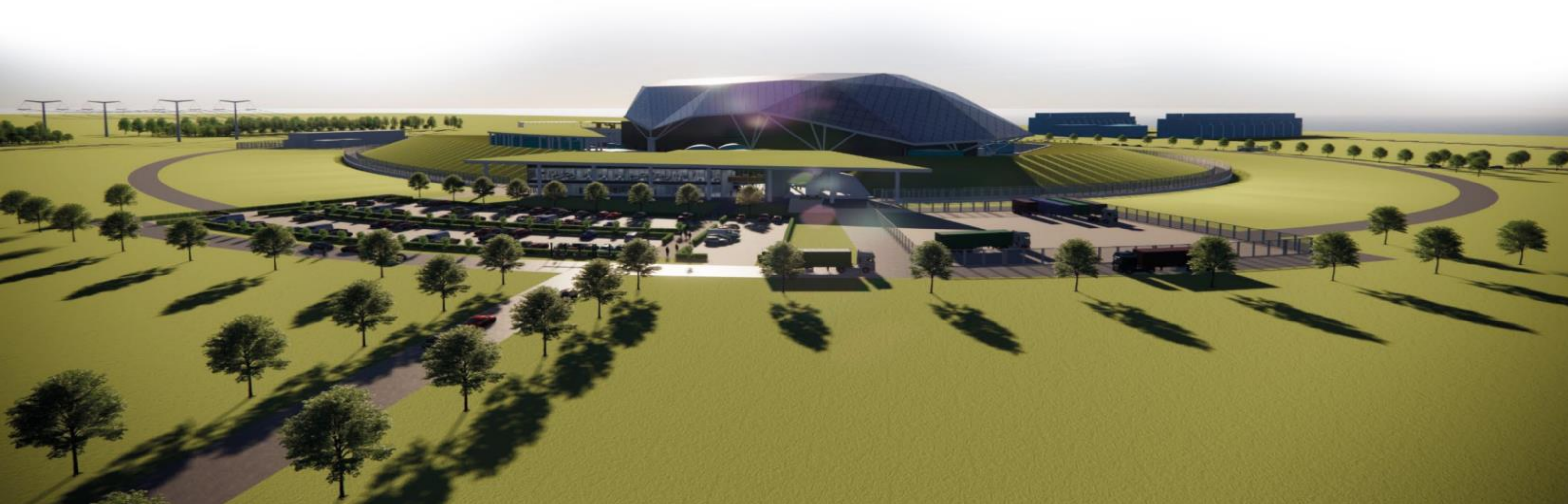
Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 22: Conventional and Fire Safety



Record of Change

Date	Revision Number	Status	Reason for Change
March 2023	1	Issue	First Issue of E3S Case
February 2024	2	Issue	Incorporates revised approaches defined at Reference Design 7, aligned to Design Reference Point 1, including: • Additional information on conventional health and safety processes • Additional information from fire strategy documentation
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 22 of the generic Environment, Safety, Security, and Safeguards (E3S) Case presents the conventional and fire safety aspects for the structures, systems, and components (SSCs) of the Rolls-Royce Small Modular Reactor (RR SMR).

The chapter outlines the arguments and evidence to underpin the high-level claim that the conventional and fire safety risks associated with the design, construction, commissioning, operation and decommissioning of the RR SMR have been reduced as low as is reasonably practicable (ALARP). Suitable conventional and fire safety methods, approaches, and requirements are established, for the RR SMR to achieve the E3S fundamental objective 'to protect people and the environment from harm'. This approach enables the design and analysis outputs presented throughout the E3S Case to provide a suitable demonstration that risks will be reduced to ALARP, apply best available techniques (BAT) and ensure secure by design and safeguards by design.

The high-level Rolls-Royce SMR Limited policies are described, including the relevant regulations, codes and standards for conventional and fire safety that are applicable to RR SMR. Strategies and processes for implementation of policies are also described.

The outputs of processes are presented to demonstrate how conventional and fire safety is embedded into the design, with particular focus on how design decisions support compliance with conventional and fire safety codes and standards. Hazard identification studies have also been undertaken, that have identified conventional and fire safety hazards, and measures to eliminate or mitigate them.

Version 2 of the generic E3S Case is developed in support of the reference design 7 (RD7) design, corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA). Further arguments and evidence are to be developed to underpin the top-level claim and to achieve the objective of the generic E3S Case, including fire strategies for RR SMR site buildings, outputs of human factors and conventional health and safety assessments, formalisation of conventional and fire requirements, further detailed layout and design features.

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22.0 Introduction to Chapter

22.0.1 Introduction

Chapter 22 of the Rolls-Royce Small Modular Reactor (RR SMR) generic Environment, Safety, Security and Safeguards (E3S) Case presents the overarching summary and entry point to the conventional and fire safety aspects of the RR SMR.

22.0.2 Scope and Maturity

The whole nuclear power station is covered in the scope of this chapter. Test rigs and manufacturing facilities are out of scope.

Nuclear fire safety is excluded from the scope of conventional fire safety, which is covered by internal hazards in the E3S Case Version 2, Tier 1, Chapter 15: Safety Analysis [1].

Version 2 of the generic E3S Case is based on reference design 7 (RD7), corresponding to design reference point 1 (DRP1) for the generic design assessment (GDA). At RD7, the relevant regulations, codes and standards are identified, and the associated RR SMR conventional and fire safety policies and processes are in place, which are being incorporated through ongoing analysis and design development.

22.0.3 Claims, Arguments, 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 [2]. The associated top-level chapter claim for E3S Case Version 2, Tier 1, Chapter 22: Conventional and Fire Safety is:

Claim 22: The conventional and fire safety risks associated with the design, construction, commissioning, operation and decommissioning of the RR SMR have been reduced as low as is reasonably practicable.

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 [3]. Given the evolving nature of the E3S Case alongside the maturing design, the underpinning arguments and evidence may still be developed in future design stages; the trajectory of this information, where possible, is also illustrated in the route map, which aligns the anticipated arguments and evidence to future issues of the generic E3S Case (subject to ongoing planning).

A proportionate summary of the arguments and evidence from lower tier information, available at the current design stage, is presented within this chapter. A mapping of the claims to the corresponding sections that summarise the arguments and/or evidence is provided in, Appendix A (section 22.5).

22.0.4 Applicable Regulations, Codes and Standards

The relevant codes and standards are identified in Table 22.0-1.

Table 22.0-1: Conventional and Fire safety Codes and Standards

Applicable to:	Codes and Standards
Conventional health and safety	British Standard BS 5975: 2019 Code of Practice for Temporary Works
	Confined Spaces Regulations 1997
	Construction (Design and Management) Regulations 2015
	Control of Major Accident Hazards Regulations 2015
	Control of Substances Hazardous to Health Regulations 2002
	Dangerous Substances and Explosive Atmospheres Regulations 2002
	Lifting Operations and Lifting Equipment Regulations 1998
	Management of Health and Safety at Work Regulations 1999
	Manual Handling Operations Regulations 1992 (as amended)
	Pressure Systems Safety Regulations 2000
	Provision and Use of Work Equipment Regulations 1998
	Restriction of Chemicals (REACH) etc. (Amendment) Regulations 2021
	The Control of Noise at Work Regulations 2005
	The Electricity at Work Regulations (as amended) 1989
	The Work at Height Regulations 2005
	Workplace (Health, Safety and Welfare) Regulations 1992
Conventional health and safety, Fire safety	Building Regulations 2010
	Equality Act 2010

Applicable to:	**Codes and Standards**
	Health and Safety at Work Act 1974
Fire safety	Construction (Design and Management) Regulations 2015
	Control of Major Accidents and Hazards Regulations 1999
	Dangerous Substances and Explosive Atmospheres Regulations 2002
	Regulatory Reform (Fire Safety) Order 2005
	The Building Safety Act

Applicable regulations, codes and standards that are relevant to Conventional Safety are discussed in Section 22.1.1 of this chapter.

