REGULATORY OBSERVATION

REGULATOR TO COMPLETE

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Observation title:	Optimisation of collective occupational radiation exposure for the UK HPR1000
Lead technical topic: 16. Radiological Protection	**Related technical topic:** 1. Chemistry 6. Cross Cutting 11. Human Factors 14. Mechanical Engineering 17. Rad Waste, Decommissioning and Spent Fuel 20. Structural Integrity

Regulatory Observation

Background

The primary objective of this Regulatory Observation (RO) is to state ONR's expectations for Generic Design Assessment (GDA) for the Requesting Party (RP) to provide suitable and sufficient evidence to demonstrate the design and intended normal operations of the UK HPR1000, are capable of minimising collective occupational radiation exposures, and reducing them to As Low As Reasonably Practicable (ALARP).

In Chapter 22 of the Pre-construction Safety Report (PCSR) [Ref. 1], the RP has provided an overview of their derivation of anticipated doses to workers during normal operations for UK HPR1000. Further information is provided in the Worker Dose Evaluation Topic Report [Ref. 2]. The RP determined the initial annual collective occupational radiation exposure from the 10-year outage programme data based on Operational Experience (OPEX) from M-310 and CPR1000 operating plants in China. This was calculated at 565 Man mSv/yr and includes both the Normal Refuelling Outage and In-Service Inspection Outages.

The RP's approach is based on international good practice for estimating collective occupational radiation exposure. However, the RP claim their calculated value of 565 Man mSv/yr is higher than they anticipate for UK HPR1000, because the calculated collective dose is weighted towards older Chinese PWRs. Suitable and sufficient evidence has not yet been provided to corroborate this claim.

In addition, ONR has not yet seen suitable and sufficient evidence to demonstrate the estimated collective occupational radiation exposure of 565 man mSv/yr for the UK HPR1000, is capable of being reduced further, once aspects of the RP's claimed improved design and operational features for UK HPR1000, versus the "older" Chinese M-310 and CPR1000 reactors, have been taken into account. The RP acknowledge that further optimisation is required during Step 4 of GDA, in order to robustly demonstrate that the collective occupational radiation exposure anticipated for the UK HPR1000 are minimised and reduced to ALARP.

The collective occupational radiation exposures anticipated for UK HPR1000 are high, compared to other operating civil PWRs worldwide and in the UK [Ref. 3]. Furthermore, adequate evidence to satisfy RQ-UK HPR10000294 [Ref. 4], which asked for a demonstration that a systematic approach to identifying all potential improvements that may lead to a reduction in radiation does, has not been implemented for the UK HPR1000. ONR is also yet to see evidence regarding what impact UK HPR1000 maintenance arrangements and design provisions, (i.e. plant design features, frequency, intrusiveness of inspections, space provisions etc.), and the impact of other manual tasks and operations, have on the extent of the anticipated collective occupational

radiation exposures.

In summary, the dose data as currently presented for the UKHPR1000 does not compare favourably with PWRs worldwide and as such the RP is required to demonstrate that collective occupational radiation exposure has been suitably optimised.

This RO has therefore been raised to ensure ONR gains sufficient confidence in the RP's approach to defining and justifying the radiation exposures anticipated for UK HPR1000, to support their safety case claim that the design and proposed operation of UK HPR1000 reduces collective occupational radiation exposure to ALARP.

Relevant Legislation, Standards and Guidance

The following provides details of the legislation, standards and guidance relating to occupational radiation exposure, optimisation and the application of ALARP.

The Radiation Protection section of the ONR Safety Assessment Principles (SAPs) [5] contains the following expectations:

RADIATION PROTECTION

576. *Most of the Euratom Basic Safety Standards (BSS) Directive (2013/59/Euratom) is implemented in Great Britain by the Ionising Radiations Regulations 2017 (IRR17) which are made under the Health and Safety at Work etc Act 1974 (HSW Act). Northern Ireland publishes separate regulations.*

577. *The main aim of the Regulations and the supporting Approved Code of Practice (ACoP) and Guidance (Ref. 12) is to establish a framework for ensuring that exposure to ionising radiation arising from work activities is kept as low as reasonably practicable and does not exceed specified dose limits.*

Radiation protection	Hierarchy of control measures	RP.7
The dutyholder should establish a hierarchy of control measures to optimise protection in accordance with IRR17.		

585. The dutyholder should have a strategy to restrict radiation exposure. This should include, but not be restricted to, the minimisation of sources of radiation, system and component design including shielding optimisation and layout, and management arrangements including the use of time and distance during operations. Optimisation of protection and limitation of doses to individuals should be adequately dealt with in the safety case. An important element of optimisation of protection is that the collective effective dose to people on site, as a result of the operation of the facility, should be kept ALARP.

Radiation protection	Normal operation (Planned Exposure Situations)	RP.1
Adequate protection against exposure to radiation and radioactive substances should be provided in those parts of the facility to which access is permitted during normal operation.		

587. In line with guidance in the ACoP, the safety case should give preference to the use of appropriate engineering controls and design features. The restriction of exposure to radiation and radioactive contamination should not preclude admission to, or occupancy of, any facility area where access is needed to achieve or maintain a stable, safe state.

589. Exposures should be estimated in advance for normal operations (planned exposure situations) and then monitored and assessed during the work activity using personal dosemeters or suitably located devices.

The Ionising Radiations Regulations 2017, Approved Code of Practice (ACOP) and Guidance [6] contains the following requirements:

Regulation 9(1)	*(1) Every employer must, in relation to any work with ionising radiation that it undertakes, take all necessary steps to restrict so far as is reasonably practicable the extent to which its employees and other persons are exposed to ionising radiation.*

91 Where the design of new facilities is being considered for work with ionising radiation, the employer must consider the construction, commissioning and operation of the facility together with its maintenance and decommissioning to ensure that exposure will be restricted as far as reasonably practicable during the life-span of the facility.

