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| ONR Assessment Report  Generic Design Assessment of the Rolls-Royce SMR – Step 2 assessment of Nuclear Liabilities Regulation |



ONR Assessment Report

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**Report Title**: Step 2 assessment of Nuclear Liabilities Regulation

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# Executive Summary

This report presents the outcome of my nuclear liabilities regulation (NLR) assessment of the Rolls-Royce Small Modular Reactor (SMR) as part of Step 2 of the Office for Nuclear Regulation’s (ONR) Generic Design Assessment (GDA). This assessment is based upon the information presented in version 2 of Rolls-Royce SMR Limited’s Environmental, Safety, Security and Safeguards (E3S) case chapters and supporting documentation.

ONR’s GDA process calls for a step-wise assessment, which increase in detail as the project progresses. The focus of my assessment in this step was towards the fundamental adequacy of the Rolls-Royce SMR design and safety case, and the suitability of the methodologies, approaches, codes, standards and philosophies which form the building blocks for the design and generic safety case.

I targeted my assessment, in accordance with my assessment plan, at the content of most relevance to NLR against the expectations of ONR’s Safety Assessment Principles (SAPs), Technical Assessment Guides (TAGs) and other guidance which ONR regards as relevant good practice.

I targeted the following aspects in my assessment of the Rolls-Royce SMR E3S case:

* Radioactive waste management up to and including any on-site storage, potentially over many decades, pending transport off-site for either disposal and/or other appropriate processing. The focus was on waste streams that may present higher safety hazards through activity, and/or chemical and physical properties, such as higher activity radioactive waste (HAW);
* Decommissioning of facilities following cessation of generation through to a site end state. The focus was on whether there is appropriate consideration of decommissioning-by-design and whether the proposed approach is consistent with relevant good practice; and,
* Spent fuel management, following some initial period of in-pond cooling, including interim on-site storage, potentially over many decades, pending transfer to a geologial disposal facility (GDF) in line with UK government policy. I also focussed on those non-fuel core components (NFCC) which may be co-stored with spent fuel.

My assessment has involved regular engagement with the requesting party (RP), Rolls-Royce SMR Limited, including technical progress and topic-based meetings. I have also worked closely with other ONR discipline areas and the environment agencies in areas which interface closely with NLR.

Based upon my assessment, I have concluded the following:

* The design and E3S case show good alignment with UK regulatory expectations especially at a strategic level, and appears consistent with relevant UK policy, and international standards and principles;
* The RP has demonstrated that minimisation of waste generation and accumulation is a significant factor influencing its Rolls-Royce SMR design. There are no clearly identifiable problematic waste streams of fundamental concern which might become a legacy waste without a recognised end point to its planned management;
* There are notable areas of good practice being proposed and learning applied from shortfalls identified in previous GDAs;
* The RP has demonstrated good recognition of the need for the design to be consistent with as low as is reasonably practicable (ALARP) considerations. Generally, there is more attention on those aspects which are novel, or present higher inherent hazards such as spent fuel, HAW and NFCCs;
* There are some areas where insufficient detail has been presented for me to form a judgement on the adequacy of the E3S case and design. These areas include: the design-for-decommissioning approach, effects from modularisation on decommissioning, and a holistic approach for the generation of waste records; and,
* The RP has already identified, within the Step 2 submission documents, many of these areas for further work. Further, I consider that it appears to be addressing many of these areas appropriately.

Overall, based on my assessment to date, and subject to the provision and assessment of suitable and sufficient supporting evidence, I have not identified any fundamental safety shortfalls that could prevent ONR permissioning the construction of a power station based on the generic Rolls-Royce SMR design.

# List of Abbreviations

ALARP As Low As is Reasonably Practicable

BAT Best Available Techniques

CAE Claim, Argument and Evidence

CNS Civil Nuclear Security (ONR)

DAC Design Acceptance Confirmation

DFRP Dry Fuel Repackaging Plant

DOORS Dynamic Object Orientated Requirements System

DRP Design Reference Point

E3S Environment, Safety, Security and Safeguards

GDA Generic Design Assessment

GDF Geological Disposal Facility

HAW Higher Activity Radioactive Waste

HLW High Level Waste

HSE Health and Safety Executive

HVAC Heating, Ventilation and Air Conditioning

IAEA International Atomic Energy Agency

ILW Intermediate Level Waste

IWS Integrated Waste Strategy

LC Licence Condition

LLW Low Level Waste

LLWR Low Level Waste Repository

LoC Letter of Compliance

NDA Nuclear Decommissioning Authority

NFCC Non-Fuel Core Components

NLR Nuclear Liabilities Regulation

NRW Natural Resources Wales

NWS Nuclear Waste Services

ONR Office for Nuclear Regulation

OPEX Operational Experience

PWR Pressurised Water Reactor

RCP Reactor Cooler Pumps

RGP Relevant Good Practice

RP Requesting Party

RPV Reactor Pressure Vessel

RQ Regulatory Query

RWMC Radioactive Waste Management Case

SAP Safety Assessment Principle(s)

SG Steam Generators

SMR Small Modular Reactor

SRL Safety Reference Levels

SSC Structure, System and Component

TAG Technical Assessment Guide(s) (ONR)

TSC Technical Support Contractor

WAC Waste Acceptance Criteria

WENRA Western European Nuclear Regulators’ Association

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# Introduction

1. This report presents the outcome of my nuclear liabilities regulation (NLR) assessment of the Rolls-Royce Small Modular Reactor (SMR) as part of Step 2 of the Office for Nuclear Regulation (ONR) Generic Design Assessment (GDA). This assessment is based upon the information presented in version 2 of Rolls-Royce SMR Limited’s Environmental, Safety, Security and Safeguards (E3S) case chapters (refs. [1], [2], [3], [4], [5], [6], and [7] respectively) and supporting documentation.
2. Assessment was undertaken in accordance with the requirements of the ONR Regulation Management System and follows ONR’s guidance on the mechanics of assessment, NS-TAST-GD-096 (ref. [8]). The ONR Safety Assessment Principles (SAPs) (ref. [9]), together with supporting Technical Assessment Guides (TAGs) (ref. [10]), have been used as the basis for this assessment.
3. This is a major report (refer to NS-TAST-GD-108 (ref. [11])).

