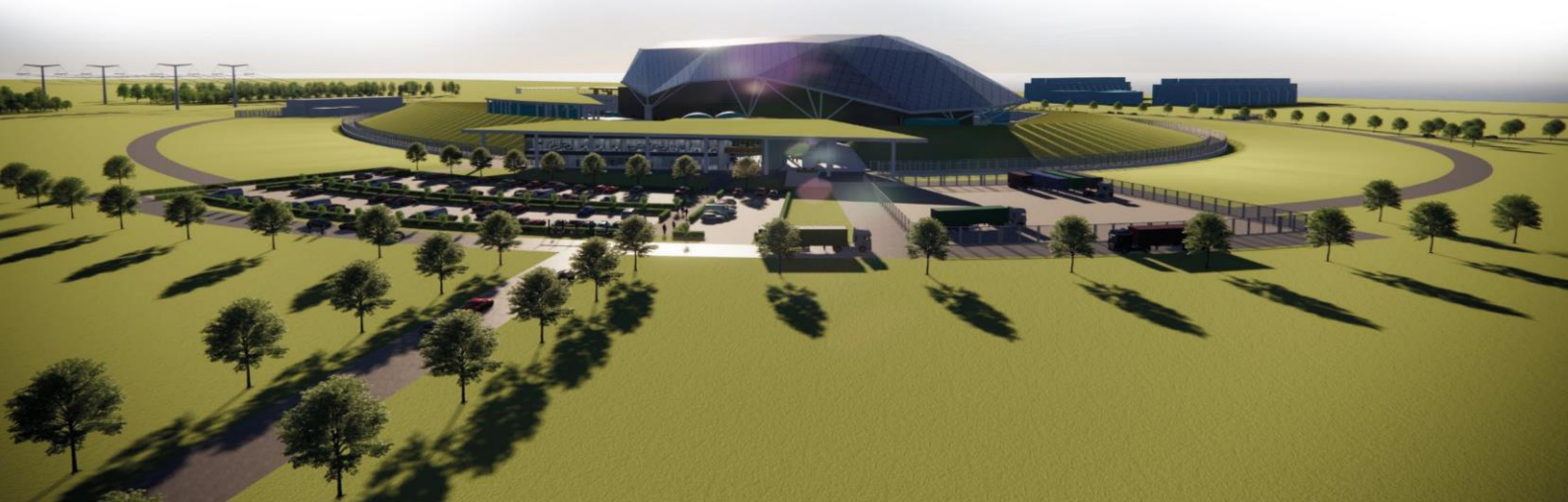
Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 13: Conduct of Operations



Record of Change

Date	Revision Number	Status	Reason for Change
March 2023	1	Issue	First issue of E3S Case
February 2024	2	Issue	Incorporates revised approaches defined at Reference Design 7, aligned to Design Reference Point 1, including the inclusion of: • Concept of Operations [1] • Human Factors Engineering Summary [2] This report also reflects updates to: • Power Station Operating Philosophy [3] • Reactor Island Operating Philosophy [4]
May 2024	3	Issue	Updated to correct revision history status at Issue 2. Chapter changes include: • Additional information on operational safety procedures (section 13.3) • Additional detail within conclusion section for how arguments and evidence presented meet the generic E3S objective Also minor template/editorial updates for overall E3S Case consistency.

Executive Summary

Chapter 13 of the generic Environment, Safety, Security, and Safeguards (E3S) Case presents the arrangements that are being developed, to ensure the Rolls-Royce Small Modular Reactor (RR SMR) can be operated in line with the Operational Limits and Conditions (OLCs) described in E3S Case Chapter 16: Operational Limits and Conditions [5].

The chapter outlines the arguments and evidence to underpin the high-level claim that the design facilitates development of operational arrangements in accordance with the E3S Case and associated defined limits and conditions for the RR SMR. This is in accordance with the E3S fundamental objective 'to protect people and the environment from harm'. The design and analysis outputs presented throughout the E3S Case provide a suitable demonstration that risks will be reduced to as low as reasonably practicable (ALARP), apply best available techniques (BAT) and ensure secure by design (SbyD) and safeguards by design.

