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REGULATORY OBSERVATION Resolution Plan	
RO Unique No.:	RO-UKHPR1000-0046
RO Title:	Demonstration that the Risks to HIC Components from Internal Hazards are Reduced to ALARP
Technical Area(s)	Internal Hazards
Revision:	0
Overall RO Closure Date (Planned):	2021-03-31
Linked RQ(s)	
Linked RO(s)	RO-UKHPR1000-0008
Related Technical Area(s)	Civil Engineering,External Hazards,Fault Studies,Mechanical Engineering,PSA,Security,Structural Inte
Other Related Documentation	
Scope of Work	

Background and Regulator's Expectations

It is ONRs expectation that a safety case demonstrates the SSCs with highest reliability claims are not challenged by internal hazards such that the estimated likelihood of gross failure is very low or the safety case claims of gross failure can be discounted (Ref. 1).

The UKHPR1000 pre-construction safety report (PCSR) claims the highest integrity components (HIC) have appropriate withstands against internal hazards. During step 3 analyses were undertaken by the requesting party (RP) to identify those areas where HIC could be impacted by internal hazards (IH) to demonstrate that the claims made are appropriately substantiated.

From the assessment of supporting reports analysing internal hazard effects on HIC (Ref.2, 3, & 4), and subsequent RP engagements (Ref. 5, 6, 7 & 8), ONR has identified that currently there is insufficient detail to provide assurance that the risks to HIC components from IH are as low as is reasonably practicable (ALARP).

ONR sampling has identified shortfalls in the completeness of the safety case for HIC; in particular there is a lack of evidence to support the assumptions and claims used in the analysis, both in terms of the methods used and the level of conservatism applied. Additionally, where IH challenges have been identified it is unclear what analysis has been undertaken to review the design in order to optimise plant layout to eliminate the internal hazard challenge to the HICs.

To address the shortfalls identified and given the guidance detailed above, ONR expects the

requesting party to review the plant layout of HICs and provide a robust demonstration that risks to HICs associated with internal hazards have been reduced ALARP.

Where necessary, this demonstration should include consideration of different design options to prevent, protect or mitigate the effects on HICs from IH.

ONR recognises that the assessment of HIC components is still underway in the structural integrity topic area. The response to this RO should therefore be informed by the progression of work undertaken within the RP's structural integrity specialism. In particular the work associated with the consequence assessment for HIC candidates and the work undertaken in response to RO-UKHPR1000-0008 action 3 (Ref. 9) should be used to inform the wider IH aspects to address this regulatory observation.

Description of the Response and of the Scope of Work

This resolution plan provides a response for demonstration that risks to HICs associated with internal hazards have been reduced ALARP:

1) Demonstrate optimisation of plant layout in respect to HIC;
2) Present the safety case to cover the consequences of internal hazards on HIC, including:
   a) Deriving the Hazard loading for all HIC components;
   b) Presenting the HIC withstand criteria
   c) Presenting the golden thread

Present ALARP justification to demonstrate that the risk to HIC components from IH is reduced ALARP.

Deliverable Description

RO-UKHPR1000-0046.A1 – Demonstration of optimisation of plant layout in respect to HIC.

The Regulatory Observation Action 1 states that:

In response to this Regulatory Observation Action, the RP should:

- *Where IH sources have been identified to impact HICs, undertake a review of the plant layout and demonstrate that the IH sources have been eliminated where possible.*

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

The RP will issue the report "***ALARP Demonstration on Plant Layout in Respect to HICs***" in response to RO Action 1.

This report aims to demonstrate that the plant layout in respect to HIC has been optimised such that IH sources that could cause damage to the HICs have been eliminated as far as is reasonably practicable.

The main scope of this report will include information on:

- The list of HICs, the description of HICs layout and the description of internal hazards sources around HICs;
- The principles applied for the optimisation of layout for HIC (especially for protection against internal hazards);
- Where IH sources have been identified to impact HICs. The demonstration of how the internal hazards sources are eliminated where possible and why they could not be eliminated through optimisation of plant layout completely.

