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PSR Part B Chapter 12 Control of Non-Radiological Hazards

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12.1 INTRODUCTION

The Fundamental Purpose of the Generic Design Assessment (GDA) Safety, Security and Environment Case (SSEC) is to demonstrate that the Generic Small Modular Reactor (SMR)-300 can be designed, constructed, operated, and decommissioned on a generic site in the United Kingdom (UK) to fulfil the future licensee's legal duties to be safe, secure and protect people and the environment as defined in Preliminary Safety Report (PSR) Part A Chapter 1 Introduction [1].

The Fundamental Purpose is supported by the PSR's Fundamental Objective which is to summarise the safety standards and criteria, safety management and organisation, claims, arguments and intended evidence to demonstrate that the Generic SMR-300 design risks to people are likely to be tolerable and As Low As Reasonably Practicable (ALARP).

The PSR Part B Chapter 12 presents the Claims, Arguments and intended Evidence (CAE) which underpin the nuclear site health and safety and conventional fire safety of the Generic SMR-300.

12.1.1 Purpose and Scope

The Fundamental Purpose follows a golden thread throughout the SSEC to CAE via the objectives of the PSR, Preliminary Environmental Report (PER) and Generic Security Report (GSR) [2]. The overarching SSEC claims are presented in PSR Chapter A Part 3 Claims, Arguments and Evidence [3], and this chapter links to the overarching claims through:

Claim 2.3: The design and safety assessment of the generic SMR-300 considers the entire reactor lifecycle.

This chapter presents the nuclear site health and safety and conventional fire safety topics for the Generic SMR-300 to support the above claim through Claim 2.3.5:

Claim 2.3.5: Nuclear site health and safety and conventional fire safety are managed to ensure that the conventional health and safety risks, and fire safety risks to workers and the public are reduced so far as is reasonably practicable.

Further discussion on how the Level 3 claim is broken down into Level 4 claims and how the Level 4 claims will be met is provided in subchapter 12.3.

The scope of Chapter B12 includes the following:

- The management of Nuclear Site Health and Safety throughout the entire lifecycle of the Generic SMR-300;
- Conventional fire safety assessment for the Generic SMR-300.

Nuclear Site Health and Safety is driven by the requirements of the Health and Safety At Work etc Act (HASAWA), 1974 [4]. The Health and Safety Executive (HSE) provide guidance and Approved Codes of Practice (ACoP) that outline their expectations for health and safety.

The focus of conventional fire safety activities during the GDA process is to ensure that the design of the Generic SMR-300 aligns with the Office for Nuclear Regulation's (ONR) expectations for the protection of people from the effects of fire and the requirement from the HASAWA [4] that risks are reduced to ALARP. Noting that the scope of conventional fire activities during GDA is limited to specific aspects of the design, refer to section for 12.5.2 for further details.

A master list of definitions and abbreviations relevant to all PSR Chapters can be found in PSR Part A Chapter 2 General Design Aspects and Site Characteristics [5].

12.1.2 Assumptions

There are no assumptions related to Nuclear Site Health and Safety and Conventional Fire at this revision.

12.1.3 Interfaces

Nuclear Site Health and Safety and Conventional Fire safety are both broad disciplines that interface with many of the other PSR chapters. Interfaces for Nuclear Site Health and Safety and Conventional Fire safety with other PSR chapters in the PSR are detailed below.

PSR Part A Chapter 2 General Design and Site Characteristics [5]: Health and safety risks must be eliminated and controlled by the Principles of Prevention in line with UK health and safety legislation, such as Construction Design and Management (CDM) (2015).

PSR Part B Chapter 4 Instrumentation and Control (I&C) [6]: Fire alarm and control interfaces, fire induced risk on I&C systems and contribution of the I&C systems to fire risk.

PSR Part B Chapter 6 Electrical Engineering [7]: Installations must be suitably located, periodically checked and clearly indicated. Fire risks and fire loads from electrical cables and cabinets.

PSR Part B Chapter 9 Conduct of Operations [8]: Health and safety risk to operatives must be eliminated and controlled by the Principles of Prevention in line with UK health and safety legislation, such as CDM (2015) [9].

PSR Part B Chapter 10 Radiological Protection [10]: Health and safety risk to operatives must be eliminated and controlled by the Principles of Prevention in line with UK health and safety legislation.

PSR Part B Chapter 17 Human factors [11]: Human factors must be considered during the design stage. Advice on manual firefighting intervention, evacuation, movement of personnel and design of fire-fighting equipment as required.

PSR Part B Chapter 18 Structural Integrity [12]: The management of Nuclear Site Health and Safety applies to the full lifecycle of all structural integrity Structures, Systems and Components (SSCs) in the SMR-300.

PSR Part Chapter 19 Mechanical Engineering [13]: The management of Nuclear Site Health and Safety applies to the full lifecycle of all mechanical SSCs in the SMR-300. Fire

compartmentation between different compartments where services penetrate compartment walls/floors (e.g. Incorporation of fire dampers).

PSR Part B Chapter 20 Civil Engineering [14]: The management of Nuclear Site Health and Safety applies to the full lifecycle of all civil SSCs in the SMR-300.

PSR Part B Chapter 21 External Hazards [15]: Assessment of the effects of fires, explosions, and hazard control beyond the site boundary.

PSR Part B Chapter 22 Internal Hazards [16]: Assessment for the effects of fires, explosions, and hazard control.

PSR Part B Chapter 25 Construction & commissioning [17]: The performance and certification of materials and systems in support of the fire strategy.

PSR Part B Chapter 26 Decommissioning Approach [18]: The requirement of fire protection systems for deconstruction, decontamination and demolition activities during different stages of decommissioning.

