REGULATORY OBSERVATION

REGULATOR TO COMPLETE

RO unique no.:	RO-UKHPR1000-0014
Revision:	1
Date sent:	10/09/19
Acknowledgement required by:	01/10/19
Agreement of Resolution Plan Required by:	15/11/19
TRIM Ref:	2019/238645
Related RQ / RO No. and CM9 Ref: (if any)**:**	RQ-UKHPR1000-0261 (2019/183333) RQ-UKHPR1000-0262 (2019/183338) RQ-UKHPR1000-0263 (2019/183359) RQ-UKHPR1000-0267 (2019/183368) RQ-UKHPR1000-0268 (2019/183392) RQ-UKHPR1000-0270 (2019/183397) RQ-UKHPR1000-0404 (2019/218988)
Observation title:	Spent Fuel Building – Design of Nuclear Lifting Operations to Demonstrate Relevant Risks are Reduced to ALARP
Lead technical topic: 14. Mechanical Engineering	**Related technical topic(s):** 2. Civil Engineering 3. Control & Instrumentation 5. Conventional Health & Safety 9. Fault Studies 10. Fuel & Core 11. Human Factors 12. Internal Hazards 16. Radiological Protection 17. RadWaste, Decommissioning & Spent Fuel Management

Regulatory Observation

Background

UK health and safety legislation requires duty holders to reduce risks so far as is reasonably practicable (SFAIRP). The term SFAIRP is often used interchangeable with ALARP (as low as reasonably practicable). Fundamental to reducing risks SFAIRP/ALARP is the hierarchy of risk reduction:

- Eliminate;
- Reduce; and
- Control.

In its assessment of Pre-Construction Safety Report Chapter 28 Fuel Route and Storage [Ref. 1], ONR has considered the UK HPR1000 Fuel Handling and Storage System (PMC [FHSS]) Drawings [Ref. 2] and flow diagrams [Ref.1]. These have been used to understand how the spent fuel cask will be: imported, prepared, loaded and exported. From this review, ONR judges that there are features of the UK HPR1000 Fuel Handling and Storage System that may expose operators to conventional health and safety and radiological hazards/risks that may be avoidable.

Examples identified from the information provided to date are as follows:

- Without administrative controls, the auxiliary crane does not appear to be prevented from accessing fuel within the Spent Fuel Pool. ONR SAPs ELO.1 (Access), ELO.4 (Minimisation of the effects of incidents) and EKP.1 (Inherent safety).

- Import of the Spent Fuel Container (cask) requires it to be rotated from horizontal (for transport) to vertical (for loading). The size of the hoist well prevents this being undertaken by the Spent Fuel Container Crane alone. To rotate the cask, the transport vehicle has to be moved horizontally as the load is raised or lowered by the crane. ONR considers that this is a 'complex' lift as defined within BS7121-1:2016 - Code of practice for safe use of cranes – General [Ref. 5].

- The Spent Fuel Container Crane must be capable of raising its lifting feature high enough to clear the Auxiliary Crane underneath [Ref. 2]. Consequently, the Spent Fuel Container Crane has the potential to lift the cask to a height much greater than required normally. The operator must therefore 'control' the height of the cask to ensure that its drop withstand capability is not exceeded. ONR SAP ELO.4 (Minimisation of the effects of incidents).

- The safe transport configuration of the cask requires its cover/lid to be fully secured. During the movement of the cask between the Loading Pit and the Cleaning Pit, it is understood that the cask will only have its shield cover in place, secured by four bolts/screws only, i.e. the sealing lid/cover is not fitted. The four screws might not be adequate to retain the cask contents in a dropped load event and will not be fitted during the initial lift of the cask to the top of the loading pit. ONR SAP ELO.4 (Minimisation of the effects of incidents) and RP.6 (Shielding).

- Without administrative controls, there is no apparent means of preventing the cask shield plate being lifted off the cask when it is in the Cleaning Pit with no shielding water cover. The four bolts/screws identified above might not be sufficient to prevent this as the crane could attempt to lift the cask via the shield plate. ONR SAPs EHF.2 (Allocation of safety actions) and RP.6 (Shielding).

- The Spent Fuel Container Crane lifting bale (lifting beam) engages with the cask underwater. The operator's view of the lifting bale, as it engages with the cask, appears compromised (N.B. significant distance below operating floor level. Successful engagement appears to be inferred by the position of the lifting arms at the top of the lifting beam cross member, not the point of engagement on the cask trunnions. The potential to use an underwater camera to view the trunnions is noted but the images obtained might not be adequate to give positive assurance. ONR SAP EHF.1 (Integration within design, assessment and management).

