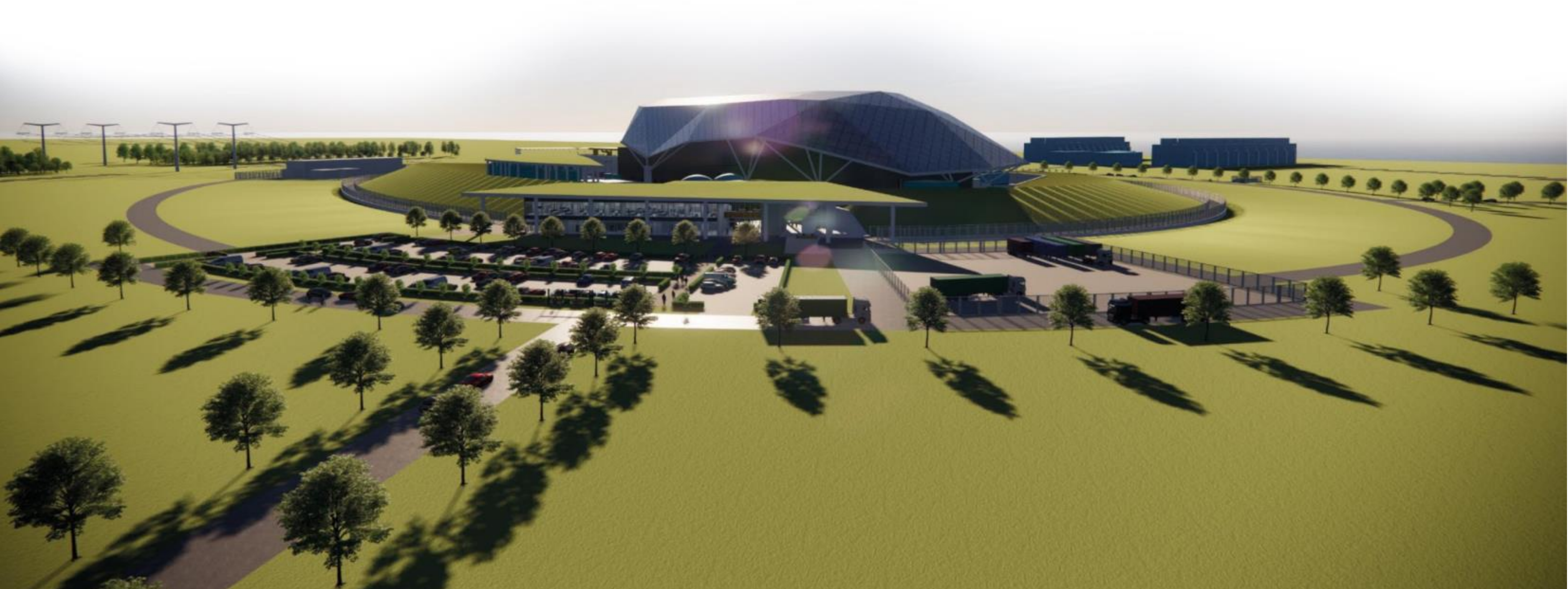
Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 33: Safeguards



Record of Change

Date	Revision Number	Status	Reason for Change
March 2023	1	Issue	First issue of E3S Case
January 2024	2	Issue	Revision of site layout at Reference Design 7, aligned to Design Reference Point 1 Inclusion of additional relevant good practice and fora that apply to Safeguards.
May 2024	3	Issue	Updated to correct revision history status at Issue 2. Chapter changes include: • Additional detail within conclusions section for how arguments and evidence presented meet the generic E3S Case objective Also minor template/editorial updates for overall E3S Case consistency.

Executive Summary

This chapter of the Environment, Safety, Security, and Safeguards (E3S) Case presents the Safeguards arrangements of the Rolls-Royce Small Modular Reactor (RR SMR).

Safeguards are defined as the measures to verify that countries abide by their commitments to use qualifying nuclear materials (QNM) (plutonium, uranium, and thorium) for declared peaceful purposes.

An overview of the United Kingdom (UK) and international relevant good practice (RGP) for Safeguards that is applicable to RR SMR is presented in this revision.

The objective of the generic E3S Case is to provide confidence that the RR SMR design will be capable of delivering the E3S fundamental objective. Version 2 of the generic E3S Case is developed in support of the Reference Design 7 (RD7) design stage, corresponding to Design Reference Point 1 (DRP1).

To ensure the design can facilitate all safeguards expectations, requirements have been developed from the UK and international RGP for safeguards and placed onto the design. These are described in this version of the E3S Case.

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33.0 Introduction to Chapter

33.0.1 Introduction

Chapter 33 of the Rolls-Royce Small Modular Reactor (RR SMR) generic Environment, Safety, Security, and Safeguards (E3S) Case presents the overarching summary and entry point for the consideration of safeguards in the design of the RR SMR. It provides details of the safeguards approach incorporated within the RR SMR design, such that it is capable of being built and operated in a way that is acceptable from a safety, environment, security and safeguards point of view throughout its entire lifecycle.

