Review of Shannon LNG COMAH Documentation

Prepared for:

An Bord Pleanála

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Contents

1 INTRODUCTION

1.1 SLNG Report

This report note sets out our review of the COMAH document[1] submitted as part of the by Shannon LNG, on behalf of An Bord Pleanála (APB). This was issued under the control of major accident hazard (COMAH) Regulations, SI 209 of 2015 (sometimes also referred to as the Seveso III Regulations). This COMAH document comprises the following reports:

- Quantitative Risk Assessment
- Preliminary MATTE Assessment
- Oil and Hazardous and Noxious Substances Spill Plan
- EIAR Chapter 02 – Project Description
- Marine Navigation Risk Assessment
- EIAR Chapter 14 – Major Accidents and Disasters

These are reviewed in the sequence in which they are presented in the COMAH document. Where necessary, we have included cross referencing between documents, to clarify or expand on points raised.

We have focused our review on the elements and aspects of the reports that are relevant to ABP, in the context of land use planning (LUP) matters. It is not our purpose to drill down into the detail of individual accident scenarios to verify that all necessary measures will be in place to protect against these scenarios. This will be an ongoing requirement of the operator as part of their general duties required under the Regulations; verification of this compliance will be overseen by the Health and Safety Authority (HSA), which is the Competent Authority under COMAH. It is not the purpose of this report, nor the role of ABP to replicate the HSA role under the legislation. In this context we note that the planning application has been referred to the HSA, who advised that they do not advise against the development (see also Section 1.2).

From the documentation, the proposed LNG Terminal will comprise:

- A floating storage regasification unit (FSRU), which will have an LNG storage capacity of up to 180,000 m^3. The LNG vaporisation process equipment to regasify the LNG to natural gas shall be on-board the FSRU. The heat for LNG regasification shall be via seawater, supplemented by heat from gas fired heaters when the water temperature is inadequate. Loading of LNG onto the FSRU shall be via a ship to ship transfer from another LNG carrier (LNGC) berthed alongside.
- Jetty and access trestle, with the jetty comprising of an unloading platform, mooring dolphins and breasting dolphins.
- Four tugboats moored on the proposed jetty for FSRU and LNG carrier mooring operations.
- Onshore facilities including a nitrogen generation facility, a control room, a guard house, workshop and maintenance buildings, instrument air generator, fire water system.
- An Above Ground Installation (AGI) to include an odourisation facility, gas heater building, gas metering and pressure control equipment. The AGI facilitates the connection of the LNG terminal to the consented 26 km Shannon Pipeline.

[1] Shannon Technology and Energy Park Information to Cover the COMAH Regulations 2015

The proposed Power Plant will comprise of:

- A flexible modular power plant design with up to three (3) blocks of Combined Cycle Gas Turbines (CCGT), each block with a capacity of circa 200 MW for a total installed capacity of up to 600 MW. The multishaft arrangement of the power plant provides fast acting response with very low minimum stable generation and is ideally suited to support increased intermittent renewable generation.
- Each block shall comprise of two (2) gas turbine generators, two (2) heat recovery steam generator and one (1) steam turbine generator and an air-cooled condenser.
- A 120 MW for 1 hour (120 MWhr) Battery energy storage facility (BESS). Due to its very fast response, the BESS supports intermittent renewable generation.

Due to the quantities of dangerous substances that will be stored and handled at the site, it will qualify as an upper tier establishment under the COMAH Regulations (SI 209 of 1015). As such, the operators will be required to carry out various tasks in compliance with the Regulations, including a Notification to the HSA, the development of a Major Accident Prevention Policy (MAPP) and Safety Management System (SMS) for operating the site, preparing a Safety Report and the development of an Internal Emergency Plan for the site.

The Environmental Impact Assessment (EIA) guidelines state that "*The EIA must include the expected effects arising from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project. Where appropriate, the description of expected significant effects should include details of the preparedness for and proposed response to such emergencies.*

There are two key considerations, namely:

- *The potential of the project to cause accidents and/or disasters, including implications for human health, cultural heritage, and the environment;*
- *The vulnerability of the project to potential disasters/accidents, including the risk to the project of both natural disasters (e.g. flooding) and man-made disasters (e.g. technological disasters).*

These considerations are separate to any assessment of the project required under the Seveso III Directive, which is likely to include a detailed risk assessment."

Under the COMAH Regulations all new establishments must satisfy certain criteria with respect to land use planning, to ensure that the risks to human health and to the environment associated with the development are in accordance with the criteria that have been established by the Health and Safety Authority (HSA). These criteria are described in the following sub-section.

When assessing the risk assessment and other details for the proposed development, we have done so on the basis that it comprises the following principal components.

- Terminal / Receiving infrastructure and AGI
- Power station and battery

Where practicable, we have related any comments on issues or queries identified in our assessment to the relevant component.

1.2 COMAH Developments and Land Use Planning Implications

To provide context for our review of the COMAH documentation, this section of our report provides a high-level overview of the approach to Land Use Planning (LUP) as described in the HSA's guidance[2]. This approach involves the identification of approach major accident scenarios, based on, e.g. the nature of the planned activity, the hazardous materials present and the conditions under which these materials will be stored, handled and used.

