REGULATORY OBSERVATION

REGULATOR TO COMPLETE

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CM9 Ref:	2020/308070
Related RQ / RO No. and CM9 Ref: (if any)**:**	RO-UKHPR1000-0014 (CM9 2019/238645)
Observation title:	Fuel Route Safety Case
Lead technical topic: 6. Cross Cutting	**Related technical topic(s):** 2. Civil Engineering 3. Control & Instrumentation 5. Conventional Health & Safety 9. Fault Studies 10. Fuel & Core 11. Human Factors 14. Mechanical Engineering 15. Probabilistic Safety Analysis 16. Radiological Protection 17. RadWaste, Decommissioning & Spent Fuel Management

Regulatory Observation

Background

The Requesting Party (RP) has submitted the majority of its planned documents that detail the safety case and design for the UK HPR1000 fuel route. These describe how it is proposed that new and used fuel is safely handled during operations of the UK HPR1000 generic design. While many aspects are adequate, ONR's detailed assessment has highlighted several shortfalls in meeting our expectations.

These shortfalls against ONR's expectations relate to two main aspects:

- the safety case for the equipment used to handle spent nuclear fuel in the spent fuel pool; and
- the risks associated with handling of loaded spent fuel casks in the spent fuel building (BFX);

This means that, overall, the UK HPR1000 fuel route for the BFX does not demonstrate that relevant risks have been reduced to As Low As Reasonably Practicable (ALARP).

During Step 3, ONR raised RO-UKHPR1000-0014 [1]. This RO requires the RP to provide further justification for lifting operations within the BFX, with an emphasis on the design. To date, the RP has made progress towards resolving the gaps identified in that RO, but it is unlikely that the responses will fully address the safety case related gaps described in this RO. This RO has therefore been raised to compliment RO-UKHPR1000-0014, with the expectation that when considered together the RP's responses to both ROs should provide the holistic safety case and engineering substantiation that underpins it.

Relevant Legislation, Standards and Guidance

The ONR Safety Assessment Principles (SAPs) [2] include a number of expectations that are relevant to this RO. The SAPs are further supported by the associated Technical Assessment Guides (TAG). Those of most relevance to this RO are detailed further below, for each specific shortfall.

Regulatory Expectations

The following sections detail the specific regulatory expectations associated with each of the identified shortfalls in the fuel route for UK HPR1000.

It is important to note that, while these two specific shortfalls have been identified discretely as part of this RO to aid the RP in understanding regulatory expectations, ONR does expect the RP to consider these more holistically in developing a suitable and sufficient safety case and design for the UK HPR1000 fuel route. Consideration of the lifting operations in response to RO-UKHPR1000-0014 may also influence the resolution to this RO, and vice versa.

Handling of Spent Nuclear Fuel

Spent nuclear fuel contains a significant inventory of gaseous and volatile fission products which is contained by the fuel cladding. Fuel assembly drops or collisions are likely to damage the cladding and lead to a release of this radioactivity which potentially poses significant consequence.

In the spent fuel pool, the UK HPR1000 fuel handling device is called the Spent Fuel Pool Crane (SFPC). The equipment's design allows for movement outside of the spent fuel pool area. Interlocks limit the crane's movement and prevent fuel from moving outside of the spent fuel pool area. When handling nuclear fuel, the crane carries a long tool to limit the maximum lift height. The SFPC is classified as NC (non-safety classified).

Given the significance of such faults it is important that the Structures, Systems and Components (SSCs) that handle spent fuel are adequately safety classified and the safety case demonstrates that they are engineered commensurate with this classification. ONR considers that this is not currently the case for the UK HPR1000.

ONR notes the following which present challenges against the SAPs, including:

- The SFPC has the capability to travel outside of the pool area. The EKP.1 expectation would be to eliminate the hazard of a fuel assembly colliding with or being carried over the edge of the pool wall where reasonably practicable.
- The design requires control system interlocks to avoid over-raising of fuel assemblies or driving outside of the pool area. ECS.1 would expect that these interlocks are classified in line with their safety functions. The interlocks for the SPFC are not safety classified.
- The safety analysis requires a fuel assembly drop frequency less than 10^{-4} per annum (Ref. 3). ECS. 3 would expect the fuel's lifting system's classification and engineering align with the functional reliability claims. However, the SFPC safety classification is non-classified.
- The SFPC has been designed to meet a generic overhead crane design standard. ECS. 3 expects that the designs standards are appropriate for the function and claimed reliability. The RP should justify that their design approach will meet the required 10^{-4} per annum reliability.
- It is unusual to use an overhead crane for handling spent nuclear fuel in the UK. The safety case should demonstrate that this approach reduces relevant risks ALARP. This could include comparing the SFPC's safety benefits and disbenefits with other handling solutions, such as the UK HPR1000's fuel handling machine in the reactor building.

