



SMR

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Title E3S Case Chapter 19: Emergency Preparedness & Response		
Executive Summary <p>This chapter of the Environment, Safety, Security, and Safeguards (E3S) Case presents the emergency preparedness and response of the Rolls-Royce Small Modular Reactor (RR SMR). The chapter outlines the arguments and preliminary evidence available at the Preliminary Concept Definition (PCD) design stage to underpin the high-level Claim that the design of the RR SMR facilitates effective emergency preparedness and response to accidents that may result in a potential radioactive release.</p> <p>At PCD, the evidence presented are the international treaties, laws, regulations, and guidance relating to emergency preparedness and response that are relevant to the RR SMR, as well as a high-level description of the RR SMR design features that will facilitate compliance with them by a future dutyholder/licensee.</p> <p>Further evidence to be developed to underpin the Claim includes specific design requirements derived from the identified legislation and E3S analysis, and evidence of their verification in the design.</p>		

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19.0 Introduction

19.0.1 Introduction to Chapter

Chapter 19 of the Rolls-Royce Small Modular Reactor (RR SMR) Environment, Safety, Security and Safeguards (E3S) Case forms part of the Pre-Construction Safety Report (PCSR), as defined in E3S Case Chapter 1: Introduction, Reference [1].

Chapter 19 presents the overarching summary and entry point to the design and arrangements for preparedness and response to nuclear or radiological emergencies, as defined at Reference Design (RD) 5 level of design maturity. It considers the provision of on-site infrastructure and communications links to off-site infrastructure necessary to prepare for, and respond to, a radiation emergency.

19.0.2 Scope

The scope of this report identifies the United Kingdom (UK) and international treaties, laws, regulations, and guidance relating to emergency preparedness and response. It also covers the design features of the RR SMR that facilitate a future dutyholder/licensee to comply with the identified regulations and guidance, noting the design information presented is based on a level of maturity commensurate with the Preliminary Concept Definition (PCD) design stage.

At PCD, the development of detailed E3S requirements for inclusion in the design to facilitate emergency response are still to be developed.

Definition of the initial conceptual boundary of responsibility between RR SMR and the future dutyholder/licensee and local authorities is not defined at this stage. Where applicable, “Assumptions and Commitments on the Future Dutyholder/Licensee” are identified within this report.

19.0.3 Claims, Arguments, Evidence Route Map

The Chapter level Claim for E3S Case Chapter 19: Emergency Preparedness & Response is:

Claim 19: The design of the RR SMR facilitates effective emergency preparedness and response to accidents that may result in a potential radioactive release.

A decomposition of this Claim into Sub-Claims, Arguments, and link to the relevant Tier 2 Evidence is provided in Appendix A. For each lowest level Sub-Claim, the sections of this report providing the Evidence summary are also identified. The complete suite of evidence to underpin the Claims in the E3S Case will be generated through the RR SMR design and E3S Case programme and documented in the Claims, Arguments, Evidence (CAE) Route Map, Reference [2] described further in E3S Case Chapter 1: Introduction, Reference [1].

19.1 Emergency Preparedness and Response Arrangements

19.1.1 Overview of Treaties, Laws, Regulations and Guidance

This sub-section provides an overview of the various treaties, laws, regulations, and additional technical guidance that relate to emergency preparedness and response.

The operation of a nuclear power plant in the UK must comply with the national obligations under various international treaties, for example the Convention on Nuclear Safety, Reference [3], and the Convention on Early Notification of a Nuclear Accident, Reference [4]. The International Atomic Energy Agency (IAEA) publishes a Fundamental Safety Objective and Fundamental Safety Principles, Reference [5]. Principle 9 deals with emergency preparedness and response and states that, “*Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents.*”

The general arrangements for preparedness for a radiation emergency are covered as a set of IAEA safety standards, References [6] and [7], with their supporting criteria given in Reference [8].

