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| **GDA Regulatory Observation** |
| **REGULATOR TO COMPLETE** |
| **RO unique no.:** | RO-RRSMR-004 |
| **Revision:** | 1 |
| **Date sent:** | 22 November 2024 |
| **Acknowledgement required by:** | 13 December 2024 |
| **Resolution Plan Agreement Required by:** | 10 January 2025 |
| **Record Reference:** | ONRW-2126615823-5067 |
| **Related RQ / RO No. and CM9 Ref:** (if any)**:** | RQ-01090RQ-01211 |
| **Observation title:** | Site Autonomy Following Extended LOOP |
| **Lead technical topic:**Fault Studies | **Related technical topic(s):**Electrical EngineeringProbabilistic Safety AnalysisSevere Accident Analysis |
| **REGULATORY OBSERVATION:** |
| **Background**Great Britain’s electricity transmission system is reliable and is the preferred source of electrical supply for all UK nuclear power plants. When the electricity system is lost, through either a major failure of the system or its connection points, this is typically referred to as Loss Of Offsite Power (LOOP). During a LOOP event, nuclear power plants rely on onsite equipment to provide resilience and support fundamental safety functions until off-site power is restored. Without proper consideration of the onsite measures required to maintain safety functions for an appropriate mission time, a LOOP has the potential to lead to damage of the nuclear fuel and a large or early release of radioactivity.Since licensees have limited influence over the reliability of their connections to the GB electricity transmission system, typically only modest safety case claims have been made on the failure frequencies related to LOOP. In recent years there has been a significant increase in the use of smart devices and a dependency on renewable energy to support the electricity transmission system. This, coupled with potential impacts of climate change, means that newer power plants should place even less reliance on GB’s electricity transmission system than what has been claimed previously.Dialogue between the National Energy System Operator (NESO) (formally known as National Grid Electricity System Operator), licensees and ONR has resulted in reviews of previous assumptions and ONR asked all licensees to demonstrate on-site resilience to LOOP events. These discussions were summarised in [1] and take note of government policy [2], learnings from Fukushima and developments in the electricity transmission system.In the most recent revision of the Rolls-Royce SMR E3S case (ref. [3] and [4]), the Requesting Party defines a 72 hour frequent LOOP and a 168 hour infrequent LOOP. The justification for the frequencies and durations appears to be based on information set out in RO-ABWR-0009 (ref. [5]), which pre-dates the developments described above. Refs. [3] and [4] do not set out any further justification for the selection of event durations and frequencies, although they do note that these are subject to change following future discussions with NESO.This Regulatory Observation has been raised as ONR judges that there is a gap in the safety case for the demonstration that the generic site considered in GDA with a single Rolls-Royce SMR unit has autonomy i.e. does not need off-site intervention, for an appropriate duration for a range of faults. Based on the submissions received to date, ONR judges that appropriate site autonomy times have not been set out, and there is insufficient information regarding which SSCs will be claimed to support faults in which there is a prolonged loss of offsite power, including their classification, required mission times and consumables. **Relevant Legislation, Standards and Guidance**ONR’s SAPs provide the main source of guidance for ONR inspectors. The main SAPs relevant to this Regulatory Observation are:**ONR SAPs SC.4** – ‘A safety case should… support claims and arguments with appropriate evidence, and with experiment and/or analysis that validates performance assumptions; … To demonstrate that risks have been reduced to ALARP, the safety case should… justify the options chosen in terms of meeting relevant good practice, and discard any options as being either less effective than the chosen option(s) or grossly disproportionate.’ (ref. [6]).**ONR SAP EES.1** - Essential services should be provided to ensure the maintenance of a safe plant state in normal operation and in fault and accident conditions. (ref. [6]).**ONR SAP EES.3** - Each source should have the capacity, duration, availability, resilience and reliability to meet the maximum demands of its dependent systems. (ref. [6]).**ONR SAP FA.1 – FA.9, FA.15 and FA.16** – Design basis, beyond design basis, and severe accidents should be identified, and fault tolerance be demonstrated.ONR’s SAPs are benchmarked against IAEA standards and guidance. The most relevant IAEA requirements and guidance are:**SSR2/1 Requirement 53** - The capability to transfer heat to an ultimate heat sink shall be ensured for all plant states. (ref. [7])**SSR2/1 Requirement 61** - The design of the nuclear power plant shall include an emergency power supply capable of supplying the necessary power in anticipated operational occurrences and design basis accidents, in the event of a loss of off-site power. The design shall include an alternate power source to supply the necessary power in design extension conditions. (ref. [7])ONR also look to industry guidance and standards when determining relevant good practice. The European Utility Requirements (EURs) (ref. [8]) have been applied to inform the design of reactors that have previously undergone GDA. Moreover, Rolls-Royce SMR Ltd. identify the EURs as relevant good practice. For this reason, the following EURs have been identified as relevant to this RO. **EUR 2.1/6.7.2.A** - The design shall ensure heat removal under all Operational States, Accident Conditions\*, Design Basis External Hazards and Rare and Severe External Hazards for 7 days without off-site support for each Unit. \*[‘Accident Conditions’ includes design basis conditions and design extension conditions] (ref. [8])**EUR 2.1/6.7.3.A** - The plant shall be independent from the off-site electrical power supplies at least for 7 days in all Plant States\* and Rare and Severe External Hazards. \*[‘Plant States’ includes normal operation, anticipated operational occurrences, design basis conditions and design extension conditions] (ref. [8]).