

Hitachi-GE Nuclear Energy, Ltd.
UK ABWR GENERIC DESIGN ASSESSMENT
Resolution Plan for RO-ABWR-0067
UK ABWR Generic Site Envelope
– External Flooding and Beyond Design Basis events.

RO TITLE:	UK ABWR Generic Site Envelope – External Flooding and Beyond Design Basis events.	
REVISION :	0	
Overall RO Closure Date (Planned):	31st October 2016	
REFERENCE DOCUMENTATION RELATED TO REGULATORY OBSERVATION		
Regulatory Queries	-	
Linked ROs	-	
Other Documentation	-	

Scope of work :
<p>Background</p> <p>Two Regulatory Queries have been raised and responses have been received from the RP.</p> <p>RQ-ABWR-0660 [Ref 1] relates to External Flooding, specifically regarding the “dry site” concept and whether sufficient consideration has been given to the mitigation of flooding events within the Generic Site Envelope (GSE). Hitachi-GE proposed the permanent external barriers concept [Ref-2] which is mentioned in IAEA SSG18 [Ref-3]. In the case that the permanent external barriers concept is applied, the structural integrity of the barriers should be considered against external hazard load (e.g. design basis seismic load) carefully.</p> <p>RQ-ABWR-0667 [Ref-4] relates to the post-Fukushima response regarding external flooding, placement of the Backup Building and Beyond Design Basis (BDB) External Hazard events. Hitachi-GE proposed the action plan of beyond design basis margin analysis which will be implemented and submitted to ONR during GDA step 4.</p> <p>ONR has identified shortfalls related to justification to demonstrate that the mitigation measures for beyond design basis external hazards including external flooding reduce risks ALARP, specifically regarding (but not limited to) the response to protection against sea water inundation.</p> <p>Scope of Work</p> <p>The objective of this resolution plan is to introduce Hitachi-GE’s current action items and schedule to respond to those ONR comments.</p> <p>[Ref-1] ONR, RQ-ABWR-0660, External Flooding (Generic Site Envelope) [Ref-2] Hitachi-GE, GA91-9201-0003-01085 (LE-GD-0184), Rev.0, Response to RQ-ABWR-0660 (External Flooding (Generic Site Envelope)) [Ref-3] IAEA Safety Standards Series – Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Installations – SSG-18 [Ref-4] ONR, RQ-ABWR-0667, External Hazards post-Fukushima response</p>

Description of work:

ACTION 1a– BDB margin evaluation for external flooding

For action 1a, Hitachi-GE will provide the following information for the design margin for beyond design basis external flooding:

- 1) Identification of Systems, Structures and Components (SSCs) for extreme external flooding event
Long-term LOOP and LUHS are assumed for extreme external flooding. Basic management strategy (e.g. RCIC, DC power supply) including Fukushima countermeasure (e.g. FLSS, FLSR) to remain in a stable condition in a hot standby state will be reviewed.

Design basis flood level and credible beyond design basis flood level cannot be known until site specific stage. However, allowable relative height of flooding will be investigated for each derived SSC.
- 2) Review of potential cliff edge effects for extreme external flooding based on the event tree
Based on derived SSCs in 1) of action 1b shown above, success paths (scenario) for extreme external flooding will be identified. Allowable relative height of flooding will be identified for each derived scenario.
- 3) BDB margin evaluation and ALARP demonstration for extreme external flooding
Exact design margin for each postulated flooding condition for SSCs will be reviewed based on allowable relative height of flooding. This action will be linked with ACTION 3.

ACTION 1b – BDB margin evaluation for external hazards

For action 1b, Hitachi-GE will provide the following information for the design margin for beyond design basis external hazards:

- 1) Margin Analysis for seismic hazard based on EUR*1
To investigate the design margin against beyond DB seismic load, sensitivity study with changes to seismic load (~1.5 times) will be addressed based on ASCE43 code.

Hitachi-GE will use Section 2.2.1 in ASCE43-05 for seismic margin analysis, not for seismic hazard definition. Seismic hazard definition is in accordance with SAP. Only the criteria in section 1.3 of ASCE43-05 are applied to the cliff-edge effect evaluation. Please note that DBE described in the criteria is not relevant to hazard definition in Section 2.0 in ASCE43-05 but is compliant with SAP. According to SAP EHA.7 ('Cliff-edge' effects), a cliff-edge effect is where a small change in analysis assumptions. Although the deterministic evaluation includes conservativeness in the analysis conditions, probabilistic evaluation can provide realistic response including additional margins for structural design. Hitachi-GE reckons that the margins can envelop "a small change" in the structural evaluation. Therefore, Hitachi-GE will use the criteria based on probabilistic evaluation in section 1.3 of ASCE43-05. Response acceleration at some probabilities of unacceptable performance can be obtained from the results in seismic fragility evaluation.
- 2) Margin Analysis for meteorological hazards*2
Seismic load is one of the most critical design basis loads for the building design. Therefore the seismic BDB sensitivity studies described in 1) should demonstrate the critical BDB behaviour of the structures. To substantiate this claim, the design margin provided above the DB meteorological hazards, will be compared with the design basis seismic load (DBE) based on simplified structural analysis.