Safeguards are measures to verify that countries abide by their commitments to qualifying nuclear material (QNM) for declared peaceful purposes. They are an international confidence measure based on independent verification by international safeguards inspectors and form a cornerstone of the global nuclear non-proliferation regime.

Safeguards inspections are carried out by the Office for Nuclear Regulation (ONR), which is responsible for delivering the State System for Accountancy and Control for United Kingdom (UK) nuclear power plants, European Atomic Energy Community (EURATOM), who perform a similar role for the European Commission and the International Atomic Energy Agency (IAEA) who have worldwide oversight of safeguards.

The objective of IAEA safeguards is the timely detection of diversion of nuclear material from peaceful activities, and the deterrence of such diversion by the risk of early detection. To facilitate the implementation of safeguards, the IAEA establishes high level facility specific safeguards guidelines and communicates these to stakeholders at appropriate times during the design process. The IAEA is promoting safeguards by design (SBD) as an approach whereby international safeguards are fully integrated into the design process of a nuclear facility [1].

Safeguards are captured in RR SMR E3S design principles [2] which will be promulgated into the design with specific functional requirements. Those systems, structures and components (SSCs) important to safeguards, for example uninterruptible power supplies, will be tagged as important to ensuring safeguards, this ensures that future design iterations maintain all features necessary for safeguards. The plant is designed with safeguards in mind from the very beginning, incorporating safeguards by design as detailed in Section 33.1.4 of this chapter.

33.0.2 Scope and Maturity

The scope of this chapter covers specific areas detailing SBD for the RR SMR, including how the design facilitates material accountability, and containment and surveillance (C/S). It also outlines the key UK and international standards, regulations, and relevant good practice (RGP) which have been considered during the design of the RR SMR.

For IAEA safeguards purposes, the containment used in a C/S system consists of structural features of a nuclear facility or of equipment which permit the IAEA to establish the physical integrity of an area or item by preventing undetected access to, movement of, nuclear or other material, or interference with the item, IAEA safeguards equipment, or data. Examples are the walls of a storage room or a storage pool, transport flasks and storage containers. The continued integrity of the containment is ensured by containment examination, and by C/S measures for penetrations of the containment such as doors, vessel lids and water surfaces.

Similarly, surveillance is the collection of information through inspector and/or instrumental observation, which is aimed at monitoring the movement (or non-movement) of nuclear material, detecting interference with the containment, or tampering with IAEA safeguards devices, samples, or data. There is a range of surveillance devices available, and the use of any one depends on the individual circumstances.

Physical security aspects of SBD are presented within the E3S Case Chapter 32, Generic Security Report [3].

The safeguards presented in this revision of the E3S Case are largely based on the Reference Design (RD)7 design which corresponds to Design Reference Point 1 (DRP1), capturing the engineering and analysis undertaken as the programme works progress, as well as the output of regulatory assessment on Issue 1 of the generic E3S Case. Safeguards principles, standards, and expectations have been identified, and are referred to throughout this chapter. Safeguards requirements are being continually developed and placed onto the design at the appropriate design reference points.

33.0.3 Claims, Arguments, 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 [4]. The associated top-level chapter claim for E3S Case Version 2, Tier 1 Chapter 33: Safeguards is:

Claim 33: The RR SMR layout and design facilitates nuclear material accountancy and minimises the potential for diversion of Nuclear Material through the lifecycle of the facility.

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 [5]. 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 versions of the generic E3S Case (subject to ongoing planning).

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 (in section 33.5).

33.1 International and National Standards and Regulations

33.1.1 International

The legal basis for IAEA safeguards in the UK is represented in Figure 33.1-1.