Regulations, codes, and standards that are relevant to Fire Safety are presented in section 22.2.1.

22.1 Conventional Health and Safety

22.1.1 Applicable Regulations, Codes and Standards

The RR SMR is being designed to ensure compliance with relevant regulations, codes and standards for Conventional Health and Safety based on relevant good practice (RGP) listed below, noting this list is not exhaustive. The health and safety executive (HSE) publish guidance documents on many of these regulations. The complete list will form part of the transverse requirement set.

22.1.1.1 Health and Safety at Work Act 1974 (HSWA)

The Health and Safety at Work Act 1974 [4] requires that employers provide a safe environment for their employees and requires that risks are reduced to a level that is as low as reasonably practicable (ALARP). Reasonably practicable is considered as the incorporation of risk reduction measures such that the time, money, and trouble of implementing them is not grossly disproportionate to the level of risk reduction achieved.

22.1.1.2 Building Regulations 2010

The Building Regulations 2010 [5] impose a series of requirements which apply to most building works conducted in England and Wales.

22.1.1.3 Management of Health and Safety at Work Regulations 1999

The Management of Health and Safety at Work Regulations 1999 [6] were introduced to reinforce the Health and Safety Act 1974. They explicitly outline what employers are required to do to manage health and safety and apply to every work activity. The regulations place a set of duties on employers and employees to maintain a safe and healthy workplace.

22.1.1.4 Construction (Design and Management) Regulations 2015

Projects undertaken within Great Britain are subject to the requirements of the Construction (Design and Management) Regulations 2015 (CDM Regulations) [7]. The objective of CDM Regulations is to reduce risk to health and safety during construction and maintenance of construction sites and occupied buildings.

22.1.1.5 Lifting Operations and Lifting Equipment Regulations (LOLER) 1998

LOLER [8] covers all lifting equipment used at work. All lifting equipment is required to undergo a periodic thorough examination and inspection. The aim of LOLER is to ensure that all lifting equipment used in a work environment is maintained regularly and conforms to industry standards of safety.

22.1.1.6 Provision and Use of Work Equipment Regulations (PUWER) 1998

PUWER [9], places duties on people and companies who own, operate or have control over work equipment. PUWER also places responsibilities on businesses and organisations whose employees use work equipment, whether owned by them or not.

22.1.1.7 Control of Substances Hazardous to Health Regulations 2002 (as amended)

The Control of Substances Hazardous to Health Regulations 2002 (as amended) [10] is a United Kingdom Statutory Instrument which states general requirements imposed on employers to protect employees and other persons from the hazards of substances used at work by risk assessment, control of exposure, health surveillance and incident planning.

22.1.1.8 Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) etc. (Amendment) Regulations 2021

UK REACH [11] is a regulation that applies to the majority of chemical substances that are manufactured in or imported into Great Britain (England, Scotland, Wales). This can be:

- A substance on its own
- A substance in a mixture, for example ink or paint
- A substance that makes up an 'article' – an object that is produced with a special shape, surface or design, for example a specific component within the power station.

22.1.1.9 Confined Spaces Regulations 1997

Confined Spaces Regulations [12] apply where a risk assessment identifies risks of serious injury from work in confined spaces. These regulations contain the following key duties:

- Avoid entry to confined spaces
- If entry to a confined space is unavoidable, follow a safe system of work
- Put in place adequate emergency arrangements before the work start.

22.1.1.10 Dangerous Substances and Explosive Atmospheres Regulations 2002

The Dangerous Substances and Explosive Atmospheres Regulations 2002 [13] restrict the use of dangerous substances and the formation of potentially explosive atmospheres and require that risk assessments are completed where there is potential for dust, mists, or gases to gather in potentially explosive concentrations. If the risk of explosion cannot be eliminated, then hazardous area zones are formed, in which potential ignition sources are eliminated or controlled.

22.1.1.11 Control of Major Accident Hazards Regulations 2015

The Control of Major Accidents and Hazards (COMAH) Regulations 2015 [14] aim to prevent and mitigate the effects on people and on the environment of major, non-nuclear incidents involving hazardous substances. The COMAH Regulations will require that hazardous substances are identified, and control measures implemented (for example bunding and firefighting systems) depending on the substance and quantities involved.

22.1.1.12 Manual Handling Operations Regulations 1992 (as amended)

Manual Handling Operations Regulations 1992 (as amended) [15] aim to reduce the incidence and prevalence of musculoskeletal disorders arising from the manual handling of loads at work.

22.1.1.13 The Work at Height Regulations 2005

The purpose of The Work at Height Regulations 2005 [16] is to prevent death and injury caused by a fall from height. Employers and those in control of any work at height activity must make sure work is properly planned, supervised and carried out by competent people. This includes using the right type of equipment for working at height. Low-risk, relatively straightforward tasks will require less effort when it comes to planning.

22.1.1.14 Legionnaires' disease; The control of legionella bacteria in water systems. Approved Code of Practice and guidance on regulations L8

This code of practice [17] is aimed at dutyholders, including employers, those in control of premises and those with health and safety responsibilities for others, to help them comply with their legal duties in relation to legionella. These include identifying and assessing sources of risk, preparing a scheme to prevent or control risk, implementing, managing and monitoring precautions, keeping records of precautions and appointing a manager to be responsible for others.

22.1.1.15 British Standard BS 5975: 2019 Code of Practice for Temporary Works

BS 5975 [18] on temporary works procedures gives recommendations and guidance on the procedural controls to be applied to all aspects of temporary works.

22.1.1.16 Workplace (Health, Safety and Welfare) Regulations 1992

The Workplace Health Safety and Welfare Regulations 1992 [19] stipulates requirements that cover three main areas:

- Health
- Safety
- Welfare.

Each of these areas contains specific measures relating to health and safety concerns in the workplace.

22.1.1.17 The Control of Noise at Work Regulations 2005

The Control of Noise at Work Regulations 2005 [20] place a duty on employers within Great Britain to reduce the risk to their employees' health by controlling the noise they are exposed to whilst at work.

22.1.1.18 The Electricity at Work Regulations (as amended) 1989

The purpose of the Regulations [21] is to require precautions to be taken against the risk of death or personal injury from electricity in work activities.

22.1.1.19 Pressure Systems Safety Regulations 2000 (PSSR)

The duties imposed by PSSR [22] relate to pressure systems for use at work and the risk to health and safety. The aim of these Regulations is to prevent serious injury from the hazard of stored energy as a result of the failure of a pressure system or one of its component parts.

22.1.1.20 Equality Act 2010

The Equality Act 2010 [23] aims to protect people from discrimination in the workplace and in wider society. In respect of the RR SMR site and building design, the Equality Act requires that reasonable adjustments be made in relation to accessibility. In practice, this means that due regard must be given to any specific needs of likely building users that might be reasonably met.

'Accessibility and inclusivity' serve as a primary interface to fire safety design, particularly in respect of means of warning and escape provided to buildings and to the site. Therefore, the site fire strategy and building-specific fire strategies must include provisions to reasonably accommodate occupants who may have specific needs (e.g. mobility issues, neurodiversity etc.)

22.1.2 Conventional Safety Processes

Rolls-Royce SMR Ltd employs an integrated management system (IMS). The IMS is integral in enabling Rolls-Royce SMR Ltd, at all levels, to fulfil its responsibility for the safe delivery of the SMR programme, and the effective management of its business through the implementation of a governance framework, policies, manuals and business processes ensuring compliance to the applicable external legal, regulatory and nuclear industry requirements and expectation.