Integrating a severe accident management programme into the emergency preparedness and response arrangements is covered in Reference [9]. How the response to a radiation emergency should be prepared for is covered in Reference [10]. If the event is combined with another type of emergency, such as an earthquake or aircraft crash, then additional guidance is given in Reference [11]. Which actions are carried out and when has a significant influence on protecting the public and guidance material covers the initial actions by the control room operators that must be taken into account, Reference [12].

Adequate training of personnel that operate the plant and respond to an emergency is outlined in Reference [13] and ensuring that the leadership, human performance and internal communications are adequate during a radiation emergency is addressed in Reference [14].

Testing of the emergency response arrangements through the use of emergency exercises is addressed in Reference [15], which should make staff familiar with their tasks and may highlight deficiencies in the response arrangements themselves.

Learning lessons from major events around the world is a key element of safety management. The IAEA assist in this by publishing lessons learnt information, including after the Fukushima-1 accident, References [16] and [17].

The government of the UK (and with some element of devolved powers to the Scottish, Welsh and Northern Irish parliamentary bodies) has published various laws, regulations and guidance material which adopt the international conventions, standards and guidelines in a comprehensive manner, Reference [18].

The Health and Safety at Work etc. Act 1974 (HSWA), Reference [19], is the overarching safety legislation for the UK. Sections two and three of the Act impose duties upon RR SMR as the organization responsible for the design of the RR SMR.

The nuclear-specific regulations apply to the site of RR SMR and it will be licensed under the Nuclear Installations Act 1965, Reference [20]. The Office for Nuclear Regulation (ONR) Licence Condition (LC) handbook, Reference [21], states the 36 different licensing conditions considered in relation to the granting of a licence. LC 11 relates specifically to emergency preparedness and response arrangements. Compliance with the LCs is taken to meet the general conditions of HSWA. Further details of how a dutyholder/licensee can meet LC 11 are given in the Nuclear Safety Technical Inspection Guide, Reference [22].

The ONR Safety Assessment Principles (SAPs) for Nuclear Facilities, Reference [23], includes the regulatory expectations for emergency preparedness and response by nuclear power plant operators.

Learning the lessons from events that have happened around the globe is a significant contributor to ensuring future operations are safe. The events surrounding the earthquake and tsunami-induced Fukushima-1 accident in Japan provided several important lessons relating to emergency preparedness and response. The ONR's Chief Inspector of Nuclear Installations detailed the lessons that were relevant to the UK, Reference [24].

The response to a significant event may require the participation of external parties. The organizational links from the on-site control room through to the Cabinet Office Briefing Room (for England and Wales) are presented in the Nuclear Emergency Planning and Response, Concept of Operations report, Reference [25]. The Civil Contingencies Act 2004 (CCA), Reference [26], outlines the coordination between external agencies for general disaster management.

The Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPiR), Reference [27], impose duties on dutyholders/licensees to identify the hazards arising from activities that have the potential to cause a radiation emergency, assess the consequences of the radiation emergency and liaise with the local authority. The dutyholder/licensee and local authority must engage in planning against the radiation emergency occurring, test their plans and provide relevant information to the public. The Regulations are accompanied by an Approved Code of Practice and guidance (ACOP), Reference [28], which gives further details of the expected co-ordination actions between all parties.

The Ionising Radiations Regulations 2017 (IRR 2017), Reference [29], places duties on employers if there are sources of ionising radiation present in the workplace and encompass many more locations and activities than the nuclear power industry specific legislation.

The RR SMR site may be designated under the Control of Major Accident Hazards Regulations 2015 (COMAH), Reference [30], as a COMAH site. There have been efforts to integrate the emergency response to any large-scale accident so that there are no major coordination differences between a nuclear-related event and other major hazard industry events. It is assumed that the arrangements described to satisfy REPPiR and IRR 2017 will also satisfy the COMAH regulations.