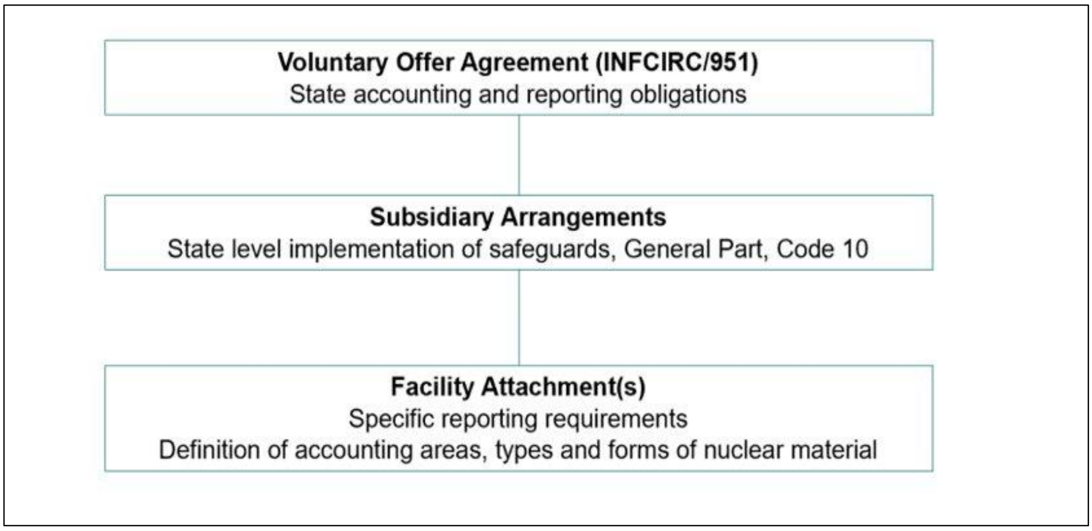

Figure 33.1-1: International Legal Basis for Safeguards

The UK has concluded agreements with international stakeholders, which are relevant to this document. These specifically are agreements with the IAEA [6].

The relevant international agreements are defined in the Nuclear Safeguards (Fissionable Material and Relevant International Agreements) (EU Exit) Regulations 2019 (NSR19) [7].

While nuclear material accountancy at nuclear facilities remains fundamental, the use of other information relevant to safeguards means that safeguards at similar facility types may differ from State to State, as well as from facility to facility within the same State. Therefore, no single specification exists for Safeguards implementation [8].

Safeguards techniques and measures used by the IAEA can include:

- On-site inspections by IAEA inspectors
- Definition of material balance areas (MBAs) for nuclear material accounting
- Definition of key measurement points (KMP) for measuring flow and inventories of nuclear material
- Unique identifiers for nuclear material items
- Locations for surveillance, containment and monitoring, and other verification measures of nuclear material
- Review of operating records and State reports

- Annual physical inventory verification (PIV), which will generally be performed during facility shutdown; routine interim inventory verifications (monthly, quarterly, annual, or random)
- Verification of transfers of nuclear material to and from the site
- Statistical assessment of the nuclear material balance to evaluate material unaccounted for
- Reactor power monitoring
- Verification of facility design at all stages from construction onward for features relevant to Safeguards
- Verification of the performance of the Dutyholder/Licensee/Permit Holder’s measurement system.

33.1.2 United Kingdom

The legal basis for safeguards in the UK is represented in Figure 33.1-2.

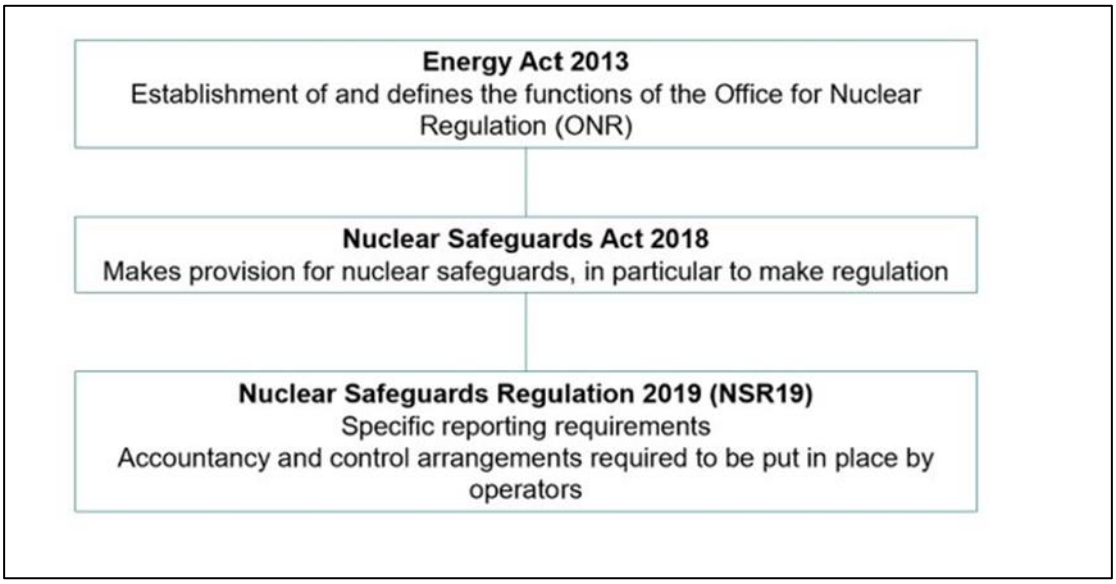

Figure 33.1-2: UK Legal Basis for Safeguards

The overriding legalisation in the UK are the Nuclear Safeguards Regulations (NSR) 19 [7]. Parts of NSR19 are prescriptive and often related to enabling the UK to fulfil its international nuclear safeguards obligations, and parts are outcome focused, in line with the extant regulatory approach applied within the UK across most industries, including nuclear.

ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles (ONMACS) defines Fundamental Safeguards Expectations (FSEs) [9], based on the requirements of UK law (NSR19), relevant international agreements, and in accordance with relevant good practice. FSEs are detailed in Table 33.1-1.

