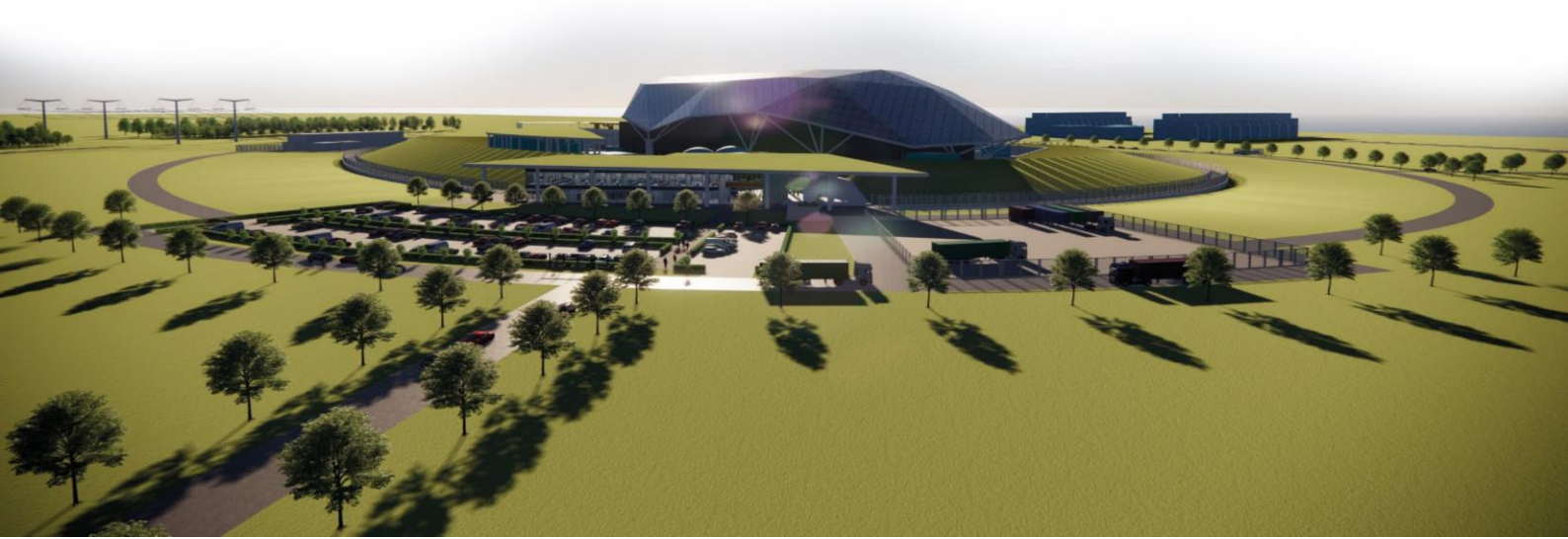
Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 19: Emergency Preparedness and Response



Record of Change

Date	Revision Number	Status	Reason for Change
March 2023	1	Issue	First issue of E3S Case
February 2024	2	Issue	Incorporates additional detail on design features for emergency preparedness defined at Reference Design 7, aligned to Design Reference Point 1.
May 2024	3	Issue	Updated to correct revision history status at Issue 2 Chapter changes include: • Additional detail within conclusion section for how arguments and evidence presented meet the generic E3S objective Also minor template/editorial updates for overall E3S Case consistency.

Executive Summary

Chapter 19 of the generic Rolls-Royce Small Modular Reactor (RR SMR) Environment, Safety, Security and Safeguards (E3S) Case presents the overarching summary and entry point to the demonstration of emergency preparedness and response for the RR SMR.

This chapter discusses the design and arrangements for preparedness and response to nuclear or radiological emergencies, as defined at reference design (RD) 7 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.

Preliminary evidence is presented to support the top-level chapter claim that 'the design facilitates effective emergency preparedness and response to accidents that may result in a potential radioactive release', which contributes to the overall E3S objective to protect people and the environment from harm, and the demonstration that risks are reduced as low as reasonably practicable (ALARP).

Version 2 of the generic E3S Case is developed in support of the RD7 design, corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA). At RD7, 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. This chapter provides a high-level description of the design features that will facilitate compliance by a future dutyholder/licensee/permit holder, such as control facilities and access/egress arrangements.

A large amount of relevant good practice (RGP) and legislation related to emergency preparedness have been identified, which are being incorporated into the design development. Whilst the design is continuing to develop, there is confidence that risks can be reduced to ALARP.

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19.0 Introduction to Chapter

19.0.1 Introduction

Chapter 19 of the Rolls-Royce Small Modular Reactor (RR SMR) Environment, Safety, Security and Safeguards (E3S) Case presents the overarching summary and entry point to the demonstration of emergency preparedness and response for the RR SMR.

