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		GDA-REC-GNSL-006684	

REGULATORY OBSERVATION Resolution Plan	
RO Unique No.:	RO-UKHPR1000-0039
RO Title:	Performance Analysis of UK HPR1000 Heating Ventilation and Air Conditioning Systems
Technical Area(s)	Mechanical Engineering
Revision:	0
Overall RO Closure Date (Planned):	2021-04-30
Linked RQ(s)	RQ-UKHPR1000-0556/RQ-UKHPR1000-0386
Linked RO(s)	RO-UKHPR1000-0002/RO-UKHPR1000-0004/RO-UKHPR1000-0012/RO-UKHPR1000-0023
Related Technical Area(s)	Control & Instrumentation, Cross-cutting,Electrical Engineering, Fault Studies, Human Factors, PSA,Sever
Other Related Documentation	

Scope of Work

Background

ONR issued Regulatory Observation (RO) – “Performance Analysis of UK HPR1000 Heating Ventilation and Air Conditioning Systems”.

The purposes of this mechanical engineering RO is for the RP to:

- *Develop, and agree with ONR, a strategy to adequately model a sample of risk important UK HPR1000 HVAC systems, rooms and their contents during a selection of plant transients. The strategy should justify the samples chosen.*
- *Adopt a graded approach to the analysis.*
- *Implement the strategy to demonstrate the sample of UK HPR1000 HVAC systems can adequately deliver the operational and safety demands placed upon them (as detailed within their safety functions and / or design provisions). This specifically relates to the environmental demands on a sample of HVAC systems.*
- *Confirm via independent verification that the UK HPR1000 HVAC systems environmental modelling approach is satisfactory.*
- *Identify whether there are any gaps in the design of the UK HPR1000 HVAC systems.*
- *Undertake an ALARP study against any gaps identified.*

RO-UKHPR1000-0039 placed the following actions:

- *A1–Develop an Appropriate UK HPR1000 HVAC Environmental Modelling and Analysis Strategy*
- *A2–Model and Analyse the UK HPR1000 Heating Ventilation and Air Conditioning Systems*
- *A3 –Undertake a ALARP Analysis for UK HPR1000 HVAC Systems*

In this RO the terms:

- "environmental modelling" refers to temperature, humidity and enthalpy.
- "safety demands" refer to safety functional and / or design provisions (including limits and conditions of safe operation).

The Requesting Party (RP) acknowledges the significance of performance Analysis in UK HPR1000 HVAC systems and accepts that the information currently provided may not be adequate. The RP makes the following resolution plan for this RO.

Scope of work

This Resolution Plan describes the current plan to address RO-UKHPR1000-0039. It contains the planned activities and deliverables, milestones, and timescales.

A simplified diagram of the overall approach is presented in Figure 1.