## Background

1. The ONR’s GDA process (ref. [12]) calls for a stepwise assessment of the requesting party's (RP) submissions with the assessments increasing in detail as the project progresses. Rolls-Royce SMR Limited is the RP for the GDA of the Rolls-Royce SMR design.
2. In April 2022 ONR, together with the Environment Agency and Natural Resources Wales (NRW), began Step 1 of the GDA for the generic Rolls-Royce SMR design. Step 1, which is the preparatory part of the design assessment process and mainly associated with initiation of the project and preparation for technical assessment in later steps, was successfully completed in 12 months.
3. Step 2 commenced in April 2023. This is the first substantive technical assessment step. The focus of ONR’s assessments in this step is towards the fundamental adequacy of the design and safety and security cases, and the suitability of the methodologies, approaches, codes, standards and philosophies which form the building blocks for the design and generic safety and security cases. The objective is to undertake an assessment of the design against regulatory expectations to identify any fundamental safety or security shortfalls that could prevent ONR permissioning the construction of a power station based on the design.
4. Prior to the start of Step 2 I prepared a detailed assessment plan for NLR (ref. [13]). This has formed the basis of this assessment and was also shared with the RP to maximise openness and transparency.
5. This report is one of a series of assessments which support ONR’s overall judgements at the end of Step 2 which are recorded in the Step 2 summary report (ref. [14]).

## Scope

1. The assessment documented in this report is based upon the E3S case for the design as summarised in the E3S case chapters and supporting documentation.
2. The overall scope of the Rolls-Royce SMR GDA is described in (ref. [15]). Rolls-Royce SMR Limited has indicated that it intends to complete a three step GDA, with the objective of receiving a Design Acceptance Confirmation (DAC) from ONR and has aligned its GDA scope with this objective. The GDA scope defines the generic plant and layout and includes all systems, structures and components that are identified as being important to safety, security and safeguards, all modes of operation, and all stages of the plant lifecycle.
3. However, given the stepwise assessment during GDA, information has not been submitted for all aspects within the GDA Scope during Step 2. This has had a limited impact on the NLR area.
4. My assessment has considered the following aspects:

* Radioactive waste management up to and including any on-site storage, potentially over many decades, pending transport off-site for either disposal and/or other appropriate processing;
* Decommissioning of facilities following cessation of generation through to a site end state and ensuring the design takes decommisioning needs into account; and,
* Spent fuel management, following some initial period of in-pond cooling, including interim on-site storage, potentially over many decades, pending transfer to a geologial disposal facility (GDF) in line with UK government policy.

# Assessment standards and interfaces

1. For ONR, the primary goal of the GDA Step 2 assessment is to reach an independent and informed judgment on the adequacy of a preliminary safety, security and safeguards case for the reactor technology being assessed.
2. ONR has a range of internal guidance to enable Inspectors to undertake a proportionate and consistent assessment of such cases. This section identifies the standards which have been considered in this assessment.
3. This section also identifies the key interfaces with other technical topic areas.

## Standards

1. The ONR SAPs (ref. [9]) constitute the regulatory principles against which the RP’s case is judged. Consequently, the SAPs are the basis for ONR’s assessment and have therefore been used for the Step 2 assessment of the Rolls-Royce SMR.
2. The International Atomic Energy Agency (IAEA) safety standards (ref. [16]) and nuclear security series (ref. [17]) are a cornerstone of the global nuclear safety and security regime. They provide a framework of fundamental principles, requirements and guidance. They are applicable, as relevant, throughout the entire lifetime of facilities and activities.
3. Furthermore, ONR is a member of the Western European Nuclear Regulators Association (WENRA). WENRA has developed reference levels (ref. [18]), which represent good practices for existing nuclear power plants, and safety objectives for new reactors (ref. [19]).
4. The relevant SAPs, IAEA standards and WENRA reference levels are embodied and expanded on in the TAGs (ref. [10]). The TAGs provide the main means for assessing the detailed NLR aspects.

### Safety Assessment Principles (SAPs)

1. The key SAPs (ref. [9]) applied within my assessment are RW.1, RW.3, RW.5, and RW.6 (concerning radioactive waste management), DC.1, DC.2, DC.3, and ECE.26 (concerning decommissioning); and ENM.1, ENM.3, and ENM.6 (concerning control of nuclear matter). These SAPs cover some of the more strategic and fundamental aspects for NLR at this stage of assessment. Hence any potential shortfalls in the RP’s proposed approach against these SAPs could present a more significant and fundamental shortfall in Step 2. Therefore, I have specifically considered these SAPs in my assessment approach and implementation.
2. A list of the SAPs considered explicitly in this assessment is listed in Appendix 1. Given the breadth of the NLR topic, many other SAPs were considered as part of the overall assessment during Step 2, although not all are referenced formally in this report.

### Technical assessment guides (TAGs)

1. The following TAGs have been used as part of this assessment:

* NS-TAST-GD-096 - Guidance on Mechanics of Assessment (ref. [8])
* NS-TAST-GD-024 - Management of Radioactive Materials and Radioactive Waste on Nuclear Licensed Sites (ref. [20])
* NS-TAST-GD-026 - Decommissioning (ref. [21])
* NS-TAST-GD-081 - Safety Aspects Specific to Storage of Spent Nuclear Fuel (ref. [22]).

### National and international standards and guidance

**National**

1. ONR and the environment regulators publish and maintain guidance on the management of higher activity radioactive waste (HAW) on nuclear licensed sites (ref. [23]). This is to promote joint regulation and help prevent potentially contradictory regulatory expectations. The guidance sets out the expectations on matters of joint concern, on for example, radioactive waste management safety cases; and key principles for waste minimisation, characterisation, segregation, storage, conditioning and disposal.
2. The Nuclear Decommissioning Authority (NDA) has produced guidance to promote good practices during the long-term storage of HAW, before the availability of a GDF; a period often referred to as interim storage in the UK[[1]](#footnote-2) (ref. [24]). The nuclear safety and environment regulators supported the development of the ‘interim storage’ guidance (ref. [25]).

**International**

1. IAEA fundamental principles, requirements and guidance have been considered as part of my assessment during Step 2. The following were applied directly in my assessment:

* GSR Part 5 Predisposal Management of Radioactive Waste (ref. [26]).
* GSR Part 6 Decommissioning of Facilities (ref. [27]).
* SSG-15 Storage of Spent Nuclear Fuel (ref. [28]).

1. The following WENRA safety reference levels (SRLs) were also considered during my assessment:

* Radioactive waste treatment and conditioning (ref. [29]).
* Decommissioning (ref. [30]).
* Waste and spent fuel storage (ref. [31]).

## Integration with other assessment topics

1. I have worked closely with other topics as part of my NLR assessment. Similarly, other assessors sought input from my assessment. These interactions are key to the success of GDA to prevent or mitigate any gaps, duplications or inconsistencies in ONR’s assessment.
2. The key interactions with other topic areas were:

* Environment, notably on issues relating to radioactive waste management and specifically regarding the interface between storage and waste disposal/disposability. ONR has vires for on-site waste accumulation. Hence, when waste is not disposed of promptly it represents an accumulation while it remains stored on-site pending disposal. This accumulation represents a potential nuclear safety risk. Hence this interface area with the regulatory bodies is of considerable significance;
* Chemistry, notably with respect to how the RP has derived its source term, and applied waste minimisation principles. Chemistry is providing the lead assessment on the RP’s proposed soluble boron-free approach and use of potassium hydroxide both of which could have important down-stream NLR-related implications;
* Radiological protection, notably with respect to how the RP has derived estimates of activated materials (as part of the source term) and out-of-core criticality control. Other areas of common interest include interim storage such as aspects of design and operation, and decommissioning. The RP’s licencing lead on this topic also co-leads the NLR area;
* Interactions with other areas have been ad hoc, and have included civil engineering, human factors, and fuel and core. These interactions in Step 2 have been on specific items as they have emerged. I anticipate more significant interactions during Step 3 on these and across ONR topic areas where detailed assessment interests overlap; and,
* Additionally, I have engaged with Nuclear Waste Services (NWS) to a proportionate extent. While the environment agencies lead this interaction, given its vires on disposal, I have maintained an oversight due to the inherent risk from prolonged on-site accumulation which could be exacerbated should the RP’s anticipated HAW arisings not be compatible with the GDF.