The following processes are in place to implement conventional safety policies and strategies. Application of these processes will support the reduction of risks to ALARP.

22.1.2.1 Design for Conventional Safety Process

The design for conventional safety process [24] is the overarching process for ensuring that conventional safety requirements inform the design, and that regulation, legislation and directive compliance is achieved.

The Health and Safety at Work Act 1974 (UK)/Directive 89/391/EEC – Occupational Safety and Health (EU) and their associated regulations, require the application of principles of prevention to reduce risk. The principles of prevention are:

- Avoiding risks
- Evaluating the risks which cannot be avoided
- Combating the risks at source
- Adapting the work to the individual, especially as regards the design of workplaces, the choice of work equipment and the choice of working and production methods, with a view, in particular, to alleviating monotonous work and work at a predetermined work-rate and to reducing their effect on health
- Adapting to technical progress

- Replacing the dangerous by the non-dangerous or the less dangerous
- Developing a coherent overall prevention policy which covers technology, organisation of work, working conditions, social relationships and the influence of factors relating to the working environment
- Giving collective protective measures priority over individual protective measures
- Giving appropriate instructions to employees.

These principles are applied in Rolls Royce SMR in line with the hierarchy of controls to ensure that hazards are eliminated wherever practicable before control measures are introduced.

22.1.2.2 Conduct Design Optioneering Process

The design optioneering process [25] generates design concepts and performs structured selection from them to reach a preferred solution. The process aims to ensure that RGP is identified and considered. The process ensures traceability in the decision-making process, that all necessary stakeholders are involved, and that the decision is formally approved and recorded in decision files.

22.1.2.3 Engineer Safe, Secure, Safeguarded and Environmentally Sound Products Process

The engineering of safe, secure, safeguarded and environmentally sound products process [26] is an iterative process that develops with the design. E3S design principles [27] are applied and any further design work required to meet these is identified. Hazard identification (HAZID) hazard and operability (HAZOP) studies, hazard log, internal hazard layout reviews or human factors assessments are being carried out as required.

22.1.2.4 Definition Review (DR) Process

The DR process [28] is used to provide technical governance for the development of product structures, systems, and components (SSCs) throughout the design lifecycle. It ensures a multi-disciplinary review of the SSCs at key points in its definition such that corrective actions can be taken as required. These reviews are chaired by delegates of the Chief Engineer who are independent from the work that is being reviewed. This process is repeated at each DR gate review in line with the governance plan.

22.1.2.5 Define and Manage Requirements Process

The define and mange requirements process [29] defines, develops, documents, and releases a set of clear and consistent requirements that address the needs of all stakeholders. The method seeks to ensure that all lifecycle stages are considered and that an agreed set of requirements is available against which a design solution can be developed and verified. Requirement definition is not necessarily linear and is inherently iterative, and so this process will be revisited many times throughout design. Conventional safety and fire requirements are captured in line with the processes and are stored in the requirements management database.

22.1.3 Conventional Safety Policies

Rolls-Royce SMR Ltd has the following conventional safety policies in place:

- Health, Safety and Environment Policy [30]
- Sustainability Policy [31]
- Nuclear Safety Culture Policy [32]
- Product Safety Policy [33].

The health and safety policy sets out the general approach to health and safety, ambitions, accountabilities and explains management arrangements for health and safety in the RR SMR.

The sustainability policy highlights commitments and responsibilities to safeguarding the environment, supporting people and the surrounding communities.

The nuclear safety culture policy sets out the duties of the company to customers, supply chain and to future generations to ensure the highest standards and safest solutions achieve a healthy, mature, and sustainable nuclear safety culture.

The product safety policy outlines the principles and responsibilities for eliminating, as far as is reasonably practicable, the risk of delivering an unsafe nuclear power station.

22.1.4 Conventional Safety Strategies

Rolls-Royce SMR Ltd has developed conventional safety strategies which include:

- SMR Construction (Design and Management) Strategy for Generic Design [34]
- RR SMR United Kingdom Conformity Assessed (UKCA) and CE Marking Compliance Strategy [35].

The SMR Construction (Design and Management) Strategy for Generic Design [34] defines the strategy to deliver projects that comply with the requirements of CDM [7]. Thus, ensuring health and safety is considered for the lifetime of the power station.

Rolls-Royce SMR Ltd has embedded CDM arrangements within its ways of working and the purpose of the document is to demonstrate a clear alignment between existing RR SMR process and governance arrangements, and those required for the management of CDM. This strategy builds upon initial CDM arrangements set out in the engineering management plan for RR SMR [36].

The RR SMR UKCA and CE Marking Compliance Strategy [35] provides initial strategic direction for Rolls-Royce SMR Ltd to deliver compliance with UKCA and Conformité Européene (CE) legislation, including where nuclear exclusions apply.

UKCA/CE legislation imposes legal obligations regarding conventional product safety and the free movement of goods across international borders. The legislation and its potential impact on RR SMR are discussed, together with the means and capabilities required to assure our compliance.

Further development on the conventional health and safety aspects associated with constructability of the RR SMR will be reported in future revisions of the E3S Case.

22.1.5 Skills, knowledge, experience and organisational capability for design

CDM Regulation [7], 5(1)(a) requires Rolls-Royce SMR Ltd to appoint a Principal Designer in writing. Currently the Chief Plant Engineer is the appointed Principal Designer for the generic design and the client is Rolls-Royce SMR Ltd [37].

CDM Regulation [7] 4(1) requires that Rolls-Royce SMR Ltd makes suitable arrangements for managing a project, including the allocation of sufficient time and other resources. Process S1.1.5 Identify and Manage Core Capability is used in Rolls-Royce SMR Ltd to determine the minimum level of core capability to demonstrably ensure that its organisation is capable of delivering designs and products which meet nuclear environmental protection, nuclear safety, security and safeguards requirements and meet the commercial and other expectations of its customers and stakeholders. This process provides minimum process requirements for identifying and managing core nuclear (including intelligent customer), and core business capabilities and for reporting on their status.

For conventional health and safety, required resource levels are reviewed regularly with a view of determining whether additional subject matter experts (SME) are needed.

CDM Regulation [7] 8(3) requires that Rolls-Royce SMR Ltd takes reasonable steps to ensure that designers, and the principal designer, appointed to work on a project have the skills, knowledge and experience, and, if they are an organisation, the organisational capability, necessary to fulfil the role that they are appointed to undertake, in a manner that secures the health and safety of any person affected by the project.

Rolls-Royce SMR Ltd ensures that it has suitably qualified and experienced personnel (SQEP) through deployment and governance of IMS process S1.3 (Develop People) with a defined process to assess competence (S1.3.1) and undertake training and evaluation (S1.3.2). Formal competence assessment is captured within the 'Skills Assured' tool which informs subsequent training requirements.

Informed conventional safety and fire safety input for the design is provided from the Health, Safety, Environment and Quality (HSEQ) Group under an integrated E3S input.

22.1.6 Implementation in Design

The engineering process C3.2.2-2 Conduct Design Optioneering [25] outlines the steps for selecting the best solution to an engineering problem from several potential concepts. The starting point is to have a number of concepts and then through a structured process to narrow them down to the 'best' solution, including conventional health and safety consideration. Detailed design after the down selection process will require the full lifecycle to be considered.

The conventional health and safety interfaces with numerous design disciplines, which are identified in this section.

22.1.6.1 Human Factors

Human factors consider ergonomics in design. Human factors design requirements are defined for health and safety for the RR SMR, these are discussed in E3S Case Version 2, Tier 1, Chapter 18: Human Factors Engineering [38].