The Current list of HICs in line with SI classification methodology are ::

- RPV
- PZR
- SG
- MCL
- RCP casing & Flywheel
- MSL in containment

The list of internal hazards:

- Internal Fire
- Internal Explosion
- Internal Flooding
- High Energy Pipe Failures
- Dropped Loads
- Internal Missiles
- Electromagnetic Interference
- Toxic and Corrosive Materials and Gases
- Vehicular Transport Impact

In addition to the single internal hazard described above, combined hazards on HICs also are considered.

Time Schedule:

The "***ALARP Demonstration on Plant Layout in Respect to HIC***" in response to RO Action 1 is

scheduled to be submitted before September 15th 2020.

RO-UKHPR1000-0046.A2 – Present the safety case to cover the consequences of internal hazards on HIC

The Regulatory Observation Action 2 states that:

For those IH that could not be eliminated through optimisation of plant layout, the RP should :

- ***Derive the Hazard loading for all HIC components****: Provide a robust demonstration that the identification and quantification of all remaining IH sources (those that could not be eliminated) that impacting HIC has been undertaken:*
  - *Demonstration that a robust hazard analysis has been undertaken, including justification of screening of sources, application of assumptions, analysis methods and the incorporation of appropriate conservatism.*
- ***Present the HIC withstand criteria:*** *To enable adequate assessment of HIC given the IH loadings this should include**:***
  - *A justification of the methodologies and standards from which the criteria are derived; and*
  - *A clear justification of why the withstand criteria for the HIC are conservative.*
- ***Present the golden thread*** *for the safety case (claims, arguments and evidence) for those HICs against which an IH withstand claim has been made. This should include:*
  - *A clear presentation of the requirements for the HICs and / or any additional protective measures;*
  - *Substantiation of the withstand capability of HIC, against IH loads, which may involve multi-discipline consideration; and*
  - *Substantiation of any other claims made - for example any additional protection measures identified.*

For Regulatory Observation Action 2, RP's planned response consists of the following work:

Action 2.1 ***Derive the Hazard loading for all HIC components****:*

In response to RO Action 2, The RP has produced internal hazard safety assessment reports covering all the identified internal hazards. In these reports the hazard loadings have been derived for HIC components. The aim of this process is to demonstrate that the identification and analysis to derive these loads for the HICs is adequate.

The approach to carrying out the consequences analysis of internal hazards on HIC components is described as follows:

- For each internal hazard, with respect to HIC components, the safety assessment strategy is to assess them case by case in the safety assessment reports. In these reports, Criterion C is used to identify these scenarios where internal hazards sources that could not be

eliminated to impact HIC components.

Criterion C: the internal hazards scenarios which have the potential to cause damage to the High Integrity Component (HIC).

- The assumptions, definition of internal hazards sources, internal hazards loads calculation methods have been addressed in individual internal hazards safety evaluation methodology reports and combined hazards safety evaluation methodology report.
- The identification and derivation of internal hazard loads for HIC components are described in the ***internal hazards safety assessment reports (Ref.10, 11, 12, 13, 14, 15, 16, 17 & 18)*** and "***Combined Hazards Safety Assessment Report (Ref.19)***".
- Based on the above, for each HIC, the summary of all internal hazard loads will be described in substantiation report of each HIC which is the report for Aciton 2.3.

Action 2.2 Present the HIC withstand criteria:

In response to RO Action 2.2, the RP will issue the report "***Substantiation Method of HIC against IH loads***".

This report aims to present the approach for HIC substantiation against internal hazards loads, including the withstand criteria and their justification of conservatism. This report also aims to present the substantiation methodologies for those scenarios against internal hazards loads where internal hazards sources impacting HIC could not be eliminated, including assumptions, calculation methods and the withstand criteria.

Time Schedule:

The "***Substantiation Method of HIC against IH loads (Version B)***" in response to RO Action 2.2 is scheduled to be submitted before September 10th 2020.

Action 2.3 Present the golden thread *for the safety case (claims, arguments and evidence) for those HICs against which an IH withstand claim has been made.*

In response to RO Action 2.3, the RP will issue the substantiation report of each HIC against Internal Hazards. This includes six reports:

- Substantiation of Reactor Pressure Vessel against Internal Hazards
- Substantiation of Steam generator against Internal Hazards
- Substantiation of Main Steam Line against Internal Hazards
- Substantiation of Pressuriser against Internal Hazards

- Substantiation of Main Coolant Lines against Internal Hazards
- Substantiation of RCP Casing & Flywheel against Internal Hazards

The main scope of each report is described as follows:

- The substantiation for those scenarios where internal hazards sources impacting HIC could not be eliminated, including substantiation considerations, process and conclusions.
- Additional protection measures and associated requirements. Where the results of substantiation of HIC against IH show that the cases do not meet the withstand criteria, the consequence is unacceptable. The additional protection measures will be provided for HIC. In this process, the optioneering will be performed, including option description, scoring and conclusion.
- The substantiation of claimed protection measures is presented.

