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REGULATORY OBSERVATION Resolution Plan

RO Unique No.:	RO-UKHPR1000-055
RO Title:	Consequential internal hazards resulting from seismic events
Technical Area(s)	Internal Hazards
Revision:	Rev. 0
Overall RO Closure Date (Planned):	30/06/2021
Linked RQ(s)	RQ-832
Linked RO(s)	---
Related Technical Area(s)	8. External Hazards
Other Related Documentation	---

Scope of Work

Background

In Step 3 of GDA, CGN has identified earthquake as a potential initiator for a range of consequential internal hazards. The RP has analysed the reference design against these internal hazards and reported this on a building-by-building basis in a suite of Earthquake Safety Evaluation Reports.


In Step 4, ONR raised a Regulatory Queries (RQs) regarding to earthquake safety evaluation reports, mainly on consequential internal hazards induced by design basis earthquake. CGN provided the safety evaluation for the consequential internal hazards induced by earthquake identified in *External Hazards Combination Safety Evaluation Report* (GHX86000001DOZJ00GN, Rev. A)

In the subsequent technical Level 4 meetings, ONR considered the responses to RQ-UKHPR1000-0832 did not provide sufficient confidence in earthquake induced internal fire and the dropped loads effects (including falling objects and swing effects), and detailed safety evaluation are not provided.

ONR's expectation is that the UKHPR1000 generic safety case should provide an adequate demonstration that the design is robust against consequential internal hazards resulting from an earthquake initiator and the risks are tolerable and or bound by existing load cases.

Abbreviations and Acronyms

ALARP	As Low As Reasonably Practicable
CGN	China General Nuclear Power Corporation

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FCG3	Fangchenggang Nuclear Power Plant Unit 3
GDA	Generic Design Assessment
GNSL	General Nuclear System Limited
MCR	Main Control Room
ONR	Office for Nuclear Regulation
RGP	Relevant Good Practice
RO	Regulatory Observation
RP	Requesting Party
RQ	Regulatory Query
RSS	Remote Shutdown Station
SSC	Structures, Systems and Components
UK	United Kingdom of Great Britain and Northern Ireland
UK HPR1000	The UK Version of the Hua-long Pressurized Reactor

Scope of work

The earthquake induced internal hazards have been analysed based on the reference design and reported on a building-by-building basis in a suite of Earthquake Safety Evaluation Reports (Reference [1] to Reference [8]), there are potential shortfalls for earthquake induced internal fire and the dropped loads (including the falling objects and the swing loads).

The design will be substantiated to demonstrate that the overall risks relevant to earthquake induced internal fire and dropped loads (including the falling objects and the swing loads) will be reduced to ALARP and the external hazards safety case will be complete.

This Resolution Plan describes the current plan to address the RO, however, as the work develops, it may be necessary to choose an alternative means to address the RO in agreement with the regulators.

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Deliverable Description

RO-UKHPR1000-0055.A1 – Demonstration, based on key examples, that the UK HPR1000 design is robust against consequential internal hazards initiated by an earthquake, and that results reported in the earthquake safety evaluation reports are underpinned by a robust evidential basis

The RO action 1 states that:

In response to this action, for the Fuel Building (BFX), Safeguard Building B (BSB) and Safeguard Building C (BSC) the RP should provide:

- Documentation demonstrating that a detailed, comprehensive and systematic identification and characterisation of the consequential internal hazard loads to targets as a result of a design basis seismic event has been undertaken for:
 - Internal fire analysis for Safeguard Building C (BSC);
 - Dropped load analysis (including falling objects and swing loads) for Fuel Building (BFX) and Safeguard Building B (BSB);
- Documentation to demonstrate that the consequences from the identified loads on targets are bounded where appropriate by the existing hazard analysis, or where this is not the case provide justification why the risks are tolerable.

Resolution Plan

In response to the action, a systematic review will be undertaken.

Two new submissions are planned for internal fire and dropped loads effects (including falling objects and swing loads) induced by earthquake separately:

- a) **Earthquake induced internal fire safety evaluation report (based on Safeguard Building C)**
 - 1) Earthquake induced internal fire safety evaluation methodology will be presented.

For the methodology, the following aspects will be included:

- Applicable code, standards and guidance;
- Analysis scope;
- Main assumptions used in the evaluation process;
- Flowchart of the evaluation showing the main steps used in the evaluation process of earthquake induced internal fire, the main steps are listed as below:

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- Collect design information of SSCs, including seismic category, etc.

In this step, the ignition source list and seismic equipment list which are credited in post seismic safe shutdown will be derived.

- Identify key seismic-fire interaction analysis compartments

Compartments housing SSCs credited in post seismic safe shutdown will be identified.

- Assess potential impact of seismically induced fires

In this step, following tasks will be performed:

- i. potential seismic fire ignition source types will be identified and analysed
 - ii. Map generic ignition source types to plant specific ignition sources and screen those which are not a potential threat
 - iii. Eliminate those sources from i) which are specified as SSE1
 - iv. The Zone of Influence (ZOI) of sources retained will be analysed without credit for short term fire suppression, and further screening will be performed based on functional analysis if it is needed
 - v. For sources retained in iv), develop and apply guidelines for enhancing seismic design and installation
- 2) The Safeguard Building C will be analysed to verify the robustness of UK HPR1000 design during earthquake induced internal fire by using the methodology listed in 1), as the Main Control Room (MCR) and the Remote Shutdown Station (RSS) are all arranged in Safeguard Building C.
- To make a well-founded analysis process, a datasheet will be developed for Safeguard Building C, and the templet of the datasheet will be consistent with RO-UK HPR1000-053.
 - In the datasheet, the information for the items will be provided, including the function category, the seismic category, etc., and internal ignition fire sources induced by earthquake will be included;
 - According to the safety evaluation, analysis will be performed to judge whether the risk is reduced to be ALARP, and any reasonably practicable enhancements will be identified for potential vulnerabilities.

