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

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| RO Unique Number: | RO-RRSMR-002 |
| RO Title: | PSA Project Plan and Integration |
| Lead Technical Topic: | Probabilistic Safety Assessment |
| Related Technical Topic(s) | External Hazards  Fault Studies  Internal Hazards  Radiological Consequences  Severe Accident Analysis |

## Background

The Generic Design Assessment (GDA) of the Rolls-Royce SMR Ltd.’s Small Modular Reactor (SMR) started in April 2022. The Rolls-Royce SMR design is currently mid-way through Step 2 of the GDA.

The Rolls-Royce SMR design is being developed through a safety-informed, systems engineering approach. Probabilistic Safety Assessment (PSA) is being carried out on the design to support the claim that “the safety analysis has informed the Rolls-Royce SMR design to provide suitable and sufficient levels of defence-in-depth to deliver the Fundamental Safety Functions and reduce nuclear safety risks to workers and the public”.

Information submitted to date has not provided sufficient confidence to the Office of Nuclear Regulation (ONR) in the progress and scope of the PSA topic; particularly in relation to the PSA Development Strategy (SMR0004735, Issue 1) which was produced earlier in the year and has since been reviewed by the regulator.

The ONR have therefore highlighted a number of areas for improvement, in the form of four Actions in Regulatory Observation RO-RRSMR-002. This Resolution Plan sets out how Rolls-Royce SMR Ltd. intend to respond to these actions. The information provided as part of completion of this resolution plan will be assessed by ONR to determine whether it is sufficient to address these actions and close out the Regulatory Observation (RO).

### Related RO and Resolution Plan

The ONR have raised RO-RRSMR-001 (SMR0008156) on the Environmental, Safety, Security and Safeguards (E3S) Case. In response to that RO, Rolls-Royce SMR Ltd. will submit three overarching documents that will collectively describe the set of arrangements for how the generic E3S Case has been developed, and is being further developed, and managed to support the evolving design, for the remainder of GDA Step 2 and Step 3. These three documents are the:

* Regulatory Affairs Functional Manual
* E3S Case Development and Management Arrangements
* E3S Requirements and Analysis Arrangements

These documents will encompass a suite of relevant information that has previously been shared with the regulators through GDA submissions during Step 1 and Step 2 to date. They will also incorporate information that has been shared through Regulatory Engagements. Additional information from ongoing work will also be incorporated into each document to provide further clarity and evidence for resolution of Action 1 of RO-RRSMR-001.

The submissions produced by Rolls-Royce SMR Ltd. to support that E3S RO will provide the procedural framework in which the resolution to this PSA RO takes place. However, the close out of the two ROs are not dependent on each other.

### Independent Peer Review

It is noted that the Independent Peer Review (IPR) function of Rolls-Royce SMR Ltd. is now in operation and a sample of the PSA documents being produced by the Rolls-Royce SMR Ltd. will go through this process. While at this stage, the IPR activities are performed in parallel with submissions of information to the regulator. Over time this function will take a stronger role in providing the internal validation of the work produced by the PSA topic, before it is submitted to the ONR. IPR does not impact this resolution plan specifically but does provide confidence that Rolls-Royce SMR Ltd. are developing their internal assurance capability and that these do, and will, apply to the PSA topic.

## Regulatory Observation Actions and Resolution Plans

**ONR Regulatory Observation Action RO-RRSMR-002.A1 – PSA Project Plan**

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

* *Provide a Rolls-Royce SMR PSA project plan to cover GDA. This should include the following:*
  + *A detailed scope for the PSA for the totality of the three step GDA it has asked the regulators to undertake, including a clear statement of any exclusions, including aspects that would be developed post-GDA.*
  + *A complete list of the PSA objectives, applications and definition of the requirements of the PSA to fulfil these.*
  + *The identification and justification of the computer code(s) that will be used for the Level 1, Level 2 and Level 3 PSA Rolls-Royce SMR PSA (including supporting calculations).*
  + *Clarity on the expected scope of the hazards PSA, including how PSA hazards screening will inform the rest of the hazards scope of work.*
  + *Clarity on how the radiological risks to on-site workers will be evaluated.*
  + *Clarity on which radioactive materials (e.g. nuclear fuel, nuclear waste etc.) and locations (reactor, fuel handling, fuel storage etc.) will be considered in the PSA.*
  + *Definition of the PSA tasks required to be completed during GDA (including the tasks already completed or ongoing).*
  + *Identification of the various procedures, PSA models and reports which will be produced or updated during the development of the Rolls-Royce SMR PSA, for all the PSA tasks and PSA applications.*
  + *A detailed work programme including all planned deliverables. This should identify which design reference points (DRP) will be modelled and how any gap between the final GDA DRP and the final GDA PSA will be managed. The human resources required to deliver this programme should also be identified.*

**Rolls-Royce SMR Ltd. Resolution Plan for RO-RRSMR-002.A1**

The response to this action will be fulfilled through information provided in three documents:

1. The existing **Rolls-Royce SMR PSA Development Strategy (SMR0004735)** will be updated (Issue 2) and submitted on 5th January 2023 to include information in relation to:

* A detailed scope for the PSA for the totality of the three step GDA, including a clear statement of any exclusions, including aspects that would be developed post-GDA.
* A complete list of the PSA objectives, applications and definition of the requirements of the PSA to fulfil these.
* Clarity on how the radiological risks to on-site workers will be evaluated.
* Clarity on which radioactive materials (e.g. nuclear fuel, nuclear waste etc.) and locations (reactor, fuel handling, fuel storage etc.) will be considered in the PSA.
* A brief summary on the scope of hazards PSA with reference out to the Rolls-Royce SMR PSA Hazard Event Modelling Methodology.

