**Regulatory Observation**

**Summary**

Hitachi-GE’s proposed safety case on turbine disintegration is based on combined deterministic and probabilistic aspects. Hitachi-GE’s proposed Design Basis (DB) safety case is based on a single missile hitting the Heat Exchanger Building (HxB). The site location of the HxB has not been optimised against turbine disintegration and a robust deterministic safety case has yet to be developed. ONR has particular concerns with the proposed methodology, claims and arguments, ALARP and the lack of optioneering studies.

The aim of this RO is to ensure that a robust deterministic safety case is developed by:

- Clearly define and substantiate the number of missiles generated by a turbine disintegration event, and impact with buildings, during DB and BDB events.
- Develop a robust deterministic safety case.
- Provide an ALARP justification.

**Background**


ONR assessed this report and RQ-ABWR-0769 was raised. The RQ summarised concerns on the proposed methodology, claims and arguments, ALARP, and lack of optioneering studies.

During Step 4 of the GDA, the safety case for turbine disintegration has been discussed in a number of Internal Hazards (IH) L4 meetings, where Hitachi-GE’s presented its progress (SE-GD-0455, SE-GD-0494, and SE-GD-0515).

Hitachi-GE’s proposed methodology, safety case development and ONR’s concerns are given below:

- Hitachi-GE considers the low trajectory turbine missile strikes to concentrate within an area of 25 degree angle to the turbine wheel planes passing through the end wheels of the low-pressure stage. The 25 degree angle is stated within IAEA Safety Guide NS-G-1.11 [2] which states “the layout of the main turbine generator should be such that potential critical targets (such as the control room) lie within the area least susceptible to direct strikes from the turbine; that is, within a cone with its axis
Regulatory Expectation

Hitachi-GE has made limited overall progress in this area and ONR's concerns are largely outstanding.

ONR's expectation is that a robust deterministic safety case shall be developed and cohesive claims, arguments and evidence shall be presented. Hitachi-GE shall address the following:

- The proposed safety case is based on the assumption that a DB event will involve a single missile impacting the Hx/B damaging a single division, whereas a BDB event will involve all three divisions of RSW / RCW cooling in the Hx/B being destroyed by one or several high energy missiles.

Substantiation of these claims is required reflecting ONR's SAPs FA.2, FA.5, AV2, AV.3, AV6, and...
EMC and ECS series as appropriate.

- The HxB has not been optimised against turbine disintegration as it is located within the direct strike of a missile. The Hx/B building design appears to provide protection for each train of SSC delivering the key safety functions by segregation within the building in line with ONR's SAP EDR.2. However, the segregation provided within the Hx/B appears inadequate to protect the SSCs housed in the Hx/B from internal hazards initiated outside the building and capable to disable more than one train of SSC (SAP ESS.18).

- The safety case shall address unavailability of SSCs in line with ONR's SAPs ESS.23 and ESS.25.
- Defence in depth arguments shall be presented in line with ONR’s SAP EKP.3.
- Consideration of all relevant buildings in addition to Hx/B shall be given.
- Consequential hazards shall be presented.
- Demonstration of ALARP, including evidence of appropriate optioneering of all various options eg relocation of the HxB to a favourable location, provision of safety trains in alternative locations, strengthening the walls of buildings, and etc.

References


2. Protection against Internal Hazards other than Fires and Explosions in the Design of Nuclear Power Plants. International Atomic Energy Authority IAEA NS-G 1.11


Regulatory Guide 1.115, Protection Against Turbine Missiles

NUREG-0800 - Standard Review Plan, 3.5.1.3, Turbine Missiles

Regulatory Observation Actions

RO-ABWR-0079.A1

- A1.1 Clearly define and substantiate the number of missiles generated by a turbine disintegration event, and impact with buildings, during DB and BDB events.
  - The methodology, data and assumptions used in the analysis to derive the number of missiles generated and impact with buildings shall be presented together with appropriate sensitivity studies.
  - This shall include a justification of the assumed 25 degree of direct missile strike. Appropriate sensitivity studies shall be presented.

- A1.2. Develop a robust deterministic safety case by:
  - Systematic identification and quantification of consequences for all relevant buildings, including consequential hazards such as fire, flooding, steam release and etc.
  - Addressing common cause failure and cliff edge effects.
  - Reflecting all plant states and equipment unavailability.
  - Presenting appropriate claims, arguments and evidence.
  - Presenting defence in depth arguments.

- A1.3 Provide an ALARP justification that includes:
  - Evidence of optioneering studies on plant layout, separation/ segregation, redundancy, structural
strengthening of buildings and other protection measures to eliminate or reduce the risk to ALARP.

Resolution required by to be determined by Hitachi-GE Resolution Plan

<table>
<thead>
<tr>
<th>REQUESTING PARTY TO COMPLETE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Acknowledgement date:</td>
</tr>
<tr>
<td>RP stated Resolution Plan agreement date:</td>
</tr>
</tbody>
</table>