## Use of technical support contractors

1. I have not engaged technical support contractors (TSCs) to support my Step 2 NLR assessment.

# Requesting party’s submission

1. Rolls-Royce SMR Limited submitted a series of E3S chapters, or summary reports, and other supporting references, which outline the E3S case for the generic Rolls-Royce SMR design. This section presents a summary of the RP’s safety case for NLR. It also identifies the documents submitted by the RP which have formed the basis of my NLR assessment of the design.

## Summary of the Rolls-Royce SMR design

1. The generic Rolls-Royce SMR design is a three loop Pressurised Water Reactor (PWR) with a target electrical power output of 470 MWe (from a thermal power of 1,358 MWth) and a design life of 60 years for non-replaceable components.
2. The design has been developed by the RP based upon well-established PWR technology, which is in use all over the world. Innovation comes in the form of its modular approach to construction which would see the majority of the power station built in factory conditions and assembled on site.
3. The reactor itself is of a typical PWR design, including a steel reactor pressure vessel (RPV) holding fuel assemblies, steam generators (SG), reactor coolant pumps (RCP) and piping, all held within a steel containment vessel. The reactor is equipped with a number of supporting systems for normal operations and a range of safety measures are present in the design to provide cooling, control criticality and contain radioactivity under fault conditions. Passive safety features are preferred to active components, reflecting the RP’s design philosophy.
4. Another proposed innovation, of relevance to the NLR area, is the use of a boron-free aqueous chemistry approach with full shutdown margin provided by the control rods alone (ref. [1]). This approach extends to include (spent) fuel stored in ponds and dry casks (ref. [4]). The implications to waste management are generally considered to be positive factors. This is partly because boron tends to be problematic when incorporated into the cementitious grouts. Such grouts are widely used to passivate radioactive wastes into forms suitable for on-site interim storage pending disposal to a GDF, or directly to the Low Level Waste Repository (LLWR).

## E3S case approach and structure

1. Rolls-Royce SMR Limited has chosen to develop its cases in a holistic manner, as an E3S case. The overall objective for the E3S case is to demonstrate that the design will ‘protect people and the environment from harm’.
2. This means that, although the case made for each of the E3S purposes (i.e. environment, safety, security and safeguards) will inevitably be different at the top level, it will draw upon common evidence outputs (as well as other non-common outputs) to substantiate each of the purposes. This is claimed to offer benefits in terms of clarity, integration and understanding impacts from any changes to the case.
3. The E3S case is being developed using a three-tier hierarchy and incorporating a claim, argument and evidence (CAE) structure with the highest-level claims being derived from the RP’s own E3S principles. The highest level of the three tiers is the RP’s Tier 1 E3S chapters, with the lower tiers providing more detailed arguments and evidence. This is illustrated in Figure 1.

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**Figure 1: Claim, Argument and Evidence (CAE) structure within the E3S hierarchy** (ref. [1])

1. The structure of the E3S case largely aligns with the IAEA guidance for safety cases, SSG-61 (ref. [32]), supplemented to include UK specific expectations and expanded to include the other E3S purposes.

## Summary of the requesting party’s E3S case for nuclear liabilities regulation

1. The aspects covered within the E3S case concerning NLR can be broadly grouped as follows:

### Radioactive waste management

1. The RP, in Chapter 11 (ref. [5]), states a top level claim that radioactive waste systems and arrangements are conservatively designed and verified to deliver E3S functions through-life and minimise the generation of radioactive waste and discharges, in accordance with the E3S design principles, to reduce risks to ALARP.
2. There is also corresponding consideration of matters relating to environmental protection through the demonstration of best available techniques (BAT). This is a matter for the environment agencies, although there are aspects that are relevant to both ONR and the environment agencies in the NLR area (see subsection 2.2).

### Decommissioning

1. The overall claim made by the RP in Chapter 21 (ref. [6]) is that the Rolls-Royce SMR is designed to facilitate decommissioning safely with risks reduced to ALARP. There is also corresponding consideration of matters relating to environmental protection through the demonstration of BAT which is a matter for the environment agencies.
2. Other notable claims (see ref. [33]) include: the design adopts a ‘design for decommissioning approach’ to reduce risks and ensure safe and effective decommissioning at end of life; and the layout is optimised to facilitate decommissioning.

### Spent fuel management

1. The overall claim made by the RP in Chapter 9A (ref. [4]) is that the Rolls-Royce SMR auxiliary systems are designed and substantiated to achieve functional and non-functional safety requirements through the lifecycle, and reduce risks to be ALARP.
2. This includes lower-level claims that the safety categorised functional requirements and non-functional system requirements are derived and justified based on sound safety principles and methods, and the design has been substantiated to achieve its safety requirements through the lifecycle.
3. After six to ten years (to be confirmed) of fuel cooling in a storage pool to allow sufficient radioactive decay, the RP states that it is desirable for spent fuel to be moved into a more passive dry storage (see ref. [34]). The RP states that it is exploring remote handling innovations to enable reduced dose to workers (see ref. [4]).

### ALARP

1. The RP’s proposed approach in Chapter 24 (ref. [7]) to demonstrate ALARP is largely consistent with comparable, but typically larger PWR reactors. As such operational experience (OPEX) is heavily drawn upon and application of national and international guidance used to justify relevant good practice (RGP). For example, decay storage to form more readily disposable low level waste (LLW) is a significant part of the planned solid waste management approach.
2. A small number of innovations are described with claimed benefits that these control risks as part of an overall ALARP case (see refs. [7], [35]). These include use of:

* Boron-free chemistry which may simplify waste management notably with respect to the relaxation for the need of a heavy-duty evaporator;
* Back-washable filters which should result in solid LLW rather than intermediate-level waste (ILW) more typical of standard cartridge filters;
* Modularisation, which is claimed to provide significant opportunities for decommissioning, as dismantling, size reduction, handling, packaging and transportation activities should be simplified; and,
* Multiple deployment of SMRs in the UK (and/or internationally) with the potential opportunity for cross-site OPEX, and standardisation of approaches. In the NLR area opportunities include sharing waste storage and processing facilities at, for example, a regional level.