12.2 DESCRIPTION OF NUCLEAR SITE HEALTH AND SAFETY AND CONVENTIONAL FIRE SAFETY

12.2.1 Nuclear Site Health and Safety

Holtec International Health and Safety (H&S) management system and supporting programmes are developed and implemented based on International Standardisation Organisation (ISO) 45001 standards. Environmental, Health and Safety (EH&S) Management Manual [19] lays the foundation of the management system based on the elements of the ISO standards. These include Holtec's H&S Policy; Context of the Organisation; Leadership Commitment and Worker Participation; Planning; Hazard identification; Environmental impacts; Risk assessment; Communication and Employee training; Support; Performance Evaluation and Continuous Improvement.

The H&S Management Manual uses supplemental procedures to implement the H&S Management System, namely, Health, and Safety Incident Prevention [20], and Contractor and Construction Safety Management [21].

It is Holtec International's policy to provide safe working conditions for the prevention of work-related injury and illness, to identify and eliminate hazards that may adversely affect workers' health and safety, to continually evaluate the H&S management system, and to implement processes that encourage and enable worker participation at all applicable levels.

Holtec International have significant experience of operations on nuclear licenced sites, both as Site Licensee and/or Licensed Operator at multiple United States (US) nuclear stations and as Lead Designer at Sizewell B during the construction and commissioning of the new Dry Fuel Store in the UK.

The Palisades reactor is in the process of being restarted and the Oyster Creek, Pilgrim and Indian Point nuclear stations are being decommissioned. Holtec International are the Site Licensee for the Palisades nuclear station and the decommissioned Big Rock Point nuclear power plant and its associated spent fuel storage facility. Holtec Decommissioning International (HDI) are the decommissioning operator at Palisades.

12.2.2 Conventional Fire Safety

The Generic SMR-300 is being developed with consideration of the following aspects of conventional fire safety:

- Fire Alarm Warning.
- Means of Escape.
- Control of Internal Fire Spread.
- Fire Compartmentation.
- Control of External Fire Spread.
- Access and Facilities for Firefighting.

Conventional fire safety precautions have been included in the SMR-300 design based on the recommendations of National Fire Protection Association (NFPA) fire safety standards (e.g., NFPA 101 [22] for provisions relating to means of escape). Additionally, the recommendations of the Nuclear Regulatory Commission (NRC) Regulatory Guide (RG)1.189 [23] have also

been included in the design, although the focus of RG.1.189 [23] is fire risks which pose a potential challenge to nuclear safety.

12.3 NUCLEAR SITE HEALTH AND SAFETY AND CONVENTIONAL FIRE SAFETY CLAIMS, ARGUMENTS, EVIDENCE

The primary purpose of a Claims, Arguments, Evidence (CAE) approach is to capture the golden thread of a safety case narrative demonstrating how plant and operational evidence is brought together to justify that a high-level or fundamental claim is true. In the context of the Generic SMR-300, that is how the Fundamental Purpose of the SSEC (Safety, Systems and Environmental Case) (presented in PSR Chapter A Part 1 [1]) is achieved.

The Fundamental Purpose follows a golden thread throughout the SSEC to CAE via the objectives of the PSR, PER and GSR. The overarching SSEC claims are presented in PSR Chapter A Part 3 [3], and this chapter links to the overarching claims through Claim 2.3:

Claim 2.3: The design and safety assessment of the generic SMR-300 considers the entire reactor lifecycle.

This chapter presents the nuclear site health and safety and conventional fire safety topics for the Generic SMR-300 to support the above claim through:

Claim 2.3.5: Nuclear site health and safety and conventional fire safety are managed to ensure that the conventional health and safety risks, and fire safety risks to workers and the public are reduced so far as is reasonably practicable.

Claim 2.3.5 is further decomposed into Level 4 claims within PSR Part B Chapter 12, across the design lifecycle, to provide confidence that the relevant requirements on health and safety and fire life safety within the facility will be met during all lifecycle phases.

This has been done by breaking down Claim 2.3.5 into two Conventional Fire Safety Level 4 claims:

Claim 2.3.5.1: The Generic Holtec SMR-300 is designed so that occupants are able to evacuate their building safely, without assistance, in the event of a fire.

Claim 2.3.5.2: The Generic Holtec SMR-300 is designed so that the fire and rescue service can undertake firefighting activities in the event of a fire.

and one Nuclear Site Health and Safety Level 4 claim:

Claim 2.3.5.3: The Generic Holtec SMR-300 is designed such that Nuclear Site Health and Safety risk is demonstrated to be reduced so far as is reasonably practicable using the hierarchy of risk control throughout the plant lifecycle.

By substantiating the Level 4 claims, Claim 2.3.5 is satisfied. Table 1 shows in which subchapter of this PSR these claims are demonstrated to be met.

Table 1: CAE Chapters

Claim No	Claim	Chapter Section
2.3.5.1	The Generic Holtec SMR-300 is designed so that occupants are able to evacuate their building safely, without assistance, in the event of a fire.	Conventional Fire Safety Assessment
2.3.5.2	The Generic Holtec SMR-300 is designed so that the fire and rescue service can undertake firefighting activities in the event of a fire.	Conventional Fire Safety Assessment
2.3.5.3	The Generic Holtec SMR-300 is designed such that Nuclear Site Health and Safety risk is demonstrated to be reduced so far as is reasonably practicable using the hierarchy of risk control throughout the plant lifecycle.	Nuclear Site Health and Safety

A summary of the current CAE route map for PSR Part B Chapter 12 is provided in Table 2: Chapter B12 CAE Route Map which is taken from the Generic SMR-300 Overarching SSEC Claim Routemap presented in Appendix A of PSR Part A Chapter 3 [3]. A further update on claim decomposition, argument development and evidence maturity will be provided in the subsequent update of the chapter.