- To prevent the rope and pulleys of the Spent Fuel Container Crane lifting bale entering the water, it is understood that the level of shielding water cover in the loading pit must be raised and lowered accordingly. The ability to raise and lower the water level in the loading pit must therefore be adequately controlled to ensure there is sufficient shielding water cover present. ONR SAP RP.6 (Shielding) and supporting paragraph 602.

- The New Fuel Elevator, normally used to import new fuel into the pool, has two additional functions identified in the technical specification [Ref. 1]:

  - Repair Mode: the basket is raised to a level where there is 3 metres of shielding water.

  - Adding Mode: the basket is raised slowly and "in order to keep safety" the elevator is equipped with a gamma radiation detector that cuts power to prevent further hoisting of the basket.

  Risks resulting from the failure to prevent further hoisting of the spent fuel (resulting in a significant radiological dose) will need to be demonstrated to be ALARP.

- The cask is moved across the 18.3m operating floor at low level, i.e. below normal handrail height [Ref. 2]. The Spent Fuel Pool Crane has a "pensile walkway" [suspended operator platform]; its underside is below normal handrail height. The Requesting Party (RP) has informed ONR [Ref. 4] that the handrails are "demountable". As the handrails are not permanent, this introduces risk of operators

falling from height or falling into the Spent Fuel Pool. Although operators may be protected whilst the handrails are in place, suitable 'control' means (e.g. safety harnesses and lanyards) would be required when the handrails are "demounted" or being adjusted.

- To load spent fuel into the cask, the handling tool has to be moved beyond the area served by the pensile walkway under the Spent Fuel Pool Crane. A temporary platform/bridge [Ref. 2] has to be placed over the Loading Pit to enable operation of the handling tool (i.e. disengage fuel assembly). It is also not evident how the operator can access the platform safely, without climbing over the handrails.

- The Fuel Building drawings [Ref. 2] do not indicate how workers (operators and maintenance staff) can access the cranes safely from the building. The on-board access platforms for the cranes appear to be limited to a single girder platform and crab [hoisting trolley] platform. Handrails also do not appear to provide full height protection on both sides, which would require workers to use safety harnesses and lanyards.

From these examples, ONR has identified aspects of the design of the UK HPR1000 Fuel Handling and Storage System (PMC[FHSS]), which it judges do not meet relevant good practice (RGP). Based on the information received to date, ONR considers that the layout and configuration of the UK HPR1000 Fuel Handling and Storage System significantly affects reducing the risks from nuclear lifting and handling operations to ALARP.

To date, the information provided by the RP in Chapter 28 of the PCSR [Ref. 1] and relevant supporting references [Refs. 1&2], does not provide sufficient detail and/or clarity, to give an adequate, coherent justification of the safety of nuclear lifting operations in the Spent Fuel Building. This has been the topic of several Regulatory Queries (RQs) already raised by ONR [Ref. 3] and has been discussed during mechanical engineering technical Level 4 meetings with the Requesting Party (RP) [Ref. 4].

As a consequence ONR does not have sufficient information and confidence to judge whether:

- The design of relevant UK HPR1000 Fuel Handling and Storage System structures, systems and components (SSCs) considers all mandatory requirements originating from relevant UK health and safety legislation. For example, Regulation 9 (Thorough examination and inspection) of the Lifting Operations and Lifting Equipment Regulations (see Relevant Legislation, Standards and Guidance below).

- As well as nuclear safety-related risks, suitable and sufficient consideration has been given to risks associated with conventional and health safety hazards in the UK HPR1000 Spent Fuel Building.

- The RP's application of the risk reduction hierarchy to the UK HPR1000 Spent Fuel Building is appropriate, and can be justified to represent relevant good practice for the UK HPR1000 design.

- The design of the UK HPR1000 Spent Fuel Building has been appropriately optimised to ensure nuclear lifting operations are not compromised and can be conducted safely; and

- Relevant risks associated with nuclear lifting operations in the UK HPR1000 Spent Fuel Building are reduced SFAIRP.

These are currently gaps in the UK HPR1000 generic safety case. However, ONR is aware the RP is continuing to develop its safety justification for the UK HPR1000 fuel route. This Regulatory Observation (RO) has therefore been raised to address the issues it has identified associated with nuclear lifting and handling operations in the Spent Fuel Building.

The RO is necessary to gain confidence that ONR's regulatory expectations will be adequately addressed by the RP, as its fuel route safety case develops.

