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| **Rolls-Royce SMR RO Resolution Plan** |

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| RO unique Number: | RO-RRSMR-003 |
| RO Title: | Design Basis Maintenance Assumptions and Redundancy Requirements for Class 2 Safety Measures |
| Lead Technical topic: | Fault Studies |
| Related Technical topic(s): | Mechanical Engineering Electrical Engineering |

## Regulatory Observation

## Background

It is well established relevant good practice, in Design Basis Analysis (DBA), to assume the most limiting random single failure, together with losses consequential to the initiating event and the worst normally permitted plant configuration (including unavailability due to planned maintenance, test or repair). As such the DBA supports a demonstration that there are sufficient independent and redundant means to deliver safety functions.

Therefore, as part of the Generic Design Assessment (GDA), the Requesting Party (RP) is required to provide DBA which appropriately includes the unavailability of Structures, Systems and Components (SSC) due to planned maintenance, test or repair. Such analysis is required in order to demonstrate:

* the adequacy of the generic Rolls-Royce SMR design, in particular regarding the relationship between equipment redundancy and maintenance,
* that the scheduling of planned maintenance test or repair has been informed by, and appropriately included within, the safety analysis and engineering and
* that operating rules identified within the safety case account for planned maintenance, test or repair as appropriate.

Maintenance requirements identified during GDA will be a key input for any future licensee defining arrangements to ensure the on-going safe operation of the facility. ONR is therefore seeking to build confidence that the RP’s assumptions for planned maintenance, test or repair in the DBA meet UK regulatory expectations and are consistent with the relevant SSC’s design and engineering requirements.

The submissions received to date (Refs. [1] and [2]) do not provide sufficient confidence in this regard as they appear to present an inconsistent approach and only cover operating Modes 1 and 2.

Notably, following assessment in Step 2 and through Regulatory Queries (Refs. [3] and [4]), ONR has found that the RP has not provided sufficient detail regarding the DBA rules which cover assumptions of unavailability due to planned maintenance for all modes of operation. Furthermore, whilst it is clear the RP’s design principles for Class 1 SSCs require sufficient redundancy for planned maintenance activities (Ref. [5]), this is not the case for Class 2 SSCs and further clarity is required regarding when planned maintenance of Class 2 SSCs will be performed.

**Relevant Legislation, Standards and Guidance**

The guidance provided in this RO is based on ONR's Safety Assessment Principles (SAPs) (Ref. [6]) and Technical Assessment Guide (TAG) NS-TAST-GD-006 Issue 5.1 (Ref. [7]), which highlight the need to identify maintenance activities, and ensure that they are represented appropriately within the safety analysis.

These expectations are captured within the following relevant SAPs; FA.6, EMT.1, EMT.2, EMT. 5-7, ESS.2 and ESS.23.

**Regulatory Expectations**

From a deterministic fault studies perspective, it is ONR’s expectation (SAP FA.6) that the RP’s design basis fault sequences should include, as appropriate:

* The worst normally permitted configuration of equipment outages for maintenance; and
* The most onerous initial operating state within the inherent capacity of the facility permitted by the operating rules.

Therefore, facilities should include design provision for faults occurring in all planned operating modes and configurations, even if such a position would only exist for a short period of time or occur infrequently during the operational life of the facility (Ref. [7]). The effectiveness of this provision should be demonstrated through suitable DBA.

Based on the guidance outlined in SAP FA.6 (para 631) (Ref. [6]) and NS-TAST-GD-006 Issue 5.1 (Ref. [7]), ONR expects that the DBA includes appropriate consideration of equipment unavailability due to planned maintenance, test or repair activities. This should include relevant supporting systems (such as standby and alternate AC power sources for example) for both the principal and diverse means of protection. This expectation applies to all operational modes and the analysis of spent fuel pool cooling faults, and faults during refuelling, as well as at power reactor faults.

