CGN EDF General Nuclear System	REGULATORY OBSERVATION RESOLUTION PLAN RO-UKHPR1000-054	Rev.: 0	Page **1 / 11**
		GDA-REC-GNSL-008376	

REGULATORY OBSERVATION Resolution Plan	
RO Unique No.:	RO-UKHPR1000-0054
RO Title:	Validation of Internal Hazard loadings used for Civil Engineering design of non-barrier elements
Technical Area(s)	Internal Hazards
Revision:	0
Overall RO Closure Date (Planned):	2021-06-30
Linked RQ(s)	RQ-0943, RQ-1123
Linked RO(s)	
Related Technical Area(s)	Civil Engineering
Other Related Documentation	

Scope of Work

Background

It is expected that during GDA the requesting party (herein referred to as RP) demonstrates, through the provision of a safety case, that the risks to nuclear safety associated with internal hazards have been reduced to ALARP.

The safety case is required to provide sufficient articulation of the safety case claims, arguments and evidence to demonstrate that the internal hazards that pose a nuclear safety risk have been identified, eliminated, minimised and/or mitigated, through the application of a robust hazard analysis process.

The safety case needs to address the interactions between internal hazards and the civil structures, as the latter fulfil safety functions such as the provision of safety barriers delivering segregation of structures, systems and components (SSCs). The internal hazards analysis provides a key input into the civil engineering analysis, as the hazard loadings (e.g. due to fire, explosion, impacts etc.) need to be clearly defined such that structural barriers and other civil structures may be substantiated to withstand these loads.

ONR has discussed the importance of identifying and analysing internal hazard loadings on civil structures with the RP [Refs 1 - 5]. ONR has made it clear that such analysis should include both divisional barriers and other civil structures that are required to deliver safety functions.

The RP's design methodology for Civil Engineering structures subject to internal hazard loading is summarised in Section 7 of Ref. 6. The methods show that the RP's approach within Civil

Engineering considers internal hazard loads for non-barrier elements (structures other than those that provide divisional separation).

However, the current internal hazards analyses for UKHPR1000 [Refs. 7–11] do not include consideration of impact of loads on key internal non-barrier structural elements, examples of shortfalls in this regard include but are not limited to:

- only those elements forming the same compartment as the divisional barrier are considered;
- it is apparent (Table T-5-1 in Ref. 7) that only limited loads are considered, ie, those from internal hazards with global effect loads such as internal flooding, internal explosion, high energy pipe failure inc overpressure.
- For the global effect loads currently being considered on non-barrier elements, these appear to be associated with the bounding load for barrier elements. However, some of the global effects that are bounding for the barriers (e.g. internal explosion) may not be bounding for the non-barrier elements, meaning bounding loads may be being overlooked;
- internal hazard loads (both global and local effects) have not been considered on non-barrier elements (walls/columns) that are located outside a compartment;

To follow-up these observations, regulatory query RQ-UKHPR1000-0943 [Ref. 12] was raised. The RQ sought clarification on how hazard loads to structural elements other than those that provide divisional separation had been accounted for, to gain confidence that the design had been underpinned by a robust hazard analysis. The response to this RQ confirmed that internal hazard loadings had not been included in the civil engineering analysis of non-barrier structural hazards.

To allow the analysis of non-barrier civil structures against internal hazard loads to progress it was agreed in a workshop held in September 2020 [Ref.13] that a conservative approach to the definition of these loads be taken (note ONR SAP SC-5 paragraph 103 [Ref. 15] “Areas of uncertainty should be offset by appropriate levels of conservatism.”). This is documented further in RQ-UKHPR1000-1123 [Ref. 14].

This approach allows the civil engineering analysis to proceed, however, there is still a need to validate these conservatively derived loads by systematic characterisation of the internal hazards loads for the non-barrier elements.

In summary, the current safety case does not adequately demonstrate that the loads on non-divisional civil structures from internal hazards have been adequately characterised and specified.

