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### REGULATORY OBSERVATION Resolution Plan

<b>RO Unique No.:</b>	RO-UKHPR1000-0060
<b>RO Title:</b>	Scope and Plan for Radiation Shielding Assessments for the UK HPR1000 Generic Design
<b>Technical Area(s)</b>	Radiological Protection
<b>Revision:</b>	0
<b>Overall RO Closure Date (Planned):</b>	2021-08-31
<b>Linked RQ(s)</b>	RQ-UKHPR1000-1409, RQ-UKHPR1000-1498,
<b>Linked RO(s)</b>	
<b>Related Technical Area(s)</b>	
<b>Other Related Documentation</b>	

#### Scope of Work


##### Background

During GDA Step 4, a Regulatory Query, RQ-UKHPR1000-1409 [1], was raised by the Office for Nuclear Regulation (UK) (ONR) to request methods, assumptions and other technical matters from the Requesting Party (RP) and support the assessment of the *Penetrations Shielding Design Report* [2]. On the basis of ONR's assessment of Reference [2] and engagements with the RP on the topic of radiation shielding provisions for bulk shielding, openings, penetrations and local shielding, it is ONR judgment that there is an ambiguous shielding assessment scope with respect to penetrations for the UK HPR1000 generic design and evidence has not been provided in sufficient detail to demonstrate that the adequacy of radiation shielding penetrations assessment.

A Regulatory Observation (RO), RO-UKHPR1000-0060 [3], was subsequently raised by the ONR to:

- a) Explain ONR's expectations;
- b) Ensure the RP provides a robust demonstration that radiation shielding assessment scope and delivery is appropriately balance between during and post-GDA, and the radiation shielding penetrations assessment is adequate for the UK HPR1000 generic design; and to
- c) Assist ONR's judgement of whether radiation doses to workers are capable of being reduces to ALARP.

The ONR's expectation is for the UK HPR1000 safety case documentation to substantiate the claim that adequate shielding provisions are required to support the claim that worker doses are restricted such that

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they meet legal limits and are ALARP. In support of this demonstration, the ONR expect the RP to:

- a) Clearly identify and justify what shielding assessments i.e. bulk shielding, openings, penetrations and local shielding, for the UK HPR1000 generic design, have already been completed and those planned to be completed both during, and post-GDA;
- b) Clearly document the method(s) for identifying and assessing radiation shielding penetrations in the UK HPR1000 generic design and justify why they represent good practice and are fit-for-purpose. ONR would therefore expect to see suitable and sufficient evidence to demonstrate:
  - 1) The appropriate application of the method(s) selected to identify and assess penetrations requiring radiation shielding.
  - 2) The adequacy of radiation shielding penetrations assessment, e.g. shield plates and angled penetrations, for either the UK HPR1000 generic design, or the Reference Plant Design, Hua-long Pressurised Reactor under construction at Fangchenggang nuclear power plant unit 3 (HPR1000 (FCG3)).
  - 3) Confidence in the RP's method for application of shielding techniques which are in line with the UK practices.
  - 4) That any increases in dose rates due to penetrations, openings and local shielding will not significantly impact radiation zoning or worker doses, for the UK HPR1000 generic design, and justify that doses are reduced to ALARP.

In line with the expectations set out above, this RO places two actions:


RO-UKHPR1000-0060.A1 – Radiation Shielding Assessment Scope and Delivery.

RO-UKHPR1000-0060.A2 – Suitable and Sufficient Evidence for Radiation Shielding Provisions for Penetrations.

### **Scope of Work**

On the basis of engagements with ONR on the topic of radiation shielding provisions during GDA Step 4, CGN have systematically updated the UK HPR1000 shielding design reports [4] to address the UK context and regulatory queries [5] [6] identified by shielding samples review, they are:

- a) Improve the golden thread of UK HPR1000 radiation shielding design safety case documentation, including:
  - 1) clearly description of shielding design principles;
  - 2) clearly description of calculation codes for shielding cases and the uncertainty of calculation results;
  - 3) clearly description of reference calculation point.

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- b) Consider the approach of the source term generation for parent and daughter radionuclides;
- c) Provide the approach of radiation shielding design optioneering for bulk shielding, openings shielding, local shielding and transient source term shielding;
- d) Improve the ALARP review for openings shielding.

However, the RP has not clearly stated the contributions from penetrations are not considered in the presented dose rates. Therefore, the RP decides to supplement a new document, "Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design", to clearly define and justify the radiation shielding design scope for the UK HPR1000 generic design, and to provide the appropriate references to demonstrate the shielding provisions for bulk shielding, openings shielding, local shielding and transient source term shielding based on the generic layout design have been completed for GDA.