Regulatory Expectations

As stated previously, it is ONR's expectation that the RP provides robust evidence to substantiate the claim that improved design features from the M-310 and CPR1000 plants have been incorporated into the UK HPR1000 design. ONR expect this to be taken into account when considering potential options that may reduce occupational exposure, to reflect any changes in design, specification, or proposed operational controls, or any other factors that may impact collective occupational radiation exposure.

In Step 3 of GDA, the RP provided calculated estimates of radiation exposure to workers arising from normal operations of the UK HPR1000. During Step 4 of GDA, the RP will undertake further dose assessments and optimisation work, in order to demonstrate that the collective occupational radiation exposure for the UK HPR1000 is capable of being reduced to ALARP. ONR expect this will include the application of a systematic, transparent approach to the identification of potential improvements, together with a robust assessment of the impact on UK HPR1000 maintenance arrangements and other operational tasks, on occupational radiation exposure. ONR would also expect this to adequately capture any differences between Chinese practices and any additional, or different requirements, introduced in the context of making a UK safety case for the UK HPR1000 design i.e. highest reliability claims and associated in-service inspection requirements etc., or any other relevant differences.

During GDA,ONR expect a robust demonstration to be made that the UK HPR1000 design and intended operations thereof, have both been optimised to a point where predicted doses are demonstrably comparable to, or perhaps lower than, the current average for PWRs worldwide. When making specific reference to ONR's assessment of "new" reactor designs, ONR's Technical Assessment Guide (TAG) on the demonstration of ALARP, TAG-0005 (Ref. 7), states, *"The level of safety must be no less than a comparable facility already working or being constructed in the UK or somewhere else in the world".*

In summary, when responding to this RO, ONR would expect the RP to provide a robust demonstration to show that:

- OPEX from Chinese PWRs is representative of the UK HPR1000, that the high initial collective occupational exposure is weighted towards the older designs (M-310 and CPR1000), and that this will demonstrably reduce once the claimed "improved design features" for UK HPR1000 have been taken into account and assessed in detail.

- The impact of UK HPR100 maintenance arrangements and other operational tasks/requirements on occupational exposures have been adequately accounted for and robustly assessed i.e. manual versus automated procedures, differences between Chinese practices and UK expectations etc.

- A systematic approach to option identification has been employed as part of the ALARP process to ensure that all potential improvements that may lead to a reduction in worker radiation doses have been identified, and all reasonably practicable improvements will be implemented into the UK HPR1000 design.

- Collective occupational radiation exposures will be reduced to ALARP for the design and operation of the UK HPR1000.

References

[1] Pre-Construction Safety Report Chapter 22, Radiological Protection, HPR/GDA/PCSR/0022, Rev 001, January 2020, General Nuclear Systems Ltd, CM9 Ref. 2020/13968.
[2] Worker Dose Evaluation Topic Report, Rev B, April 2019, General Nuclear Systems Ltd. CM9 Ref. 2019/127453.

[3] GDA Step 3 Assessment of Radiological Protection for the UK HPR1000 Reactor, Assessment Note, ONR-NR-AN-19-16, 20/01/2020, CM9 Ref: 2020/19481.
[4] Radiological Protection – Worker Dose Optimisation, RQ-UKHPR1000-0294, 31/07/2019, CM9 Ref: 2019/146689.
[5] Safety Assessment Principles for Nuclear Facilities, 2020 Edition, Revision 1, Office for Nuclear Regulation, 2020. www.onr.org.uk/saps/saps2014.pdf
[6] Work with Ionising Radiation, Ionising Radiations Regulations 2017, Approved Code of Practice and Guidance, L121, HSE Books, 2018. http://www.hse.gov.uk/pubns/priced/l121.pdf
[7] NS-TAST-GD-005 (Rev 10) – ONR Guidance on the demonstration of ALARP, CM9 Ref: 2019/315236.

Regulatory Observation Actions

RO-UKHPR1000-0035.A1 – Robust determination of collective occupational radiation exposure for the UK HPR1000

In response to this Regulatory Observation Action (ROA), ONR would expect that RP will need to undertake and document the following activities:

1. Provide adequate evidence that OPEX from Chinese PWRs is representative of the UK HPR1000 to determine collective occupational radiation exposure and demonstrably show that the high initial calculated estimate is weighted towards the older Chinese PWRs, as claimed.

2. Provide a gap analysis and explanation of any differences between Chinese PWRs and the UK HPR1000 regarding occupational radiation exposures (i.e. from maintenance and other manual or operational tasks etc.).

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-UKHPR1000-0035.A2 – Optimisation of collective occupational radiation exposure for the UK HPR1000

In response to this ROA, and based on the outcome of the work to address ROA1 under this RO, ONR would expect that RP will need to undertake and document the following activities:

1. Demonstrate that a systematic approach to option identification has been employed as part of the ALARP process for radiological protection, which ensures that all potential improvements that may lead to a reduction in worker radiation doses have been identified, and all reasonably practicable improvements will be implemented for UK HPR1000.

2. Demonstrate that occupational radiation exposures for UK HPR1000 will be acceptable, minimised and reduced to ALARP.

3. Provide suitable and sufficient evidence to substantiate the claim that improved design features from the M-310 and CPR1000 plants have been incorporated into the UK HPR1000 design, and how these will lead to reductions in collective occupational radiation exposure.

4. Provide suitable and sufficient evidence of how any other changes in design, specification, proposed operational controls or any other factors that can affect collective occupational radiation exposure, have been adequately considered in the UK HPR1000 design.

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:	