

Hitachi-GE Nuclear Energy, Ltd.
UK ABWR GENERIC DESIGN ASSESSMENT
Resolution Plan for RO-ABWR-0082
(Substantiation of the UK ABWR Class 1 Barriers against Internal Hazard Loads)

RO TITLE:	Substantiation of the UK ABWR Class 1 Barriers against Internal Hazard Loads	
REVISION :	0	
Overall RO Closure Date (Planned):	22 September 2017	
REFERENCE DOCUMENTATION RELATED TO REGULATORY OBSERVATION		
Regulatory Queries	RO-ABWR-0082	
Linked ROs	-	
Other Documentation	See Related Deliverables in Description of Work and References	

Scope of work :
<p>Background</p> <p>Throughout Step 4 of GDA, ONR has assessed and raised a number of Regulatory Queries for Hitachi-GE to address the generic Class 1 barriers that require further assessment against Internal Hazard loads, including dropped loads, pipe whip and internal missiles: RQ-ABWR-0993 (TRIM Ref. 2016/279879); RQ-ABWR-1231 (TRIM Ref. 2017/482272); RQ-ABWR-1302 (TRIM Ref. 2017/47503); RQ-ABWR-1380 (TRIM Ref. 2017/111610) and RQ-ABWR-1445 (TRIM Ref. 2017/182028).</p> <p>In the dropped loads assessment, Hitachi-GE has generally applied the R3 procedure in an attempt to substantiate the Class 1 slabs and this has resulted in the prediction that failure by perforation and/or scabbing is credible on the Reactor Building Operating Deck and Control Building. Hitachi-GE has proposed to perform Finite Element Modelling (FEM) to demonstrate the integrity of the barriers, post GDA.</p> <p>The Pipe Whip and Jet Impact Topic Report predicts failure of Class 1 barriers against a single pipe impact in ~40 locations, given the reference GDA pipework layout. Consequential failures have been excluded from detailed assessment based on a perceived low probability of occurrence given US OPEX.</p> <p>The assessment of Class 1 barriers against global effects e.g. compartment pressurisation, steam release, loss of unclassified supporting structures etc. has also not been provided.</p> <p>Hitachi-GE has also excluded systems from assessment based on their operating regime. ONR regulatory expectations on the level of assessment required, and the requisite ALARP case was communicated in RQ-ABWR-1310. ONR's Safety Assessment Principle (SAP) NT.2 states that "<i>there should be control of radiological hazards at all times</i>". It is also ONR's expectation that "<i>the short duration of the increased risk should not be used as the sole argument for justifying risks are</i></p>

ALARP” and that “Any reasonably practicable step that can be taken to eliminate, reduce or mitigate increased risks should be taken even though the time of higher risk may be short”

Responses to the above Regulatory Queries and Topic Reports, and technical discussions in meetings with Hitachi-GE have evidenced that satisfactory resolution of the above issues may not be achieved within the GDA Step 4 timeframe, unless a robust scope is developed and sufficient resource is allocated.

It should be stated here that the Class 1 barriers is a key claim within the internal hazards area and therefore lack of substantiation of these barriers renders the internal hazard safety case unsubstantiated.

Based on the information provided it appears that the design criteria to meet Internal Hazards requirements have not been captured in the civil design.

The ONR expectation were reiterated and presented within RO-ABWR-0082.

Description of work:

RO-ABWR-0082. A1

RO Action

Hitachi-GE will develop a consolidated list of cases where Class 1 Nuclear Safety barriers have not been fully substantiated against all foreseeable Internal Hazard loads including combined consequential events. This will include:

- Identification of the status of UK ABWR Class 1 barriers against Internal Hazard (IH) loads. This will clearly identify those predicted to fail and those substantiated against specific hazards.
- Identification of the failure mechanism e.g. scabbing, perforation, cone-cracking etc. as applicable.

Planned Submission to Cover RO Action

Consolidated list will be provided in update Barrier Substantiation Report (BSR) as Appendix B with description in main body of report as part of update of the BSR. A list covering identified consequential and correlated hazards will be included in Appendix D of the Combined Hazards Report

RO-ABWR-0082. A2

RO Action

Hitachi-GE will provide the proposed assessment methodologies, assumptions and base information needed for substantiation of the Class 1 barriers where different from the Step 4 methods e.g. R3 procedure.

This will include:

- Any revised pipe whip, dropped loads etc. methodologies.
- The proposed method to assess combined loads on barriers, global responses including compartment pressurisation and failure of unclassified supporting elements.
- Combined consequential events should be appropriately identified and quantitatively characterized (e.g. pipe and steam release, or pipe whip and jet impact or flood, or failure of multiple pipes in the same room).
- An auditable trail of any assumptions, numeric models, equations and parameter values used in the calculations.

Planned Submission to Cover RO Action

The assessment methodologies, assumptions and base information needed for substantiation of the Class 1 barriers will be provided in BSR revision 5 section 4.

RO-ABWR-0082. A3

RO Action

Substantiation of a robust set of representative Class 1 barriers (which will cover the most challenging consequences and all the relevant internal hazards, combined loads and global effects) within the GDA step 4 timeframe.