Table 33.1-1: Fundamental Safeguards Expectations

FSE No	FSE Description
FSE 1	Leadership and Management for Nuclear Material Accountancy, Control and Safeguards (NMACS)
FSE 2	Organisational Culture
FSE 3	Competence Management
FSE 4	Reporting Anomalies and Investigations
FSE 5	Reliability, Resilience and Sustainability
FSE 6	Measurement Programme and Control
FSE 7	Nuclear Material Tracking
FSE 8	Data Processing and Control
FSE 9	Material Balance
FSE 10	Quality Assurance and Control for Nuclear Material Accountancy, Control and Safeguards

There is a legal requirement for a Dutyholder/Licensee/Permit Holder to have in place an adequate NMACS. NMACS may include, but not be limited to: a physical inventory, closed-circuit television (CCTV) and access points to enable material accountancy and surveillance in the fuel route.

This is captured in the following Commitment on Future Dutyholder/Licensee/Permit Holder:

Commitment on Future Dutyholder/Licensee/Permit Holder C33.1: *The future Dutyholder/Licensee/Permit Holder shall put into place an adequate Nuclear Material Accountancy and Control System (NMACS) for Safeguards*

FSEs underpin all activities that contribute to sustain high standards of NMACS. They fall into two categories:

1. Strategic enablers – FSEs 1-5 are expectations focussed on creation of the right conditions to support effective NMACS strategy

2. Material controls – FSEs 6-10 are expectations focussed on implementation and maintenance of effective and robust NMACS arrangements.

The ONR may consult with a Dutyholder/Licensee/Permit Holder on what safeguards equipment is appropriate for a qualifying nuclear facility and will facilitate interactions with the IAEA as part of the Generic Design Assessment (GDA) process in GDA Step 3.

On receipt of a written request from the ONR, a Dutyholder/Licensee/Permit Holder must install suitable Safeguards equipment in each qualifying nuclear facility to provide independent confirmation that the information recorded by the operator or provided by the operator to the ONR or to the IAEA, is accurate and up to date.

NSR19 places a duty on Dutyholders/Licensees/Permit Holders to establish, implement and maintain a system of accountancy and control of QNM in each Qualifying Nuclear Facility (QNF). Dutyholders/Licensees must also ensure that arrangements are in place to provide the accounting reports required by NSR19.

Dutyholders/Licensees/Permit Holders are required under NSR 19 to make a number of submissions to the ONR, these are specified in [10] and include but are not limited to: Declaration of Basic Technical Characteristics (BTC) of a QNF, an Annual Outline Programme of Activities, an Accountancy and Control Plan and Accounting Reports [9].

This is captured in the following Commitment on a Future Dutyholder/Licensee/Permit Holder:

Commitment on Future Dutyholder/Licensee/Permit Holder C33.2: *The future Dutyholder/Licensee/Permit Holder shall establish, implement, and maintain an accountancy and control system of Qualifying Nuclear Materials in each Qualifying Nuclear Facility, to enable provision of reporting requirements under Nuclear Safeguards Regulations (NSR19).*

33.1.3 Other Relevant Good Practice

The publications in the IAEA Nuclear Energy Series present good practices and advances in technology, as well as practical examples and experience in the areas of nuclear reactors, the nuclear fuel cycle, radioactive waste management and decommissioning, and on general issues relevant to nuclear energy.

RGP can be found in the National Occupational Standards (NOS) for Nuclear Material Accountancy and Safeguards, which provide a suite of standards that cover the activities carried out by individuals working on behalf of Dutyholders/Licensees/Permit Holders to meet NMACS [10].

The measurement and accountancy systems of QNFs should comply with relevant good practice such as those set out in ISO standards, for example ISO/IEC 17025:2017 [11] and ISO 10012:2013 [12]. This criterion also applies where accounting reports are based on calculations (burn-up declarations and nuclear production and loss occurring in power reactors).

Rolls-Royce SMR Limited are engaged with numerous fora sharing RGP and gaining a wider understanding of best practice. Such engagements ensure that the most up to date concepts are considered and incorporated into the design.

33.1.4 Safeguards by Design

SBD [1], is the process of including the consideration of international safeguards throughout all phases of a nuclear facility project, from the initial conceptual design to facility construction and into operations, including design modifications and decommissioning. The 'by design' concept encompasses the idea of preparing for the implementation of safeguards in the management of the project during all these stages. Safeguards by design does not introduce new requirements but rather presents an opportunity to facilitate the cost-effective implementation of existing requirements.

SBD provides guidance to State authorities, designers, equipment providers and prospective Dutyholders/Licensees/Permit Holders, on the importance of taking international safeguards into account when designing a nuclear facility or process. A voluntary best practice, SBD allows for informed design choices that optimize economic, operational, safety and security factors, in addition to international safeguards. It is applicable to all aspects of the nuclear fuel cycle. For new nuclear facilities, especially novel designs, or processes, the earlier the discussion of safeguards the better: SBD allows for safeguards to be built 'into' the system, rather than around it afterwards.

