Office for Nuclear Regulation

ONR Assessment Report

Generic Design Assessment of the BWRX-300 – Step 2 Assessment Report – Life Fire Safety

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Executive summary

In December 2024, the Office for Nuclear Regulation (ONR), together with the Environment Agency and Natural Resources Wales, began Step 2 of the Generic Design Assessment (GDA) of the BWRX-300 design on behalf of GE Verona Hitachi Nuclear Energy International LLC, United Kingdom (UK) Requesting Party (RP).

This report presents the outcomes of my Life Fire Safety (LFS) assessment of the BWRX-300 design as part of Step 2 of the ONR GDA. This assessment is based upon the information presented in the RP's safety, security, safeguards and environment cases (SSSE), the associated revision 3 of the Design Reference Report (ref. [1]) and supporting documentation.

ONR's GDA process calls for an assessment of the RP's submissions. The focus of my assessment in this step was to support ONR's decision on the fundamental adequacy of the BWRX-300 design and LFS case, and the suitability of the methodologies, approaches, codes, standards and philosophies which form the building blocks for the design and generic safety, security and safeguards cases.

I targeted my assessment, in accordance with my assessment plan (ref. [2]), at the areas that were fundamental to the acceptability of the design and methods for deployment in Great Britain (GB), benchmarking my regulatory judgements against the expectations of recognised UK fire standards (ref. [3] [4] [5]), and where applicable ONR's Technical Assessment Guides (TAGs) and other guidance which ONR regards as relevant good practice, such as the International Atomic Energy Agency (IAEA) safety, security and safeguards standards. Where appropriate, I have considered how I could use relevant learning and regulatory conclusions from the UK ABWR GDA to inform my assessment of the BWRX-300.

I targeted the following aspects in my assessment of the BWRX-300 SSSE:

- Compliance with chosen fire safety design codes
- Adequacy of generic fire safety information in the Conventional Fire Safety Strategy (CFSS) (ref. [6])
- Adequacy of methodologies and approach for LFS design
- Demonstration of As Low As Reasonably Practicable (ALARP)
- Adequacy of plant layout for fire safety

Based upon my assessment, I have concluded the following:

- The RP has identified adequate fire safety design principles to support the construction and operation of its design.
- The RP has completed a thorough review and identified ten departures that exist in the LFS design between the National Fire Protection Association (NFPA) codes that apply in the USA and Canada, and UK Relevant Good Practice (RGP) which, in this case, is BS 9999:2017 (ref. [5]).

- The RP has acknowledged that the current design and departures from UK RGP presents certain challenges that require further consideration during any future GDA step or site-specific licensing phase.
- The departures are associated to conditions on multiple levels across the Power Block design. Specifically, they relate to the lack of design compliant firefighting shafts, the lack of both vertical and horizontal compartmentation, and the lack of smoke and heat ventilation, each offer an individual departure scenario. They should be considered individually and collectively, as they impact on the overall risk profile for means of escape and access for emergency responders.
- The RP has undertaken preliminary optioneering to document potential solutions for these departures. The RP has confirmed that more detailed optioneering for all remaining departures will be undertaken post-Step 2 of this GDA process. Importantly, the RP has acknowledged that the potential interplay between departures should be considered to ensure any cumulative effects of multiple departures are addressed.
- I have confidence that the RP has considered and understood the challenges and differences that exist in the current design between UK RGP (ref. [5]) and the NFPA codes. I am satisfied that the RP has displayed sufficient commitment to address them, and it has adequately recorded them in the Forward Action Plan (FAP) (ref. [7]). They are referenced as PSR 24-86, PSR 24-87, PSR 24-88, PSR 24-387, PSR 24-388, and PSR 24-389.

Overall, based on my assessment to date I have not identified any fundamental LFS shortfalls that could prevent ONR permissioning the construction of a power station based on the generic BWRX-300 design; noting that any decision to permission a BWRX-300 will require further assessment (in either a future Step 3 GDA or during site specific activities) of suitable and sufficient supporting evidence that can substantiate the claims and proposals made in the GDA Step 2 submissions.

