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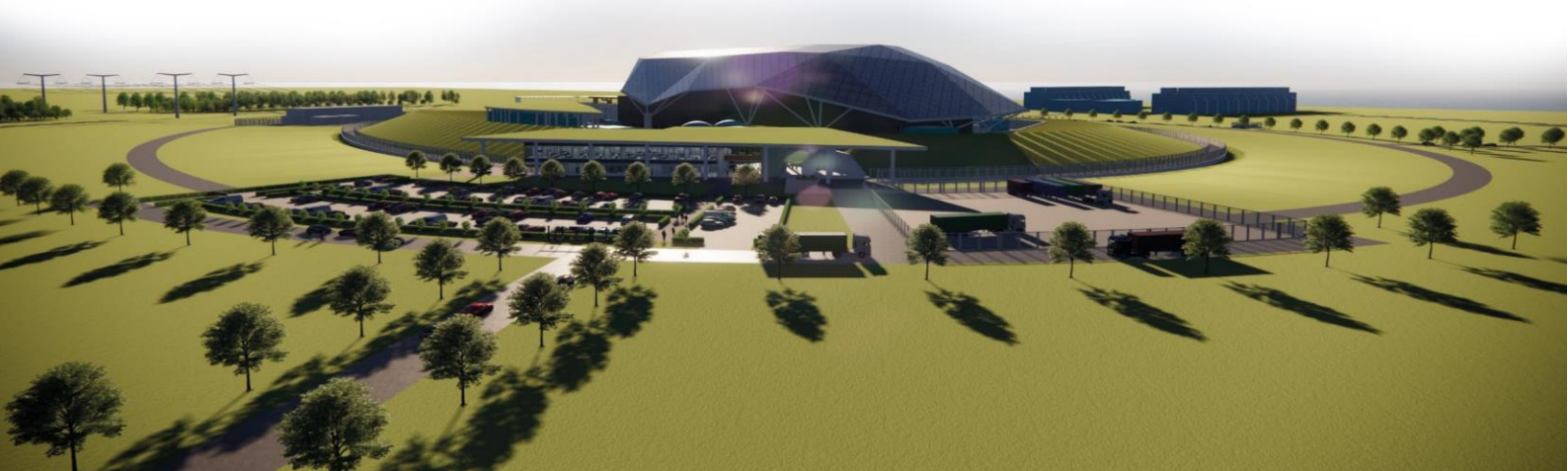
Title

E3S Case Chapter 16: Operational Limits & Conditions

Executive Summary

This chapter of the Environment, Safety, Security & Safeguards (E3S) Case for the Rolls-Royce Small Modular Reactor (RR SMR) will ultimately present the arguments and evidence to support the claim that Operational Limits and Conditions (OLCs) are defined by the design and safety analysis to enable safe operation of the RR SMR. This revision presents information available at the Preliminary Concept Definition (PCD) design stage, including the principles and basis for development of OLCs. As the design progresses, OLCs will be defined along with the processes to ensure they are transferred into operational documentation.



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16.0.1 Introduction to Chapter

Chapter 16 of the Rolls-Royce Small Modular Reactor (RR SMR) Environment, Safety, Security & Safeguards (E3S) Case forms part of the Pre-Construction Safety Report (PCSR) and is a supporting reference to the Generic Environment Report (GER) and Generic Security Report (GSR), as defined in E3S Case Chapter 1: Introduction, Reference [1].

Chapter 16 presents the overarching summary and entry point to the Operational Limits and Conditions (OLCs) of the RR SMR, as defined at Reference Design (RD) 5 level of design maturity.

16.0.2 Scope

At Preliminary Concept Definition (PCD) design stage, OLCs for the RR SMR are still in development through the specification of requirements in the design and safety analysis. The scope of this chapter covers the bases for development of OLCs, including the principles to define OLCs in the design and safety analysis and to ensure they are successfully transferred into operational documentation.

Details of the operational documentation (procedures, technical specifications etc.) that will be developed by the future dutyholder/licensee to implement the OLCs and ultimately demonstrate compliance, will be covered in E3S Case Chapter 13: Conduct of Operations, Reference [2], and not within the scope of this report.

16.0.3 Claims, Arguments, Evidence Route Map

The Chapter level Claim for E3S Case Chapter 16: Operating Limits and Conditions is:

Claim 16: Operational limits and conditions are defined by the design and safety analysis to enable safe operation of the RR SMR

A decomposition of this Claim into Sub-Claims, Arguments, and link to the relevant Tier 2 Evidence will be presented in future revision of this chapter. The complete suite of evidence to underpin the Claims in the E3S Case will be generated through the RR SMR design and E3S Case programme and documented in the Claims, Arguments, Evidence (CAE) Route Map, Reference [3], described further in E3S Case Chapter 1: Introduction, Reference [1].