As the international organization responsible for the verification of a State's obligations on the peaceful uses of nuclear energy, the IAEA provides various resources to promote the implementation of the concept of SBD. Through its Member State Support Programme (MSSP), the IAEA has undertaken a task on "safeguards by design for SMRs" with several Member States. The task aims to identify the key technical challenges for safeguards implementation involving SMRs, and the steps that can be taken to support incorporating SBD principles into the designs. Rolls-Royce SMR Limited is actively engaged with the IAEA and is participating in a UK Support Programme. Further details will be reported in future issues of the E3S Case.

33.2 Design for Safeguards

33.2.1 Introduction

RR SMR is incorporating SBD in line with international best practice and guidance. This will benefit the design by avoiding costly and time-consuming retrofits or redesigns of the facility to accommodate safeguards; Whilst easily enabling the implementation of international safeguards for the Dutyholder/Licensee/Permit Holder, the State, and the IAEA.

33.2.2 E3S Design Principles

E3S design principles are derived from UK and International good practice and guidance. Rolls-Royce SMR E3S design principles [2] state "The design shall permit provision of safeguards in line with international obligations. The design should permit safeguard measures that provide:

- Material Accountability – tracking all inward and outward transfers and the flow of materials. This includes sampling and analysis of nuclear material, on-site inspections, review, and verification of operating records.
- Physical Security – restricting access to nuclear materials at the site of use.
- Containment and Surveillance – automatic cameras and other instruments to detect unreported movement or tampering with nuclear materials.

The design should provide Safeguards by design so far as is reasonably practicable. Safeguards by design include incorporation of equipment, space and support services required for inspection and verification activities within the design."

Specific details of how RR SMR facilitates the above will be presented within the BTC [13].

33.2.3 Safeguards Requirements

Detailed IAEA design criteria for safeguards equipment or systems might only be specified late in the design life cycle [8]. The RR SMR design process will allow for the provision of cabling, power, data transmission and penetrations for such equipment and systems at an early design stage. Specific details will be presented in the BTC. The ability to provide access to stable, reliable power and access to secure data transmission capability throughout RR SMR will prevent some of the costliest aspects of retrofitting for Safeguards equipment systems and allow flexibility for future safeguards technology installation.

The implementation of Safeguards can be facilitated by such things as:

- Simplifying the path of nuclear material through the facility and the number of locations where it is stored
- Understanding safeguards use of containment, authentication of data, and continuity of knowledge

- Installing a robust automated accounting system that provides all necessary reports electronically
- Providing physical access and access to data for verification purposes.

Candidate requirements to facilitate the implementation of safeguards will continue to be developed and placed on the design in line with the E3S Case route map.

33.2.4 Material Accountability

All QNM shall be accounted for from arrival at the facility until it leaves site, this is known as material accountability. The BTC will detail specific QNM as applicable to RR SMR.

The BTC will define the facilities MBA and all QNM will be located within it. An MBA is an area where the quantity of nuclear material in each transfer into or out of the MBA can be determined and the physical inventory of nuclear material can be determined.

The locations, within the MBA, in which QNM can be held will be defined as key measurement points (KMP).

Inventory KMPs are generally located in fuel storage areas: fresh fuel storage, reactor core and reactor spent fuel storage. Current thinking is that flow key measurement points will be located at fuel transfer sites: such as fresh fuel receipt and inspection area, fuel transfers from fresh fuel storage to the reactor core, irradiated fuel transfer from the reactor core to spent fuel pool, transfer of recirculating core fuel, transfer of spent fuel to storage and spent fuel transfer/shipment from the MBA/facility. Specific information will be detailed within the BTC.

Figure 33.2-1 shows a simplified flow of QNM through RR SMR along with examples of KMPs.

