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REGULATORY OBSERVATION Resolution Plan	
RO Unique No.:	RO-UKHPR1000-0035
RO Title:	Optimisation of collective occupational radiation exposure for the UK HPR1000
Technical Area(s)	Radiological Protection
Revision:	0
Overall RO Closure Date (Planned):	2021-02-28
Linked RQ(s)	RQ-UKHPR1000-0294
Linked RO(s)	RO-UKHPR1000-0028
Related Technical Area(s)	Reactor Chemistry,Cross-cutting,Human Factors,Mechanical Engineering,Radwaste, Decommissioning & Spe
Other Related Documentation	NA
Scope of Work	

Background

Based on the information on worker dose during normal operations for the UK HPR1000 provided in *Pre-Construction Safety Report (PCSR) Chapter 22*, Reference [1] and its supporting report *Worker Dose Evaluation Topic Report*, Reference [2], ONR has recognised that the methodology for collective dose evaluation adopted by the Requesting Party (RP) aligns with international good practice. However, ONR have identified that the preliminary value of collective dose during normal operation for the UK HPR1000 is higher than that of comparable plants across the world. The collective dose is calculated using operational experience from the Chinese NPP fleet and is claimed to be weighted towards older Chinese PWRs, but suitable and sufficient evidence has not yet been provided by the RPs to corroborate this claim. To date, ONR have not yet seen suitable and sufficient evidence to demonstrate that this preliminary value of collective dose for the UK HPR1000, is capable of being reduced further.

Regulatory Observation (RO) RO-UKHPR1000-0035 has been raised by the ONR to clarify their expectations as following to seek evidence and to gain confidence from the RP that the collective dose can be reduced to a level comparable to, or perhaps lower than, comparable plants across the world:

a) Provide 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;

b) Provide evidence on application of a systematic and transparent approach to the identification of potential improvements, together with a robust assessment of their impacts on the UK HPR1000 maintenance arrangements and other operational tasks, on occupational radiation exposure;

c) Demonstrate robustly 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.

Two RO Actions (ROAs) are therefore identified in this RO against which the RP have developed a resolution plan to address the RO as detailed in the deliverables description section below.

Scope of Work

RP have reviewed RO-UKHPR1000-0035 considering relevant Regulatory Queries (RQ) such as RQ-UKHPR1000-0294, Reference [3] and established the resolution plan presented hereafter to address the regulatory expectations identified in each of the RO actions.

The scope of work related to this RO is consistent with the scope of PCSR Chapter 22, which focuses on the evaluation of collective dose and the ALARP demonstration for radiological protection during normal operation for the UK HPR1000.

To respond to the ROAs of this RO, the following work will be carried out:

a) Review the approach for Operational Experience (OPEX) data selection, refine the starting point of collective dose evaluation and provide relevant information to ONR;

b) Perform a gap analysis to assess the differences between Chinese PWRs and the UK regarding occupational exposure (such as on maintenance and operational tasks, etc.) and provide an explanation for how they are anticipated to influence the occupational exposure (if any) on the UK HPR1000;

c) Provide evidence by a suite of ALARP documents produced by Structures, Systems and Components (SSC) design areas and Radiological Protection area to demonstrate the application of the ALARP process for radiological protection to minimise occupational exposure and reduce it to ALARP;

d) Establish linkages to SSC design area documents as evidence to substantiate the improved design features from the M-310 and CPR1000 plants which have been incorporated into the UK HPR1000 design and confirm that the influence from these improved design features have been evaluated and reflected in the collective dose;

e) Assess the impact on collective dose from the design modifications implemented in Design Reference (DR) 2.2.

Deliverable Description

Based on the scope outlined above, the following documents will be produced or updated to address this RO:

New documents to be produced:

- Report 1: *Establishment of the Starting Point for the Collective Dose Evaluation of the UK HPR1000;*
- Report 2: *EMIT Consistency Analysis;*
- Report 3: *Evaluation of the Impacts on Collective Dose from the Design Improvements.*

Existing documents to be updated:

- Report 4: *ALARP Demonstration of PCSR Chapter 22;*
- Report 5: *Worker Dose Evaluation Topic Report.*

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:

ROA1.1: *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 initial high calculated estimate is weighted towards the older Chinese PWRs, as claimed.*

ROA1.2: *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.).*

Resolution Plan

ROA1.1:

As presented in *Worker Dose Evaluation Topic Repo*rt, Reference [2], the method for collective dose evaluation for the UK HPR1000 is based on OPEX data from comparable operating plants. It considers adjustment for design differences between the UK HPR1000 and the OPEX units as well as the influence of further design modification made during ALARP demonstration, as shown in Figure 1. This method is aligned with internationally accepted practice.