The RP also recognises the obligations placed on them to demonstrate that the appropriate application of the method(s) selected to identify and assess penetrations requiring radiation shielding, and to demonstrate that the potential changes in dose rates due to the detailed penetrations shielding design post-GDA will not significantly impact layout design and radiation zoning, and justify that radiation doses to workers are reduced to ALARP. The RP will update the Penetrations Shielding Design Report [2], which aims to provide the penetrations shielding design examples undertaken for HPR1000 (FCG3) and demonstrate that the method of tamping and sealing the annular gap between penetrations sleeve and penetrations can be implemented in the site license, and justify the method application of shielding techniques for penetrations which are in line with the UK practices. The regulatory requirements capture, UK practices review and justification, assumptions for modelling of penetrations, and systematic ALARP approach for penetrations shielding assessment will be taken into account in the updated version of Reference [2] to demonstrate all potential radiation risks due to penetrations have been sufficient identified for the UK HPR1000 generic design and the further assessment during post-GDA will not significantly impact the layout design and radiation zoning. Whilst a lot of further work on radiation shielding penetrations assessment will be performed post-GDA, as part of the detailed design process, this scope of work is therefore to gain confidence in the assessment method for the UK HPR1000 generic design. This will support the claim that radiation doses to workers are acceptable and reduced ALARP.

The Radiation Protection Design Principles of Opening [7] will be updated to address the regulatory queries in the RQ-UKHPR1000-1498. The UK HPR1000 shielding design reports [4] will be updated to incorporate a summary of the updated version of Penetrations Shielding Design Report and draw conclusions that potential changes in dose rates for all shielding assessments post-GDA will not significantly impact radiation zoning and layout design.

The Radiation Shielding Topic Report [8] will be also updated to incorporate a summary of the "Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design" and the updated version of Reference [2] to support the claim that the radiation doses to workers during normal operation comply with UK legal requirements and are ALARP.

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To respond to this RO, the following work will be carried out:


- a) Supplement a new document “Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design” to clearly define and justify the radiation shielding design scope for the UK HPR1000 generic design i.e. the shielding provisions for bulk shielding, openings shielding, local shielding and transient source term shielding have already been completed. The method selected to identify and assess penetrations requiring radiation shielding planned to be updated during GDA, and the detailed radiation shielding penetrations design will be undertaken during site license;
- b) Provide suitable and sufficient evidence to demonstrate that the shielding provisions for bulk shielding, openings shielding, local shielding and transient source term shielding have been adequate assessments and radiation doses to workers have reduced to ALARP for the UK HPR1000 generic design (this has been completed in the latest version of UK HPR1000 shielding design report [5]);
- c) Provide the penetrations design examples undertaken for HPR1000 (FCG3) to demonstrate that the method of tamping and sealing the annular gap between penetrations sleeve and penetrations can be implemented in the site license;
- d) Update the Penetrations Shielding Design Report [2] to address the queries in RQ-UKHPR1000-1409 to ensure that all transmission paths are adequately captured for GDA and to demonstrate that potential changes in dose rates due to the detailed penetrations shielding design post-GDA will not significantly impact radiation zoning and layout design;
- e) Update the Radiation Protection Design Principles of Opening [7] to address the queries in RQ-UKHPR1000-1498;
- f) Update the UK HPR1000 shielding design reports [4] and Radiation Shielding Topic Report [8] to draw conclusions that the potential changes in dose rates for all shielding assessments post-GDA will not significantly impact radiation zoning and layout design.

#### Deliverable Description

Based on the scope outlined above, the following documents will be produced or updated to address this RO:

Document to be newly produced or updated:

- Report 1: Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design (new document);
- Report 2: Penetrations Shielding Design Report (updated version);
- Report 3: Radiation Protection Design Principles of Opening (updated version);
- Report 4: Reactor Building Shielding Design Report (updated version);

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- Report 5: Nuclear Auxiliary Building Shielding Design Report (updated version);
- Report 6: Fuel Building Shielding Design Report (updated version);
- Report 7: Safeguard Building Shielding Design Report (updated version);
- Report 8: Radiation Shielding Topic Report (updated version).