Consequence modelling and risk assessment techniques are used to calculate the levels of risk presented to the surroundings by the activities. From this, risk contour plots are developed, to show the levels of fatality risk to human health. The following contours are used:

- Inner Zone: 10 chances per million (cpm) per annum of fatality
- Middle Zone: 1 cpm per annum of fatality
- Outer Zone: 0.1 cpm per annum of fatality

In each case the contours represent the risk presented to persons who are permanently present at the location.

When assessing the risks associated with new developments in the vicinity of a COMAH establishment, different levels of development will be permitted within each of the risk zones identified above. This is illustrated in Table 1, which is based on Table 4 from the HSA guidance.

Table 1: Nature of LUP advice for each risk zone

	Inner Zone	Middle Zone	Outer Zone
Sensitivity Level 1	✓	✓	✓
Sensitivity Level 2	×	✓	✓
Sensitivity Level 3	×	×	✓
Sensitivity Level 4	×	×	×

Therefore, for example, a development which qualifies as Sensitivity Level 2 would be advised against, if it was in the Inner Zone of a COMAH establishment, but not in the other zones.

The sensitivity of a development is dependent on the numbers of people who will be present and on the vulnerability of these people. This is illustrated in Table 2, which is based on Table 3 from the HSA guidance.

Table 2: Sensitivity Levels by development type

Level	Development Type
Sensitivity Level 1	Workplaces, car parks
Sensitivity Level 2	Development for use by the general public
Sensitivity Level 3	Development for use by vulnerable people
Sensitivity Level 4	Very large or sensitive development

Note that the descriptions above are indicative and the sensitivity is also a function of the numbers of people involved. For example, while most residential developments are Sensitivity Level 2, one-off housing would be Sensitivity Level 1, while high density residential developments would be Sensitivity Level 3. Appendix 2 from the HSA guidance expands on and clarifies the approach.

[2] Guidance on technical land use planning advice for planning authorities and COMAH establishment operators

For new establishments, the following criteria apply:

- 1×10^{-6} per annum: Maximum tolerable risk to a member of the public
- 5×10^{-6} per annum: Maximum tolerable risk to a person at an offsite work location

The guidance also applies metrics for assessing the societal risk implications for a development (i.e. where a large number of people may be at risk from a major accident).

In addition to risks to human health, the COMAH Regulations are also concerned with potential environmental risks associated with major accident scenarios. The HSA's LUP guidance advises on the prevention of major accidents to the environment (MATTEs). Assessment is based on a Source-Pathway-Receptor model. For new establishments, the CCA will focus on the removal of accident pathways to receptors (through the use of additional technical measures: appropriate containment, within the confines of current good practice and ALARP, for example). For significant modifications, the risk-based approach developed by the Chemical and Downstream Oil Industries Forum (CDOIF), and outlined in the Guidance on 'Significant Modifications' Under the COMAH Regulations, is used.

2 Land Use Planning Quantitative Risk Assessment

This report describes a quantitative risk assessment (QRA) that was carried out for the proposed Shannon Technology and Energy Park (STEP) Liquefied Natural Gas (LNG) terminal, power plant and above ground installation (AGI). This is the most directly relevant of the reports that were included in the COMAH documentation package in terms of calculating and reporting the land use planning implications associated with the development. We have reviewed the QRA from a technical standpoint and compared the findings with the HSA's guidance. It should be noted that the QRA report was issued in 2021, and so this was before the current HSA guidance on land use planning. The assessment was carried out in accordance with the guidance that was in place at the time of preparation / lodgement of the application.

The QRA has considered hazards from LNG and natural gas associated with the operation of the following:

- Onshore pipelines and equipment at the terminal;
- The Above Ground Installation (AGI);
- 600 MW Power plant and associated Battery Energy Storage System and onsite 220 KV substation;
- The Floating Storage and Regassification Unit (FSRU); and,
- Transfer of LNG to the FSRU from a Liquefied Natural Gas Carrier (LNGC).

This assessment was carried out to calculate the individual risk (IR) fatality contours for the site and to assess the findings against published criteria for individual risk and for societal risk.

The risks associated with the storage and handling of LNG arise due to the flammable nature of this material. Section 1.5.3 of the QRA report discusses the flammable hazards of LNG. There is discussion of pool fires, jet fires, flash fires and explosions. The report notes that, if ignited, a vapour cloud can generate damaging overpressures, where there is confinement of the of the cloud. Areas congested with equipment and structures can facilitate damaging overpressures if a vapour cloud is ignited within such an area. The QRA report notes that if a vapour cloud infiltrates a process plant area with various vessels, structures, and piping and the cloud ignites, the portion of the cloud within that congested area may generate damaging overpressures.

The report also states that the onshore plant layout is relatively open and the degree of congestion is low. The potential for vapour cloud explosion (VCE) on site have therefore judged to be insignificant. To check this approach we have reviewed the research report "Review of Vapour Cloud Explosion Incidents" (RR1113) prepared by the UK Health and Safety Executive (HSE) for details which may be relevant to the explosion hazards of LNG, as set out in Table 3. The primary objected of the UK HSE in developing that report was to improve understanding of vapour cloud development and explosion in order to examine the potential for these hazards to exist or develop at LNG export plants that store substantial quantities of these flammable gases for use in the liquefaction process or as a by-product from the liquefaction. The proposed Shannon development also involves the storage of these materials and so we have referred to this report for guidance.