19.1.2 Design Requirements

A set of requirements based on a combination of the regulations, etc. discussed in Section 19.1.1, current relevant good practice (RGP), feedback from operational experience (OPEX) and appropriate E3S analyses (such as severe accident analysis) will be produced. The requirements will be placed into the Dynamic Object-Oriented Requirements System (DOORS). Requirements



will be reported in a future revision of the E3S Case in the CAE Route Map, Table 19.5-1, as evidence is developed.

19.1.3 Arrangements

The development of organisational arrangements and procedures that demonstrate compliance with the treaties, laws, regulations, and guidance will be the responsibility of a future dutyholder/licensee. This is captured in the following Commitment on Future Dutyholder/Licensee:

Commitment on Future Dutyholder/Licensee C19.1: Arrangements to meet the regulations, and guidance for emergency preparedness and response shall be developed and implemented

19.2 Emergency Response Facilities

19.2.1 Main Control Room

The RR SMR will include the provision of a centralised Main Control Room (MCR) located within Reactor Island [R01]. From the MCR, the operators can monitor and take action to correct identified deviations, including response to accidents, noting the passive nature of the plant means that no operator action is required within the first 30 minutes of a fault occurring.

The MCR will be designed to maintain a habitable environment for a given timescale following the onset of a hazard, with a withstand capability against bounding design basis hazards.

An Emergency Habitability System will be incorporated into the design of the MCR providing a backup to normal ventilation system in the event of loss of power, or if an inhospitable environment (e.g., radioactive particulate) is detected, with automatic isolation initiation and isolation of the MCR from the standard ventilation system.

Design of the MCR (and other emergency response facilities) for habitability is described further in E3S Case Chapter 18: Human Factors Engineering, Reference [31]. The Control and Instrumentation elements of the design of the MCR (and other emergency response facilities) are described further in E3S Case Chapter 7: Instrumentation and Control, Reference [32].

19.2.2 Supplementary Control Room

The RR SMR also includes the provision of a Supplementary Control Room (SCR), should the MCR become uninhabitable (e.g. due to fire). The SCR is **{REDACTED FOR PUBLICATION}**, located such that a single incident should not threaten both control rooms (e.g. with physical and electrical separation and segregation) but also be close enough to allow the safe transfer of operating personnel. The SCR will include monitoring and control of safety related systems, to ensure a safe state is achieved and maintained.

The design of the control rooms will ensure that operation can only take place from a single control room at any time, with means of preventing spurious or malicious operation.

19.2.3 Emergency Control Centre

The Emergency Control Centre (ECC) will co-ordinate the activities required to manage the response to events such as a release of radiation or fires.

19.2.4 Off-Site Emergency Control Centre

If an accident has progressed such that off-site arrangements are needed (e.g., evacuation), then an Off-Site ECC will be mobilised as a backup to the ECC. This facility will be a permanent structure, but only staffed when required in order to communicate with the personnel on-site, identify the appropriate off-site actions required, and communicate these with the relevant authorities and the public as required.



19.2.5 Plant Status Information

The operators will require an array of information to manage the plant post-accident, this information will be identified and incorporated into the displays for the MCR and SCR, as well as the Off-Site ECC where needed.

Post-accident, the operator will retain the ability to conduct samples and monitor for release of radiation.

19.2.6 Communications Systems

Appropriate communication systems will be installed to facilitate communications between relevant locations in the event of a radiation emergency.

19.2.7 Emergency Access/Egress

The layout of the RR SMR is being developed in accordance with design requirements from many disciplines to reduce risks to As Low As Reasonably Practicable (ALARP), including radiation protection, internal hazards, human factors, and emergency preparedness and response. Development of a layout to facilitate access and egress in the event of an emergency will be reported in a future revision of the E3S Case as evidence in the CAE Route Map is developed.

19.2.8 Other Onsite Facilities

Other onsite facilities supporting emergency preparedness and response will be described in future revisions of the E3S Case.