Relevant Legislation, Standards and Guidance

ONRs SAPs [Ref.15] and internal hazards TAG NS-TAST-GD-014 [Ref.16] highlight that where claims of withstand capability are made on structures, the hazards loads should be derived, and the relevant structures substantiated against them. These expectations are captured within the following

relevant SAPs; EHA.1-6, EHA.19, ECE.6, ECE.12 and ECE.3.

ONR Regulatory Expectations

To address the concerns identified above the RP should characterise the internal hazard loads for non-barrier structural elements and demonstrate that the bounding assumptions used to allow the civil engineering analysis to progress are conservative.

For the purposes this RO the RP should provide full documentation that demonstrates a systematic, comprehensive approach that clearly characterises the loads to be used within the civil engineering analysis for the rooms below the spent fuel pool.

The RP should provide clear evidence of the application of the process for identification, data collection, and analysis of individual internal hazard loads as well as the derivation of bounding design basis loadings.

The process is expected to be documented at a detailed level for the agreed examples and presented in a format that allows demonstration of a clear golden thread from the initial hazard identification through to the final bounding internal hazard loads that are to be used to confirm the adequacy of the civil engineering design. These loads should then be used to demonstrate that the loads previously used for the civil engineering analysis are conservative.

Description of the Response and of the Scope of Work

a) Work scope and interface

1) Following diagram shows general work scope of this RO as well as interface with relevant civil analysis. Decoupled Conservative Internal Hazard Loads are to be used for non-barrier civil structure evaluation in parallel with Internal Hazards review in this area. **Resolution plan provides evidence to justify all hazards loads derived in sampled areas are bounded by Decoupled Internal Hazard Loads.** If not，any shortfalls will be identified and be discussed with ONR (Civils and IH) to agree a forward action plan to address the shortfall.