## Basis of assessment: requesting party’s documentation

1. The principal documents that have formed the basis of my NLR assessment of the E3S case are:
2. Chapter 11 of the E3S, concerning radioactive waste, including Tier 2 and 3 documents such as:

* Integrated Waste Strategy (ref. [36])
* Solid Operational Waste Identification (ref. [37])
* Disposability Case Report (ref. [38])
* Waste Facilities Basis of Design (ref. [39])
* System Design Description for the Solid Radioactive Waste Management System (ref. [40]).

1. Chapter 21 of the E3S case concerning decommissioning (ref. [6]), including Tier 2 and 3 documents such as:

* Decommissioning Strategy (ref. [41])
* Decommissioning and Waste Management Plan (ref. [42])
* Source Term Strategy Report (ref. [43]) – which concerns the whole site life cycle including generation through to decommissioning.

1. Chapter 9(A) E3S case concerning fuel storage and management (ref. [4]), including Tier 2 and 3 documents such as:

* Spent Fuel Storage Optioneering (ref. [44])
* System Outline Description for the Handling of Nuclear Equipment [F] System (ref. [34])
* Damaged Fuel Strategy (ref. [45])
* System Design Description for the External Dry Storage of Filled Casks System [FDB] (ref. [46]).

1. Many of the submitted documents are relevant across the NLR topic areas, as expected, and is consistent with a holistic approach.

# ONR assessment

## Assessment strategy

1. The assessment plan for NLR is described in (ref. [13]) and is made specifically against the RP’s baseline generic design referred to as Design Reference Point (DRP) 1 in (ref. [47]). The plan, informed by GDA technical guidance (ref. [48]) consists of three main specific strands of work, and a fourth of intra-topic matters, concerning:

### Radioactive waste management

1. The overall aim being to judge whether the generic design applies and the E3S case has justified the principles of radioactive waste generation and accumulation minimisation based on RGP and has, or plans to, substantiate this during GDA.
2. The plan included the intention to sample both from the RP’s strategic plans (for example, the integrated waste strategy (IWS)), and from ‘bottom-up’ evidence where available, for example information on key waste-related systems, facilities and processes across the operational and decommissioning lifecycle.
3. The plan targeted radioactive waste streams that may present higher safety hazards (for example through activity, and/or chemical and physical properties). Essentially, this comprises of HAW as it cannot be disposed to any existing UK facilities and requires interim long-term storage as an on-site accumulation. As such HAW has higher safety significance requiring more challenging management to comply with RGP. Additionally, any novel, or potentially novel, waste streams and /or treatment routes proposed would be considered high priority for targeting due to the inherent uncertainties.
4. The environment agencies lead on disposability. However, the engagement between NWS and the RP is relevant and provides a means with which to establish whether the RP’s proposed HAW may challenge the GDF envelope of acceptability (see ref. [38]) and hence potentially risk becoming a site-based legacy waste without an envisioned disposal route.
5. I followed the original assessment plan, with additional sampling of the RP’s documents on interim storage, and I observed engagement between NWS and the RP, and had other related contact with NWS.

### Decommissioning

1. The focus being to judge whether there is appropriate consideration of decommissioning-by-design and whether other relevant factors are consistent with RGP. In particular, the plan sought to assess whether the effect from the RP’s modularisation approach is consistent with ONR expectations for decommissioning (for example with reference to the relevant SAPs). I note the composition of the RP’s decommissioning wastes is likely to be relatively metal rich compared with industry norms to date. I intended to establish whether the RP’s case suitably considers this aspect.
2. The plan was followed, although the RP’s plans for decommissioning were found to be of limited maturity, with much of the contents focussed on strategic matters and intent for Step 3.

### Spent fuel management

1. The overall aim being to judge whether spent fuel management is substantiated following some period of in-pool cooling (up to about 10 years) after removal from the reactor core through to the anticipated removal from site to a GDF consistent with UK Government policy.
2. The plan intent was to assess whether the proposed interim storage system to safely manage spent fuel is suitable given the long durations envisaged, and the high inherent radioactivity. The plan included consideration of Non-Fuel Core Components (NFCC) on the basis that these are often co-stored with spent fuel and that learning from previous GDA, and new reactor assessments, has highlighted the challenges presented by safe management of NFCC.
3. The RP made only minor changes to its Step 2 submission plan during the assessment period. Additional information on failed spent fuel was presented, and early implications for safe interim storage outlined. I consider that the plan was otherwise followed as expected.

### Cross-cutting matters

1. The plan highlighted several technical matters common to all three of the areas where learning from previous GDA has indicated potential NLR-area challenges. For example, it included factors such as waste characterisation and maintaining appropriate whole-life records. Assessment outcomes for these are described in subsection 4.2.4.
2. The plan also highlighted the importance of how the RP justifies technical decisions through optioneering exercises, including whether these cover appropriate factors when selecting preferred options to carry forward into the design.
3. A further focus was any novel approaches proposed where these might challenge identification of suitable RGP. Therefore, an overall objective was to establish whether the RP has demonstrated that it has minimised the risk of generating radioactive waste and spent fuel without a suitable management endpoint.
4. I have taken design maturity of the systems into account as part of my assessment. The RP states that most of the systems are at final concept stage (see ref [5]). However, there are some important NLR-relevant systems which remain at an early concept stage. I consider, at Step 2, this is understandable for systems that are either ‘downstream’ such as interim stores, or where they may have a high degree of site dependence.

## Assessment

### Radioactive waste management

**Integrated waste strategy**

1. The RP previously developed an IWS, and in Step 2 provided an update which reflected design developments (see ref. [36]). I anticipate regular future updates and am encouraged by its evolution during the GDA process to date. The IWS is focused on normal operations and decommissioning, it also identifies further development to include ‘expected events’.
2. The IWS includes consideration of a range of risks and opportunities. These appear, generally, to be focussed on the specific context of the design. I consider it would be beneficial for consideration of the most relevant wider national and international strategic risks concerning waste management, although some are highlighted within ‘assumptions’, to improve the robustness of the strategy. I also note that the NDA, within the UK, has led various initiatives to tackle long-term risks (such as security of supply), and the RP, if it has not already done so, could consider engaging with these.
3. The IWS is also underpinned by a more detailed Solid Operational Waste Identification report which provides some useful analysis on uncertainties in waste arisings during operations (ref. [37]).
4. I have concluded that the IWS is broadly consistent with the expectations in SAP RW.1 and is appropriately comprehensive. However, it will need regular updating, given the pace of design developments, if it is to continue to remain a useful part of the E3S case. For example, it could be beneficial if the RP provided updated waste arising analysis and determined the potential for any cliff-edge effects from design-related uncertainties and accident scenarios. I will continue to engage with the RP to ensure the IWS is updated appropriately during Step 3.