This chapter discusses the design and arrangements for preparedness and response to nuclear or radiological emergencies, as defined at reference design (RD) 7, corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA). 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 and Maturity

The scope of this chapter 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/permit holder to comply with the identified regulations and guidance, noting the design information presented is based on a level of maturity commensurate with the RD7/DRP1 design maturity.

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

The initial conceptual boundary of responsibility between RR SMR and the future dutyholder/licensee/permit holder and local authorities is not defined at this stage. Where applicable, “Assumptions and commitments on the Future Dutyholder/Licensee/Permit Holder” are identified within section 19.4.2 of this chapter.

19.0.3 Claims, Arguments and Evidence Route Map

The overall approach to claims, arguments, evidence (CAE) and the set of fundamental E3S claims to achieve the E3S fundamental objective are described in E3S Case Version 2, Tier 1, Chapter 1: Introduction [1]. The associated top-level chapter claim for E3S Case Version 2, Tier 1, Chapter 19: Emergency Preparedness and 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, 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 [2]. 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.

A proportionate summary of the arguments and evidence from lower tier information, available at the current design stage, is presented within this chapter. A mapping of the claims to the

corresponding sections that summarise the arguments and/or evidence is provided in Appendix A (section 19.6).

19.0.4 Applicable Regulations, Codes and Standards

This section provides an overview of the UK and international treaties, laws, regulations, codes and standards, 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 [3] and the Convention on Early Notification of a Nuclear Accident [4]. The International Atomic Energy Agency (IAEA) publishes a fundamental safety objective and fundamental safety principles, [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 [6] [7] along with their supporting criteria [8].

Integrating a severe accident management programme into the emergency preparedness and response arrangements is covered in [9]. How the response to a radiation emergency should be prepared for is covered in [9]. If the event is combined with another type of emergency, such as an earthquake or aircraft crash, then additional guidance is given in [10]. 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 [11].

Adequate training of personnel that operate the plant and respond to an emergency is outlined in [12] and ensuring that the leadership, human performance and internal communications are adequate during a radiation emergency is addressed in [13].

Testing of the emergency response arrangements through emergency exercises is addressed in [14], 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 [15] [16] [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 [18].

The Health and Safety at Work etc. Act 1974 (HSWA) [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 include licensing under the Nuclear Installations Act 1965 [20]. The Office for Nuclear Regulation (ONR) Licence Condition (LC) handbook [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. Further details of how a dutyholder/licensee/permit holder can meet LC 11 are given in the Nuclear Safety Technical Inspection Guide [22].

The ONR Safety Assessment Principles (SAPs) for Nuclear Facilities [23] and Security Assessment Principles (SyAPs) [24] include 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 [25].

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 [26]. The Civil Contingencies Act 2004 (CCA) [27] outlines the coordination between external agencies for general disaster management.

The Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPIR) [28] impose duties on dutyholder/licensee/permit holders 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/permit holder 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) [29], which gives further details of the expected co-ordination actions between all parties.

The Ionising Radiations Regulations 2017 (IRR 2017) [30] 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) [31] 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 Arrangements for Performing Functions Essential for the Emergency Response

19.1.1 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/permit holder. This is captured in the following commitment on future dutyholder/licensee/permit holder, noting that this could be for any emergency (radiological or non-radiological):

Commitment on Future Dutyholder/Licensee/Permit Holder C19.1: The future dutyholder/licensee/permit holder shall develop and implement a set of arrangements that meet the regulations and guidance for emergency preparedness and response.

19.2 Emergency Response Facilities

19.2.1 Requirements

Design requirements related to emergency preparedness are contained in the RR SMR requirements management system, based on a combination of the regulations, etc. discussed in section 19.1, current relevant good practice (RGP), feedback from operational experience (OPEX) and appropriate E3S analyses (such as severe accident analysis). The E3S case throughout its future revisions will be updated to reflect any development of requirements.

19.2.2 Control Facilities

The RR SMR is planned to have several control facilities, as discussed in the RR SMR Control Facilities Description [32]. Some of these, discussed below, will support the future dutyholder/licensee/permit holder to implement the emergency arrangements.

Initial requirements for these spaces have been developed, for example for the protection of these spaces from hazards, environmental conditions and required adjacencies. These requirements continue to be developed and expanded.

19.2.2.1 Main Control Room

The RR SMR includes the provision of a centralised main control room (MCR) located within the Reactor Island [R01]. From the MCR, the operators will 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 from the MCR within the first 30 minutes of a fault occurring.

