REGULATORY OBSERVATION

REGULATOR TO COMPLETE

RO unique no.:	RO-UKHPR1000-0022
Revision:	0
Date sent:	08/11/2019
Acknowledgement required by:	29/11/2019
Agreement of Resolution Plan Required by:	Date already agreed
TRIM Ref:	2019/206552
Related RQ / RO No. and TRIM Ref: (if any)**:**	RQ-UKHPR1000-0059, RQ-UKHPR1000-0373
Observation title: Design for Inspectability	Design for Access and Inspectability
Lead technical topic: 20. Structural Integrity	**Related technical topic(s):** 2. Civil Engineering 11. Human Factors 14. Mechanical Engineering 16. Radiological Protection

Regulatory Observation

Background

Access for Non-destructive Testing (NDT) and 'design for inspectability' are prominent nuclear safety considerations. Design for access and inspectability is a concept where the requirements for NDT are explicitly considered in the design of the item to be inspected. Reference designs that are submitted for a Generic Design Assessment (GDA) may not have anticipated this concept and it is expected that, where appropriate, design modifications will be considered to improve the performance of the inspection. The extent to which these modifications are considered will depend upon the structural integrity classification of the structure or component and the role of the NDT in assuring structural integrity (SI). The designer should take a balanced view such that any design modifications should not be to the detriment of the overall demonstration of SI.

It is expected that the concept of design for access and inspectability is applied to structures and components of all safety classes in a proportionate or risk informed manner, with the requirements for highest reliability (i.e. high integrity structures and components (HICs) in the Requesting Party's (RP's) SI classification scheme), being the most onerous. Since NDT plays an essential role in the avoidance of fracture case for HICs it is expected that the design provides conditions that promote a high level of reliability for the NDT.

Gaps present in the information presented in the RP's submissions (Ref. 1 and 2), along with the response to regulatory query (RQ) RQ-UKHPR1000-0059 (Ref. 3), have informed the development and need for this regulatory observation (RO).

Relevant Legislation, Standards and Guidance

In the UK, and in accordance with the need to reduce risks So Far as is Reasonably Practicable (SFAIRP) (or to As Low As Reasonably Practicable (ALARP)), ONR expects that, wherever practicable, new reactors are designed and built to maximise the effectiveness of NDT. In this regard the relevant safety assessment principles (SAPs) (Ref. 4 and 5) are:

- *EMC.8: Geometry and access arrangements should have regard to the need for examination.*
- *EMC. 13: Materials employed in manufacture and installation should be shown to be suitable for the purpose of enabling an adequate design to be manufactured, operated examined and maintained throughout the life of the facility.*

The SAPs also emphasise the important role in-service inspection (ISI) plays in confirming that a structure is free from significant defects:

- *EMC.27: Provision should be made for examination that is capable of demonstrating with suitable reliability that the component or structure has been manufactured to an appropriate standard and will be fit for purpose at all times during future operations.*

Regulatory Expectations

In GDA Step 2, raised several RQs relating to the RP's proposals for demonstrating high reliability NDT for HIC structures and components (Ref. 6 and 7). ONR also issued RQ-UKHPR1000-0059 to understand the RP's intentions during GDA for presenting its approach to design for access and inspectability for both HIC and non-HIC structures and components. In response, the RP indicated that '*inspectability had been fully considered during the design of components and welds, which were held to be designed to ensure the NDT feasibility at manufacturing and PSI/ISIS stages conserving the geometry and access arrangement.'* In addition, the RP identified a set of principles to facilitate the achievement of inspectability by ensuring:

- inspectability for the geometry (e.g. the slope changes, discontinuity and profile changes)
- sufficient access based on the NDT method (e.g. the distance of angle beam ultrasonic to give full volumetric coverage for thickness of welds)
- the surface condition of the inspection areas required by the NDT techniques (e.g. the roughness), and
- the access for NDT equipment and personnel.

The RP also committed to providing a review of access for the NDT of HIC welds. In GDA Step 3 the RP has described its approach to design for access and inspectability in two documents:

- Access and Inspectability Assessment. The focus of this document relates to ISI considerations for HIC welds (Ref. 1).
- Application of the Weld Ranking Procedure, Ref. 2. While not dedicated to design for access inspectability, this document contains the relevant information from which a judgement could be made as to the provisions made for the manufacturing NDT of HIC welds. It is noted that in the absence of a complete SI Equipment Classification List, this document is incomplete and so an updated version is expected to present the relevant information for all structures and components with a HIC classification.

In Reference 1, a key design for inspectability principle is stated: '*The basic design idea for inspectability is to fully consider the manufacturing inspections and PSI/ISI requirements during the component design, rather than making adjustments after the design has been completed*'.

ONR notes however, that in several cases there are significant impediments to the NDT, such as scanning restrictions and the RP's has not described what measures, if any, had been considered to improve the inspectability and why these had been discarded. Furthermore, the general criteria used to judge whether the UK HPR1000 Reference Design (Fangchenggang Unit 3 (FCG-3)) is adequate, with respect to NDT requirements, were not described. Consequently, ONR considers the RP has not provided an adequate justification of their claim that for UK HPR1000, access and inspectability has been fully addressed at the design stage. For example:

- The ISI of the reactor pressure vessel (RPV) upper dome to flange weld is to be performed from the external surface. It appears that lifting lugs fixed to the outside of the dome, and the change of section on the flange, will restrict the application of probes to the external surface. The RP does not describe what consideration has been given to deploying probes from the inner surface during the ISI (Ref. 1).
- The RP does not describe what measures are taken, if any, to ensure that the ultrasonic attenuation of stainless steel forgings is sufficiently low (Ref. 1 and 2).
- The surface condition of the cladding (machined, ground, or as-clad) is not described (Ref. 1 and 2).
- There does not appear to be a consideration of the position of the weld counterbores for the main coolant line (MCL). In particular, the presence of a counterbore region will restrict the coverage of the inspection volume for the RPV safe-end to MCL weld from the inner surface. In this case it is not clear if improvements were considered in, for instance, moving the position of the counterbores. Furthermore, the counterbore could return ultrasonic signals that would interfere with the interpretation of defect signals (Ref. 1 and 2).
- Where probes are deployed from the external surface of the MCL there were significant scanning limitations arising from a change of section or the presence of an elbow. These would impede the inspection for both longitudinal and transverse defects and it was not clear as to what design

improvements had been considered or could be made (Ref. 1 and 2).

The above listing is not intended to be exhaustive; rather it serves as a means to highlight some potential shortfalls relating to the achievement of design for access and inspectability for UK HPR1000, which ONR has identified in the RP's submissions made to date. The salient point is that the provisions for access and 'design for inspectability' for UK HPR1000 should be commensurate with reducing risks to ALARP and that for GDA, this demonstration needs to be made in the generic safety case.

Overall, ONR's assessment of Refs. 1 and 2 has concluded that these submissions, in themselves, do not provide sufficient confidence that the requirements for manufacturing and in-service NDT have been adequately considered in the design of the UKHPR1000. ONR considers there is currently a gap between the approach that is presented by the RP and ONR's expectations. Consequently, ONR is seeking to resolve the matter through the issue of this RO. This RO has therefore been raised to:

- Explain ONR's regulatory expectations regarding the design for inspectability;
- gain confidence that adequate evidence will be provided by the RP to support the claims and arguments made regarding design for inspectability; and
- assist ONR's judgement whether the UKHPR1000 generic design has, wherever reasonably practicable, adopted measures to enhance the reliability of the NDT.

The Regulatory Observation Actions (ROAs) given below are therefore structured in such a way to enable the above information to be provided in a logical and step-wise manner, to facilitate ONR's assessment as GDA progresses.

References

1. Generic Design Assessment for UK HPR1000, Access and Inspectability Assessment. GHX00100044DPCH03GN, Revision B, 23/04/2019,(2019/133136)
2. Generic Design Assessment for UK HPR1000, Application of Weld Ranking Procedure, GHX00100005DPCH03GN, Revision D, 2019, (2019/94204).
3. RQ-UKHPR1000-0059 Access for Non Destructive Testing & 'Design for Inspectability' for the UK HP1000 Reactor, (2018/122781).
4. Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 0, ONR, November 2014.
5. ONR Technical Assessment Guide (TAG): NS-TAST-GD-016, Integrity of Metal Components and Structures, Revision 5, March 2017.
6. RQ-UKHPR1000-0057, Plan for High Reliability NDT of High Integrity Components in the UK HP1000 Reactor, (2018/122772).
7. RQ-UKHPR1000-0058, Inspection Qualification Strategy for the NDT of High Integrity Components for the UK HP1000 Reactor, (2018/122774).

Regulatory Observation Actions

RO-UKHPR1000-0022.A1 – Considerations to enhance the reliability of NDT for high integrity components in UK HPR1000

In response to this ROA action, the RP should:

- explain the approach/method that will be adopted to enhance the manufacuring and PSI/ISI NDT for HIC structures and components.
- explain what measures (i.e. options) have been considered to date to enhance the reliability of the NDT and the basis for their selection or rejection in the UK HPR1000 Reference Design;
- consider what additional reasonably practicable measures (i.e. options), including potential design changes, could be incorporated into the UK HPR1000 generic design, to further improve the reliabilityof the NDT;
- provide a proportionate, robust demonstration that the provisions for access and 'design for inspectability' for high integrity components in UK HPR1000 reduces risks to ALARP; and
- explain how the approach and its implementattion will be documented in the safety case for the UK HPR1000.

The response should include both manufacturing NDT and PSI/ISI and take cognisance of relevant information provided in response to regulatory queries e.g. RQ-UKHPR1000-0059 and RQ-UKHPR1000-0357.

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

RO-UKHPR1000-0022.A2 – Considerations to enhance the reliability of NDT for non-high integrity components in UK HPR1000

In response to this ROA, the RP should provide :

- the approach/method that will be adopted to enhance the manufacuring and PSI/ISI NDT for non-HICs. It is expected that measures will be considered on a risk informed basis that are proportionate to the structural integrity classification of the structure or component and the role of the NDT in assuring the integrity, with the emphasis placed on structures and components with significant structural integrity classsifications.
- explain what measures (i.e. options) have been considered to date to enhance the reliability of the NDT and the basis for their selection or rejection in the UK HPR1000 Reference Design;
- consider what additional reasonably practicable measures (i.e. options), including potential design changes, could be incorporated into the UK HPR1000 generic design, to further improve the reliabilityof the NDT;
- using examples, apply the approach/method, to provide a proportionate, robust demonstration that the provisions for access and ‘design for inspectability’ for non-high integrity components in UK HPR1000 reduces risks to ALARP; and
- explain how the approach and its implementattion will be documented in the safety case for the UK HPR1000.

The response should include both manufacturing NDT and PSI/ISI and take cognisance of relevant information provided in response to regulatory queries e.g. RQ-UKHPR1000-0059 and RQ-UKHPR1000-0357.

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:	