My recommendation is as follows:

Recommendation: ONR should consider the outcomes from my assessment as part of the decision on fundamental adequacy of the generic BWRX-300 design.

List of abbreviations

ABWR	Advanced Boiler Water Reactor
ALARP	As low as reasonably practicable
BOP	Balance of Plant
BWR	Boiling Water Reactor
CNSC	Canadian Nuclear Safety Commission
CFS	Conventional Fire Safety
CFSS	Conventional Fire Safety Strategy
CST	Condensate Storage Tank
DAC	Design Acceptance Confirmation
DEC	Design Extension Conditions
DR	Design Reference
DRR	Design Reference Report
EA	Environment Agency
ESBWR	Economic Simplified Boiling Water Reactor
FAP	Forward Action Plan
GB	Great Britain
GDA	Generic Design Assessment
GVHA	GE Vernova Hitachi Nuclear Energy Americas LLC
IAEA	International Atomic Energy Agency
LFS	Life Fire Safety
MDSL	Master Document Submission List
NFPA	National Fire Protection Association
NPP	Nuclear Power Plant
NRW	Natural Resources Wales
ONR	Office for Nuclear Regulation
OPEX	Operational Experience
PSA	Probabilistic Safety Assessment
PSAR	Preliminary Safety Analysis Report
PSR	Preliminary Safety Report
RGP	Relevant Good Practice
RI	Regulatory Issue
RO	Regulatory Observation
RP	Requesting Party
RQ	Regulatory Query
RWST	Refuelling Water Storage Tank
SMR	Small Modular Reactor
SAP	Safety Assessment Principle(s)
SSC	Structure, System and Component
SSSE	Safety, Security, Safeguards and Environment Cases
TAG	Technical Assessment Guide(s) (ONR)
TSC	Technical Support Contractor
UK	United Kingdom
US	United States of America

US NRC	Unites States Nuclear Regulatory Commission
WENRA	Western European Nuclear Regulators' Association

Contents

1. Introduction

1. This report presents the outcome of my Life Fire Safety (LFS) assessment of the BWRX-300 design as part of Step 2 of the Office for Nuclear Regulation (ONR) Generic Design Assessment (GDA). My assessment is based upon the information presented in the Safety, Security, Safeguards and Environment cases (SSSE) head document (ref. [8]), specifically chapter 24 (ref. [9]) the associated revision of the Design Reference Report (DRR) (ref. [1]) and supporting documentation.

2. Assessment was undertaken in accordance with the requirements of the ONR's Management System and follows ONR's guidance on the mechanics of assessment, NS-TAST-GD-096 (ref. [10]) and ONR's risk informed, targeted engagements (RITE) guidance (ref. [11]. The ONR Safety Assessment Principles (SAPs) are relevant to nuclear safety, radiation protection and radioactive waste management. Conventional hazards associated with a nuclear facility are excluded, except where they have a direct effect on nuclear safety or radioactive waste management. Fire hazards with a nuclear safety impact are addressed within ONR's Internal Hazards assessment report (ref.[23]). In this LFS assessment report, I have applied the ONR SAPs only where relevant, primarily in relation to overarching topics such as design management and layout considerations.

3. This is a major report (as per ONR's guidance, NS-TAST-GD-108, Issue No. 1 (ref. [12]).

1.1. Background

4. The ONR's GDA process (ref. [13]) calls for an assessment of the Requesting Party's (RP) submissions with the assessments increasing in detail as the project progresses. This GDA will be finishing at Step 2 of the GDA process. For the purposes of the GDA, GE Vernova Hitachi Nuclear Energy International LLC, United Kingdom (UK) Branch, is the RP. GE Vernova Hitachi Nuclear Energy Americas LLC (GVHA) is a provider of advanced reactors and nuclear services and is the designer of the BWRX-300. GVHA is headquartered in Wilmington, North Carolina, United States of America (US).

