

<b>REGULATORY OBSERVATION</b>	
<b>REGULATOR TO COMPLETE</b>	
<b>RO unique no.:</b>	RO-ABWR-0040
<b>Date sent:</b>	11th March 2015
<b>Acknowledgement required by:</b>	1 <sup>ST</sup> April 2015
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<b>Resolution of Regulatory Observation required by:</b>	<i>To be determined by the Hitachi-GE Resolution Plan</i>
<b>TRIM Ref.:</b>	2015/60355
<b>Related RQ / RO No. and TRIM Ref. (if any):</b>	
<b>Observation title:</b>	UK ABWR Probabilistic Safety Analysis: Identification of Applicable Internal Hazards
<b>Technical area(s)</b> 4. PSA	<b>Related technical area(s)</b> Internal Hazards Fault Studies Human Factors Civil Engineering and External Hazards Severe Accident Analyses
<b>Regulatory Observation</b>	
<b>Summary</b>	
<p>ONR's assessment during Step 3 of GDA of the Requesting Party submission "Identification of External and Internal Hazards" (Ref. 1) has identified shortfalls. The objective of this Regulatory Observation (RO) is to state ONR's expectations related to the identification of internal hazards for the UK Advanced Boiling Water Reactor (ABWR) Probabilistic Safety Analyses (PSA) and to request Hitachi-GE to respond to the shortfalls identified by ONR's review.</p>	
<b>Background and Regulatory Expectations</b>	
<p>ONR's assessment during Step 3 of GDA of the Requesting Party (RP)'s submission "Identification of External and Internal Hazards" (Ref. 1) has identified a number of shortfalls where regulatory expectations are not met. As part of the ONR's assessment of Ref. 1, a number of guidance documents were reviewed to provide a consensus regarding the approach and technical basis for the identification and prioritisation of internal hazards to be considered in the GDA PSA (Ref. 2, 3, 4, 5, 6).</p> <p>The concerns highlighted by the ONR's assessment are summarized below.</p> <p><u>Identification of internal hazards</u></p> <p>ONR considers that although a relatively complete list of internal hazards is initially presented by the RP these are not transferred to the PSA evaluation. The PSA analyses should start from a complete initial list of possible internal event initiators.</p> <p>The review has also identified the following additional hazards that could be added to the analyses. These may not be applicable to the UK ABWR but should still be on the initial list for documentation of the appropriate disposition:</p> <ul style="list-style-type: none"> <li>• Spurious or required actuation of fire protection water systems.</li> <li>• Spurious or required actuation of Halon or CO<sub>2</sub> fire protection systems.</li> </ul>	

### Prioritisation of Internal Hazards for PSA

ONR review of the RP's submission has identified that there is a lack of criteria that are auditable for the basis for PSA screening. In addition, the review has identified that the treatment of hazards is not sufficiently clear to make a determination that the RP intent is acceptable. Specific examples were discussed with the RP during the PSA technical workshop in February 2015 (Ref. 7).

A process to look at combinations of hazards in an efficient manner have not been found in the PSA documentation. It is not clear for ONR whether there are combinations of internal or internal/external hazards that should be considered in the PSA analyses.

ONR expectation is that the RP develops a prioritization of internal hazards and hazards combinations adequately justified to be considered in the UK ABWR PSA in line with the expectations of ONR's PSA Technical Assessment Guide (TAG) Ref.2 and international good practice. The following factors should be considered as part of the internal hazards prioritization:

- Magnitude of the hazard vs. the design basis.
- Impact on plant, systems and containment.

The potential risk of core damage and releases to the environment resulting from the hazards analyses should be added to the overall risk associated with the UK ABWR.

### Cliff Edge Effects

ONR considers that the treatment of "cliff edge" effects is important in ensuring a robust plant design.

It is ONR's expectation that the RP systematically identify the hazards that are treated within the design basis and compare their frequencies and site effects with beyond design basis hazards and their associated frequencies and consequential site effects to determine if the risk remains low even when lower frequency (higher consequence) events are considered.

### Scope of the hazards analyses

The scope of the internal hazards analysis needs to address the following:

- How such hazards are to be treated for plant conditions other than at-power conditions with the containment inerted. These might include:
  - Low power conditions (start-up) with the containment deinerted.
  - Refuel/outage conditions with the containment open and heavy load movements occurring with multiple equipment unavailable due to maintenance.

For example, it is not clear in the documentation the justification for considering the at-power Conditional Core Damage Probability sufficient to screen hazards for these non-at-power conditions from further consideration based on low perceived frequency.

- Other on-site radionuclide sources apart from the reactor. Certain hazards may be legitimately considered as low priority for consideration of resulting core damage for at-power conditions. However, these hazards may, in fact, result in releases from other on-site radionuclide sources (e.g., SFP) and therefore should be incorporated into the overall PSA program search for hazards. ONR expectation is that this should be considered in the RP's documentation.

