Arriscar Pty Limited
ACN 162 867 763
www.arriscar.com.au

Sydney
Level 26
44 Market Street
Sydney NSW 2000
T: +61 2 9089 8804

Melbourne
Level 2 Riverside Quay
1 Southbank Boulevard
Southbank VIC 3006
T: +61 3 9982 4535

ASSESSMENT REPORT

Port Kembla Gas Terminal (SSI 9471)

For NSW Department of Planning and Environment

11 April 2019

DOCUMENT HISTORY AND AUTHORISATION

Rev	Date	By	Description	Check	Approved
A	15 Mar 2019	PS	Draft for client review.	JL	PS
0	11 Apr 2019	PS	Final report.	JL	PS

1 INTRODUCTION

Arriscar Pty Ltd (Arriscar) was engaged by the NSW Department of Planning and Environment (DP&E) to undertake an assessment of the 'Hazards and Risks' for the proposed Port Kembla Gas Terminal (PKGT) development (SSI 9471).

The proposed PKGT includes construction and operation of a liquefied natural gas (LNG) terminal on the eastern side of the inner harbour at Port Kembla and includes:

- a floating storage and regasification unit (FSRU);
- LNG carrier (LNGC) vessels to supply the FSRU;
- ancillary wharf infrastructure; and
- a pipeline connection to the existing east coast gas transmission network.

2 SCOPE

The scope of the assessment relates to the 'Hazards and Risks' requirements for the PKGT development, as outlined in the Secretary's Environmental Assessment Requirements (SEARs).

The SEARs for the PKGT require that the Environmental Impact Statement (EIS) must address the following specific issues with the level of assessment of likely impacts proportionate to the significance of, or degree, of impact on, the issue, within the context of the project location and the surrounding environment:

- **Hazards and Risks** – including a comprehensive Quantitative Risk Assessment (QRA), covering all aspects of the project which may impose public risks, to be prepared consistent with *Hazardous Industry Planning Advisory Paper No. 6 – Guidelines of Hazard Analysis* (DPE, 2011). This QRA must include:
  - identification of all potential hazards and associated control measures for all aspects of the project, including but not limited to entry of LNG carriers into port, mooring, refilling of FSRU, regassification, and transfer of LNG into gas network distribution tie in point, and other external threats (such as propagation risks from other facilities and vessel movements and cargoes and impacts from adverse sea conditions on the FSRU);
  - a quantitative risk assessment to estimate the risks from activities of LNG Carrier and/or FSRU operation, with reference to applicable International and/or Australian Standards and Industry Best Practice. The risk assessment must consider the worst-case scenarios from all identified potential hazards that may result in off-site impact. It must also consider:
    - the potential risk exposure to all shipping terminal activities at the port, including cruise shipping; and
    - the potential propagation risks to and from neighbouring industrial facilities, such as the steelworks, onshore approved bulk liquid storage facilities and other berth activities (such as loading/unloading of dangerous goods at nearby berths);
  - a quantitative pipeline risk assessment to estimate the risks from the pipeline to the surrounding land uses, with reference to *Australian Standards AS2885 Pipelines – Gas and Liquid Petroleum - Operation and Maintenance*;

- demonstration that the risks from the project comply with the criteria set out in *Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 – Risk Criteria for Land Use Safety Planning* (DoP, 2011);
- an assessment of the adequacy of existing firefighting systems on shore and within the harbour (e.g. fire tugs) through a preliminary Fire Safety Study; and
- proposed on-going maintenance and safety management of the project inclusive of associated pipeline infrastructure.

The EIS for the proposed PKGT was the primary document reviewed (Principally Chapter 10 – 'Hazard and risk' and Appendix D – 'Preliminary Hazard Analysis'); however, the applicant also provided additional information to address specific queries raised by the reviewers. These additional documents are listed in the attached Comment Response Sheet (CRS)

3 APPROACH

To comply with the SEARs, the QRA for the PKGT is required to comply with the *Hazardous Industry Planning Advisory Paper (HIPAP) No. 6 Hazard Analysis*, and therefore must incorporate:

1. Identification of the nature and scale of all hazards at the facility, and the selection of representative incident scenarios;
2. Analysis of the consequences of these incidents on people, property and the biophysical environment;
3. Evaluation of the likelihood of such events occurring and the adequacy of safeguards;
4. Calculation of the resulting risk levels of the facility; and
5. Comparison of these risk levels with established risk criteria and identification of opportunities for risk reduction.

The SEARs also include additional specific requirements, such as requiring a quantitative pipeline risk assessment (Refer to Section 2).

The documents submitted by the applicant were reviewed and the findings are included in Section 4 (Note: Section 4 and the attached CRS are structured to generally align with the key steps outlined above from HIPAP No. 6).

The key assessment criteria (Acts & Regulations / Standards / Guidelines) used during the review are listed in the attached CRS (e.g. SEARs, HIPAP No. 4, HIPAP No. 6, etc.). Observations raised with the applicant during the review are listed in the attached CRS and were categorised based on their relative importance with respect to the assessment criteria.

4 FINDINGS

4.1 Project Description

The EIS submitted by the applicant did not include some information required to undertake the review (e.g. LNG transfer operations, odorant dosing, etc.). Therefore, additional information and clarifications were sought from the applicant (Refer to attached CRS – ID # 1 – 9).

The applicant advised that final design information was not available for some equipment (e.g. odorant dosing) and some safety systems. This is consistent with HIPAP No. 6 (Section 1), in which it is noted that: "A PHA may be based on limited information since complete data on the design and

precise safeguards may not be available at the initial stage. The PHA should be as final and comprehensive as the available information allows."

The applicant has advised that safety systems have not generally been factored into the QRA, which should provide some conservatism in the risk results; however, if the development is approved, then it will be important to ensure that the final design is thoroughly assessed in the post approval studies (particularly the Final Hazard Analysis).

4.2 Hazard Identification

The EIS submitted by the applicant did not appear to address some potentially hazardous events (e.g. grounding of an LNG carrier, a release of LNG due to unintended decoupling of multiple MLAs or transfer hoses, etc.). Therefore, additional information and clarifications were sought from the applicant (Refer to attached CRS – ID # 10 – 16).

The 'Preliminary Hazard Analysis Addendum' provided by the applicant included additional potentially hazardous events (e.g. grounding of an LNG carrier, a release of LNG due to unintended decoupling of multiple MLAs or transfer hoses, etc.). A revised cumulative individual fatality contour was also produced to include these additional potentially hazardous events.

4.3 Consequence Analysis

The EIS submitted by the applicant did not include the consequence analysis results for some potentially hazardous events (e.g. a spill of LNG onto water due to grounding of an LNG carrier, a release of LNG from multiple MLAs or transfer hoses, etc.). Therefore, additional information and clarifications were sought from the applicant (Refer to attached CRS – ID # 17 – 26).

The 'Preliminary Hazard Analysis Addendum' provided by the applicant included the consequence analysis results for additional potentially hazardous events (e.g. a spill of LNG onto water due to grounding of an LNG carrier, a release of LNG from multiple MLAs or transfer hoses, etc.). A revised cumulative individual fatality contour was also produced to include these additional potentially hazardous events.

4.4 Frequency Analysis

The EIS submitted by the applicant did not include the frequency analysis results for some potentially hazardous events (e.g. total ignition probabilities for the identified representative release events). Therefore, additional information and clarifications were sought from the applicant (Refer to attached CRS – ID # 37 – 33).

The 'Preliminary Hazard Analysis Addendum' provided by the applicant included the requested information.

4.5 Risk Analysis and Assessment

The EIS submitted by the applicant did not include the risk analysis and assessment for some potentially hazardous events (e.g. acute toxic injury and irritation risks due to a release of odorant). Therefore, additional information and clarifications were sought from the applicant (Refer to attached CRS – ID # 34 – 31).

A revised cumulative individual fatality contour was included in the 'Preliminary Hazard Analysis Addendum'.

The findings, with respect to each of the DP&E's risk criteria, are as follows:

Risk Criteria	Findings
Individual Fatality Risk	A revised cumulative individual fatality contour was included in the 'Preliminary Hazard Analysis Addendum' to address the observations raised during the review. The revised 50 pmpy cumulative individual fatality risk contour extends beyond the site boundary into an adjacent industrial land use. In this case, the relatively small exceedence of the 50 pmpy individual fatality risk criterion occurs in an industrial area of a port precinct with low occupancy and may be tolerable based on the guidance provided in HIPAP No. 4 (Refer to Section 5.1). The 10 pmpy cumulative individual fatality risk contour extends beyond the site boundary to an area where members of the public may be present. This exceedence is primarily at a roadway, which is not zoned for open space uses and only a relatively low number of people are typically present (i.e. individuals fishing rather than a larger number of individuals that would occur at a sporting facility) and may be tolerable based on the guidance provided in HIPAP No. 4 (Refer to Section 5.1). The 5 pmpy, 1 pmpy and 0.5 pmpy cumulative individual fatality risk contours appear to comply with the corresponding DP&E criteria for commercial, residential and sensitive uses.
Property Damage or Injury Risk from Heat Radiation (4.7 or 23 kW/m^2) or Overpressure (7 or 14 kPa)	The cumulative risks of property damage or injury risk from heat radiation or explosion overpressure are included in Section 9.2 of the PHA and appear to comply with the DP&E's corresponding risk criteria.
Acute Toxic Injury Risk and Risk of Irritation	It is reported in the 'Preliminary Hazard Analysis Addendum' that the consequences of a release of odorant do not reach residential or sensitive use areas (Refer to attached CRS – ID # 10).

Risk Criteria	Findings
Societal Risk	It is reported in Section 9.3 of the PHA that the societal risk was not quantified because the population within the extent of the individual fatality risk contours is relatively low. This was queried due to the possibility of people accessing the nearby waterfront road. It was subsequently reported in the 'Preliminary Hazard Analysis Addendum' (Section 8) that NSW Ports has advised that "numbers of users are in the dozens, not the 100's, with the largest crowds seen there for the arrival of the Port's first cruise ship. Subsequent cruise ship arrivals have seen the crowd numbers dwindle". Therefore, societal risk was also not quantified in the 'Preliminary Hazard Analysis Addendum'. Whilst quantification of the societal risk is preferred to demonstrate compliance with the DP&E's societal risk criteria, it does not appear to be warranted in this case due to the relatively low numbers of people that may be near the proposed FSRU berth (Refer to attached CRS – ID # 41). If this development is approved, then this should be re-evaluated in the FHA.
Risk to Biophysical Environment	A qualitative assessment has been undertaken to demonstrate compliance with the DP&E's risk criteria for damage to the biophysical environment (Refer to HIPAP No. 4, Section 2.4.4 and attached CRS – ID # 35). The Department acknowledges that a spill of LNG, odorant (Total inventory of 2 x 200 kg tanks) or marine diesel is unlikely to result in long term damage to an extensive area and the controls to mitigate a release are expected to be addressed through compliance with relevant standards (e.g. bunding of odorant tanks).
Qualitative Risk	An assessment against the DP&E's qualitative risk criteria (Refer to HIPAP No. 4, Section 2.2) was not included in the PHA (Refer to attached CRS – ID # 35). The applicant's response to this observation was incomplete (Refer to attached CRS, ID # 34); however, additional assessments are to be conditioned if the development is approved (Refer to Section 5.2).