Hitachi-GE will:

- Provide the assessment results according to the revised methodologies;
- Perform sensitivity analyses to address uncertainty in the models, parameters and key assumptions;
- Document the specific options / measures required to prevent the failure of each Class 1 barrier;
- Demonstrate that the measures will not be foreclosed by the generic design (e.g. seismic qualification), and will remain available so that that future design considerations and assessment do not result in the need for significant changes to layout.

Hitachi-GE will document any required changes from the reference design so that they are carried forward into detailed design.

Planned Submission to Cover RO Action

The substantiation of a robust set of representative Class 1 barriers will be provided in the updated Topic Reports and the BSR.

For single hazards assessment, results will be provided and referenced as required in section 5 of the BSR that will cover each hazard, building by building with a summary in Appendix B of the same document.

In the case of combined hazards this will be covered by identifying representative rooms which could contain significant consequential or correlated hazards. The barriers within these rooms will then be assessed against the combined hazard loads.

Additionally, consequential effects of scabbing will be included in Appendix G of the Combined Hazards Topic Report.

RO-ABWR-0082. A4

RO Action

Hitachi-GE will provide justification that, where the specific barrier is not in the representative set, substantiation can be achieved without significant changes to layout.

Planned Submission to Cover RO Action

The substantiation of a robust set of representative Class 1 barriers will be provided in the updated Topic Reports and the BSR.

Representative sets of rooms will only be used as part of pressure part analysis within combined hazards. Additional justification for the selection of bounding case rooms will be included in Rev.4 of the Combined Hazards Topic Report.

RO-ABWR-0082. A5

RO Action

Provide a safety case for the failure of those high pressure safety injection systems outside of containment that are tested periodically while the reactor is at power. This should include:

- Identification of relevant systems and their location.
- Characterisation of the unmitigated consequences of the failure of the identified systems, including consequential damage to safety systems.
- Identification of the SSCs claimed to protect against the consequences of the failure and the safety function they provide, for example check valves, safety injection, barriers, drains etc.
- References to the evidence that supports the claims being made (e.g. fault studies analysis, barrier substantiation calculations) and/or clearly identify what will need to be demonstrated during a later phase of UK ABWR development to support the safety case claims.

Identification of any constraints on testing high pressure safety injection systems to be captured in Technical Specifications

Planned Submission to Cover RO Action

In response to Action 5, Hitachi-GE will provide a safety case for the failure of those high pressure safety injection systems outside of containment that are tested periodically while the reactor is at power. The will presented in a support document on low frequency pipe whip assessment.

Hitachi-GE will develop a safety case argument based around a bounding assumption that an internal hazard can spread to a second division (i.e. loss of two divisions of A-1 SSCs), which given the result of internal hazards assessments on divisional barriers is considered highly unlikely.

Additionally, Hitachi-GE will assume the most limiting single failure in the remaining A-1 division also occur concurrent with the internal hazard.

This way the remaining level of fault -tolerance in the most limiting and unlikely case can be better understood and potential cliff edge effects avoided.

The fault tolerance of the plant will be assessed based on the most limiting single failure leading to either:

- No significant response
- Change towards a safer plant condition e.g. Reactor Scram
- Slow deviation of key plant parameters

The output of this will be consistent with ONR Fault Studies advice provided on 8/6/17, will inform Hitachi-GE's ongoing ALARP strategy and will provide margin and/or address cliff-edge effects in the safety case argument.

The Safety Case argument in case of loss of two A1 divisions will be included in the Appendix G of Combined Hazard Topic Report.

Summary of impact on GDA submissions:

GDA Submission Document

Submission Date to ONR

RO-ABWR-0082 A1

- | | |
|---|----------------|
| ✓ Internal Hazards Barrier Substantiation Report Rev.5 [Ref-1] | 31 July 2017 |
| ✓ Topic Report on Combined Internal Hazards Rev.4 [Ref-2]
(Note referred from [Ref-1]) | 02 August 2017 |

RO-ABWR-0082 A2

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|---|--------------|
| ✓ Internal Hazards Queries on Step 4 Dropped Loads Assessments (Response to RQ-ABWR-1445) Rev.0 [Ref-8] | 20 June 2017 |
| ✓ Internal Hazards Barrier Substantiation Report [Ref-1] | 31 July 2017 |
| ✓ Topic Report on Internal Flooding Rev.4 [Ref-3]
(Note referred from [Ref-1]) | 23 June 2017 |
| ✓ Topic Report on Pipe Whip and Jet Impact t Rev.5 [Ref-4]
(Note referred from [Ref-1]) | 30 June 2017 |
| ✓ Topic Report on Internal Missile – Conventional Internal Missiles Rev.5 [Ref-5] | 20 June 2017 |