The MCR is being designed to maintain a habitable environment for a given timescale following the onset of a hazard, with a withstand capability against bounding design basis internal and external hazards and design extension conditions in line with RGP.

A secondary system is being 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 Version 2, Tier 1, Chapter 18: Human Factors Engineering [33]. The control and instrumentation (C&I) elements of the design of the MCR (and other emergency response facilities) are described further in E3S Case Version 2, Tier 1, Chapter 7: Instrumentation and Control [34].

19.2.2.2 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 {REDACTED}, 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.

19.2.2.3 Emergency Response Facilities

The emergency response facilities include an emergency response centre (ERC), technical support centre (TSC) and operational support centre (OSC). These provide facilities to allow the co-ordination of the activities required to manage the response to events such as a release of radiation or fires.

The ERC shall manage the flow of information to and from external bodies, including requests for external assistance and any necessary briefings to relevant off-site organisations. The ERC shall coordinate with the OSC for the field operations, and with the TSC for the technical advice to operators and key stakeholders.

19.2.2.4 Security Control Centre

The RR SMR plant will provide multiple security facilities from which security duties can be delivered. The primary facility is referred to as the Security Control Centre (SyCC), and this facility will work in co-ordination with the ERC to maintain a secure site.

19.2.2.5 Off-Site Emergency Response Centre

If an accident has progressed such that off-site arrangements are needed (e.g., evacuation), then an Off-Site ERC will be mobilised as a backup to the ERC. 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. The location of this will be determined by the future dutyholder/licensee/permit holder and is captured in the following commitment placed on the future dutyholder/licensee/permit holder:

Commitment on Future Dutyholder/Licensee/Permit Holder C19.2: The future dutyholder/licensee/permit holder shall establish an off-site Emergency Response Centre in an appropriate location.

19.2.3 Personnel Access and Egress

The RR SMR berm includes two entry/exit points for vehicles and pedestrians, located on opposing sides of the berm structure to reduce the potential for any single event to impede the entry/exit point. Specific locations for the processing of evacuated personnel, are likely to be site specific and have not been identified yet, however the RR SMR layout within the berm includes a number of equipment laydown areas which could be utilised.

At DRP1, the reactor island layout is described in the reactor island architectural and layout summary report [35]. This layout includes passageways and escape points in indicative locations. For example, the number of escape doors from Reactor Island may be increased or decreased once the Radiation Controlled Area and Contamination Controlled Area are better defined in order to ease the egress of personnel from these areas and provide separation from personnel exiting from the ‘clean’ side.

19.2.4 Procedures

Emergency operating procedures, severe accident management guidelines and related emergency response procedures for both safety and security related emergencies will be developed, routinely updated, and evaluated by the dutyholder/licensee/permit holder. This is described further in E3S Case Version 2, Tier 1, Chapter 13: Conduct of Operations [35].

E3S Case Version 2, Tier 1, Chapter 18: Human Factors Engineering [33] discuss the task analysis under development to inform and assess the RR SMR concept. These currently reflect many of the operator actions required to support design basis events. They will be extended to include operator actions required to support emergency preparedness and response.

19.3 Capability of the Operating Organization to Assess Potential Radioactive Releases in Accident Conditions

The future dutyholder/operator/permit holder must demonstrate capability to continuously assess the conditions of the plant during accident conditions and determine the potential radioactive releases and their significance. This is covered through the C&I elements of the design of the MCR (and other emergency response facilities), described in E3S Case Version 2, Tier 1, Chapter 7: Instrumentation and Control [34].

19.4 Conclusions

19.4.1 ALARP, BAT, Secure by Design, Safeguards by Design

A large amount of RGP and legislation related to emergency preparedness have been identified within this chapter, which is used to inform the RR SMR design as it develops into detailed design to provide confidence that risks associated with emergency preparedness can be reduced to ALARP.

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

Table 19.4-1: Assumptions and Commitments on Future Dutyholder/Licensee/Permit Holder.

Assumption/Commitment	ID	Description
Commitment	C19.1	The future dutyholder/licensee/permit holder shall develop and implement a set of arrangements that meet the regulations and guidance for emergency preparedness and response.
Commitment	C19.2	The future dutyholder/licensee/permit holder shall establish an off-site Emergency Response Centre in an appropriate location.

19.4.3 Conclusions and Forward Look

The generic E3S Case objective is 'to provide confidence that the RR SMR design will be capable of delivering the E3S fundamental objective as it developed from a concept design into a detailed design'. This confidence is built through development and underpinning of top-level claims across each chapter of the E3S Case, through supporting arguments and evidence. The top-level claim for chapter 19 is 'the design of the RR SMR facilitates effective emergency preparedness and response to accidents that may result in a potential radioactive release'.