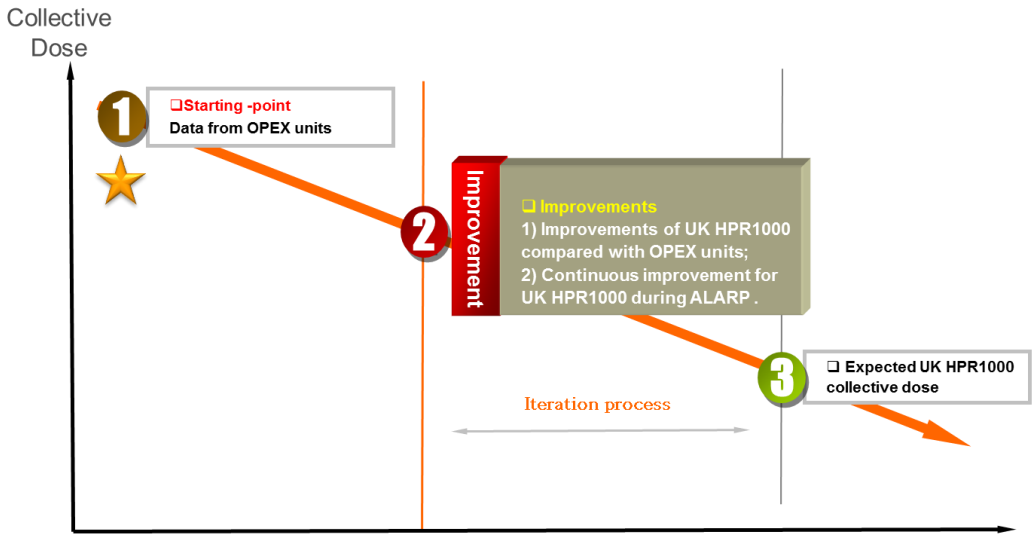

Figure 1 Overview of the Process for Collective Dose Evaluation

The reason for the high preliminary calculated collective dose is that the OPEX data from old plants (M310) have been taken into account together with more modern plants (CPR1000), which means that OPEX from old designs and practices are used without considering the design improvements between them or the increase in capability and experience of the operators. The preliminary calculated collective dose is thus considered conservative and weighted towards old design and practices, which is not appropriate for the UK HPR1000.

As planned at the beginning of step 4, and also to address ROA1.1, the approach for OPEX data selection will be reviewed to refine the starting point of collective dose for the UK HPR1000. A new report, ***Establishment of the Starting Point for the Collective Dose Evaluation of the UK HPR1000***, will be submitted to ONR as supplement for *Worker Dose Evaluation Topic Report.*

The report ***Establishment of the Starting Point for the Collective Dose Evaluation of the UK HPR1000*** will present the methodology and process for establishment of the starting point for collective dose evaluation of the UK HPR1000 from the available CGN OPEX data after review and refinement. The main contents of this report are as follows:

a) Research and collection of relevant OPEX data of collective dose from comparable reactors;

b) Identification of those comparable reactors from which the OPEX data are applicable for collective dose evaluation (i.e. those with a comparable design with the UK HPR1000 and with sufficient understanding of the background information, e.g. design features and operational management history);

c) Identification of those comparable reactors from which the OPEX data are appropriate for collective dose evaluation (e.g. be representative according to the operational management

history);

d) Determination of the starting point for collective dose evaluation by statistical analysis based on the selected OPEX data (as appropriate and applicable);

e) Comparison of the starting point with comparable plants across the world.

ROA1.2:

During the plant operation stage, both operational tasks and Examination, Maintenance, Inspection and Testing (EMIT) tasks can lead to occupational exposure. According to CGN OPEX, the ratio of occupational exposure received during power operation to that during shutdown is about 20%:80% for collective dose: the former consists of operational tasks and part of EMIT tasks; the latter consists mostly of the maintenance tasks and a few preparatory works for operational tasks. Hence, the occupational exposure received for operational tasks are relatively minor compared with EMIT tasks.