5. In Step 1, and for the majority of Step 2, the RP was known as GE-Hitachi Nuclear Energy International LLC, UK Branch, and GVHA as GE-Hitachi Nuclear Energy Americas LLC. The entities formally changed names in October 2025 and July 2025 respectively. The majority of the submissions provided by the RP during GDA were produced prior to the name change, and thus the reference titles in Section 6 of this report reflects this.

6. In the UK, the RP has been supported by its supply chain partner, Amentum, who has assisted the RP in the development of the UK-specific chapters of

the Safety, Security, Safeguards and Environment cases (SSSE), and other technical documents for the GDA.

7. In January 2024, ONR, together with the Environment Agency and Natural Resources Wales began Step 1 of this two-Step GDA for the generic BWRX-300 design.

8. Step 1 is the preparatory part of the design assessment process and is mainly associated with initiation of the project and preparation for technical assessment in Step 2. Step 1 completed in December 2024. Step 2 is the first substantive technical assessment step and began in December 2024 and will complete in December 2025.

9. The RP has stated that at this time it has no plans to undertake Step 3 of GDA and obtain a Design Acceptance Confirmation (DAC). It anticipates that any further assessment by the UK regulators of the BWRX-300 design will be on site-specific basis and with a future licensee.

10. The focus of ONR's assessment in Step 2 was:

- The fundamental adequacy of the design and safety, security and safeguards cases; and

- The suitability of the methodologies, approaches, codes, standards and philosophies which form the building blocks for the design and cases.

11. The objective is to undertake an assessment of the design against regulatory expectations to identify any fundamental SSSE shortfalls that could prevent ONR permissioning the construction of a power station based on the design.

12. Prior to the start of Step 2 I prepared a detailed Assessment Plan for Life Fire Safety (ref. [2]). This has formed the basis of my assessment and was also shared with the RP to maximise openness and transparency.

13. It should be noted that although ONR regulates and refers to this topic as Life Fire Safety, the RP uses the term Conventional Fire Safety. Throughout this assessment report where I refer to the RP and its documentation, I will use Conventional Fire Safety, however when referring to ONR's regulating duties I will use Life Fire Safety. Within ONR publications the terms Life Fire Safety and Fire Safety can be used interchangeably but both can refer to the protection of life from a fire and its effects.

14. This report is one of a series of assessments which support ONR's overall judgements at the end of Step 2 which are recorded in the Step 2 Summary Report (ref. [14]) and published on the regulators' website.

1.2. Scope

15. The assessment documented in this report is based upon the SSSE for the BWRX-300 (refs. [8], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [9], [48], [49], [50], [51]). For life fire safety, the specific chapters I have assessed are Chapter 24 Conventional Safety and Fire Safety Summary Report, Rev B, 8 July 2025, and ALARP Evaluation Revision A (refs. [15], [17], [9] and, [50]).

16. The RP's GDA scope has been agreed between the regulators and the RP during Step 1. This is documented in an overall Scope of Generic Design Assessment report (ref. [52]). This is further supported by its DRR (ref. [1]) and the MDSL (ref. [53]). The GDA scope report documents the submissions which were provided in each topic area during Step 2 and provides a brief overview of the physical and functional scope of the Nuclear Power Plant (NPP) that is proposed for consideration in the GDA. The DRR (ref. [1]) provides a list of the systems, structures and components (SSCs) which are included in the scope of the GDA, and their relevant GDA reference design documents.

17. The RP has stated it does not have any current plans to undertake GDA beyond Step 2. This has defined the boundaries of the GDA and therefore of my own assessment.

18. The GDA scope includes the Power Block (comprising the Reactor Building, Turbine Building, Control Building, Radwaste Building, Service Building, Reactor Auxiliary Structures) and protected areas as well as the balance of plant. It includes all modes of operation.

19. The regulatory conclusions from GDA apply to everything that is within the GDA scope. However, ONR does not assess everything within it, or all matters to the same level of detail. This applies equally to my own assessment, and I have followed ONR's guidance on the mechanics of assessment, NS-TAST-GD-096 (ref. [10]) and ONR's guidance on RITE (ref. [11]).