5 OVERALL FINDINGS & RECOMMENDATIONS

5.1 Overall Findings

The majority of the 'Hazards and Risks' aspects for the proposed PKGT, as required to be assessed in accordance with the SEARs, appear to be addressed in the EIS (Principally Chapter 10 – 'Hazard and risk' and Appendix D – 'Preliminary Hazard Analysis') and in the applicant's responses to the questions raised during the review (See attached CRS).

The applicant has advised that safety systems have not generally been factored into the QRA, which should provide some conservatism in the risk results; however, if the development is approved, then it will be particularly important to ensure that the final design is thoroughly assessed in the post approval studies (particularly the Final Hazard Analysis). A more comprehensive FHA will be required than would have been the case if a more finalised design had been considered in the PHA.

The 50 pmpy and 10 pmpy cumulative individual fatality risk contours do not strictly comply with the corresponding DP&E criteria for industrial and open space uses. However, it is acknowledged in HIPAP No. 4 that: "…there can be some degree of flexibility in the implementation and interpretation of probabilistic risk criteria…".

In this case, the relatively small exceedence of the 50 pmpy individual fatality risk criterion occurs in an industrial area of a port precinct with low occupancy (Refer to attached CRS – ID # 36) and may be tolerable based on the guidance provided in HIPAP No. 4. However, if the development is approved, the risk reduction provided by the safety systems included in the final design should be demonstrated in the FHA.

The 10 pmpy exceedence is primarily at a roadway and waterfront area, which is not zoned for open space uses (it is within the special activities zone of the port) and only a relatively low number of people are typically present (i.e. individuals fishing rather than a larger number of individuals that would occur at a sporting facility). Therefore, exceedence of the 10 pmpy individual fatality risk criterion may be tolerable in this case based on the guidance provided in HIPAP No. 4. However, if the development is approved, the risk reduction provided by the safety systems included in the final design should be demonstrated in the FHA.

5.2 Recommendations

If the development is approved, then the observations that were conditionally closed during the review should be addressed by specific consent conditions. The recommended consent conditions for each conditionally closed observation are listed in the attached CRS.

ATTACHMENT - COMMENT RESPONSE SHEET (CRS)

1. INTRODUCTION

Review Ref. #: Comment Response Sheet (CRS) No. 1

Review Revision #: 4

Review Date: 11 April 2019

Scope of Review

The scope of this review relates to the 'Hazards and Risks' requirements, as outlined in the Secretary's Environmental Assessment Requirements (SEARs), for the proposed Port Kembla Gas Terminal (PKGT) development (SSI 9471).

Document(s) Reviewed

Title	Ref. #	Rev.	Date
EIS for the PKGT (Principally Chapter 10 – 'Hazard and risk' and Appendix D – 'Preliminary Hazard Analysis')	-	-	Nov-2018
FEED PKGT Pipeline Safety Management Study Report	401010-01496-PL-REP-0002	A	25-Oct-2018
HAZID and HAZOP Studies Report	401010-01496-SR-REP-0003	A	25-Oct-2018
Heat and Material Balances			Nov-2018
PHAST Risk Model Inputs (Excel Spreadsheet)	-	-	Nov-2018
Piping and Instrumentation Diagrams (P&IDs)			Nov-2018
Process Flow Diagrams (PFDs)			Nov-2018
Utility Flow Diagrams (UFDs)			Nov-2018
Technical Memo - STS LNG Transfer			20-Dec-2018
Technical Memo - Regassification of LNG on the FSRU			20-Dec-2018
Technical Memo - Flow and Pressure Control			20-Dec-2018
Technical Memo - FSRU Safety Systems			20-Dec-2018
Rules for Classification, Ships, Part 5 Ship types, Chapter 7 Liquefied gas tankers			Jul-2016
Rules for Classification, Ships, Part 6 Additional class notations, Chapter 4 Cargo operations			Jul-2016
Crater Depth and Width Model From Pipeline Research Committee International Report On Project PR-3-9604			Jun-1999
Tabulated consequence analysis results for full bore rupture events			
Parts count spreadsheet			
Calculation worksheet for ship collision frequency			
Preliminary Hazard Analysis Addendum	401010-01496-SR-TEN-0002	A	19-Feb-19
Additional information by email			27-Mar-19

Assessment Criteria (Acts & Regulations / Standards / Guidelines)

Title	Ref. #	Rev.	Date
Applying SEPP 33	DOP HAZ_002	-	Jan-2011
Assessment Guideline – Multi-Level Risk Assessment	DOP HAZ_003	-	Jan-2011
Environmental Planning and Assessment (EP&A) Act and Regulations	-	-	Nov-2018
HIPAP No. 4 – Risk Criteria for Land Use Safety Planning	DOP HAZ_007	-	Jan-2011
HIPAP No. 6 – Hazard Analysis	DOP HAZ_009	-	Jan-2011
HIPAP No. 10 – Land Use Safety Planning	DOP HAZ_013	-	Jan-2011
Secretary's Environmental Assessment Requirements for the PKGT	SSI 9471	-	10-Aug-2018
SEPP No 33 – Hazardous and Offensive Development	1992 No 129	-	31-Jul-2014

Other Supporting Documents and References

Title	Ref. #	Rev.	Date
A Guide to Quantitative Risk Assessment for Offshore Installations	ISBN 1 870553 365	-	1999
Consequences of Liquefied Natural Gas Marine Incidents (Pitblado, et. al.)	Process Safety Progress (Vol.24, No.2)	-	2005
Guidance on Risk Analysis and Safety Implications of Large Liquefied Natural Gas (LNG) Spill Over Water ('Sandia Report')	SAND2004-6258	-	Dec-2004

2. OBSERVATIONS

All observations relating to the document(s) reviewed (Refer to Section 1) are tabulated below. Each observation is categorised as follows.

Category 1

This category includes significant observations that may directly affect the overall assessment of the document/s being reviewed.

These observations require immediate resolution and are particularly important if information (including data and results) in the document/s being reviewed will be subsequently used in other documents.

Category 2

This category includes significant observations that may directly affect the overall assessment of the document/s being reviewed, but which do not require immediate resolution.

Category 3

An observation that should be addressed in the next revision of the document/s being reviewed. No immediate response is required for these observations.

This category includes minor observations that are unlikely to have a significant impact on the overall assessment of the document/s being reviewed. These are recorded for completeness and are expected to be addressed when the document is re-issued but are not in themselves enough to warrant a re-issue of the document.

Query

An observation that has no immediate or direct impact on the overall assessment, but where the Reviewer is seeking clarification or is seeking to highlight something for the Project's attention.

Comment

An observation providing supporting information, or an assumption made by the Reviewer during the review process. It provides information relevant to the review process and does not require a response.

Note: A cross-reference to the Acts & Regulations, Standards and Guidelines considered during the review (As listed in Section 1) is generally only included for each of the Category 1, 2 and 3 observations.

3. STATUS OF OBSERVATIONS

Category	Total Raised	Open	Closed
1	27	0	27
2	14	0	14
3	0	0	0
Query	1	0	1
Total =	**42**	**0**	**42**