Operational tasks are those daily tasks performed to keep the plant operating as anticipated no matter the location of the plant. It is considered there is not a significant difference in operational tasks arrangements between Chinese practice and UK practice. Details of the operational tasks arrangements are not within GDA scope and will be developed for the UK HPR1000 during site license stage and operational stage. For GDA, a high level justification will be provided to substantiate that there will not be a significant difference in operational tasks arrangements for the UK HPR1000 between a plant operated in the UK or in China. This information will be included in the updated version of the ***Worker Dose Evaluation Topic Report***.

Therefore, the main interest to perform this gap analysis will be on the EMIT tasks arrangements.

As proposed in the resolution plan for RO-UKHPR1000-0021, Reference [4]:

"..., the UK requirements will be reviewed to identify any potential gap within current Examination, Maintenance, Inspection and Testing (EMIT) Strategy of UK HPR1000. And these UK requirements are part of the input data to define the EMIT activities, frequency especially when UK requirements of EMIT are specific. Beside the above legislations, codes and standards, the regulatory expectations in SAP will also be considered to make sure UK HPR1000 EMIT arrangements meet regulatory expectations…

Furthermore, ***EMIT Consistency Analysis*** *is provided to check whether EMIT requirements are consistent within the safety case for the UK HPR1000."*

The EMIT design process provided in report *Examination, Maintenance, Inspection and Testing (EMIT) Strategy,* Reference [5] will be applied. This process covers all technical areas, and is jointly developed by the relevant technical teams in CGN.

Report 2: *EMIT Consistency Analysis* aims to confirm that the EMIT requirements are consistent

within the UK HPR1000 safety case. This report will consist of the following contents:

a) Review of the UK requirements to check whether there is any gap for UK HPR1000:

- Identification of a list of standards and codes related to EMIT;
- Determination a review approach for EMIT relevant disciplines;
- Identification any special requirement in terms of EMIT frequencies or tasks.

b) Identification of any inconsistency between EMIT and other safety case requirements, which include fault studies, SSC design, layout design, radiation protection requirements, etc.;

c) Analysis of the impact of the gap or inconsistency (if there is any) with regards to EMIT and identify impacted documentation within safety case;

d) Clarification of the plan to address any identified gap and eliminate inconsistency.

The gaps (if any) identified by this work will then be analysed to see how they will impact the occupational exposure. It will be reflected in the collective dose of the UK HPR1000 in the updated version of ***Worker Dose Evaluation Topic Report***.

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:

ROA2.1: *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.*

ROA2.2: *Demonstrate that occupational radiation exposures for UK HPR1000 will be acceptable, minimised and reduced to ALARP.*

ROA2.3: *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.*

ROA2.4: *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.*

Resolution Plan

ROA2.1&2.2:

The ALARP demonstration for radiological protection during normal operation was planned at the beginning of step 3 and continues during step 4. It should be noted that:

a) The radiological protection area is the upstream of the SSC design areas since the insight from radiological risk (i.e. the activities with highest contribution to collective doses as well as suggestions in terms of reduction of source term, reduction of the manual operational requirements and reduction of operational duration, etc.) are inputs for the SSC design area, which have already been transmitted from radiological protection area technical team to the relevant SSC design areas technical teams at the beginning of step 3, as well as the Eliminate, Reduce, Isolate, Control and Personal Protective Equipment (ERIC/PPE) methodology to assist the SSC design areas technical teams to identify potential options to minimise the doses. These inputs are summarised in the *ALARP Demonstration Report of PCSR Chapter 22*, Reference [6] and developed in a suite of supporting reports for ALARP demonstration;

b) The radiological protection area technical team is involved in the ALARP demonstration and optioneering process of the SSC design areas/disciplines technical teams during GDA stage to provide necessary expertise (e.g. by scoring or weighting based on impact on source term, local dose rate, exposure duration and frequency) in terms of minimising the occupational exposure. These processes are part of the multi-disciplinary design iteration processes. The supporting reports for ALARP demonstration summarise these process and justify the conclusions. The conclusions therefore support the summary ALARP demonstration for radiological protection during normal operation provided in the updated version of ***ALARP Demonstration Report of the PCSR Chapter 22***;

c) The radiological protection area is also downstream of the SSC design areas since the decisions made on design modification are fed into the UK HPR1000 in the DR and finally reflected in the collective dose evaluation. The information on evaluation of design modification will be provided in the updated version of ***Worker Dose Evaluation Topic Report*** and the newly planned report ***Evaluation of the Impacts on Collective Dose from the Design Improvements***.

The SSC design areas/disciplines highly related to radiological protection in terms of minimising occupational exposure during normal operation are as shown in Figure 2.