**Minimisation of waste generation and accumulation**

1. The RP states in its E3S case (ref. [5]) that wastes are eliminated at source, or where this is not possible, that wastes are minimised as far as possible. The IWS (ref. [36]) describes several factors in the design that the RP considers consistent with this approach; although there is notably less explicit consideration of minimising accumulation.
2. I consider that the RP’s overall demonstration of how it minimises radioactivity and also applies suitable control on the generation of activation products are fundamental inputs to this determination. ONR inspectors in chemistry and radiological protection topic areas have assessed relevant inputs to this determination at Step 2, see for example (refs. [49] and [50] respectively).
3. My assessment has found, at a high level, there is clear evidence that the RP recognises the importance of minimising waste generation and accumulation. The RP provided a useful ‘signposting’ type document (ref. [51]), in response to a regulatory query (RQ) (ref. [52]), to demonstrate its overall approach to minimisation.
4. The RP has outlined how the E3S case demonstrates this fundamental ONR expectation, as defined in the SAPs (for example RW.2 and RW.3), and states that it includes relevant requirements within its dynamic object orientated requirements system (DOORS) which provides further assurance it is factored into the overall design’s philosophy. I have not independently verified this.
5. The RP has derived most of its waste-stream inventory from OPEX (see ref. [43]); I have not independently verified the suitability of the selected OPEX. The RP identifies that one waste stream, comprising reverse osmosis membranes, lacks significant OPEX (ref. [37]) with which to base firm estimates and might therefore present additional challenge to demonstrate a suitable management approach. Consequently, I intend to follow up on the RP’s plans for this waste stream in Step 3.
6. I am not able to judge whether the design has yet fully demonstrated waste generation and accumulation minimisation at Step 2, since the design is still being developed in many relevant areas. Important ‘uncertain’ factors include:

* Its waste package designs, which for some solid ILW (see ref. [53]), includes consideration of temporary storage in thick walled containers (on ALARP related arguments). This could imply additional whole-life-cycle waste arisings which will need to be fully justified as part of an ALARP case;
* Substantiation of the claims that the impact from novel approaches (such as boron free chemistry, and modulisation) are net positives to waste generation under normal and accident conditions; and,
* The NWS on-going assessment of spent fuel and HAW ‘disposability’ which will inform waste accumulation requirements over the life-cycle.

1. However, I have concluded that the RP has demonstrated, at a strategic level, an approach across its E3S case that seeks to minimise waste generation and accumulation which is suitable and sufficient for Step 2 and consistent with the expectations defined by SAPs RW.2 and RW.3, and relevant IAEA Standards (ref. [26], notably Requirement 8). I intend to follow up on this aspect during Step 3 as the design matures and the source term information, specifically, is improved.

**Interim storage**

1. The RP states that the ‘shielded’ interim storage facility for packaged ILW is at an early concept stage (ref. [40]) and considers that the design will be notably dependent on the characteristics of the waste packages and site. The RP provides clear recognition that the store will need to provide protection of workers, the public, optimise package lifetime and maintain disposability of the waste packages until the waste can be transported to a future GDF (ref. [5]).
2. I agree that the store and waste package designs need to be appropriately considered as part of an overall storage system (see ref. [25]), and that site characteristics may influence some aspects of design. The RP identifies the use of a heating, ventilation and air conditioning (HVAC) system to control the store environment consistent with RGP. It also identifies the need to specify operating limits (ref. [39]) which I consider will be sensitive to the waste package design, notably the container material(s) selected, as part of a holistic approach to demonstrate ALARP. I note that an outline operating range is provided for the store temperature (ref. [40]).
3. I consider, overall, that the store design is aligned with relevant international expectations (for example, appropriate WENRA SRLs (ref. [31]), and IAEA safety standards (ref. [26])).
4. I note the RP’s intention to potentially decay store some wastes within the ILW store. This aspect will need to be justified as part of any future ALARP case, especially if several different container designs are utilised and associated hazards will need to be properly assessed and managed.
5. The RP highlights the use of dummy packages and coupons to monitor packages (ref. [40]). I consider while this is consistent with RGP, it of itself might not be sufficient to assure package performance, which would need to be demonstrated as part of an overall ALARP case. I consider that there is good alignment with the NDA’s Industry Guidance on storage (see ref. [25]) and regulatory expectations.
6. I consider that the RP should develop a more coherent overall approach to package monitoring (frequency, techniques etc) and propose management approaches for any packages that may not meeting the stores waste acceptance criteria (WAC) when these are developed (noting relevant WENRA SRLs, see for example (ref. [31]) and IAEA standards (ref. [26]). This should help assure a more meaningful assessment of the adequacy of the proposed ILW storage system in Step 3.
7. I consider that more explicit consideration of the effect that novel aspects of the design may have on storage requirements (for example, should boron need to be introduced and result in changed waste arisings) would strengthen the E3S case.
8. I have concluded that the early concept store design is consistent with the relevant SAPs (for example, RW.5) noting the observations outlined above. I expect to assess the waste storage system in more depth during Step 3 given the long duration of storage, potential high hazard HAW, and uncertainties in the proposed management routes while the design is firmed up. The RP has identified a risk concerning the impact on the ILW store sizing (ref. [40]) and identified some mitigations, which I consider reasonable at this stage.

**Waste processing and passivation**

1. I consider that the RP has developed appropriate waste-processing approaches that appear sufficiently based on RGP (see ref. [39]) and international standards (for example, ref. [29]). This includes a baseline grouting option to passivate most ILW and LLW wastes using standard approaches, on a batch basis (ref. [5]). I consider that alternative grout formulations may be needed, over the coming decades, due to security of supply issues with current grouts. Therefore, a flexible plant could be advantageous and this strategic risk of security of supply should be considered further.
2. The RP has additionally identified the possible use of thick-walled shielded containers (for dry ILW). While this would avoid or delay the need for any grout, it does potentially raise the issue of whether the waste is sufficiently passivated and could imply the generation of secondary wastes and double handling if repacking was necessary. However, I consider that the approach is broadly consistent with the SAPs (for example, RW.6) noting several observations, as above, for follow up in Step 3.

**Decay storage and LLW management**

1. I have seen limited direct evidence to substantiate arguments for the decay storage of some ILW into more readily disposable LLW forms. As it forms a significant part of the radioactive waste management strategy, this will benefit from further underpinning during Step 3. Many of the waste streams are identified as being ILW/LLW boundary wastes (for example, see ref. [36]) which might imply a sensitivity to the RP’s current inventory assumptions. However, the approach to ‘delay and decay’ is consistent with RGP and international practice (see ref. [26]).
2. Additionally, I consider it important that those wastes identified for decay storage (to LLW) continue to be assessed by NWS to minimise the risk of legacy wastes being generated without an identified disposal route. I am aware that NWS has not identified any significant issues with the currently envisioned LLW inventory and the LLWR’s WAC.
3. The RP does not consider LLW storage capacity a ‘risk’ (ref. [40]). It assumes LLWR will meet its requirements. I have not established the buffer storage available for LLW and consider this has the potential to impact safe operations should LLWR, or other disposal facilities, not be available for a prolonged period. I intend to follow up on this aspect during my Step 3 assessment as a residual matter.

