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REGULATORY OBSERVATION Resolution Plan	
RO Unique No.:	RO-UKHPR1000-0050
RO Title:	Selected Spent Fuel Interim Storage Technology ALARP Demonstration
Technical Area(s)	Radwaste, Decommissioning & Spent Fuel Management
Revision:	0
Overall RO Closure Date (Planned):	2021-05-31
Linked RQ(s)	
Linked RO(s)	RO-UKHPR1000-0014
Related Technical Area(s)	Conventional Health & Safety, Fault Studies, Fuel & Core, Mechanical Engineering ,Radiological Protection
Other Related Documentation	

Scope of Work

Background

ONR has commenced Step 4 of the Generic Design Assessment (GDA) for the UK HPR1000. During Step 2 of the GDA ONR and the Environment Agency provided clarification to the Requesting Party (RP) on the regulatory expectations for the concept design of the Spent Fuel Interim Storage (SFIS) Facility. The objective of the letter was to provide the RP with clarity on our expectations for the scope of the SFIS topic based upon what the regulators considered to be necessary in order to undertake a meaningful assessment during the GDA for the UK version of the Hua-long Pressurised Reactor (UK HPR1000).

This RO is therefore being raised to:

- Articulate ONR's regulatory expectations;
- Ensure that the hazard identification and risk evaluation(s) supporting the selected SFIS technology are fit-for-purpose, commensurate with a GDA, and presented coherently, in a timely manner during Step 4 of the GDA for the UK HPR1000; and to
- Ensure updates are made to the generic safety case to demonstrate that the interim storage of spent fuel can be implemented safely for the UK HPR1000 generic design and that relevant risks associated with SFIS, are capable of being reduced to As Low As Reasonably Practicable (ALARP).

Scope of work

SFIS is part of the whole fuel route within the nuclear power plant and starts from the transferring of spent fuel

out of the spent fuel pool and finishes with the retrieval and repackaging of spent fuel for final disposal. The safety case related to lifting/handling operations in BFX is being provided as part of the resolution plan for RO-UK HPR1000-0014. For the storage of In-Core Instrument Assemblies (ICIAs), including the storage in BQF, the safety case is part of the resolution plan for RO-UK HPR1000-0037. Therefore, the safety cases of lifting/handling operations in BFX and ICIAs storage in BQF are excluded from the scope of this RO resolution plan, the ALARP demonstration related to SFIS focus on the following operations carried out in Fuel Building (BFX) and in the Spent Fuel Interim Storage Facilities (BQF):

- In BFX: casks lifting and handling operations, water filling and drainage, vacuum drying, gas refilling, canister sealing, cask sealing.
- In BQF: canister/cask handling, cask transfer and storage, concrete silo handling, monitoring and inspection, maintenance operations.

The SFIS is not included in the UK HPR1000 reference plant design as the spent fuel management strategy in China is spent fuel reprocessing and therefore does not require interim storage on-site post storage in Spent Fuel Pool (SFP). In the UK, the spent fuel management strategy is disposal in a Geological Disposal Facility (GDF). As there is currently no GDF available in the UK, spent fuel are to be stored on-site pending for availability of the UK GDF. In GDA, a technology optioneering has been conducted to select the UK HPR1000 option among the wet storage or dry storage technology, considering UK context and ALARP and Best Available Techniques (BAT) principles, Reference [1]. Considering UK and worldwide practice, the dry storage technology has been selected and a conceptual design for SFIS is being developed for UK HPR1000 during GDA, Reference [2]. To ensure the feasibility of the design and support the ALARP demonstration of SFIS during GDA, a matching analysis and preliminary safety evaluation are being carried out, Reference [3] and [4]. Based on these four documents, the ALARP demonstration for SFIS then is summarised in a specific report, Reference [5]. As the design development of UK HPR1000 and the GDA ALARP process, a risk / hazard assessment (commensurately to GDA stage and scope) is being developed and the outcomes of this work will be added in the documentation related to ALARP demonstration and in the ALARP demonstration dedicated report during GDA step 4.

The resolution plan provided below details the actions and timescales for improving the safety case related to the SFIS for the UK HPR1000. The resolution plan presents all the work that will be undertaken to provide a response to this RO, including the work that has already been completed, that is already planned and any new work that might be required.