Table 3: Review of RR1113 – UK HSE guidance

Details from RR1113	Comments
This review (RR1113) has not found any historical records of LNG (methane) vapor cloud explosions in open areas with severity sufficient to cause secondary damage to tanks and pipes and consequently rapid escalation of an incident from a minor process leak to a major loss of inventory. On the other hand some LNG sites (especially export sites) also hold substantial amounts of refrigerant gases and blends containing ethane, propane, ethylene and iso-butane. Higher hydrocarbons may also be produced and stored on LNG export sites as by-products of gas condensation. There are numerous examples of Vapor Cloud Explosions (VCEs) in open areas involving these higher molecular weight materials and the storage and use of higher molecular weight hydrocarbons on LNG export sites may (if not managed adequately) introduce an additional set of incident scenarios in which VCEs trigger rapid escalation of loss of containment	Indicating that the explosion hazard is lower for LNG than for heavier materials. The materials listing for the STEP development is included in Table 4-1 of the MATTE assessment (see Section 3). The majority of these other materials do not present a significant flammable hazard. The most significant such hazard would appear to be the odorant, which is included in the QRA as a potential BLEVE hazard. It is not clear from the review whether there is such an escalation hazard from, e.g. a BLEVE of the odorant tank, or a fire or explosion at the BESS.
It is worth noting that the siting of new LNG export terminals with large liquefaction facilities is subject to significant regulatory control especially through 49 CFR Part 193. Application of a range of other standards (especially NFPA 59A) is intended to minimize risks through strong requirements in the areas of: design, materials, construction, testing, fire protection (detection, notification, extinguishment), operating, training and maintenance. Furthermore, all LNG export terminals covered by DOT would also be under USCG safety and security regulations and likely under FERC regulations and safety reviews. LNG export terminals within navigable waters are not under DOT 49 CFR 193, but under FERC/OSHA/EPA if within state waters and USCG/MARAD if within federal waters	This point broadly applies here. The regulatory control for the terminal will be under the COMAH Regulations, enforced by the HSA. No planning implications for ABP.

Details from RR1113	Comments
The potential importance of nil/low-wind conditions in an overall risk assessment has been investigated theoretically using a simple test case that might be of relevance at LNG sites: 2" and 4" liquid releases from a 30,000 gallon tank containing propane at 288K. For wind speeds of 2 m/s and 5 m/s (F2 and D5 in the Pasquill classification scheme – Pasquill, 1961) the contour defining the lower flammable limit (LFL) reaches a maximum extent within a period of less than 30 seconds. In nil/low-wind conditions the cloud continues to grow throughout the time that the tank takes to empty (which is 350 -1500 seconds) (not accounting for shutoffs which can reduce the release duration) The maximum area covered by the flammable cloud is typically several hundred times greater in nil/low-wind conditions than in light winds Losses of containment in nil/low-wind conditions are also particularly dangerous because a highly homogeneous cloud can be formed that may spread by gravitational slumping (without significant dilution) for hundreds of metres	The use of D5 and F2 weather conditions is a standard approach adopted by the HSA also. D5 represents typical weather conditions and F2 represents calm weather conditions with low wind speed. The various gas release scenarios are outlined in Appendix B of the QRA report and it is clear that each of these has been modelled in D5 and in F2 conditions.
A very large cloud that is all close to the stoichiometric ratio increases the risk of flame acceleration to a high pressure regime capable of seriously damaging storage and process facilities, when compared with clouds that are entraining air because of wind-driven dilution. This is because fundamental burning rates fall off rapidly for concentrations away from the stoichiometric ratio (Poinsot and Veynante 2005). Once a high-pressure regime is established explosions are not confined to congested areas of a site. In many of the cases reviewed almost all the footprint of the cloud was exposed to pressures in excess of 2000 mbar (29 psi). In at least one case the cloud detonated, causing extremely severe damage over the area covered by the cloud.	This passage indicates that high overpressures may be generated in clouds where there is ignition in a cloud which is close to the stoichiometric ratio. The flash fire model results (starting on page 114) show that there are several scenarios for which a flammable cloud can be generated and extend to distances of several hundred meters. As such, can these releases find congested areas anywhere within the site footprint or in the forested area to the south or east of the proposed development land?
The complete failure of a tank whether it be an ASME storage vessel or an LNG tank is not generally considered a credible scenario.	This is consistent with the approach in the QRA.