12.4 CODES, STANDARDS AND METHODOLOGY

12.4.1 Nuclear Site Health and Safety

The SMR-300 has evolved under the USA Occupational Safety and Health Administration (OSHA) regulatory system whilst aligning to ISO 45001, as set out in this sub-chapter.

Notwithstanding recognised differences between the OSHA and UK legislative framework, it should be acknowledged that there will be some interactions between the OSHA regulatory system that can be adapted to the generic SMR-300 in the UK. This includes regulatory good practice and safety leadership. The differences between the two regulatory frameworks and processes will be identified and mapped out in a Step 2 report and reported in Rev. 1 of this PSR chapter, see sub-section 12.6.1.

Claim 2.3.5.3 will be achieved by demonstrating that the SMR-300 is designed in-line with modern western and internationally recognised health and safety standards. Relevant Holtec International procedures in relation to nuclear health and safety are as follows:

- Holtec International - Environmental, Health and Safety Management System (SMS) Manual [19]
- Holtec International - Contractor and Construction Safety Management [21]
- Holtec International - Environmental, Health, and Safety Incident Prevention [20]
- Holtec International - Contractor and Construction/Decommissioning Safety Management [24]

These procedures are coherent with US and International health and safety standards, set out in subchapter 12.4.

In the US, where the SMR-300 has been developed to a pre-concept stage, there is no equivalent regulation or standard for early-stage health and safety design, that mirrors CDM 2015. It is acknowledged that there may be further shortfalls between Holtec International's procedures and UK legislation, standards and guidance.

Currently, the SMR-300 has evolved under the US OSHA regulatory system whilst aligning to ISO 45001 occupational health and SMS [20].

The below regulations are applicable to the UK for nuclear site health and safety; several standards and guidance have also been identified which represent industry relevant good practice. The following list is not meant to be exhaustive:

Label	Title	Revision / Date
	Health and Safety at Work etc. Act [4]	1974
	Construction (Design and Management) Regulations [9]	2015
	Management of Health and Safety at work Regulations [25]	1999
	Provision and Use of Work Equipment Regulations [26]	1998
	Workplace (Health, Safety and Welfare) Regulations [27]	1992
	The Control of Major Accident Hazards Regulations (COMAH) [28]	2015
	Lifting Operations and Lifting Equipment Regulations [29]	1998
	Work at Height Regulations [30]	2005
	Confined Spaces Regulations [31]	1997

Label	Title	Revision / Date
	Control of Substances Hazardous to Health Regulations [32]	2002
	Manual Handling Operations Regulations [33]	1992
	The Control of Noise at Work Regulations [34]	2005
	The Control of Vibration at Work Regulations [35]	2005
	Dangerous Substances and Explosive Atmospheres Regulations [36]	2002
	The Electricity at Work Regulations [37]	1989
	Pressure Systems Safety Regulations [38]	2000
L111	The Control of Major Accident Hazards Regulations: Guidance on Regulations [39]	2015
HSG 65	Managing for Health and Safety Health and Safety Guidance (HSG) [40]	
L113	Safe use of lifting equipment: Lifting Operations and Lifting Equipment Regulations 1998. Approved Code of Practice and guidance [41]	1998
L101	Safe work in confined spaces: Confined Spaces Regulations. Approved Code of Practice [42]	1997
L5	Control of substances hazardous to health: The Control of Substances Hazardous to Health Regulations Approved Code of Practice and guidance, [43]	2002
L153	Managing health and safety in construction: Construction (Design and Management) Regulations. Guidance on Regulations, [44]	2015
BS 5975:2019	Code of practice for temporary works [45]	

Relevant ONR standards and Guidance (not exhaustive):

ONR Technical Assessment Guides (TAG) (not exhaustive):

- TAG 005 [46] – Regulating duties to reduce risks to ALARP

Refers to the concept of ALARP, which stands for “as low as reasonably practicable.” It’s a fundamental principle in risk management, particularly within the British health and safety system.

- TAG 027 [47] – Training and Assurance Personnel Competence

Refers to the training and assurance of personnel competence. It’s essential for organisations to ensure that their personnel have the necessary skills, knowledge, and qualifications to perform their roles effectively.

- TAG 049 [48] – Licensee Core Safety and Intelligent Customer Capabilities

Refers to core capability and concept of an intelligent customer involves retaining control of nuclear safety while using contractors.

- TAG 107 [49] – Safety Leadership

Refers to safety leadership behaviours from relevant good practice sources

- TIG 074 [50] – Construction (Design and Management) Regulations

Refers to the ONR expectations for the management of Construction (Design and Management) Regulations 2015.

12.4.2 Conventional Fire

12.4.2.1 Basis of Generic SMR-300 Design

Conventional fire safety provisions within the SMR-300 design are being incorporated based on the recommendations from American fire safety standards (primarily NFPA standards), and it is intended that the SMR-300 buildings and structures will comply fully or as near as practicable with applicable NFPA standards.

For example, provisions for means of escape and firefighting access are being incorporated based on the recommendations in NFPA 101 [22], whilst fire protection systems are being developed based on standards such as NFPA 13 [51] and NFPA 72 [52]. A full list of the NFPA standards adopted in the SMR-300 design is provided in Project References Document [53].

The recommendations of RG1.189 [23] have also been included in the SMR-300 design, although the focus of RG.1.189 [23] is more so fire risks which pose a potential challenge to nuclear safety (covered in the Internal Hazards Chapter B22 [16] and identified as a key interface 12.1.3). Nonetheless, there will likely be life safety benefits from the additional RG1.189 [23] precautions incorporated into the design in addition to those required to meet conventional fire life safety requirements.

12.4.2.2 Fire Safety Regulations

In addition to UK regulations listed in section 12.4.1, the following regulations with fire safety requirements are applicable for the design of new buildings in England and Wales:

- The Building Regulations 2010 (with amendments) [54].
- (Post occupation) Regulatory Reform (Fire Safety) Order 2005 [55].