In combination, ONR judges that the radiological risks from a dropped fuel assembly to the workers when handled with the SFPC have not been shown to be reduced ALARP. ONR expects that these shortfalls will need to be resolved by production of a suitable and sufficient safety case, including appropriate engineering substantiation.

Handling of Spent Fuel Casks

The RP's proposed solution for interim spent fuel storage is to export it from the BFX inside spent fuel casks. The safety case does not present the radiological consequences of a dropped and spilled cask. However, ONR can infer that, given the consequences of one dropped fuel assembly within the spent fuel pool are close to the BSL for workers, the unmitigated consequences of a spilled cask are likely to be significantly higher than the SAPs' Numerical Target 4 Basic Safety Level (BSL) [2].

The RP has presented a concept spent fuel cask design to demonstrate that these can be safely loaded and dispatched from the BFX. The current spent fuel cask concept contains 24 to 32 fuel assemblies. The spent fuel cask is handled with the Spent Fuel Cask Crane. During the filling and dispatch operations the cask is carried between 3 pits while it is assembled. Some of the lifts take place when the cask is not fully assembled. Other operations have lift heights that exceed the drop qualification height of the cask. The most serious hazards associated with this process are therefore related to handling of the filled spent fuel cask.

Given the potential consequences for a cask handling fault, the safety case should be suitably robust and demonstrate that all reasonably practicable steps have been taken to reduce this risk. This is yet to be adequately demonstrated for the UK HPR1000.

ONR consider that the UK HPR1000 approach challenges a number of the SAPs, including:

- EKP.1, a facility's design should avoid radiological hazards rather than controls them. The unmitigated radiological consequences of a dropped and spilled spent fuel cask are unlikely to be acceptable. Therefore, the design should ensure the hazard is prevented where reasonably practicable. The design has not avoided the need to lift greater than the drop qualification height of the cask and the design requires the cask to be lifted while it is partially assembled. Equivalent plants in the UK have adopted reasonably practicable and diverse design solutions to remove these risks.
- EDR. 3, limits the reliability that can be claimed for an SSC that employs diverse or redundant components to greater than 10^{-5} per demand due to common cause failure. A crane is a system that meets this definition. Therefore, the frequency of a dropped cask would not normally be less than 10^{-5} per demand in the fault analysis if it is handled with a crane.
- FA. 5, requires that all faults with an initiating event frequency greater than 10^{-5} per annum and significant radiological consequences are included in the design basis analysis. The reliability of the lifting system is limited through EDR.3. Therefore, our expectation is that a dropped cask is within the design basis.
- FA.7, the radiological consequences of an initiating event should be analysed and reduced as low as reasonably practicable. In practice, the numerical targets for dose and frequency should be met. However, the RP has not presented failure modes analysis and unmitigated radiological consequence analysis for a spilled fuel cask. So, we cannot judge that these are acceptable.

ONR expects the RP to provide a suitable and sufficient safety case for handling spent fuel casks within the BFX. This should include a review to determine reasonably practicable measures to eliminate the hazard of a spilled cask during handling operations. This review should also demonstrate that the adverse consequences of any changes are considered and adequately addressed.

References

[1] RO-UKHPR1000-0014, Design of Nuclear Lifting Operations to Demonstrate Relevant Risks are Reduced to ALARP, Rev 1, CM9 Ref. 2019/238645
[2] ONR Safety Assessment Principles 2014 Edition, (2020 Revision).
[3] UK HPR1000 Fault Schedule Rev C, GHX00600276DRAF02GN, CM9 2020/305441

Regulatory Observation Actions

RO-UKHPR1000-0056.A1 – Handling of Spent Nuclear Fuel

In response to this Regulatory Observation Action, the RP should provide a suitable and sufficient safety case for the handling of spent fuel by the SFPC. This should demonstrate that the relevant risks from spent fuel handling have been reduced to ALARP.

ONR anticipates that this will include:

- Application of the RP's categorisation and classification methodology
- Suitable and sufficient engineering substantiation to demonstrate that the SFPC meets the requirements for that classification of SSC

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

RO-UKHPR1000-0056.A2 – Handling of Spent Fuel Casks

In response to this Regulatory Observation Action, the RP should provide a suitable and sufficient safety case for the handling of spent fuel casks within the BFX. This should demonstrate that the relevant risks from spent fuel cask handling have been reduced to ALARP. **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:	