	3	5.9	Tolerable if ALARP	6.0	6.0	5.0	6.0		Yes	Yes	4	4	3	4	1	4.0	Tolerable if ALARP	4.0	4.0	3.0	4.0
3	5	3	Collision - IERRT Ro-Ro Vessel ICW Bunker Barge	4	3	2	3	3	5.5	Tolerable if ALARP	6.0	5.0	4.0	5.0		Yes	Yes	4	3	2	3	1	4.0	Tolerable if ALARP	4.0	3.0	2.0	3.0
4	19	3	Collision - IERRT Ro-Ro Vessel ICW Cargo	4	3	1	3	2	4.4	Tolerable if ALARP	5.0	4.0	2.0	4.0			Yes	4	3	1	3	1	4.0	Tolerable if ALARP	4.0	3.0	1.0	3.0
5	7	3	Collision - IERRT Ro-Ro Vessel ICW Tanker	4	4	4	4	2	5.0	Tolerable if ALARP	5.0	5.0	5.0	5.0			Yes	4	4	4	4	1	4.0	Tolerable if ALARP	4.0	4.0	4.0	4.0
6	22	17	Collision - IERRT Ro-Ro Vessel ICW Tug, Service and Other Small Vessel	3	2	1	2	2	3.5	Tolerable if ALARP	4.0	3.0	2.0	3.0			Yes	3	2	1	2	1	3.0	Tolerable if ALARP	3.0	2.0	1.0	2.0
7	10	13	Collision - IERRT Ro-Ro Vessel ICW 3rd Party Passenger	3	4	4	4	2	4.9	Tolerable if ALARP	4.0	5.0	5.0	5.0			Yes	3	4	4	4	1	3.5	Tolerable if ALARP	3.0	4.0	4.0	4.0
8	10	22	Contact (Allision) - Bunker Barge with IOT Trunkway	3	4	4	4	2	4.9	Tolerable if ALARP	4.0	5.0	5.0	5.0	Yes	Yes		2	2	2	2	1	2.0	Broadly Acceptable	2.0	2.0	2.0	2.0
9	10	19	Contact (Allision) - Coastal Tanker with IOT Trunkway	3	4	4	4	2	4.9	Tolerable if ALARP	4.0	5.0	5.0	5.0	Yes	Yes		2	3	3	3	1	2.5	Broadly Acceptable	2.0	3.0	3.0	3.0
10	1	13	Contact (Allision) - IERRT Ro-Ro Vessel with IOT Trunkway	4	4	4	4	3	6.0	Intolerable	6.0	6.0	6.0	6.0	Yes			2	3	3	3	2	3.5	Tolerable if ALARP	3.0	4.0	4.0	4.0
11	7	3	Contact (Allision) - Bunker Barge with IOT Finger Pier	3	3	3	3	3	5.0	Tolerable if ALARP	5.0	5.0	5.0	5.0	Yes	Yes		3	2	2	2	2	4.0	Tolerable if ALARP	4.0	3.0	3.0	3.0
12	4	3	Contact (Allision) - Coastal Tanker with IOT Finger Pier	3	4	3	4	3	5.8	Tolerable if ALARP	5.0	6.0	5.0	6.0	Yes	Yes		3	3	2	3	2	4.0	Tolerable if ALARP	4.0	4.0	3.0	4.0
13	1	3	Contact (Allision) - IERRT Ro-Ro Vessel with IOT Finger Pier	4	4	4	4	3	6.0	Intolerable	6.0	6.0	6.0	6.0	Yes	Yes	Yes	3	3	2	2	2	4.0	Tolerable if ALARP	4.0	4.0	3.0	3.0
14	20	19	Contact (Allision) - Tug, Service and Other Small Vessel with IOT Finger Pier	2	3	2	2	2	3.6	Tolerable if ALARP	3.0	4.0	3.0	3.0	Yes	Yes		2	3	2	2	1	2.5	Broadly Acceptable	2.0	3.0	2.0	2.0
15	7	1	Contact (Allision) - IERRT Ro-Ro Vessel with IOT River berths	4	4	4	4	2	5.0	Tolerable if ALARP	5.0	5.0	5.0	5.0				4	4	4	4	2	5.0	Tolerable if ALARP	5.0	5.0	5.0	5.0
16	15	17	Contact (Allision) - Bunker Barge with IERRT Jetty	3	3	4	3	2	4.6	Tolerable if ALARP	4.0	4.0	5.0	4.0		Yes		3	3	3	3	1	3.0	Tolerable if ALARP	3.0	3.0	3.0	3.0
17	15	13	Contact (Allision) - Coastal Tanker with IERRT Jetty	3	4	3	3	2	4.6	Tolerable if ALARP	4.0	5.0	4.0	4.0		Yes		3	4	3	3	1	3.5	Tolerable if ALARP	3.0	4.0	3.0	3.0
18	6	13	Contact (Allision) - IERRT Ro-Ro Vessel with IERRT Jetty	1	4	1	3	3	5.1	Tolerable if ALARP	3.0	6.0	3.0	5.0		Yes	Yes	1	4	1	3	2	3.5	Tolerable if ALARP	2.0	5.0	2.0	4.0
19	20	19	Contact (Allision) - Tug, Service and Other Small Vessel with IERRT Jetty	2	3	2	2	2	3.6	Tolerable if ALARP	3.0	4.0	3.0	3.0		Yes	Yes	2	3	2	2	1	2.5	Broadly Acceptable	2.0	3.0	2.0	2.0
20	13	3	Breakaway - Bunker Barge at IOT Finger Pier	2	4	4	4	2	4.8	Tolerable if ALARP	3.0	5.0	5.0	5.0		Yes		2	3	3	4	2	4.0	Tolerable if ALARP	3.0	4.0	4.0	5.0
21	13	3	Breakaway - Coastal Tanker at IOT Finger Pier	2	4	4	4	2	4.8	Tolerable if ALARP	3.0	5.0	5.0	5.0		Yes		2	4	3	4	2	4.0	Tolerable if ALARP	3.0	5.0	4.0	5.0
22	15	1	Breakaway - IERRT Ro-Ro Vessel at IERRT Jetty	4	1	4	4	2	4.6	Tolerable if ALARP	5.0	2.0	5.0	5.0				4	4	3	4	2	5.0	Tolerable if ALARP	5.0	5.0	4.0	5.0