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
1	**Project Description – EIS App. D (Section 3.5.1)** The Department cannot fully understand some of the proposed operations based on the information presented in the PHA. In accordance with Section 9.7 of HIPAP No. 6, please provide a description (with reference to the relevant PFD, P&ID, etc.) of the following operations and associated equipment: a. Transfer of LNG from the LNGC to the FSRU. b. Regassification of LNG on the FSRU. c. Transfer of NG from the FSRU to shore (including pressure control for pipeline). d. Odorant dosing (including refilling of the odorant tank/s). e. All equipment and operations at the tie-in point to the Eastern Gas Pipeline (EGP) at Cringila, including pig launcher/s / receiver/s, cold vent, metering, etc.	1	**Project Response 1 (21 January 2019)** a. Attachment 1: AIE PKLT - Memo STS LNG Transfer b. Attachment 2: AIE PKLT - Memo Regasification of LNG on the FSRU c. Attachment 3: AIE PKLT - Memo Pressure Flow d. Odorant injection of gas will take place prior to entering the gas pipeline to allow for detection of the gas in line with Gas Safety regulations. Odorant storage and injection will be a vendor supplied skid. Once a vendor has been selected an arrangement can be provided. Tanks will either be replaced or re-filled on site. It is expected that there will be 2x200kg tanks. e. Gas quality conditioning will be provided, including a gas analyser and nitrogen gas metering skid, to ensure the rich gas compositions comply with the required gas specifications prior to entry into the EGP network. Nitrogen supplied from a third party will be injected into the gas stream to achieve the required specification. The Kembla Grange EGP Pipeline tie-in facility controlled by Jemena will have a pig receiver and a custody gas metering station to measure the volume of gas delivered. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
2	**Project Description – EIS App. D (Section 3.5.1)** Will the FSRU be required to leave Port Kembla (PK) for maintenance (dry dock) or other operational reasons during the proposed life of the project? If so, what is proposed with respect to supply of natural gas whilst the FSRU is not available? Note: If it is proposed to temporarily use another FSRU to supply the natural gas, then this may require additional approvals.	2	**Project Response 1 (21 January 2019)** The FSRU will not leave Port Kembla over the project duration. Inspection and maintenance regime will be defined in agreement with flag state / AMSA / classification society so FSRU is subject to an extended dry-docking interval equal to project duration. **Review Response 1 (8 February 2019)** Noted and conditionally closed.	Conditionally Closed	If the development is approved, then a condition of consent should be included relating to the ongoing presence and maintenance of the FSRU. If the FSRU is required to be replaced during, or after, the project duration, then a modification to the approval (including updated Hazard Analysis) may be required.
3	**Project Description – EIS App. D (Section 3.5.1)** It is reported that transfer of LNG from the LNGC to the FSRU will occur over 24-36 hours. It is also understood that the FSRU has four cargo tanks. a. Will all four cargo tanks be filled simultaneously? b. Will the FSRU continue to export gas while filling the cargo tanks? If simultaneous operation is part of normal operation, then please provide details of the safety systems proposed to detect and mitigate an incident. For example, will detection of a leak result in automatic shutdown of the LNGC transfer and/or export of gas?	1	**Project Response 1 (21 January 2019)** There are four cargo tanks. Tanks can be filled simultaneously if required. This could occur in the following manner - Prior to loading a new LNG parcel which may have a different composition, LNG from tanks #2, #3 and #4 may be moved to tank #1. LNG stored in tank #1 will then be regasified and sent to shore. Tanks #2, #3 and #4 will be loaded first, before tank #1 is filled up with the reminder of the new LNG parcel. FSRU will continue to export gas while filling the cargo tanks (see explanation/example above). Attachment 4: AIE PKLT - Memo Transfer ESD between LNGC_FSRU_Jetty **Review Response 1 (8 February 2019)** The safety systems described in the attachment appear to be comprehensive. Noted and conditionally closed.	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The effectiveness of the safety systems included in the final design should be specifically addressed in the Final Hazard Analysis.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
4	**Project Description – EIS App. D (Section 3.5.1)** It is reported in Section 3.5.1 of the PHA that: "Purpose built cryogenic flexible hoses will be used to transfer LNG from visiting LNG carriers to the FSRU. It is expected that the FSRU itself will have five hoses which will include four for receiving LNG and one for maintaining a balance of vapour between the ships." Please advise whether hoses and / or Marine Loading Arms (MLAs) will be provided for transferring LNG from the LNGC to the FSRU. This question has been raised due to the following observations: • The image on the cover sheet of the EIS shows MLAs on the FSRU (for connection to LNGC) and on shore. • The detailed P&IDs show an Emergency Release System (ERS) is provided on the starboard side of the FSRU. • The modelling input (Excel) file from the risk software does not appear to include a release from the hoses; however, some consequence analysis results are included in the PHA. If hoses are used, then please: a. Provide the diameter of each hose for the liquid and vapour. b. Confirm the number of transfer hoses that will be operated simultaneously (Also refer to ID # 3) c. Provide the liquid and vapour transfer rates (total and per MLA / hose) and advise whether these rates are based on transfer over 24 or 36 hours.	1	**Project Response 1 (21 January 2019)** LNG transfer hoses will be used for ship-to-ship operations. Refer to Attachment 1: AIE PKLT - Memo STS LNG Transfer for details. The hoses were included. The modelling input excel file descriptions are misleading. The excel file rows for MLAs - loading arms are meant to represent the LNG loading hoses between the LNGC and FSRU. The MLAs - unloading arms in the excel file are meant to represent the Marine Loading Arms from ship to shore. Different failure data was used for the hoses and MLAs accordingly. a. There will be 6 x 10" multi-LNG white hoses (Gutteling), 15.5m long, with a maximum working pressure of 10bar. b. The 6 hoses will be used simultaneously: 4 for LNG transfer and 2 for vapour return. c. The maximum LNG transfer rate will be 9,000m3/h, i.e. 2,250m3/h per hose. This rate will allow to offload a 170,000m3 LNGC in approximately 26 hours (flanging to cast-off). **Review Response 1 (8 February 2019)** Noted and closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
5	**Project Description – EIS App. D (Section 3.5.1)** It is reported in Section 3.5.1 of the PHA that the regasification units are typically at the bow or centre of the FSRU. The PHA has assumed that the regasification units are at the bow of the FSRU. If the regasification units may be at the centre of the FSRU, then the affect on the risk contours should also be demonstrated in the PHA.	2	**Project Response 1 (21 January 2019)** Post issue of the PHA a FRSU with regasification unit at the bow has been selected. **Review Response 1 (8 February 2019)** Noted and conditionally closed.	Conditionally Closed	Alternative locations of the regasification unit may affect the risks to the surrounding land uses. Therefore, if the development is approved, a consent condition should be included to stipulate the regasification unit must be located at the bow (i.e. as assessed in the PHA).
6	**Project Description – EIS App. D (Section 3.5.1.1, 3.5.2.1 and App. B)** More information should be provided in the PHA for the proposed control measures, particularly where these control measures were factored into the risk analysis. For example: a. Safety instrumented systems (e.g. HIPPS, SIL rated systems). b. Leak detection systems. c. Blowdown systems. For example: i. What situations will trigger a release to the cold vent? ii. How quickly the system can be depressurised? d. Emergency isolation systems (e.g. Emergency Release System for the MLAs). For example: a. What situations will trigger isolation? b. How quickly critical isolation valves will close in the event of emergency (ESD response time)? e. Fire detection and protection systems (both active and passive).	1	**Project Response 1 (21 January 2019)** Risk modelling uses initial discharge rates with no credit taken for safeguards. So the assessment is conservative. As the FSRU has now been selected there is more certainty about the design and operational safeguards. Additional HAZID Studies will be completed in the execute phase HAZID and further detail added as the design is finalised. DNV-GL classification of the FSRU will be carried out in line with the DNV-GL classification requirements outlined in the following two documents: Attachment 5: Rules for Classification - Ships - Part 5 Ship Types - Chapter 7 Liquefied Gas Tankers; and Attachment 6: Rules for Classification - Ships - Part 6 Additional Class Notations - Chapter 4 Cargo Operations. **Review Response 1 (8 February 2019)** The PHA should assess the risk based on the preliminary design, it should consider the worst-case scenarios, and it should err on the side of conservatism.	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The effectiveness of the safety systems included in the final design should be specifically addressed in the Final Hazard Analysis. If the development is approved, then a condition of consent should be included to require submission of the class certificate/s and to ensure validity of the certificate/s is maintained throughout the operating life of the FSRU.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
	It is recognised that some details may not be available at this stage; however, the PHA should review the adequacy of the proposed or existing safety related hardware, and operational and organisational safeguards, and should take due regard of these controls in the risk analysis (Refer to HIPAP No. 6, Section 3). The information provided in the HAZID table (App. B) is currently too generic. Note: It is understood that the FSRU will be classed by DNV-GL and that this will include the safety systems. If available, the specific requirements for acceptance of the safety systems by DNV-GL might provide some of the detailed descriptive information for the safety systems proposed on FSRU.		If the development is approved, then a Final hazard analysis (FHA) will be required and this should be based on the final design and should take account of all relevant safeguards. Noted and conditionally closed.		If the development is approved, then a condition of consent shuold be included to require periodic independent Hazard Audits. The safety systems must be reviewed during these audits.
7	**Project Description – EIS App. D (Section 3.5.2)** The preliminary layout drawing in Appendix A if the EIS is not the same as Figure 3-5 the PHA (e.g. firefighting water tanks are in a different location). Please confirm which figure shows the correct layout.	2	**Project Response 1 (21 January 2019)** The drawing in Figure 3-5 is 401010-01496-GE-DWG-007-001. The latest revision (Rev C) was issued in December 2018 which shows the fire water tanks in an updated location compared to Figure 3-5. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	
8	**Project Description – EIS App. D (Section 3.5.3)** Some of the information presented in the PHA for the proposed pipeline appears to be inconsistent. For example, in Section 3.5.3 of the PHA, it is reported that the gas pipeline will be DN 400 with an MAOP of 14.895 MPag. However, in Table 6-5 of the PHA, the pressure of the natural gas supplied from the regassification module to the pipeline is reported to be 12MPag and the diameter is reported to be 450 mm on Figure 1-1.	1	**Project Response 1 (21 January 2019)** EGP is owned and operated by Jemena with DN450 main trunkline and MAOP of 14.895 MPag as specified by Jemena EGP Operations Manual (GTS-599-OM-GEN-001). The EGP is outside the risk modelling scope. At the current stage of the project the new pipeline is DN450 with a MAOP of 14.72 MPag. However, the operating pressure in the new pipeline is limited FSRU maximum supply pressure of 12 MPag. The risk calculations use a pressure of 12 MPag.	Conditionally Closed	If the development is approved, then a condition of consent should be included to limit the MAOP for the proposed pipeline to 12 MPag (i.e. as assessed in the PHA). If the development is approved, then the final design of any above ground equipment associated with the pipeline (e.g. at the Cringila tie-

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
	It is understood that the MAOP for the Eastern Gas Pipeline (EGP) is up to 16.55 MPa with a pipeline diameter of 450 mm. Please confirm the diameter, MAOP and operating pressure of the proposed pipeline and advise if this differs from the data currently used in the risk calculations. If the MAOP of the proposed pipeline is less than the MAOP for the Eastern Gas Pipeline, then this should be considered in the PHA. Similarly, if the proposed operating pressure for the proposed pipeline is less than the operating pressure of the EGP, then this should be considered in the PHA (i.e. is a booster station required at the Cringila tie-in?). Please also identify any aboveground sections of the pipeline (e.g. to cross over waterways etc.) and any other above ground equipment associated with the pipeline (e.g. at the Cringila tie-in). Aboveground pipelines and equipment may require specific consideration in the risk analysis (e.g. due to higher failure frequency rate).		If the operating pressure within EGP raises to and above the 12 MPag, then the supply of gas from the FSRU to EGP will stop and wait for condition to return to normal. It is understood that the EPG normal operating pressure is 8 to 11MPag Ref Process Design Philosophy (401010-01496-PR-PHL-0001) No aboveground crossings. Aboveground section at start of pipeline and at Cringila tie-in considered in PHA. **Review Response 1 (8 February 2019)** The MAOP of the proposed pipeline is noted and conditionally closed. Please provide the leak frequencies used in the PHA for the aboveground sections at the start of the pipeline and at the Cringila tie-in. **Review Response 2 (15 March 2019)** The requested leak frequency data was not provided; however, the equipment associated with the aboveground sections of the pipeline (e.g. at the Cringila tie-in) are included in the parts 'Parts count spreadsheet' and appear to have been included in the PHA (As per project response 1 above). If the development is approved, this data will be reviewed again at the FHA stage for the detailed design.		in) should be specifically addressed in the Final Hazard Analysis.
9	**Project Description – EIS App. D (Section 3.7)** A 'preliminary fire safety study', which is required to comply with the SEARs, should be submitted to the Department. The information provided in Section 3.7 of the PHA is insufficient. A detailed fire safety study (in accordance with HIPAP No. 2) is likely to be required if the development is approved. Therefore, the 'preliminary fire safety study' required at the	1	**Project Response 1 (21 January 2019)** A detailed Fire Safety Study will be completed early in the execute phase. The following firefighting provisions have been included in the design: - 3 monitor towers to provide coverage of the FSRU - 2 x 1680KL onsite fire water storage tanks - Two Class A firefighting tugs	Conditionally Closed	If the development is approved, a condition of consent should be included to require a detailed fire safety study (in accordance with HIPAP No. 2).

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	pre-approval stage is expected focus on preliminary considerations such as: • Is firefighting water available at this location? • How much on-site storage is likely to be required? • Are the two required Class A firefighting support ships currently available? • Is there sufficient space at the proposed site to ensure the firefighting equipment on shore is accessible for firefighters and protected from damage due to incidents on the LNGC or FSRU or from neighbouring facilities?		- Fire water tanks and emergency response control room located outside 25mm jet fire radius from the FSRU, onshore piping and pipeline. **Review Response 1 (8 February 2019)** Noted and conditionally closed.		
10	**Hazard Identification – EIS App. D (Section 5.1)** It is reported that an odorant will be dosed into the natural gas supply to the EGP. The odorant is flammable and is a potential irritant. This material should be included in the risk analysis and assessment (Also refer to ID # 14 and 39). Note: Details of <u>all</u> Dangerous Goods that will be stored or handled within the site boundary, including storage quantities and transport frequency (if applicable), should be provided in the PHA and considered in the hazard and risk analysis accordingly.	1	**Project Response 1 (21 January 2019)** Final selection of the odorant chemical compound has not yet been occurred. However, the odorant to be used will be non-toxic. On site storage is expected to be small 2 x 200kg tanks. The tanks will be refilled via truck transfer or the tanks changed out on site. Given the small volume stored onsite inclusion in the risk calculations is expected to have a minor impact on both onsite and offsite risk. **Review Response 1 (8 February 2019)** Also refer to ID # 39. The risk of acute toxic injury and the risk of irritation from exposure to a release of potentially toxic materials (e.g. Odorant – refer to ID # 10 and 14) should be analysed and assessed against the relevant DP&E risk criteria from HIPAP No. 4. Note: Based on the location and inventory, it may be sufficient to demonstrate that the consequences do not reach residential or sensitive use areas.	Conditionally Closed	If the development is approved, the final design of the odorant system should be specifically addressed in the Final Hazard Analysis.