The Rolls-Royce SMR PSA Hazard Event Modelling Methodology which is being produced, and Issue 1 is due to be submitted on 15th December 2023, will include information in relation to:

* Details on the scope of the hazards PSA, including how PSA hazards screening will inform the rest of the hazards scope of work.

1. A new supporting **PSA Procedure** will be produced by Rolls-Royce SMR Ltd. (the title and content will be consistent with the procedures for the other disciplines). This new procedure will ensure consistency across Rolls-Royce SMR Ltd.’s governance arrangements and will refer to, and draw upon, previous submissions made under the PSA topic area. This procedure will sit under the hierarchy of E3S arrangements as discussed above and as covered within the Resolution Plan to RO-RRSMR-001 (SMR0008156). Delivery of the PSA activities will follow generic E3S arrangements where they are applicable, with the PSA Procedure providing PSA-specific arrangements required for the delivery and governance of PSA activities.

This supporting procedure for PSA will include:

* PSA specific activities, required in addition to the E3S arrangements, that support the delivery of all PSA tasks, plus highlight any further PSA-specific activities which will be produced or updated during the rest of the development of the Rolls-Royce SMR PSA design for GDA.
* The identification and justification of the computer code(s) that are being used for the Level 1, Level 2 and Level 3 Rolls-Royce SMR PSA (including supporting calculations). Noting that this may require reference out to the documentation of other topics, notably Severe Accidents and Radiological Consequences for some of these codes and calculations.

Issue 1 of this supporting PSA Procedure will be submitted on 26th April 2024, noting that as it is used, the supporting procedure will be updated to incorporate lessons learned and as the topic develops. It is the aim that Issue 1 will provide sufficient information to support ONR’s close out of this action. An Issue 2 of this procedure will be produced late in 2024 to capture learning and ensure that it remains fit for purpose but this does not form part of this resolution plan.

1. While the updated PSA Strategy document, as described in (1) above, will provide an overview of the totality of PSA activities being undertaken, Rolls-Royce SMR Ltd. will produce a **GDA Step 3 PSA Scope and Submission Plan** to provide detail of the PSA work and submissions specifically being undertaken and delivered to support completion of the GDA. This new GDA Step 3 PSA Scope and Submission Plan will provide:

* Definition of the PSA tasks that will be completed during GDA Step 3 (including any tasks already ongoing).
* Identification of the PSA models and reports which will be produced or updated during the development of the Rolls-Royce SMR PSA, for all the PSA tasks and PSA applications.
* An outline work programme including all planned deliverables. This will also identify which design reference points (DRP) will be modelled and how any gap between the final GDA DRP and the final GDA PSA will be managed. The human resources required to deliver this programme will also be identified.

Some high-level discussions on PSA activities and dependencies has already started and detailed Step 3 GDA planning will commence from November 2023. To answer the questions pertaining to this RO, a Rolls-Royce SMR GDA Step 3 PSA Scope and Submission Plan will be provided at Issue 1 on the 31st May 2024 ahead of the start of GDA Step 3 in support of Step 3 readiness.

The three documents will be submitted to the regulators in accordance with the plan in Schedule 1.

**ONR Regulatory Observation RO-RRSMR-002.A2: PSA Quality Assurance Plan and quality assurance procedures**

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

* *Submit to ONR the relevant Rolls-Royce SMR PSA QA plans and procedures that detail the necessary level of QA for each PSA task, including those that require involvement of other departments.*

**Rolls-Royce SMR Ltd. Resolution Plan for RO-RRSMR-002.A2**

The supporting PSA Procedure as set out above in response to Action 1 will include processes and activities for managing the quality assurance of the PSA work performed by Rolls-Royce SMR Ltd.

In addition, Rolls-Royce SMR Ltd. will produce a PSA Quality Assurance Plan. This will be submitted to the ONR along with the procedure on 26th April 2024 along with the procedure and in accordance with the plan in Schedule 1.