## Regulatory Observation Actions and Resolution Plan

**RO-RRSMR-003.A1 – Demonstrate that the assumptions of unavailability due to planned maintenance for all modes of operation used in DBA are consistent with regulatory expectations.**

ONR understands that the RP’s DBA rules assume there will be no planned maintenance of SSCs that would challenge delivery of safety functions during powered operations. Although a consistent approach is not presented in the RP’s documentation (Refs. [1] & [2])

Based on Refs. [1] and [3] it is ONR’s understanding that for reactor faults originating during Modes 1 and 2 there will be no SSCs that are unavailable due to planned maintenance. It therefore follows that maintenance of those SSCs (and the support systems required to ensure their availability or operability) will be undertaken during Modes 3 to 6, although the DBA rules which cover assumptions of unavailability in these modes of operation have not been presented.

In response to this Regulatory Observation Action, Rolls-Royce SMR Ltd should:

* Confirm (or otherwise) ONR’s understanding of the RP’s rules regarding assumptions of unavailability due to planned maintenance,
* Provide a complete set of DBA rules which cover assumptions of unavailability due to planned maintenance for all modes of operation,
* Confirm that assumptions made in the DBA will be implemented in the operating rules governing planned maintenance.

Resolution required by: To be determined by the Rolls-Royce SMR Ltd. Resolution Plan.

**Rolls-Royce SMR Ltd. Resolution Plan RO-RRSMR-003.A1**

The information required to provide the resolution of Actions 1 and 2 of this Regulatory Observation will be contained in a new report titled “Redundancy of Class 2 Systems during Planned Preventive Examination, Maintenance, Inspection and Testing” [19]. The report will be issued and submitted in a staged manner throughout Step 3 as the available information develops – this resolution plan outlines the staged update and submission of the report. An outline of the contents of the report is shown in Figure 1. Other documentation is referenced in this resolution plan where further information will be provided.

The application of the rule to avoid planned maintenance of Systems, Structures and Components (SSC)s during powered operation will be considered on a case-by-case basis depending on deterministic analysis. However, this is the design intent. For reactor faults originating during Modes 1 and 2 there will be no SSCs that are fully unavailable due to planned maintenance. There may be trains unavailable, but the system will be capable of delivering its safety function when taking into account single failure and consequential loss.

The key reference for the rules is the E3S Design Principles [10]. The next issue of the Design Basis Assessment Methodology report on 19/12/24 [11] and the next issue of the EMIT Strategy on 19/12/24 [12] will contain elaboration of these rules for clarity, as well as the new Redundancy of Class 2 Systems report [19] on 31/01/25.

The complete set of DBA rules which cover assumptions of unavailability due to planned maintenance for all modes of operation will be included in the next issue of the Design Basis Assessment Methodology report [11]. This is planned for submission on 19/12/24 and will confirm that states with a train unavailable due to planned maintenance will be analysed.

Where the DBA makes assumptions of unavailability due to planned maintenance, these assumptions will be implemented in the operating rules governing planned maintenance. This will be reported in Version 3 of Chapter 16 of the E3S case [15], in August 2025. An OLC Methodology Report [13] is being developed which will address the inclusion of these assumptions in the OLCs. The OLC methodology report will be submitted into GDA on 30/04/2025. In addition the new Class 2 Redundancy report [19] will discuss these assumptions.



**Figure 1 – Contents of Class 2 Redundancy Report**

The final Action RO-RRSMR-003.A1 submission will be on the 29/08/25 following issue of the E3S Case chapters.

**RO-RRSMR-003.A2 – Identify all Class 2 SSCs for which planned preventative maintenance may prevent delivery of safety functions**

In response to this Regulatory Observation Action, Rolls-Royce SMR Ltd should:

* Identify all Class 2 SSCs (including support systems, required to ensure availability or operability of said SSCs) that are claimed to deliver safety functions in the DBA fault sequences, and
* For each SSC identified in the previous bullet, determine whether planned maintenance activities could prevent delivery of safety functions (when other relevant design basis assumptions, such as single failure and consequential loss, are applied).