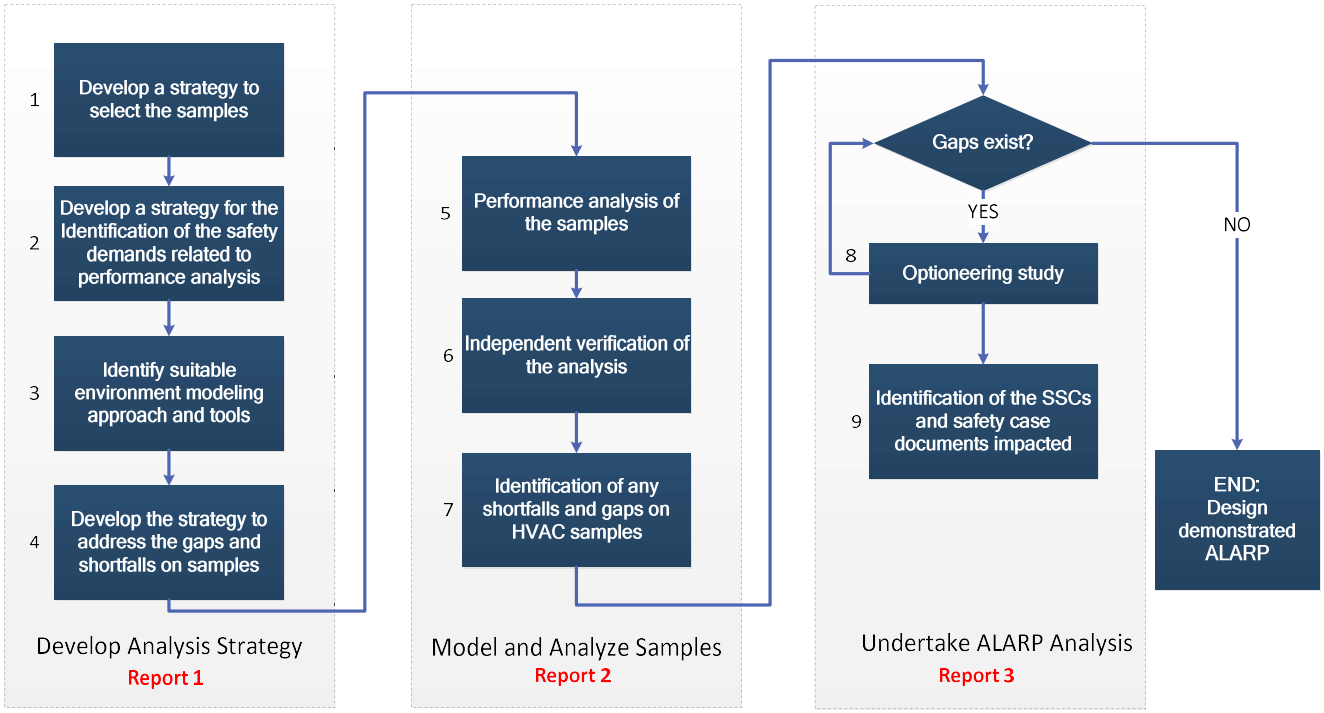

Figure 1: The Simplified Diagram of Overall Approach

The main steps of above overall approach are listed below:

- Step 1: Develop a strategy to select the samples

  RP will develop a strategy to choose the samples HVAC systems, and will justify the samples chosen.
- Step 2: Develop a strategy for the identification of the safety demands related to the performance analysis

  RP will develop a strategy to identify and justify all the safety demands related to the performance

analysis.

- Step 3: Identify suitable environment modeling approach and tools

  RP will identify an appropriate environment modeling approach and tools to assure the quality of the performance analysis.

- Step 4 Develop the strategy to address the gaps and shortfalls on samples

  RP will develop the strategy to address the gaps and shortfalls (if exist) on samples to describe how the analysis output will be used.

Deliverable: At this point of the process, a strategy report of the HVAC environmental modeling and analysis will be issued (Report 1 in Figure 1).

- Step 5: Performance analysis of the samples

  RP will use the strategy developed in RO A1 to undertake the performance analysis of the samples.

- Step 6: Independent verification of the analysis

  RP will implement the independent verification of the analysis process and results in accordance with the project's *Design and development control procedure* (Ref.1).

- Step 7: Identification of any shortfalls and gaps on HVAC samples

  RP will identify any shortfalls and gaps in the HVAC samples performance result against their safety demands.

Deliverable: At this point of the process, an analysis report of the HVAC sample system will be issued (Report 2 in Figure 1).

Based on the outcome of report 2, RP will undertake an ALARP analysis against the shortfalls and gaps identified on HVAC systems. Any other impacted SSCs (not HVAC SSCs) will also be identified in the report, but ALARP considerations of these impacted SSCs is out of the scope of this RO. The ALARP analysis will perform the following steps:

- Step 8: Optioneering study

  For the identified gaps/differences relating to HVAC systems, an options identification and review is undertaken in accordance with the project optioneering process (Ref. 2) and the preferred options will be selected (if relevant to do so during GDA) through the decision-making process (Ref. 2 & 3).

- Step 9 Identification of the SSCs and safety case documents impacted

  The preferred options are introduced into the design modification process During this step, the impacted SSCs and safety case documents will be identified (commensurately to GDA stage and scope).

Deliverable: At this point of the process, an optioneering and ALARP demonstration report of the HVAC sample system will be issued (Report 3 in Figure 1).

The work carried out to complete the RO plan may impact on or be impacted by other technical areas. Preliminary assessment has identified these as mainly:

- Control & Instrumentation
- Cross Cutting
- Electrical Engineering
- External Hazards

- Fault Studies
- Human Factors
- Probabilistic Safety Analysis
- Severe Accident Analysis.

The HVAC technical team will cooperate closely with the involved technical areas to ensure the related expectations are adequately considered and the relevant actions are finished on time.

In addition, related ROs and RQs will be taken into consideration to address RO-0039:

1) RO-UKHPR1000-0002 (Demonstration that the UK HPR1000 Design is Suitably Aligned with the Generic Site Envelope): the external air parameters and their application principles determined in RO-0002 will be used as inputs for RO-0039;
2) RO-UKHPR1000-0004 (Development of a Suitable and Sufficient Safety Case), the requirements on safety case are also applicable and will be considered in the process of performance analysis;
3) RO-UKHPR1000-0012 (Identification and Application of Relevant Good Practice Applicable to Mechanical Engineering for the UK HPR1000 Design), the RGPs related to performance analysis identified in RO-0012 will be used as inputs for RO-0039;
4) RO-UKHPR1000-0023 (Demonstration of Diverse Protection for frequent faults), the diversity modifications derived from RO-0023 are key consideration in the performance analysis process;
5) RQ-UKHPR1000-0386 (Consequence Analysis of HVAC Failure Supplying Safety Important Control and Monitoring Locations), the analysis on main control room identified in RQ-0386 shall comply with the approaches and tools used for RO-0039, and will be embedded in RO-0039;
6) RQ-UKHPR1000-0556 (UK HPR1000 HVAC Analysis), the analysis listed in RQ-0556 shall comply with the approaches and tools used for RO-0039 and will be embedded in RO-0039.