**Non-fuel core components**

1. The RP has provided information on possible options for the long-term management of NFCCs. This has included an early optioneering study (ref. [54]) and consideration of expected arisings (ref. [37]). The RP is working up options for the management of NFCCs including processing via the spent fuel (see subsection 4.2.3) and HAW routes. I consider the approach to date to be suitable and sufficient noting the RP has identified several uncertainties, is working with NWS to establish disposability and is still to make some wider design decisions which could affect the preferred management pathways.
2. I expect to undertake targeted assessment of the proposed NFCCs management during Step 3 given their potentially high activity levels and uncertainty with their management route.

**Summary and conclusions**

1. I have not identified any fundamental safety shortfalls in the design. I consider that the information the RP has submitted on radioactive waste is consistent with UK RGP and should enable the RP to further develop the generic Rolls-Royce SMR design and associated E3S case evidence.

### Decommissioning

**Decommissioning strategy**

1. The RP has developed a high-level strategy (see ref. [41]) and an associated optioneering report (see ref. [55]). These consider safety, other factors and decommissioning stages. The preferred strategy of ‘immediate decommissioning’ is consistent with UK policy, the expectations in SAP DC.2 and DC.3 and appears consistent with IAEA General Safety Requirements for decommissioning (ref. [27]) and relevant WENRA SRLs (ref. [30]). I note there are only limited links to other related strategies such as the IWS (ref. [36]). I would expect to see such links enhanced in future issues as the design and the RP’s plans are advanced to provide a more demonstrable and holistic approach.

**Design for decommissioning**

1. The RP makes a claim that it has adopted a design for decommissioning approach to reduce risks and ensure safe and effective decommissioning at end of life (ref. [33]). From my assessment of sampled documents and interactions with the RP I am yet to observe any significant evidence where the design has been notably modified to consider specific decommissioning needs. While this could be evidence for a potential shortfall against SAP DC.1 or ECE.26, it may also reflect limited sampling in my assessment.
2. In particular I note WENRA SRL DE-15 (see ref. [30]), IAEA standards such as (ref. [27]) and the detailed ONR guidance provided in the decommissioning TAG NS-TAST-GD-026 (ref. [21]) expressing the need to take account of decommissioning during planning and design phases.
3. The RP has identified requirements from decommissioning within DOORS, and there are examples of RGP being proposed and considered (for example, decontamination), with more detail expected in Step 3 (refs. [42], [52]). The RP has also indicated widespread engagement between the E3S case developers and the engineering functions to highlight the decommissioning requirements.
4. Given modularisation is a relatively novel approach, I would expect to see more consideration of the implications to decommissioning within the Step 3 submission to enable a meaningful assessment (see also subsection 4.2.4), and I intend to follow up on this as a residual matter. I note from recent engagement with the RP that ‘decommissioning’ needs are considered within design decision meetings.

**Decommissioning and waste management plan**

1. The RP has provided an early plan, consistent with SAP DC.4, which it acknowledges is limited due to the current design stage (see ref. [42]). I note there are several identified areas of future work which cover areas of regulatory concern which I have also identified during my assessment. While the plan is incomplete, it provides a consistent overview of the proposed approach. It is also aligned with the development of a funded decommissioning programme (FDP) required by UK law but is not part of ONR’s vires to enforce (see ref. [56]).
2. The RP is intending to develop a decommissioning ILW interim storage facility (DILWISF) (ref. [36]). Few details have been provided to date. However, I consider its inclusion in the E3S case, albeit to a limited extent, is meaningful given the uncertainties in the availability of a GDF and source-term, and I would expect further details to be provided during Step 3.

**Summary and conclusions**

1. The information that has been submitted is broadly consistent with UK RGP and should enable the RP to further develop the generic Rolls-Royce SMR design and associated E3S case evidence. There is also consistency with international expectations with consideration of decommissioning during the design phase (see refs. [27], [30]).
2. However, insufficient detail has been presented to form a firm judgement on the extent of application of the ‘design-for-decommissioning’ approach by the RP (see also subsection 4.2.4) and I will seek further information in Step 3 on this as a residual matter.

### Spent fuel management

**Processing**

1. The RP is considering a fuel-cleaning process to remove crud from partially spent and spent fuel during outages and before cask loading. I consider that the optioneering carried out (ref. [57]), and a review of the preferred ultrasonic technology as the selected baseline to be sufficiently underpinned at this stage. Some consideration of radioactive waste arisings has been made should ‘ultrasonic filters’ become a radioactive waste arising (ref. [37]). It is an area I would expect to follow up on during Step 3, given the possible hazardous nature of any arisings.
2. The RP also notes that the use of purposeful cleaning could prevent unintended accumulation of crud in the pond – hence cleaning, if necessary, could be consistent with SAP ENM.3. I consider there is adequate consideration that transfers and accumulation of nuclear matter have generally been minimised appropriately.
3. The RP states the need to develop a Dry Fuel Repackaging Plant (DFRP) before spent fuel could be transported to a GDF. It cites the proposed approach at Sizewell B. I consider, at this stage, this provides sufficient confidence that the RP is considering full life-cycle requirements.

**Interim storage**

1. The RP has selected an approach consistent with standard national and international practice, see for example (ref. [28]). The approach being short-term pool cooling followed by long-term dry storage of spent fuel in casks pending transport to a GDF. The RP justified this decision based on an optioneering study which considered a range of assessment criteria and other relevant technical options (see ref. [44]). I consider that the methodology and concluding outcome are based on reasonable assumptions and maturity of the design. I note similar approaches have been adopted or are planned at the other UK-sited PWRs. I also conclude the approach is consistent with SAP ENM.1 and ENM.3, and relevant international guidance (refs. [28], [31]).
2. The RP states in recent documentation that a decision for a ‘spent fuel’ store building is an intent to be confirmed (ref. [46]). Elsewhere, the store is described as a building (for example, ref. [34]) and in other documentation and discussions with the RP it assumes a designed and covered store similar to that at Sizewell B and planned for Hinkley Point C – see response to RQ‑01017 (ref. [52]).
3. In my opinion, the RP has also adequately justified, in response to RQ‑01017 (ref. [52]) the basis for the quoted interim store lifetime of between 120 – 125 years (see ref. [34]). This is based on the spent fuel store being available for between 50 and 55 years of plant operation plus a 70-year storage period following the end of generation. The RP states that: it intends not to foreclose options for spent fuel storage; maintain consistency with WENRA SRLs (ref. [31]); it is aware of the asset management implications and anticipates that the dry store will be designed to the same or better standard as that at Sizewell B.
4. The IAEA states that design lifetimes of up to 100 years have been adopted for certain spent fuel storage facilities, and notes that “it is a fact that many existing industrial and civil analogues have lifetimes of 100–150 years and more” (ref. [28]). Hence, the RP’s quoted potential lifetime is credible although may be challenging to demonstrate robustly as a once-only store solution.
5. I note, however, a reference store lifetime of 100 years is highlighted elsewhere in the E3S case (ref. [46]) consistent with BS EN 1990:2002+A1:2005, “Eurocode. Basis of structural design”. The RP also states it considers that spent fuel storage will primarily be the responsibility of the future licensee. This may challenge whether ENM.6 can be fully satisfied as part the GDA assessment.
6. The RP has derived an estimated footprint, with some stated conservatisms (ref. [46]) in the design of the store. The need for some spare storage capacity is highlighted in the ONR TAG (ref. [22]) and WENRA SRL S-34 (ref. [31]). However, there are several aspects which remain subject to change and refinement; it is also lower than previous estimates provided (ref. [34]). The RP has also noted the possibility of fleet-wide regional solutions.
7. Overall, I consider that the approach presented at Step 2 is reasonable, although many key aspects of the design remain to be fully confirmed.