Relevant Legislation, Standards and Guidance

Regulations (examples):

- Management of Health and Safety at Work Regulations 1999;
- Construction (Design and Management) Regulations 2015;
- Provision and Use of Work Equipment Regulations 1998;
- Lifting Operations and Lifting Equipment Regulations 1998;
- The Work at Height Regulations 2005; and
- Workplace (Health, Safety and Welfare) Regulations 1992

Including Approved Codes of Practice (ACoPs) for such regulations.

ONR Safety Assessment Principles:

- EKP.1 Inherent safety;
- EDR.1 Single failure criterion;
- ELO.1 Access;
- ELO.4 Minimisation of the effects of incidents;
- EHF.1 Integration within design, assessment and management;
- EHF.2 Allocation of safety actions;
- ECV.2 Minimisation of releases;
- ECV.3 Means of confinement; and
- RP.6 Shielding.

ONR Technical Assessment Guides (examples):

- NS-TAST-GD-005 Guidance on the Demonstration of ALARP (As Low As Reasonably Practicable);
- NS-TAST-GD-036 Redundancy, Diversity, Segregation and Layout of Mechanical Plant; and
- NS-TAST-GD-056 Nuclear lifting operations.

Regulatory Expectations

ONR expects the RP to apply the General Principles of Prevention to the design of the UK HPR1000 Spent Fuel Building as set out in of the Management of Health and Safety Regulations 1999 Schedule 1, with the aim, so as far as is reasonably practicable, of eliminating foreseeable risks. Where this is not possible, ONR expects the RP to take reasonably practicable steps to reduce the risks, or to control them, through the design process.

The General Principles of Prevention:

(a) avoiding risks;

(b) evaluating the risks which cannot be avoided;

(c) combating the risks at source;

(d) adapting the work to the individual, especially as regards the design of workplaces, the choice of work equipment and the choice of working and production methods, with a view, in particular, to alleviating monotonous work and work at a predetermined work-rate and to reducing their effect on health;

(e) adapting to technical progress;

(f) replacing the dangerous by the non-dangerous or the less dangerous;

(g) developing a coherent overall prevention policy which covers technology, organisation of work, working conditions, social relationships and the influence of factors relating to the working environment;

(h) **giving collective protective measures priority over individual protective measures;** and

(i) giving appropriate instructions to employees.

ONR's regulatory expectations to demonstrate ALARP are presented in Technical Assessment Guide (TAG) NS-TAST-GD-005 (see above). ONR would also expect the RP to take due account of the guidance contained in this TAG, when undertaking optioneering to support its safety case for the UK HPR1000 fuel route. More specifically, ONR would expect the RP to include the following:

a) **Relevant Good Practice (RGP):** 'Relevant' means it should be appropriate to the activity and associated risks (i.e. the generic design), and should be up-to-date. ONR will form a judgement by comparing the RP's approach to justifying new fuel handling, spent fuel storage and handling, and spent fuel export operations, against RGP and good design principles.

As a guide, the RP should aim at and compare against levels of safety that are known to have been achieved in other designs. ONR expects that UK HPR1000 would not give rise to a risk level greater than that achieved by the existing practice for comparable functions. Where others are achieving a higher standard, ONR will challenge the RP whether this standard is, in effect, good practice.

Common practice may not necessarily be good practice or reduce risks to ALARP – the RP should not assume that it does. What is good practice may cease to be relevant with the passage of time and new technology may make a higher standard reasonably practicable.

b) **Options and optioneering:** For UK HPR1000 new fuel handling, spent fuel storage and handling, and spent fuel export operations from the Spent Fuel Building, a selection amongst options is required.

An effective approach for demonstrating that risks are ALARP is to start with the safest option within the range of practicable solutions. This option should be chosen by the RP unless it can show it is not reasonably practicable; in which case attention should pass to the next safest option. ONR will form a judgement as to whether the approach presented for UK HPR1000 new fuel handling, spent fuel storage and handling, and spent fuel export operations in the Spent Fuel Building, reduces risks to ALARP. This will include knowledge of RGP in the area, ONR's consideration of other possible options, and our judgement of the arguments and evidence presented in the RP's case.

To aid transparency in the ALARP demonstration, ONR would expect the RP to record the range of options considered and discarded.

Thought should also be given to the robustness of the conclusions from the optioneering with respect to uncertainties and to any assumptions employed in the demonstration. Where a case uses quantitative methods, sensitivity studies to test the robustness of the arguments should be provided.