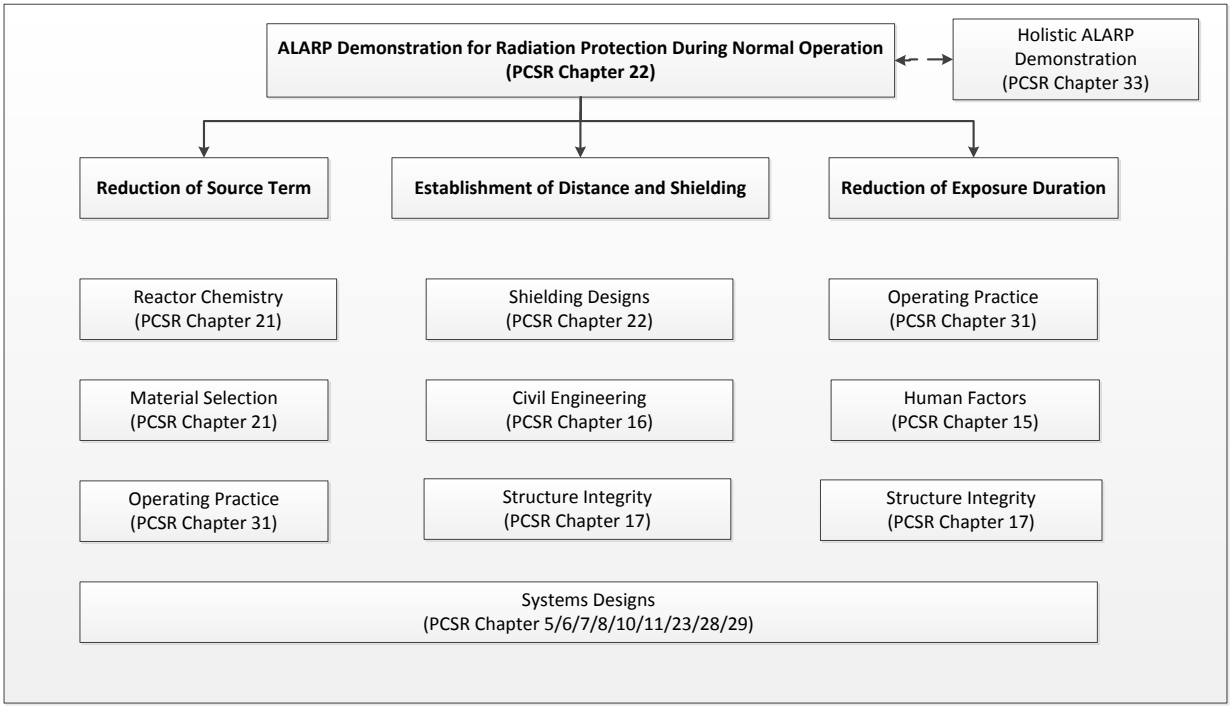

Figure 2 Interfaces with Other Chapters

The list for the suite of supporting documents for the ALARP demonstration for radiological protection during normal operation will be provided in the updated version of ***ALARP Demonstration of PCSR Chapter 22***. These supporting documents present the whole safety case for the ALARP demonstration for radiological protection during normal operation following the ALARP methodology for the UK HPR1000, Reference [7].

ROA2.3:

The relevant improved design features from CPR1000 and their influence on collective doses have already been summarised in *Worker Dose Evaluation Topic Report*, Reference [2].

To respond to ROA2-3, the design improvements will be separated according to the evolution timeline of the DRs for the UK HPR1000 (i.e. CPR1000 to DR1.0 and DR1.0 to DR 2.2) so as to better facilitate ONR understanding how the UK HPR1000 design evolves and how the improvements influence the collective dose step by step. (This is also part of resolution plan for ROA2.4).

In addition, improved linkage will be applied to facilitate traceability back to the SSC design area documents for evidence proving that all these identified improvements have been implemented in the UK HPR1000.

All this information will be added in the later updated version of ***Worker Dose Evaluation Topic***

Report.

ROA2.4:

To respond to ROA2-4, as also proposed in part of the resolution for ROA2-3, the design improvement will be separated according to the evolution timeline of the DR for the UK HPR1000 to improve understanding of the design improvement made on the UK HPR1000.