20. As appropriate for Step 2 of the GDA, information has not been submitted for all aspects within the GDA scope. Detailed aspects of the design are to be considered in the future. The following aspects of the SSSE are therefore out of scope of this assessment:

- Layout of external plant
- Nuclear Fire Safety (undertaken as part of the Internal Hazards assessment)
- Dangerous Substances Explosive Atmospheres (DSEAR) (considered in Conventional Safety work)

- Site-specific characteristics
- Fire safety assessments of specific construction, operating, maintenance or decommissioning procedures as they do not yet exist. I consider outages will come under the umbrella of maintenance which will also require consideration of additional numbers of personnel and their familiarity with the plant layout. I therefore have not considered them within my assessment.

21. My assessment has considered the following aspects:

- Compliance with chosen fire safety design codes
- Adequacy of generic fire safety information in top level safety case documentation
- Adequacy of methodologies and approach for LFS design and analysis
- Adequacy of plant layout for fire safety
- Demonstration of ALARP

22. I have assessed the BWRX-300 design against the requirements and expectations of UK Relevant Good Practice (RGP). This was identified by the RP, and agreed by ONR, as BS 9999:2017 (ref. [5]).

23. The main technical areas within this assessment have been how National Fire Protection Association (NFPA) design codes compare and achieve the intended outcomes of UK RGP. I have assessed the RP's fire safety provisions and architectural design against the requirements of its selected design codes, and considered if they achieve the expectations required of UK RGP such as BS 9999:2017 (ref. [5])

24. This approach has focused primarily, but not solely, on matters relating to:

- Means of escape – Protection of routes and travel distances to be traversed
- Fire alarm and detection systems
- Architectural design, including access and egress arrangements for emergency responders
- Smoke control / extraction systems including HVAC arrangements
- Compartmentation provision
- Suppression systems – sprinklers

25. This is further discussed in Section 4.1.

2. Assessment standards and interfaces

26. The primary goal of the GDA Step 2 assessment is to reach an independent and informed judgment on the adequacy of the RP's SSSE for the reactor technology being assessed.

27. ONR has a range of internal guidance to enable Inspectors to undertake a proportionate and consistent assessment of such cases. This section identifies the standards which have been considered in this assessment. This section also identifies the key interfaces with other technical topic areas.

2.1. Standards

28. Regulatory requirements for LFS are broadly defined within the following legislation, which apply throughout the construction phases and lifetime of buildings are described below.

- **The Health and Safety at Work Act 1974 (ref** [54]**)** which requires that employers provide a safe environment for their employees and that risks are reduced to ALARP.

- **The Building Regulations 2010 (ref.** [4]**)** which set out functional requirements for fire safety. While the majority of the site is likely to be exempt from these regulations, it is accepted UK practice to use the functional requirements as a benchmark for fire safety.

- **The Regulatory Reform (Fire Safety) Order 2005 (RRFSO) (ref.** [55]**)** which requires fire precautions to be put in place where necessary and to the extent that it is reasonably practicable to do so.

29. For my assessment of the proposed design, and in advance of the construction phase and built environment I have used the most applicable UK RGP described below.

- BS 9999 Fire Safety in the design, management and use of buildings – 2017 (ref. [5])

- The Building Regulations 2010 (ref. [4])

- BS 7974 Application of fire safety engineering principles to the design of buildings (ref. [3])

30. The International Atomic Energy Agency (IAEA) safety standards (ref. [56]) and nuclear security series (ref. [57]) are a cornerstone of the global nuclear safety and security regime. They provide a framework of fundamental principles, requirements and guidance. They are applicable, as relevant, throughout the entire lifetime of facilities and activities.

31. Furthermore, ONR is a member of the Western European Nuclear Regulators Association (WENRA). WENRA has developed Reference Levels (ref. [58]), which represent good practices for existing nuclear power plants, and Safety Objectives for new reactors (ref. [59]).