### Hazards impact analyses for PSA

ONR review has also identified issues regarding the lack of clarity regarding references to key hazards information that should support the internal hazards prioritization for the PSA. ONR expectations reflected in the PSA TAG (Section A1-2.7.1) are that:

- The frequencies and magnitude of all hazards selected for analysis are identified.
- The hazard impact analysis (as a function of the magnitude of the hazard if appropriate) is auditable

and covers possible initiating events, damage to equipment and structures, and impact on human performance.

- The hazard impact analysis has been undertaken using an adequate method and is auditable.

ONR's expectation is that as part of the PSA, internal hazard impact analysis is performed as a function of the magnitude of the hazard and in an auditable way. For example, the impact would be measured as damage to systems, structures, and components (SSCs), human interface degradation and containment.

**References:**

1. Hitachi-GE Standard ABWR Initiating Events and Estimations for Internal/External Hazards, GA91-9901-0048-00001, Rev. D.
2. ONR PSA Technical Assessment Guide (TAG), T/AST/030, Rev. 5.
3. Electric Power Research Institute, "Identification of External Hazards for Analysis for Probabilistic Risk Assessment," EPRI 1022997, December 2011.
4. Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities, Revision 2, U.S. Nuclear Regulatory Commission, March 2009.
5. US NRC, PRA Procedures Guide, NUREG/CR-2300, January 1983.
6. IAEA Safety Standards Series, "Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants", IAEA Guidance SSG-3, 2010.
7. ONR-GDA-CR-14-309 UK ABWR GDA Step 3 Technical Workshop 9<sup>th</sup> to 12<sup>th</sup> February 2015. TRIM 2015/62468.

**Regulatory Observation Actions**

**RO-ABWR-00NN.A1: Identification of internal hazards for the UK ABWR PSA**

Hitachi-GE is requested to explain whether the following hazards are applicable to the UK ABWR and should be added to the internal hazards list for the PSA screening:

1. Spurious or required actuation of fire protection water systems
2. Spurious or required actuation of Halon or CO<sub>2</sub> fire protection systems

*Resolution required by:* To be determined by the Hitachi-GE Resolution Plan

**RO-ABWR-00NN.A2 : Prioritization of internal hazards for the UK ABWR PSA**

Hitachi-GE is requested to develop a prioritisation of the internal hazards from a complete list of internal hazards in terms of:

- Magnitude of the hazard vs. the design basis.
- Impact on plant, systems and containment.

*Resolution required by:* To be determined by the Hitachi-GE Resolution Plan

**RO-ABWR-00NN.A3 : Combinations of hazards for the UK ABWR PSA**

1. Hitachi-GE is requested to expand the list of internal hazards and the hazards prioritization to address plausible combinations of internal and external hazards for the PSA.
2. Hitachi-GE is requested to provide the technical basis for assessment of combinations of internal and external hazards and the criteria used to prioritize hazard combinations for the PSA.

*Resolution required by:* To be determined by the Hitachi-GE Resolution Plan

**RO-ABWR-00NN.A4: Scope of the internal hazards analyses for the UK ABWR PSA**

1. Hitachi-GE is requested to review the scope of the internal hazards analysis to address how such hazards are to be treated for plant conditions other than at-power conditions with the containment inerted. These might include:
  - a. Low power conditions (start-up) with the containment deinerted.
  - b. Refuel/outage conditions with the containment open and heavy load movements occurring with multiple equipment unavailable due to maintenance.
2. Hitachi-GE is requested to provide an analysis of the impact of internal hazards on other on-site radionuclide sources (e.g. SFP, etc.) that could result in releases.

*Resolution required by:* To be determined by the Hitachi-GE Resolution Plan

**RO-ABWR-00NN.A5: Internal hazard impact analyses for the UK ABWR PSA**

Hitachi-GE is requested to provide an auditable internal hazard impact analysis to support the hazards prioritisation in Action 2. The impact would be measured as damage to systems, structures, and components (SSCs), human interface degradation and containment.

*Resolution required by:* To be determined by the Hitachi-GE Resolution Plan

**RO-ABWR-00NN.A6: UK ABWR hazard PSA programme**

1. Hitachi-GE is requested to review the PSA programme to include the development of the PSA for all the internal hazards for which a more detailed probabilistic evaluation needs to be undertaken in line with the results of the hazards prioritisation requested in Action 2.
2. Hitachi-GE is requested to provide an updated PSA programme to address the hazards impact on other radioactivity sources and plant conditions.

*Resolution required by:* To be determined by the Hitachi-GE Resolution Plan

**REQUESTING PARTY TO COMPLETE**

**Actual Acknowledgement date:**

**RP stated Resolution Plan agreement date:**