Deliverable Description

RO-UKHPR1000-0050.A1– Hazards and Risks Associated with SFIS Arising Within the Existing Fuel Building

In response to this ROA, the RP should make improvements to the safety case through:

a) Explicitly identifying the principal hazards and risks arising within the Fuel Building, during normal

operations, associated with the implementation of the selected SFIS technology.

b) *Identifying the initiating events which could give rise to the faults associated with the systems, structures and components (SSCs) required for the packaging of spent fuel into dry canisters within the Fuel Building.*

c) *Identifying the potential consequences of the faults.*

d) *Identifying how defence in depth (prevention, protection and mitigation) principles have been applied.*

e) *Where a fault cannot be eliminated, identify the measures put in place to minimise the likelihood of the fault occurring.*

f) *Identifying the key limits and conditions necessary in the interests of safety required to provide assurance of the fuel clad integrity in normal SFIS operations, and to support the prevention, protection and mitigation measures described.*

g) *Identifying and appropriately manage any assumptions (i.e. requirements) for the detailed design of the SSCs required for the packaging of spent fuel into dry canisters within the Fuel Building.*

RO-UKHPR1000-0050.A2 – Reasonably Practicable Improvements to the Fuel Building

In response to this ROA, the RP should:

a) *Draw a clear conclusion that either, there are no further reasonably practicable improvements that could be implemented into the existing UK HPR1000 generic design, to support SFIS and associated operations; or provide details of any reasonably practicable modifications which should be implemented for the UK HPR1000 generic design, together with information on the degree to which they are to be implemented during GDA.*

b) *Make an explicit conclusion, making reference to the relevant arguments and evidence that the risks associated within the implementation of the selected SFIS technology within the Fuel Building can be reduced to ALARP.*

Resolution Plan

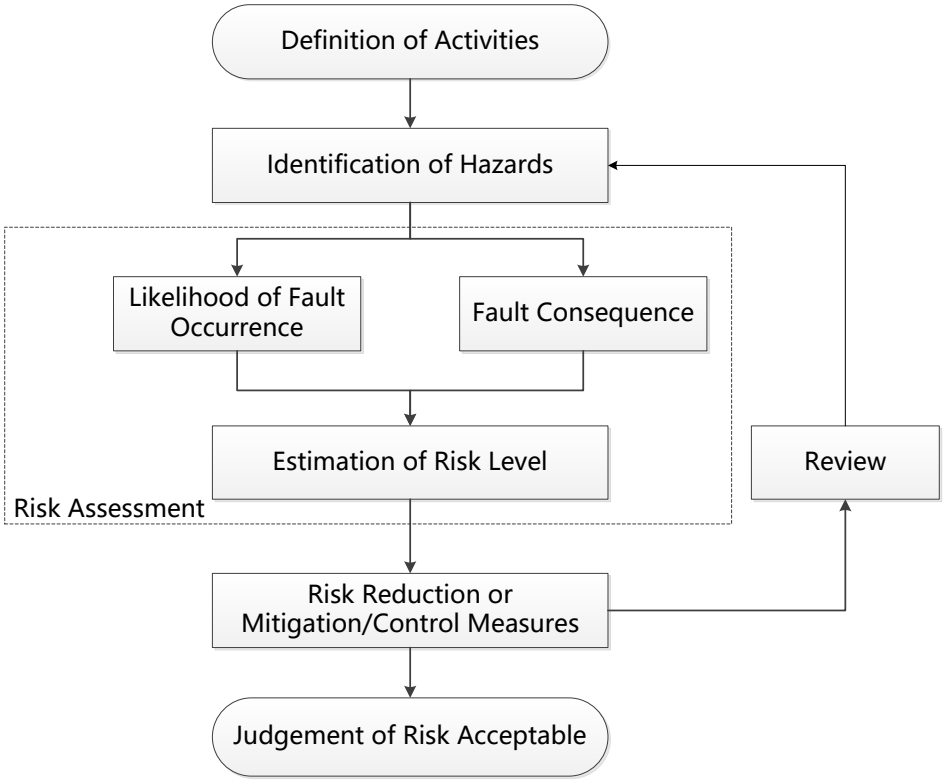
The risks assessment for all the operations related to the implementation of the selected SFIS technology in BFX, including water filling and drainage, welding, vacuum drying and gas refilling, will be reviewed and complemented where relevant.