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			Project Response 2 (15 February 2019) Refer to 'Preliminary Hazard Analysis Addendum' (Section 6). **Review Response 2 (15 March 2019)** It is reported in the 'Preliminary Hazard Analysis Addendum' that the consequences of a release of odorant do not reach residential or sensitive use areas. This is based on dispersion analysis for representative leak sizes of 10 mm, 25 mm and 50 mm (Max.) and exposure concentrations of 25 ppm (ERPG-2) for irritation and 100 ppm (ERPG-3) for acute toxic injury. The use of ERGP-2 and ERPG-3 does not align with the DP&E criteria; however, the distance to residential or sensitive use areas appears to be sufficiently large to ensure compliance with the DP&E criteria (i.e. even if lower concentrations were used). If the development is approved, then the final design of the odorant system should be reassessed in the FHA. Conditionally closed.		
11	**Hazard Identification – EIS App. D (Section 5.1.1)** From Section 5.1.1, it is understood that 'rich' LNG may be delivered to the FSRU. Will Jemena accept 'rich' blend natural gas for the EGP? If not, then how will this be managed?	1	**Project Response 1 (21 January 2019)** Gas quality conditioning will be included for incoming rich gas to comply with the required gas specification (High Heating Value (HHV) and Wobbe Index correction). The gas conditioning facilities consist of gas analyser and nitrogen gas metering skid which analyses the incoming natural gas and determines the amount of nitrogen required for injection. Refer to project BOD (401010-01496-PM-BOD-0001) for more information. **Review Response 1 (8 February 2019)** Gas quality conditioning is unlikely to be a significant risk contributor. Noted and conditionally closed.	Conditionally Closed	If the development is approved, the risks associated with the gas conditioning equipment should be specifically addressed in the Final Hazard Analysis.

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12	**Hazard Identification – EIS App. D (Section 5.1.1)** From Section 5.1.1, it is understood that LNG will be delivered from various sources and may include 'rich' LNG. The potential for stratification and a 'rollover' event should be considered in the analysis as the potential vapour release may be significant. The proposed control measures to detect and mitigate stratification should also be identified in the PHA.	1	**Project Response 1 (21 January 2019)** It is expected that the FSRU may have to handle a wide range of available LNG compositions. Current established Industry procedure to prevent potential rollover in this situation is as follows: 1. Combine any remaining LNG in the same tank prior to loading, generally tank #1 (smallest tank) is used. 2. Continue send-out to the regasification system from this tank to "empty" the tank while loading the other tanks. 3. If the send-out is not sufficient to empty the tank before loading new LNG, either re-distribute the remaining LNG into the already filled tanks or load LNG at a low rate into the remaining tank; This depends on the cargo densities and volumes being loaded. Density Profile Measurement System (DPMS) is an extension module to the K-Cauge Custody Transfer System from Kongsberg Maritime and is included on the FSRU. The DPMS allowing the Radar Tank Cauge to be used as a combined level gauge and densimeter and comes with a built-in LNG aging tool to prevent rollover scenarios. To avoid layering in an LNG tank, Cargo Tank no.1 is equipped with both top and bottom filling to ensure correct mixing of old and fresh LNG. The radar based densimeter continuously measure the density profile down the tank, and together with level, temperature and pressure inputs, the system will give the operator instant information status of the situation in the tank. Further, SIGTTO doc. "Guidance for the Prevention of Rollover in LNG Ships" is implemented.	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The effectiveness of the safety systems included in the final design should be specifically addressed in the Final Hazard Analysis.

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			Review Response 1 (8 February 2019) Noted and conditionally closed.		
13	**Hazard Identification – EIS App. D (Section 5.1.2)** It is reported in Section 5.1.2 of the PHA that Glycol is used in the regassification process. It is understood from the detailed P&IDs that glycol is also used in the cargo machinery room. The glycol in the machinery room appears to be heated by steam / electric heaters and the glycol in the regasification process is only heated by sea water. Is this correct? Is (or can) the glycol be heated to above its flash point in the cargo machinery room? If so, what controls are provided and how has a potential fire been addressed in the PHA?	2	**Project Response 1 (21 January 2019)** Glycol is used as intermediate loop for regasification and is heated by sea water. Hot glycol water heating system for cofferdams is heated by steam from engine room. The glycol in the regasification process is used as intermediate medium to regasify the LNG. A hot glycol water heating system is also used to maintain the temperature within cofferdams. The steam pressure could be as high as 8 barg at 170 °C. Depending on the type of glycol used, the steam temperature could exceed the glycol flash point. Pool fire within the machinery room will be localised and subject to the on-board fire containment and fire-fighting measures and would not impact other port users. See ID 9 - Inclusion of available FSS details into PHA. See also 31 below. **Review Response 1 (8 February 2019)** The potential for escalation should be addressed (As required in HIPAP No. 6). **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 4 and Appendix C). **Review Response 2 (15 March 2019)** Consequence analysis results for a glycol spill are included in the 'Preliminary Hazard Analysis Addendum' (Appendix C). It is also reported in Section 6 that 'The glycol heating system design is currently not known as no detailed P&IDs are available, but it is expected that it will be a small system with minimal potential	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The final design of the glycol system should be specifically addressed in the Final Hazard Analysis.

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			leak sources and subsequently a low leak frequency'. This is a reasonable assumption (based on preliminary design information); however, if the development is approved the final design should be reassessed in the FHA. Conditionally closed.		
14	**Hazard Identification – EIS App. D (Section 5.2 and App. B) & HAZID and HAZOP Studies Report** The Department has reviewed the PHA report, HAZID and HAZOP Studies Report and the modelling input (Excel) file from the risk software. It is unclear from this review whether the PHA has identified and considered all potentially hazardous incidents, including (but not limited to): a. Ship collision resulting in a spill onto water and a pool fire, flash fire, VCE and/or RPT rapid phase transition (RPT). The potential for collision should be considered for all relevant vessel movements, including: i. Entry of the LNGC into Port Kembla through the outer and inner harbour. ii. Departure of the LNGC from Port Kembla through the outer and inner harbour (Possibly only relevant if the LNGC is still laden with a significant quantity of LNG). iii. Manoeuvring the LNGC alongside the FSRU. iv. Other vessels passing the moored LNGC or FSRU. Note: This case appears to have been included in the PHA; however, it is not clear if the consequences of a spill onto water have been addressed. b. A release of LNG during entry / departure of the LNGC into / from Port Kembla through the outer	1	**Project Response 1 (21 January 2019)** a. As per Table 6-8 ship collision was modelled as leading to pool fire and flash fire. VCE was not considered a credible scenario as there was not considered to be enough congestion or confinement required to lead to an explosion. RPT is a very rapid physical phase transformation of LNG liquid to methane vapour mainly due to submersion in water. RPT does not involve any combustion and cannot be characterised as a detonation. The pressure pulse created by small pockets of LNG that evaporates instantaneously when superheated by mixing in water, will travel by the speed of sound and decay as any other pressure pulse. Underwater the overpressure is typically of short duration and attenuated rapidly by distance by the water itself. In the air the overpressure may be of longer duration but typically of a lower magnitude, damaging only to less robust structures. The worst case consequence of RPT due to ship collision would then be further damage to the already punctured hull increasing the rupture size. The ship collision already models a 1m2 ship leak size and therefore RPT is not considered further. [LNG Risk Based Safety - Modelling and Consequence Analysis by J.L.Woodward and R.M.Pitblado, 2010] & [Rapid Phase Transition of LNG by BG Plc, Gaz de France and NTNU]. i. During the QRA modelling it was found that the risk contours are driven largely by the high pressure process streams on the FSRU. The LNGC (present for only 1 day	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of compliance with the Department's risk criteria and demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The items identified in ID#14 should be specifically re-evaluated by the Department when this information is provided for the final design.

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	and inner harbour (e.g. due to equipment failure, grounding, etc.). c. All incidents that may result in a spill onto water and a subsequent pool fire, flash fire, VCE and/or RPT rapid phase transition (RPT). Note: Some potential incidents are identified in the PHA (e.g. a leak from a transfer hose / MLA leakage during ship to ship transfer, etc.); however, it is unclear whether all relevant initiating events and consequences have been adequately addressed. d. A release due to unintended decoupling of multiple MLAs or transfer hoses (e.g. due to adverse sea or weather conditions, mooring failure, etc.) (Refer to ID # 32). e. Overfilling of the LNG tanks on the FSRU. f. Stratification and 'rollover' events (Refer to ID # 12). g. Escalation of events between the LNGC or FSRU. For example, a fire or explosion onboard one vessel impacting upon equipment on the same or adjacent vessel (e.g. unloading manifolds, regasification units, etc.). h. Any potential escalation of events from the LNGC or FSRU to wharf side equipment (e.g. firefighting equipment, odorant storage tank/s, etc.). i. A release of odorant (Refer to ID # 10). j. The potential for BLEVE incidents (Refer to ID # 15). k. The potential for an unintended release via the cold vent.		every 2 weeks, with considerably fewer leak sources and a low pressure inventory) only slightly contributed to extending the risk contours around the LNGC into the harbour. Therefore the entry of the LNGC, a moving vessel entering the harbour once every 2 weeks, was considered a low contribution to the risk contours, that would make a negligible impact on the overall risk contours. ii. Similar to the comment response above to item (i) the departure of the LNGC occurs only briefly every 2 weeks. Additionally it should be empty of inventory as the likelihood of the LNG not being unloaded is not considered a credible scenario taking into account the cost associated with and LNGC delivery. iii. As discussed in Section 7.2.3 for a ship collision to lead to hull puncture it must have enough kinetic energy as dictated by its weight and speed. A heavy vessel such as the LNGC would lead to hull puncture at a speed of 2.5 knots. When the LNGC is manoeuvred alongside the FSRU this will be done with tugs at very low speed and a collision of this sort leading to a LOC is considered unlikely. iv. The ship collision into the moored LNGC or FSRU was considered. As per Table 6-8 this was considered to lead to pool fire and flash fire. These were modelled as a horizontal LOC. b. See ID 14. I & ii. Regarding grounding, in the history of LNG shipping, LNG carriers have rarely been involved in collisions and groundings and none of these collisions and groundings led to a breach of an LNG tank. Because of the design of LNG carriers (e.g. double hulls), breach of containment from a collision is a risk only if an LNG carrier collided with another vessel of a large enough size,		

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	The potentially hazardous incidents and outcomes listed above should also be included in the hazard and risk analysis as appropriate.		going at or above a certain speed and striking the LNG carrier at a specific angle. In summary, collisions and groundings involving an LNG carrier are expected to be very rare events and collisions and groundings that lead to the piercing of two hulls and the tank walls of an LNG carrier are expected to be even rarer. Damage of LNG tank in ship can occur only when the hulls are breached by high energy collisions. Grounding within the harbour is considered to be an unlikely event as tanker movement within the inner and outer harbour is controlled by the port authority with tugs at low speed. The frequency of grounding in the bay is estimated to be in the 10-8 pa range using shipping collision calculation technique from CMPT. Assuming rupture and fatality are given, the incremental of risk would be insignificant and outside of 5E-07 pa HIPAP risk level. c. PHAST "vessel or pipe source" model was used for all specified leak sizes. This mode includes discharge calculations to obtain the release rate and state, and fire, explosion and toxic (if any) calculations to obtain representative effect zones for the dispersing cloud. RPT has been excluded as the consequential impacts are limited to the LNG and water mixing zone as noted previously. d. The loading and unloading of LNG failure rates have been incorporated into MLAs model folder as Loading Arms and Unloading Arms. The failure data is sourced from TNO Purple Book, Table 3.21, with a 15% safety factor. The failure rate used is higher than those specified in the UKHSE Failure Rate and Event Data for use within Risk Assessment (28/062012) (i.e. ship hardarm transfer). Therefore, the failure rate used is considered to be conservative.		