Version 2 of the generic E3S Case is developed in support of the reference design 7 (RD7) design, corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA). Further arguments and evidence are to be developed to underpin the top-level claim and to achieve the objective of the generic E3S Case. These include the refinement of operating philosophies to incorporate relevant learning from operational experience (OPEX), ongoing analyses and verification and validation across the E3S disciplines.

At DRP1, the report summarises the operating philosophies that have been developed for RR SMR. These will inform the development of operating procedures by a future dutyholder/licensee/permit holder. Many aspects of Chapter 13 relate to arrangements for a future dutyholder/licensee/permit holder that have not yet been developed. These include demonstration of a suitable operating organization, and the development of operational safety and training programmes. These are captured in commitments placed upon the future dutyholder/licensee/permit holder.

Contents

13.0 Introduction to Chapter

13.0.1 Introduction

Chapter 13 of the Rolls-Royce Small Modular Reactor (RR SMR) generic Environment, Safety, Security and Safeguards (E3S) Case presents the overarching summary of the operational aspects of the RR SMR that provide the framework for the RR SMR to achieve its E3S objectives.

13.0.2 Scope and Maturity

The scope of this chapter is to describe how design and operational documentation developed for RR SMR will facilitate a future dutyholder/licensee/permit holder to fulfil its prime responsibility to implement E3S in operation. This includes organisational arrangements, competencies and training programmes (in line with the Human Factors principles presented in E3S Tier 1 Case Chapter 18: Human Factors Engineering [6]), operational safety programmes, and operating procedures and guidelines.

This chapter broadly follows the format set out in International Atomic Energy Agency (IAEA) Specific Safety Guide, (SSG) SSG-61, Format and Content of the Safety Analysis Report for Nuclear Power Plants [7]. It should be noted that the organizational structure of operating organization, training and actual implementation of the operational safety programme will be the responsibility of the future operating dutyholder/licensee/permit holder. This is captured in commitment C13.1.

The design and operation of site factories, siting aspects and land quality management are not set by the generic design and are all out of scope of the generic E3S Case.

Version 2 of the generic E3S Case is based on reference design 7 (RD7), corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA). At RD7, the conduct of operations is being established. This revision is, therefore, limited to a summary of the operational philosophies being developed for the RR SMR design. These operating philosophies will be developed to inform the RR SMR operating procedures as the design matures. Many operational aspects within the scope of this chapter will need to be developed by the future operating organization in accordance with licence condition (LC) [8] compliance arrangements, or equivalent international arrangements.

The operating procedures for RR SMR will need to reflect the operational limits and conditions (OLCs) derived in the E3S analysis and design. OLCs will be presented in E3S Case Version 2, Tier 1, Chapter 16: Operational Limits and Conditions for Safe Operation [5], and are not within the scope of this chapter.

13.0.3 Claims, Arguments and Evidence Route Map

The overall approach to claims, arguments, evidence (CAE) and set of fundamental E3S claims to achieve the E3S fundamental objective are described in E3S Case Version 2, Tier 1, Chapter 1: Introduction [9]. The associated top-level chapter claim for E3S Case Version 2, Tier 1, Chapter 13: Conduct of Operations is:

Claim 13: The design facilitates development of operational arrangements in accordance with the E3S Case and associated defined limits and conditions.

A decomposition of this claim into sub-claims, and mapping to the relevant Tier 2 and Tier 3 information, containing the detailed arguments and evidence, is presented in the E3S Case Route Map [10]. Given the evolving nature of the E3S Case alongside the maturing design, the underpinning arguments and evidence may still be developed in future design stages. The trajectory of this information, where possible, is also illustrated in the route map, which aligns the anticipated arguments and evidence to future issues of the E3S Case (subject to ongoing planning). Most of the new information will be developed by the future operator as reflected in section 13.6.3.

A proportionate summary of the arguments and evidence from lower tier information, available at the current design stage, is presented within this chapter. A mapping of the claims to the corresponding sections that summarise the arguments and/or evidence is provided in Appendix A (section 13.8).

13.0.4 Applicable Regulations, Codes and Standards

In Great Britain, the RR SMR will be licensed under the Nuclear Site Licence as described in the Nuclear Installations Act 1965 [11]. The Office for Nuclear Regulation (ONR) LC handbook [8] states the 36 different licensing conditions considered in relation to the granting of a licence, many of which are related to operational aspects covered within the scope of this chapter.