**ONR Regulatory Observation Action RO-RRSMR-002.A3: Integration of PSA into the wider safety case**

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

* *Demonstrate how the PSA is integrated into the wider safety case, including the analysis and engineering disciplines. This should highlight both inputs to the PSA (e.g. claims related to transient analysis, performance analysis, human reliability analysis) and where evidence from the PSA will be used to support the safety case (e.g. Optioneering reviews, demonstration of a balanced design etc.) in line with the expectations of Technical Assessment Guide 30 on PSA.*
* *Set out how the PSA will [be] used to inform, complement, support and strengthen the demonstrations across the safety case that radiological risks have been reduced ALARP in the design.*

**Rolls-Royce SMR Ltd. Resolution Plan for RO-RRSMR-002.A3**

The processes through which integration of the PSA topic into the wider safety case will be provided at a higher level (along with the other safety analysis topics) in the governance document ‘E3S Requirements and Analysis Arrangements’ as described in the Background section above. The supporting PSA Procedure, the timeline for its production having been discussed above, will then provide the processes as to how PSA interacts with the E3S Case. This is expected to include:

* Support to and influencing the design (see Resolution Plan response to Action 4 below).
* Requirements setting.
* Use of PSA to review and support the overall ALARP position.
* Interaction with Deterministic Safety Analysis.
* Provision of input to Severe Accident case (from the Level 2 PSA).
* Input to the assessment against Rolls-Royce SMR Numerical Targets 5 – 9 through the use of Level 2 and Level 3 PSA.
* Interaction with the Internal Hazards case.
* Input to the derivation of Examination, Inspection, Maintenance and Testing (EIMT) requirements.
* Use of Human Factors information to inform Human Reliability Assessment (HRA) and then results of PSA informing Human Factors.
* Informing the development of Emergency Arrangements.

It should be noted that within Step 2, not all elements as to where PSA supports the overall case will have been completed. However, the outcome of the interaction of PSA with the wider E3S Case at Step 2 will be presented within the following documents:

* PSA Main Report to be delivered 5th January 2024.
* ALARP Summary Report to be delivered 26th January 2024.
* E3S Case Tier 1 Chapters Issue 2 to be delivered May 2024.

**ONR Regulatory Observation Action RO-RRSMR-002.A4: Integration of PSA into the design**

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

* *Demonstrate how the PSA is integrated into the development of the generic design. The criteria for when PSA should be used, and when it is justified for it not to be used, should be clearly laid out.*

**Rolls-Royce SMR Ltd. Resolution Plan for RO-RRSMR-002.A4**

PSA is already integrated into Rolls-Royce SMR Ltd.’s design development processes as detailed in the Rolls-Royce SMR Ltd.’s Integrated Management System (IMS), with PSA being a fundamental part of the design optioneering process.

In order to close out this action, Rolls-Royce SMR Ltd. will provide:

* Information on the processes in the IMS which require PSA to be part of the design process.
* A sample of evidence of where PSA has been integrated into design decisions and Gate Reviews for the systems designs. This will include examples of where PSA has been used and not used to support design decisions to date.
* Clarify within the supporting PSA procedure (as detailed on Action 1 above) on the format and likely content of information that shall be by the PSA team to the designers going forward to further strengthen the integration of PSA into the design.

The outcome of the interaction of PSA into the design at Step 2 will be presented within the following documents:

* Relevant IMS Engineering Process documents.
* A selection of Design Decision Records and Gate Review Documentation.
* Delivery of the supporting PSA Procedure as discussed above for Action 1.

Information in support of this action will be provided before 31st May 2024.

## Schedule 1

## Impacted Submissions

The table below lists the submissions on the Master Document Submission List (MDSL) that will be impacted through resolution of this RO, and how they will be impacted.

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| **Existing MDSL Submission** | **Impact** |
| Rolls-Royce SMR PSA Development Strategy (SMR0004735) | Additional content as part of planned issue of document. |
| Rolls-Royce SMR PSA Hazard Event Modelling Methodology (SMR number TBD) | Additional content as part of planned production of document. |

| **New Submissions** | **Impact** |
| --- | --- |
| Supporting PSA Procedure (SMR number TBD) | Set out how the PSA topic is managed at the more detailed level (in the context of the E3S procedural arrangements. |
| GDA Step 3 PSA Scope and Submission Plan (SMR number TBD) | Details the planning for GDA Step 3 for PSA, including tasks, timescales, resourcing and deliverables. |
| PSA Quality Assurance Plan (SMR number TBD) | Provides a plan for the Quality Assurance activities of the PSA area. |

## References/Attached Documents (if applicable)

1. Rolls-Royce SMR Ltd. Report, SMR0003171 Issue 1, “GDA Scope and Submission Plan for Probabilistic Safety Assessment”, December 2022.

## Record of Change

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| --- | --- | --- |
| **Date** | **Revision Number** | **Reason for Change** |
| 10/11/2023 | 1 | First issue of RO Resolution Plan |

## Approvals

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Author | Sign | Print | Role | Date |
|  |  | PSA Licencing Lead | See Digital Signature |
| Reviewer | **Sign** | **Print** | **Role** | **Date** |
|  |  | PSA Technical Lead | See Digital Signature |
| Reviewer | **Sign** | **Print** | **Role** | **Date** |
|  |  | Safety & Regulatory Affairs PSA Management Lead | See Digital Signature |
|  | **Sign** | **Print** | **Role** | **Date** |
| Reviewer |  |  | Head of Regulatory Affairs | See Digital Signature |