16.0.4 Applicable Codes and Standards

The International Atomic Energy Agency (IAEA) requirements and guidance relevant to OLCs include:

1. IAEA Specific Safety Requirements, Reference [4]

2. Operating Limits and Conditions and Operating Procedures for Nuclear Power Plants, Reference [5]

Western European Nuclear Regulators Association (WENRA) Safety Levels for Existing Reactors, Reference [6], and the United States Nuclear Regulatory Commissioning (US NRC) Standard Technical Specifications - Westinghouse Plants (NUREG-1431), Reference [7], also provide Relevant Good Practice (RGP) related to development of OLCs.

In the United Kingdom (UK), the Office for Nuclear Regulation (ONR) the Safety Assessment Principles (SAPs), Reference [8], and Technical Assessment Guide (TAG) 035, Reference [9], outline the regulatory expectations that are applicable to the development of OLCs (it is noted that RR SMR utilise the terminology of OLCs consistent with IAEA terminology, whilst the ONR use the equivalent term Limits and Conditions (Operating Rules) (LCOs).

16.1 Bases for Development

16.1.1 E3S Design Principles

The RR SMR E3S Design Principles, Reference [10], state that the design definition should include the OLCs which define the conditions that must be met to prevent situations that might lead to initiating events or to mitigate the consequences of initiating events should they occur.

Adequate margins should be ensured between operational limits and the established classified systems settings, to avoid undesirably frequent actuation of systems. Limits should be established using a conservative approach to take uncertainties in the analyses into account.

OLCs should include limits on:

1. Operating parameters
2. Material parameters
3. Chemistry parameters
4. Environmental parameters
5. Storage, movement, and treatment of nuclear matter
6. Stipulation for minimum amount of operable equipment
7. Minimum staffing levels
8. Actions to be taken by the operators in the event of deviations from the operational limits and conditions and the time allowed to complete these actions
9. Where operability requirements cannot be met or ascertained, or the plant behaves in an unexpected way, the actions to bring the plant to a safer state should be specified, and the time allowed to complete the action should be stated.

Adequate margins should be ensured between operational limits and the established classified systems settings, to avoid undesirably frequent actuation of systems. Limits should be established using a conservative approach to take uncertainties in the analyses into account.

16.1.2 Flow of E3S Requirements into Operations

The Deterministic Safety Methodologies [11] provides an initial description of how OLCs will flow from safety requirements derived in the analysis. It identifies Figure 16.1-1 taken from ONR TAG 035 [9] as a useful illustration on hierarchical approach at which OLCs should be set, as well as NUREG-1431 [7] that can be used as good practice and a checklist when identifying OLCs. Equivalent methodologies will be developed for environment, security and safeguards.