32. The RP's case is judged against the regulatory principle of RGP. RGP is a generic term for those control measures, standards, policies and other practices which are relevant to a situation and that, if implemented, would usually be considered to meet a goal-setting obligation or expectation.

33. The key guidance is identified below and is referenced, where appropriate, within Section 4 of this report. RGP, where applicable, has also been cited within the body of this report.

2.1.1. Safety Assessment Principles (SAPs)

34. The principles presented in ONR SAPs are relevant to nuclear safety, radiation protection and radioactive waste management. Conventional hazards associated with nuclear facilities are excluded, except where they have a direct effect on nuclear safety or radioactive waste management.

35. Fire hazards with a nuclear safety impact are addressed within ONR's Internal Hazards assessment report (ref. [60])

36. In this report, I have applied the ONR SAPs only where relevant, primarily in relation to overarching topics such as design management and layout considerations.

2.1.2. Technical Assessment Guides (TAGs)

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

- NS-TAST-GD-096 - Guidance on Mechanics of Assessment (ref. [61])
- NS-TAST-GD-005 – Regulating duties to reduce risks ALARP (ref. [62])
- NS-TAST-GD-051 – The Purpose, Scope and Content of Safety Cases (ref. [63])

2.1.3. National and international standards and guidance

38. The following national and international standards and guidance have been used as part of this assessment:

- BS 9999 Fire Safety in the design, managementand use of buildings - 2017, British Standards Institute, 2017. (ref. [5]) This standard is widely used by architects, fire engineers, building managers, and regulators in the UK and internationally to ensure buildings meet modern fire safety expectations while allowing design flexibility.

- British Standard 7974; - Application of fire safety engineering principles to the design of buildings (ref. [3]) This is a British Standard that provides a structured framework for applying fire safety engineering (FSE) principles to building design. It supports a performance-based approach to fire safety, offering an alternative to traditional prescriptive codes. This is particularly useful for complex or innovative buildings where standard regulations may be too restrictive or not fully applicable.

- IAEA Tecdoc 1944, Fire Protection in Nuclear Power Plants (2021) (ref. [64]) This document is used by nuclear safety authorities, plant designers, and operators to align fire protection programs with international safety standards and to support regulatory compliance.

2.2. Integration with other assessment topics

39. To deliver the assessment scope described above I have worked closely with a number of other topics to inform my assessment. Similarly, other assessors sought input from my assessment. These interactions are key to the success of GDA to prevent or mitigate any gaps, duplications, or inconsistencies in ONR’s assessment.

40. The key interactions with other topic areas were:

- Internal Hazards – Including requirements for fire protection systems and claims on barriers for fire separation and compartmentation.

- Mechanical Engineering – Including provision of mechanical ventilation systems.

- Conventional Safety – Including the option to provide hatches to ensure floor compartmentation can be achieved.

2.3. Use of technical support contractors

41. During Step 2 I have not engaged Technical Support Contractors (TSCs) to support my assessment of the life fire safety aspects of the BWRX-300 GDA.

3. Requesting Party's submission

42. The RP submitted the SSSE at the start of Step 2 in four volumes that integrate environmental protection, safety, security, and safeguards. This was accompanied by a head document (ref. [8]), which presents the integrated GDA environmental, safety, security, and safeguards case for the BWRX-300 design.

43. All four volumes were subsequently consolidated to incorporate any commitments and clarifications identified in regulatory engagements, regulatory queries and regulatory observations, and were resubmitted in July 2025. This consolidated revision is the basis of the regulatory judgements reached in Step 2.

44. The RP's main submission document for the assessment of the fire safety design was contained in the Topical Report NEDC-34146P, Revision 4, BWRX-300 UK GDA Conventional Fire Safety Strategy (ref. [6]). This document offers a comprehensive description of the fire safety design which includes a detailed description of those aspects of the design which do not conform to UK RGP.

45. The RP provided a comprehensive description of the departures from RGP, along with an overview of the alternative options considered to address these shortfalls. The optioneering studies included either a preferred way forward (including potential design changes) or a justification for retaining the current design configuration.