Resolution required by: To be determined by the Rolls-Royce SMR Ltd. Resolution Plan.

**Rolls-Royce SMR Ltd. Resolution Plan** **RO-RRSMR-003.A2**

All classified SSCs are claimed to deliver safety functions in the DBA fault sequences, including Class 2 SSCs.

In August 2025, Chapter 3 of the E3S Case [11] will be updated to include a populated list of the nuclear safety classification of all items of SSCs making up the power station. The development of this is being informed by existing classification of SSC, which is reported in the Safety Measure Design Descriptions (SMDD) for safety measures and System Design Definitions (SDDs) for SSC. This facilitates the identification of all classified SSC, including Class 2 SSC, in support of the first part of this action.

In addition, a new issue Categorisation and Classification report [16] will be produced at tier 2 of the E3S Case, which will summarise the application of the nuclear safety categorisation and classification methodology. This will include a listing of all Class 1, 2 and 3 SSC, along with rationale for the classification.

The cases in which planned maintenance of classified SSC could affect delivery of safety functions is being carried out by reviewing the Fault Schedule and SMDDs. The output of this exercise will be reported in the new Redundancy of Class 2 systems report, at its first issue on 31/01/25. This includes but is not limited to Class 2 SSC – for example, where Class 3 SSC are claimed to support safety functions with decreasing categorisation over time.

The final Action RO-RRSMR-003.A2 submission will be completed on 31/01/25, with the required information provided in the first issue of [14].

**RO-RRSMR-003.A3: Clarify the implications of the generic Rolls-Royce SMR’s design (with regards to the provision of redundancy) on the maintenance strategy**

In response to this Regulatory Observation Action, Rolls-Royce SMR Ltd should:

* For those SSCs identified in Action 2, for which planned maintenance activities may prevent delivery of safety functions, explain:
1. How the design (with regards to the provision of redundancy) has informed the development of a maintenance strategy, and how maintenance requirements have informed the provision of redundancy,
2. When planned maintenance, test or repair activities will be undertaken (i.e., in which operating states),
3. What operating constraints will be necessary to ensure adequate availability of SSCs (Operating Rules, temporary equipment etc.).

Resolution required by: To be determined by the Rolls-Royce SMR Ltd Resolution Plan

**Rolls-Royce SMR Ltd. Resolution Plan RO-RRSMR-003.A3**

To further explain how the design is informed by and informs the development of a maintenance strategy, and how maintenance requirements have informed the provision of redundancy, Rolls-Royce SMR Ltd. will provide an update to the EMIT Strategy on 19/12/24 [12]. The EMIT Strategy will then be updated on 07/07/25 [17], and this update will include examples of how and where maintenance requirements have informed provision of redundancy.

In addition, an On-Line Maintenance Guide [14] will be developed in mid-2025, which will record the approach to justifying SSC design, reliability and availability performance, with respect to redundancy and EMIT unavailability. Once the issue date of this document is confirmed it will be communicated via the GDA Deliverables Schedule.

Where operating constraints will be necessary to ensure adequate availability of SSC, these will be the responsibility of the licensee to set. However, they will be identified through the application of the OLM Guide [14], and they will be informed by the OLC minimum availability requirements. OLCs will be reported in tier 3 of the E3S Case, as discussed in the response to RQ-01245 [20].

The Through-Life Activities Modules/datasheets will identify the EMIT task (scope, interval and required resources), and these will be delivered as part of the SDS documents. The E3S Case Deliverables Plan [18] lists the submission dates for the SDS documents.

In addition to the above, the new Class 2 Redundancy report [19] will discuss operating constraints implemented as a result of reduced redundancy during maintenance, including the applicable modes of operation under which maintenance will be conducted.