Certain meteorological and hydrological hazards will be mitigated by how a SSC is detailed or positioned, rather than by pure structural capacity. This includes hazards such as flooding; please see our response under Action 1 b) and action 3.
- 3) Plant response analysis on HVAC design
Hitachi-GE will demonstrate design margin of HVAC system against extreme high and low temperature.

It should be noted that margin analysis for external flooding will be implemented on action 1b and action 3.

*1 For GDA, the seismic load is based on the EUR spectra

*2 Air Temperature, Wind, Rain & Ice, Snow

ACTION 2 – Document update with regard to external flooding mitigation

For action 2, we will update all the relevant GDA documents to include the revised external flooding mitigation strategy. The relevant EH documents are listed below.

GDA Submission Document Title	Document ID (Document No.)	Submission Date to the Regulators
Topic Report on External Hazard Protection	GA91-9201-0001-00031 (AE-GD-0126)	31-Aug-16
Topic Report on Generic Site Envelope	GA91-9201-0001-00030 (XE-GD-0183)	30-Aug-16
Support Document on Meteorology and Hydrology for Generic Site Envelope	GA91-9201-0003-00657 (XE-GD-0316)	30-Sep-16
List of Safety Category and Class for UK ABWR	GA91-9201-0003-00266 (AE-GD-0224)	30-Apr-16

It is note that the revised external flooding mitigation strategy will be reflected on the Revision C of relevant PCSR chapters (2: Generic Site Envelope, 6: External Hazards).

ACTION 3 – The redundancy of UK ABWR against external flooding

For action 3, we will provide the following information for the redundancy of UK ABWR against external flooding:

- 1) Identification of external openings on reactor building
Ingress of water from external openings on buildings may lead to loss of essential SSCs for preventing core damage. Therefore, external openings on reactor building and their relative elevation above nuclear island platform will be identified. The Hitachi-GE GDA flood protection strategy remains unchanged. That is to
 - prevent the sea water or estuarine inundation from reaching the site. This will be done preferably by dry-site method but can also be achieved by permanent external barrier method (as per SSG-18).
 - provide cutoff features to prevent runoff and ground water from on land but off the site running onto the site.
 - provide a site drainage system which captures and channels the rainfall that lands on the site and groundwater, such that it will remain below the threshold of the buildings. The actual design basis and appropriate beyond design basis flood levels can only be calculated for a specific site.

- 2) Review of recommended standard details of measures
The allowable relative height of flooding for each derived SSC in ACTION 1b will be reviewed. The event tree of external flooding will be updated if needed. Based on the event tree, recommended standard details of potential measures (e.g. additional waterproof measures) will be investigated for each postulated condition to enhance the redundancy of UK ABWR against extreme external flooding.

Programme Milestones/ Schedule:

Our response activity Gantt chart is Table 1.

Reference:
N/A

Table 1 RO-ABWR-0067 Gantt Chart

UK ABWR Generic Site Envelope – External Flooding and Beyond Design Basis events				2016/2					3				4				5				6						
				1	8	15	22	29	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27		
Level	Action Title	Start (Plan)	Finish (Plan)																								
1	Regulator's issue of RO																										
1.1	ONR Issue RO	17-Feb-16	17-Feb-16																								
1.2	Hitachi-GE acknowledge RO & issue Resolution Plan	17-Feb-16	31-Mar-16																								
1.3	Regulator's confirm credibility of Resolution Plan	1-Apr-16	30-Jun-16																								
1.4	Regulator's publish RO and Resolution Plan	1-Jul-16	10-Jul-16																								
2	Preparation of Submissions and Closure of RO Actions																										
2.1	ACTION 1b – BDB margin evaluation for external flooding																										
2.1.1	1) Identification of Systems, Structures and Components (SSCs) for extreme external flooding event	1-Apr-16	30-Apr-16																								
2.1.2	2) Review of potential cliff edge effects for extreme external flooding based on the event tree	1-Apr-16	30-Jun-16																								
2.1.3	3) BDB margin evaluation and ALARP demonstration for extreme external flooding	1-Apr-16	30-Jun-16																								
2.2	ACTION 1a – BDB margin evaluation for external hazards																										
2.2.1	1) Margin Analysis for seismic hazard based on EUR	1-Apr-16	30-Oct-16																								
2.2.2	2) Margin Analysis for meteorological hazards	1-Apr-16	30-Oct-16																								
2.2.3	3) Plant response analysis on HVAC design	1-Apr-16	30-Jun-16																								
2.3	ACTION 2 – Document update with regard to external flooding mitigation																										
2.3.1	Submission of revised Topic Report on External Hazard Protection	31-Aug-16	31-Aug-16																								
2.3.2	Submission of revised Topic Report on Generic Site Envelope	30-Aug-16	30-Aug-16																								
2.3.3	Support Document on Meteorology and Hydrology for Generic Site Envelope	30-Sep-16	30-Sep-16																								
2.3.4	List of Safety Category and Class for UK ABWR	30-Apr-16	30-Apr-16																								
2.4	ACTION 3 – The redundancy of UK ABWR against external flooding																										
2.4.1	1) Identification of external openings on reactor building	1-Feb-16	1-Apr-16																								
2.4.2	2) Review of recommended standard details of measures	1-Apr-16	30-Jun-16																								
3	Regulator's Closure of RO																										
3.1	Regulators Assessment	30-Oct-16	31-Dec-16																								
3.2	Regulator's publication of RO closure letter	1-Jan-17	31-Jan-17																								