**Regulatory Expectations**ONR expects that faults are identified with an appropriate frequency, and that those faults are demonstrated to be tolerated by the design. LOOP events are dependent on regional differences in the electricity transmission system, and therefore the frequency and duration may be site specific. Given a specific site location is unknown ONR expects a suitably bounding set of assumptions for the generic site envelope.The Grid Code sets requirements to facilitate restoring power to 60% of regional demand within 24 hours, and 100% of national demand within 5 days, as set out in the ESRS. As a future licensee will have limited influence over this, ONR considers that a conservative approach should be taken when making assumptions on the electricity transmission system restoration times. The EURs (ref. [8]) set ‘autonomy objectives’. Of particular relevance to this Regulatory Observation is that no-offsite support should be required for 7 days for all accident conditions (referred to hereon as site autonomy). This includes ‘design basis conditions’ and ‘design extension conditions’. This terminology is commonly used internationally. ONR’s expectations for demonstration of protection for both the principle and diverse means of protection (both to be treated with design basis techniques), and beyond design basis accidents (including severe accidents) broadly aligns with this terminology. However, ONR’s guidance does not set out explicit site autonomy objectives. ONR does not expect that independent on-site consumables are provided for each level of defence in depth where there is sufficient time to provide these by alternate means on-site (for example, it may be appropriate to credit realignment of plant configuration, move fuel across site and replenish water tanks etc. which can be shared by multiple levels of defence in depth). ONR expects that a safety case is presented for LOOP. The safety case should provide a justification for the chosen duration and frequencies. It should summarise the permanent and non-permanent equipment on site that provide support during a LOOP event, the available consumables (incl. Fuel, oil, water, etc,) on site, and provide a demonstration that there is sufficient capacity to maintain the fundamental safety functions over the appropriate timescales.**References**[1] ONR Letter, Information on Extended Loss of Grid scenarios, RRSMR-REG-0017N, 09 May 2023, (CM9 Ref. 2023/27454)[2] UK Government, Policy Paper: Introducing a new ‘Electricity System Restoration Standard’: policy statement, 2021. [www.gov.uk/government/publications/introducing-a-new-electricity-system-restoration-standard/introducing-a-new-electricity-system-restoration-standard-policy-statement](http://www.gov.uk/government/publications/introducing-a-new-electricity-system-restoration-standard/introducing-a-new-electricity-system-restoration-standard-policy-statement) [3] Rolls-Royce SMR Limited, E3S Case Chapter 15: Safety Analysis, SMR0003977, Issue 3, May 2024. (Record ref. ONRW-2019369590-9923).[4] Rolls-Royce SMR Limited, Rolls-Royce SMR Definition of Postulated Initiating Events and Derivation of Initiating Event Frequencies, SMR0001389 Issue 4 (Record ref. ONRW-2019369590-7003).[5] ONR, RO-ABWR-0009, “Analysis of loss of offsite power event,” 2017. [www.onr.org.uk/media/documents/gda/uk-abwr/ro-abwr-0009.pdf](http://www.onr.org.uk/media/documents/gda/uk-abwr/ro-abwr-0009.pdf) [6] ONR, Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 1, January 2020. [www.onr.org.uk/media/pobf24xm/saps2014.pdf](http://www.onr.org.uk/media/pobf24xm/saps2014.pdf) [7] IAEA, Safety of Nuclear Power Plants: Design, Specific Safety Requirements, No. SSR 2/1. Rev. 1, February 2016. [www.iaea.org](http://www.iaea.org) [8] European Utility Requirements, Volume 2, Revision D, December 2016. <https://europeanutilityrequirements.eu/>  |
| **REGULATORY OBSERVATION ACTIONS** |
| **RO-RRSMR-004.A1 – Site Autonomy**In response to this Regulatory Observation Action, Rolls-Royce SMR Ltd should:Determine autonomy times for:* Design basis faults;
* Design basis sequences including failure of the principle means of protection;
* Beyond design basis faults; and
* Severe accidents.

Justification for the derivation of the site autonomy time should be provided, and should be based on a combination of relevant good practice, operational experience, discussions with NESO and any relevant analysis, as appropriate. Resolution required by '*to be determined by Rolls-Royce SMR Limited Resolution Plan*' |
| **RO-RRSMR-004.A2 – Fault Analysis to Support Site Autonomy Claims**In response to this Regulatory Observation Action, Rolls-Royce SMR Ltd should:In supporting claims related to site autonomy times, for each accident category listed in A1:* Identify relevent safety measures and supporting equipment (this needn’t duplicate the fault schedule, but summarise claims related to site autonomy for each accident category);
* Identifiy the categorisation and classification of the equipment;
* The required mission times of the safety measures and supporting equipment;
* Provide a demonstration that the safety functions are maintained for the required duration; and
* Demonstrate that sufficient consumables are available on site to support the above safety functions.

This should be based on the most limiting cases for each category, as appropriate.  Resolution required by '*to be determined by Rolls-Royce SMR Limited Resolution Plan*' |
| **REQUESTING PARTY TO COMPLETE** |
| **Actual Acknowledgement date** (dd/mm/yy)**:** |  |
| **RP stated Resolution Plan agreement date** (dd/mm/yy)**:** |  |