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			The mooring system has been designed for a 1 in 100 year storm surge and infragravity wave occurrences as outlined in the Basis of Design (401010-01496-PM-BOD-0001) Section 7.2 & 7.5. e. UKHSE HCRD used accounts for design faults, equipment faults, operational faults and procedural / human error. Accidental events such as overfilling with control failures resulting in liquid in vapour lines leading to material damage and LOC would required to be reported to UKHSE and captured in the HCRD. Therefore, overfilling of FSRU is not included separately as it would be considered as double counting of LOC events. f. See ID 12. g. While jet fires may reach the adjacent vessel, explosion contours were typically limited to the vessel itself. The risk modelling does not take credit for the mitigation measures implemented, so risk calculated is conservative. Escalation has not been considered. h. The wharf is located well below the process equipment deck of LNGC and FSRU, where direct flame impingement is unlikely. The risk modelling does not take credit for the mitigation measures implemented, so risk calculated is conservative. Escalation has not been considered. I. See ID 10 j. See ID 15. k. Cold vent has been designed with the worst case relief event where radiation at 2m above grade is below 6.31 kW/m2. **Review Response 1 (8 February 2019)** It is understood that a spill on water may result in RPT, which is generally associated with a localised overpressure effect. However, ignition of an LNG spill on water may potentially have		

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			a significant heat radiation impact. Additional information should be provided to demonstrate the risk from pool or flash fire events that result from a spill on water. Such 'worst-case' events may include multiple transfer hose failures, multiple MLA failures, tank rupture due to ship collision, tank overfilling, etc. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Sections 2 and 3). **Review Response 2 (15 March 2019)** Multiple hose (x6) and single MLA failure events are included in the 'Preliminary Hazard Analysis Addendum' (Sections 2 and 3) and the individual fatality risk contours have been re-estimated (Sections 2 and 11). Additional analysis of ship collision, grounding, etc. is included in the 'Preliminary Hazard Analysis Addendum' (Section 3) and the individual fatality risk contours have been re-estimated (Sections 3 and 11). This includes vessel movements through the harbour and is based on data applicable for port waters.		
15	**Hazard Identification – EIS App. D (Section 5.5.3)** The PHA should address the potential for BLEVE incidents for all relevant equipment (e.g. LNG suction drum, odorant tanks, etc.).	2	**Project Response 1 (21 January 2019)** There is no recorded incident where a BLEVE occurred on a LNGC / FSRU. All the recorded incidents are all on onshore facilities / roads. Hence, likelihood of BLEVE on a LNGC / FSRU is expected to be very low as sequence of multiple event would need to align: - Large LOC - Ignition occurs - Vessel in area and impinged - Vessel relief valve fails / incorrectly designed and undersized - F&G detection system fails to detect	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The potential for BLEVE, and the associated mitigation measures, should be

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			- Isolation and blowdown system fails The detailed Fire Safety Study will review the potential for BLEVE and vessel survivability. **Review Response 1 (8 February 2019)** It is acknowledged that a BLEVE involving equipment such as the LNG suction drum, odorant tanks, etc. could have a significant impact on site; however, is unlikely be a major risk contributor off site. The potential for BLEVE should be considered further in the FHA and FSS.		considered further in the FHA and FSS.
16	**Hazard Identification – EIS App. D (Section 5.5.5)** It is reported in Section 5.5.5 of the PHA that the consequences of a Rapid Phase Transition (RPT) can be severe but are highly localised within or in the immediate vicinity of spill area. Please clarify whether RPT was considered for a spill of LNG due to: (i) ship collision; and, (ii) failure of the transfer hoses / MLAs during LNG transfers from the LNGC to the FSRU. For scenario (ii), the LNGC will be moored alongside the FSRU and this may exacerbate the consequences of a RPT due to the potential confinement (i.e. expansion is constrained). The PHA should provide additional justification for excluding RPT events from the analysis (e.g. additional analysis to demonstrate that the effects are localised and will not result in escalation). Control measures to prevent or mitigate RPT should be included in the PHA.	2	**Project Response 1 (21 January 2019)** (i) Refer also to item 14a which discusses RPT due to ship collision. (ii) As discussed in item 14a RPT occurs due to mixing of LNG and water leading to overpressure underwater and above water. The most likely case in which enough mixing would occur to lead to RPT would be if a transfer hose failure led to one end disconnecting and falling below water while LNG was still pumped through. Even if RPT were to occur the overpressure generated is not considered to reach levels which could lead to rupture not only of the ship outer hull (20-26mm thick) but also the inner hull (20mm thick) and the LNG tank. Therefore, no credible consequences were identified and the scenario was not considered further. Even with the LNGC moored next to the FSRU there is typically distance of a few meters between them. Additionally, confinement will only be partial, on both sides, but without confinement in the up and down directions. Considering the already low and rapidly attenuated overpressure levels from RPT, the partial confinement is not considered to cause these to be increased to levels that will cause rupture of the ships outer and inner hulls and LNG tanks.	Conditionally Closed	Refer to ID # 14.

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			RPT is a very rapid physical phase transformation of LNG liquid to methane vapour mainly due to submersion in water. RPT does not involve any combustion and cannot be characterised as a detonation. The pressure pulse created by small pockets of LNG that evaporates instantaneously when superheated by mixing in water, will travel by the speed of sound and decay as any other pressure pulse. This is unlikely to damage large structural elements of a ship. No specific modelling is undertaken for RPT as it is unlikely to increase the hazard range of a major releases that has already occurred. See ID 12.g **Review Response 1 (8 February 2019)** Refer to ID # 14. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 2). **Review Response 2 (15 March 2019)** Refer to ID # 14.		
17	**Consequence Analysis – EIS App. D (Section 6.1)** It is reported in Section 6.1 that an older version of SAFETI (v.6.7) was used. Please justify why the latest software has not been used (v. 8.11) and identify any potential implications for the analysis.	2	**Project Response 1 (21 January 2019)** WorleyParsons currently only has version 8.11 for PHAST and not PHAST-Risk. As per PHAST 8 release note, DNV GL Webinar Presentation held on 23/11/17 and inhouse software testing, the main differences between version 8 and 6.7, in respect to the FSRU risk modelling, are the improved dispersion calculation which generates more realistic shorter impact distances for low wind condition. The UDM in PHAST 6.7 produces more conservative impact distances compared to PHAST 8.11, therefore the risk modelling is conservative and still applicable. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
18	**Consequence Analysis – EIS App. D (Section 6.3)** The majority of the consequence modelling for the LNGC and FSRU assumes a release at 14 m above ground level. Justification for the 14 m release height should be provided, particularly as some events could occur closer to ground level (e.g. a release from the MLA on shore). Also, some might result in a flow of liquid over the side of the vessel (e.g. major liquid release on the deck) or be directed downward (e.g. release from MLAs / hoses). If the current assumption is not sufficiently conservative (as required to comply with HIPAP No. 6), then the release height should be amended accordingly.	1	**Project Response 1 (21 January 2019)** 14m is the estimated averaged equipment height of the LNGC and FSRU above the wharf and onshore equipment. Currently the FSRU unloading arm is modelled at 14 m above wharf. Release from the onshore piping have been modelled at 1m above grade. The leak from the MLA was modelled in all 3 directions (horizontal, vertical down and vertical up). Some sensitivity checks during the QRA modelling showed that varying a release height between 0-14m had negligible impact on the overall risk contours. Changing the MLA release to, for example, 7m would therefore make no notable difference to the results. **Review Response 1 (8 February 2019)** Please provide the assumed probability distribution for the 3 directions (i.e. X% horizontal, Y% vertical down and Z% vertical up). **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 9). **Review Response 2 (15 March 2019)** The assumed probability distribution for the 3 directions (i.e. X% horizontal, Y% vertical down and Z% vertical up) is reported in the 'Preliminary Hazard Analysis Addendum' (Section 9). It is reported that 25% were modelled as vertical down (with exception of leaks from the tanks or the underground pipeline).	Closed	
19	**Consequence Analysis – EIS App. D (Section 6.3 and App. C)** It is reported in the PHA that a release from the storage tanks on the LNGC or FSRU due to ship collision is assumed to cause a 1 sqm equivalent hole size (equivalent to c. 1.1 m diameter hole) at 7m above ground level. Conservative representative release heights should be considered to comply with HIPAP No. 6 and the potential for	1	**Project Response 1 (21 January 2019)** Although the rupture point has been modelled to be a 7m above wharf (representing the bow height of the impacting ship), the LNG liquid release is conservatively modelled with 14m head. The LNG Pool Fire Modelling White Paper considers 3 categories of LNG releases: A hole above the water surface (category 1), a hole at or close to the water surface (category 2), and a hole	Closed	

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	a leak at or below the water line may be credible (Based on the schematic drawings of the FSRU provided in the PHA). A release from the tank at a lower location on the vessel will have a higher release pressure due to the higher tank head and should be considered in the analysis. Similarly, a release below the water line should be considered in the analysis as this will affect the consequence modelling. The representative equivalent hole size appears to be consistent with published values (e.g. 0.5 to 1.5 m diameter is reported in the paper 'Consequences of Liquefied Natural Gas Marine Incidents' by Pitblado, et. al.)		underwater (category 3). Category 2 leaks are recommended to be the focus of consequence and risk analysis due to the driving pressure being at its maximum resulting in larger spill rates and volumes. Therefore, ship collision was modelled at the category 2 height, which lead to the more conservative risk results, rather than splitting the leak frequency between the 3 leak locations. **Review Response 1 (8 February 2019)** Please provide all consequence analysis results for the tank rupture scenarios. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 3 and Appendix B). **Review Response 2 (15 March 2019)** Consequence analysis results are included in the 'Preliminary Hazard Analysis Addendum' (Section 3 and Appendix B) and the individual fatality risk contours have been re-estimated (Sections 3 and 11) based on the revised ship collision frequencies (Refer to ID # 14).		