Time Schedule:

The substantiation report of each HIC against IH in response to RO Action 2.3 which will be submitted in two batches. The first batch will be submitted before October 30th 2020, the second batch will be submitted before November 30th 2020.

GDA Submission Document	**Planned schedule for submission**
Substantiation of Reactor Pressure Vessel against Internal Hazards	October 30th 2020
Substantiation of Steam generator against Internal Hazards	October 30th 2020
Substantiation of Main Steam Line against Internal Hazards	October 30th 2020
Substantiation of Pressuriser against Internal Hazards	November 30th 2020
Substantiation of Main Coolant Lines against Internal Hazards	November 30th 2020
Substantiation of RCP Casing & Flywheel against Internal Hazards	November 30th 2020

RO-UKHPR1000-0046.A3 – Present ALARP justifcation

The Regulatory Observation Action 3 states that:

- *Demonstrate that the risk to HIC components from IH is reduced ALARP taking into consideration the work undertaken under RO-UKHPR1000-0008 action 3.*

The risk to HIC components from IH being reduced ALARP will be demonstrated according to

Action 1 and Action2.

The strategy and Process for managing risk to HIC from IH is as follows:

Strategy and Process for Managing Risk to HIC from IH		**Output**
Step 1	Identification of Internal Hazards	The Identification and Screening Process of Internal and External Hazards
	Identification of HICs	Equipment Structural Integrity Classification List
Step 2	Plant Layout (IH sources that could cause damage to the HICs are eliminated where possible)	ALARP Demonstration on Plant Layout in Respect to HIC (ROA1)
Step 3	Identification of Internal Hazards Scenarios Impacting HIC	For each internal hazards: Internal Hazard Safety Assessment Report & Combined Hazards Safety Assessment Report
		For each HIC: Substantiation report of each HIC against Internal Hazards (ROA 2.3)
Step 4	Consequence Analysis of HICs against Internal Hazards	Substantiation Method of HIC against Internal Hazards loads (ROA 2.2)
		Substantiation report of each HIC against Internal Hazards (ROA 2.3)
Step5	Identification of additional protection measures (if necessary)	Substantiation report of each HIC against Internal Hazards (ROA 2.3)

This process and these works are performed in UK HPR1000 which can demonstrate that the risk to HIC components from IH is reduced ALARP.

In summary, the supporting submissions are involved in this resolution plan:

GDA Submission Document	Related ROAs	Planned schedule for submission
ALARP Demonstration on Plant Layout in Respect to HIC	ROA1	September 15th 2020
Substantiation Method of HIC against Internal Hazards loads	ROA2.2	September 10th 2020
Substantiation of Reactor Pressure Vessel against Internal Hazards	ROA2.3	October 30th 2020
Substantiation of Steam generator against Internal Hazards	ROA2.3	October 30th 2020
Substantiation of Main Steam Line against Internal Hazards	ROA2.3	October 30th 2020
Substantiation of Pressuriser against Internal Hazards	ROA2.3	November 30th 2020
Substantiation of Main Coolant Lines against Internal Hazards	ROA2.3	November 30th 2020
Substantiation of RCP Casing & Flywheel against Internal Hazards	ROA2.3	November 30th 2020

Impact on the GDA Submissions

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

Timetable and Milestone Programme Leading to the Deliverables

See attached Gantt Chart in APPENDIX A.

Reference

[1] ONR, Safety Assessment Principles For Nuclear Facilities, SAP, 2014 Edition, January 2020.

[2] CGN, High Energy Pipe Failures Safety Assessment Report for Reactor Building (Based on Bounding Cases), GHX84200015DOZJ03GN, Rev. A, September 2019.

[3] CGN, High Energy Pipe Failures Safety Assessment Report for Fuel Building (Based on Bounding Cases), GHX84200018DOZJ03GN, Rev. B, October 2019.