Appendix D
Impact Protection Engineering Note

CONTROLLED DOCUMENT STATUS

CLIENT	Nash Maritime
PROJECT TITLE	Immingham Ro-Ro Terminal Impact Protection
SUBJECT	Impact Protection
DOCUMENT TITLE	Cost and Design Review
DOCUMENT REF	2333-BRL-01-XX-TN-C-0001

REVISION RECORD

REV	STATUS	DATE	SUMMARY OF CHANGES	PREP	CHK	APP
P01	S2 – For Information	29/08/23	-	GT	TKHB	TKHB
P02	S2 – For Information	05/09/23	Changed location of protection system.	GT	TKHB	TKHB

CONTENTS

1 INTRODUCTION

1.1 Project Background

1.1.1 Associated British Ports (ABP) propose to construct three Ro-Ro berths adjacent to the existing Immingham Oil Terminal (IOT), see Figure 1.1.

1.1.2 As part of the proposed scheme, ABP have indicated that a ship impact protection system could be installed adjacent to the terminal's access jetty, which supports the pipework that connects the terminal's berths to the shore, however, it is noted that they do not consider this to be essential.

1.1.3 Beckett Rankine (BR) has been appointed by Nash Maritime to undertake a high-level costing review for a potential impact protection scheme to protect the oil terminal access jetty in case of any failures in the Ro-Ro vessels operating nearby.