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
20	**Consequence Analysis – EIS App. D (Section 6.3)** It is reported in Section 6.3 that the pipeline leaks were modelled as 20% vertical and 80% at 45 degrees. The justification for this assumption, with cross-reference to relevant sources, should be provided (Note: The potential for a horizontally orientated release due to third party activity from 'horizontal directional drilling' should also be considered).	2	**Project Response 1 (21 January 2019)** The angle is based on the Crater Depth and Width Model from the Pipeline Research Committee International Report, PR-3-9604, June 1999, using soil type of mixed or gravel (Refer to Attachment 7). It is more likely that pipeline puncture would be caused by an excavator above the pipeline rather than horizontal drilling which would be require detailed engineering and planning prior to drilling. Additionally, if horizontal drilling does rupture the pipeline, it is likely that the surrounding soil would be blown away creating a crater and 45 degree release. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	
21	**Consequence Analysis – EIS App. D (Section 6.5)** What surface temperature was assumed for a spill on water and a spill on land? Note: the evaporation and burning rate for a spill on water may be higher than for a spill on land. This should be considered in the consequence analysis.	2	**Project Response 1 (21 January 2019)** The surface temperatures used for water are the same as those used for ground as specified in Table 6-3. These temperatures are lower than the ambient air temperature and range between 17 - 25C. The PHAST pool evaporation model on water takes into account the higher heat conductivity rate. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
22	**Consequence Analysis – EIS App. D (Section 6.7)** The pressure used in the consequence modelling for the proposed pipeline is reported to be 12 MPag, which is lower than the reported MAOP (14.895 MPa). Is 12 MPag the correct pressure for modelling releases from this pipeline, particularly based on the observations in ID # 8? What pressures were used for the release cases that are not listed in Table 6-5 (e.g. during transfer of LNG from the LNGC to the FSRU)? The pressure reported for the LNG from the tanks to the regassification units (550 kPag) may be too low and should be reviewed (c.f. The detailed P&IDs indicate a design pressure of 1.3 or 1 MPag for the liquid cargo lines and 1.5 MPag for the suction drum to the booster pumps).	1	**Project Response 1 (21 January 2019)** 12 MPag is the design pressure and MAOP of the FSRU. The new pipeline design pressure is 14.72 MPag but operating pressure within the pipeline will be limited to 12MPag. Also see ID 8 response. 5.50 barg @ -160 °C, as per Scenario 3 conditions for the LNG pumped out of the FSRU storage tanks. These conditions were used both for LNG transfer from the LNGC. Attachment 2: AIE PKLT - Memo Regasification of LNG on the FSRU The LNG from the ship's cargo tanks is delivered by regas feed pumps at a pressure of ~ 5.5 barg and -160 °C. **Review Response 1 (8 February 2019)** Noted and closed (Also refer to ID # 8).	Closed	Refer to ID # 8.
23	**Consequence Analysis – EIS App. D (Section 6.8)** The results presented in Table 14 of the PHA indicate that an overpressure of 35 kPa could occur from an explosion in the cargo machinery room explosion. This may potentially impact other equipment or pipework at deck level. Similarly, an explosion at a regassification unit may potentially impact other equipment or pipework at deck level. The potential for incident escalation due an explosion on the LNGC or FSRU should be considered in the PHA.	1	**Project Response 1 (21 January 2019)** Explosion modelled from the cargo machinery room assumes all leaks within this room will lead to an explosive atmosphere and does not account for the mitigation systems available. Additionally, the 35kPa would need to first damage the cargo machinery room walls before it could impact other equipment or pipework. As the risk modelling does not take credit for the mitigation measures implemented, risk calculated is conservative. **Review Response 1 (8 February 2019)** The potential for escalation should be addressed (As required in HIPAP No. 6). **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 5).	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The potential for escalation should be specifically addressed for the final design in the Final Hazard Analysis.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Review Response 2 (15 March 2019) Consequence analysis results for an explosion on the LNGC or FSRU are included in the 'Preliminary Hazard Analysis Addendum' (Section 5). If the development is approved, then the potential for escalation for the final design should be reassessed in the FHA. Conditionally closed.		
24	**Consequence Analysis – EIS App. D (Appendix C)** The consequence modelling results present in Appendix C of the PHA only include hole sizes up to 100 mm. Please provide representative consequence results for the larger release cases (e.g. FBR events, leaks from the tanks on the LNGC or FSRU, etc.). Also, consequence results for multiple hose or MLA failures (e.g. due to vessel movement during transfers) should be included as appropriate (Refer to ID # 4).	1	**Project Response 1 (21 January 2019)** The results were updated to also present the full bore rupture results based on the largest full bore sizes used in the QRA for each of the 6 scenarios (Refer to Attachment 8). As per the QRA basis outlined in Section 6.4 for the full bore leaks the release rate were limited to the maximum production flow rate and the consequence results are based on this. **Review Response 1 (8 February 2019)** Also refer to ID # 26. Consequence results for multiple hose or MLA failures (e.g. due to vessel movement during transfers) should be included (Refer to ID # 14). The risk results should be amended accordingly to include these 'worst-case' events (which may potentially result in a spill on water). **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 2 and Appendix A). **Review Response 2 (15 March 2019)** Multiple hose (x6) and single MLA failure events are included in the 'Preliminary Hazard Analysis Addendum' (Section 2) and the individual fatality risk contours have been re-estimated (Sections 2 and 11). Consequence analysis results are also included in the 'Preliminary Hazard Analysis Addendum' (Appendix A)	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
25	**Consequence Analysis – EIS App. D (Appendix C)** Some of the tabulated consequence modelling results present in Appendix C of the PHA do not include the scenario description and source terms (It appears that some rows may have been inadvertently 'hidden' – For example: the results for FSRU 'scenario 1', 'scenario 2', etc.?). Please provide the scenario description and source terms (pressure and temperature) where this is currently not shown.	2	**Project Response 1 (21 January 2019)** The scenario numbers used in the Appendices match the descriptions (including pressure and temperature) summarised in Table 6-5. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	
26	**Consequence Analysis – EIS App. D (Appendix C)** Consequence modelling results are presented for only one pool fire scenario in Appendix C of the PHA (due to a release of liquid during transfer to the regassification units). It is reported that this is because all other release cases did not result in pool formation. This should be amended as the formation of a liquid pool from other release cases would appear to be credible, particularly on the deck of the LNGC or FSRU or if there is a release from the storage tanks (Refer to ID # 19).	1	**Project Response 1 (21 January 2019)** The PHAST model itself determined that there were no pool fire results for the other scenarios (based on the combination of pressure, temperature, composition, leak rate and atmospheric conditions), even if they were expected. PHAST generated no pool fire results for these scenarios, most likely as the LNG was flashing off quickly as it was released. With the addition of the full bore rupture results (per ID 24) a few more pool fire cases were added. **Review Response 1 (8 February 2019)** Also refer to ID # 24. Consequence results for multiple hose or MLA failures (e.g. due to vessel movement during transfers) should be included (Refer to ID # 14). The risk results should be amended accordingly to include these 'worst-case' events (which may potentially result in a spill on water). **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 2, Appendix A and Appendix B).	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Review Response 2 (15 March 2019) Consequence analysis results are also included in the 'Preliminary Hazard Analysis Addendum' (Appendix A and Appendix B).		
27	**Frequency Analysis – EIS App. D (Section 7 and Section 11)** It is reported in Section 7 of the PHA that the failure frequencies are based on the UKHSE Hydrocarbon release database. From the list of references, it appears that only data from 1992 to 1999 was considered. The Department has carried out a high-level review of the UK HSE website and has noted that more recent data is available. It is also noted from the reference Offshore Statistics & Regulatory Activity Report 2017, that the frequency of LOC incidents for equipment and system types can be determined by combining the HCR incident data and population data. Such data is available on UKHSE covering data from 1992 to 2016. Based on the above, please clarify the following: a. How does the data from 1992 -2016 compare with the data from 1992 to 1999? What is the reason for selecting the older set of data? b. There are other offshore failure databases available, such as OGP or OREDA. How does the selected failure rate compare with the other references? c. The event frequency data provided in the modelling input table does not match up with the failure rate provided in the leak frequency table (Page 87 of PHA). Please provide additional information to clarify this difference (e.g. utilisation factors, parts counts, etc. – Also refer to ID # 29).	1	**Project Response 1 (21 January 2019)** This is an error. The actual data range is from 1992 to 2014. a. The data for the range used is not significantly different to 1992 to 2016. b. OGP data source is based on UKHSE HCRD from 1992 to 2006, which is older than the data source used (i.e. from 1992 to 2014). OREDA data are captured in a different format, where critical failure data with accidental release is not broken down to the leak sizes provided by UKHSE HCRD. c. There are a number of reasons the event frequency data in the modelling input table may not match up depending on how it was calculated. First note that vessel header and the pipeline are modelled as routes, where the event frequency data is located on a different tab in the input sheet (Route Segment) and to be calculated in combination with the probability of the event occurring on the main sheet. Secondly, while included in the excel sheet, the QRA model only considered 2 of the 3 regasification trains to be in operation, as 1 train is typically turned off for normal operations in line with n+1 redundancy principles. The leak frequency table only accounts for 2 trains. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
28	**Frequency Analysis – EIS App. D (Section 7.1)** The event tree used in the risk analysis is reported in Figure 7-1 and the probability split between immediate and delayed ignition is reported in Table 7-1. a. It is noted that the event tree has too many 'no ignition' branches and should be corrected. b. The total ignition probability is not provided in Table 7-1. The total ignition probability should be reported for each release case. c. Ignition probabilities for offshore operations appear to have been used for the proposed FSRU. Justification for using offshore data for the proposed FSRU (which is located at a berth) should be provided with reference to other relevant data sources.	1	**Project Response 1 (21 January 2019)** The event tree could be simplified to remove the extra No ignition branch. Ignition probability is based on the leak rate, therefore there are 5 ignition probabilities for each of the areas modelled. The fire frequencies in Table 3 in Appendix D are calculated based on these ignition probabilities and the leak frequencies in Table 1. Although UKOOA is UK Offshore Operators Association, the ignition probabilities are based on a more conservative onshore facility (i.e. Large Plant Gas LPG) as noted in Section 7.1 of the PHA. **Review Response 1 (8 February 2019)** Please provide the total ignition probability for each release case. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 7). **Review Response 2 (15 March 2019)** The total, immediate and delayed ignition probabilities are reported in the 'Preliminary Hazard Analysis Addendum' (Section 7 and Appendix D).	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
29	**Frequency Analysis – EIS App. D (Section 7.2.1 and App. D)** It is not clear how some of the leak failure frequencies have been derived since the parts counts and utilisation data is not included in the PHA. For example: a. Are the leak frequencies for the tanks reported in Appendix D (Table 1), per tank or for 4 tanks? Note: Is this an external leak from the hull, a leak onto the deck or a leak internal to vessel? b. Have the reported leak frequencies for the LNGC been 'factored' down based on a utilisation (or presence) factor? If so, what factor was applied for the LNGC? Please provide additional information (e.g. parts count and utilisation or presence factors) to enable verification of all reported leak frequencies.	1	**Project Response 1 (21 January 2019)** The leak frequency presented for Cargo Tank is for all 4 tanks. This is the leak frequency from the topside equipment for the cargo tanks. LOC due to ship collision is presented in Table 2 in PHA. LNGC leak frequency has been factored down to 24 hours exposure once every 2 weeks as noted in Section 7.2.1 in PHA. The parts count summary sheet and associated marked up P&IDs are included in Attachment 9 - Parts Count Sheet & P&IDs. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	
30	**Frequency Analysis – EIS App. D (Section 7.2.1)** Please confirm the number of proposed regassification trains (Section 7.2.1 of the PHA and the detailed P&IDs show 3 trains, whereas the schematic PFD shows 4 trains).	2	**Project Response 1 (21 January 2019)** The P&ID is correct - there will be 3 regasification trains on the FSRU. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	
31	**Frequency Analysis – EIS App. D (Section 7.2.1)** It has been assumed in the PHA that the consequences of jet fires and flash fires within the cargo machinery room will be contained within the room. Additional information should be provided to justify this assumption (e.g. the construction and ventilation arrangements for the machinery room may mean that this not a valid assumption).	2	**Project Response 1 (21 January 2019)** The cargo machinery room has forced mechanical ventilation with gas detection sampling points with steel walls and roof sections. **Review Response 1 (8 February 2019)** Also refer to ID # 23. The potential for escalation should be addressed (As required in HIPAP No. 6).	Conditionally Closed	Refer to ID # 13.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
	The potential for escalation and impact on other equipment in or near the cargo machinery room should also be considered.		**Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 4). **Review Response 2 (15 March 2019)** Consequence analysis results for a glycol spill are included in the 'Preliminary Hazard Analysis Addendum' (Appendix C). It is also reported in Section 6 that 'The glycol heating system design is currently not known as no detailed P&IDs are available, but it is expected that it will be a small system with minimal potential leak sources and subsequently a low leak frequency'. This would appear to be a reasonable assumption (based on preliminary design information); however, if the development is approved the final design should be reassessed in the FHA. Conditionally closed.		
32	**Frequency Analysis – EIS App. D (Section 7.2.2)** It is reported in Section 7.2.2 of the PHA that the failure frequency for the MLAs is based on data from the TNO 'Purple Book' (i.e. 6E-05 per transhipment). It is also reported that the MLA is assumed to be connected once per year. The Department queries whether the assumed connection rate may potentially underestimate the failure rate as it does not consider unintended decoupling due to other causes. Also, the PHA has not considered a release due to unintended decoupling of multiple MLAs or transfer hoses (e.g. due to adverse sea or weather conditions, mooring failure, etc. – See Item FR 3.3.1 'Ship Hardarms' in the HSE's 'Failure Rate and Event Data for use within Risk Assessments'). The failure frequency for the MLAs, and the potential for multiple connection failures, should be reviewed and the risk analysis amended accordingly.	1	**Project Response 1 (21 January 2019)** The MLAs are to remain connected between the FSRU and shore to allow for continuous flow of high pressure gas from the regasification unit to the pipeline as the FSRU is permanently moored. It is expected that the MLAs will only be disconnected for maintenance purposes, or due to failure. The FSRU mooring system has been designed for 1 in 100 year storm surge and infragravity wave occurrences as outlined in the Basis of Design (401010-01496-PM-BOD-0001) Section 7.2 & 7.5. The total MLA leak frequency was calculated as 6.6E-04 per annum, indicating failure leading to reconnection is considerably less than once per year. The failure data is sourced from TNO Purple Book, Table 3.21, with a 15% safety factor. The failure rate used is higher than those specified in the UKHSE Failure Rate and Event Data for use within Risk Assessment (28/06/2012) (i.e. ship hardarm transfer) Therefore, the failure rate used is considered to be conservative.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Review Response 1 (8 February 2019) Also refer to ID # 14. Additional information should be provided to demonstrate the risk from a release due to unintended decoupling of multiple MLAs (FSRU to shore) or transfer hoses (LNGC to FSRU). **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 2). **Review Response 2 (15 March 2019)** Multiple hose (x6) and single MLA failure events are included in the 'Preliminary Hazard Analysis Addendum' (Sections 2 and 3) and the individual fatality risk contours have been re-estimated (Sections 2 and 11).		
33	**Frequency Analysis – EIS App. D (Section 7.2.3 and App. D)** The leak frequency due to ship collision is listed in Table 2 on Page 87 of PHA and is understood to be based on the data reported in Section 7.2.3 of the PHA. Please provide an explanation of how the frequencies Table 2 on Page 87 of PHA were estimated, including each of the calculation steps. Justification for each assumption / data input should also be provided. For example: a. What is the reference source for the assumed vessel movement (entry and exit) data? b. What is the basis for the assumption that 50% of all ships entering and exiting the harbour have sufficient kinetic energy to puncture an LNG cargo tank?	1	**Project Response 1 (21 January 2019)** The frequencies calculated in for ship collision are based on the methodology in A Guide to QRA for Offshore Installations - CMPT [Ref 9 in the PHA]. Refer to the provided Attachment 10 - Ship Collision Frequency for calculation steps. (a) & (b) The ship movement data is based on discussion with the Harbour Master, who provided input on the number of vessels entering and exiting the harbour, and the number of these with the size and speed required to puncture the LNGC or FSRU. c) & (d) These assumptions are based on recommended probability values in the CMPT Guide to QRA for Offshore Installations.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
	c. What is the basis for the assumption that there is a 5% chance that passage planning was not successfully carried out? d. What is the basis for the assumption that there is a 5% chance that a tugboat fails to change the course of a moving vessel?		**Review Response 1 (8 February 2019)** The methodology adopted in the PHA is for estimating the likelihood of collision between a vessel and an offshore structure. This may not be applicable for incidents in port areas. The leak frequency due to ship collision, allision and/or grounding should be reviewed and revised accordingly to ensure it is appropriately conservative for the LNGC and FSRU in the port areas. Reference to appropriate data for port areas should be provided to justify the leak frequencies used to generate the risk contours. Some example sources are discussed in the following paper: Ronza, A.; Carol, S.; Espejo, V.; Vílchez, J.A.; Arnaldos, J. (2006-1). *A Quantitative Risk Analysis Approach to Port Hydrocarbon Logistics*. Journal of Hazardous Materials, 128(1), pp. 10-24. Revised risk contours should be submitted. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 3). **Review Response 2 (15 March 2019)** Additional analysis of ship collision, grounding, etc. is included in the 'Preliminary Hazard Analysis Addendum' (Section 3) and the individual fatality risk contours have been re-estimated (Sections 3 and 11). This includes vessel movements through the harbour and is based on data applicable for port waters.		