22.1.6.2 Construction (Design and Management)

The SMR Construction (Design and Management) Strategy for Generic Design document [34] defines the RR SMR strategy to deliver projects that comply with the requirements of CDM. Thus, ensuring health and safety is considered for the lifetime of the power station.

RR SMR will engage with a power plant operator during the design process to eliminate, reduce or control foreseeable health and safety risks through the design process, such as those that may arise during construction and maintenance.

There is an intent to use building information modelling (BIM) to deliver various benefits in collaborative working and communication and this includes the embedding of health and safety information into 3D models, which can be used for lifetime management and maintenance purposes.

22.1.6.3 Fire Safety Design

Interfaces with fire safety design are discussed in section 22.2.5.

22.1.6.4 Layout

The SMR process C3.2.2-4: Design for Conventional Safety [24] is applicable to the layout at the various lifecycle stages of the plant and its proposed use, inclusive of operation, maintenance, construction, manufacture, commissioning, and decommissioning. This process supports the legislative compliance of the design in line with the principles of prevention, focusing on hazard identification and elimination in the concept phase of the design before ensuring that risks are reduced to ALARP in the detailed design phase.

The layout design risk management employs the hierarchy of controls for all risks, including conventional and fire safety, radiation protection, and internal and external hazards. In preference order, the design:

- Eliminates the risk (inherently safe, secure, and environmentally protected)
- Controls the risk using passive engineered means
- Controls the risk using active engineered means
- Controls the risk using administrative means
- Protects the people and the environment from a manifested risk.

The layout design contributes to enablement of safe and reliable performance of the operator through-life and through all operating modes by complying with examination, maintenance, inspection and testing (EMIT) requirements. EMIT requirements are considered fundamental to plant layout requirements. EMIT requirements are derived from a combination of SSC definition, nuclear and conventional safety requirements, and human factors requirements.

The layout at DRP1 has been developed to meet a number of different requirements. It will continue to be optimised and process C3.2.2-4 [24] will be followed to understand what the conventional safety risks are and what measures are required to ensure that they are reduced to ALARP.

22.1.6.4.1 Safety Electrical, Controls & Instrumentation Systems

Within the electrical, controls & instrumentation (EC&I) systems block there are high voltage system, the high voltage switchboards, considered as Areas of Special Fire Hazard Assessment as per the RI Fire Strategy [39]. These high voltage switchboards are in restricted-access areas so only trained personnel can gain access, as detailed in the EC&I systems layout report [40].

22.1.6.4.2 Fuelling Systems

The layout is to be optimised to ensure that all manual access operations interfacing the spent fuel storage and cask loading can be completed, whilst ensuring conventional and nuclear safety throughout. Should any operator activities be considered superfluous to the layout design, when considering the risk of operator dose uptake, the activities will be reviewed to determine alternative means of completion. Key considerations for the conventional safety of the fuel block are detailed in the fuelling systems layout report [41].

22.1.6.4.3 Containment and Interspace

At DRP1 the conventional safety aspects within containment and the interspace have not been assessed in detail. There are several requirements in place regarding conventional safety and the layout will develop to comply with these as well as all relevant legislation and regulations.

Some of the specific conventional safety considerations of the containment and interspace are the areas around the top of the pools within containment, where mechanical handling operations take place in conjunction with system routing and personnel access, and confined spaces when carrying out EMIT activities in areas such as the main containment sumps.

Throughout the Containment and the Interspace there are a multitude of mechanical handling solutions which are also being modelled as part of the verification strategy to ensure any clashes are identified, such that they can be resolved in a timely manner. Mechanical handling equipment and operations is designed to ensure they do not obstruct access and egress routes and provide safe means of access to the equipment themselves. Safe locations for mechanical handling operators are identified such that they are not at risk of any conventional safety hazards which could occur from a dropped load in the local vicinity.

The containment and interspace layout at DRP1 has been developed to meet a number of different requirements. It will continue to be optimised and process C3.2.2-4 [24] will be followed to understand what the conventional safety risks are and what measures are required to ensure that they are reduced to ALARP.

22.1.6.4.4 Waste Management Systems

At DRP1 the following bounding conventional safety risks have been identified and managed accordingly.

- The intermediate level waste (ILW) tank spaces, located on the lower levels of the northern auxiliary cluster, are classified as a confined spaces due to poor ventilation in an enclosed tank. As Penetrations at lower levels have been minimised to provide robust containment of potential leaks within the tank space. The design of the tanks and the respective ancillary components will minimise the requirement for entry into the tank spaces with sufficient space and planning for access equipment and forced ventilation as determined by a risk assessment. Additional ports are provided above the tanks for removal of smaller components such as C&I equipment.

- Management of risk is focused on elimination. EMIT activities use remote methods where possible, such as cameras, to avoid wherever practicable the requirement for operators to enter the tanks spaces.

- The coolant purification system bleed of primary coolant to the ion exchange columns and filters within the northern auxiliary block is classified as high-pressure pipework. Suitable mechanical kit-of-parts barriers will enclose the high-pressure let-down and make-up lines as they cross major circulation routes and other process modules. Detailed high-pressure pipe routing with suitable kit-of-parts protection is planned for the next design phase.

- Environmental hazards are present in the auxiliary and waste systems layout, from the use of gases in systems such as the treatment system. potentially explosive gases such as hydrogen are fed from a centralised service ring main through the block. Asphyxiant blanket gases are also present as part of the cover gas network. The gaseous distribution networks require adequate segregation and protection to prevent environmental release. Detailed gaseous distribution routes and kit-of-parts protection solutions are being developed concurrently for implementation in the next design phase.

- Routine operations within the waste block require overhead lifting equipment and mobile mechanical handling solutions such as fork-lift trucks. Segregation of personnel access and egress routes from the areas in which mechanical handling equipment operates are being considered.

22.2 Fire Safety

22.2.1 Applicable Regulations, Codes and Standards

The RR SMR is being designed to ensure compliance with relevant regulations, codes and standards for fire safety, which represent RGP, please note this list is not exhaustive. The Site Fire Strategy [42] establishes the applicable fire safety related legislation, guidance and technical standards which apply to the RR SMR site, buildings, and systems. These are summarised below.

22.2.1.1 Health and Safety at Work Act 1974 (HSWA)

The Health and Safety at Work Act 1974 [4] requires that employers provide a safe environment for their employees and requires that risks are reduced to a level that is ALARP. Reasonably practicable is considered as the incorporation of risk reduction measures such that the time, money, and trouble of implementing them is not grossly disproportionate to the level of risk reduction achieved.

22.2.1.2 Building Regulations 2010

Whilst the Building Regulations 2010 [5] are not applicable to most of the buildings on the site, the functional requirements are adopted by the fire strategy to gauge the acceptability of fire safety measures; particularly where departures from good practice are proposed. The safety levels described by the functional requirements are considered the minimum level of fire safety expected from new buildings in England and Wales, and their application is considered good practice.

Regulation 38 of the Building Regulations 2010 requires that a package of fire safety information ('as built' information), which records the fire safety design, must be provided to the person responsible for the premises. The fire safety information provided should include all fire safety design measures in appropriate detail and with sufficient accuracy to assist the responsible person to operate and maintain the facility in reasonable safety.

22.2.1.3 Regulatory Reform (Fire Safety) Order 2005

The Regulatory Reform (Fire Safety) Order 2005 (RRO) [43] requires fire precautions to be put in place where necessary and to the extent that it is reasonably practicable to do so.

Responsibility for complying with the RRO rests with the 'responsible person'. The responsible person is that person that has control over the premises. For commercial premises this is usually the occupier or owner of a building. The responsible person can appoint competent persons to carry out preventative and protective measures.

The RR SMR facility must be operated in accordance with the RRO. It is therefore a requirement for the design to support the operational use of the site, in accordance with the RRO.