Details from RR1113	Comments
Smaller leaks are much more common than catastrophic failures. Risks of sustained leaks at LNG export sites are minimised by the use of gas detection and shut-off systems and other standards e.g. for overfill protection.	The report notes that detection, isolation and emergency shut down systems will be put in place to protect against such scenarios. We presume that such systems will be put in place in accordance with good practice guidance as part of the overall process of demonstrating to the HSA that all necessary measures will be in place at the site to protect against major accidents, in accordance with the genal duties of all COMAH operators, as per Regulation 7. No planning implications for ABP.
By contrast with gasoline clouds at storage depots, the incident history for LPG pipeline failures suggests that even if a very large cloud develops and is ignited, the risk of a VCE is probably less than 50%. This appears to be because some clouds are very rich or even over the UFL. It may be that there is a significant probability that, even if a large LPG cloud does accumulate in nil/low-wind conditions, it will be too rich to undergo transition to a VCE. This is clearly of relevance to the assessment of risk at LNG sites. Additional experimental and modelling work would be useful to establish what kinds of LPG spray releases in nil/low-wind conditions result in clouds within the flammable range. The evidence at Flixborough strongly suggests that, in this case, DDT occurred in highly confined and congested areas (deflagration to detonation transition). The resulting detonation propagated widely through the extensive cloud around the plant, causing massive damage. Avoiding the potential for DDT by appropriate plant layout remains a priority. Significant new work in this area is underway at the time of writing (Davis et al 2016).	This relates back to the earlier comment on congested areas. The narrative indicates that the plant layout is open, thereby reducing this risk. It would be useful to have details describing how congestion is determined and assessed for the purposes of calculating or ruling out overpressure events in this manner.
there are numerous examples of such VCEs in open areas involving higher molecular weight materials and mixtures, especially common materials such as LPG (Liquid Petroleum Gas) and gasoline. Refrigerants commonly used at LNG facilities would come within these categories. Losses of containment in very low wind conditions are particularly dangerous because a highly homogeneous flammable cloud can be formed that may spread (without significant entrainment) for hundreds of metres. Both high and low pressure releases can form such clouds: seal failures or pipeline faults are typical high pressure failures and tank overfills are typical low pressure events. Low pressure releases of refrigerants are not expected to be likely events at LNG sites.	As noted above, the modelling in Appendix B is consistent with this point and there are scenarios modelled which result in a flammable atmosphere at distances of several hundred meters from the release point. We also note that there is a section in the report which discusses the Moneypoint site as a potential ignition source. The report does not seem to have any scenarios modelled which have hazard distances extending far enough to reach the Moneypoint site, so it would be useful to have clarity on where this factored into the assessment.

Details from RR1113	Comments
It follows from the above that storage and use of higher molecular weight hydrocarbons on LNG export sites may introduce an additional set of major incident scenarios in which VCEs trigger rapid escalation of loss of containment. Refrigerant gases of particular relevance are ethane, propane/ethane blends, propane, ethylene, ethylene blends, propane/isobutane blends and isopentane. Some higher hydrocarbons may also be produced and stored on LNG export sites as by-products of gas condensation.	There do not appear to be any refrigerants stored at the site. The only higher molecular weight hydrocarbons identified in the report are for storage of odorant and of diesel. Of these, the odorant presents a potential fire or explosion hazard. The report should clarify whether other incidents, e.g. the BLEVE of the odorant storage, could have similar knock-on effects and act to initiate a VCE elsewhere.
There are important implications for the probability of development of very large gravity driven clouds on refineries. The typical convection rates driven by process heat are likely to prevent such gravity-driven transport in substantial areas of the plant. This might be an important consideration in the analysis of LNG export facilities. Convective heat release is likely to be intermediate between that at refineries and tank farms but might still effectively prevent accumulation of gas in nil/low wind conditions in some areas. Cooling fans are extensively used in LNG export facilities and these will further restrict the accumulation of gas in some important locations	We did not note any discussion of this topic, so it is unclear if this would have a bearing on the finding that overpressures would be negligible due to the low degree of confinement.
For LNG sites, the issue would be releases of LPG from refrigerant systems rather than release of LNG due to the relatively low burning velocity of methane.	Not an issue here; no LPG storage.
Overall the incident history suggests that large clouds are generally associated with very light or zero winds. If such a cloud develops the risk of a VCE is probably less than 50%. It may be that there is a significant probability that, even if a large LPG cloud accumulates in very light or nil wind conditions, it will be too rich to undergo transition to a VCE. This is clearly of relevance to the assessment of risk at LNG sites	The modelling was carried out in D5 and in F2 conditions, which is consistent with the HSA guidance. F2 represents low wind speeds and calm atmospheric conditions.

Rapid Phase Transitions (RPT) are described in the QRA but are not modelled. This is a phenomenon involving the near-instantaneous transition from the liquid to vapour phase and associated rapid pressure increase. The QRA notes that this may result in two types of effects:

1. Overpressure resulting from the rapid phase change; and,
2. Dispersion of the ‘puff’ of LNG expelled into the atmosphere.

The report states that rapid phase changes have not resulting in any known major incidents involving LNG. In view of this, and the fact that the jetty structure for the facility is relatively open, not involving any solid walls against the side of the ship, RPTs have not been modelled in the QRA.

It would be useful if the report could clarify whether modelling was conducted on the second of these effects, to determine the rate of gas evolution to atmosphere and the extent of the flammable cloud that could arise as a result of this mechanism, to see if it could extend to a congested or confined region in the vicinity. This ties in with our comments also on RR1113 and on whether there would be sufficient confinement or congestion of the cloud to give rise to overpressures. If the risk of overpressures can be discounted, the major gas release scenarios could presumably still give rise to a large flammable cloud and give rise to impacts at long distance in the event of a flash fire.

At the AGI we note that there is there is pressure reduction / flow equipment to reduce the gas pressure. This is in a 16 m × 13 m building. Has the QRA considered the potential risk of a gas release inside the building? This would presumably act as a confined region within which the conditions for a VCE could arise.

Section 3 describes the QRA methodology, as well as a discussion on risk assessment methodologies. The generic details on the approach to risk assessment – developing nodes, assigning probabilities from the literature and based on dimensions and type of installation, the approach to direct and delayed ignition, the use of the Probit functions for assessing the consequences of a release, etc. – appear reasonable.