Deliverable Description

The main actions to be undertaken to resolve the RO are described as follows.

RO-UKHPR1000-0039.A1 – Develop an Appropriate UK HPR1000 HVAC Environmental Modelling and Analysis Strategy

Actions requested by the Regulator as stated in the RO:

- *Develop a strategy to analyse a sample of UK HPR1000 HVAC systems. The strategy should seek to:*
  - *Identify a suitable method(s) to model the HVAC systems. For example, a software modelling package with appropriate certification.*
  - *Describe how the UK HPR1000 HVAC systems performance will be analysed, which should:*
    - *Identify and justify which UK HPR1000 HVAC systems, rooms and their contents will be considered.*
    - *Describe the modelling approach for the different systems / and or room types.*
    - *Identify and explain the related UK HPR1000 safety demands (associated input data)*

against which the performance analysis will be undertaken. This should include the:

- *Safety functions / design provisions;*
- *Safety classification of equipment delivering the safety function / design provisions;*
- *Qualified limits and conditions of safe operation of the associated equipment;*
- *Selection of bounding plant transients against which the analysis will be undertaken; and*
- *Approach to sensitivity analysis*

- *Describe how the analysis output will be used (including ALARP considerations and appropriately documenting the work in the generic safety case).*

Resolution Plan:

To address these expectations, the main actions will be undertaken from step 1 to step 4 presented in Figure 1.

- Develop a strategy to select the samples:

Considering the samples should be safety important HVAC systems and rooms, the strategy developed will consider the following aspects:

- PSA approach: analysis of the importance of the HVAC systems for the overall plant safety,
- The safety functional classification,
- The sensitivity of the equipment served by the HVAC to environmental conditions.

- Develop a strategy for the identification of the safety demands related to the performance analysis:

RP will identify all safety demands according to the strategy presented by the *requirement management summary report* (Ref. 5). RP will ensure the technical interactions between the relevant technical areas to identify the safety demands and establish the relation between the safety demands and the design parameters, to ensure all of the safety demands related to the performance analysis are delivered. Related safety demands mainly include:

- Safety functions and Safety classification;
- External design condition (such as extreme temperature/enthalpy) protection requirement
- Internal design condition (temperature/humidity) requirement
- Operation condition
- Identification and justification of the scenario(s).

- Identify suitable environment modeling approach and tools

RP will consider the relevant RGP/OPEX, and identify:

- a suitable environment modeling approach with appropriately certified software,
- the sensitivity analysis approach of external parameters potential evolution to avoid any cliff edge effect.

- Develop the strategy to address the gaps and shortfalls on samples

RP will develop the strategy to address the gaps and shortfalls (if exist) on samples to describe how the analysis output will be used. The identified based on:

- ALARP approach;
- impact on safety case documentation.

Deliverable:

The report "Strategy of the HVAC environmental modeling and analysis" will be submitted on September 30th 2020.

It is recognised that this strategy will be updated considering the potential modifications and ALARP considerations to the UK HPR1000 generic design through the GDA process.

RO-UKHPR1000-0039.A2 – Model and Analyse the UK HPR1000 Heating Ventilation and Air Conditioning Systems

Actions requested by the Regulator as stated in the RO:

- *Using the method identified in ROA 1, analyse and confirm the performance (or otherwise) of the UK HPR1000 HVAC systems against the safety demands.*
- *Detail and justify any assumptions within the analysis undertaken, including undertaking a suitable sensitivity analysis.*
- *Undertake an independent verification of the analysis.*
- *Confirm or otherwise, using the results of the analysis, the level of agreement between the commercial software package and the RP's extant analysis.*
- *Identify any shortfalls and gaps in the HVAC systems performance against their safety demands.*

Resolution Plan:

To address these expectations, the main actions will be undertaken from step 5 to step 7 presented in Figure 1. RP will use the strategy identified in RO A1 to carry out the performance analysis of the samples, the analysis report will:

- List the samples chosen,
- Outline the input data (such as external design condition / internal design condition / operation condition / heat load, …),
- Detail the scenarios considered (plant transient, duration, systems in service, etc.),
- Detail and justify any assumptions within the analysis and modeling undertaken,
- Detail the sensitivity analysis of external parameters potential evolution to avoid any cliff edge effect,
- Detail the analysis process and present the results,
- Detail the independent verification of the analysis,
- Outline the gaps identification.