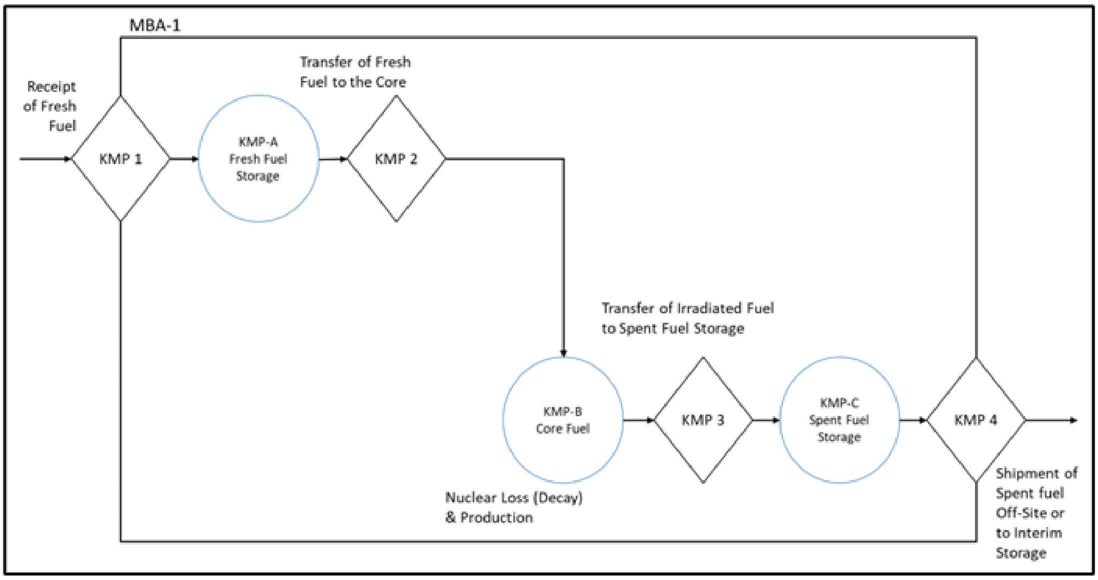

Figure 33.2-1: Example of Fuel Flow through RR SMR

In summary, fuel will arrive at the New Fuel Receipt and Inspection Area [FAA] within fuel transport containers. The transport containers will remain in this area, under surveillance, until individual assemblies are inspected and recorded within the NMACS.

Fuel assemblies are transferred to the Spent Fuel Pool (SFP) [FAB10] and onwards via the Fuel Transfer Channel [FCK] to the Refuelling Pool [FAF] and Refuelling Cavity [FAE] within the reactor. Following irradiation, fuel assemblies and other radioactive parts are stored in the SFP [FAB10], which is used for interim storage of fuel, fuel inspection, fuel repair and cask loading. A variety of inspections are expected to take place on fuel assemblies and control rods, such as visual, ultrasonic, gamma ray spectroscopy, eddy current (oxide/coating thickness and defect testing), in-mast and in-pool sipping, and dimensional measurement. It is expected that the SFP will be under constant surveillance and that the Fuel Transfer Channel will be secured with security seals when not in use. An inventory will record where specific fuel assemblies are located e.g., SFP, Refuelling Pool or reactor cavity.

To support the safe operation and control of the refuelling system, the Electrical, Control and Instrumentation (EC&I) system will be required to monitor a range of key system parameters and provide appropriate indication. It is expected that the EC&I system will be required to monitor and indicate fuel storage positions and allow identification of individual fuel assemblies and any individual damaged rods that have been removed from fuel assemblies. CCTV and other SSCs for operability, fuel inspection and nuclear material accountancy, will be incorporated into the design.

After {REDACTED} years of fuel cooling in the SFP [FAB10], it is desirable to transfer fuel into dry storage and to move the fuel to a different storage location to minimise the size of the SFP in the reactor island building. The benefits are a reduced footprint for the SFP and the movement of fuel into a long term, fully passive storage system.

The RR SMR is expected to use dry concrete cask storage for the interim storage of spent fuel and other nuclear equipment, as described in [14]. Typical dry concrete storage casks include a thin-walled multi-purpose canister (MPC), which is placed within a large concrete storage cask. During loading within the Cask Loading Pit [FAB20], the MPC is placed inside a metal on-site transfer cask. Following sealing, lid welding, draining, helium fill and inspection, the MPC is transferred to the dry concrete storage cask and removed to dry store. Further detail on the dry store for spent fuel and other nuclear equipment will be detailed in the BTC.

33.2.5 Physical Security

Physical Security will be detailed within the E3S Case Version 2, Tier 1 Chapter 32: Generic Security Report [3].

33.2.6 Containment and Surveillance

Maintaining ‘continuity of knowledge’ [8], refers to the process of using surveillance, containment, and monitoring measures to maintain already verified safeguards information by detecting any efforts to alter an item’s properties which are relevant to safeguards.

When continuity of knowledge is maintained successfully, it can reduce the amount of remeasurement activity in subsequent inspections. Equipment that facilitates continuity of knowledge can include cameras within Reactor Island monitoring core activities, IAEA installed seals on containment penetrations and important fuel transfer channels and non-destructive assay (NDA) measurements of fresh and irradiated fuel.

Design work is ongoing and will ensure continuity of knowledge. Safeguards requirements have been placed on the design and are maintained within the transverse requirements module of the requirements management database.

