REGULATORY OBSERVATION

REGULATOR TO COMPLETE

RO unique no.:	RO-UKHPR1000-0050
Revision:	
Date sent:	23/09/2020
Acknowledgement required by:	14/10/2020
Agreement of Resolution Plan Required by:	30/10/2020
TRIM Ref:	2020/282104
Related RQ / RO No. and TRIM Ref: (if any)**:**	RO-UKHPR1000-0014 (2019/238645)
Observation title:	Selected Spent Fuel Interim Storage Technology ALARP Demonstration
Lead technical topic: 17. RadWaste, Decommissioning & Spent Fuel Management	**Related technical topic(s):** 5. Conventional Health & Safety 9. Fault Studies 10. Fuel & Core 14. Mechanical Engineering 16. Radiological Protection 21. Environmental

Regulatory Observation

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 [Ref. 1]. 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 HPR1000.

Key regulatory expectations for the scope of SFIS in [Ref. 1], relevant to this Regulatory Observation (RO) are summarised below:

- The principal hazards/risks associated with the technical option selected for spent fuel storage will need to be identified.
- ONR will need to understand the safety functions that need to be provided and the structures, systems and components (SSCs) within the generic design, which will deliver those.
- A proportionate evaluation of the impact on the existing generic design – including identifying any potential reasonably practicable modifications which may be necessary to reduce the risks so far as is reasonably practicable (SFAIRP), and a demonstration of the versatility of the generic design to incorporate any future modifications, as a minimum.
- The regulators will need some design information to be submitted in order to judge whether implementing the technical option selected for spent fuel storage is feasible, and both “ALARP” and “BAT”.
- Suitable and sufficient information (evidence) should be provided in support of the ALARP demonstration for the technical option selected for spent fuel storage and the SSCs associated with its implementation.

For GDA, the technical option selected by the RP for the interim storage of spent fuel is the generic concept of storing dried spent fuel assemblies in welded canisters contained in concrete storage silos, within a purpose built interim storage facility. The design life, and expected interim storage period for the purpose built store is assumed to be 100 years. The RP identified the need to accommodate the Systems, Structures and / or Components (SSCs), and operations required to package the spent fuel into the canister within the existing

Fuel Building and to then transfer the canister to the SFIS Facility, using a transfer cask, prior to placement of the canister into the concrete storage silo for long-term interim storage.

ONR has assessed a number of submissions from the RP relevant to SFIS, with the objective of identifying whether the key regulatory expectations identified above, have been met:

- Matching Analysis of Selected SFIS technology with current UK HPR1000 Design [Ref. 2];
- Preliminary Safety Evaluation of SFIS [Ref. 3];
- SFIS Facility Design [Ref. 4]; and
- ALARP Demonstration of SFIS [Ref. 5].

ONR's assessment of Refs. 2-5 has identified several shortfalls with the RP's demonstration that relevant risks arising from SFIS, are capable of being reduced to As Low As Reasonably Practicable (ALARP):

- The Matching Analysis document [Ref. 2] highlights engineering requirements to deliver the selected SFIS technology within both the existing Fuel Building and new SFIS Facility. These primarily focus on services (power, inertia gas and water) and the overall impact of the selected SFIS technology on the lifecycle of the power station (for example, on decommissioning). No conclusion is made as to whether the cost (in terms of time, trouble, or money) of implementing any further improvements to the UK HPR1000 generic design to support the installation / operation of the selected SFIS technology within the Fuel Building, would be grossly disproportionate to the risk(s) averted.
- Several Postulated Initiating Events (PIEs) within the SFIS Facility are identified within Section 5.1.2 of [Ref. 3]; however these are not consistent with the form of PIEs identified elsewhere in the UK HPR1000 generic safety case.
- The SFIS Facility Design [Ref. 4] identifies Relevant Good Practice (RGP) from the Western European Nuclear Regulators Association (WENRA), *'Waste and Spent Fuel Storage Safety Reference Levels',* guidance related to safety functional requirements for the selected SFIS technology. SSCs required to deliver the selected SFIS technology, together with their safety functions are identified in Table T-6-3 of Ref.4. However, no link is made to the fault analysis (identification of faults and potential consequences).
- The ALARP Demonstration of SFIS [Ref. 5] is a sign posting document summarising relevant information from other submissions. No overall conclusion is made as to why the RP consider that the relevant risks associated with the selected SFIS technology are capable of being reduced to ALARP; therefore, it does not in itself provide an adequate ALARP demonstration.
- None of the submissions provide the arguments or evidence that fuel criteria have been taken into consideration within the design and intended operations supporting the selected SFIS technology. Demonstrating the continued integrity of the fuel cladding is fundamental, because it provides the first barrier to fission product release during SFIS-related operations and long-term interim storage, in both normal operations and fault conditions.

