REGULATORY OBSERVATION

REGULATOR TO COMPLETE

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Observation title:	Steam Generator Code Provisions and Mitigation of Relevant Risks
Lead technical topic: 20. Structural Integrity	**Related technical topic(s):** 9. Fault Studies 12. Internal Hazards 13. Management of Safety Quality Assurance 14. Mechanical Engineering

Regulatory Observation

Background

The design, manufacture, inspection, testing, installation and proposed operation of nuclear island equipment for Fangchenggang Unit 3 (FCG-3), the reference plant for the UK HPR1000, are mainly based on the French codes/standards RCC-M 2007, RSE-M 2010 and 2012 Addendum (Ref. 2 and 3). However, General Nuclear Services Ltd (GNS), the requesting party (RP) for the UK HPR1000, is proposing that as with FCG-3, the SGs for the UK HPR1000 are designed and manufactured to the United States codes ASME III 2007 and 2008 Addendum (Ref.4), but with pre-service (PSI) and in-service inspection (ISI) to the rules of the French RSE-M code i.e. to use a combination of American and French codes/standards.

In Step 2 of the Generic Design Assessment (GDA) of UK HPR1000, ONR asked the RP to explain the basis of their proposals for the SG, and to justify how their selection of codes and standards to underpin the structural integrity case for the SGs, is commensurate with reducing risks so far as is reasonably practicable. For the purpose of this RO, the term as low as reasonably practicable (ALARP) is used for brevity (Refs 5 and 6). ONR emphasised that combining codes and standards incurs risks that need to be managed through-out the complete life cycle of the component. Similarly, alternative code options, to improve coherency and consistency may also incur risks.

In response, the RP initiated a high-level SG ALARP code assessment, and with input from an expert panel, considered four SG code options (Ref. 1):

- Option 1 – reference design (FCG3) with ASME III design plus additional requirements and RSE-M for PSI/ISI;
- Option 2 – reference design but ASME Section XI for PSI/ISI (design, manufacture, ISI to ASME);
- Option 3 – reference design but re-design to follow RCC-M/RSE-M (design, manufacture, ISI); and
- Option 4 – re-design a new SG following RCC-M/RSE-M (design, manufacture, ISI)

The RP concluded that as with the reference FCG-3 design, Option 1 was their preferred option for the UK HPR1000. This option includes supplementing full compliance with the ASME code for design and manufacture with additional measures from RCC-M and RSE-M.

ONR concluded that there is no evidence from Ref. 1 to suggest that Option 1 is derived from *'cherry picking'*; i.e. where selective and more lenient aspects of codes and standards are chosen with the resulting collective provisions potentially providing an inadequate basis to justify integrity. ONR therefore considers that Option 1 could be a viable SG code option for the UK HPR1000. Nonetheless, in reviewing Ref 1, ONR identified points to follow-up covering: the due process, management of risks; and specific design questions.

ONR was uncertain on the status of several actions raised during the RP's expert panels and hence the efficacy of the RP's proposed SG code option. ONR raised RQ-UKHPR1000-0219 to seek clarification of the completion of the RP's due process, and as a pre-requisite, to addressing the management of the risks (Ref. 7). ONR concluded that the SG code ALARP report has completed the GNS due process. This notwithstanding, the focus of the RP's response to RQ-0219 was a description of the quality assurance (QA) arrangements for the SG design and manufacture implemented in the reference plant (FCG-3), which are also proposed for the UK HPR1000. These QA arrangements were informed by practices developed for the SGs in the QingShan II, CNP650 nuclear power plant in China (SGs designed and manufactured to ASME III with RCCM/RSEM used for the remainder of the nuclear island equipment), which has successfully operated for about 16 years. However, the underlying philosophy in developing the QA arrangements and how they are intended to control and/or mitigate risks at the physical and organisational interfaces is not explained, nor is it clear how these arrangements would be adapted for a future UK licensee.

To illustrate, there are potential risks arising from, for example, the use of different QA systems during SG design, manufacture and plant construction, with attendant differences in the responsibilities of the organisations involved e.g. under ASME and RCC-M the 'owner' may have different responsibilities. For GDA, ONR considers there needs to be a basis for confidence that in the future, adequate control arrangements can be developed to secure achievement of the design intent and also that there are no significant 'gaps' in the organisational responsibilities during the SG design, manufacture, installation and operation.