Section 5 maps out the QRA. This covers the onshore facilities and AGI. With respect to the FSRU, it is noted that at this stage in the process, the details of the specific FSRU to be used are not available. A typical FSRU design was therefore used for the assessment. This seems a reasonable approach at this stage in the project. The approach should be reviewed and the QRA updated to reflect the actual FSRU, once these details are available.

A similar approach is adopted for the LNGCs as the details of the specific LNGCs to be used are not available and so a typical LNGC design was adopted for the QRA. Again, this is reasonable. The QRA should be reviewed, and if necessary updated, periodically in line with good practice.

Section 6 describes the release cases. The sections of piping systems and equipment used for calculation of inventories are listed in Table 6-1, Table 6-2, Table 6-3 and Table 6-4 which detail the following overall process areas:

- 1. Onshore Installation: Natural gas pipeline from the FSRU on the jetty and onshore feeding natural gas to the AGI and to the Power Station;
- 2. AGI – Conditioning of natural gas and connection to the Shannon Pipeline;
- 3. FSRU – Storage and vaporisation of LNG and supply of natural gas to the jetty;
- 4. LNGC – Transfer of LNG to the FSRU

The risk assessment does not include accident scenarios associated with the BESS. This is consistent with the guidance as the BESS does not qualify as an installation under the COMAH Regulations. The batteries will contain sulphuric acid, which is a dangerous substance under the CLP Regulation (Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures), but it does not present any of the hazardous properties required for qualification under COMAH. As such, it is consistent with the LUP approach that the accident scenarios are focused on the other areas of the proposed development which do contain COMAH substances.

As noted in the report, the odorant tank presents a risk of a BLEVE. The contour plot in Figure 5-7 shows the impacts of such an event to the surroundings. The report states that the event would not present significant offsite hazards and would not lead to a MATTE. The plot also shows that the impacts extend only over a small area of the site. The report should clarify if this means that the odorant tank does not present any credible or significant escalation hazard at the site (e.g. by causing damage to a pipeline or other infrastructure in the vicinity).

We are conscious also that BESS developments can present a fire risk. As such, the operator is likely to be required to conduct a fire risk assessment for this aspect of the development under the Fire Services Act, which places a general duty to ensure fire safety at developments. Any such assessment will likely also include consideration of appropriate controls to ensure safe operation of the BESS, e.g. by reference to appropriate FM and/or NFPA standards, or other equivalents.

An incident at the BESS is likely to be relatively small in impact compared with the COMAH related infrastructure for LNG. However, in our view, the COMAH assessment should include consideration of whether there is a credible risk that a fire at the BESS could result in damage to other parts of the plant which do qualify as COMAH installations and thereby initiate a major accident at the development.

If this escalation risk does not arise, e.g. because of the provision of sufficiently large separation distances between the BESS and the other infrastructure, then this should be described. If this escalation risk does arise, it should be reflected in the severities or probabilities of certain accident scenarios which would be influenced by the presence of the BESS. (We note that there is an assessment of the environmental risk presented by the BESS, described in the MATTE assessment, as discussed in Section 3 below.)

Section 7 describes the frequency analysis and various literature sources are referenced.

Spill sizes are based on the results of the Sandia studies and not on the Purple Book, as described in 10.3. Referring to this section, the Sandia approach applies larger spill volumes than for 'large' spills than the Purple Book. As such, this is a conservative approach to assessing this element of the risk when compared with the Purple Book.

Section 8 discusses ignition. With respect to immediate ignition probabilities, references are made to Cox, Lees and Ang, to the Purple Book and to the UK HSE guidance.

Use of low probability for immediate ignition is described as conservative, as it allows a larger proportion of releases to develop into flammable vapour clouds. Also chosen as there will be control of ignition sources on site. The on-site assessment takes account of on-site ignition sources when determining the potential for delayed ignition.

Section 8.2.2 discusses off-site ignition sources. This extends to traffic using the coast road (L1010), shipping moving along the Shannon and Moneypoint power station (located approximately 3 km to the north of the proposed development). This suggests that the model results show that there can be very large flammable clouds generated for some loss of containment events.

Section 9 sets out the approach to the fatality calculation. The probit relationship is used for assessing impacts to people outdoors. Building response is used for assessing impacts to people indoors.

There is a statement on p.61 of 552 which requires clarification "*On this basis personnel within the FSRU or LNGC are at very low risk of harm. It has therefore been assumed that personnel vulnerability within the LNGC or FSRU structure is 10% of that for a standard onshore building, which is considered to be conservative.*" This seems to imply that the approach to assessing the impacts of major accident scenarios at the vessel is that there is effectively a cap of 10% lethality even for the worst case impacts. If so, this may under-estimate the consequences for worst case scenarios at the vessel.

Table 10-2 sets out the frequency with which D5 and F2 conditions occur, at daytime and at night-time. It is not clear what overall probability was assigned to these two weather conditions. The HSA's LUP guidance is to assume that D5 conditions apply 80% of the time and F2 conditions occur 20% of the time. It would be useful to confirm that, as the modelling was done in D5 and F2, what overall probabilities were assigned in the QRA to each weather condition and that the probabilities of these two conditions is 1.0.

The key outputs of the risk assessment are the risk contour plots, showing the implications for individual risk for the development, and the societal risk calculation, using the EV and the EN curve. These show the risks associated with the facility, including the terminal and the power plant. The findings are, based on QRA findings, that the risks are in accordance with the HSA's criteria. This interpretation of the findings is valid, notwithstanding that we have raised some questions or matters for clarification on the risk assessment methodology underpinning these findings. Where appropriate, these notes have been assigned to the relevant element or section of the proposed development (e.g. terminal, power station or site-wide). These are set out in Section 8 of this report.