Safeguards requirements placed on the design at RD7/DRP1 consist of the following guidance:

- Provide infrastructure support (e.g. normal and backup power, lighting for surveillance, access, dedicated space, data transmission capability) inside the facility

- Protect data from the environment, for example if a video surveillance or fuel flow monitoring system is used that requires a data collection cabinet, to install the cabinet in an area/room protected from extreme temperature, humidity and dust

- Minimize the number of access points in the reactor containment and other shielding structures through which any fresh or spent fuel movement can take place

- Design for adequate uninterruptible electrical power to support safeguards equipment and instrumentation (for example instrument cabinet, instrument sensors, IAEA installed or facility illumination, cooling and heating) with battery/diesel generator/gas turbine backup for unattended systems

- Plan the fuel transport routes so that surveillance, containment and monitoring and nuclear material flow monitoring systems have the ability to clearly distinguish between routine fuel transfers and other fuel activities, and also between fuel and non-fuel activities

- Ensure that optical surveillance systems are not blocked by large pieces of equipment (for example the fuel handling crane)

- To consider penetrations through containment for cabling for safeguards equipment to avoid situations where penetrations have to be drilled later during construction

- Provide adequate access for attaching, replacing or servicing any seals

- Minimize the effect of safeguards on plant operation by designing locations for safeguards equipment that are accessible for inspection, monitoring and maintenance and that do not obstruct or impede plant operations

- Ensure that inspectors can accomplish all safeguards activities safely and expeditiously and that safeguards equipment is reasonably protected from unintentional damage

- Consider provisions protecting proprietary and restricted information

- Clearly label all safeguards equipment (including cabling power supplies and switches) to avoid inadvertent interruptions in surveillance and monitoring

- Provide capabilities to enable the use of safeguards seals at KMPs and features relevant to safeguards such as key junction boxes where cables are terminated or connected

- Ensure verification of spent fuel in storage without undue handling, ease of verification can include unattended monitoring for fuel movement, surveillance, containment and monitoring of IAEA equipment inside of containment, and provisions for sealing of the storage to reduce the need to re-verify fuel assemblies and/or rods

- Provide a single dedicated space for safeguards' electronic equipment that can be access controlled by the inspectorate, this space might include some additional room to accommodate future IAEA equipment

- Minimize the impact on facility operations from inspector's measurements by considering controlled space, access control and access to facility infrastructure (for example cranes, bridge over spent fuel pool) for any required verification measurements

- Provide means to mitigate the consequences of losing safeguards continuity of knowledge from abnormal events.

Additional requirements may be identified during participation in the MSSP and will be incorporated into the design and reported in future issues of the E3S Case.

33.2.7 Layout

The layout with regards to safeguards is described in the BTC. [13]

At RD7/DRP1, the RI layout complies with the safeguards requirements in the following aspects:

- A simple and straight route has been defined in the RI layout for new fuel import, cask export, fuel transfer to Containment and fuel transfer in Containment from the Refuelling Pool to the RPV.

- Access to the Fuelling Block, and exit for casks containing spent fuel, is via the Fuelling Block labyrinth, as discussed in [13]. The labyrinth is a straight channel, although it shall contain physical security measures which have not been defined at RD7/DRP1. The geometry of the channel provides straight line of sight to any QNM containment (new fuel containers and spent fuel casks).

- The open-plan layout of the Fuelling Block, particularly the SFP area, provide clear line of sight to the penetrations of QNM containment, such as the cask lids and SFP water surface.

- The Fuelling block layout makes space provision for inspection and adequate surveillance of casks. Further details of the Fuelling Block layout and provisions for Safeguards are presented in the Fuelling Systems Outside Containment Layout Report [15].

Fuel transfers within containment occur in a straight line. On the operating level of Containment, clear line of sight is possible to penetrations of QNM containment such as the RPV head and Refuelling Pool water surface.

33.3 Conclusions

33.3.1 ALARP, BAT, Secure by Design, Safeguards by Design

To ensure the design can facilitate all safeguards expectations, requirements continue to be developed from UK and international RGP for safeguards. These have been placed as candidate requirements onto the design. The verification and validation of these requirements will support the overall claim that “The RR SMR layout and design facilitates nuclear material accountancy and minimises the potential for diversion of Nuclear Material through the lifecycle of the facility”, which contributes to the overall E3S objective to protect people and the environment from harm, and the demonstration of safeguards by design.

33.3.2 Assumptions and Commitments on the Future Dutyholder/ Licensee/ Permit Holder

Assumptions and commitments raised on the future Dutyholder/ Licensee/Permit Holder are summarised in Table 33.3-1.

Table 33.3-1: Assumptions and Commitments on Future Dutyholder/Licensee/Permit Holder

Assumption/ Commitment	ID	Description
Commitment	C33.1	The future Dutyholder/Licensee/Permit Holder shall put into place an adequate Nuclear Material Accountancy and Control System (NMACS) for Safeguards
Commitment	C33.2	The future Dutyholder/Licensee/Permit Holder shall establish, implement, and maintain an accountancy and control system of Qualifying Nuclear Materials in each Qualifying Nuclear Facility, to enable provision of reporting requirements under Nuclear Safeguards Regulations 19 (NSR19)

33.3.3 Conclusions and Forward Look

The generic E3S Case objective at Version 2 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’ [4]. 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 33 is “The RR SMR layout and design facilitates nuclear material accountancy and minimises the potential for diversion of Nuclear Material through the lifecycle of the facility”.