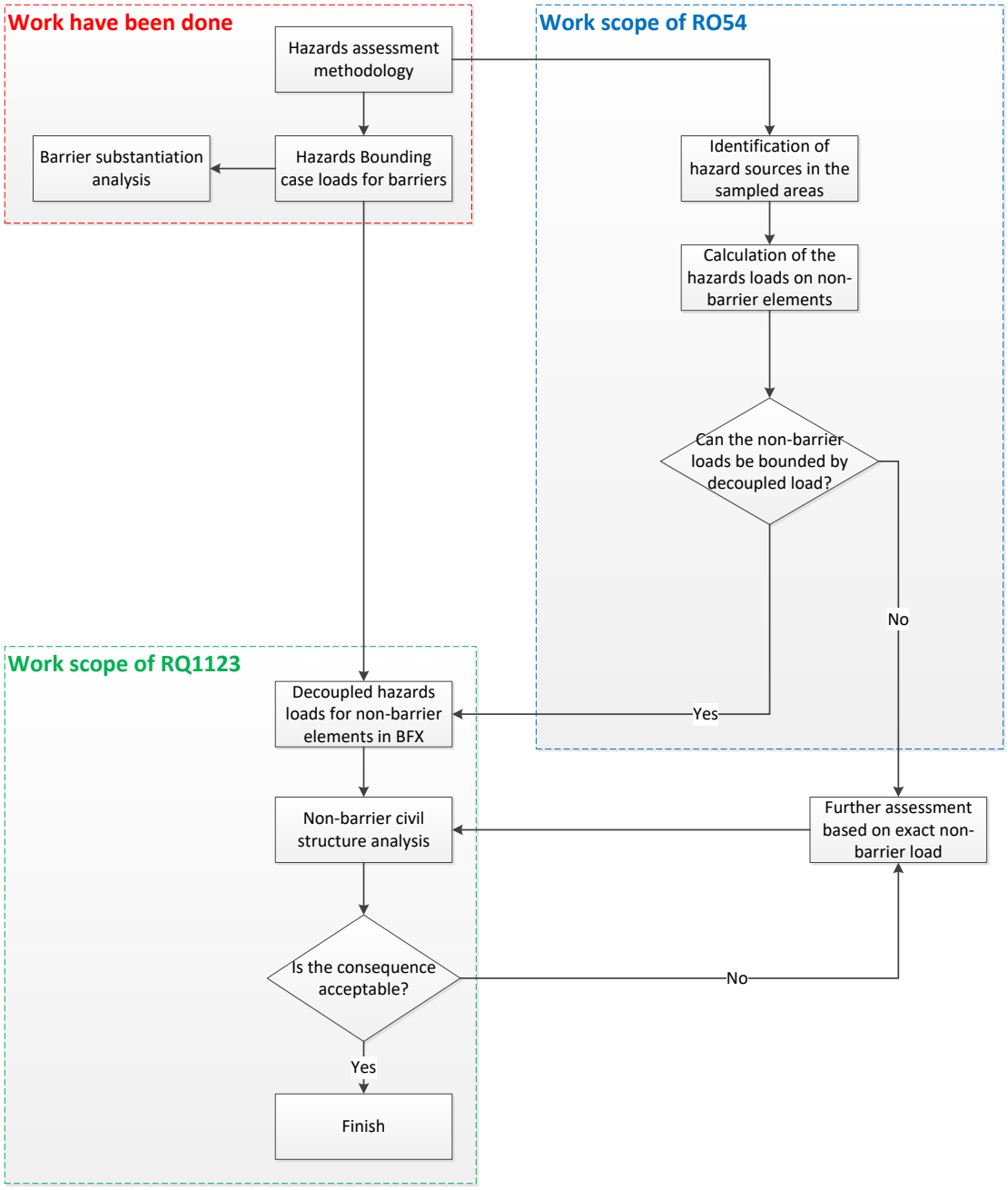

Figure 1

As presented in Figure 1, the main work contents with in the Regulatory Observation Action include:

2) A holistic internal hazard review to identify all the hazard sources located in the sampled areas and to determine the hazard scenarios impact the non-barrier structures in the sampled areas.

3) A conservative calculation of the hazards loads on the non-barrier structures in the sampled areas. The calculation method and the assumptions should be in line with the methodology applied in the hazard assessments for bounding cases.

4) A comparison of the hazards loads on the non-barrier structures in the sampled areas with the decoupled hazards loads used in civil engineering analysis to justify that the hazards loads on the non-barrier structures can be bounded by the decoupled hazards loads.

5) Any shortfalls will be identified and be discussed with ONR (Civils and IH) to agree a forward action plan to address the shortfall.

b) Sampling Areas:

The sampled areas are the rooms below the spent fuel pool which are highlighted in yellow in the following figures. The room list is presented in Table 1. The Validation of Internal Hazard loadings used for Civil Engineering design of non-barrier elements will be carried out for these rooms.

protected information

Figure 1 BFX building level-

protected information

Figure 2 BFX building level -

protected information

Figure 3 BFX building level -

Table 1 Room List of the Sampled Areas

Level	Room Number	Description
	protected information	

CGN EDF General Nuclear System	REGULATORY OBSERVATION RESOLUTION PLAN RO-UKHPR1000-054	Rev.: 0	Page **7 / 11**
		GDA-REC-GNSL-008376	

protected information

	protected information

c) Internal Hazards to be Considered in these Ares:

According to the layout arrangement, the list of internal hazards to be considered in these areas includes:

- Internal Fire
- Internal Explosion
- Internal Flooding
- High Energy Pipe Failures
- Dropped Loads
- Internal Missiles

- Vehicular Impact
- Combine Hazards

Deliverable Description

RO-UKHPR1000-0054.A1 –Demonstration based on key examples, that the UK HPR1000 internal hazards analysis has been undertaken in a way that delivers the necessary information to input to the design of the UK HPR1000 civil structures.

For Regulatory Observation Action 1, RP's planned response consists of the following work:

The RP will issue the report "*Validation report of Internal Hazard Loadings used for Design of Non-Barrier Elements (based on sample areas)*" in response to RO Action 1.

a) The aims and main scope of this report is to:

- Provide the evidence to support the approach/process of identification and characterisation of internal hazard loads on the non-barrier structures in the rooms below the spent fuel pool (fuel building);
- Capture detailed information as input to review hazards sources within sampled area. The input data will be documented in form of the room datasheet for each room using the format generated as part of Regulatory Observation 053.
- Calculate the hazards loads on the non-barrier structures in the sampled areas and justify that the load on the non-barrier structures can be bounded by the decoupled load used in civil engineering analysis.

b) Time Schedule:

The validation report in response to RO Action 1 is scheduled to be submitted before Feb, 26th 2021.