22.2.1.4 The Building Safety Act

The building safety act is a legislative framework in the United Kingdom which is designed to enhance the safety of buildings.

Effective from 1st April 2023, this legislation primarily targets the design, construction, and oversight of buildings considered "high-risk".

The purpose of the act is to ensure that high-rise buildings are designed, constructed, and managed to be safe for occupants.

It applies to England and Wales and focuses on buildings that are 18 metres or more in height. It also covers the responsibilities of building owners, managers, and developers.

The act provides a legal framework for various regulations and guidance related to building safety. This includes fire safety and structural integrity.

The act holds those responsible for building safety accountable and imposes penalties for non-compliance.

22.2.1.5 Construction (Design and Management) Regulations 2015

Projects undertaken within Great Britain are subject to the requirements of the CDM Regulations [7]. The objective of CDM Regulations is to reduce risk to health and safety during construction and maintenance of construction sites and occupied buildings.

Virtually everyone involved in a construction project has legal duties under the CDM Regulations. The 'duty holders' at this stage in the design are as follows:

- Designer - An organisation or individual whose work involves preparing or modifying designs, drawings, specifications, bills of quantity or design calculations. Designers can be architects, consulting engineers and quantity surveyors, or anyone who specifies and alters designs as part of their work. They can also include tradespeople if they carry out design work. The designer's main duty is to eliminate, reduce or control foreseeable risks that may arise during construction work, or in the use and maintenance of the building once built. Designers work under the control of a principal designer on projects with more than one contractor.

- Principal designer - A designer appointed by the client to control the preconstruction phase on projects with more than one contractor. The principal designer's main duty is to plan, manage, monitor, and coordinate health and safety during this phase, when most design work is carried out.

The design will require the implementation of a Design Risk Register which documents the methods by which the fire safety risks, and risks arising from the implementation of fire safety systems required to support the fire strategy, are addressed and managed throughout the lifecycle of the plant.

22.2.1.6 Dangerous Substances and Explosive Atmospheres Regulations 2002

The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR) [13] restrict the use of dangerous substances and the formation of potentially explosive atmospheres and require that risk assessments are completed where there is potential for dust, mists, or gases to gather in potentially explosive concentrations. If the risk of explosion cannot be eliminated, then hazardous area zones are formed, in which potential ignition sources are eliminated or controlled.

Designers will need to undertake DSEAR assessments to identify dangerous substances and the associated fire or explosion risks, to eliminate or reduce the risks and to propose suitable control measures.

Designers need to prepare and issue DSEAR assessments and design proposals. This activity is relevant to the fire safety design because there are risk reduction measures that are common to both aspects of the design. This will include equipment specified in accordance with the Equipment and Protective Systems for Use in Potentially Explosive Atmospheres Regulations 2016 (EPSR Regulations) [44].

The fire strategy should be co-ordinated with the development of the DSEAR assessments and design proposals so that there is a consistent approach to the design.

22.2.1.7 Control of Major Accidents and Hazards Regulations 1999

The COMAH Regulations [14] aim to prevent and mitigate the effects on people and on the environment of major, non-nuclear incidents involving hazardous substances. The COMAH Regulations will require that hazardous substances are identified, and control measures implemented (e.g. bunding and firefighting systems) depending on the substance and quantities involved.

22.2.1.8 Equality Act 2010

The Equality Act 2010 [23] aims to protect people from discrimination in the workplace and in wider society. In respect of the RR SMR site and building design, the Equality Act requires that reasonable adjustments be made in relation to accessibility. In practice, this means that due regard must be given to any specific needs of likely building users that might be reasonably met.

'Accessibility and inclusivity' serve as a primary interface to fire safety design, particularly in respect of means of warning and escape provided to buildings and to the site. Therefore, the site fire strategy and building-specific fire strategies must include provisions to reasonably accommodate occupants who may have specific needs (e.g. mobility issues, neurodiversity etc.)

22.2.2 Applicable Primary Fire Safety Guidance

The guidance presented in this section relates to the primary fire safety guidance documents typically applied to support the fire safety design of buildings within England and Wales.

These documents typically form the basis for conventional (life) fire safety design assessments of such buildings and make reference to other standards and guidance documents which inform the design and construction of fire safety provision.

A compliance check against a primary fire safety guidance document does not provide a sufficient demonstration of the appropriateness of fire safety provisions in the design. The provision of risk reduction measures beyond the recommendations presented in fire safety guidance documents is expected to be necessary within a high hazard facility, such as a nuclear power plant, to reduce the overall life safety risk to ALARP. However, application of primary fire safety guidance, and referenced standards, is considered to represent good practice in developing the design and as part of the demonstration of safe design.

22.2.2.1 Approved Document B

Approved Document B (ADB) [45] is the statutory fire safety guidance applicable in England and Wales, which sets out a prescriptive minimum package of fire safety provisions considered to provide an appropriate level of safety within common buildings.

Approved Document B acknowledges that the guidance presented within this document may not be appropriate if the case is unusual in terms of its design, setting, scale or technology. It is considered that the guidance presented in Approved Document B is not appropriate for buildings on the RR SMR site which are complex in layout or incorporate significant plant / processing equipment. However, the guidance presented within Approved Document B may be referred to where it incorporates significant changes in technical standards, processes or regulations which have not yet been implemented by other applicable documentation (e.g. removal of national classifications for reaction to fire).

22.2.2.2 British Standard 9999

British Standard (BS) 9999 Fire safety in the design, management and use of buildings - code of practice [46] is the primary fire safety guidance document typically applied to complex buildings within England and Wales. The provisions of this document allow a more transparent and flexible approach to fire safety design, through use of a structured approach to risk-based design, where designers can take account of varying physical and human factors. Many of the measures recommended in BS 9999 are based on fire safety engineering principles, although it is not intended as a guide to fire safety engineering.

22.2.2.3 British Standard 7974

BS 7974 Application of fire safety engineering principles to the design of buildings – code of practice [47] is intended to provide a framework for the application of fire safety engineering principles to the design of buildings. Fire safety engineering provides an alternative approach to fire safety and can be the only practical way to achieve a satisfactory standard of fire safety in some large and complex buildings. BS 7974 is supported by the PD 7974 series of Published Documents that contain guidance and information on how to undertake detailed analysis of specific aspects of fire safety engineering in buildings.

The BS 7974 process involves the application of a qualitative design review (QDR) process in which the design team and relevant stakeholders agree on aspects of the proposed fire safety engineering analysis. The output of any QDR process is documented and referred to within any subsequent fire safety engineering analysis which is applied to the RR SMR design, and supports the claims, arguments and evidence justifications for the nuclear safety case.

Where fire safety engineering principles are adopted within the design, the guidance presented in BS 7974 should be adopted by the design. This includes, but is not limited to, the application of smoke transport modelling, structural fire modelling, evacuation modelling etc.

22.2.3 Processes and Strategies

22.2.3.1 Fire Safety Design Principles

Fire safety design principles have been defined to guide the overarching approach, including decisions on the specific preventative, protective and mitigative measures implemented in response to the fire hazard across the RR SMR project. The RR SMR fire safety design principles are presented in Table 22.2-1.