**Passive safety**

1. The RP states that criticality prevention is assured for the storage of spent fuel in dry casks (ref. [4]). However, the robustness of the claim is uncertain. In an underpinning document (ref. [46]) the RP states that there might be insufficient safety margin without reducing the storage capacity of each cask or design modifications. The former implies a greater store footprint. This is another aspect I intend to follow-up as a residual matter in Step 3 as it may challenge expectations in SAP ENM.6 and WENRA SRL S‑19 (ref. [31]).
2. The RP states that the store environment must be suitable and identifies the need for regular monitoring and testing of casks and safe recovery of potentially compromised casks (ref. [34]). I consider this is consistent with RGP, SAP ENM.7, and expectations of RW.5/ENM.6 on passive and safe storage. Other RP-supplied documentation is less specific (ref. [46]) beyond an intent for an engineered building (as part of its concept design). Most of the submitted documentation assumes a building will be necessary, as stated in response to RQ-01017 (see ref. [52]). I consider a storage system including a building could be a less onerous approach with which to demonstrate full consistency with ENM.6 and ENM.7 in a UK context at least.
3. I consider that the RP’s approach for thermal assessment, with respect to long-term storage, is appropriate at Step 2 (see ref. [58]) and consistent with ENM.6.

**Defective fuel**

1. The RP has begun to address the issue of damaged and failed fuel (see ref. [45]). The RP states that its calculations for quantities of failed fuel are likely to be cautious in RQ-01074 (see ref. [52]). I consider that the approach adopted to date appears reasonable for Step 2 and is consistent with the SAPs (ENM.5,.6 and .7). I also note that the store footprint estimate takes some account of such arisings, consistent with regulatory guidance and WENRA SRL S-36 and S-50 (ref. [31]). Nonetheless, it is an aspect that I would expect to assess in greater depth in Step 3 as the design is progressed and inventory estimates refined.

**Non-fuel core components**

1. The RP has carried out optioneering of the proposed life-cycle management of NFCC some of which might be co-stored with spent fuel in casks and some in separate waste packages (ref. [54]) ‑ this is discussed in section 4.2.1. The potential for, and the implications from, interactions between NFCC with fuel (and damaged fuel) under interim storage conditions has yet to be substantiated and is an aspect I intend to consider in Step 3 as a residual matter.

**Summary and conclusions**

1. I consider that there may be benefits from the RP developing a suitable Radioactive Waste Management Case (RWMC) for spent fuel and associated NFCC waste streams, given the prolonged storage envisaged and hazards. Whilst this is not a regulatory requirement (refs. [22], [23]), I consider a well-planned, implemented and maintained RWMC could aid the RP and any future licensee demonstrate that the risks associated with storage arrangements, including interfaces, remain ALARP.
2. To minimise the risk that spent fuel (and any damaged fuel) remains on site indefinitely, it is important that the RP continues its effective engagement with the NWS assessment process and takes due account of advice received to ensure consistency with any future WAC for a GDF.
3. The E3S case does not contain specific limits and conditions relevant to judge whether the expectations of SAP RW.5/ENM.6 and corresponding WENRA SRLs on passive safe storage will be met (ref. [31]). This includes important factors such as environmental controls highlighted in IAEA guidance (see ref. [28]). However, I consider this is reasonable given the current design maturity.
4. In my opinion the information that has been submitted is consistent with UK RGP and should enable the RP to further develop the generic Rolls-Royce SMR design and associated E3S case evidence. In particular I expect the RP’s case to be further developed in Step 3 to demonstrate consistency with the more detailed expectations of design described in the ONR TAG guidance on spent fuel storage (ref. [22]) and consistency with WENRA SRLs including S-19 to S-30 (ref. [31]).

### Cross-cutting matters

1. The NLR assessment plan (ref. [13]) describes several cross-cutting NLR topic technical matters which had been discussed with the RP during Step 1. Other matters have also emerged during the Step 2 assessment. I have identified the following aspects as potential ‘minor’ shortfalls or observations during my Step 2 assessment, and which were not fully resolved before completing this report. I intend to follow-up on these during Step 3, as appropriate, as residual matters.

**Characterisation**

1. I note that the RP has made only limited consideration of the need to characterise (solid) radioactive wastes as part of an effective HAW management approach, for example in the IWS (see ref. [36]). Although the role of characterisation is detailed at a high level elsewhere in the E3S case and largely as an environmental issue (with respect to discharges). I have not yet been able to confirm consistency with ONR SAP RW.4, although there appears more alignment with the management of NFCC and spent fuel in this respect – see SAP ENM.5. I expect to follow-up on this important area as a residual matter during Step 3, noting the expectations also outlined in TAG NS-TAST-GD-24 (ref. [20]).

**Records and knowledge management**

1. I have seen little evidence, beyond the RP’s internal systems (for example, DOORS), about how the proposed operation of the waste systems will generate appropriate waste records during generation and decommissioning phases. I have insufficient evidence to judge whether the SAP principles (RW.7, DC.6) are consistent with the design, although the RP recognises the need for records during storage (see ref. [39]). I also note that waste package records form a significant part of the NWS disposability assessment process.
2. The RP identifies future work in the decommissioning and waste management plan (see ref. [42]), which appears appropriate, and I intend to follow up on this area during Step 3, noting the expectations also outlined in the NLR-themed TAGs (see ref. [20], [21], [22] respectively) and the corresponding WENRA SRLs on records (refs. [30] and [31]).

**Asset management and ageing**

1. I have observed little consideration of the needs and the NLR-relevant effects from asset management and ageing of infrastructure. This is an area I intend to consider in more detail, given, for example, the longevity required from the waste storage systems with respect to WENRA SRL S-44 (ref. [31]) and WENRA Issue I (ref. [18]).