Deliverable:

The report "Analysis report of the HVAC sample system" will be submitted on October 30th 2020.

RO-UKHPR1000-0039.A3 – Undertake an ALARP Analysis for UK HPR1000 HVAC Systems

Based on the outcome of the work to respond to ROA 1 and 2 above, Actions requested by the Regulator as stated in the RO:

- *Identify any other impacted UK HPR1000 safety systems, ALARP considerations of these impacted systems is outside the scope of the ROA.*
- *Undertake an optioneering study to identify appropriate solutions to address shortfalls and / or gaps in the UK HPR1000 HVAC systems*
- *Explain and justify whether any options have been identified as being reasonably practicable to implement.*
- *Explain which, if any, UK HPR1000 HVAC systems may require modifying.*
- *Explain how those modifications could be implemented, and how the generic safety case will be updated.*

Resolution Plan:

Based on the outcome of the work to respond to ROA 1 and 2 above, identified gaps will be subject to Optioneering Studies, the main actions will be undertaken from step 8 to step 9 presented in Figure 1. The optioneering study of the HVAC sample will be provided in a report “Optioneering study for identified gaps of sample of HVAC systems “ (Report 3 in Figure 1). The impacted SSCs and safety case documents will be identified in this step. Any ”non HVAC” impacted SSCs will also be outlined in the report, but ALARP considerations of these ”non HVAC” impacted SSCs is out of the scope of this RO.

RP will undertake an ALARP approach to make the optioneering study for identified gaps that will include the following aspects:

- Present the optioneering process and assessment criteria,
- For significant gap/difference, identifying all relevant options,
- Evaluate and score each option against the assessment criteria,
- Conclude on the preferred options,
- Identify impacted SSCs and safety case documents.

During the optioneering study work, RP will also Identify the UK HPR1000 SSCs requiring modification and the impact on safety case documentation.

Deliverable:

The report “Optioneering study for identified gaps of sample of HVAC systems” will be submitted on December 20th 2020.

For the reports outlined in response to RO A1, 2, 3, the anticipated timescales to submit these documents are given in the Gantt Chart in Appendix A.

Impact on the GDA Submissions

The results of the gap analysis may lead to design changes. The impact on the UK HPR1000 safety case documentation will need to be established. The main documents are as follows:

- PCSR Sub-chapters
- Safety Case Documents
- Support Evidence Documents

These documents will be revised in accordance with the corresponding actions as the RO progresses.

The list of reports that will be produced to address RO39 will be part of the safety case and will be added to the IDP:

No.	Name	Time	Content
1	Strategy of the HVAC environmental modelling and analysis	30/09/2020	Develop a strategy of the samples chosen Develop a strategy for the identification of the safety demands related to the performance analys Identify suitable environment modeling approach and tools Develop the strategy to address the gaps and shortfalls on samples
2	Analysis report of the HVAC sample system	30/10/2020	Performance analysis of the samples Independent verification of the analysis Identification of the gaps and shortfalls on the samples HVAC system's performance
3	Optioneering study for identified gaps of sample of HVAC systems	20/12/2020	Optioneering study of HVAC SSCs impacted by identified gaps

Timetable and Milestone Programme Leading to the Deliverables

See attached Gantt Chart in APPENDIX A.

Reference

References

[1] CGN, Design and development control procedure, PJ-30E-001, Rev H, February 2018

[2] CGN, ALARP Methodology, GHX00100051DOZJ03GN, Rev D, 2020

[3] GNSL, Guidance for Optioneering & Decision-Making, HPR-GDA-REPO-0080, Rev0, 2019

[4] GNSL, UK HPR1000 Modification Control Procedure, HPR-GDA-PROC-0053, Rev.000, 2018

[5] CGN, Requirement Management Summary Report , GHX00100127DOZJ03GN, Rev A, 2020

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APPENDIX A RO-UKHPR1000-0039 Gantt Chart

Task and Schedule		2020								2021				
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
RO Action 1														
1	Development of deliverable-[Strategy of the HVAC environmental modeling and analysis]													
2	Submission of deliverable-[Strategy of the HVAC environmental modeling and analysis]					▲								
RO Action 2														
3	Development of deliverable-[Analysis report of the HVAC sample system]													
4	Submission of deliverable-[Analysis report of the HVAC sample system]						▲							
RO Action 3														
5	Development of deliverable-[Optioneering study for identified gaps of sample of HVAC systems]													
6	Submission of deliverable-[Optioneering study for identified gaps of sample of HVAC systems]								▲					
Assessment														
7	Regulatory Assessment													
8	Target RO Closure Date												▲	