46. This section presents a summary of the RP's safety case for LFS. It also identifies the documents submitted by the RP which have formed the basis of my Step 2 assessment of the BWRX-300 design.

3.1. Summary of the BWRX-300 Design

47. The BWRX-300 is a single unit, direct-cycle, natural circulation, boiling water reactor with a power of ~870 MW (thermal) and a generating capacity of ~ 300 MW (electrical) and is designed to have an operational life of 60 years. The RP claims the design is at an advanced concept stage of development and is being further developed during the GDA in parallel with the RP's SSSE.

48. The BWRX-300 is the tenth generation of the boiling water reactor (BWR) designed by GVHA and its predecessor organisations. The BWRX-300 design builds upon technology and methodologies used in its earlier designs, including the Advanced Boiling Water Reactor (ABWR), Simplified Boiling Water Reactor (SBWR) and the Economic Simplified Boiling Water Reactor (ESBWR). The ABWR has been licensed, constructed and is currently in operation in Japan, and a UK version of the design was

assessed in a previous GDA with a view to potential deployment at the Wylfa Newydd site. Neither the SBWR or ESBWR have been built or operated.

49. The BWRX-300 reactor core houses 240 fuel assemblies and 57 control rods inside a steel reactor pressure vessel (RPV). It uses fuel assemblies (GNF2) that are already currently widely used globally (ref. [6]).

50. The reactor is equipped with several supporting systems for normal operations and a range of safety measures are present in the design to provide cooling, control criticality and contain radioactivity under fault conditions. The BWRX-300 utilises natural circulation and passive cooling rather than active components, reflecting the RP's design philosophy.

51. Importantly for life fire safety, the design is intended to be compact, with the bulk of the Reactor Building being below grade (ground) level. This approach is novel to the UK nuclear industry and has implications for fire compartmentation, access and egress and structural fire performance which I have considered in my assessment.

3.2. BWRX-300 Case Approach and Structure

52. The RP has submitted information on its strategy and intentions regarding the development of the SSSE (ref. [65] [66] [67] [68]). This was submitted to ONR during Step 1.

53. The RP has submitted a SSSE for the BWRX-300 that claims to demonstrate that the standard BWRX-300 can be constructed, operated, and decommissioned on a generic site in GB such that a future licensee will be able to fulfil its legal duties for activities to be safe, secure and will protect people and the environment. The SSSE comprises a Preliminary Safety Analysis Report (PSAR) which also includes information on its approach to safeguards and security, a security assessment, a Preliminary Environment Report (PER), and their supporting documents.

54. The format and structure of the PSR largely aligns with the IAEA guidance for safety cases, SSG-61 (ref. [69]), supplemented to include UK specific chapters such as Structural Integrity and Chemistry. The RP has also provided a chapter on ALARP, which is applicable to all safety chapters. The RP has stated that the design and analysis referenced in the PSR is consistent with the March 2024 Preliminary Safety Analysis Report submitted to the US Nuclear Regulatory Commission (US NRC). The Security Assessment and PER are for the same March 2024 design but have more limited links to any US or Canadian submissions.

3.3. Summary of the RP's case for Life Fire Safety

55. The aspects covered by the BWRX-300 safety case in the area of Life Fire Safety can be broadly grouped under 3 headings which are summarised as follows.

3.3.1. Sitewide fire strategy

56. The RP makes the claim that (ref. [6]):

- The CFS requirements for the design are complete and correct.

57. The CFS assessments have applied a consistent approach throughout this process. The RP states that each assessment identifies the following outcomes:

- Identifies the appropriate UK CFS regulatory expectations.
- Defines methods that could be used to identify gaps between UK regulatory expectations and information currently available in the existing design.
- Defines methods for assessing the identified gaps and determining how these may be addressed, which may include the need to perform further work.
- Applies the defined methods for identifying and assessing potential gaps to UK CFS regulatory expectations, within key Power Block building assessment workshops.
- Captures the results of the CFS workshops performed, the potential gaps to UK regulatory expectations that were identified, and any actions that were placed to address them.