Task	Planned schedule
Validation report of Internal Hazard Loadings used for Design of Non-barrier Elements (based on sample areas)	26/02/2021

Impact on the GDA Submissions

These reports are all new documents. So these reports will be added in the GDA submissions.

CGN EDF General Nuclear System	REGULATORY OBSERVATION RESOLUTION PLAN RO-UKHPR1000-054	Rev.: 0	Page **10 / 11**
		GDA-REC-GNSL-008376	

Timetable and Milestone Programme Leading to the Deliverables

NA

Reference

1. ONR-NR-CR-19-299 - UK HPR1000 - Generic Design Assessment – Civil Engineering & External Hazards Step 3, Level 4 Workshop 3 for Civil Engineering - 14-18 October 2019, File Ref: 2019/312670
2. ONR-NR-CR-19-464 - UK HPR1000 GDA Step 3 - Internal Hazards Interaction No.9 Level 4 Meeting - 16 January 2020, File Ref: 2020/29526
3. ONR-NR-CR-19-533 - UK HPR1000 Generic Design Assessment Step 4 - Internal Hazards Interaction No.12 and No.13 Level 4 Meetings - 18-19 March 2020, File Ref: 2020/87269
4. ONR-NR-CR-20-273 - UK HPR1000 Generic Design Assessment – Civil Engineering Step 4, Design Process Walkthroughs L-3, File Ref: 2020/211881
5. ONR-NR-CR-20-278 - UK HPR1000 - Civil Engineering Step 4, Design Process Walkthroughs L-3 - 01-08 July 2020, File Ref: 2020/212704
6. GHXNIX10001DWJG42GN, Structural Analysis and Design Method Statement, Rev E, File Ref: 2020/232712
7. GHXFXX10005DWJG42GN, Reinforced concrete barrier substantiation report for BFX, Rev B
8. GHX84200045DOZJ03GN - Internal flooding safety assessment report for Fuel Building - Revision A
9. GHX84200046DOZJ03GN - Internal missiles safety assessment report for Fuel Building - Revision A
10. GHX84200049DOZJ03GN - Internal fire safety assessment report for Fuel Building - Revision A
11. GHX84200050DOZJ03GN - Internal explosion safety assessment report for Fuel Building - Revision A
12. RQ-UKHPR1000-0943 - Civil Engineering - Design and Analysis of Structural Elements Subjected to Internal Hazard Loads, 10th July, File Ref: 2020/208279
13. ONR-NR-CR-20-521 - ONR-NR-CR-20-521 -UK HPR1000 Generic Design Assessment – Civil Engineering Step 4, Workshop W-5, File Ref: 2020/289345
14. RQ-UKHPR1000-1123 - Civil Engineering - Civil Engineering Analysis of Internal Hazard Loads for Non-Barrier Structural Elements, 18 September 2020, File Ref: 2020/277894
15. Safety Assessment Principles for Nuclear Facilities. 2014 Edition, Revision 1. (January 2020). ONR. www.onr.org.uk/saps/saps2014.pdf
16. Technical Assessment Guide - Internal Hazards NS-TAST-GD-014 Revision 6. ONR. November 2019 (http://www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-014.pdf).

CGN EDF General Nuclear System	REGULATORY OBSERVATION RESOLUTION PLAN RO-UKHPR1000-054	Rev.: 0	Page: **11 / 11**
		GDA-REC-GNSL-008376	

APPENDIX A RO-UKHPR1000-054 Gantt Chart

Task and Schedule		2020					2021							
		Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Aug	Sep
RO Action 1														
1	Development of deliverable - [Validation report of Internal Hazard Loadings used for Design of Non-barrier Elements (based on sample areas)]													
2	Submission of deliverable - [Validation report of Internal Hazard Loadings used for Design of Non-barrier Elements (based on sample areas)]													
Assessment														
3	Regulatory Assessment													
4	Target RO Closure Date													