3 Preliminary MATTE Assessment

As noted in Section 1.2 of our report, the COMAH Regulations are concerned with the risks presented by major accidents to human health and to the environment. The QRA report (discussed in Section 2, assesses the risks to human health. The MATTE (major accident to the environment) assessment deals with the environmental risk.

The report describes how a qualitative assessment was carried out of possible scenarios that can give rise to accidental releases from the development. Scenarios have been identified involving major releases of the following:

- Odorant
- Transformer oil
- Fire water run off

These events are described as being low risk as initiating would require major fire or explosion.

Section 1.3.1 describes the pollution mitigation and response, including with the Shannon Estuary Anti-Pollution Team (SEA-PT).

Section 3 describes the risk of a MATTE and the use of the CDOIF (Chemical and Downstream Oil Industries Forum) approach. This sets out the criteria for environmental damage which are used to determine if a release is a MATTE or not. This approach is consistent with the HSA guidance.

With respect to extent of damage, there is reference to Schedule 6. This is a different set of criteria than set out in the CDOIF guidance, but the two systems are comparable and, most notably for this purpose, using either approach a release that could damage 0.5 ha of the Shannon would be considered.

The report notes that the CDOIF approach sets out criteria for harm to a wide range of receptors but that for the purpose of this assessment only the possible impacts to the most sensitive receptors will be considered (NHA, SPA and SAC), as these are the most vulnerable receptors, with the most stringent criteria. This is a reasonable approach given the location.

Section 4.1 sets out the sources (hazardous substances). Table 4-2 sets out the materials and their eco-toxicity. The report discusses of source – pathway – receptor approach used. Section 4.2.1 discusses the drainage system and the controls to protect against a release escaping offsite via this route.

The report states that, with exception of LNG and natural gas, materials present on the FSRU and LNGC have not been included in this preliminary assessment as they do not differ in any notable way from other large ships passing along the estuary. These should be included in the risk assessment if they arise from a new activity at the estuary which introduces new hazards to the estuary, even if they are not different in nature to existing hazards. We note that there will be storage of small quantities of diesel oil at the site, which would present an environmental hazard, although the quantities stored may be sufficiently small that the environmental risk will prove to be not significant. This should be screened against the CDOIF criteria, to determine if a worst-case release could give rise to a MATTE and, if so, to determine the significance of the environmental risk. This will need to be demonstrated in the safety report to the HSA. Provided that appropriate controls are in place to protect against a release onshore escaping to the estuary (e.g. with appropriate primary, secondary and tertiary containment), this risk should be able to meet the HSA / CDOIF criteria, in which case there would be no significant planning implications.

Shipping activities will introduce a source of risk for an oil release to the Shannon. Shipping activities are not covered by the COMAH Regulations, but nonetheless are of relevance in the broader assessment of the development. Shipping activities in the Estuary are managed by the Shannon Foynes Port Company, which oversees navigation, piloting, etc. The shipping activities for the STEP would be similarly managed. We also understand that the activities of the STEP will not result in a significant increase in shipping volume in the Shannon Estuary. The risks directly associated with the shipping activities are covered in the Marine Risk assessment, as discussed in Section 6.

The report includes discussion of the risks associated with fire water run-off. Fire water run-off from a storage building fire will be expected to be contained on site and will only reach the Shannon estuary if a very large quantity of firewater is used it is not clear how much would be a very large amount in this context, nor if it is anticipated that a very large amount of water is expected to be used in this scenario. In this event, water contaminated with materials that may be hazardous to the environment could enter the estuary. If such a release was prolonged, and contained materials that are ecotoxic, it is possible that the local SAC/SPA could be affected, possibly leading to a MATTE. The report states that fire water retention will be provided and the retention facilities will be sized in accordance with the EPA guidance. With the measures proposed for preventing building fires and controlled discharge of fire water to the estuary, the risk of a MATTE from fire water run-off is considered to be very low.

There is a statement that "All of the MATTE events identified are considered to be low frequency and consequently low risk, as the initiating event for release would be a significant fire or explosion on the LNG Terminal or Power Plant". We would note that low probability events can still be associated with relatively high risks, where the associated consequences are high. We recommend that the report includes calculations of the probabilities of these MATTE events (based on loss of containment due to an explosion or a major release by other mechanism, such as catastrophic mechanical failure of a vessel), and that the risks should be calculated and compared with the CDOIF criteria. These are set out in Figure 1 below, for reference.

Figure 1: Risk criteria for a MATTE (source: CDOIF)

Severity of Harm					
	4		C	D	D
	3		B	C	D
	2		A	B	C
	1	*Sub-MATTE Harm*			
		1	2	3	4
		Harm Duration Category			

Frequency at which the CDOIF *consequence* level is reached or exceeded	Frequency per receptor per establishment per year	
	Intolerable (greater than)	Broadly Acceptable (less than)
A	1.0 E-02	1.0 E-04
B	1.0 E-03	1.0 E-05
C	1.0 E-04	1.0 E-06
D	1.0 E-05	1.0 E-07

We acknowledge that the developer will have to go through this process of more detailed MATTE assessment as part of the safety report submission and review process. As such it does not constitute a significant issue for the planning assessment on behalf of ABP.