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
34	**Risk Analysis and Assessment – EIS App. D (Section 9.1)** An assessment against the DP&E's qualitative risk criteria (Refer to HIPAP No. 4, Section 2.2) should be included in the PHA.	1	**Project Response 1 (21 January 2019)** HIPAP 4 qualitative criteria: a) All avoidable risks should be avoided: A known technology was selected and an industrial location was selected. B) Risk from a major hazard should be reduced wherever practicable: A HAZID was conducted for the project to identify all risks and assess whether the design preventative and mitigative controls were acceptable or whether further mitigation was required. c) Consequences of more likely hazardous events should be contained within the boundaries: The PHA identifies whether risk could potentially impact the public. d) Where there is an existing high risk from a hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risks: This is a new facility. Overall risk and propagation risk to adjacent facilities are considered in the PHA. Further HAZID studies and formal safety assessment including a Fire Safety Study will be completed in the next project phase. **Review Response 1 (8 February 2019)** Noted. The response provided is incomplete; however, additional assessments are to be conditioned if the development is approved. Therefore, this item is considered closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
35	**Risk Analysis and Assessment – EIS App. D (Section 9.1)** An assessment against the DP&E's risk criteria for damage to the biophysical environment (Refer to HIPAP No. 4, Section 2.4.4) should be included in the PHA.	1	**Project Response 1 (21 January 2019)** According to HIPAP No. 4 Section 2.4.4 in the case of the biophysical environment, fire and explosion hazards are less relevant in comparison to the effect of these hazards on people. Toxicity impacts are those which must be addressed with the main concern on the effect over whole systems of populations. In this case no toxic inventories were identified on the FSRU or wharf facility (odorant is not toxic) and therefore no further assessment is required. **Review Response 1 (8 February 2019)** The Department acknowledges that a spill of LNG, odorant (Total inventory of 2 x 200 kg tanks) or marine diesel is unlikely to result in long term damage to an extensive area. Furthermore, the controls to mitigate a release are expected to be addressed through compliance with relevant standards (e.g. bunding of odorant tanks). An assessment against the DP&E's risk criteria for damage to the biophysical environment (Refer to HIPAP No. 4, Section 2.4.4) should be provided. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 6). **Review Response 2 (15 March 2019)** An assessment against the DP&E's risk criteria for damage to the biophysical environment has not been provided in the 'Preliminary Hazard Analysis Addendum' (Section 6). **Project Response 3 (27 March 2019)** LNG, odorant and diesel are all located on either the FSRU or wharf and have the potential to impact the environment in the event of a loss of containment from any of their respective systems. The Hazardous Industry Planning Advisory Paper No. 4	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			(HIPAP 4) for Risk Criteria for Land Use Safety Planning suggests assessing the likelihood and size of accidental release and making a judgement on what the consequences of such releases are based on Table 3 of Section 2.4.4.1 in HIPAP 4. LNG releases have been assessed in the PHA. An LNG release to grade or to water will flash rapidly to its vapour phase and disperse and is considered unlikely to cause significant environmental damage. When assessed against Table 3 in HIPAP 4 the environmental consequence would be ranked as "Moderate" defined as "temporary alteration or disturbance beyond natural viability" with "recovery <5 years". This is the lowest consequence category in the table, only above "Not detectable". The likelihood of such a release is summarised in the leak frequency sections in the PHA and PHA addendum and is considered low. Odorant releases have been assessed in Section 6 of the PHA Addendum. The odorant will only be stored in small volumes at the facility and will be contained, with a very low likelihood of a leak / rupture. An accidental release would mainly impact the public as assessed in the addendum, with negligible impact to the environment. The environmental consequence of this release would be "not detectable" per Table 3 in HIPAP 4 with "alteration or disturbance within natural viability, effects not accumulating, and resources not impaired". Diesel fuel is stored at the wharf as fuel for the fire water pumps and as an emergency backup to LNG for the FSRU fuel. The diesel for the fire water pumps will be stored in small quantities as it is only required in emergency situations. This storage will comply with relevant Australian Standards and will have bunding as a minimum. The highest risk activity is refuelling either the onshore storage or the FSRU as the most likely leak would be in the transfer system rather than the storage equipment. There		

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			are known controls such as hose inspection and testing, dry break couplings, ignition control and spill containment should a release enter the water. Considering the controls and experience from a similar FSRU which has not refuelled in 5 years. Therefore, likelihood of an environmental release is considered to be very low. The environmental consequence is ranked as "Moderate", similar to LNG above. **Review Response 3 (11 April 2019)** Noted and closed.		
36	**Risk Analysis and Assessment – EIS App. D (Section 9.1)** The 50 pmpy individual fatality risk contour, as shown on Figure 9-2 in the PHA, extends beyond the site boundary. The PHA should address this apparent exceedance of the 50 pmpy risk criterion for industrial uses (e.g. by reducing the risk and/or other appropriate control measures – Refer to HIPAP No. 6, Section 8.2).	1	**Project Response 1 (21 January 2019)** The 5E-05 contour extends marginally beyond the facility fence line on land and beyond the LNGC into the harbour. It does not reach adjacent industrial facilities nor does it reach any public areas. The Site boundary is the yellow fence line shown on the LSIR plots and the red line on Figure 3-5. **Review Response 1 (8 February 2019)** Subject to re-estimation of the overall risks with the worst-case scenarios (Refer to ID # 14 and 32), the 50 pmpy cumulative individual fatality risk contour may extend beyond the site boundary (See the corner between the blue and yellow line). If it does extend beyond the site boundary, then an agreement with the land owner/s should be obtained to ensure the exposed area will not be occupied by personnel. Confirmation of this agreement should be provided to the Department as soon as practicable; therefore, this observation has not been closed. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 8).	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The risk reduction provided by safety systems included in the final design should be demonstrated in the FHA.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Review Response 2 (15 March 2019) The 50 pmpy cumulative individual fatality risk contour extends beyond the site boundary. Measures to address this exceedance have not been included in the 'Preliminary Hazard Analysis Addendum'. **Project Response 3 (27 March 2019)** The current location of the 1E-05 contour extends beyond the proposed eastern site boundary and is west of PKCT Truck Wash. This area is not normally occupied and PKCT have advised AIE that the truck wash is a back-up to their northern truck wash and would only be used rarely if the northern truck wash is out of service. When in use occupancy of truck drivers is expected to in the order of minutes not hours. Hence, occupancy per annum will be low. The equipment adjacent the truck wash undergoes maintenance for a period of 2-3hrs once per quarter. Again occupancy per annum will be low. The risk contours presented in the existing PHA take no credit for fire or gas detection, or emergency shut down and blowdown and are therefore conservative. With further detailed assessment some contraction of the contours may occur. **Review Response 3 (11 April 2019)** The 50 pmpy cumulative individual fatality risk contour does not strictly comply with the corresponding DP&E criterion for industrial and open space uses; however, it is acknowledged in HIPAP No. 4 that: "…there can be some degree of flexibility in the implementation and interpretation of probabilistic risk criteria…". The relatively small exceedence of the 50 pmpy risk criterion may be tolerable based on the guidance provided in HIPAP No. 4. However, if the development is approved, the risk reduction provided by safety systems included in the final design should be demonstrated in the FHA. Conditionally closed.		