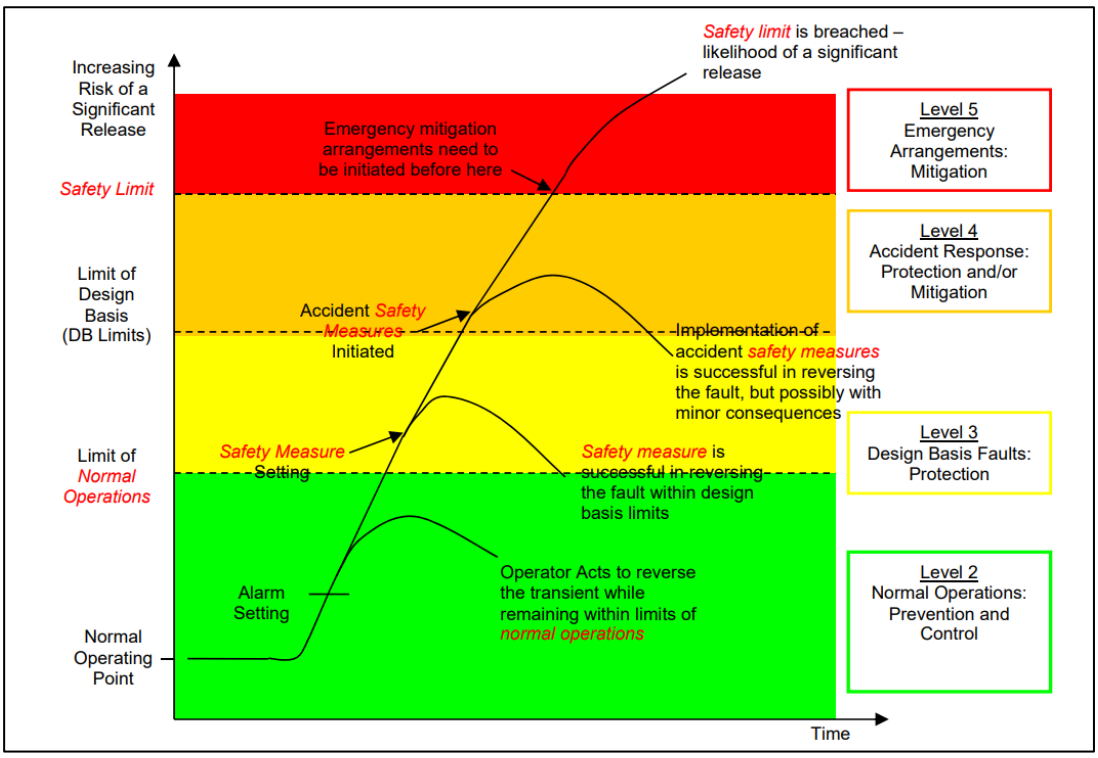

Figure 16.1-1: Illustration for setting OLCs [9]

Broadly, OLCs stem from the following sources/fall into the following categories:

1. Safety limits or important assumptions that are made in the performance analysis. Examples are:

a. 'Shutdown Margin shall be within xxx limit'

b. 'The measured core reactivity shall be within ± yyy of predicted values'

2. The number of redundancies of safety systems that shall be available, or performance requirements (volumes, concentrations) of safety systems. Examples are:

a. 'Three Reactor Coolant System loops shall be operable and in operation'

b. 'Three accumulators shall be operable'

Further action conditions will also be specified for each OLCs, derived from further safety assessment considerations, such as probabilistic analysis and sensitivity studies.

16.2 Conclusions

16.2.1 Conclusions

At PCD design stage, evidence is still to be developed to support the overall claim that 'Operational limits and conditions are defined by the design and E3S analysis to enable safe operation of the RR SMR'.

The principles and basis for development of OLCs is presented in this chapter. The definition of OLCs, and the processes to ensure they are transferred into operational documentation, will be presented in future revisions of the E3S Case as evidence in the CAE Route Map is developed.

16.2.2 Assumptions and Commitments on Future Dutyholder/ Licensee

None identified in this revision.

16.3 References

[1] RR SMR Report, SMR0004294/001, “E3S Case Chapter 1: Introduction,” March 2023.
[2] RR SMR Report, SMR0004247/001, “E3S Case Chapter 13: Conduct of Operations,” March 2023.
[3] RR SMR Report, SMR0002155/001, “E3S Case CAE Route Map,” March 2023.
[4] IAEA, SSR-2/2 (Rev 1), “Safety of Nuclear Power Plants: Commissioning and Operation,” February 2016.
[5] IAEA SSG-70, “Operating Limits and conditions and Operating Procedures for Nuclear Power Plants,” September 2022.
[6] WENRA, “WENRA Safety Reference Levels for Existing Reactors,” 2020.
[7] USNRC NUREG-1431, Standard Technical Specifications – Westinghouse Plants, 2021.
[8] Office for Nuclear Regulation, “Safety Assessment Principles for Nuclear Facilities,” January 2020.
[9] Office for Nuclear Reglation NS-TAST-GD-035, “Limits and Conditions for Nuclear Safety (Operating Rules),” March 2018.
[10] RR SMR Report, SMR0001603/001, “E3S Design Principles,” August 2022.
[11] RR SMR Report, SMR0000531/001, “Rolls-Royce SMR Deterministic Safety Case - Methodologies,” October 2022.

16.4 Acronyms and Abbreviations

CAE	Claims, Arguments, Evidence
E3S	Environment, Safety, Security and Safeguards
GER	Generic Environment Report
GSR	Generic Security Report
IAEA	International Atomic Energy Agency
LCOs	Limits and Conditions (Operating Rules)
OLCs	Operational Limits and Conditions
ONR	Office for Nuclear Regulations
PCD	Preliminary Concept Definition
PCSR	Pre-Construction Safety Report
RGP	Relevant Good Practice
RR SMR	Rolls-Royce Small Modular Reactor
SAP	Safety Assessment Principle
TAG	Technical Assessment Guide