(Note referred from [Ref-1])	
✓ Topic Report on Dropped and Collapsed Loads Rev.4 [Ref-6] (Note referred from [Ref-1])	28 July 2017
✓ Topic Report on Combined Internal Hazards Rev.4 [Ref-2] (Note referred from [Ref-1])	02 August 2017
<u>RO-ABWR-0082 A3</u>	
✓ Internal Hazards Barrier Substantiation Report [Ref-1]	31 July 2017
✓ Topic Report on Internal Flooding Rev.4 [Ref-3] (Note referred from [Ref-1])	23 June 2017
✓ Topic Report on Pipe Whip and Jet Impact t Rev.5 [Ref-4] (Note referred from [Ref-1])	30 June 2017
✓ Topic Report on Internal Missile – Conventional Internal Missiles Rev.5 [Ref-5] (Note referred from [Ref-1])	20 June 2017
✓ Topic Report on Dropped and Collapsed Loads Rev.4 [Ref-6] (Note referred from [Ref-1])	28 July 2017
✓ Topic Report on Combined Internal Hazards Rev.4 [Ref-2] (Note referred from [Ref-1])	02 August 2017
✓ Refined Assessment results by Considering True Pipe Runs -Pipework with Low Frequency of Functional Failure	31 July 2017
<u>RO-ABWR-0082 A4</u>	
✓ Internal Hazards Barrier Substantiation Report [Ref-1]	31 July 2017
✓ Topic Report on Internal Flooding Rev.4 [Ref-3] (Note referred from [Ref-1])	23 June 2017
✓ Topic Report on Pipe Whip and Jet Impact t Rev.5 [Ref-4] (Note referred from [Ref-1])	30 June 2017
✓ Topic Report on Internal Missile – Conventional Internal Missiles Rev.5 [Ref-5] (Note referred from [Ref-1])	20 June 2017
✓ Topic Report on Dropped and Collapsed Loads Rev.4 [Ref-6] (Note referred from [Ref-1])	28 July 2017
✓ Topic Report on Combined Internal Hazards Rev.4 [Ref-2] (Note referred from [Ref-1])	02 August 2017
✓ Refined Assessment results by Considering True Pipe Runs -Pipework with Low Frequency of Functional Failure Rev.0 [Ref-7]	31 July 2017
<u>RO-ABWR-0082 A5</u>	
✓ Topic Report on Combined Internal Hazards Rev.4 [Ref-2] (Note referred from [Ref-1])	02 August 2017
✓ Refined Assessment results by Considering True Pipe Runs -Pipework with Low Frequency of Functional Failure Rev.0 [Ref-7]	31 July 2017

References:

<u>Ref.</u>	<u>Document Title</u>	<u>Document ID</u>	<u>Rev.</u>
[Ref-1]	Internal Hazards Barrier Substantiation Report	GA91-9201-0003-00426 (BKE-GD-0019)	5
[Ref-2]	Topic Report on Combined Internal Hazards	GA91-9201-0001-00096 (SE-GD-0217)	4
[Ref-3]	Topic Report on Internal Flooding	GA91-9201-0001-00091 (SE-GD-0143)	4
[Ref-4]	Topic Report on Pipe Whip and Jet Impact	GA91-9201-0001-00092 (ZD-GD-0008)	5
[Ref-5]	Topic Report on Internal Missile – Conventional Internal Missiles	GA91-9201-0001-00181 (SE-GD-0346)	5
[Ref-6]	Topic Report on Dropped and Collapsed Loads	GA91-9201-0001-00093 (LE-GD-0082)	4
[Ref-7]	Refined Assessment results by Considering True Pipe Runs -Pipework with Low Frequency of Functional Failure	GA91-9201-0003-02246 (OZJ-GD-1706)	0
[Ref-8]	Internal Hazards Queries on Step 4 Dropped Loads Assessments (Response to RQ-ABWR-1445)	GA91-9201-0003-02208 (LE-GD-0398)	0

Table1: RO-ABWR-0082 Gantt Chart

Substantiation of the UK ABWR Class 1 Barriers against Internal Hazard Loads: Resolution Plan for RO-ABWR-0082				August				September			
				7	14	21	28	4	11	18	25
Level	Action Title	Start	Finish								
1	Regulator's Issues of RO										
1.1	ONR issue of RO	7-Aug-17	7-Aug-17	■							
1.2	Hitachi-GE acknowledge RO	21-Aug-17	21-Aug-17		■						
1.3	Hitachi-GE issue Resolution Plan	31-Aug-17	31-Aug-17			■					
1.4	Regulator's confirm credibility of Resolution Plan	4-Sep-17	8-Sep-17				■				
1.5	Regulator's publish RO and Resolution Plan	11-Sep-17	15-Sep-17					■			
2	Preparation of Submission Documentation										
2.1	Action 1	1-Sep-17	11-Sep-17				■	■	■		
2.2	Action 2	1-Sep-17	12-Sep-17				■	■	■		
2.3	Action 3	1-Sep-17	13-Sep-17				■	■	■		
2.4	Action 4	1-Sep-17	14-Sep-17				■	■	■		
2.5	Action 5	1-Sep-17	15-Sep-17				■	■	■		
3	Regulator's Closure of RO										
3.1	Regulators' assessment for closing RO	11-Sep-17	22-Sep-17					■	■		
3.2	Regulator's publication of RO closure letter	25-Sep-17	29-Sep-17							■	