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| <b>REGULATORY OBSERVATION Resolution Plan</b>  |  |       |                                  |     |                         |     |                          |     |                       |     |                         |
|--|--|-------|----------------------------------|-----|-------------------------|-----|--------------------------|-----|-----------------------|-----|-------------------------|
| <b>RO Unique No.:</b>  | RO-UKHPR1000-0022  |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>RO Title:</b>   | Design for Access and Inspectability   |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Technical Area(s)</b>   | Structural Integrity   |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Revision:</b>   | Rev 0  |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Overall RO Closure Date (Planned):</b>  | 31/03/2021   |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Linked RQ(s)</b>  | RQ-UKHPR1000-0059, RQ-UKHPR1000-0373   |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Linked RO(s)</b>  | -  |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Related Technical Area(s)</b>   | 2. Civil Engineering<br>11. Human Factors<br>14. Mechanical Engineering<br>16. Radiological Protection |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Other Related Documentation</b>   | -  |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <b>Scope of Work</b>   |  |       |                                  |     |                         |     |                          |     |                       |     |                         |
| <p><b><u>Background</u></b></p> <p>RO-UKHPR1000-0022 has been raised by the ONR in order to explain the Regulatory Expectations with regards to the design for access and inspectability, and to ensure that there is sufficient confidence that the requirements for manufacturing NDT and PSI/ISI have been adequately considered during the design of the UK HPR1000. The RP has already provided a review of the available access for the manufacturing NDT and PSI/ISI of HIC components for the UK HPR1000, in the documents '<b><i>Access and Inspectability Assessment</i></b>' (Ref.1) and '<b><i>Application of the Weld Ranking Procedure</i></b>' (Ref.2) during Step 3. However, the ONR has highlighted that these reports do not fully demonstrate that all reasonably practicable options have been considered as part of the design for inspectability.</p> <p><b><u>Abbreviations and Acronyms</u></b></p> <table> <tr> <td>ALARP</td> <td>As Low As Reasonably Practicable</td> </tr> <tr> <td>CSR</td> <td>Component Safety Report</td> </tr> <tr> <td>HIC</td> <td>High Integrity Component</td> </tr> <tr> <td>ISI</td> <td>In-Service Inspection</td> </tr> <tr> <td>NDT</td> <td>Non-Destructive Testing</td> </tr> </table> |  | ALARP | As Low As Reasonably Practicable | CSR | Component Safety Report | HIC | High Integrity Component | ISI | In-Service Inspection | NDT | Non-Destructive Testing |
| ALARP  | As Low As Reasonably Practicable   |       |                                  |     |                         |     |                          |     |                       |     |                         |
| CSR  | Component Safety Report  |       |                                  |     |                         |     |                          |     |                       |     |                         |
| HIC  | High Integrity Component   |       |                                  |     |                         |     |                          |     |                       |     |                         |
| ISI  | In-Service Inspection  |       |                                  |     |                         |     |                          |     |                       |     |                         |
| NDT  | Non-Destructive Testing  |       |                                  |     |                         |     |                          |     |                       |     |                         |

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|            |  |
|------------|--|
| ONR        | Office for Nuclear Regulation                        |
| PSI        | Pre-Service Inspection                               |
| RO         | Regulatory Observation                               |
| RP         | Requesting Party                                     |
| RQ         | Regulatory Query                                     |
| SI         | Structural Integrity                                 |
| SIC        | Structural Integrity Class                           |
| SSCs       | Structures, Systems and Components                   |
| UK HPR1000 | The UK Version of the Hua-long Pressurized Reactor   |
| UK         | United Kingdom of Great Britain and Northern Ireland |


### **Scope of work**

In accordance with the regulatory observation actions of RO-UKHPR1000-0022, and regulatory query RQ-UKHPR1000-0059 (Ref.3), the RP will provide additional detailed evidence to demonstrate that all reasonably practicable options have been considered for enhancing access and inspectability. The scope of work in this resolution plan covers the following aspects:

- 1) Design requirements and guidance for manufacturing NDT and PSI/ISI of safety significant metallic components and structures, specially focused on the HIC components.
- 2) A systematic review of access and inspectability for each HIC component, along with a sample of typical non-HIC components, in order to identify any potential shortfalls with regards to design for access and inspectability.
- 3) A review of any identified shortfalls in order to determine whether design changes to enhance access and inspectability are reasonably practicable.