19.3 Conclusions

19.3.1 Conclusions

Preliminary evidence is presented to support the overall chapter claim that ‘The design of the RR SMR facilitates effective emergency preparedness and response to accidents that result in a potential release of radioactive substances’, which contributes to the overall E3S objective to protect people and the environment from harm, and the demonstration that risks are reduced ALARP.

At PCD, the evidence presented is limited to identification of international treaties, laws, regulations, and guidance relating to emergency preparedness and response that is relevant to the RR SMR, as well as a high-level description of the design features that will facilitate compliance by a future dutyholder/licensee.

Future revisions of this report are expected to include specific design requirements derived from the legislation and informed by E3S analysis and their verification, as evidence in the CAE Route Map is developed.

19.3.2 Assumptions and Commitments on Future Dutyholder/Licensee

Table 19.3-1: Assumptions and Commitments on Future Dutyholder/Licensee

Assumption/Commitment	ID	Description
Commitment	C19.1	Arrangements to meet the regulations and guidance for emergency preparedness and response shall be developed and implemented.

19.4 References

- [1] RR SMR Report, SMR0004294/001, "E3S Case Chapter 1: Introduction," March 2023.
- [2] RR SMR Report, SMR0002155/001, "E3S Case Route Map," March 2023.
- [3] IAEA, "Convention on Nuclear Safety, IAEA-INFCIRC/449," 1994.
- [4] IAEA, "Convention on Early Notification of a Nuclear Accident, IAEA-INFCIRC/335," IAEA, Vienna, 1986.
- [5] IAEA, "Fundamental Safety Principles," 2006.
- [6] IAEA, "Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7," 2015.
- [7] IAEA, "Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-G-2.1," 2007.
- [8] IAEA, "Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-1," 2011.
- [9] IAEA, "Accident Management Programmes for Nuclear Power Plants, IAEA Safety Standards Series No. SSG-54," 2019.
- [10] IAEA, "Method for the Development of Emergency Response Preparedness for Nuclear or Radiological Accidents, IAEA-TECDOC-953," 1997.
- [11] IAEA, "Preparedness and Response for a Nuclear or Radiological Emergency Combined with Other Incidents or Emergencies, Emergency Preparedness and Response," 2020.
- [12] IAEA, "Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, Emergency Preparedness and Response," 2013.
- [13] IAEA, "Overview of Training Methodology for Accident Management at Nuclear Power Plants, IAEA-TECDOC-1440," 2005.
- [14] IAEA, "Leadership, Human Performance and Internal Communication in Nuclear Emergencies, IAEA Nuclear Energy Series no. NG-T-1.5," 2018.
- [15] IAEA, "Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, Emergency Preparedness and Response," 2005.
- [16] IAEA, "The Fukushima Daiichi Accident, Non-serial Publications , Technical Volume 3/5," 2015.
- [17] IAEA, "IAEA Report on Preparedness and Response for a Nuclear or Radiological Emergency in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant, Action Plan on Nuclear Safety Series," 2013.
- [18] HM Government, "How we regulate radiological and civil nuclear safety in the UK," 2021.
- [19] HM Government, "Health and Safety at Work etc. Act 1974 (c.47)," 1974.
- [20] HM Government, "Nuclear Installations Act 1965," 1965.
- [21] ONR, "Licence Condition Handbook," 2017.
- [22] ONR, "LC-11 On-site Emergency Arrangements. Nuclear Safety Technical Inspection Guide NS-INSP-GD-011 Issue 7," 2021.
- [23] ONR, "Safety Assessment Principles for Nuclear Facilities, Revision 1," 2020.
- [24] ONR, "Japanese earthquake and tsunami: Implications for the UK nuclear industry, Final Report, ONR-FR-REP-11-002, Revision 2," 2011.
- [25] Department of Energy and Climate Change, "Nuclear Emergency Planning and Response Guidance - Concept of Operations," 2015.
- [26] HM Government, "Civil Contingencies Act 2004 (c.36)," 2004.