Various other overarching legislation applies including the Health and Safety at Work etc. Act 1974 and the Ionising Radiations Regulations 2017 (IRR 2017).

The IAEA establishes safety standards, which are issued in the IAEA Safety Standards Series. This series covers nuclear safety, radiation safety, transport safety and waste safety. SSR-2/2, (Rev.1) Safety of Nuclear Power Plants: Commissioning and Operations [12] specifically details Safety Requirements for Nuclear Power Plants.

Further safety guidance is given in IAEA SSGs that are applicable to the conduct of operations include, but are not limited to:

- SSG-48: Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, [13]
- SSG-72: The Operating Organization for Nuclear Power Plants, [14]
- SSG-73: Core Management and Fuel Handling for Nuclear Power Plants, [15]
- SSG-75: Recruitment, Qualification and Training of Personnel for Nuclear Power Plants, [16].

13.1 Organizational Structure of the Operating Organization

The organizational structure shall demonstrate that all the management and technical functions for the safe operation of the nuclear power plant, such as policy making functions, operating functions, supporting functions and review functions, are adequately addressed. Guidance is given in IAEA Safety Standards Series SSG-72 [14].

E3S Case Version 2, Tier 1, Chapter 18: Human Factors Engineering [6] describes the task analysis and allocation of function (AoF) that will develop the staffing concept through identification of the tasks which personnel are required to complete.

Ultimately the organizational structure of the operating organization will be decided by the future dutyholder/licensee/permit holder. E3S Case Version 2, Tier 1, Chapter 18: Human Factor Engineering [6] contains a commitment on future dutyholder/licensee/permit: “The future dutyholder will develop a nuclear baseline from the RR SMR staffing concept which supports the claims within the E3S case”.

13.2 Training

Detailed arrangements for training staff so they can safely undertake the identified activities are the responsibility of the operator/licensee. However, early consideration of training as part of the production of a robust staffing model is beneficial, and key to the provision of a design solution that is attractive to operators/licensees. Further recommendations are provided in IAEA Safety Standards Series No. SSG 75 [16].

E3S Case Version 2, Tier 1, Chapter 18: Human Factor Engineering [6] describes how future phases of the design programme will include a training needs analysis (TNA), which is a structured process to identify training requirements and training options for a design solution. The output of the TNA is a set of training recommendations for consideration in training design, which includes selection and development of the most appropriate training medium to deliver the training recommendation.

Chapter 18 contains a commitment on the future dutyholder/licensee/permit holder: "The future dutyholder will deliver a training programme which provides the operators with the knowledge, skills and attitudes required to support the claims within the E3S case".

13.3 Implementation of the operational safety programme

Operational safety programmes are specific programmes performed to ensure the adequate state of the plant regarding relevant requirements for safe operation. An operational safety programme shall include details of how all aspects of operation are conducted and may include the following information:

- Examination, Maintenance, Inspection and Testing (EMIT)
- Core management and fuel handling
- Ageing management and long term operation
- Control of modifications
- Programme for the feedback of operating experience
- Documents and records
- Outages
- Environmental qualification programme
- Fire protection programme
- Monitoring and sampling programme
- Radiation protection programme
- Reactor operator training programme
- Non-licenced plant staff training programme
- Emergency preparedness and planning
- Process control programme
- Security
- Management of safety and quality assurance
- Initial test programme.

These operational safety programmes will be developed based on the E3S Case. For example, programmes for EMIT will be developed based on through-life activities (TLA) defined for SSCs within the RR SMR requirements database, which cover safety derived tasks such as in-service inspection (ISI), reliability derived tasks (reliability centred maintenance (RCM)/preventative maintenance), and industry best practice/operational experience (OPEX).

The implementation of operational safety programmes is the responsibility of the future dutyholder/licensee/permitholder. This is captured as a commitment on the future dutyholder/licensee/permit holder:

Commitment on Future Dutyholder/Licensee/Permit Holder C13.1: The future dutyholder/ licensee/permit holder shall develop an operational safety programme based on the E3S Case and operating philosophies.

13.4 Plant Procedures and Guidelines

13.4.1 Administrative procedures

Administrative procedures will be developed by the future dutyholder/licensee/permit holder based on the operating philosophies. This is captured as a commitment on the future dutyholder/ licensee/permit holder:

Commitment on Future Dutyholder/Licensee/Permit Holder C13.2: The future dutyholder/ licensee/permit holder shall develop administrative procedures based on the E3S Case and operating philosophies.