Report 3: ***Evaluation of the Impacts on Collective Dose from the Design Improvements*** will be produced to provide information on how the influence of the relevant design improvement identified during GDA stage on collective dose will be analysed in a case by case basis. It will contain the following content:

a) Identification of those design modifications implemented from DR1.0 to DR 2.2 that can impact the occupational exposure;

b) Evaluation of the impact on occupational exposure from each of identified design modifications:

- Identification of which category of activities each design modification can impact;
- Check of the dose for each impacted category of activities before implementation of the dedicated design modification;
- Analysis of the impact from each design modification on the occupational exposure for each category of activities, i.e. evaluate at what range the design modification can impact the area dose rate, the exposure duration and the frequency, etc.;

c) Summary of the impacts on occupational exposure from all the design modifications implemented from DR1.0 to DR2.2.

Impact on GDA Submissions

The information relevant to this RO will be incorporated into PCSR Chapter 22 V2 and its supporting documents. The submission planning for the deliverables to address this RO is as follows:

Title of Submission	Related ROAs	Planned Submission Date
Establishment of the Starting Point for the Collective Dose Evaluation of the UK HPR1000	ROA1.1	2020/07/31
EMIT Consistency Analysis	ROA1.2	2020/07/31
Evaluation of the Impacts on Collective Dose from the Design Improvements	ROA2.4	2020/11/30

ALARP Demonstration Report of PCSR Chapter 22, Rev C or follow-up	ROA1&2	2020/05/30
ALARP Demonstration Report of PCSR Chapter 22, Rev D or follow-up	ROA1&2	2020/10/31
Worker Dose Evaluation Topic Report, Rev C or follow-up	ROA1&2	2020/06/30
Worker Dose Evaluation Topic Report, Rev D or follow-up	ROA1&2	2020/11/30

The resolution of this RO will involve Reactor Chemistry (PCSR Chapter 21), Mechanical Engineering (PCSR Chapter 5~8, 10, 11), Radwaste Management (PCSR Chapter 23), Structural Integrity (PCSR Chapter 17), Civil Engineering (PCSR Chapter 16) and Operating Practice (PCSR Chapter 31). However, the impacts on these areas as well as relevant PCSR chapters are deemed to be minor.

Timetable and Milestone Programme Leading to the Deliverables

A Gantt chart presenting the timetable and milestones of this RO resolution is provided in APPENDIX A.

Reference

[1] GNSL, Pre-Construction Safety Report Chapter 22 Radiological Protection, HPR/GDA/PCSR/0022, Rev 001, December 2019.

[2] CGN, Worker Dose Evaluation Topic Report, GHX40200063DNFP03GN, Rev B, April 2019.

[3] ONR, Radiological Protection – Worker Dose Optimisation, RQ-UKHPR1000-0294, June 2019.

[4] GNSL, REGULATORY OBSERVATION RESOLUTION PLAN RO-UKHPR1000-0021, HPR/GDA/REPO/000021, November 2019.

[5] CGN, Examination, Maintenance, Inspection and Testing (EMIT) Strategy, GHX42EMT001DOYX45GN, February 2020.

[6] CGN, ALARP Demonstration Report of PCSR Chapter 22, GHX00100075KPGB03GN, Rev A, March 2019.

[7] CGN, ALARP Methodology, GHX00100051DOZJ03GN, Rev D, April 2020.

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APPENDIX A RO-UKHPR1000-0035 Gantt Chart

		Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21
RO Action 1														
	Development of deliverable-[Establishment of the Starting Point for the Collective Dose Evaluation of the UK HPR1000]													
	Submission of deliverable-[Establishment of the Starting Point for the Collective Dose Evaluation of the UK HPR1000]													
	Development of deliverable-[EMIT Consistency Analysis]													
	Submission of deliverable-[EMIT Consistency Analysis]													
	Development of deliverable-[Worker Dose Evaluation Topic Report, Rev D or follow-up]													
	Submission of deliverable-[Worker Dose Evaluation Topic Report, Rev D or follow-up]													
	Regulators Assessment													
	Target Cloure Date													
RO Action 2														
	Development of deliverable-[Evaluation of the Impacts on Collective Dose from the Design Improvements]													
	Submission of deliverable-[Evaluation of the Impacts on Collective Dose from the Design Improvements]													
	Development of deliverable-[ALARP Demonstration Report of PCSR Chapter 22, Rev C or follow-up]													
	Submission of deliverable-[ALARP Demonstration Report of PCSR Chapter 22, Rev C or follow-up]													
	Development of deliverable-[ALARP Demonstration Report of PCSR Chapter 22, Rev D or follow-up]													
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