Whilst the Regulatory Reform (Fire Safety) Order is enforceable on a nuclear licenced site, the majority of associated buildings are exempt from compliance with the Building Regulations [54]; however, the high-level performance requirements relating to fire safety in the Building Regulations are considered Relevant Good Practice (RGP).

Additionally, the Generic SMR-300 design is governed by the requirements in the HASAWA [4], including the requirement that risks (e.g., fire safety risks) are reduced to ALARP.

12.4.2.3 Fire Safety Guidance and Standards

ONR GDA guidance documents [56] and [57] will be used to inform the scope of the analysis undertaken for conventional fire during the GDA process.

Building Regulations are a means to ensure that buildings, once occupied, provide an acceptable level of fire safety. As mentioned in section 12.4.2.2, buildings on a nuclear licence site are generally exempt from compliance with them. However, meeting the high-level performance requirements of the Building Regulations is considered RGP. The national published guidance which sets out methods for achieving Building Regulations objectives is therefore also considered RGP. In England and Wales both Approved Document B and British Standard (BS) 9999 [58] offer approved means to provide an acceptable level of fire safety. Approved Document B offers a prescriptive approach to fire safety and is likely to be suited to the smaller buildings on the site without nuclear processes or nuclear safety systems. BS 9999 [58] provides a mix of prescriptive and risk-based fire safety guidance and is expected to be better suited to the larger buildings and/or those containing nuclear processes and nuclear safety systems (in line with guidance in ONR GDA guidance document [57]).

Where it is not practical to follow applicable guidance in Approved Document B or BS 9999, a fire safety engineering approach based upon the methodology set out in the BS 7974 suite of standards [59] is normally employed to assess and/or develop fire strategy measures.

Relevant fire safety design guidance is as follows:

- ONR-GDA-GD-006, New Nuclear Power Plants: Generic Design Assessment Guidance to Requesting Parties. Revision 0, October 2019 [56].
- ONR-GDA-GD-007, New Nuclear Power Plants: Generic Design Assessment Technical Guidance Revision 0, May 2019 [57].
- BS 9999 (2017): Fire safety in the design, management, and use of buildings – Code of practice [58].

- Approved Document B:
  - Approved Document B, Vol 2: Buildings other than dwellings, 2019 edition incorporating 2020 and 2022 amendments – for use in England [60].
  - Approved Document B, Vol 2: Buildings other than dwellinghouses, 2006 Edition incorporating 2010, 2013, 2016, 2017 and 2020 amendments - for use in Wales [61].
- BS 7974 (2019): Application of fire safety engineering principles to the design of buildings – Code of practice [59].

12.5 CONVENTIONAL FIRE SAFETY ASSESSMENT

Claim 2.3.5.1: The Generic Holtec SMR-300 is designed so that occupants are able to evacuate their building safely, without assistance, in the event of a fire.

Claim 2.3.5.2: The Generic Holtec SMR-300 is designed so that the fire and rescue service can undertake firefighting activities in the event of a fire.

This subchapter outlines the approach to Conventional Fire Safety Assessment to be used in the design of the Generic SMR-300.

12.5.1 General

Conventional Fire and Internal Hazards share a role in developing the strategy for fire safety, and aligning the design of fire compartments, evacuation routes, fire alarm warning, control of external fire spread, and fire-fighting systems. Conventional Fire focuses on the risk to life of personnel, whereas Internal Fire focuses on the fire risks which pose a potential challenge to nuclear safety. Refer to PSR Part B Chapter 22 Internal Hazards [16] for further details on Internal Fire proposals.

12.5.2 Conventional Fire GDA Focus

The main focus of Conventional Fire activities during GDA will be on aspects of the Generic SMR-300 design that could challenge the civil design or architectural layout, as suggested in ONR GDA guidance document [57]. It is assumed that such challenges will arise predominately from the features included in the design for means of escape and firefighting access. Detailed analyses of other fire safety provisions (e.g., fire detection, occupant warning, fixed firefighting, compartmentation) will be deferred until after PSR, though there may be some initial analyses of these provisions if relied upon for an ALARP claim at PSR.

Examples of areas that might be challenging for Conventional Fire safety in nuclear facilities (as suggested in ONR GDA Guide [57]) are:

- Extended escape distances, particularly in buildings with only a single means of escape.
- Inner-inner rooms.
- Installation of services and equipment unrelated to fire safety in protected escape routes and firefighting access routes.
- Staircases which do not directly discharge to open air (particularly in the case of NFPA based design solutions).
- Smoke ventilation for the removal of heat and smoke, e.g., in basement or areas with radiological risks.

12.5.3 Conventional Fire Codes, Standards and Methodology

The SMR-300 Conventional Fire design is based upon the incorporation of recommendations from NFPA fire safety standards, with the adopted NFPA standards listed in the SMR-300 Project References for Design and Licensing [53] . Conventional Fire safety precautions have also been included in the SMR-300 design based on recommendations in document RG1.189 [23], although the focus of this document is nuclear fire safety.

NFPA standards are commonly applied internationally to provide a satisfactory level of fire safety, and whilst their approach and some of their recommendations may differ from the UK RGP, it is considered that the overall level of fire safety achieved is similar to what would be achieved by the application of UK RGP. The application of internationally recognised fire safety standards in the Generic SMR-300 UK design is considered to contribute towards level 4 fire safety sub-claims 2.3.5.1 and 2.3.5.2.

The UK RGP applicable to Conventional Fire studies during GDA are:

a) The fire safety performance requirements in the Building Regulations [54], typically achieved by adopting British Standard BS 9999 [58] or Approved Document B (ADB) [60] [61] guidance.
b) BS 7974 [59] in the application of fire safety engineering principles.
c) ONR GDA guidance documents [56] and [57].
d) The requirement in the Health and Safety at Work Act [4] that risks are reduced to ALARP.