On the basis of the documentation submitted during step 3 and planned step 4 submissions, and taking cognisance of the regulatory expectations, the following documents will be updated or produced to address this RO and satisfy ONR's regulatory expectations.

- 1) ***Design for Inspectability Requirements and Guidance of HIC Components***
- 2) ***Design for Inspectability Requirements and Guidance of Non-HIC Components***
- 3) ***Access and Inspectability Assessment (all HIC components and typical non-HIC components)***
- 4) ***Application of the Weld Ranking Procedure***

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**5) ALARP Justification Reports**

**6) Component Safety Reports**

This Resolution Plan describes the current plan to address RO-UKHPR1000-0022. However, as the work develops, it may be necessary to adjust or update this plan to align with the latest review schedule in agreement with the regulators.

**Deliverable Description**

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

The RO Action 1 states that:


*In response to this ROA, the RP should:*

- *explain the approach/method that will be adopted to enhance the manufacturing 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 reliability of 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 implementation will be documented in the safety case for the UK HPR1000.*

**Resolution Plan**

The structural integrity safety classification is a key factor when determining the requirements for access and inspectability of components. For HIC components, it is essential that there is good access and inspectability to facilitate manufacturing inspections, PSI and ISI in order to ensure components are free from structurally significant defects. For HIC components these requirements may exceed those required by code compliance alone because of the postulated consequences of gross failure in the absence of other physical defence in depth measures.

To address this ROA, the following three phases are described for the approach/method to enhance the reliability of NDT for HIC components, and the flowchart is shown in the Appendix A, which will be added in the document of '**Access and Inspectability Assessment**' to address the enhancement of access and

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inspectability.

### **Phase 1.1: Design Requirements and Guidance Relative to Access and Inspectability**

To evaluate whether the design of UK HPR1000 is adequate, with respect to NDT requirements, the RP will produce a new document titled '*Design for Inspectability Requirements and Guidance for HIC Components*'. This document will describe the general criteria to be considered as part of the design of HIC components in order to ensure there is adequate access and inspectability.


The main contents of this report will be as follows:

- a) The principles, goals and methodologies to be applied during the design of HIC components in order to ensure that there is adequate access and inspectability for manufacturing NDT and PSI/ISI.
- b) The general design requirements and guidance for types of NDT (visual testing, surface and volumetric testing).
- c) The special design requirements and guidance for HIC components, including:
  - The most likely inspection methods and techniques to be applied.
  - Any inspectability issues: inspection coverage, scanning surface, beam probes, manual or mechanized inspection, etc.
  - Any accessibility issues: required access (sufficient distances free from obstructions for inspection), adequate surface flatness or roughness, inspection personnel and equipment access, etc.

### **Phase 1.2: Access and Inspectability Assessment for Each HIC Components**

A systematic review will be carried out for each HIC component in order to assess the compliance with the principles, goals and methodologies defined in Phase 1.1. The results of this review will be presented in an update of the document '*Access and Inspectability Assessment*'. The main changes to this document will be as follows:

- a) Review the impacts or limitations of the current design with respect to NDT requirements, such as scanning restrictions or radiation protection.
- b) Review the measures and actions which have been considered as part of the design/fabrication or PSI/ISI, to enhance the reliability of NDT.
- c) Identify any potential access or inspectability problems or shortfalls, where there is a gap against the requirements and guidance defined in Phase 1.1.

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The document of '**Application of the Weld Ranking Procedure**' will be updated to present the relevant inspectability information for all HIC components based on the latest and complete SI Equipment Classification List. In addition, GDA technical justification reports of limiting HIC welds will also be produced in detail, to demonstrate that the design of welds enables relative good access and inspectability.

Therefore, the systematic review of the current design for HIC components will be documented in the development of '**Access and Inspectability Assessment**' and '**Application of the Weld Ranking Procedure**'.