4 Oil Spill Development Framework

This is quite a high-level document at this stage in the project. It is not as directly relevant to planning matters, but it provides additional context when understanding the controls that will be in place to ensure that the development meets the HSA requirements. These response plans are not yet in place. The report describes the approach that will be adopted to developing them.

This report notes that "Shannon Energy Park will manage the response to any Tier 1 and Tier 2 incident for any pollution on the water within their area of jurisdiction with the full cooperation and integration of the response with the Shannon Foynes Port, the Shannon Estuary Anti-Pollution Team (SEAPT) mutual aid group which includes the three local authorities of Kerry, Clare and Limerick and other agencies as appropriate." In practice this will involve the development of a suitable Internal Emergency Plan (IEP) for the development, in accordance with Schedule 4 of COMAH and the provision of all necessary information to the relevant external agencies, particularly the IAEMO (Inter Agency Emergency Management Office). It is not clear what discussions have been held at this point, but we would anticipate that these would be carried out in parallel with the development of the project, to have the IEP in place prior to operating as an upper tier establishment.

The STEP will be responsible for the response, control and mitigation of pollution incidents within its area of jurisdiction. This will include the onshore installation, jetty facility, FSRU and discharging vessels, including a marine-base area to be agreed with the Shannon Foynes Port Harbour Master.

The plan format is described as being developed around the five operational phases of the National Contingency Plan (NCP) Standard Operation Procedure 05, as follows:

1. Discovery and notification, evaluation, identification and activation
2. Development of an Action Plan
3. Action Plan implementation
4. Response Termination and Demobilisation
5. Post Operations, Documentation of Costs/Litigation

The report states that the format will include a Risk Assessment and Response Strategies and Guidance. Presumably this will involve the development of a series of scenario-based response plans. Table 1 of this document sets out the scenarios which have been identified in the Marine Navigation Risk Assessment (NRA).

Section 10 of the document discusses the risks associated with scenarios involving spills and releases on land. These are described as being outside of the scope of the Oil Spill Development Framework. However, they will need to be covered by the development of a suitable Internal Emergency Plan (IEP), developed in accordance with Schedule 4 of COMAH.

With respect to LNG spills, the report notes that LNG vessels are of double hull construction. The LNG containment tanks occupy the entire centre of the vessels hull, all the structural strength steel is concentrated in the side shell and bottom. This concentration of strength makes the sides and bottom of LNG vessels more resistant to collision or grounding damage than conventional oil ships. The LNG cargo is contained within independent tanks or membrane barrier systems located well inside a ships protective double hull structure. The space between the hulls is used to carry ballast water when the cargo tanks are empty.

The possibility of a vessel of sufficient displacement tonnage, alluding with a LNG ship in the proposed berth with sufficient energy to breach the cargo containment system is considered not credible. This is because passing traffic will be sufficiently far to the north of any wake effects experienced at the LNG berth to be minimal. The report notes that, for safety and security reasons when a LNG ship is moored at the berth, a limited exclusion zone will be imposed around the LNG jetty to restrict all passing traffic, fishing vessels and pleasure craft from approaching too close. With all this in mind, it is not clear what size of worst case spills are envisaged in the plan. We note from the QRA report that the Sandia studies were used for spill sizes, which gives more conservative figures than the Purple Book, but this report does not seem to describe the spill size either. (The 'large' spill scenario from the Purple Book is a release of 126 m^3, for reference).

This is a framework document at present, but the general approach appears reasonable and consistent with good practice for oil spills. The particulars of the plan will have to be finalised to reflect the risk assessment for the site and in accordance with the requirements of other authorities, such as the HSA and/or SEA-PT and so, provided that these other authorities are satisfied with the spill response arrangements, this aspect is not material to ABP's decision making.

5 EIAR Chapter Two

For the purposes of our review, this section of the COMAH submission is primarily used as a point of reference, for context on the various hazards and risks described in the various studies.

As noted earlier, the IEP for the site has yet to be developed. As such there is limited information on the fire-fighting arrangements that will be in place. Section 2.4.3.1.4 of the EIAR describes the fire water storage and fire water pumps. This gives the size of the tanks and notes that additional firewater will be stored in the firewater retention pond, as described in 2.4.7.3. Presumably this is additional retention capacity, not additional storage. This will all need to be expanded on for the IEP, which should set out scenario-based responses, including fire-fighting, to clarify the quantities of fire-fighting water that may be required for major accident scenarios at the site. This will be required to ensure that there is sufficient provision of fire-fighting resources at the site, to apply the required quantities at the required flow rates and durations, based on good practice guidance. This will also be necessary to determine the fire-water retention requirements, to ensure that appropriate provisions are made to protect against run off escaping offsite also.

6 Marine Risk

The Marine Risk assessment was commissioned by SFPC to deliver a navigation risk assessment for the proposed LNG facility. The copy of the report included in the COMAH documentation is an updated assessment from 2021.

The focus of this section of the COMAH document is on marine navigation risk. As such it is not directly related to the COMAH Regulations. The marine activities for the terminal, and the risks associated with these activities, fall under the jurisdiction of the port company rather than the HSA. The focus of our review of the documentation for An Bord Pleanála is on risks arising at the terminal itself.