12.5.4 Conventional Fire SSCs

There are no specific Generic SMR-300 conventional fire SSCs within the scope of this Chapter, as clarified in SMR-300 PSR Chapter A2 [5].

The SSCs important to Conventional Fire studies are the following five buildings/structures:

- Containment Enclosures Structure (CES).
- Containment Structure (CS).
- Reactor Auxiliary Building (RAB).
- Intermediate Building (IB).
- Radioactive Waste Building (RWB).

High-level drawings for these buildings/structures and a description of their functions are provided in PSR Chapter A2 [5]. Details of nuclear fire safety related SSCs are provided in the Internal Hazards PSR Chapter B22 [16].

12.5.5 Conventional Fire Claims

12.5.5.1 Level 4 Claims

Conventional Fire inputs towards sub-claims 2.3.5.1 and 2.3.5.2. ONR Guidance [57] suggests that efforts at GDA stage are focused on safe escape provisions and firefighting access and facilities, which correspond to both level 4 fire safety sub-claims respectively.

The Generic SMR-300 Conventional Fire design at PSR stage is discussed in more detail in Section 12.5.6, which elaborates the key sub-topics of Conventional Fire and how the current design contributes towards the Conventional Fire claims.

12.5.5.2 Conventional Fire activities towards ALARP

The Health and Safety at Work Act [4] requires that risks, including conventional fire safety risks, are reduced to ALARP. The following points outline the intended process (specific to the scope of conventional fire at PSR) to demonstrate ALARP.

The methodology consists of the following elements:

- Review of the SMR-300 US-based design against UK regulatory framework and RGP (noting that the scope of Conventional Fire activities during GDA are limited).
- For gaps identified between the SMR-300 US based design and UK regulatory framework and RGP, identification of options that should be considered in a future ALARP assessment.
- Assessments, in a high-level fire strategy document, of whether fire safety risks in the Generic SMR-300 design have been reduced As Low as Reasonably Practicable.

The ALARP assessments will consider the benefit provided by each possible option versus the effort needed for its incorporation, and an analysis of whether the benefit provided is proportionate or not to the effort needed.

12.5.6 General Conventional Fire Assessment

Conventional Fire has been separated into sub-topics generally aligning with the sub-topic breakdown presented within RGP, such as BS 9999 [58]. The contribution towards the level 4 fire safety sub-claims will be achieved through summarising each of the RGP sub-topics. These are based on the high-level SMR-300 US-based design information.

Early architectural layout drawings have been received for the five SMR-300 buildings listed in Section 12.5.4. Fire protection documents received to date are those developed for SMR-160. Their content is high-level, and it is assumed they will also apply to the SMR-300 design.

12.5.6.1 Fire Alarm Warning

(REDACTED)

The generic SMR-300 design intends to provide fire detection generally throughout the Nuclear Island buildings (refer to the “SMR-160 Fire Protection Features Summary” drawings for details). The fire detection and alarm system in the US-based design will generally be compliant with NFPA 72 [52].

Based on lessons learnt in other nuclear projects it is assumed that there will be some areas where the installation will be challenging. Occupant warning devices will be included based on background noise levels, radiological constraints, size, and use of spaces, and CDM considerations. The fire alarm system may be interfaced with other systems, such as fixed firefighting for the activation of water spray deluge systems and Heating, Ventilation and Air Conditioning (HVAC) for the automatic closure of fire dampers (as suggested in [62]). In many instances the fire detection system will also be interfaced with remote, site-wide monitoring systems, to allow for emergency response to be coordinated with interfaces beyond the building footprint.

The fire alarm measures proposed for SMR-300 and summarised above, contribute towards the evidence and justification for claims 2.3.5.1 and 2.3.5.2 – as a good level of fire detection coverage can reduce detection times allowing occupants to make their escape earlier in a fire situation and similarly allowing for fire intervention at an earlier stage.

12.5.6.2 Means of Escape

Means of escape considers how occupants evacuate from buildings and spaces and aims to provide escape routes that are safe and usable for the duration required for escape. This includes the provision of emergency lighting and emergency escape signage.

Due to the scale and complexity of Nuclear Power Plants (NPPs) and their associated SSCs it is not always possible to implement RGP guidance for means of escape fully. In these instances, analyses will be undertaken to demonstrate that proposals are ALARP.

(REDACTED)

Whilst details clarifying the means of escape provisions in some of the SMR-300 nuclear island buildings are still in development, architectural layout drawings for the RAB building [63] are available. An early assessment of escape distances in the RAB building did not raise any major concerns. In general, at least for the RAB building, the NFPA recommendations for means of escape are not dissimilar to those expected by UK RGP.

Current RAB building layouts show a number of protected stairs with arrangements similar to those expected by BS 9999 [58]. The detailed assessment on key gaps in the provisions provided for means of escape will be covered in the Step 2 Gaps Identification Report. This may, for example, highlight differences in some protected stair arrangements, discharging internally instead of the a final exit or into an Exit Passageway.

Figure 1: (REDACTED)

The means of escape provisions observed in the review of architectural drawings [63] for the SMR-300 RAB building (based on the application of NFPA 101 [22]) and the general alignment with BS 9999 [58] recommendations are supporting evidence for claim 2.3.5.1.

12.5.6.3 Control of Internal Fire Spread

Control of internal fire spread in buildings will be partially achieved via the fire performance criteria imposed on materials (used for the construction of the building) with SMR specific guidance currently provided in [62]. These measures are intended to limit ignition and limit fire propagation when ignition does occur.

The requirements for the fire performance of materials in the Generic SMR-300 will contribute towards the evidence for claims 2.3.5.1 and 2.3.5.2.