Table 22.2-1: RR SMR Fire Safety Design Principles

Principle ID	Principle
Fire Safety Design Principle 1	The range of facilities, buildings and operations across site shall consider all fire safety objectives holistically throughout the process of developing fire strategies. The principle of ALARP shall be applied during the specification of any fire protection systems such that all design interfaces are adequately considered.
Fire Safety Design Principle 2	Fire hazards, both fire loads and ignition sources, shall be identified, characterised and logged as part of a systematic hazards assessment.
Fire Safety Design Principle 3	Where possible plant inventory capable of contributing to a fire or fire initiation shall be removed or reduced.
Fire Safety Design Principle 4	Consideration shall be given to direct and secondary effects of fire as well as hazards associated with the implementation of fire systems and equipment.
Fire Safety Design Principle 5	The design of all facilities on site shall account for life safety requirements to provide suitable evacuation routes and access routes for firefighting.
Fire Safety Design Principle 6	A system of compartmentation or separation shall be implemented within the design to restrict the spread of fire.
Fire Safety Design Principle 7	A system to ensure early detection of fire and to raise the alarm to personnel shall be implemented within the plant design.
Fire Safety Design Principle 8	A process shall be put in place to achieve rapid, safe extinguishment of a fire once detected.
Fire Safety Design Principle 9	The design of any fire systems and protection measures shall take due account of required manual operations, maintenance and testing procedures and lifetime/obsolescence considerations to ensure the principle of ALARP is applied to all phases of the plant lifecycle.
Fire Safety Design Principle 10	Suitable fire safety management procedures shall be implemented to ensure that the organisation and responsibilities of personnel with an interest in fire safety activities are adequately defined and carried out by SQEPs.

The principles are applicable across all aspects of fire safety design and to all the facilities forming the RR SMR, including conventional, nuclear and high hazard environments. Further details and commentary on the principles are set out in the Site Fire Strategy [42].

22.2.3.2 Site Fire Strategy Provisions

The site fire strategy for the RR SMR is developed, applying the fire safety principles as defined in the Site Fire Strategy [42], and applying the primary fire safety guidance presented in BS 9999 [46].

The technical requirements for the fire safety provisions which serve the site as a whole are described in this section.

22.2.3.2.1Site Layout and Infrastructure

In order to inhibit the spread of fire between neighbouring buildings, the site layout considers the physical separation of buildings which are expected to include high fire loads (e.g. the refuse store, backup generator building) from buildings which are critical to nuclear safety, or fire protection measures (e.g. the fire protection building). Where physical separation is not possible, the risk of fire spread between these buildings is being mitigated by the provision of fire resisting external wall construction as described in the building-specific fire strategy documents.

22.2.3.2.2 Fire Control Centre

The site should be provided with a fire control centre which meets the recommendations presented in BS 9999 [46] to enable the fire and rescue service to assist the plant management to control an incident immediately on arrival.

22.2.3.2.3 Sitewide Fire Detection System

Fire detection systems are provided within all facilities of the RR SMR site in accordance with the requirements of BS 5839-1. Each building is provided with a stand-alone fire detection system provided with its own fire alarm panel and networked such that the status of all fire detection infrastructure is available within the fire control centre.

22.2.3.2.4 Sitewide Fire Alarm System

Occupant warning for fire evacuation purposes throughout the site will utilise a Public Address Voice Alarm system to sound warnings and verbal messages to all occupants of the site. The sitewide fire alarm system is developed to achieve Category V4 when designed in accordance with BS 5839-8 [48]. Each building is generally to be provided with sufficient voice alarm sounders to alert occupants of a fire in all occupied parts of the building (subject to risk assessments).

22.2.3.2.5 Evacuation Strategy

The RR SMR site is split into separate evacuation zones. At this stage in the design, it is proposed that the balance of plant facilities evacuate separately from Reactor Island, Turbine Island and cooling island facilities.

Upon detection of fire within an evacuation zone, an evacuation signal shall be broadcast within the evacuation zone of fire origin immediately. All other evacuation zones are provided with an immediate warning signal ordering occupants to remain in place, but to prepare to evacuate.

22.2.3.2.6 External Escape Routes and Assembly Points

External escape routes are provided from the final exits of buildings to a suitable fire assembly point on the site.

22.2.3.2.7 Emergency Lighting

Emergency lighting is provided to illuminate all external escape routes and assembly points in accordance with the requirements of BS 5266-1 [49] and BS EN 1838 [50].

22.2.3.2.8 Fire Safety Signage

Fire safety signage is provided in all buildings in accordance with BS 5499-4 [51] and BS ISO 3864-1 [52].

22.2.3.2.9 Fire Service Vehicle Access

To facilitate an effective response to fires within the site, the fire & rescue service are required to be provided with appropriate vehicle access.

22.2.3.2.10 Fire Service Communications

The fire and rescue service are expected to use their own hand-held radios throughout the site except where alternative communication systems are provided (e.g. refuges and firefighting lifts).

The RR SMR site includes appropriate provisions to ensure adequate coverage for hand-held radios such as signal boosters.

22.2.3.2.11 Firefighting Water Supply Provisions

The firefighting water provisions are designed in accordance with National Fire Protection Assocation (NFPA) 24 [53] with the provision of additional enhancement relating to signage, spacing of hydrants, ring main configuration and water supplies.

Whilst NFPA 24 is not a standard referenced within UK-based primary fire safety guidance, NFPA 24 provides guidance for the provision of onsite water storage to supply the site ring mains and is therefore considered RGP for application within the RR SMR site.

22.2.3.2.12 Site Fire Hydrants

The RR SMR site is provided with a site-wide ring main system which serves hydrants and fixed firefighting systems within the building. The hydrants are designed in accordance with BS 9990 [54], with some enhancements to accommodate NFPA 24 [53] requirements.

22.2.3.2.13 Firefighting Water Containment and Drainage

Facilities which contain hazardous, flammable or toxic substances is provided with appropriate facilities to contain, drain and isolate leaks and firefighting water that is applied to control a fire within these areas.

22.2.3.2.14 Portable Fire Extinguishers

Portable fire extinguishers are provided within fire extinguisher points throughout the site in accordance with the recommendations of BS 5306-8 [55].

22.2.3.2.15 Fire Safety Management Measures

The operator shall develop a fire safety management plan which documents fire safety management procedures, including but not limited to, personnel training, fire prevention measures, and EMIT of fire safety systems and equipment. This is identified as a future assumption / commitment on the future dutyholder/licensee.

22.2.3.2.16 Internal Fire Safety Provisions

This summarises fire safety provisions intended to protect specific buildings or equipment, or occupants of buildings located on the site. Performance expectations set for the fire safety provisions to be included within these areas to achieve an appropriate level of fire safety within the site are detailed in the Site Fire Strategy [42]. The building-specific fire strategy documents capture the fire safety provisions within each building.

The Reactor Island Fire Strategy [39] lists technical requirements regarding:

- Means of warning and escape
- Internal fire spread (linings)
- Internal fire spread (structures)
- External fire spread
- Firefighting access and facilities
- Fire safety management.

22.2.4 E3S Functional Requirements

Some facilities may have E3S functional requirements that are applicable and may impact the necessary fire safety provisions to demonstrate an appropriate level of E3S. For example, where parts of the building are required to remain occupied during a fire to support nuclear safety functions, the fire safety provisions within the building must reinforce this requirement (for example, by providing emergency standby lighting, appropriate fire separation from the compartment of fire origin, additional protected escape routes etc).

The Reactor Island will have applicable E3S functional requirements that may support or conflict with conventional fire safety provisions aims to demonstrate an appropriate level of safety, as detailed in the Reactor Island Fire Strategy [39]. The Reactor Island E3S functional requirements and conventional fire safety provisions are developed through iterative analysis and will be reviewed holistically to reduce risks to ALARP.

22.2.5 Implementation in Design

The fire safety design of the RR SMR site, structures, systems, and components interfaces with numerous design disciplines, which are identified in this section.

22.2.5.1 Nuclear Safety

The assessment of nuclear fire safety is covered in the internal hazards topic area, which include methodologies suitable to substantiate nuclear safety claims. However, the nuclear safety case may rely upon fire safety provisions. This may include, for example, compartmentation, fire suppression, smoke and heat control systems etc.