Similarly, ONR is uncertain how the RP intends to address the impact of other potential risks, for example, the provisions for the examination, inspection maintenance and testing (EIMT) of the SG internals were excluded from the scope of the RP's high level ALARP assessment for SG code (Ref. 1). ONR is therefore unclear how the design intent is sustained through-life and what information the RP will provide in GDA to ensure the future licensee is able to maintain the UK HPR1000 SGs, and whether these are commensurate with reducing risks to ALARP e.g. sludge lancing arrangements.

Furthermore, the RP has classified the SG primary and secondary pressure boundaries as high integrity components (HIC), akin to a highest reliability claim in the UK (Ref. 8). Thus, irrespective of the preferred SG code option, there needs to be a sound basis for the development and future implementation of additional measures including: surveillance activities, and if appropriate, additional design, manufacture and inspection measures beyond the code provisions, to underpin a highest reliability claim. ONR is uncertain whether the RP has fully captured the scope of the additional measures expected to underpin their HIC claims for SG components, how these will be implemented , and how they intend to show that adequate control arrangements during design, manufacture, installation can be developed to support a future licensee.

A future licensee will also need to be cognisant of developments in both US and French codes and standards, and be aware of relevant operational experience. These are generic points, but are particularly important to the future design, manufacture and operation of the UKHPR1000 SGs.

ONR considers the current uncertainties relating to the adequacy of the RP's consideration of relevant risks relating to the SG code provisions and their mitigation represent potential shortfalls in the safety case for the UK HPR1000 SG. As this is setting a precedent in the UK for a component subject to a highest reliability claim, this Regulatory Observation (RO) is raised to:

- Articulate ONR's regulatory expectations;
- Gain further explanation and assurance in the RP's process and consideration of relevant risks relating to the SG code provisions.
- Ensure that the risks associated with the RP's preferred SG code ALARP option for the UK HPR1000 are reduced to ALARP.

Relevant Legislation, Standards and Guidance (Ref. 9)

SAP ECS.3 Codes and Standard

Structures, systems and components that are important to safety should be designed, manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected to the appropriate codes and standards.

ECS.3 paragraph 173

'The combining of different codes and standards for a single aspect of a structure, system or component should be avoided. Where this cannot be avoided, the combining of the codes and standards should be justified and their mutual compatibility demonstrated.'

Highest reliability components and structures, paragraph 286
Discounting gross failure of a component or structure is an onerous approach to constructing an adequate safety case. Cases following this approach should provide an in-depth explanation of the measures over and above normal practice that support and justify the claim that gross failures can be discounted.
EMC. 1 Safety case and assessment
The safety case should be especially robust and the corresponding assessment suitably demanding, in order that a properly informed engineering judgement can be made that:
(a) the metal component or structure is as defect-free as possible; and
(b) the metal component or structure is tolerant of defects.
EMC. 2 Use of scientific and technical issues
The safety case and its assessment should include a comprehensive examination of relevant scientific and technical issues, taking account of precedent when available.
EMC.3 Evidence
Evidence should be provided to demonstrate that the necessary level of integrity has been achieved for the most demanding situations identified in the safety case.
EMC.3 paragraph 295
To meet Principles EMC.1 and EMC.2, the safety case should include appropriate evidence including:

(a) the use of sound design concepts and proven design features;
(b) a detailed design loading specification covering normal operation, faults and accident conditions. This should include plant transients and internal and external hazards;
(c) consideration of potential in-service degradation mechanisms;
(d) analysis of the potential failure modes for all conditions arising from design specification loadings;
(e) use of proven materials;
(f) confirmatory testing to demonstrate that the parent materials and welds have the appropriate material properties, especially strength and the necessary resistance to fracture;
(g) application of high standards of manufacture, including manufacturing inspection and examination;
(h) high standards of quality management throughout all stages of design, procurement, manufacture, installation and operation (see also paragraph 207 on excluding foreign material);
(i) pre-service and in-service examination to detect and characterise defects at a stage before they could develop to cause gross failure;
(j) defined limits of operation (operating rules), supported as necessary by safety measures (eg overpressure protection).
EMC.4 Procedural control
Design, manufacture and installation activities should be subject to procedural control.
EMC.4 paragraph 302
Changes in design, manufacture and installation should be carefully controlled through a formal procedure for change. Communication and control of the effects of change across organisation or technical interfaces warrant particular attention.