12.5.6.4 Fire Compartmentation

SMR-160 fire protection guide [62] and the current Generic SMR-300 design intent is to provide the following compartmentation in the buildings:

- The general fire compartmentation will provide a three-hour fire resistance rating (fire resistant rating to NFPA standards and RG1.189 [23]). The credited Fire Areas will be bounded by 3-hour-rated walls, floors, and ceilings, with appropriately rated fire doors, fire dampers, and fire stopping to service penetrations as necessary.
- Protected stairs will be provided a minimum two-hour fire resistance rating, which is a typical NFPA 101 [22] requirement. The design will credit some fire area separations based on the general 3-hour fire compartmentation philosophy and therefore it is likely that parts of the stairwells will in fact be 3-hour fire rated where they form a portion of the fire area boundary.

The SMR-300 compartmentation layout is in progress with a draft "DWG-15299_FB fire barrier markup," which designates the high-level fire compartmentation proposals. (REDACTED).

These provisions contribute towards the evidence and justification for claims 2.3.5.1 and 2.3.5.2.

REDACTED

Figure 2: (REDACTED)

12.5.6.5 (REDACTED)

12.5.6.6 Control of External Fire Spread

Control of external fire spread considers the design of buildings with the aim of preventing fire spread between neighbouring buildings. Integrity and stability of buildings and structures are also considered.

Typically to assess UK RGP compliance, radiant heat transfer between buildings/site boundary is assessed. However, UK RGP (primarily focused on life safety) allows fire spread between buildings to be ignored where the buildings are on the same site and managed and operated by the same organisation.

It is also assumed that the Nuclear Island buildings listed in Section 12.5.2 will be provided with windowless concrete envelopes and thus will not be concerned by external fire spread issues, which is assumed to occur via unprotected openings around the building perimeter e.g. windows.

Additional aspects may be studied by Internal Hazards and / or External Hazards; however, it is assumed that any such studies would be deferred until after PSR.

12.5.6.7 Accessibility and Facilities for Firefighting

Facilities for firefighting include the provision of fire mains, hydrants, suppression systems, smoke control systems, and access for fire appliances into and around the site. Such measures will be incorporated generally in line with UK RGP, where practicable, noting that constraints from other hazard studies may limit or make certain features impracticable.

The SMR-300 US-based design to date generally depicts the locations of fire hose stations and the areas to be fitted with fixed automatic fire suppression systems (sprinkler systems, clean-agent gaseous suppression systems, etc.).

- With regard to accessibility and firefighting strategy, the US-based design will ultimately develop a set of Pre-Fire Plans (sometimes referred to as Firefighting Strategies). This document set will be generated downstream in the design process, post PSR. The Plans will provide illustrations of all areas of the plant and guidance for operators and the fire service, addressing the following.
    - Hazards in the area (combustible/flammable, electrical, mechanical, chemical, radiological, etc.).
    - Immediate or contingent fire service and operator actions.
    - Safety related equipment in the area.
    - Safe-shutdown equipment in the area.
    - Locations for establishing fire service command post(s).
    - Recommended means/pathways of attack.
    - Suppression technique guidance for special hazards; equipment and areas to be protected from fire water runoff and overspray.
    - Life safety concerns.
    - Ventilation considerations and guidance.

ONR GDA guide [57] suggests that firefighting access provisions should be assessed as alignment with RGP. This may require structural changes to the design. Architectural layout drawings for the RAB building [63] indicate one stair, lobby, and lift in an arrangement similar to the configuration of firefighting shaft described in BS 9999 [58]. Whilst the arrangements proposed in the RAB Building are not completely aligned with BS 9999 [58], the provisions shown on the preliminary drawings contribute towards the evidence and justification for claim 2.3.5.2.

12.5.6.8 Fire Water Provisions

In the SMR-300 scheme, the Fire protection System (FPS) fire water main is a buried system encircling the site in a loop configuration and is provided with sectionalising isolation valves to permit maintenance or repair without impacting supplies to areas protecting equipment important to safety. Portions of the FPS supporting Nuclear Island (NI) locations are designed to American Water Works Association (AWWA) standards [64] and American Society of Mechanical Engineers (ASME) B31.1 [65] consistent with the response Safe Shutdown Earthquake (SSE) spectra for the plant location. The fire water main system and its appurtenances (isolation valves, hydrants) is being developed based on guidance in NFPA 24 [66].

(REDACTED)

12.5.6.9 Smoke Ventilation Systems

The US-based design has not yet considered provisions for smoke ventilation. Based on lessons learnt, the standard practice would be to deploy Radiation Protection staff in the event of a fire in a radiological area and thereafter (most likely post fire) to use means such as the building ventilation system or portable ventilation equipment to clear smoke, subject to discharge/release limits and safety case limitations.

While incorporating UK RGP on smoke venting requirements where practicable, it should be noted that there will be constraints on smoke ventilation from areas with a radiological risk and it may not be possible. Where it is impracticable to implement fully the requirements from UK RGP, a risk assessment will be undertaken to demonstrate that ALARP is achieved.

12.5.7 CAE Summary

Whilst some gaps between the UK RGP and the SMR-300 building design documentation received to date that have been observed, no significant concerns regarding the future ability to demonstrate that claims 2.3.5.1. and 2.3.5.2 are achieved (and likewise for ALARP) have so far been noted.

12.6 NUCLEAR SITE HEALTH AND SAFETY

2.3.5.3 The Generic Holtec SMR-300 is designed such that Nuclear Site Health and Safety risk is demonstrated to be reduced so far as is reasonably practicable using the hierarchy of risk control throughout the plant lifecycle.

This subchapter outlines the approach to nuclear site health and safety to be used during the design and operation of the Generic SMR-300. It addresses the scope of the deliverables to be produced to support PSR Revision 1. These include:

- SMS Report;
- Holtec Britain CDM Strategy;
- COMAH Screening Assessment.