- [27] HM Government, "Radiation (Emergency Preparedness and Public Information) Regulations 2019. SI 2019/703," 2019.
- [28] Health and Safety Executive, "The Radiation (Emergency Preparedness and Public Information) Regulations 2019 Approved Code of Practice and guidance 2nd ed.," 2020.
- [29] HM Government, "Ionising Radiation Regulations 2017 SI 2017/1075," 2017.
- [30] HM Government, "Control of Major Hazard Regulations 2015 SI 2015/483," 2015.
- [31] RR SMR Report, SMR0004520/001, "E3S Case Chapter 18: Human Factors Engineering," March 2023.
- [32] RR SMR Report, SMR0003929/001, "E3S Case Chapter 7: Instrumentation & Control," March 2023.



19.5 Appendix A: Claims, Arguments and Evidence Route Map

19.5.1 Chapter 19 Route Map

A preliminary Claims decomposition from the overall Chapter 19 Claim is summarised in Table 19.5-1, including the Tier 2 Evidence underpinning the Claims at PCD (i.e. summarised in Revision 1 of this report) and further Tier 2 Evidence still to be developed.

Table 19.5-1: CAE Route Map

Level 1 Claims	Level 2 Claims	Level 3 Claims	Arguments	Evidence Summary within Chapter 19	Underpinning Tier 2 Evidence <i>*at PCD</i>	Underpinning Tier 2 Evidence <i>*in development</i>
Requirements for emergency preparedness and response are derived from RGP and OPEX	-	-	The treaties, laws, regulations, and technical guidance that inform design requirements on emergency preparedness and response are understood	Section 19.1	n/a	DOORS (TBD)
The RR SMR layout facilitates accident management and emergency response	-	-	-	Sections 19.2.1, 19.2.2, 19.2.3, 19.2.4 and 19.2.7	n/a	TBD



Level 1 Claims	Level 2 Claims	Level 3 Claims	Arguments	Evidence Summary within Chapter 19	Underpinning Tier 2 Evidence <i>*at PCD</i>	Underpinning Tier 2 Evidence <i>*in development</i>
The RR SMR design includes an emergency response facility to support operator activities and communications back to control rooms				Section 19.2	n/a	TBD
Emergency Response Procedures reflect emergency response requirements				Section 19.1.3	n/a	TBD by a future dutyholder

19.6 Acronyms and Abbreviations

ACOP	Acceptable Code of Practice and Guidance
ALARP	As Low As Reasonably Practicable
c	Chapter (relating to Acts of Parliament)
CAE	Claims, Arguments, Evidence
CCA	Civil Contingencies Act 2004
COMAH	Control of Major Accident Hazard Regulations 2015
DAC	Design Acceptance Confirmation
DOORS	Dynamic Object-Oriented Requirements System
ECC	Emergency Control Centre
ed	Edition
E3S	Environment, Safety, Security and Safeguards
GD	Guidance
GDA	Generic Design Assessment
HM	His Majesty's
HSWA	Health and Safety at Work etc. Act 1974
IAEA	International Atomic Energy Agency
INFCIRC	Information Circular
INSP	(Technical) Inspection
IRR	Ionising Radiations Regulations 2017
LC	Licence Condition
MCR	Main Control Room
NS	Nuclear Safety
ONR	Office for Nuclear Regulation
OPEX	Operational Experience



PCD	Preliminary Concept Definition
PCSR	Pre-Construction Safety Report
RD	Reference Design
REPPIR	Radiation (Emergency Preparedness and Public Information) Regulations 2019
RGP	Relevant Good Practice
RR	Rolls-Royce
SAP	Safety Assessment Principle
SCR	Supplementary Control Room
SI	Statutory Instruction
SMR	Small Modular Reactor
TBD	To Be Developed
UK	United Kingdom