58. In support of this claim the RP argues that:

- Generic CFS requirements are identified, derived, and satisfied from NFPA fire codes, primarily based in the US and Canada. The RP has not performed a comprehensive assessment of NFPA code compliance at this stage.
- The CFS requirements for fire protection & extinguishing systems are identified and are derived from applicable codes, standards, RGP, and Operational Experience (OPEX).

3.3.2. Building specific fire safety design and layout aspects

59. The RP makes claims that (ref. [9]):

- Overall, the layout of the Power Block buildings is designed to minimise life fire safety risks to ALARP.
- Building or area specific claims are presented in support of the fire safety strategy, with particular reference to defined elements of the fire safety design.
- The life fire safety design includes life fire safety requirements (ref. [6]).

60. The RP made the above claims within the RP Fire Strategy (ref. [6]) submission and discussed during Level 4 meetings throughout the Step 2 assessment process.

3.3.3. ALARP

61. The RP acknowledges that at this stage of the design and safety case development, it has not yet made a sufficient demonstration that risks have been reduced to levels which are ALARP.

62. The RP has produced a Forward Action Plan (ref. [7]) to provide clarity and a commitment regarding the aspects of the overall design related to CFS which require greater detailed consideration to reduce risks to ALARP.

3.4. Basis of assessment: RP's documentation

63. The principal documents that have formed the basis of my life fire safety assessment of the SSSE are:

- Conventional Fire Safety Strategy (ref. [6]). This document outlines a methodology for identifying and evaluating deviations from UK regulatory expectations in CFS design. The covers the full scope of the GDA buildings.
- Conventional Safety and Fire Safety Summary Report (ref. [9]). This report summarises the assessments of Conventional Health and Safety (CHS) and CFS for the BWRX-300, conducted as part of the GDA. It also evaluates how well these assessments align with UK regulatory standards.
- Forward Action Plan (FAP) (ref. [7]). This outlines the steps necessary for advancing the BWRX-300 project from the GDA to the site-specific phase. It also documents commitments made in response to Regulatory Queries and Observations.

64. Within the Conventional Fire Safety Strategy (ref. [6]), the RP has identified ten specific deviations from UK RGP (ref. [5]). The RP addressed them through a structured optioneering process, conducted via a series of workshops. The outcomes resolved several of the departures, aligning them with UK RGP and applicable legislation (ref. [19]).

65. The RP documented those departures which need greater consideration and the potential to require physical changes to the structural design in the FAP (ref. [7]) for further consideration and assessment at a point beyond this 2 step GDA.

66. The RP identified and recorded within the FAP the departures requiring additional assessment and design consideration post step 2 of this GDA. The relevant departures are:

- Departure 1: Lack of a fire-fighting shaft in basement levels and ground level of the Reactor Building
- Departure 2: Lack of basement smoke venting in the Reactor Building
- Departure 3: Lack of compartments floors in the basement levels in the Reactor Building

67. The identified departures all pertain to the "below-grade" building structure. The depth of this structure presents several unresolved challenges for fire safety design. In particular, the current provisions for emergency responder access and operations require further development and potential design modifications to meet the expectations of UK RGP.

3.5. Design Maturity

68. My assessment is based on revision 2 of the Design Reference report (ref. [1]) and the Conventional Fire Safety Strategy document (ref. [6]). The Design Reference report presents the baseline design for GDA Step 2, outlining the physical system descriptions and requirements that form the design at that point in time.

69. The reactor building and the turbine building, along with the majority of the significant structures, systems and components (SSCs) are housed with the 'Power Block'. The Power Block also includes the radwaste building, the control building and a plant services building. For security, this also includes the Protected Area (PA) boundary and the PA access building.

70. The GDA Scope report (ref. [52]) describes the RP's design process that extends from baseline (BL) 0 (where functional requirements are defined) up to BL 3 (where the design is ready for construction).