The arguments and evidence presented in Version 2 of E3S Case chapter 19 is the identification of international treaties, laws, regulations, and guidance relating to emergency preparedness and response that is relevant to the RR SMR. A high-level description of the design features for emergency preparedness that will facilitate compliance by a future dutyholder/licensee, such as control facilities and access/egress arrangements is also provided.

Further arguments and evidence will be developed in line with the E3S Case Route Map [2] 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 detailed E3S requirements for inclusion in the design to facilitate emergency response and defining initial conceptual boundary of responsibility between RR SMR and the future dutyholder/licensee/permit holder and local authorities.

19.5 References

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

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

[3] IAEA, "Convention on Nuclear Safety, IAEA-INFCIRC/449," 1994.

[4] International Atomic Energy Agency, "Convention on Early Notification of a Nuclear Accident, IAEA-INFCIRC/335," 1986.

[5] International Atomic Energy Agency, "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-2," 2011.

[9] IAEA, "Method for the Development of Emergency Response Preparedness for Nuclear or Radiological Accidents, IAEA-TECDOC-953," 1997.

[10] IAEA, "Preparedness and Response for a Nuclear or Radiological Emergency Combined with Other Incidents or Emergencies, Emergency Preparedness and Response," 2020.

[11] IAEA, "Actions to Protect the Public in an Emergency due to Severe Conditions at a Light Water Reactor, Emergency Preparedness and Response," 2013.

[12] IAEA, "Overview of Training Methodology for Accident Management at Nuclear Power Plants, IAEA-TECDOC-1440," 2005.

[13] IAEA, "Leadership, Human Performance and Internal Communication in Nuclear Emergencies, IAEA Nuclear Energy Series no. NG-T-1.5," 2018.

[14] IAEA, "Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, Emergency Preparedness and Response," 2005.

[15] IAEA, "The Fukushima Daiichi Accident, Non-serial Publications ,Technial Volume 3/5," 2015.

[16] 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.

[17] IAEA, IAEA-TECDOC-2020, "Ten Years of Remediation Efforts in Japan," 2023.

[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 Security Assessment Principles, 2022.

[25] ONR, "Japanese earthquake and tsunami: Implications for the UK nuclear industry, Final Report, ONR-FR-REP-11-002, Revision 2," 2011.

[26] Department of Energy and Climate Change, “Nuclear Emergency Planning and Response Guidance - Concept of Operations,” 2015.

[27] HM Government, “Civil Contingencies Act 2004 (c.36),” 2004.

[28] HM Government, “Radiation (Emergency Preparedness and Public Information) Regulations 2019. SI 2019/703,” 2019.

[29] Health and Safety Executive, “The Radiation (Emergency Preparedness and Public Information) Regulations 2019 Approved Code of Practice and guidance 2nd ed.,” 2020.

[30] HM Government, “Ionising Radiation Regulations 2017 SI 2017/1075,” 2017.

[31] HM Government, “Control of Major Hazard Regulations 2015 SI 2015/483,” 2015.

[32] Rolls-Royce SMR Limited, SMR0005883 Issue 2, “Rolls-Royce SMR Control Facilities Description,” December 2023.

[33] Rolls-Royce SMR Limited, SMR0004520 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 18: Human Factors Engineering,” May 2024.

[34] Rolls-Royce SMR Limited, SMR0003929 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 7: Instrumentation & Control,” May 2024.

[35] Rolls-Royce SMR Limited, SMR0004247 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 13: Conduct of Operations,” May 2024.

19.6 Appendix A: Claims, Arguments, Evidence

Table 19.6-1 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 [2]. 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 [1].

Table 19.6-1: Mapping of Claims to Chapter Sections

Claim	**Section of Chapter 19 containing Arguments / Evidence summary**
Requirements for emergency preparedness and response are derived from RGP and OPEX	19.2.1
The RR SMR layout facilitates accident management and emergency response	19.2.3
The RR SMR design includes an emergency response facility to support operator activities and communications back to control rooms	19.2
Emergency Response Procedures reflect emergency response requirements	Commitment C19.1 on future dutyholder/ operator/permit holder

19.7 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
ERC	Emergency Response 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
OSC	Operational Support Centre

RD	Reference Design
REPPIR	Radiation (Emergency Preparedness and Public Information) Regulations 2019
RGP	Relevant Good Practice
RR SMR	Rolls-Royce Small Modular Reactor
SAP	Safety Assessment Principle
SCR	Supplementary Control Room
SI	Statutory Instruction
SyCC	Security Control Centre
TSC	Technical Support Centre
UK	United Kingdom