Specific requirements relevant to the fire safety design which form part of the nuclear safety case will be incorporated within the site and building-specific fire strategy documents and captured within the RR SMR requirements management system.

22.2.5.2 Conventional Health and Safety

Conventional health and safety is considered to interface with the fire safety design in several ways, including the following:

- Radiation protection (e.g. provision of smoke control systems which do not expel air from radiologically contaminated plant areas)
- Working from height (e.g. consideration of placement of fire safety equipment that must be maintained);
- Confined spaces (e.g. consideration of access / egress restrictions, drastically reduced smoke-fill and oxygen depletion times etc.)
- Substances hazardous to health (e.g. in respect of the selection of appropriate materials and, where unavoidable, the segregation of materials and substances which could be hazardous to health) via Control of Substances Hazardous to Health (COSHH) assessments
- Potentially explosive atmospheres (e.g. where the design requires the implementation of explosion protection or fire protection provisions to mitigate the risk associated with deflagration or detonation events)
- Transportation (e.g. where emergency vehicles are required to gain access adjacent to firefighting shafts which also serve as means of escape from the building).

Requirements relevant to the fire safety design which arise from conventional health and safety assessments will be incorporated within the site and building-specific fire strategy documents and captured in the RR SMR requirements management system.

22.2.5.3 Ancillary Firefighting Systems

The ancillary systems within the Balance of Plant scope include the fire extinguishing system, which serves as a primary design interface with the fire safety strategy and provisions for the site and buildings.

This site fire strategy document confers specific requirements to the fire extinguishing systems [XG], including facilities to supply firefighting water to the site. It is expected that the building-specific fire strategies will confer performance requirements to be met by the fire extinguishing system [XG] and its subsystems.

The site and buildings are designed to accommodate these systems and provide appropriate facilities for their use in the event of an emergency.

Interfaces between these systems and the fire safety provisions within the site and buildings includes provision of:

- Sufficient quantities of firefighting water storage on the site

- Facilities to supply firefighting water at a sufficient rate and pressure to fire extinguishing systems and for manual firefighting
- Sufficient and appropriate hydrants within the site
- Appropriate fire vehicle access for hydrants
- Sufficient space to route piping and discharge points for firefighting systems
- Facilities to drain and capture spent firefighting discharge.

22.2.5.4 Mechanical, Electrical, and Public Health Engineering

Mechanical, electrical and public health engineering forms a primary interface with a substantial number of fire safety provisions included within the plant. This includes all active fire safety systems (e.g. fire detection, suppression, mechanical smoke control, secondary power supplies etc.) The mechanical, electrical and public health engineering disciplines are consulted on all matters relating to fire safety systems within their domain.

The mechanical, electrical and public health engineering disciplines are expected to implement services which penetrate fire resisting lines and divisional barriers. These aspects will require the implementation of firestopping and damper products to inhibit the spread of fire and smoke. These provisions will impact the access requirements during construction and maintenance operations.

22.2.5.5 Installation Assemblies, Civil and Structural Engineering

Structures and barriers provided on the site are required to achieve a defined period of fire resistance in terms of loadbearing capacity to meet conventional fire safety and nuclear safety requirements. On this basis, the design of loadbearing structures within the buildings incorporates requirements from the building specific fire strategy documents, which may require structural encasement, or application of fire protective coatings to structural members.

The civil design of the site is likely to have interfaces with fire safety structures and systems, including fire vehicle access, buried services (e.g. fire mains), and design of drainage for firewater runoff. The technical requirements for these aspects of the design are conferred from the site and building-specific fire strategies and from the Basis of Design documents for each of the relevant fire safety systems.

The detailed design of modules / module clusters is expected to include interface details between segments of fire resisting barriers, and equipment which is required to be connected between modules. The detailed design of modules / module clusters and interior design of modules (e.g. partition design, finishes etc.) must be conducted so as to ensure that the fire performance requirements for all elements of construction, systems and equipment within the design are met, including in the interfaces between modules and module clusters

22.2.5.6 Security

Security is a primary design interface with fire safety insofar as security restrictions can obstruct:

- egress from areas which are required to be evacuated during a fire scenario (e.g. where strict access control is required)
- access to facilities for assisted egress (e.g. where such facilities are separated from the egress route by security barriers)
- access for firefighters (e.g. where security provisions are required to remain in place even during firefighter response).
- the evacuation of security personnel who are required to remain in situ (e.g. within the Security Control Centre).

The RR SMR design will be conducted to minimise the impact that security provisions impose upon the fire safety of the site, buildings and systems. Where access to suitable egress facilities is restricted, alternative facilities may be required to be implemented to achieve an appropriate level of safety. Where access to areas of the plant is to remain restricted, a suitable firefighting access strategy for these areas must be adopted, documented and justified within the relevant fire strategy document(s).

22.2.5.7 Emergency Preparedness

The Emergency preparedness arrangements for the site include provisions for response to fire events on the site. This includes facilities for first-aid firefighting, and management procedures associated with identifying the location of a fire, managing evacuation of the site and liaising with fire service response.

The emergency preparedness plan must consider the requirements of the site and building-specific fire strategies.

E3S Case Version 2, Tier 1, Chapter 19: Emergency Preparedness and Response [56] discusses design and arrangements for preparedness and response to nuclear or radiological emergencies.

22.2.5.8 Layout

The layout and architectural design forms a primary interface with the site and building-specific fire safety designs

The layout of the buildings and use of the accommodation will impact the requirements for means of escape and internal fire spread and are influenced by requirements arising from the building-specific fire strategies (e.g. travel distance limits, fire resisting walls and floors etc.).

The height of buildings, proximity of buildings and proposed compartment sizes will impact internal and external fire spread provisions (e.g. minimum period of fire resistance, external wall fire resistance etc.).

The location and arrangement of protected escape stairs and firefighting shafts within the buildings are considered likely to impact the access and facilities for firefighters provided both within the buildings and the wider site (e.g. vehicle access provisions, hydrant locations etc.).

The architectural designers are therefore required to be consulted on the fire strategy requirements conferred by the site and building-specific fire strategy documents.

22.2.5.9 Site Layout

The site layout considers the physical separation of buildings which are expected to include high fire loads (e.g. the refuse store, backup generator building) from buildings which are critical to nuclear safety, or fire protection measures (e.g. the fire protection building). Where physical separation is not possible, the risk of fire spread between these buildings are mitigated by the provision of fire resisting external wall construction as described in the building-specific fire strategy documents.

The fire safety aim of physical segregation (by means of spatial separation or fire resisting walls) is to inhibit the spread of fire between neighbouring buildings, particularly where these buildings contain inventory for which fire would comprise a significant nuclear safety or radiological release risk, or fire protection equipment which is integral to the fire safety strategy of the site or buildings.

Services are distributed via a common service corridor which is buried below ground level and extends around the nuclear island buildings with crossing points to allow access under the vehicle access infrastructure and site factory foundations. The fire ring main is distributed within this common service corridor.

22.2.5.10 Reactor Island Layout

The Reactor Island layout complies with the key requirements of the Reactor Island Fire Strategy [39] through the following fire risk mitigation measures, detailed in the Reactor Island Architectural and Layout Summary Report [57]:

- Segregation - Where areas of high hazard or special fire hazard have been identified, spatial separation and/or compartmentalisation has been provided by fire resisting barriers. These barriers protect access and escape routes from the areas of fire hazard, and are of civil or Module Kit of Parts construction, depending on the other requirements of the access and plant spaces.

- Escape routes - Depending on the fire risk profile of the area (as defined by the Reactor Island fire strategy document), maximum single-direction and multi-direction travel distances have been defined as requirements for the layout design in accordance with BS 9999.