References

[1] CGN documents:

- HPR/GDA/PCSR/0028, Revision 0, Pre-Construction Safety Report Chapter 28 Fuel Route and Storage, September 2018 (CM9 Ref. 2018/315174)
- GH/X/17PMC/009/DPFJ/45/GN, Revision A, Fuel Handling and Storage System Design Manual Chapter 9 Flow Diagrams, Undated (CM9 Ref. 2018/316124).
- GH/X/45600/007/DPFJ/44/DS Revision A, Technical Specification for Spent Fuel Pool Crane, July 2018 (CM9 Ref. 2019/91957)
- GH/X/45600/008/DPFJ/44/DS Revision A, Technical Specification for Auxiliary Crane, July 2018 (CM9 Ref. 2019/91956)
- GH/X/45600/010/DPFJ/44/DS Revision A, Technical Specification for New Fuel Elevator, August 2018 (CM9 Ref. 2019/91957)

[2} CGN drawings:

- General Layout Drawing (Top View) for Fuel Handling and Storage System, GHX45600004DNSB44DD Revision A, June 2018 (CM9 Ref. 2019/25985)
- General Layout Drawing (Front View) for Fuel Handling and Storage System, GHX45600005DNSB44DD Revision A, June 2018 (CM9 Ref. 2019/25969)
- General Layout Drawing (A-A Section) for Fuel Handling and Storage System, GHX45600006DNSB44DD Revision B, June 2018 (CM9 Ref. 2019/25978)

  General Layout Drawing (B-B Section) for Fuel Handling and Storage System, GHX45600007DNSB44DD Revision B, June 2018 (CM9 Ref. 2019/25676)
- General Layout Drawing (C-C Section) for Fuel Handling and Storage System, GHX45600008DNSB44DD Revision B, June 2018 (CM9 Ref. 2019/25998)

[3] Mechanical Engineering Regulatory Queries (RQs)

- RQ-UKHPR1000-0221 Spent Fuel Cask Handling – Crane Interactions (CM9 Ref. 2019/98921)
- RQ-UKHPR1000-0261 Fuel Handling Equipment Technical Specifications – ALARP Justification
- RQ-UKHPR1000-0262 Spent Fuel Building – New Fuel Elevator Technical Specification
- RQ-UKHPR1000-0268 Design Process – Fuel Handling and Storage Safety Functions
- RQ-UKHPR1000-0270 Fuel Pool Cooling and Treatment System (PTR) – Minimum Water Level

[4] Regulatory interactions with Requesting Party

- Mechanical Engineering Level 4 Meeting – Lifting and Fuel Handling Operations, 29 & 30 January 2019 ONR-NR-CR-19-717 Revision 0, (CM9 Ref. 2019/33911)

[5] BS7121-1:2016 – Code of practice for safe use of cranes. General.

Regulatory Observation Actions

RO-UKHPR1000-0014.A1 – Fuel Building handling operations and hazard identification

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

- Generate detailed flow diagrams that adequately describe the new and spent fuel handling operations.
- Review the design of the Spent Fuel Building and identify the nuclear, radiological and conventional health and safety hazards that are present.

The response to this ROA may be combined with any other ROA under this RO, if deemed appropriate.

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

RO-UKHPR1000-0014.A2 – Fuel Building consequence analysis

In response to this ROA, based on the outcome of ROA 1 , the RP should:

- Undertake a proportionate consequence analysis/assessment to determine the worst case scenarios (e.g. at the fully raised position) that could result from the hazards identified.

The response to this ROA may be combined with any other ROA under this RO, if deemed appropriate.
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RO-UKHPR1000-0014.A3 – Fuel Building optioneering and demonstration relevant risks are reduced SFAIRP

In response to this ROA, based on the outcome of ROAs 1 and 2, the RP should demonstrate:

- Compliance with the statutory requirements of UK legislation;
- For new fuel handling, spent fuel storage and handling, and spent fuel export operations, the chosen option(s) which reduces risks SFAIRP has been selected; and
- A process of optimisation has been followed in a robust, transparent manner, which forms part of the UK HRP1000 generic safety case.

To achieve this, ONR would expect a response to this ROA to:

- Consider the risks that are being mitigated, including their likelihood and the consequences of high risk activites;
- Consider the measures in place to mitgate these risks – including the adoption/justification of what may be deemed measures representing RGP;
- Describe what options, or range of options, could be applied to further mitigate these risks; and
- Provide a proportionate demonstration of whether these options are reasonably practicable to implement or not.

The response to this ROA may be combined with any other ROA under this RO, if deemed appropriate.

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:	