#### **RO-UKHPR1000-0060.A1 – Radiation Shielding Assessment Scope and Delivery**


Overall, in response to this Regulatory Observation Action (ROA), the RP should clearly identify and justify what shielding assessments i.e. bulk shielding, openings, penetrations and local shielding, for the UK HPR1000 generic design, have already been completed and those planned to be completed both during, and post-GDA. ONR would therefore expect the RP to:

- a) Provide a robust demonstration showing an appropriate balance has been struck between radiation shielding assessments planned to be delivered during and post-GDA, which minimises the potential impact on the UK HPR1000 generic design, with respect to physical design modifications.
- b) Clearly define what radiation shielding assessments will be undertaken post-GDA and provide details of the methods intended to be used, supported by adequate evidence/examples of similar radiation shielding assessments previously undertaken e.g. for FCG-3, where applicable, and to justify their applicability to UK HPR1000.
- c) Clearly identify where new radiation shielding assessment work will be undertaken and where updates to existing assessments are planned.
- d) The RP should therefore provide suitable and sufficient evidence to demonstrate that any increases in dose rates due to future assessments will not significantly impact radiation zoning or worker doses, and justify that doses are reduced to ALARP.
- e) Provide delivery dates for submission to ONR, for any outstanding radiation shielding assessments planned to be submitted during GDA.

#### **Resolution Plan**

##### **ROA1.1:**

As presented in the UK HPR1000 shielding design reports, Reference [4], the shielding design provisions of UK HPR1000 can be broken down into bulk shielding and specific shielding provisions, and the specific shielding provisions can be further divided into penetrations shielding, openings shielding, local shielding, transient source term shielding and temporary shielding. The radiation shielding safety case documentation has been submitted and sampled by ONR during GDA Step 4. However, the UK HPR1000 shielding design reports [4] have been updated several times as GDA has progressed which produce the ambiguous shielding assessment scope to ONR especially for penetrations through bulk shielding. In order to demonstrate the all significant design modifications have been identified which minimises the potential impact on the UK

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HPR1000 generic design, the RP will produce a strategy document, "Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design", to clarify and justify the radiation shielding design scope for the UK HPR1000 generic design. That is the shielding provisions for bulk shielding, openings shielding, local shielding and transient source term shielding based on the generic design are completed for GDA, and the shielding design review and additional ALARP review will be further undertaken during post-GDA when the detailed layout design and design modifications are substantiated. In addition, the penetrations shielding assessment method for UK HPR1000 planned to be updated during GDA, and the detailed radiation shielding penetrations design will be undertaken during site license. The main contents of this report are as follows:


- a) Summary of shielding provisions and definition of their relationships;
- b) Use of route maps to clearly define the design progress for shielding provisions and clearly state where in the design progress are for GDA Step 4;
- c) Use of route maps to clearly define the radiation shielding assessment scope for the UK HPR1000 generic design;
- d) Justification of the radiation shielding assessment scope for GDA and post-GDA to demonstrate that the radiation shielding assessment scope and delivery for UK HPR1000 is appropriate and potential changes in dose rates for all shielding assessments post-GDA will not significantly impact the layout design and radiation zoning;
- e) Demonstration of the adequacy of shielding assessments for the UK HPR1000 generic design and provide the appropriate references to corroborate the claim that the radiation doses to worker during normal operation comply with UK legal requirements and are ALARP.

**ROA1.2&1.3&1.4:**

According to the response to ROA1.1, the radiation shielding assessment scope for the UK HPR1000 generic design can be clearly defined in the new document. The shielding provisions for bulk shielding, openings shielding, local shielding and transient source term shielding based on the generic design have already been completed for GDA, the referencing between UK HPR1000 safety case documentation and above shielding provisions assessments will be clearly addressed in the new document to demonstrate the adequacy of shielding assessments.

For the radiation shielding assessments those planned to be completed during GDA, the RP will update the Penetrations Shielding Design Report [2] to provide the penetrations shielding design examples undertaken for HPR1000 (FCG3) and to update the method will be used for the penetrations shielding assessment considering the queries in the RQ-UKHPR1000-1409 which includes assumptions of parameters for penetrations modelling and systematic ALARP approach for radiation shielding penetrations assessments.

The RP will also update the Radiation Protection Design Principles of Opening [7] to address the queries in the RQ-UKHPR1000-1498, and update the UK HPR1000 shielding design reports [4] and Radiation Shielding


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Topic Report [8] to incorporate a summary of the updated version of Penetrations Shielding Design Report and draw conclusions that potential changes in dose rates for all shielding assessments post-GDA will not significantly impact the layout design and radiation zoning and protections against penetrations have been adequately considered for UK HPR1000 generic design.