### **Phase 1.3: Justification that the Potential Design Changes to Enhance the Reliability of NDT Reduces Risk to ALARP**

Where potential shortfalls are identified during Phase 1.2, options will be considered for improving access and inspectability in order to enhance the reliability of NDT. Potential options will be evaluated, taking account of the associated benefits and disbenefits, in order to determine whether it is reasonably practicable to modify the reference design.


The outcome of this optioneering and evaluation process will be documented in '**ALARP Justification Reports**' on a case by case basis, which will be submitted in step 4.

The main contents of the ALARP Justification Reports will be:

- a) Gap identification (potential shortfalls identified in phase 1.2).
- b) Option description (identification potential design changes).
- c) Option Comparison (review the benefits and disbenefits associated with each option).
- d) Evaluation of Options.
- e) Conclusion (justify whether it is reasonably practicable to change the design in order to enhance the reliability of NDT).

The RP has defined the relevant information in support of the concept of 'design for inspectability' as part of the document titled '**Safety Case Methodology of HIC and SIC components**' (Ref.4). Arguments and evidence are presented in support of sub-claim 1 (Good design and manufacture) and sub-claim 3 (Forewarning of failure). The objective of this document is to guide the designer to develop Component Safety Reports to demonstrate the structural integrity of Systems Structures & Components (SSCs), including HIC and SIC-1/SIC-2/SIC-3 components.

Each **Component Safety Report** for HIC components will be updated to include the output from Phases 1.1 to

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1.3 in order to clarify how the UK HPR1000 design facilitates access and inspectability of HIC components.

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

The RO Action 2 states that:

*In response to this ROA, the RP should provide:*

- *the approach/method that will be adopted to enhance the manufacturing 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 classifications.*
- *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 reliability of 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 implementation will be documented in the safety case for the UK HPR1000.*


**Resolution Plan**

For non-HIC components, the consequences of gross structural failure are less onerous and lines of protection are provided to reduce the level of risk. However, it is expected that the design will provide suitable access and facilitate inspections in line with the requirements of the relevant design and inspection codes in order to ensure the absence of structurally significant defects.

To address this ROA, the following three phases are described for the approach/method to enhance the reliability of NDT for non-HIC components, and the flowchart is shown in the Appendix A, which will be added in the document of '**Access and Inspectability Assessment**' to address the enhancement of access and inspectability.

**Phase 2.1: Design Requirements and Guidance Relative to Access and Inspectability**

To evaluate whether the design of UK HPR1000 is adequate, with respect to NDT requirements, the RP will

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produce a new document titled '***Design for Inspectability Requirements and Guidance for Non-HIC Components***'. This document will describe the criteria to be considered as part of the design of non-HIC components in order to ensure there is adequate access and inspectability.

The main contents of this report will be as follows:

- a) The principles, goals and methodologies to be applied during the design of non-HIC components in order to ensure that there is adequate access and inspectability for manufacturing NDT and PSI/ISI.
- b) The general design requirements and guidance for types of NDT (visual testing, surface and volumetric testing).
- c) The special design requirements and guidance for non-HIC components, including:
  - The most likely inspection methods and techniques to be applied.
  - Any inspectability issues: inspection coverage, scanning surface, beam probes, manual or mechanized inspection, etc.
  - Any accessibility issues: required access (sufficient distances free from obstructions for inspection), adequate surface flatness or roughness, inspection personnel and equipment access, etc.


### **Phase 2.2: Access and Inspectability Assessment for Typical Non-HIC Components**

In order to demonstrate the suitability of the guidance developed under Phase 2.1, the RP will carry out a systematic review of access and inspectability of a sample of typical non-HIC components. The typical non-HIC components to be assessed will be selected and sampled in accordance with the non-HIC components confirmed for CSR production. The results of this review will be presented in an update of the document of '***Access and Inspectability Assessment***', which can be related to the safety case for the non-HIC components in the UK HPR1000.