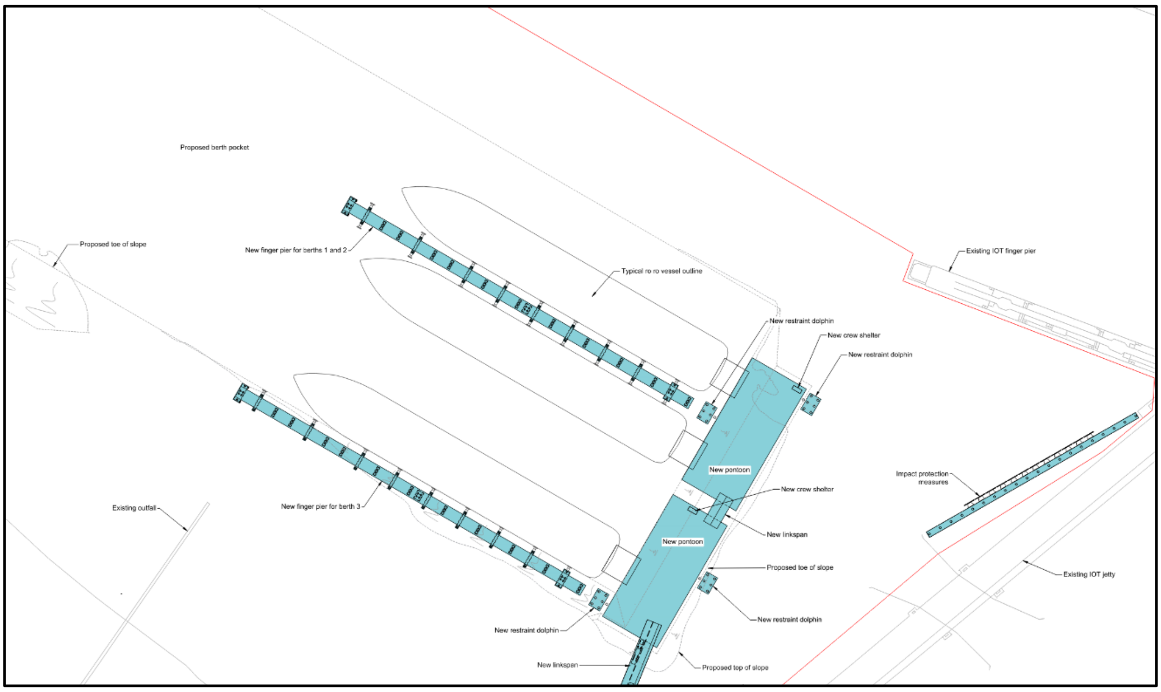

Figure 1.1: Proposed Ro-Ro berth layout

2 IMPACT PROTECTION MEASURES

2.1 Design requirements

2.1.1 BR have undertaken a high-level design review for a potential impact protection system that could be installed at IOT.

2.1.2 The *Humbria Seaways* vessel has been used as a representative vessel for the proposed Ro-Ro ships. This is noted to have a summer deadweight of approximately 17,000tonnes and a beam of 33m. The Ro-Ro vessels are proposed to reverse into the berths, and therefore are considered most likely strike the impact protection with the stern of the ship in the event of an incident.

2.1.3 The area experiences relatively strong tidal conditions, with ebb tides up to 4-knots. The impact protection system is therefore required to protect against a minimum vessel speed of 4-knots in the event of an engine failure.

2.1.4 Considering the above, we have assumed an impact force of 30MN based on the AASHTO guidance and as provided in Knott et al.[1]