Until the RP addresses these shortfalls, ONR is unable to judge whether an adequate justification that relevant risks associated with SFIS operations are capable of being reduced to ALARP has been provided, and in doing so that the regulatory expectations set out in [Ref. 1] have been satisfied. 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 ALARP.

Relevant Legislation, Standards and Guidance

Relevant Safety Assessment Principles (SAPs) [Ref. 6] are listed below, with information of particular relevance to this RO underlined for emphasis.

- ONR SAP Paragraph 14: *"The starting point for demonstrating that risks are ALARP and safety is adequate is that the normal requirements of good practice in engineering, operation and safety management are met. This is a fundamental expectation for safety cases. The demonstration should*

also set out how risk assessments have been used to identify any weaknesses in the proposed facility design and operation, identify where improvements were considered and show that safety is not unduly reliant on a small set of particular safety features."

- ONR SAP Paragraph 86. "*A safety case is a logical and hierarchical set of documents that describes risk in terms of the hazards presented by the facility, site and the modes of operation, including potential faults and accidents, and those reasonably practicable measures that need to be implemented to prevent or minimise harm."*

- SAP Paragraph 524. "*The safety functions of containment and associated systems should be clearly defined for all normal operations, fault and accident conditions identified in the safety case, including for internal and external hazards."*

- ONR SAPs on the layout of the facilities on a site, of the plant within facilities and of structures, systems and components at the facility. (SAPs ELO.1-4)

- SAP FA.1 Design basis analysis, PSA and severe accident analysis –"*Fault analysis should be carried out comprising suitable and sufficient design basis analysis, PSA and severe accident analysis to demonstrate that the risks are ALARP*" and related SAP Paragraph 617. "*Where the fault analysis is in support of a design under development, the analysis should be against a well-defined reference point in the design process. Where facility-specific or site-specific details have yet to be finalised, all the assumptions made in lieu of these should be stated explicitly and then used to support the later design and construction activities*."

- SAP FA.2 Identification of initiating faults – "*Fault analysis should identify all initiating faults having the potential to lead to any person receiving a significant dose of radiation, or to a significant quantity of radioactive material escaping from its designated place of residence or confinement."*

- SAP ENM.6 Storage in a condition of passive safety –"*When nuclear matter is to be stored on site for a significant period of time it should be stored in a condition of passive safety whenever practicable and in accordance with good engineering practice*" and SAP Paragraph 487 linking to ONR SAP RW.5.

- SAP RW.5 Storage of radioactive waste and passive safety and related SAP Paragraphs 809-813.

ONR has a number of Technical Assessment Guides (TAGs) containing guidance for ONR inspectors. Those most relevant to this RO are:

- ONR Technical Assessment Guide 5 titled *'Demonstration of ALARP (As Low As Reasonably Practicable)'* [Ref. 7] – Annex 2 '*ALARP for proposed new civil nuclear reactors'*. Within this section it is made clear that ALARP for GDA will involve consideration of the facility's design as a whole and the four main areas for the overall ALARP demonstration are expected to cover:

    - A clear conclusion that the time, cost or trouble of implementing any further risk reduction measures is grossly disproportionate to the risk that would be averted. This includes a clear conclusion that there are no further reasonable practicable improvements that could be implemented.
    - Use of Relevant Good Practice (RGP) (see below for further details)
    - Review of options including justification of the evolutions of the design and further improvements which either could be implemented or justification why they cannot.
    - The use of a risk assessment to identify potential engineering and / or operational improvements.

  TAG 5 [Ref. 7] defines 'Good Practice' as "*a generic term referring to a wide range of control measures, policies, practices and other aspects pertaining to a particular health and safety issue*". 'Good practices' change with time, such that improvements may have been identified for the facilities and / or operations (through Learning from Experience (LfE) or changes in standards). Good practice should be justified as 'relevant', termed Relevant Good Practice (RGP). For something to be 'relevant' it must be applied in appropriately similar circumstances. A source of relevant good practice in the nuclear industry is what is done on similar facilities. However, in invoking past practice it is important to be clear whether the practice remains relevant and whether it was implemented for safety reasons.

Where good practices are identified this avoids unnecessary detailed ALARP demonstrations from first principles, but the onus is on the RP to provide evidence that the good practice is relevant and there are no reasonable improvements to safety which could be made within a new facility.

- ONR TAG titled *'Safety Aspects Specific to Storage of Spent Nuclear Fuel'* [Ref. 8]. This TAG identifies 'Good Practice' related to spent fuel storage.

This list is not intended to be exhaustive.