13.4.2 Operating Philosophies

At RD7/DRP1, operating philosophies are being developed to communicate the key principles related to operation of the RR SMR, and the proposals for operation to align with the requirements of the E3S Case.

A hierarchy of operation philosophies is being developed as illustrated in Figure 13.4-1.

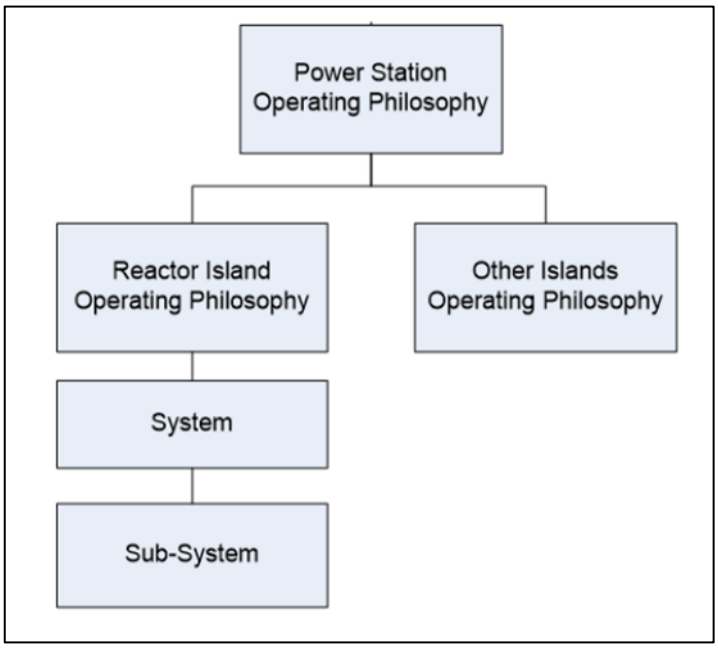


Figure 13.4-1: Relationship between Operational Philosophy Documents

The following operating philosophies have been issued at RD7/DRP1:

- Power Station Operating Philosophy [3]
- Reactor Island Operating Philosophy [4].

The power station operating philosophy provides a high-level description of how the RR SMR will be operated through normal and faulted modes of operation. The general operating principles are

outlined, including; the power station lifecycle and outage period, operating environment conditions, control, fleet approach, potential staffing numbers and their location.

The supporting 'island' level philosophies provide detailed information on how the plant and operator maintain control of key functions across the six defined operating modes, including: the operating principles, required actions, means for transitioning between the operating modes, and relevant safety systems for each mode.

Below the 'island' level philosophies, the System Design Descriptions or Safety Measure Design Descriptions contain a detailed operating philosophy for the specific system as known at the time of issue.

All of the operating philosophies continue to evolve alongside the maturing design.

The detail provided within these operating philosophies is not reproduced within this chapter. Ultimately, the approach for dissemination of philosophies into operating procedures, in line with OLCs, will be formalised and reported in subsequent revisions of the E3S Case, as evidence is developed.

13.4.2.1 Operating Modes

The Reactor Island Operational Philosophy [4], details the means by which the plant and operator maintain control of key functions across a number of defined operating modes, listed below:

1. Power Operations
2. Low Power
3. Hot Standby
4. Hot Shutdown:
    a. Steaming
    b. Non-Steaming
5. Cold Shutdown:
    a. Cold Shutdown Pressurised
    b. Cold Shutdown Depressurised
6. Refuelling
    a. Refuelling with reduced water level above fuel
    b. Refuelling with water level above nominal.

In addition to operating mode specific actions, general operational philosophies and actions are explained, as well as the means of transitioning between the operating dutyholder/licensee/permit holder.

13.4.3 Operating Procedures

Operational procedures are not yet available for RR SMR given the design phase of the programme. E3S Case Version 2, Tier 1, Chapter 18: Human Factors [6] acknowledges that whilst the detailed procedures are not available, the type of procedures used (i.e., event or symptom based) will influence the human machine interface (HMI). Therefore, the HMI development will need to consider the types of procedures likely to be used for RR SMR.