In accordance with the *ALARP Demonstration Instruction in the UK HPR1000*, Reference [6], this risk assessment includes, as relevant, PSA, fault analysis, internal hazards analysis, external hazards analysis, human factor analysis, conventional safety analysis.

For SFIS, the risk assessment uses two variable matrixes to assess the likelihood and consequence of a fault to evaluate the risk level. Likelihood is the probability that something might happen while consequence is defined as the most probable result of the fault. The likelihood and consequence matrixes are combined to define the risk matrix. The risk matrix is used to determine the level of risk associated with the fault for both the inherent risk and the residual risk. The inherent risk is the level of risk that an activity / hazard category

would pose if no controls or other mitigating factors were in place. The residual risk is the level of risk associated with an activity after design or operational measures have been implemented to further eliminate, reduce and control the risk, complying with the principle of Elimination, Reduce, Isolation, Control and Protect (ERICP).

The assessment for SFIS operation in BFX will follow the following iterative process:



F-1 Risk Assessment process

a) Step 1: Define the activities related to SFIS operations in BFX (excluding handling and lifting);

b) Step 2: Identify the principal hazards and risks which are 'inherent' to these activities, as well as the initiating events that could give rise to the faults with the SSCs involved in the activities identified in step 1. This mainly addresses ROA1 a) and b).

c) Step 3: Assess the risk levels by the following criteria. This mainly addresses ROA1 c).

   1) Determine the likelihood of the fault by using the matrix "Likelihood".

   2) Determine the consequence of the fault by using the matrix "Consequence".

   3) Use the risk matrix to determine the risk level from the likelihood and consequence descriptors.

d) Step 4: Identify the existing or proposed risk elimination, reduction or mitigation measures, and review the residual risk with those measures (go back to step 3). This mainly addresses ROA1 d) and e).

e) Step 5: Justify acceptability (i.e. ALARP reduction) of the risk.
   This includes the identification of key limits and conditions in the interest of safety and any assumptions

(i.e. requirements) for the detailed design.

The fuel criteria developed from the fuel supplier will be reviewed and assessed to ensure that current SFIS design ensures the integrity of spent fuel during SFIS normal operations. The review of fuel criteria also contributes to the development of key limits and conditions. For the limits/conditions or action levels, the detailed values will not all be defined during GDA (only the relevant ones will), nor will the actions in case of limit/level being exceeded or condition not being fulfilled. For the assessment in GDA, the list of key limits and conditions will be identified and corresponding qualitative requirements will be presented considering the available RGP/OPEX. Examples of such parameters/features include the fuel criteria related to fuel integrity, the number of spent fuels and rod cluster control assemblies / stationary core component assemblies loaded in a canister, the cask surface dose rate, limits for the cladding temperature etc. This mainly addresses ROA1 f).

The management strategy for the requirements and assumptions is also presented as a part of the judgement of risk acceptable, as well as any forward action required by the future licensee. This mainly addresses ROA1 g).

This process is iterated (step 3 and 4) until the risk level is deemed sufficiently low, i.e. until there is no further reasonably practicable improvements that could be implemented in UK HPR1000 to further reduce the risk. If further improvements are identified, they will be managed through the optioneering process, Reference [7], and, where relevant, the modification process, Reference [8]. This mainly addresses For ROA1 c) to e) & ROA2 a) and b).

According to the latest design achievement in BFX, the matching analysis, Reference [3], will be reviewed and updated to show that all requirements on BFX from SFIS, such as the capacity of the spent fuel pool, are complied with. The evidences considered in the matching analysis will be concluded and collated in Reference [5] to better support the ALARP demonstration. Sufficient linkage to the design of BFX and relevant systems, as well as the corresponding ALARP demonstration results will be added in the ALARP demonstration report for SFIS, Reference [5]. This mainly addresses For ROA2 a) and b).

A clear conclusion on risk reduction to ALARP will be made in Reference [5] with respect to the implementation of the selected SFIS technology within the Fuel Building. This mainly addresses For ROA2 a).

This risk assessment is to be carried out to a level of detail that is commensurate with the expectations for GDA and the design stage of BFX and SFIS, the latter being at the conceptual design stage during GDA. The deeper design level proposal in BFX will be considered in the assessment to ensure the feasibility of SFIS relevant design and that no significant modification will be required for BFX design in the site-specific stage.