Where marine activities have COMAH implications, the risks are identified in the marine risk assessment. The quantitative assessment of these same risks is included in the QRA (discussed in Section 2 of this report). For example, a scenario in which a vessel collides with the site infrastructure resulting in a release of gas, is covered both under the marine risk assessment and in the QRA; the consequence modelling is covered in the QRA. From a land use planning point (LUP) of view the focus is on the terminal side, where the consent is being sought, and it is the risk curves that were generated in the QRA that underpins this.

As noted above the marine risks are largely outside the scope of COMAH. Regulation 3(3) identifies developments or aspects to which the Regulations do not apply. This includes:

> "*(c) the transport of dangerous substances and directly related intermediate temporary storage by road, rail, internal waterways, sea or air outside establishments defined in Regulation 2(1), including loading and unloading and transport to and from another means of transport at docks, wharves or marshalling yards;*"

The assessment was carried out using a risk matrix approach, to rank the levels of risk presented by each scenario. For those scenarios identified as presenting higher risks, these were reviewed further and a total of 27 additional measures was identified and recommended for implementation.

The frequency and consequence ratings are set out in the methodology. From this, each scenario is assigned a risk scoring, from 0 to 10. The risk matrix is shown on page A-7 of the report (page 447 of 552 of the compiled document). This type of approach is widely used when assessing the risks of major accident hazards. One observation is that the scale appears to be a little bit off when compared with the HSA's criteria or the criteria that were used in the QRA for assessing the acceptability of a risk. For example, a scenario identified as having a probability of occurrence of the order of once every 10 years and with the potential to cause multiple fatalities is assigned a value of 5.9 on the scale, which is described as being in the ALARP region. However, this level of risk would be Intolerable based on the HSA's criteria.

Looking at the risk assessment worksheets in Annex D and Annex E, some scenarios are assigned decimal point valuations. For example, for one of the scenarios associated with tanker collision is assigned a Severity of 4 and a Frequency of 1.5. This does not appear to line up with the matrix that was shown in page A-7 of the report. The use of a fractional value for Frequency does not appear to be consistent with the approach in the matrix. According to the matrix, if the probability is less than 1 in 100 years a Frequency of 1 is assigned, while if the probability is between 1 in 10 and 1 in 99, a Frequency of 2 is assigned.

7 EIAR Chapter 14

This section effectively parlays the various major accident hazards that have been assessed for the proposed development.

Section 14.5 identifies the potential hazards:

- Flash fire
- Jet fire
- Pool fire
- VCE
- BLEVE
- Rapid Phase Transition
- MATTE

As with the QRA report, this section states that the risks from explosion overpressures were determined to be negligible, as potential release points are in open, well ventilated areas

Table 14-1 is the MAH Screening. Table 14-2 sets out the assessment, together with key control measures. This largely reiterates information from the other studies.

We note that in the discussion of a fire at the FSRU, this report states that "*Contaminated firewater will not be expected to contain significant quantities of uncombusted hydrocarbons or other chemical waste residues, therefore a discharge of fire water to the environment will only contain conventional pollutants from fire damage of assets.*" This should be reviewed using the EPA's screening tool, which is used to determine where fire water retention is required, which is determined on the basis of the quantities of dangerous substance present (on this case, on board) and on the hazardous properties they present. We note in any case that the preliminary MATTE assessment notes that fire water retention will be provided in accordance with the EPA guidance and so we would anticipate that, at this assessment stage, consideration will be given to the FSRU, to confirm whether retention facilities would be required here, based on the EPA guidance.

8 COMMENTS

Based on our review and our comments in this report, we have identified several points which may require clarification or development. In some cases these comments relate to the terminal and associated receiving infrastructure and others relate to the power station and battery. The remaining comments are applicable site-wide, or the overall assessment as it applies to multiple aspects of the development. These are set out in Table 4.

Table 4: Questions / Clarifications for COMAH documentation of proposed development

	Terminal	Power Station	Site-wide
1. The report should clarify whether there are risks of escalation to the LNG plant from a BLEVE of the odorant storage.	✓		
2. The report should clarify whether there are risks of escalation to the LNG plant from a fire or explosion at the BESS.		✓	
3. The QRA rules out the risks of significant impacts from VCE events, due to the low degree of confinement at the jetty and at the site. However, some of the consequence modelling results in the report show flammable atmospheres extending to distances of hundreds of metres. Such releases could extend over much of the site footprint or extend offsite to potentially congested areas such as the forested area to the SE of the development. The report should describe the approach that was used to identify what is or is not a congested area for the purposes of generating explosion overpressures.			✓

	Terminal	Power Station	Site-wide
4. There is a section in the report which discusses the Moneypoint site as a potential ignition source. The report should clarify are there any events identified which could result in a release extending to the Moneypoint site.			✓
5. Table 10-2 of the risk assessment sets out frequency data for D5 and F2 conditions, in day and in night-time conditions. The report should clarify what frequencies were used for these conditions in the risk assessment when generating the risk contour plots (i.e. that the combined probability of the two weather conditions modelled is 1.0).			✓
6. The scale that is used for the Marine Risk assessment matrix should be reviewed, to ensure that it is consistent with HSA guidance with respect to low probability scenarios that have potential lethal effects. Clarification should also be provided on how a scenario can be assigned a fraction value for frequency in the Marine Risk Assessment.			✓
7. The Marine Assessment should also provide clarity on how to determine appropriate weightings when calculating the weighted average for the Risk Score.	✓		