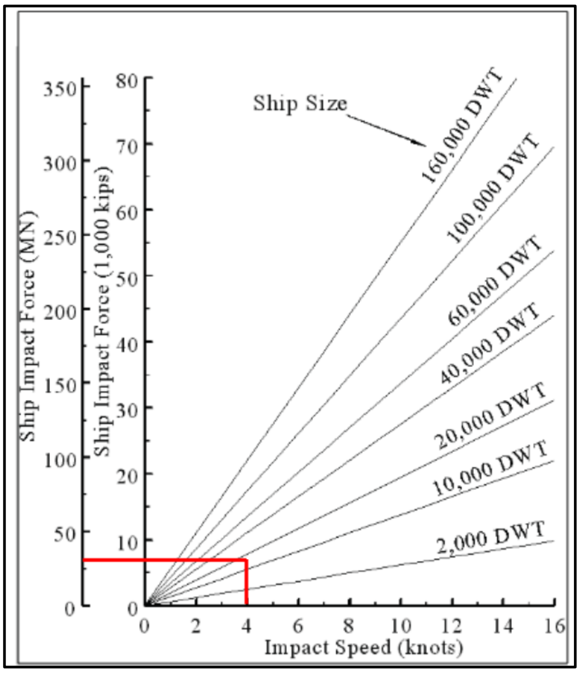

Figure 2.1: Ship impact force as per AASHTO

1. Vessel collision design – risk analysis and deep foundation issues for bridges over navigable waterways, Michael A. Knott, P.E., Moffatt & Nichol, Richmond, VA, USA

2.2 Proposed Design Review

2.2.1 ABP have proposed a potential impact protection scheme that comprises 20no. large diameter piles, approximately 1m diameter connected by a continuous capping beam and a series of fenders to absorb the vessel impact force (see Figure 2.2 and Figure 2.3).

2.2.2 BR have carried out a high-level review of this impact protection scheme and have the following concerns:

- The protection system is shown remarkably close to the existing terminal infrastructure which leaves little margin for deflection of the protection structure. Also, vessel overhangs may over-ride the protection structure with a risk of contacting the IOT pipework.
- The proposed location does not protect the finger dock for berths 6 to 9 from vessel impact.
- The system appears under designed considering the tidal conditions and the potential magnitude of the impact. Although, it should be noted, a detailed calculation check has not been undertaken and the type of fender system is not defined.

