9. *Can you demonstrate explicitly that the criteria in Annex A, tables A2 of EN 1473:2007 and A4 will be met?*

The EN 1473:2007 standard allows either a deterministic assessment (i.e. consequence based) and/or a probabilistic assessment (i.e. risk based) to be performed when assessing the safety of the installation (Section 4.4.2.1).

The deterministic approach involves establishing a set of 'credible hazards', analysing the consequences of these credible hazards (in terms of thermal radiation contours, for example) and comparing the results with the criteria in Annex A. Note that only 'credible' hazards are assessed.

EN 1473:2007 does not contain any guidance as to hazards that should, and those that should not, be defined as credible. Therefore, in establishing credible process hazards, Shannon LNG makes reference to NFPA 59A, 2006 edition; an established LNG Standard requiring deterministic assessment of credible scenarios (e.g. design spills).

The design spill for "impounding areas serving only vaporization, process, or LNG transfer areas" specified in NFPA 59A is "the flow from any single accidental leakage source for 10 minutes or for a shorter time based on demonstrable surveillance and shutdown provisions acceptable to the authority having jurisdiction".

SCENARIOS
The following scenarios have all been selected as the largest, credible events for each section of the Terminal:

Jetty Head
Rupture of an emergency shutdown valve located on a 3" bypass line at the jetty head during unloading.

This release is assumed to fall on to the surface of the water.

Transfer Lines
The transfer lines at the terminal will be fully welded and use 'pipe-in-pipe' technology. As such, no release scenarios from the main sections of these large diameter transfer pipes have been considered, although failure of a 3" valve bypass line during unloading has been considered.

This release is assumed to fall on to the surface of the water.

Storage Tanks
The storage tanks will be full containment type with all penetrations being made at the top of the tank. Table 1 of the standard indicates the scenarios to be considered in the hazard assessment as a function of tank type. For full containment tanks with a concrete roof (as is the case here) there is a footnote to the table which states:

"Roof collapse is not considered for these tank types except if it is specified in risk analysis."

Note that a range of full containment tank failures, from 300mm hole through to catastrophic failure, has been considered within ERM's QRA. Hence roof collapse of a full containment tank with concrete roof has not been deemed credible for the purposes of the deterministic assessment.

Consequently, failure of a tank sendout emergency shutdown valve 3" bypass line has been considered as credible. This release has been assumed to be directed to the impoundment basin (see below).

Boil-off Gas Handling
Within the BOG handling process the BOG recondenser will hold the most significant volume of LNG. Failure of a 3" valve bypass branch connection resulting in the spill of the entire contents of the recondenser and the associated piping was considered in this assessment. This release has been assumed to be directed to the impoundment basin (see below).

High Pressure Pumps
Individually, the high pressure LNG sendout pumps will not contain significant volumes of LNG when compared with other process inventories. However, the pumps will be increasing the LNG pressure to approximately 90barg, and as such a failure of a 3" branch connection on a HP pump discharge isolation valve has been considered. This release has been assumed to be directed to the impoundment basin (see below).

Vaporiser Exchangers
High pressure LNG from the HP Pumps will flow into the vaporiser exchangers and as such a failure of a 3" branch connection on an exchanger feed isolation valve has been considered. This release has been assumed to be directed to the impoundment basin (see below).

Gas Sendout/Metering
Failure of an instrument connection equivalent to 2" diameter is postulated as a credible event.

Impoundment Basins
In the unlikely event of LNG releases at locations across the terminal the following impounding features are included in the design:

- Tank area - the top platforms and paving areas below them will incorporate spill collection features and a drainage channel leading to the impoundment basin with an approximate capacity of 400m^3.
- Process Area - the paved areas around the process equipment will incorporate spill collection features and a drainage channel leading to the impoundment basin with an approximate capacity of 400m^3. This will be the same impoundment basin as that serving the tank area.

RESULTS

Table A.2 of EN1473:2007 presents the following allowable thermal radiation flux levels excluding solar radiation outside the boundary.

OUTSIDE BOUNDARY	MAXIMUM THERMAL RADIATION FLUX (kw/m^2)
Remote area [a]	8
Critical area [b]	1.5
Other areas [c]	5

[a] An area only infrequently occupied by small numbers of persons, e.g. moor land, farmland, desert.

[b] This is either an unshielded area of critical importance where people without protective clothing can be required at all times including during emergencies or urban areas (defined as an area with more than 20 persons per square kilometre) or a place difficult or dangerous to evacuate at short notice (e.g. hospital, retirement house, sports stadium, school, outdoor theatre).

[c] Other areas typically include industrial areas not under control of the operator/occupier of the LNG facilities.

The land around the terminal does not fit the definition of a critical area as it is essentially farmland with a small number of isolated residences and a population density less than 20 persons per square kilometre.

Taking into account the proximity of the nearest residence to the facility, Shannon LNG considers that the heat flux from a fire resulting from a credible spill and subsequent ignition should not exceed $5kW/m^2$ at this residence.

Jetty Head and Transfer Lines

The distance between a fire at the jetty head or transfer lines (on water) and the $5kW/m^2$ isopleths is calculated to be approximately 60 metres from the release source.

The minimum distance between the jetty head (location of credible spill sources) and the closest residence is approximately 1000 metres (reference ARUP Dwg C045).

Impoundment Basin

The distance between a fire in the impoundment basin and the $5kW/m^2$ isopleths is calculated to be approximately 47 metres from the edge of the impoundment.

The process area impoundment basin is located approximately 440 metres from the closest residence (reference ARUP Dwg C045).

Gas Sendout/Metering

The maximum distance between a fire from the gas sendout/metering and the 5kW/m^2 isopleths is calculated to be approximately 140 metres from the source.

The distance between the gas sendout/metering and the closest residence is approximately 340 metres (reference ARUP Dwg C045).

Conclusion

Given the above calculations of the consequences of credible hazards, the SLNG design meets the requirements of Table A.2 in EN1473:2007.

Table A.4

The terminal will not have a flare.

Each tank will be fitted with a vent stack for discharge of methane in the event of a significant process upset. These vent stacks will be designed in accordance with EN1473:2007. It is normal for the calculations detailing the compliance of vents to be carried out during the Front End Engineering Design stage of a project where more detailed information is available. That said, it is ERM's experience that fires from accidentally ignited vent stacks do not give significant thermal flux levels at the ground, and that compliance with the requirements of Table A.4 will be easily attained by the appropriate sizing of the vent height, angle, diameter and other parameters. In addition the vent stacks will be fitted with fire suppression equipment which will ensure that any accidental fire can be rapidly extinguished.