12.6.1 Safety Management System Report

The Safety Management System Report will review Holtec International's management system to establish whether the US health and safety arrangements are in alignment with UK legislation.

It will review the existing Holtec International Health & Safety Management System to give a benchmark of its current status. The review will include a high-level legal review and outline a corrective implementation action plan to bring it in-to-line with regards to UK context, if needed.

A Compliance Analysis for Legislation Codes and Standards will be undertaken to determine a list of UK specific ACoP guidance and regulatory requirements applicable to the Generic SMR-300.

The SMS review will include an assessment of the following:

- A competence and assurance strategy;
- Existing codes, standards and legislation
- Identification of any gaps and areas for improvement within Holtec International's and Holtec Britain's current arrangements.
- Understanding the fundamental approach to demonstrating compliance with UK legislation;
- General principles of prevention
- General environmental, health and safety organisational responsibilities;
- Nuclear health and safety culture;
- Behavioural safety;
- Safety observations / Learning from Experience (LFE)

12.6.2 CDM Strategy

The CDM Strategy will ensure the communication and application requirements of the Construction (Design & Management) Regulations 2015 (thereafter known as CDM2015) when planning for construction projects relating to the design of the Generic SMR-300.

This will address the proposals for the planning, managing and monitoring of design, construction health & safety arrangements and resources for discharging their responsibilities under CDM 2015.

And therefore, will seek to address:

- Duty Holder appointment structure
- Duty Holder roles and expectations
- Design Risk Management Processes and Procedures
- Competence, organisational training and upskilling
- Project CDM Assurance

12.6.2.1 Generic SMR-300 Design Risk Criteria and Objectives

It is recognized that the design of the Generic SMR-300 considers a number of aspects that would need to be considered in detail by CDM2015. SMR-300 Top Level Plant Design Requirements [67] includes design objectives taken from the Electric Power Research Institute (EPRI) User Requirement Document considered during the design, construction, and operation of the Generic SMR-300. The following requirements cited under the Top Level plant design requirements [67], provide examples of the criteria and objectives for the design of the maintenance, testing, inspection, and operational programmes of the Generic SMR-300:

- The design shall provide adequate access space for installation, construction, and commissioning of plant SSCs.
- The design shall provide adequate access space for maintenance, testing, operation, and component removal or replacement necessary to achieve plant design life.
- The plant shall be designed so that the environment under which the maintenance and testing of equipment must be performed provides satisfactory working conditions, including temperature, dose, ventilation, and illumination.
- Access provisions to equipment and components requiring routine maintenance and inspection shall consider human factors, relevant good practice and operational experience. Confined spaces requiring routine entry for maintenance and inspection of equipment and components shall be minimised by design.

12.6.3 COMAH Screening Assessment

A COMAH screening assessment will be carried out by the Conventional Environmental Impact team. The output of this assessment will be particularly useful when determining site risks that are applicable during the construction phase.

The purpose of the COMAH screening assessment is to identify whether the generic SMR-300 design will likely be a COMAH establishment. and if so, which tier is most likely to be applicable. The outcome of this decision influences the SMR-300 design and operation to ensure compliance with UK Government COMAH Regulations.

12.6.4 CAE Summary

The management of Health and Safety is an integral part of the Holtec International business and has been key in the design development of the generic SMR-300. The CDM strategy and the Safety Management System Report, produced at PSR Revision 1, will ensure that all UK

legislation requirements are reviewed and any gaps in the Health and Safety arrangements identified. This information will be used to formulate an argument to respond to Claim 2.3.5.3 in Rev. 1 of this PSR chapter.

12.7 CHAPTER SUMMARY AND CONTRIBUTION TO ALARP

This section provides an overall summary and conclusion of the Chapter and how this Chapter will contribute to the overall demonstration of ALARP for the Generic SMR-300 Technical Summary

PSR Part B Chapter 12 demonstrates how Nuclear Site Health and Safety and Conventional Fire Safety risks will meet the high-level Claims of the SSEC and that the Claims can be substantiated at Pre-Construction Safety Report (PCSR) stage. This is demonstrated through the following sub-claims:

Claim 2.3.5: Nuclear site health and safety and conventional fire safety are managed to ensure that the conventional health and safety risks, and fire safety risks to workers and the public are reduced so far as is reasonably practicable.

Holtec International have significant experience of operations on nuclear licenced sites, both as Site Licensee and/or Licensed Operator at multiple US nuclear stations and as Lead Designer at Sizewell B during the construction and commissioning of the new Dry Fuel Store.

The Palisades reactor is in the process of being restarted and the Oyster Creek, Pilgrim and Indian Point nuclear stations are being decommissioned. Holtec International are the Site Licencee for the Palisades nuclear station and the decommissioned Big Rock Point nuclear power plant and its associated spent fuel storage facility. Holtec Decommissioning International (HDI) are the decommissioning operator at Palisades.

The design of the Generic SMR-300 will need to take into account a number of aspects that would need to be considered in detail by CDM2015. The Top Level Plant Design Requirements [67] includes design objectives taken from the EPRI User Requirement Document considered during the design, construction and operation of the Generic SMR-300.

The design of the Generic SMR-300 is being developed based upon the incorporation of fire safety recommendations from relevant NFPA standards. NFPA standards are commonly applied internationally to provide a satisfactory level of fire safety, and whilst their approach and some of their recommendations may differ from standard practices in the UK, it is considered that the overall level of safety achieved is not dissimilar to what would be achieved via application of UK RGP.

The forward actions identified in this report will highlight differences between OSHA and UK legislation deliverables.