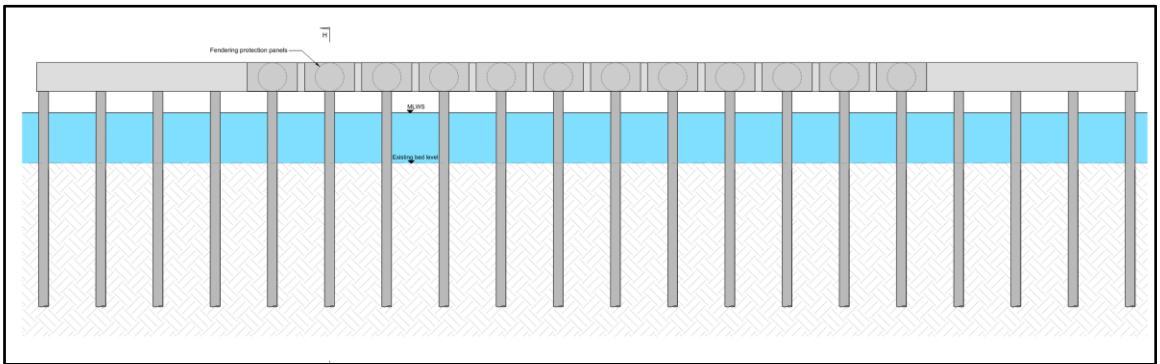

Figure 2.2: ABP's Proposed impact protection

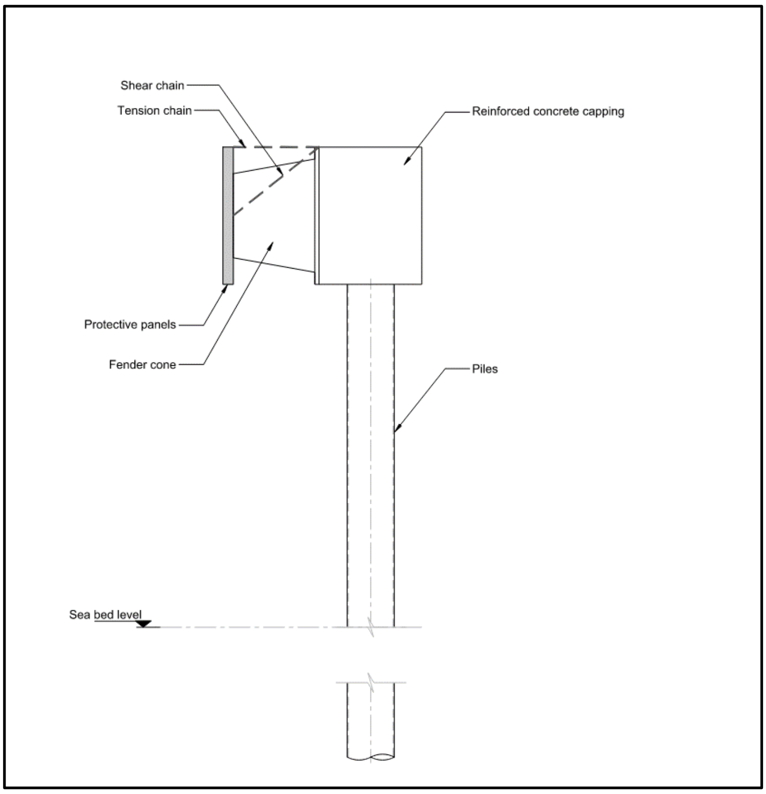

Figure 2.3: ABP's Proposed impact protection cross-section

2.3 Alternative Design Option

2.3.1 BR have developed an alternative layout that would provide a greater level of protection for the IOT infrastructure than the ABP proposal. We have not undertaken detailed design calculations; however, we have undertaken high-level estimates to justify feasibility of the scheme.

2.3.2 The layout is proposed to extend from the new berthing pontoon extending in front of the finger dock for berths 6 to 9. This will require berths 8 & 9 to be closed as vessel access will be restricted to small craft such as tugs and maintenance vessels.

2.3.3 The protection system comprises 12No. 2.8m diameter piles, spaced at 16.5m apart to restrict the Ro-Ro vessel (see Figure 2.4). The piles will be placed in two rows with a series of steel tubular cross-bracing to distribute the impact force between the piles.

2.3.4 The piles are recommended to be fitted with pile collars, and possibly also fenders, which are designed to fail during vessel impact to absorb the impact force and prevent significant damage to the piles. These proprietary items can be more readily replaced than the piles, should an impact occur.