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
37	**Risk Analysis and Assessment – EIS App. D (Section 9.1)** The 10 pmpy individual fatality risk contour, as shown on Figure 9-2 in the PHA, extends to a waterfront area where members of the public may congregate. It is understood that members of the public can access this area (e.g. for fishing) and that there have been occasions where relatively large numbers have congregated (e.g. to observe the arrival of a cruise liner). The PHA should address this apparent exceedance of the 10 pmpy risk criterion for open space uses (e.g. by reducing the risk and/or other appropriate control measures – Refer to HIPAP No. 6, Section 8.2).	1	**Project Response 1 (21 January 2019)** As stated in Table 10-1 there is limited exposure to people on the private Seawall Road. It is a private, no through road which is only open during daylight hours which may be closed by NSW Ports for operational or safety requirements such as weather, security, arrival of shipments. As a result the road is not used regularly. Simple additional measures could be taken with NSW Ports agreement if required, such as closing the road during the arrival of Cruise ships, as there are numerous other lookout points available to the community, including the Maritime Centre. **Review Response 1 (8 February 2019)** It is now understood that only a small number of people will occasionally access this area. However, as suggested, additional measures should be agreed with the land owner/s to ensure the road is closed during arrival of cruise ships, and/or during LNGC unloading. Confirmation of this agreement should be provided to the Department as soon as practicable; therefore, this observation has not been closed. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 8). **Review Response 2 (15 March 2019)** It is reported in the 'Preliminary Hazard Analysis Addendum' (Section 8) that NSW Ports has advised that "The road tends to be used by surfers, rock fishers and occasional on-lookers for unusual events, such as the arrival of a large cruise ship. However, numbers of users are in the dozens, not the 100's, with the largest crowds seen there for the arrival of the Port's first cruise ship. Subsequent cruise ship arrivals have seen the	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). The risk reduction provided by safety systems included in the final design should be demonstrated in the FHA.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			crowd numbers dwindle" and "It is not uncommon for the road to be closed 6 – 10 times a year for operational purposes". The 10 pmpy cumulative individual fatality risk contour extends beyond the site boundary to an area where members of the public may be present. Although this area is not zoned for open space uses, measures to address this exceedance have not been included in the 'Preliminary Hazard Analysis Addendum'. **Review Response 3 (11 April 2019)** The 10 pmpy exceedence is primarily at a roadway / waterfront area, which is not zoned for open space uses and only a relatively low number of people are typically present (i.e. individuals fishing rather than a larger number of individuals that would occur at a sporting facility). Therefore, exceedence of the 10 pmpy individual fatality risk criterion may be tolerable in this case based on the guidance provided in HIPAP No. 4. However, if the development is approved, the risk reduction provided by the safety systems included in the final design should be demonstrated in the FHA. Conditionally closed.		
38	**Risk Analysis and Assessment – EIS App. D (Section 9.1) and FEED PKGT Pipeline Safety Management Study Report** It is reported in Section 5.1 of the FEED PKGT Pipeline Safety Management Study Report that: "Post the SMS validation workshop, the Coniston Public School was identified as being within the measurement length of the pipeline. A secondary location classification of sensitive (or S) will be applied for this location." Where is this school relative to the 0.5 pmpy individual fatality risk contour?	2	**Project Response 1 (21 January 2019)** Conniston Public School is located to the north of Springhill Road, the main road which the second half of the pipeline follows. The school is approximately 500m from the closest point of the 0.5 pmpy contour around the pipeline. **Review Response 1 (8 February 2019)** Noted and closed.	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
39	**Risk Analysis and Assessment – EIS App. D (Section 9.2)** The risk of acute toxic injury and the risk of irritation from exposure to a release of potentially toxic materials (e.g. Odorant – refer to ID # 10 and 14) should be analysed and assessed against the relevant DP&E risk criteria from HIPAP No. 4.	1	**Project Response 1 (21 January 2019)** Final selection of the odorant chemical compound has not yet occurred. However, the odorant will be non-toxic. **Review Response 1 (8 February 2019)** Also refer to ID # 10. The risk of acute toxic injury and the risk of irritation from exposure to a release of potentially toxic materials (e.g. Odorant – refer to ID # 10 and 14) should be analysed and assessed against the relevant DP&E risk criteria from HIPAP No. 4. Note: Based on the location and inventory, it may be sufficient to demonstrate that the consequences do not reach residential or sensitive use areas.	Closed	
40	**Risk Analysis and Assessment – EIS App. D (Section 9.2.2)** Dangerous Goods (including Class 1 explosives) are transferred at other berths in the inner harbour. The potential for propagation should be considered in the PHA for these activities.	2	**Project Response 1 (21 January 2019)** This PHA report considered in Section 9.2 the propagation risk onto other nearby facilities from the FSRU and wharf facility. The potential for propagation from those other facilities was discussed in Section 9.2.1. The propagation risks from other facilities were assessed when the information was available. **Review Response 1 (8 February 2019)** Class 1 explosives are transferred at other berths in the inner harbour. The limits permitted to be handled at each berth are included in the Port Authorities guidelines for handling DGs. The potential for these quantities of explosives to impact upon the FSRU operation should be assessed in the PHA. **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 10). **Review Response 2 (15 March 2019)** It is reported in the 'Preliminary Hazard Analysis Addendum' (Section 10) that "information has been requested from the Port	Closed	

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Kembla Harbour Master and once received an assessment of the potential impacts can be completed". **Project Response 3 (27 March 2019)** According to the shipment data provided by the Port Authority (see attached), there were three explosive types that entered the harbour between Feb 2013 and May 2018 (i.e. 1913 days) with the following maximum quantities: - Class 1.2E, Cartridges for Weapons, 1,441 kg – 2 shipments - Class 1.3C, Smokeless Powder, 13,995 kg – 5 shipments - Class 1.4S, Small Arms Cartridges, 17,424 kg – 5 shipments Studies have shown that the ignition of small arms cartridges, produces no explosion overpressure or projectiles at high velocity. The Fridley Minnesota Fire Department in July 1983 conducted various ammunition impairment tests with 281,000 rounds of ammunition containing more than 180 kg of power. One of the tests involved confined burning of ammunition placed in a specially built 6 x 6 foot concrete block structure with oil-soaked scrap timber stacked beneath the ammunition and a flat boilerplate placed on top of the structure to complete the confinement of the ammunition. The outcome of the tests concluded that: - When ammunition is involved in a fire, it will not mass detonate or explode. - Projectiles from ammunition are at low velocity and do not present any significant hazard to firefighters wearing standard firefighting and face protection. - Ammunition will not support its own combustion. Therefore, shipments of small arms cartridges are not expected to generate damaging explosion overpressure toward the LNGC / FSRU.		

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Smokeless powder and weapon cartridges cargoes are unloaded at the following berth locations: - Smokeless powder cargo berth 106, 107 or 203. - Weapon cartridges cargo berth 202 or 203. The closest berth location to berth 101 (LNGC / FSRU) is berth 106 / 202 with a distance of 800 m. Explosion modelling was conducted and determined that a TNT mass of ~ 135,000 kg is required to generate a 14 kPa blast overpressure at berth 101 (LNGC / FSRU). Both of the Class 1.2E and Class 1.3C explosive shipments to Port Kembla are significantly lower than the required TNT mass to generate the blast overpressure for propagation. Therefore, the location of berth 101 (LNGC / FSRU) is considered to be sufficiently far from the explosive cargo berths. In terms of propagation risk from explosive carrying cargo ship movements close to berth 101 (LNGC / FSRU) to get to their berth (i.e. smokeless powder cargo ship), the propagation risk is estimated to be 5.5x10-8 per year with the following inputs: - Berth 101 is assumed to be exposure to 2 hours of explosion hazards from explosive carrying cargo ship heads toward their berths within the inner bay. - 5 shipments every 5.2 years (supplied by Port Authority). - 2.5x10-4 per year of cargo ship total loss due to fire and explosion (historical data from 2000 to 2010 – Report for AMSA Ship Oil Spill Risk Models by DNV 2011). Therefore, based on the historical ship fire incident data and explosives shipment data, the cargo ship explosion risk toward berth 101 (LNGC / FSRU) is considered to be acceptable (below the 50 in a million years 14 bar propagation frequency from HIPAP 4).		

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
			Review Response 3 (11 April 2019) The types and quantities of explosives identified by the Project appear to be consistent with the berth limits in the DG Guidelines for Port Kembla. The potential for propagation appears to be low and has been adequately assessed by the Project. Closed.		
41	**Risk Analysis and Assessment – EIS App. D (Section 9.3)** It is reported in Section 9.3 of the PHA that the societal risk was not quantified because the population within the extent of the individual fatality risk contours is relatively low. However, it should be noted that relatively large numbers of people have congregated near the proposed FSRU berth (e.g. to observe the arrival of a cruise liner) and the DP&E criteria have a 1000 person 'cut-off' which is not dependent on the frequency (i.e. even a short duration exposure might be enough to exceed the societal risk criteria). The societal risk should be quantified to demonstrate compliance with the DP&E's societal risk criteria. This should include the LNGC/FSRU operations (due to potential for members of public to be nearby) and the proposed pipeline (due to proximity to residential areas).	1	**Project Response 1 (21 January 2019)** AIE is not aware of any instances where large crowds, even approximating 1000 people have congregated on the southern end of the Seawall Rd in areas which are anywhere near the project risk contours. Likewise for the pipeline risk contours. As such a societal risk assessment is not required. **Review Response 1 (8 February 2019)** Please provide supporting information to verify the low number of people typically at the southern end of Seawall Road (e.g. correspondence from port operator). **Project Response 2 (15 February 2019)** Refer to 'Preliminary Hazard Analysis Addendum' (Section 8). **Review Response 2 (15 March 2019)** It is reported in the 'Preliminary Hazard Analysis Addendum' (Section 8) that NSW Ports has advised that "numbers of users are in the dozens, not the 100's, with the largest crowds seen there for the arrival of the Port's first cruise ship. Subsequent cruise ship arrivals have seen the crowd numbers dwindle". Whilst quantification of the societal risk is preferred to demonstrate compliance with the DP&E's societal risk criteria, it does not appear to be warranted in this case due to the relatively low numbers of people that may be near the proposed FSRU berth. If this development is approved, then this should be re-evaluated in the FHA. Conditionally closed.	Conditionally Closed	If the development is approved, then one or more condition of consent should be included to require further demonstration of compliance with the Department's risk criteria and demonstration of the adequacy of the proposed safety systems (e.g. FHA, FSS, HAZOP studies, Safety Integrity Level (SIL) assessment, etc.). Compliance with the societal risk criteria should be specifically re-evaluated by the Department when this information is provided for the final design in the Final Hazard Analysis.

ID #	Observation	Cat.	Response and Follow-up Review	Status	Requirements for Conditional Closure
42	**FEED PKGT Pipeline Safety Management Study Report** Did any personnel from Jemena participate in the pipeline SMS review?	Query	**Project Response 1 (21 January 2019)** Jemena was not involved in the SMS during this FEED phase of the project. **Review Response 1 (8 February 2019)** Noted and conditionally closed.	Conditionally Closed	If the development is approved, then a condition of consent should be included to require an additional Pipeline Safety Management Study with participation by all relevant stakeholders (including Jemena).