The arguments and evidence presented to meet the generic E3S Case objective at Version 2 include international and UK RGP for safeguards, which has led to derivation of requirements for safeguards. These requirements are established in the RR SMR requirements management system as non-functional system requirements, which are applied to SSCs through engineering processes. The application of these processes supports the ongoing the design of the RR SMR. Application of safeguards requirements has been placed on design in the lead up to DRP1. Influencing the layout of the fuelling block including space for inspection and direct line of sight to enable C/S. This provides confidence at RD7/DRP1 that the design at this stage can facilitate safeguards measures and a NMACS.

Further arguments and evidence to underpin claims will be developed in line with the E3S Case Route Map [5] 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 development of a validation strategy for safeguards requirements as part of the overall verification and validation process for the design and the continuation of embedding safeguards by design, through incorporating findings from the IAEA MSSP, ahead of DRP2.

Timescales for development of further arguments and evidence for the generic E3S Case are outlined in the safeguards scope and submission plan [16].

33.4 References

[1] IAEA, “IAEA Nuclear Energy Series No NP-T2-8 International Safeguards in Nuclear Design and Construction,” 2013.

[2] Rolls-Royce SMR Limited, SMR0001603 Issue 1, “Environment, Safety, Security and Safeguards Design Principles,” August 2022.

[3] Rolls-Royce SMR Limited, SMR0004682 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 32: Generic Security Report,” May 2024.

[4] Rolls-Royce SMR Limited, SMR0004294 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 1: Introduction Report,” May 2024.

[5] Rolls-Royce SMR Limited, SMR0002155 Issue 3, E3S Case Route Map, November 2023.

[6] IAEA, Legal framework for IAEA Safeguards ISBN 978-92-0-141810-4, 2013.

[7] UK Government, “UK Statutory Instrument Number 196,” London, 2019.

[8] IAEA Nuclear Energy Series, No, NP-T-2.9, “International Safeguards in the Design of Nuclear Reactors,” August 2014.

[9] ONR, SG-TAST-GD-001, “Safeguards Technical Assessment Guide, Issue 4,” January 2023.

[10] ONR-CNSS-MAN-001 Rev5, “ONR Nuclear Material Accountancy, Control, and Safeguards,” 2022.

[11] ISO, “ISO/IEC 17025:2017 - General requirements for the competence of testing and calibration laboratories,” ISO, 2017.

[12] ISO, “ISO 10012:2003 - Measurement management systems — Requirements for measurement processes and measuring equipment,” ISO, 2003.

[13] Rolls-Royce SMR Limited, SMR0004750 Issue 2, “E3S Basic Technical Characteristics - Safeguards,” January 2024.

[14] Rolls-Royce SMR Limited, EDNS01000915124 Issue 1, “Spent Fuel Storage Optioneering,” February 2021.

[15] Rolls-Royce SMR Limited, SMR0008151 Issue 1, “Fuelling Systems Outside Containment Layout Report,” January 2024.

[16] Rolls-Royce SMR Limited SMR0011014, “Generic E3S Case Scope and Deliverables Document - Safeguards Issue 1,” April 2024.

33.5 Appendix A: Claims, Arguments, Evidence

Table 33.5-1 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 [5]. 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 [4].

Table 33.5-1: Mapping of Claims to Chapter Sections

Claim	**Section of Chapter 33 containing Arguments / Evidence summary**
Safeguards requirements defined for the RR SMR are complete and correct	33.1 and 33.2
Overall layout is optimised to achieve Safeguards requirements	33.2.7
The design facilitates the provision of cameras and instrumentation to detect movement or tampering with Nuclear Material	33.2.6
Access to Nuclear Material within the site is appropriately restricted	See E3S Case Version 2, Tier 1 Chapter 32: Generic Security Report [3]

33.6 Glossary of Terms and Abbreviations

ALARP	As Low As Reasonably Practicable
BTC	Basic Technical Characteristics
CAE	Claims, Arguments, Evidence
CCTV	Closed-Circuit Television
C/S	Containment/Surveillance
E3S	Environment, Safety, Security and Safeguards
EC&I	Electrical, Control and Instrumentation
EURATOM	European Atomic Energy Community
FCD	Final Concept Definition
FSE	Fundamental Safeguards Expectation
GDA	Generic Design Assessment
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
INFCIRC	Information Circular
ISO	International Organization for Standardization
KMP	Key Measurement Point
MBA	Material Balance Area
MPC	Multi-purpose canister
MSSP	Member State Support Programme
NDA	Non-destructive assay
NMACS	Nuclear Material Accounting and Control System
NOS	National Occupational Standards
NSR	Nuclear Safeguards Regulation

ONR	Office for Nuclear Regulation
ONMACS	ONR Nuclear Material Accountancy, Control and Safeguards
PCD	Preliminary Concept Definition
QNF	Qualifying Nuclear Facility
QNM	Qualifying Nuclear Material
RD	Reference Design
SBD	Safeguards By Design
SFP	Spent Fuel Pool
SSC	Structures, Systems and Components