Action RO-RRSMR-003.A3 will be closed on 29/08/25, at which time all supporting documentation including the E3S case chapters update will have been issued.

**RO-RRSMR-003.A4: Present the safety justification that the design of the generic Rolls-Royce SMR provides sufficient redundancy in Class 2 SSCs to adequately support the requirement for planned maintenance activities**

In response to this Regulatory Observation Action, Rolls-Royce SMR Ltd should:

For those SSCs identified in Action 2, for which planned maintenance activities may challenge the redundancy required to deliver safety functions, provide a demonstration that the design reduces risks associated with the Rolls-Royce SMR design ALARP. Further guidance on ONR’s expectations can be found in Appendix 5 of [7].

The information provided should enable ONR to judge whether a suitable and sufficient safety case has been constructed for these aspects of the design, that meets UK regulatory expectations.

Resolution required by: To be determined by the Rolls-Royce SMR Ltd. Resolution Plan.

**Rolls-Royce SMR Ltd. Resolution Plan RO-RRSMR-003.A4**

Demonstration that each case is ALARP will be provided in the new Class 2 Redundancy report on 28/08/25. This will provide a specific discussion focusing on cases where planned maintenance activities could challenge the redundancy required to deliver safety functions. The ALARP justification will draw on all of the elements discussed for the previous actions, including deterministic and probabilistic analysis where appropriate as well as other aspects of ALARP justification as required, such as disproportionality of risk and RGP.

The provision of redundancy during maintenance from a fault-by-fault perspective will be summarised in chapter 24 of the E3S Case [15], and will refer to Chapter 15, Safety Analysis. The next issue of the E3S Case chapters [15] is scheduled for 28/08/25. The discussion provided in the E3S Case chapters will provide the fault-view of redundancy, with the systems-view provided in the documentation referred to under Actions 2 and 3.

A timeline of the activities to be undertaken and the submission of documents in support of this is indicated in Schedule 1, below.

In addition to the above, maintenance schedules will be developed as the design of the power station progresses. This is expected before the end of 2026, and so may not be available for assessment within GDA. However, these will be developed in line with the strategies and guidance which will be available for assessment as detailed within this resolution plan.

## Schedule 1



The final Action RO-RRSMR-003.A4 submission will be made on 29/08/25, following issue 2 of [16] and the issue of the updated E3S case chapters.

## Impacted Submissions

The table below lists the submissions that will be impacted through resolution of this RO, and how they will be impacted.

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| **Existing Submissions (or Submissions Already Planned)** | **Impact** |
| SMR0012935: Plant Performance Analysis Methodology for Reactor and Fuel Handling Pond Design Basis Faults. Issue 1, to be submitted 19/12/2024. | This document will contain elaboration of the relevant deterministic rules, as part of the closure of Action A1. |
| SMR0009111: RR SMR Examination, Maintenance, Inspection and Testing Strategy. Issue 2, to be submitted 19/12/2024. | This document will contain elaboration of the relevant deterministic rules, as part of the closure of Action A1. |
| Operating Limits and Conditions Methodology. Issue 1, to be issued 30/04/2025. | Assumptions of unavailability due to planned maintenance will be implemented in the operating rules governing planned maintenance. This document will describe the process for the inclusion of these assumptions in the OLCs. |
| On-Line Maintenance Guide. Issue 1, to be issued. | This document will record the approach to justifying SSC design, reliability and availability performance, with respect to redundancy and EMIT unavailability. |
| E3S Case. Version 3, to be submitted 28/08/2025. | Chapter 16 will report implementation of assumptions of unavailability in the operating rules governing planned maintenance.Chapter 3 will include a list of classified SSC, and their classification.Chapter 24 (with reference to Chapter 15) will summarise the provision of redundancy during maintenance from a fault-by-fault perspective. |
| Categorisation and Classification Summary. Issue 1, to be submitted 30/04/2025. | This will identify Class 2 and Class 3 SSC, to inform the identification of SSC which fall within the scope of this RO. |
| SMR0009111: RR SMR Examination, Maintenance, Inspection and Testing Strategy. Issue 3, to be submitted 07/07/2025. | This update will include examples of how and where maintenance requirements have informed provision of redundancy. |