**Modularisation and compact design**

1. I have noted little specific consideration of the effects that modularisation and the compact design will have on decommissioning and waste management. While these factors are being considered by the RP, the presented information concerning the NLR area has not been sufficient to make a meaningful assessment at Step 2. The RP makes some reasoned outline arguments to suggest how the modularisation approach may aid decommissioning (ref. [59]) and some inherent challenges (ref. [60]).

**Option foreclosure**

1. The RP has not selected many NLR-related design choices while the overall design is still being developed. The RP has indicated that this is so as not to foreclose options, where they consider that the design may be notably site specific. The RP has, in places, presented several credible options as still being considered – and some of these could imply different downstream management, such as waste package handling and storage requirements.
2. The RP’s approach on keeping design options open has had limited impact on my assessment at Step 2. However, moving forward into Step 3, it may become problematic if key design aspects are not firmed up to a greater extent. If not resolved, then it would inevitably transfer some risk to a future licensee (for example, the store designs might only be progressed to a limited extent in Step 3). However, I note working up contingency options is good practice; see for example WENRA (ref. [31]) and need not be nugatory effort in order to manage key uncertainties.

**Summary and conclusions**

1. I consider that there is insufficient detail presented, in the submitted information, to form a firm judgement on the adequacy of the E3S case on these matters; I will seek further information during Step 3 on these residual matters. While the significance of some of these issues may be limited, taken together, their impact may be more problematic unless resolved satisfactorily.

### ALARP

1. I consider that the RP has demonstrated good recognition of the need for the design to be consistent with ALARP considerations (see ref. [35]). Generally, there is more attention on those aspects which are novel or have higher inherent hazards such as HAW, NFCCs and spent fuel.
2. The information that has been submitted is consistent with UK relevant good practice and should enable the RP to further develop the generic Rolls-Royce SMR design and associated E3S case evidence.

### Overview assessment of E3S case and generic design

1. In my opinion the E3S case provides a coherent and good-quality account across the NLR topic area, which is largely based on OPEX and well-proven approaches. There is generally a consistent and traceable narrative across the tiers of documentation. In particular I confirm that Issue 3 of the most relevant E3S Chapters (refs. [1], [2], [3], [4], [5], [6], and [7]) are appropriately consistent with the underlying NLR reports submitted by the RP.
2. I also consider that the RP’s baseline generic design, referred to as DRP1 in (ref. [47]), is consistent with the documentation I have reviewed as part of the assessment.

# Conclusions

## Conclusions

1. This report presents the Step 2 NLR assessment for the GDA of the Rolls-Royce SMR design. The focus of my assessment in this Step was towards the fundamental adequacy of the design and safety case. I have assessed the Tier 1 E3S chapters and relevant supporting documentation provided by Rolls-Royce SMR Limited to form my judgements. I targeted my assessment, in accordance with my assessment plan (ref. [13]), at the content of most relevance to NLR and against the expectations of ONR’s SAPs, TAGs and other guidance which ONR regards as relevant good practice.
2. I have concluded, based upon my assessment of the sampled submissions, that the RP has at Step 2:

* Aligned its design and E3S case to be largely consistent with ONR’s expectations. This is usually more noticeable within the submissions relating to strategy and higher-level plans. It is also aligned with UK Government Policy, and relevant international standards and principles set out by the IAEA and WENRA SRLs;
* Developed a broadly consistent and good quality E3S case across the Tier 1 to 3 documentation which is often based on OPEX and well-proven approaches;
* Applied a radioactive waste generation and accumulation minimisation approach in its design and E3S case;
* Applied ALARP considerations and focussed attention on those items that present the highest hazards and risks, such as HAW, NFCCs, and spent fuel;
* Not always been sufficiently clear when a technology or design decision is confirmed versus being a preferred or potential option among many. I consider that at Step 2 this is often justifiable as there is a purposeful desire not to foreclose options unnecessarily while the ‘up-stream’ design is firmed up;
* Proposed to utilise notable areas of recognised good practice: use of dummy packages etc, and learning from previous GDA on, for example, defective fuel management and NFCCs;
* Identified no clearly problematic waste streams of fundamental concern to which might become a legacy waste without a recognised end point to its planned management;
* Revealed aspects of its design which are less well developed, but has demonstrated coherent plans to address these over the coming months (for example, design for decommissioning);
* Limited ambitions to work up the design in some areas such as interim storage, which it considers largely for a future licensee due to being site specific. I accept this in part, but I think there are aspects which could be taken forward further to demonstrate the design is underpinned over the full lifecycle. Similarly there is limited consideration on a holistic approach for the generation of waste records;
* Limited recognition of strategic risks and opportunities - such as the availability of a GDF, horizon scanning RGP developments and security of supply - and approaches to manage and/or exploit these. I recognise that these may fall outside the GDA process, however, given the fleet-wide ambitions these may impact at a generic level; and,
* Considerable more work to substantiate the NLR-related safety claims and provide sufficient detail for a meaningful Step 3 assessment.

1. I also note that the RP is engaging NWS in a positive manner. This interaction is important to minimise the risk that any radioactive wastes or spent fuel arising from the design might represent an intractable legacy waste issue.
2. I consider that the information that has been submitted is sufficiently consistent with UK RGP and should enable the RP to further develop the generic Rolls-Royce SMR design and associated E3S case evidence.
3. Overall, based on my assessment to date, and subject to the provision and assessment of suitable and sufficient supporting evidence, I have not identified any fundamental safety shortfalls that could prevent ONR permissioning the construction of a power station based on the generic Rolls-Royce SMR design.

## Recommendation

1. My recommendation is:

* Recommendation 1: ONR should consider the outcome from my assessment as part of the decision to progress to Step 3 of GDA for the generic design.

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# Appendix 1 – Relevant SAPs considered during the assessment

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| SAP No. | SAP Title |
| RW.1 | Strategies for radioactive waste |
| RW.2 | Generation of radioactive waste |
| RW.3 | Accumulation of radioactive waste |
| RW.4 | Characterisation and segregation |
| RW.5 | Storage of radioactive waste and passive safety |
| RW.6 | Passive safety timescales |
| RW.7 | Making and keeping records |
| DC.1 | Design and operation |
| DC.2 | Decommissioning strategies |
| DC.3 | Timing of decommissioning |
| DC.4 | Planning for decommissioning |
| DC.6 | Records for decommissioning |
| ENM.1 | Strategies for managing nuclear matter |
| ENM.3 | Transfers and accumulation of nuclear matter |
| ENM.5 | Characterisation and segregation |
| ENM.6 | Storage in a condition of passive safety |
| ENM.7 | Retrieval and inspection of stored nuclear matter |
| ECE.26 | Provision for decommissioning |

1. The IAEA discourages the use of ‘interim storage’ in this context as storage is by definition an interim measure (ref. [24]). However, its use is widespread in the UK to describe the multi-decade period of spent fuel and HAW storage on site, pending the availability and transfer to a suitable disposal facility such as, for example, a GDF. [↑](#footnote-ref-2)