13.4.4 Operational Limits and Conditions

At all times, the RR SMR will be operated in accordance with the E3S Case and associated defined limits and conditions. At RD7/DRP1, a full set of OLCs is not yet defined. A detailed list of the OLCs will be developed for the design to provide the operators with boundaries of operation (that is, the safe operating envelope), which will be presented in Technical Specifications, operating documents, and procedures. The OLCs will be informed by the safety analysis and this process is described in E3S Case Version 2, Tier 1, Chapter 16: Operational Limits and Conditions [5].

13.4.5 Procedures and guidelines for operating the plant during accidents

The Reactor Island Operating Philosophy [4], provides preliminary information related to containment management and post-accident arrangements. The approach for dissemination of operational philosophies into procedures will be reported in a future revision of the E3S Case as evidence in the E3S Case Route Map is developed.

13.5 Nuclear Safety and Nuclear Security Interfaces

13.5.1 Integrated E3S Case

Rolls-Royce SMR Limited has developed integrated E3S principles where environment, safety security and safeguards are approached in a top-down holistic design manner. Specific input from each of the E3S disciplines aims to reduce the risk of harm to people and the environment. Hence some protective measures that adequately address the requirements of the environment or nuclear safety should also satisfy the requirements for nuclear security and safeguards.

Early integration between human factors (HF) engineering and E3S has been undertaken and is ongoing as an integral part of the iterative design process [2], [17].

To reduce E3S claims on the operator, a key design principle of the RR SMR is for systems to be passive and automated. E3S Case Version 2, Tier 1, Chapter 18: Human Factors [6] provides a summary of the Allocation of Function analysis completed to date. This chapter also provides a discussion of the Human Based Safety Claims currently claimed within the Fault Schedule and Probabilistic Safety Assessment.

Similarly, there is an expectation that the RR SMR will be both secure by design (SbyD) and incorporate safeguards by design. Therefore, limiting the need for active security and safeguards systems and associated security and safeguards based claims on the operator. It is anticipated that Human Based Security Claims will be identified and substantiated within the next phase of concept development.

A vital area identification workshop has been carried on the Fuelling Block (containing the spent fuel pool, cask pit and new fuel storage/inspection) to identify any potential causes of significant release of radiation if there was a security breach. Suitably qualified and experienced personnel from the HF and E3S teams provided guidance and input to this workshop.

Details of the safety and operational aspects for security and interfaces with other E3S disciplines will be presented in a future issue of the E3S Case Version 2, Tier 1, Chapter 32: Generic Security Report [18].

13.6 Conclusions

13.6.1 ALARP, BAT, Secure by Design, Safeguards by Design

The operational philosophies described here facilitate the future operator in developing their operational arrangements to ensure operation of the RR SMR reduces risks to as low as reasonably practicable (ALARP), apply best available techniques (BAT) and ensure SbyD and safeguards by design.

13.6.2 Assumptions and Commitments on Future Dutyholder / Licensee / Permit Holder

Table 13.2-1: Assumptions and Commitments on Future Dutyholder/Licensee/Permit Holder

Assumption/Commitment	ID	Description
Commitment	C13.1	The future dutyholder/licensee/permit holder shall develop an operational safety programme based on the E3S Case and operating philosophies.
Commitment	C13.2	The future dutyholder/licensee/permit holder shall develop administrative procedures based on the E3S case and operating philosophies.

13.6.3 Conclusions and Forward Look

The generic E3S Case objective is 'to provide confidence that the RR SMR design will be capable of delivering the E3S fundamental objective as it developed from a concept design into a detailed design'. This confidence is built through development and underpinning of top-level claims across each chapter of the E3S Case, through supporting arguments and evidence. The top-level claim for chapter 13 is '*The design facilitates development of operational arrangements in accordance with the E3S Case and associated defined limits and conditions*'.

The arguments and evidence presented in Version 2 of E3S Case chapter 13 are limited to operating philosophies developed for the maturing design. These will be developed further as the design progresses to eventually inform the production of operating procedures and Technical Specifications. Many of these aspects will be developed by the future dutyholder/licensee/permit holder.

Operating procedures are being developed for RR SMR, alongside the design phase of the programme. Future task analyses (TA) will provide a description of operator activities, identifying the personnel, location, controls and indications, forming a pre-cursor to the procedures themselves. The TA, and ultimately the procedures, will be a fundamental part of the training programme.