Regulatory Expectations

Consistent with the regulatory expectations outlined within [Ref. 1] and summarised above, below are ONR's expectations for the outcome of this RO:

- A robust identification of the hazards and risks associated with SFIS, during normal operations.
- Fit-for-purpose fault analysis, commensurate with the level of design detail available during GDA, starting with a clear articulation of the risks/hazards relevant to SFIS (including risk/hazards introduced into the Fuel Building through implementation of the selected SFIS technology).
- The provision of arguments and evidence, proportionate to a GDA, that the design of the SFIS Facility, and operations required to support the future implementation of the selected SFIS technology, are capable of reducing the risk of fuel failures during long-term interim storage, to ALARP.
- The provision of arguments and evidence, proportionate to a GDA that the design of the SFIS Facility takes into consideration fuel criteria, in an appropriate way. For GDA, this should be demonstrated by identifying key limits and conditions necessary in the interests of safety, or clearly identifying any assumptions made, which will be required to be implemented in the future detailed design of the SFIS facility, to ensure fuel criteria can be satisfied.
- 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.
- In line with the regulatory expectations highlighted in [Ref. 1], for the SFIS Facility itself, the RP is expected to demonstrate the versatility of the generic design to be able to incorporate any necessary future modifications, to show relevant risks are capable of being reduced to ALARP.

The Regulatory Observation Actions (ROAs) given below are structured in such a way to enable provision of this information in a logical and step-wise manner, to facilitate ONR's assessment. More detailed regulatory expectations are also articulated under each ROA.

SFIS was not part of the Fangchenggang Unit 3 (FCG-3) design, which is the Reference Design for the UK HPR1000 generic design; as such it is "new" for UK HPR1000 GDA. The SFIS Facility itself is therefore at a preliminary stage of design, which is acceptable for GDA. However, the Fuel Building is an existing facility and is consequently at a more advanced stage of design. In responding to this RO, ONR therefore expect the breadth and depth of the RP's demonstration to be proportionate to the level of design information available.

ONR has previously raised RO-UKHPR1000-0014, *Spent Fuel Building – Design of Nuclear Lifting Operations to Demonstrate Relevant Risks are Reduced to* ALARP [Ref. 9] ONR does not expect the RP's work to resolve this RO to duplicate work already being delivered to respond to Ref. 9 and would therefore regards risks associated with nuclear lifting operations in the Fuel Building to be out of scope for this RO. However, ONR expects the RP to appropriately manage the interfaces between this RO and Ref. 9, and vice versa.

References

[Ref. 1] UK HPR1000 GDA Scope for Spent Fuel Interim Storage (SFIS), Letter, Office for Nuclear Regulation and Environment Agency, 11 October 2018, CM9 Ref. 2018/329187.
[Ref. 2] GHX00100080DNFF03GN Revision C, The Matching Analysis of Selected SFIS Technology with Current UK HPR1000 Design, CM9 Ref. 2020/388.
[Ref. 3] GHX00100046DNFP03GN, Revision D, Preliminary Safety Evaluation of Spent Fuel Interim Storage, CM9 Ref. 2020/130841.
[Ref. 4] GHX00100081DNFF03GN, Revision D, Spent Fuel Interim Storage Facility Design, CM9 Ref. 2020/130890

[Ref. 5] GHX00100074KPGB03GN, Revision C, ALARP Demonstration of Spent Fuel Interim Storage, CM9: 2020/130880.
[Ref. 6] Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 1, Office for Nuclear Regulation, January 2020
[Ref. 7] ONR Technical Assessment Guide, NS-TAST-GD-005, Guidance on the Demonstration of ALARP (As Low As Reasonably Practicable), Revision 10.
[Ref. 8] ONR Technical Assessment Guide, NS-TAST-GD-081, Safety Aspects Specific to Storage of Spent Nuclear Fuel, Revision 3.
[Ref. 9] RO-UKHPR1000-0014, Spent Fuel Building – Design of Nuclear Lifting Operations to Demonstrate Relevant Risks are Reduced to ALARP, September 2019 CM9 Ref. (2019/238645)

Regulatory Observation Actions

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

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

- Explicitly identifying the principal hazards and risks arising within the Fuel Building, during normal operations, associated with the implementation of the selected SFIS technology.
- 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.
- Identifying the potential consequences of the faults.
- Identifying how defence in depth (prevention, protection and mitigation) principles have been applied.
- Where a fault cannot be eliminated, identify the measures put in place to minimise the likelihood of the fault occurring.
- 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.
- 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.

Resolution required by '*to be determined by General Nuclear System Resolution Plan*'

RO-UKHPR1000-0050.A2 – <u>Reasonably Practicable Improvements to the Fuel Building</u>

In response to this ROA, the RP should:

- 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.
- 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 required by '*to be determined by General Nuclear System Resolution Plan*'

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

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

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

- Identifying the potential consequences of the faults.
- Identifying how defence in depth (prevention, protection and mitigation) principles have been applied.
- Where a fault cannot be eliminated, identifying the measure(s) put in place to minimise the likelihood of the fault occurring.
- 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.
- 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.
- 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 required by '*to be determined by General Nuclear System Resolution Plan*'

REQUESTING PARTY TO COMPLETE	
Actual Acknowledgement date:	
RP stated Resolution Plan agreement date:	