The following reports will be updated to include the above mentioned information:

a) The report *Preliminary Safety Evaluation of Spent Fuel Interim Storage*, Reference [4], will be updated as a result of risks assessment as presented above. This report will be updated and submitted by 31st December 2020;

b) As noted in the current version of the report, *Spent Fuel Interim Storage Facility Design*, Reference [2],

the design requirements and assumptions related to SFIS equipment supplier selection and detailed design development will be further identified and recorded, including any requirements and assumptions resulting from the risks/hazards assessment. This report will be updated and submitted by 31st December 2020;

c) The matching analysis report, Reference [3], will be reviewed and updated according to the latest design achievement in BFX. The evidence considered in the matching analysis will be added to better support the ALARP demonstration. The matching analysis report will be updated and submitted by 31st January 2021.

d) The report, *ALARP Demonstration of Spent Fuel Interim Storage*, Reference [5], is aiming at demonstrating that the risks associated with spent fuel interim storage are reduced to ALARP. A new chapter on risks assessment will be added in the report to address the risk assessment for selected SFIS operations in BFX, which includes the potential risks and hazards list, the PIEs, the qualitative assessment results for the faults probability and consequence, as well as corresponding OLCs (as relevant). The risks assessment results, as well as the safety measures for risks, will be summarised in the ALARP demonstration report to support the final conclusion that the risks have been reduced to ALARP. This report will be updated and submitted by 31st January 2021.

RO-UKHPR1000-0050.A3 – Hazards and Risks Associated with the new SFIS Facility

In response to this ROA, the RP should make improvements to the safety case through:

a) Explicitly identifying the principal hazards and risks associated with the SFIS facility during normal operations (including management of radioactive wastes generated during the operations).

b) Identifying the initiating events which could give rise to the faults associated with the Systems, Structures and Components (SSCs) required for the movement / storage of spent fuel within dry canisters within the SFIS facility (including transport to SFIS).

c) Identifying the potential consequences of the faults.

d) Identifying how defence in depth (prevention, protection and mitigation) principles have been applied.

e) Where a fault cannot be eliminated, identifying the measure(s) put in place to minimise the likelihood of the fault occurring.

f) Identifying the key limits and conditions necessary in the interests of safety which are required to provide assurance of the fuel clad integrity in normal SFIS operations and to support the prevention, protection and mitigation measures described.

g) Identifying and appropriately manage any assumptions (i.e. requirements) made for/about SFIS, which will need to be implemented in the detailed design of the SFIS facility.

h) To ensure the generic design does not unduly constrain future operator choices, provide appropriate evidence to demonstrate the versatility of the generic SFIS facility design to be able to incorporate any further, future necessary modifications, to ensure risks are capable of being reduced to ALARP.

Considering the SFIS facility is at a preliminary stage of design, ONR would therefore expect the breadth and depth of the RP's response to this ROA to be commensurate with its current level of design maturity.

Resolution Plan

The risks assessment for all the operations related to the implementation of the selected SFIS technology in BQF, including canister transfer and storage, concrete silo handling, monitoring and inspection during interim storage, will be reviewed and complemented where relevant.

The risk assessment for SFIS operation in BQF will follow the iterative process shown in F-1. This mainly addresses ROA3 a) to g). The assessment for operations in BQF is to be carried out to a level of detail commensurate with the expectations for GDA and the design stage of BQF, which is conceptual design stage.

To show that current generic design does not unduly constrain future operation choices, a new chapter will be added in the ALARP demonstration report to present the principal interfaces between SFIS proposal and UK HPR1000 design and how these are considered during the design of SFIS proposal. Any assumptions made with respect to the size and lifting limits in BFX or to radiation protection design considerations of BQF, will also be presented in this new section to show that appropriate design assumptions have been developed during the design and that the facility is able to incorporate future necessary design development/improvements. Any assumption and requirements for future design will be captured in the design report, Reference [2] to inform the future designer. This mainly addresses ROA3 h).