Further arguments and evidence will be developed in line with the E3S Case Route Map [10] and reported in future revisions of the generic E3S Case, which will further build confidence that the RR SMR can deliver its fundamental E3S objective. This broadly includes the refinement of operating

philosophies to include relevant learning and good practice from existing nuclear power plants and the establishment of OLCs as analyses mature.

13.7 References

[1] Rolls-Royce SMR Limited, SMR0005048 Issue 1, “Concept of Operations,” March 2023.
[2] Rolls-Royce SMR Limited, SMR0009395 Issue 1, “Human Factors Engineering Summary,” January 2024.
[3] Rolls-Royce SMR Limited, SMR0005213 Issue 1, “Power Station Operating Philosophy,” July 2023.
[4] Rolls-Royce SMR Limited, SMR0006900 Issue 1, “Reactor Island operating Philosophy,” July 2023.
[5] Rolls-Royce SMR Limited, SMR0004555 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 16: Operational Limits and Conditions,” May 2024.
[6] Rolls-Royce SMR Limited, SMR0004520 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 18: Human Factors Engineering,” May 2024.
[7] International Atomic Energy Agency SSG-61, “Format and Content of the Safety Analysis Report for Nuclear Power Plants,” 2021.
[8] Office for Nuclear Regulation, “Licence Conditions Handbook,” February 2017.
[9] Rolls-Royce SMR Limited, SMR0004294 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 1: Introduction,” May 2024.
[10] Rolls-Royce SMR Limited, SMR0002155 Issue 3, “E3S Case Route Map,” November 2023.
[11] UK government, “Nuclear Installations Act,” 1965.
[12] International Atomic Energy Agency, SSR -2/2 (Rev 1), “Safety of Nuclear Power Plants: Commissioning and Operations,” February 2016.
[13] International Atomic Energy Agency SSG-48, “Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants,” November 2018.
[14] International Atomic Energy Agency SSG-72, “The Operating Organization for Nuclear Power Plants,” September 2022.
[15] International Atomic Energy Agency SSG-73, “Core Mangement and Fuel Handling for Nuclear Power Plants,” September 2022.
[16] International Atomic Energy Agency SSG-75, “Recruitment, Qualification and Training of Personnel for Nuclear Power Plants,” October 2022.
[17] Rolls-Royce SMR Limited, SMR0009127 Issue 1, “Human Factors Risk Summary,” January 2024.
[18] Rolls-Royce SMR Limited, SMR0004682 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 32: Generic Security Report,” May 2023.

13.8 Appendix A: Claims, Arguments, Evidence

Table 13.8-1 provides a mapping of the claims to the corresponding sections of the chapter that summarise the arguments and/or evidence. The full decomposition of claims and link to underpinning Tier 2 and Tier 3 information containing the detailed arguments and evidence is presented in the E3S Case Route Map [10]. The route map includes the trajectory of Tier 2 and Tier 3 information as the generic E3S Case develops, which will be incorporated into Tier 1 chapters as it becomes available and in line with generic E3S Case issues described in [9].

Table 13.8-1: Mapping Claims to Chapter Sections

Claim	**Section of Chapter 13 containing Arguments /Evidence summary**
The design facilitates development of operational arrangements in accordance with the E3S Case and associated defined limits and conditions	13.4

13.9 Glossary of Terms and Abbreviations

ALARP	As Low As Reasonably Practicable
BAT	Best Available Techniques
CAE	Claims, Arguments, Evidence
DRP	Design Reference Point
E3S	Environment, Safety, Security and Safeguards
EMIT	Examination, Maintenance, Inspection and Testing
GDA	Generic Design Assessment
HF	Human Factors
IAEA	International Atomic Energy Agency
IRR17	Ionising Radiation Regulations 2017
ISI	In-Service Inspection
LC	Licence Condition
OLCs	Operating Limits and Conditions
ONR	Office for Nuclear Regulation
OPEX	Operational Experience
RCM	Reliability Centred Maintenance
RD	Reference Design
RR SMR	Rolls-Royce Small Modular Reactor (the design)
SbyD	Secure by Design
SSC	Structure, System and Component
SSG	Specific Safety Guide

TA	Task Analysis
TLA	Through-Life Activity