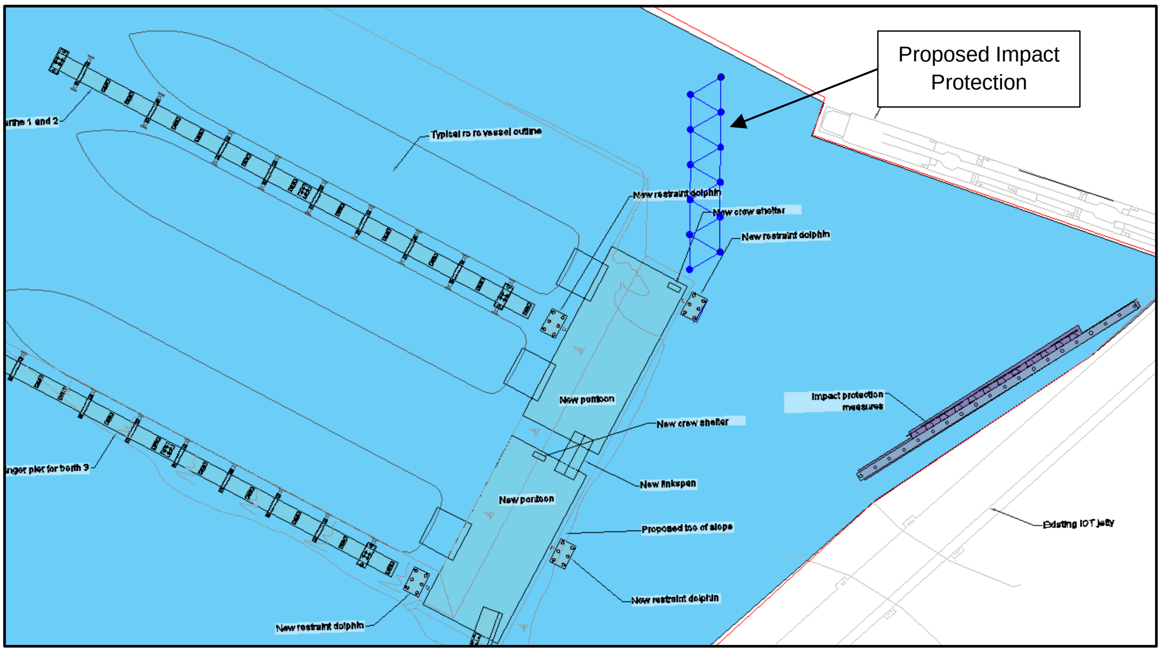

Figure 2.4: Proposed impact protection indicative layout

2.3.5 An alternative option could be to install two large diameter cellular cofferdams formed with sheet piles or combi-walls, backfilled with gravel. The cofferdams would be circa 15m diameter spaced 30m apart to restrict the vessel.

2.3.6 This option has potentially cheaper installation costs, however the maintenance of the cofferdams following a vessel impact could lead to higher costs, unless a proprietary system that could be replaced is fitted, although this would more likely a non-standard system. The cofferdams would also potentially require greater bed preparatory works and will cause a greater obstruction to the flow with potential scour issues.

2.4 Cost Estimate

2.4.1 A preliminary costing exercise has been undertaken for the 12No 2.8m diameter pile solution using prevailing rates for materials, plant and equipment based on BR project experience combined with a discussion with a specialist marine piling contractor.

2.4.2 Considering the above, the estimated construction cost is approximately £9.0M. The estimated construction period is around 6 weeks on site to install the piles.

2.4.3 The costings allow for the mobilisation of a jack-up barge, crawler crane and pile vibratory and percussive hammers for installation of the piles and the bracing system. Corrosion protection has also been considered to be required.

2.4.4 A cost saving on mobilisation could be achieved by installing the protection piles at the same time as the piles for the Ro-Ro berth.

3 RO-RO TERMINAL DESIGN REVIEW

3.1 Overall Design Review

3.1.1 BR have reviewed the proposed design drawings and reports available on the planning portal website for the proposed Ro-Ro Terminal.

3.1.2 We have not undertaken detailed design calculations; however, we have reviewed the general design principles.

3.1.3 We have the following comments on the design:

- In order to adequately protect the IOT infrastructure the Ro-Ro pontoons should be designed to resist a similar accidental impact as the ship impact protection structure, namely a Ro-Ro ship drifting at 4knots. This is to ensure that the pontoons do not break free under impact and drift down upon the IOT jetty access.
- The proposed dolphins to stabilise on the pontoon are not in the optimum positions to resist such an impact. We would expect the dolphins to be on the opposite side to the berthed vessels to restrain the pontoons against the impact forces. The dolphins on the berthing face will be inefficient to resist these forces as essentially the load will be resisted by the connections between the dolphin and pontoon only.
- The task of manoeuvring the vessels into the berths appears to be extremely challenging in the scenarios tested by HR Wallingford. The use of tugs for Ro-Ro vessel berthing is generally not favoured and how effective tug assistance could be provided for the two southern berths is unclear.

APPENDIX A ABP REFERENCE DOCUMENTS

- IERRT DCO Application – General Arrangement Plans [APP-009]
- IERRT DCO Application – Engineering Sections and Plans [AS-007]
- IERRT DCO Application – Environmental Statement Chapter 2 [APP-038]
- IERRT DCO Application - Environmental Statement Appendix 10.2 Navigation Simulation Study – Part 1 [APP-090]

NASH
MARITIME

+44 (0) 2380 381 681
info@nashmaritime.com
www.nashmaritime.com