- Fire Fighting – Fire Fighting shafts have been provided. The Fire Fighting shafts comprise Fire Fighting stairs, and a Fire Fighting lobby provided with a fire main and Fire Fighters lift. There are six Fire Fighting shafts in the Reactor Island layout; two in the Auxiliary Block, two North and South of the Interspace, adjacent to the Safety Fluids Blocks, and two in North-East and South-East of the EC&I Blocks. Detailed layout and positions of these shafts are provided in the relevant systems layout reports.

- Detection and alarm - Detection and alarm systems are required within specific areas of RI. At DRP1, these systems and their detailed requirements have not been developed; however, the risk to the layout is considered to be low.

- Suppression - Automatic fire suppression and extinguishing systems are anticipated to be required for conventional fire safety, nuclear fire safety and asset protection purposes. The suppression/extinguishing media are dependent on the application and fire type for the area. Although these systems have not been designed in detail, the potential flooding risk as a result of their use has been considered in the Internal Hazards summaries of the relevant systems layout areas.

A gap analysis has been carried out for the Reactor Island fire strategy [39]. The gap analysis summarises and tabulates where a change has occurred at DRP1 compared to previous design baselines and details the potential implications of this change. For completeness the analysis then confirms where the design has not changed from previous design baselines, so the information detailed within the main body of this chapter can be referred to. Finally, identification of any additional gaps and further work that have emerged during the assessment of the DRP1 design are noted.

22.2.5.11 Turbine Island Layout

The implementation of fire safety requirements for the Turbine Island layout will be included in future revisions of the E3S case.

22.2.5.12 Cooling Water Island

The implementation of fire safety requirements implementation for the Cooling Water Island layout will be included in future revisions of the E3S case.

22.3 Conclusions

22.3.1 ALARP, BAT, Secure by Design, Safeguards by Design

The processes, strategies, methods, and guidance for conventional and fire safety presented in this chapter are developed based on RGP from regulations, codes, and standards. They are being applied to the ongoing development of the design, analysis, and verification of SSCs through the engineering and E3S processes, to ensure the E3S fundamental objective can be met by the RR SMR at all lifecycle stages. This provides confidence that the design can reduce conventional and fire safety risks to ALARP, apply BAT, and ensure secure by design and safeguards by design.

Evidence of the implementation of these processes through both the layout and the design features at DRP1 is presented in this chapter. Further design risk assessments (DRAs), lifecycle risk assessments (LRA) and HAZID studies (including HAZOPs) will continue to be undertaken through the detailed design stages. These iterative assessments input to the design development to support ongoing risk reduction.

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

Assumptions and commitments raised on the future Dutyholder/Licensee are summarised in Table 22.3-1.

Table 22.3-1: Assumptions and Commitments on Future Dutyholder/Licensee/ Permit Holder

Assumption/ Commitment	ID	Description
Commitment	C22.1	The Future Dutyholder/Licensee/ Permit Holder shall develop a fire safety management plan which documents fire safety management procedures, including but not limited to, personnel training, fire prevention measures, and EMIT of fire safety systems and equipment.
Commitment	C22.2	The Future Dutyholder/Licensee/Permit Holder shall identify and implement the required control measures to manage the residual conventional safety risk.

22.3.3 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' [2]. 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 22 is 'the conventional and fire safety risks associated with the design, construction, commissioning, operation and decommissioning of the RR SMR have been reduced as low as is reasonably practicable'.

The arguments and evidence presented in Version 2 of E3S Case chapter 22 include descriptions of high-level Rolls-Royce SMR Limited policies, including the relevant regulations, codes and standards for conventional and fire safety that are applicable to RR SMR. Strategies and processes for implementation of policies are also described.

Further arguments and evidence to underpin the claim will be developed in line with the E3S Case Route Map [3] 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 fire strategies for RR SMR site buildings, outputs of human factors and conventional health and safety assessments, formalisation of conventional and fire requirements, and further detailed layout and design features to reduce risks associated with conventional and fire safety, both in Reactor Island and other areas of the plant.

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[51] British Standards Institute, "BS 5499-4 - Safety Signs. Code of practice for escape route signing," 2013.

[52] British Standards Institute, "BS ISO 3864-1 - Graphical Symbols - Safety colours and safety signs. Part 1: Design principles for safety signs and security markings," 2011.

[53] National Fire Protection Assocation, "NFPA 24 - Standard for the installation of private fire service mains and their appurtenances," 2019.

[54] British Standards Institute, "BS 9990 - Non automatic fire-fighting systems in buildings. Code of practice," 2015.

[55] British Standards Institute, “BS 5306-8 - Fire extinguishing installations and equipment on premises. Part 8 - Selection and positioning of portable fire extinguishers - Code of practice,” 2012.

[56] Rolls-Royce SMR Limited, SMR0004363 Issue 3, “Environment, Safety, Security and Safeguards Case Version 2, Tier 1, Chapter 19: Emergency Preparedness and Response,” May 2024.

[57] Rolls-Roycs SMR Limited, SMR0007298 Issue 1, “Reactor Island Architectural and Layout Summary Report,” January 2024.

22.5 Appendix A: Claims, Arguments, Evidence

Table 22.5-1 provides a mapping of the claims to the corresponding sections of the chapter that summarise the arguments and/or evidence. The full decomposition of claims and link to underpinning Tier 2 and Tier 3 information containing the detailed arguments and evidence is presented in the E3S Case Route Map [3]. 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 [2].

Table 22.5-1: Mapping Claims to Chapter Sections

Claim	**Section of Chapter 22 containing Arguments/Evidence Summary**
The conventional health and safety risks across the lifecycle of the RR SMR are understood and the relevant legislation for demonstrating compliance has been identified.	22.1.1, 22.2.2
The RR SMR organisation has the necessary SQEP to undertake the duties associated with developing a design to reduce conventional safety risks to ALARP.	22.1.5
Processes and methodologies to inform the design to reduce conventional and fire risks reflect RGP and are followed.	22.2.3, 22.2.3
Conventional safety and fire safety requirements for the design are complete and correct.	Not covered in this revision
The site and plant facility layout and system design minimise conventional and fire safety risks to ALARP.	22.1.6, 22.2.5
The design of the RR SMR is substantiated to confirm the conventional and fire safety risks are reduced to ALARP.	Not covered in this revision

22.6 Abbreviations

ADB	Approved Document B
ALARP	As Low As Reasonably Practicable
BAT	Best Available Techniques
BIM	Building Information Management
BS	British Standard
CAE	Claims, Arguments, Evidence
CDM	Construction (Design and Management)
CE	Conformité Européene
COMAH	The Control of Major Accidents and Hazards
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
DR	Definition Review
DRAs	Design Risk Assessments
DRP	Design Reference Point
EC&I	Electrical, Controls & Instrumentation
EMIT	Examination, Maintenance, Inspection and Testing
GDA	Generic Design Assessment
ILW	Intermediate Level Waste
IMS	Integrated Management System
HAZID	Hazard Identification
HAZOP	Hazard and Operability
HSE	Health and Safety Executive
HSWA	Health and Safety at Work Act
LOLER	Lifting Operations and Lifting Equipment Regulations
LRA	Lifecycle Risk Assessments

NFPA	National Fire Protection Association
PUWER	Provision and Use of Work Equipment Regulations
RD	Reference Design
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RGP	Relevant Good Practice
PSSR	Pressure Systems Safety Regulations
QDR	Qualitative Design Review
SME	Subject Matter Exprt
SSCs	Structures, Systems and Components
SQEP	Suitably Qualified and Experienced Personnel
UKCA	United Kingdom Conformity Assessed