Non-HIC components will be subject to inspection as part of manufacture as well as PSI and ISI according to the requirements of the relevant design code. In practice, access and inspectability conditions during manufacturing NDT are better than those during PSI and ISI. For this reason, the RP proposes to only carry out a detailed inspectability assessment for PSI and ISI of typical non-HIC components against the guidance described in Phase 2.1.

### **Phase 2.3: Justification that the Potential Design Changes to Enhance the Reliability of NDT Reduces Risk to ALARP**

Where potential shortfalls are identified during Phase 2.2, options will be considered for improving access and

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inspectability in order to enhance the reliability of NDT. Potential options will be evaluated, taking account of the associated benefits and disbenefits, in order to determine whether it is reasonably practicable to modify the reference design.

The outcome of this optioneering and evaluation process will be documented in '**ALARP Justification Reports**' on a case by case basis, which will be submitted in step 4.

The main contents of the ALARP Justification Reports will be:

- a) Gap identification (potential shortfalls identified in phase 2.2).
- b) Option description (identification potential design changes).
- c) Option Comparison (review the benefits and disbenefits associated with each option).
- d) Evaluation of Options.
- e) Conclusion (justify whether it is reasonably practicable to change the design in order to enhance the reliability of NDT).

The RP has defined the relevant information in support of the concept of 'design for inspectability' as part of the document titled '**Safety Case Methodology of HIC and SIC components**'. Arguments and evidence are presented in support of sub-claim 1 (Good design and manufacture) and sub-claim 2 (Forewarning of failure). The objective of this document is to guide the designer to develop Component Safety Reports to demonstrate structural integrity of SSCs, including HIC and SIC-1/SIC-2/SIC-3 components.


Each '**Component Safety Report**' for typical non-HIC components will be updated to include the output from Phases 2.1 to 2.3 in order to clarify how the UK HPR1000 design facilitates access and inspectability of non-HIC components.


#### Impact on the GDA Submissions

The supporting submissions are involved in this resolution plan.

| GDA Submission Document   | Related ROAs | Planned schedule for submission |
|---|--------------|---------------------------------|
| Design for Inspectability Requirements and Guidance of HIC Components     | ROA1         | 31 <sup>st</sup> March 2020     |
| Design for Inspectability Requirements and Guidance of Non-HIC Components | ROA2         | 30 <sup>th</sup> April 2020     |