[4] ONR, RQ-UKHPR1000-0509, Internal Hazard queries on high energy pipe failures

(bounding cases) for the reactor & fuel buildings, File Ref: 2019/375195.

[5] ONR-NR-CR-19-464 - Internal Hazards Interaction No.9 Level 4 meeting 16th January 2020, File Ref: 2020/29526.

[6] ONR-NR-CR-19-531 - Internal Hazards Interaction No.10 Level 4 meeting 28th February, File Ref: 2020/74080.

[7] CGN Presentation - Discussion of HIC Equipment Substantiation against Internal Hazard Loads, File Ref: 2020/17622.

[8] ONR presentation, HIC Component expectations, 10th March 2020, File Ref: 2020/77899.

[9] ONR, Regulatory Observation, Justification of the Structural Integrity Classification of the Main Coolant Loop, RO-UKHPR1000-0008, 20th Dec 2018, File Ref: 2018/409445.

[10] CGN, Internal flooding safety assessment report for Reactor Building, GHX84200039DOZJ03GN, Rev. B, June, 2020.

[11] CGN, Dropped loads safety assessment report for Reactor Building, GHX84200040DOZJ03GN, Rev. A, May, 2020.

[12] CGN, Internal fire safety assessment report for Reactor Building, GHX84200041DOZJ03GN, Rev. A, May, 2020.

[13] CGN, Internal explosion safety assessment report for Reactor Building, GHX84200042DOZJ03GN, Rev. A, June, 2020.

[14] CGN, Internal missiles safety assessment report for Reactor Building, GHX84200043DOZJ03GN, Rev. A, June, 2020.

[15] CGN, High energy pipe failures safety assessment report for Reactor Building, GHX84200044DOZJ03GN, Rev. A, September, 2020 (to be issued).

[16] CGN, Toxic and Corrosive Materials and Gases Safety Assessment Report, GHX84200001SATK03GN, Rev A, June, 2020.

[17] CGN, Internal Electromagnetic Interference Safety Assessment Report, GHX84200002SATK03GN, Rev A, June, 2020.

[18] CGN, Vehicular Transport Impact Safety Assessment Report, GHX84200024DOZJ03GN, Rev A, June, 2020.

[19] CGN, Combined Hazards Safety Assessment Report, GHX84200031DOZJ03GN, Rev. A, September, 2020 (to be issued).

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APPENDIX A RO-UKHPR1000-0046 Gantt Chart

Task and Schedule		2020								2021		
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
RO Action 1												
1	Development of deliverable - [ALARP Demonstration on Plant Layout in Respect to HIC]											
2	Submission of deliverable - [ALARP Demonstration on Plant Layout in Respect to HIC]											
RO Action 2												
3	Development of deliverable – [Substantiation Method of HIC against Internal Hazards loads (Version B)]											
4	Submission of deliverable – [Substantiation Method of HIC against Internal Hazards loads (Version B)]											
5	Development of deliverable –[Substantiation of Reactor Pressure Vessel against Internal Hazards]											
6	Submission of deliverable –[Substantiation of Reactor Pressure Vessel against Internal Hazards]											
7	Development of deliverable –[Substantiation of Steam generator against Internal Hazards]											
8	Submission of deliverable –[Substantiation of Steam generator against Internal Hazards]											
9	Development of deliverable –[Substantiation of Main Steam Line against Internal Hazards]											
10	Submission of deliverable –[Substantiation of Main Steam Line against Internal Hazards]											
11	Development of deliverable –[Substantiation of Pressuriser against Internal Hazards]											

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Task and Schedule		2020								2021		
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
12	Submission of deliverable –[Substantiation of Pressuriser against Internal Hazards]							▲				
13	Development of deliverable –[Substantiation of Main Coolant Lines against Internal Hazards]											
14	Submission of deliverable –[Substantiation of Main Coolant Lines against Internal Hazards]							▲				
15	Development of deliverable –[Substantiation of RCP Casing & Flywheel against Internal Hazards]											
16	Submission of deliverable –[Substantiation of RCP Casing & Flywheel against Internal Hazards]							▲				
Assessment												
9	Regulatory Assessment											
10	Target RO Closure Date											▲