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| **New Submission** | **Impact** |
| SMR0014176: Redundancy of Class 2 Systems during Planned Preventive Examination, Maintenance, Inspection and Testing. To be issued. | New submission to identify and provide a listing of SSC which fall within the scope of this RO. |

## References

[1] Rolls-Royce SMR, Reactor Plant Performance Design Basis Analysis Methodology, SMR0006250 Issue 2.

[2] Rolls-Royce SMR, EMIT Strategy (Examination, Maintenance, Inspection and Testing), SMR00091111 Issue 1.

[3] RQ-01081 – Full Response.

[4] RQ-01168 – Full Response.

[5] Rolls-Royce SMR, Environment, Safety, Security and Safeguards Design Principles, SMR0001603 Issue 1.

[6] ONR, Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 1, January 2020.

[7] ONR, Design Basis Analysis, NS-TAST-GD-006 Issue 5.1Rolls-Royce SMR, Reactor Plant Performance Design Basis Analysis Methodology, SMR0006250 Issue 2.

[8] Rolls-Royce SMR, EMIT Strategy (Examination, Maintenance, Inspection and Testing), SMR00091111 Issue 1.

[9] Rolls-Royce SMR, Environment, Safety, Security and Safeguards Design Principles, SMR0001603 Issue 1.

[10] SMR0001603: Rolls-Royce SMR Environment, Safety, Security and Safeguards Design Principles. Issue 2, July 2024.

[11] SMR0012935: Plant Performance Analysis Methodology for Reactor and Fuel Handling Pond Design Basis Faults. Issue 1, to be submitted 19/12/2024.

[12] SMR0009111: RR SMR Examination, Maintenance, Inspection and Testing Strategy. Issue 2, to be submitted 19/12/2024.

[13] Operating Limits and Conditions Methodology. Issue 1, to be issued 30/04/2025.

[14] On-Line Maintenance Guide. Issue 1, to be issued.

[15] E3S Case. Version 3, to be submitted 28/08/2025.

[16] Categorisation and Classification Summary. Issue 1, to be submitted 30/04/2025.

[17] SMR0009111: RR SMR Examination, Maintenance, Inspection and Testing Strategy. Issue 3, to be submitted 07/07/2025.

[18] SMR0011012: E3S Case Deliverables Plan. Issue 3, May 2024.

[19] SMR0014176: Redundancy of Class 2 Systems during Planned Preventive Examination, Maintenance, Inspection and Testing. To be issued.

[20] SMR0010214: RQ-01245 Full Response – Operational Limits and Conditions. Issue 1, March 2024.

## Record of Change

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| --- | --- | --- |
| **Date** | **Revision Number** | **Reason for Change** |
| 03/12/2024 | 1 | Issue of resolution plan |
| 13/12/2024 | 2 | Revised following accessibility and publishability checks and to ensure consistency with other resolution plan documents. |
| 24/01/2025 | 3 | Revised to correct an editorial error. |
| 29/01/2025 | 4 | Revised to reflect correct issue dates of submissions. |
| 15/07/2025 | 5 | Format and consistency update and alignment |

## Approvals

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Author | Sign | Print  | Role | Date  |
| See Teamcenter | {REDACTED} | {REDACTED} | See Teamcenter |
| Reviewer | Sign | Print | Role | Date |
| See Teamcenter | {REDACTED} | {REDACTED} | See Teamcenter |
|  | **Sign** | **Print**  | **Role** | **Date**  |
| Approver | See Teamcenter | {REDACTED} | {REDACTED} | See Teamcenter |