The following reports will be updated to include the above mentioned information:

a) The report *Preliminary Safety Evaluation of Spent Fuel Interim Storage*, Reference [4], will be updated as a result of risks and hazards assessment as presented above. This report will be updated and submitted by 31st December 2020;

b) As noted in the current version of the report, *Spent Fuel Interim Storage Facility Design*, Reference [2], the design requirements and assumptions related to SFIS equipment supplier selection and detailed design development will be identified and recorded, including any requirements and assumptions resulting from the risks/hazards assessment, as well as the considerations in current design that unduly constrains future operation choices. This report will be updated and submitted by 31st December 2020;

c) For the report, *ALARP Demonstration of Spent Fuel Interim Storage*, Reference [5], a new chapter on risks assessment will be added in the report to address the risk assessment for selected SFIS operations in BQF, which includes the potential risks and hazards list, the PIEs, qualitative assessment results for the faults probability and consequence, as well as corresponding OLCs (as relevant). The risks assessment results will be summarised in the ALARP demonstration report so as to support the final conclusion that the risks have been reduced to ALARP.

   Another new chapter will be added to show that current generic design does not unduly constrain future operation choices, including the principal interfaces between SFIS proposal and UK HPR1000 design and how the interfaces are considered with respect to incorporating future necessary design development/improvements.

This report will be updated and submitted by 31st January 2021.

Impact on the GDA Submissions

The information that form part of the response to this RO will be appropriately incorporated into the reports identified in the resolution plan described above (as per the plan presented in the Gantt chart) as well as in V2 of relevant PCSR chapters, notably PCSR Chapter 29.

Timetable and Milestone Programme Leading to the Deliverables

See attached Gantt Chart in Appendix A.

Reference

[1] CGN, Technology Optioneering on Spent Fuel Interim Storage, GHX00100057DNFF03GN, Revision B, March 2019.

[2] CGN, Spent Fuel Interim Storage Facility Design, GHX00100081DNFF03GN, Revision E, September 2020.

[3] CGN, The Matching Analysis of Selected SFIS Technology with Current UK HPR1000 Design, GHX00100080DNFF03GN, Revision D, September 2020.

[4] CGN, Preliminary Safety Evaluation of Spent Fuel Interim Storage, GHX00100046DNFP03GN, Revision E, September 2020.

[5] CGN, ALARP Demonstration of Spent Fuel Interim Storage, GHX00100074KPGB03GN, Revision C, April 2020.

[6] CGN, ALARP Demonstration Instruction, GHX00100119DOZJ03GN, Revision A, March 2019.

[7] CGN, Provisions on Optioneering Process for UK HPR1000 Generic Design Assessment (GDA) Project, GH-40M-018, Revision A, 2019.

[8] General Nuclear System Limited, UK HPR1000 Modification Control Procedure, HPR/GDA/PROC/0053, Rev.000, 2018.

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APPENDIX A RO-UKHPR1000-0050 Gantt Chart

		Sept 2020	Oct 2020	Nov 2020	Dec 2020	Jan 2021	Fre 2021	March 2021	April 2021	May 2021
RO Action 1 & 2										
	Development of deliverable-[Preliminary Safety Evaluation of Spent Fuel Interim Storage, Revision F]									
	Submission of deliverable-[Preliminary Safety Evaluation of Spent Fuel Interim Storage, Revision F]									
	Development of deliverable-[Spent Fuel Interim Storage Facility Design, Revision F]									
	Submission of deliverable-[Spent Fuel Interim Storage Facility Design, Revision F]									
	Development of deliverable-[ALARP Demonstration of Spent Fuel Interim Storage, Revision D]									
	Submission of deliverable-[ALARP Demonstration of Spent Fuel Interim Storage, Revision D]									
	Development of deliverable-[The Matching Analysis of Selected SFIS Technology with Current UK HPR1000 Design, Revision E]									
	Submission of deliverable-[The Matching Analysis of Selected SFIS Technology with Current UK HPR1000 Design, Revision E]									
	Regulators Assessment									
	Target ROA1 & ROA2 Closure date									
RO Action 3										
	Development of deliverable-[Preliminary Safety Evaluation of Spent Fuel Interim Storage, Revision F]									
	Submission of deliverable-[Preliminary Safety Evaluation of Spent Fuel Interim Storage, Revision F]									
	Development of deliverable-[Spent Fuel Interim Storage Facility Design, Revision F]									
	Submission of deliverable-[Spent Fuel Interim Storage Facility Design, Revision F]									

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