b) Earthquake induced dropped loads effects safety evaluation report (based on Fuel Building and Safeguard Building B)

- 1) Earthquake induced dropped loads effects (including falling objects and swing loads) safety

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evaluation methodology will be presented;

For the methodology, the following aspects will be included:

- Applicable code, standards and guidance;
- Analysis scope;
- Main assumptions used in the evaluation process;
- Flowchart of the evaluation showing the main steps used in the evaluation process of earthquake induced dropped loads effects, the main steps are listed as below:

- Identify the protected targets

Systems required for safe plant shutdown following a seismic event will be identified as protected targets.

- Identify the potential dropped loads sources

Significant items that are non-seismically classified and could drop or collapse, or crane loads that could swing will be identified as aggressors.

- Analyse the impact scope of source aggressors

The impact scope of the dropped loads effects (including the falling objects and the swing loads) will be determined.

- Determine the impacted targets

The systems and components required for safe shutdown in the areas that may be impacted by the aggressors will be determined using the 3D model.

- Analyse the consequence


The consequences of impact on the systems and components required for safe shutdown will be analysed to check whether they are robust, adequately protected or vulnerable to impact loading.

- Mitigate vulnerabilities

If there are unacceptable vulnerabilities identified in the process, improvements will be performed to reduce the risk to be ALARP.

2) The Fuel Building and Safeguard Building B will be analysed to verify the robustness of UK HPR1000 design during earthquake induced dropped loads effects by using the methodology listed in 1).

- To make a well-founded analysis process, a datasheet will be developed for Fuel Building and Safeguard Building B, and the templet of the datasheet will be consistent with RO-UK

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HPR1000-053.

- In the datasheet, the information for the items will be provided, including the function category, the seismic category, etc., and the sources of dropped load induced by earthquake will be included;
- The non-seismically classified items in Safeguard Building B (BSB) and Fuel Building (BFX) will be analysed to evaluate the impact scope during the falling. Their impact scope will be evaluated, and the impacted items will be listed;
- The consequences of swing of the lifted items during a seismic event will be evaluated to identify whether item important to safety are impacted.
- According to the safety evaluation, analysis will be performed to judge whether the risk is reduced to be ALARP, and any reasonably practicable enhancements will be identified for potential vulnerabilities.

Impact on the GDA Submissions

Two new documents are planned to deliver:

- a) *Earthquake Induced Internal Fire Safety Evaluation Report (Based on Safeguard Building C)* 28/02/2021
- b) *Earthquake Induced Dropped Loads Effects Safety Evaluation Report (Based on Fuel Building and Safeguard Building B)* 05/03/2021

Based on the analysis result of reports a) and b), the following report may be impacted:

- ALARP Demonstration Report for External Hazards (GHX00100061KPGGB03GN).
- External Hazards Schedule Report (GHX86000015DOZJ03GN).

Timetable and Milestone Programme Leading to the Deliverables

See attached Gantt Chart in APPENDIX A.

Reference

- [1] CGN, Earthquake Safety Evaluation Methodology Report, GHX00100053DOZJ03GN Rev. B, 27 March 2019.
- [2] CGN, Earthquake Safety Evaluation Report for Reactor Building (BRX), GHX86000005DOZJ03GN Rev. B, 25 March 2019
- [3] CGN, Earthquake Safety Evaluation Report for Fuel Building (BFX),

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GHX86000006DOZJ03GN Rev A, 18 April 2019.

- [4] CGN, Earthquake Safety Evaluation Report for Safeguard Buildings (BSA/BSB/BSC), GHX86000007DOZJ03GN Rev. A, 20 June 2019.
- [5] CGN, Earthquake Safety Evaluation Report for Nuclear Auxiliary Building and Radioactive Waste Treatment Building (BNX/BWX), GHX86000008DOZJ03GN Rev. A, 18 July 2019.
- [6] CGN, Earthquake Safety Evaluation Report for Extra Cooling System and Fire-fighting System Building (BEJ), GHX86000009DOZJ03GN Rev. A, 18 April 2019
- [7] CGN, Earthquake Safety Evaluation Report for Personnel Access Building (BPX), GHX86000010DOZJ03GN Rev. A, 20 June 2019
- [8] CGN, Earthquake Safety Evaluation Report for Emergency Diesel Generator Buildings and SBO Diesel Generator Buildings (BDA/B/C/U/V), GHX86000011DOZJ03GN Rev. A, 18 May 2019

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APPENDIX A RO-UKHPR1000-0055 Gantt Chart

Task and Schedule		2020			2021						
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
RO Action 1											
1	Development of deliverable –[Earthquake Induced Internal Fire Safety Evaluation Report (Based on Safeguard Building C)]										
2	Submission of deliverable –[Earthquake Induced Internal Fire Safety Evaluation Report (Based on Safeguard Building C)]					▲					
3	Development of deliverable –[Earthquake Induced Dropped Loads Effects Safety Evaluation Report (Based on Fuel Building and Safeguard Building B)]										
4	Submission of deliverable–[Earthquake Induced Dropped Loads Effects Safety Evaluation Report (Based on Fuel Building and Safeguard Building B)]					▲					
Assessment											
5	Regulatory Assessment										
6	Target RO Close Date									▲	