For the update of Penetrations Shielding Design Report, the detailed steps are presented in the ROA2. Detailed steps for other reports are as follows:

- a) Update the report of Radiation Protection Design Principles of Opening
  - Address the regulatory queries in the RQ-UKHPR1000-1498.
- b) Update the UK HPR1000 shielding design reports
  - Clearly state the contributions from penetrations are not considered in the presented dose rates;
  - Clearly state that the assessments of bulk shielding, openings shielding, local shielding and transient source term shielding based on the generic layout design have been completed for GDA and reference to existing shielding safety cases, and the shielding design review and additional ALARP review will be further undertaken during post-GDA when the detailed layout design and design modifications are substantiated;
  - Demonstrate that the bulk shielding, openings shielding, local shielding and transient source term shielding based on the generic layout design have been adequately assessed and reduced to ALARP for the UK HPR1000 generic design; (this has been completed in the latest version of UK HPR1000 shielding design report [4]).
  - Draw conclusions that potential changes in dose rates for all shielding assessments post-GDA will not significantly impact radiation zoning and layout design and protections against penetrations have been adequately considered for UK HPR1000 generic design.
- c) Update the Radiation Shielding Topic Report
  - Amend the description of scope to incorporate the summary, from the "Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design";
  - Incorporate a summary of the updated version of Penetrations Shielding Design Report;
  - Draw conclusions that potential changes in dose rates for all shielding assessments post-GDA will not significantly impact radiation zoning and layout design and protections against penetrations have been adequately considered for UK HPR1000 generic design.

The radiation shielding assessments those planned to be completed post-GDA will be identified in the response of ROA1.1. For penetrations shielding assessment, the detailed radiation shielding penetrations design will be undertaken post-GDA, the RP will provide examples undertaken for HPR1000 (FCG3) to demonstrate the method of tamping and sealing the annular gap between penetrations sleeve and

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penetrations can be implemented in the site silence, which can be considered as a baseline for evidence to demonstrate the adequacy of UK HPR1000 radiation shielding penetrations assessments. The demonstration of potential changes in dose rates due to the detailed penetrations shielding design post-GDA will not significantly impact radiation zoning and layout design through the update of Penetrations Shielding Design Report [2] (This is as part of the resolution plan for ROA2).

In addition, a radiation shielding design review for other shielding provisions (i.e. bulk shielding, openings and local shielding) will be also undertaken post-GDA. The potential impact with respect to physical design modifications will be minor as the main radioactive components have been consolidated during GDA and the shielding design review and additional ALARP review can be further undertaken post-GDA when the design modifications are substantiated.

### **ROA1.5**

In response to this ROA, the RP will produce a new document, "Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design", and update the Radiation Shielding Topic Report [8], Penetrations Shielding Design Report [2], Radiation Protection Design Principles of Opening [7] and UK HPR1000 shielding design reports [4] during GDA. The planned delivery dates for submission to ONR are presented in the section of Impact on the GDA Submissions.

### **RO-UKHPR1000-0060.A2 – Suitable and Sufficient Evidence for Radiation Shielding Provisions for Penetrations**

*Overall, in response to this ROA, the RP should clearly document the method(s) for identifying and assessing radiation shielding penetrations in the UK HPR1000 generic design and justify why they represent good practice and are fit-for-purpose. The RP should therefore provide suitable and sufficient evidence to demonstrate:*

- a) The appropriate application of the method(s) selected to identify and assessing penetrations requiring radiation shielding.*
- b) The adequacy of radiation shielding penetrations assessments, e.g. shield plates and angled penetrations, supported by OPEX, and examples from their application to FCG-3 and/or other plants the RP may justify as being applicable.*
- c) The RP's method application of shielding techniques for penetrations which are in line with the UK practices.*

### **Resolution Plan**

#### **ROA2.1&2.2&2.3:**

According to the response ROA 1, the RP will update the Penetrations Shielding Design Report [2] to demonstrate that an appropriate pessimism method is applied for the UK HPR1000 generic design to ensure that all transmission paths are adequately captured. The penetrations shielding design examples undertaken



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for HPR1000 (FCG3) will be provided to demonstrate the method applied in the HPR1000 (FCG3) can be a baseline for the adequacy of UK HPR1000 radiation shielding penetrations assessment. The method will be updated to address the sensitive analysis conclusions to ensure that all transmission paths are adequately captured. The detailed steps are as follows:

- a) Incorporate a summary of “Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design” to clearly state the detailed radiation shielding penetrations design will be completed during site license;
- b) Add a new section of “Regulatory Requirements Capture” to demonstrate RP’s understanding of UK context;
- c) Identify good practices for radiation shielding penetrations assessment and justify whether the techniques are appropriate for the UK HPR1000 design;
- d) Provide the penetrations shielding design examples undertaken for HPR1000 (FCG3) to corroborate the method of tamping and sealing the annular gap between penetrations sleeve and penetrations can be implemented in the site license, which can be considered as a baseline for evidence to demonstrate the adequacy of UK HPR1000 radiation shielding penetrations assessment.
- e) Update the radiation shielding penetrations assessment method to address the queries in the RQ-UK HPR1000-1409 [1], including identification and analysis different assumptions for modelling of penetrations and application of relevant good practices;
- f) Provide a systematic ALARP approach that will be used for the radiation shielding penetrations assessment to demonstrate the potential changes in dose rates due to the detailed penetrations shielding design post-GDA will not significantly impact radiation zoning and layout design;
- g) Draw conclusion that the method used for the radiation shielding penetrations assessment for UK HPR1000 will result in equal or better than that of FCG3 in the site licensing stage.

#### Impact on the GDA Submissions

The information that will form part of the response to this RO will be incorporated into PCSR Chapter 22 V2 and their supporting documents. The planning for submission of the documents that will provide the response to this RO is as follows:

Title of Submission	Related ROAs	Planned Submission Date
Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design, Rev A	ROA1	31/3/2021
Radiation Protection Design Principles of Opening, Rev B	ROA1	31/3/2021
Penetrations Shielding Design Report, Rev B	ROA1&2	31/3/2021
Reactor Building Shielding Design Report, Rev G	ROA1	30/4/2021

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Nuclear Auxiliary Building Shielding Design Report, Rev G	ROA1	30/4/2021
Fuel Building Shielding Design Report, Rev E	ROA1	30/4/2021
Safeguard Building Shielding Design Report, Rev F	ROA1	30/4/2021
Radiation Shielding Topic Report, Rev E	ROA1	30/4/2021

#### Timetable and Milestone Programme Leading to the Deliverables

A Gantt chart to present the timetable and milestone of the RO resolution in Appendix A.

#### Reference

- [1]. ONR, Queries regarding the Penetrations Shielding Design Report, RQ-UKHPR1000-1409, January 2021.
- [2]. CGN, Penetrations Shielding Design Report, GHX00100035DNFP03GN, Rev. A, October 2019.
- [3]. ONR, Radiation Shielding Provisions for Penetrations in the UK HPR1000 Generic Design, RO-UKHPR1000-0060, February 2021.
- [4]. CGN, UK HPR1000 Shielding Design Reports:
  - Reactor Building Shielding Design Report, GHX00100031DNFP03GN, Rev F, February 2021.
  - Nuclear Auxiliary Building Shielding Design Report, GHX00100032DNFP03GN, Rev F, February 2021.
  - Fuel Building Shielding Design Report, GHX00100033DNFP03GN, Rev D, January 2021.
  - Safeguard Building Shielding Design Report, GHX00100034DNFP03GN, Rev E, January 2021.
- [5]. ONR, Outstanding Questions about Shielding Samples 2(RB), 2(FB) & 3, RQ-UKHPR1000-1263, November 2020.
- [6]. ONR, Radiation Shielding Queries Regarding the Fuel Transfer Canal, RQ-UKHPR1000-1262, November 2020.
- [7]. CGN, Radiation Protection Design Principles of Opening, GHX90300010DNFP02GN, Rev A, April 2020.
- [8]. CGN, Radiation Shielding Topic Report, GHX00100028DNFP03GN, Rev. D, January 2021.

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APPENDIX A RO-UKHPR1000-0060 Gantt Chart

	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21
<b>RO A1</b>								
1	Development of deliverable-[Radiation Shielding Assessment Strategy and Scope for the UK HPR1000 Generic Design]							
2			▲					
3	Development of deliverable-[Penetrations Shielding Design Report (updated version)]							
4			▲					
5	Development of deliverable-[Radiation Protection Design Principles of Opening (updated version)]							
6			▲					
7	Development of deliverable-[Reactor Building Shielding Design Report (updated version)]							
8				▲				
9	Development of deliverable-[Nuclear Auxiliary Building Shielding Design Report (updated version)]							
10				▲				
11	Development of deliverable-[Fuel Building Shielding Design Report (updated version)]							
12				▲				
13	Development of deliverable-[Safeguard Building Shielding Design Report (updated version)]							
14				▲				
15	Development of deliverable-[Radiation Shielding Topic Report (updated version)]							
16				▲				
<b>RO A2</b>								
17	Development of deliverable-[Penetrations Shielding Design Report (updated version)]							
18			▲					
<b>Assessment</b>								
19	Regulators Assessment							
20	Target RO Cloure Date							