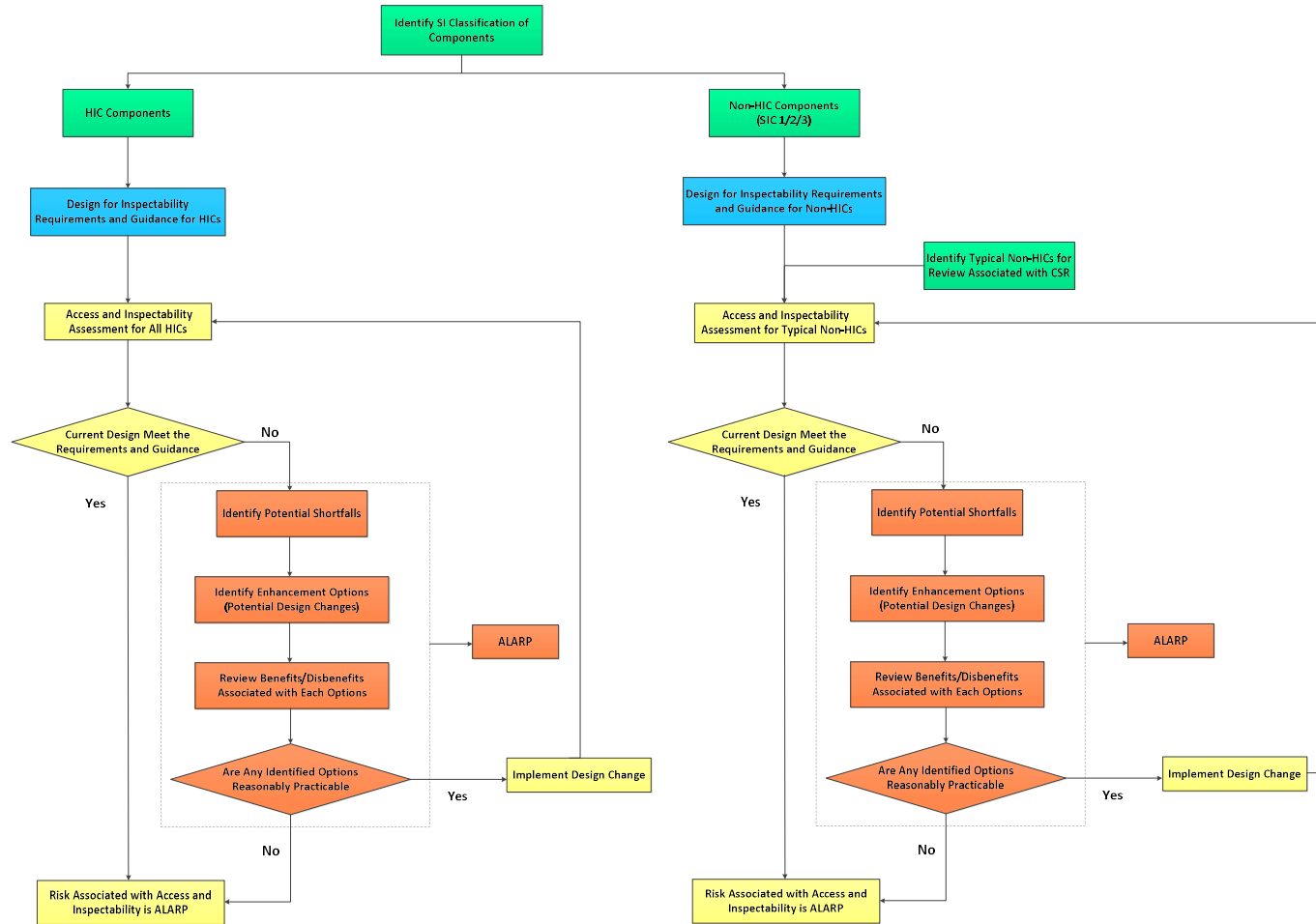
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| Application of the Weld Ranking Procedure (Updated)  | ROA1  | 29 <sup>th</sup> May 2020      |                    |              |
| Access and Inspectability Assessment (Rev.C, Updated for all HIC components)   | ROA1  | 31 <sup>st</sup> July 2020     |                    |              |
| Access and Inspectability Assessment (Rev.D, Updated for typical non-HIC components)   | ROA2  | 30 <sup>th</sup> October 2020  |                    |              |
| ALARP Justification Reports for HIC components   | ROA1  | 31 <sup>st</sup> August 2020   |                    |              |
| ALARP Justification Reports for non-HIC components   | ROA2  | 30 <sup>th</sup> November 2020 |                    |              |
| Component Safety Reports for HIC components (Updated)  | ROA1  | 31 <sup>st</sup> August 2020   |                    |              |
| Component Safety Reports for non-HIC components (Updated)  | ROA2  | 30 <sup>th</sup> November 2020 |                    |              |
| <b>Timetable and Milestone Programme Leading to the Deliverables</b>   |   |                                |                    |              |
| See attached Gantt Chart in APPENDIX B.  |   |                                |                    |              |
| <b>Reference</b>   |   |                                |                    |              |
| <p>[1] Generic Design Assessment for UK HPR1000, Access and Inspectability Assessment. GHX00100044DPCH03GN, Revision B, 23/04/2019,(2019/133136)</p> <p>[2] Generic Design Assessment for UK HPR1000, Application of Weld Ranking Procedure, GHX00100005DPCH03GN, Revision D, 2019, (2019/94204).</p> <p>[3] RQ-UKHPR1000-0059 Access for Non Destructive Testing &amp; 'Design for Inspectability' for the UK HP1000 Reactor, (2018/122781).</p> <p>[4] Safety Case Methodology for HIC and SIC Components, GHX00100001DPFJ44DS, Revision A, May. 2018.</p> |   |                                |                    |              |

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APPENDIX A Flowchart of Approach/Method to Enhance the Reliability of NDT



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APPENDIX B RO-UKHPR1000-0022 Gantt Chart