Regulatory Expectations
In summary, ONR expectations for the SG code provisions for the UK HRP1000 is that a suitable and sufficient justification is provided to show that ONR expectations can be satisfied regarding:

i) The process and consideration of relevant risks.
ii) A demonstration that relevant risks associated with the RP's preferred SG code ALARP option for the UK HPR1000 are reduced to ALARP.
iii) The basis for the development, implementation and future control arrangements relating to the additional measures that will underpin a highest reliability claim for the UKHPR1000 SG.

The Regulatory Observatory Actions (ROAs) given below are structured in a way to enable provision of information by the RP in a logical manner, to inform ONR's assessment and the progression of the GDA.

References
[1] Generic Design Assessment for UK HPR1000, High level ALARP Assessment for SG Code, Rev B, (2018/279723).
[2] RCC-M. Design and Construction Rules for Mechanical Components of PWR Nuclear Islands. 2007 Edition. Published by the French Association for Design, Construction and In-Service Inspection Rules for Nuclear Island Components – AFCEN, Paris.
[3] RSE-M. In-Service Inspection Rules for Mechanical Components of PWR Nuclear Islands, RSE-M, 2010 edition+2012 addendum, 2010, 2012, AFCEN.
[4] ASME, American Society of Mechanical Engineers Codes, 2007 edition+2008 Addenda

[5] RQ-UKHPR1000-0030, Proposed Design and Construction Codes in the UK HPR1000 Structural Integrity Case, (2018/87899)
[6] RQ-UKHPR1000-0109, Proposed Design and Construction Codes in the UK HPR1000 Structural Integrity Case, (2018/198542)
[7] RQ-UKHPR1000-0219, High Level ALARP Assessment for SG Code – Due Process, (2019/118535)
[8] Generic Design Assessment for UK HPR1000, Equipment Structural Integrity List, GH X 30000 003 DOZJ 03 GN, Rev. D, 29 May 2018. (2018/184876).
[9] Safety Assessment Principles for Nuclear Facilities, 2014 edition. http://www.onr.org.uk/saps/index.htm

RO-UKHPR1000-033.A1 – Process for the consideration of SG code relevant risks.
In response to this ROA, the RP should provide:

- A further explanation of the process for identifying the SG code relevant risks, the topic areas considered and their significance in terms of ensuring the adequacy of the SG code provisions for the UK HPR1000. This should include, but not be limited to: physical interfaces/code juridictions, QA and organisational responsibilities, EIMT provsions, and the phyical/organisational arrangements to ensure that a highest reliability case for the high integrity components in the SG can be developed.

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-UKHPR1000-033.A2 – SG code provisions and mitigation of relevant risks The RP has classified the certain SG primary and secondary pressure boundary components as a high integrity components (HIC), akin to a highest relaibility claim in the UK. This is an onerous route to a safety justification, with the expecation of measures above and beyond normal practice i.e. in nuclear design codes and stanadards. Thus, as with other HIC components, there needs to be a sound basis for the development and future implementation of these additional measures to infer highest reliability: surveillance activities, and as appropriate, additional design, manufacture and inspection measures.

ONR considers that the response to this Action should include information on:

- the measures taken to eliminate or reduce SG code relevant risks to ALARP;
- the scope of the additional measures expected to underpin the HIC classification for SG components, along with how they will be implemented and controlled during design, manufacture, and installation to support a future licensee, and
- how the claims, arguments and evidence undepinning the RP's position and mitigation measures will be documented in the generic safety case.

In response to this ROA, the RP should provide:

- A demonstration that SG code relevant risks with the potential to affect the achievement of the design intent have been considered and that an adequate highest reliability claim for the UK HPR1000 SGs can be provided with relevant risks avoided, or reduced to ALARP.
- An explanation of the process for taking account of the impact of future changes in the design, manufacturing and inspection provisions of the proposed codes e.g. ASME III/XI and RCC-M/RSE-M, on the UK HPR1000 SGs, and how these will be captured in the safety case.

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:	