12.7.1 ALARP Summary

12.7.1.1 Demonstration of RGP – Nuclear Site Health and Health & Safety

The Generic SMR-300 design has been developed in the context of US health and safety legislation and a comparative review between US and UK health and safety legislation will be undertaken for PSR Revision 1. SMR-300 Top Level Plant Design Requirements [67] includes design objectives taken from the EPRI User Requirement Document considered during the design, construction and operation of the Generic SMR-300.

12.7.1.2 Demonstration of RGP – Conventional Fire Safety

Assessments will show that the proposed building fire safety strategies provide a level of safety in line with the expectations of UK legislations. It is expected in a lot of cases, this will simply be achieved via the application (or confirmation of compliance) with appropriate guidance documents.

Where there is a gap between UK RGP and the design, assessment will be provided to show that the level of safety proposed is appropriate; such issues will be addressed systematically and supported where necessary by way of ALARP analysis.

The following documents are considered RGP for conventional fire safety activities during GDA:

- BS 9999: 2017 Code of Practice for Fire Safety in The Design, Management and Use of Buildings [58].
- Approved Document B Vol 2 (for use in England) [60] / Approved Document B Vol 2 (for use in Wales) [61].
- BS 7974: 2019 Application of Fire Safety Engineering Principles to the Design of Buildings – Code of practice [59].

12.7.1.3 Demonstration Against Risk Targets

This sub-section is not relevant to this Chapter. The aim of Conventional Fire safety is to demonstrate that persons in a building can safely make their escape and firefighters can safely undertake firefighting activities in the event of a fire. A separate Fire Hazard Analysis that considers the impact of fire on nuclear safety is presented in the SMR-160 Fire Hazards Analysis [68].

The impact of fires on nuclear safety are addressed in PSR Chapter B22 [16] and PSR Part B Chapter 16 Probabilistic Safety Assessment [69].

12.7.2 Risk Reduction Option Review

Due to the Generic SMR-300 design being developed within the US, i.e., a non-UK regulatory regime there will be differences in design approaches when compared with UK RGP. Therefore, it will be important to develop proportionate arrangements for the GDA process to ensure consideration of Risk Reduction Measure (RRM) options through the process of:

- For gaps identified, the evaluation of options (optioneering).
- Risk assessment, as a way of understanding the significance of the issue to the overall demonstration of ALARP.
- Implementation of all reasonably practicable improvements to meet RGP.

The ALARP Design Report [70] and PSR Part A Chapter 5 Summary of ALARP [71] provides further detail of how the current US design process interfaces with the requirement to demonstrate compliance with the ALARP principle and highlights options to strengthen this interface.

Based on previous experience mitigation measures that might form part of an ALARP analysis include:

- Enhanced automatic fire detection.

- Actions of fixed firefighting measures.
- Actions of active smoke control measures.
- Compartment geometry and volume.
- Restrictions on fire loads and the strategy for fire compartmentation.
- Management procedures and restricted access control.
- Training and evacuation arrangements.

12.7.3 GDA Commitments and Forward Actions

There are no GDA commitments identified for PSR Part B Chapter 12 ‘Nuclear Site Health and Safety and Conventional Fire safety’.

Forward Actions have been collated and are managed via the process described in PSR Part A Chapter 4 Lifecycle Management of Safety and Quality Assurance [72]. PSR Part A Chapter 5 ALARP Summary [71] describes the contribution of the forward actions to the ALARP argument.

12.7.4 Conclusion

This PSR seeks to present a robust case in order to ensure that nuclear site health and safety and conventional fire safety risks can be designed and managed in manner allowing risks to be effectively eliminated, reduced or controlled so far as is reasonably practicable.

Holtec International and Holtec Britain have suitable Health and Safety management arrangements that are applied on nuclear sites across the US and UK. Holtec International are the Site Licensee and/or Licensed Operator across multiple nuclear licensed sites in the US.

The design of the Generic SMR-300 has been developed taking cognisance of EPRI Utility Requirements Document (URD) requirements relating to the design of the maintenance, testing, inspection, and operational programmes. The Safety Management Systems report and CDM Strategy will define an approach for Nuclear Site Health and Safety in a UK context.

Conventional fire safety provisions in the Generic SMR-300 design are being included based on recommendations from applicable NFPA standards. The level of fire safety provided from the incorporation of NFPA standards, based on SMR-300 design details received to date, is similar to what would be achieved via application of UK RGP.

PSR Part A Chapter 5 [71] concludes that it can be demonstrated that the Generic SMR-300 reduces risks to ALARP and that the Fundamental Purpose of the SSEC has been fulfilled.

12.8 REFERENCES

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12.9 LIST OF APPENDICES

Appendix A Nuclear Site Health and Safety and Fire Safety CAE Route Map

Table 2: Chapter B12 CAE Route Map

Overarching SSEC Claim	Chapter Claim	Chapter Sub-claims	Chapter Section
Claim 2.3 – Lifecycle The design and safety assessment of the Generic Holtec SMR-300 considers the entire reactor lifecycle.	**Claim 2.3.5 - Nuclear site health and safety and fire safety** Nuclear site health and safety and conventional fire safety are managed to ensure that the conventional health and safety risks, and fire safety risks to workers and the public are reduced so far as is reasonably practicable.	**Sub-claim 2.3.5.1** The Generic Holtec SMR-300 is designed so that occupants are able to evacuate their building safely, without assistance, in the event of a fire.	**12.5 Codes, Standards and Methodology**
		Sub-claim 2.3.5.2 The Generic Holtec SMR-300 is designed so that the fire and rescue service can undertake firefighting activities in the event of a fire.	**12.5 Codes, Standards and Methodology**
		Sub-claim 2.3.5.3 The Generic Holtec SMR-300 is designed such that Nuclear Site Health and Safety risk is demonstrated to be reduced so far as is reasonably practicable using the hierarchy of risk control throughout the plant lifecycle.	**12.6 Nuclear Site health and Safety**