71. In the March 2024 design reference, SSCs in the power block are stated to be at BL1. BL1 is defined as:

- System interfaces established;
- (included) in an integrated 3D model;
- Instrumentation and control aspects have been modelled;
- Deterministic and probabilistic analysis has been undertaken; and
- System descriptions developed for the primary systems.

72. The balance of plant remains at BL0 for which the RP has established plant requirements only, and SSC design remains at a highly conceptual level.

- The life fire safety design is relatively mature but some challenging departures from UK RGP (ref. [5]) exist which will require further detailed review and consideration at a point beyond step 2 of this GDA.
- The RP has categorised these departures from UK RGP (ref. [5]) and has provided clarity, and a commitment, for the requirement to give considerable future attention to additional assessment and optioneering to assure compliance with an ALARP life fire safety design.

4. ONR assessment

4.1. Assessment strategy

73. The objective of my GDA Step 2 assessment is to reach an independent regulatory judgement on the fundamental aspects of the BWRX-300 design, relevant to life fire safety as described in sections 1 and 3 of this report. My assessment strategy is set out in this section and defines how I have chosen which matters to target for assessment. My assessment is consistent with the delivery strategy for the BWRX-300 GDA [70].

74. GVHA is currently engaging with regulators internationally, including the Nuclear Regulatory Commission in the US (US NRC) and the Canadian Nuclear Safety Commission in Canada (CNSC). It is proposing a standard BWRX-300 design for global deployment with minimal design variations from country to country. My assessment takes cognisance of work undertaken by overseas regulators where appropriate.

75. Whilst there is no operating BWR plant in the UK, ONR has previously performed a four-step GDA on the Hitachi-GE UK ABWR (ref. [71]). I have taken learning from this previous activity, targeting my assessment on those aspects of the BWRX-300 which are novel or specific to this design. I have not looked to reassess inherent aspects of BWR technology which were considered in significant detail for the UK ABWR and judged to be acceptable.

76. A detailed description of my approach to this assessment can be found in assessment plan Step 2 Life Fire Safety Assessment Plan for the Generic Design Assessment of the BWRX-300 (ONRW-2126615823-4134, Revision 1), (ref. [2]).

4.1.1. Compliance with chosen fire safety design codes

77. As part of my assessment of the LFS aspects of the BWRX-300 design I have undertaken the following:

- An assessment of whether the codes and standards selected by the RP are appropriate and sufficient for their intended application within the design.

- An evaluation of the BWRX-300 fire safety measures and architectural design against the requirements of the chosen design codes. This includes verifying that the design meets these requirements or, where full compliance is not achievable, that a robust optioneering process has been conducted to ensure the risk to life from fire is reduced to a level that is ALARP.

78. Following receipt of the RP's submissions, I have undertaken my assessment in line with the goals of Step 2, as detailed in Section 4.1.1 of this report. Regarding the second point, I have identified elements of the physical design that do not provide the level of confidence expected under UK RGP (ref. [5]). As a result, the RP has acknowledged that further detailed assessment and optioneering will be necessary at a later stage. This requirement has been captured in the FAP (ref. [7]).

79. My assessment encompasses a review of several key areas critical to fire safety assurance. These include the adequacy of the generic fire safety information presented within the top-level safety case, the robustness of the methodologies and approaches adopted for the design and analysis of life fire safety (LFS) measures, and the suitability of the overall plant layout in supporting effective fire safety performance. I have evaluated each of these elements to determine whether they collectively provide a coherent and compliant basis for managing fire risks across the facility.

4.1.2. Demonstration of ALARP

80. I have assessed the adequacy of the optioneered changes to the design to address specific departures from fire safety codes.

81. As per my assessment plan (ref. [2]), in Step 2 I had anticipated that the step 2 submissions would include optioneered solutions to the majority of departures from code.

82. During Step 2, it became evident that several identified departures from applicable codes would require further evaluation and the development of options to address gaps between the current design and the expectations of UK RGP (ref. [5]). The most significant challenges relate to access and safety features for emergency responders in below-grade areas, which will need focused attention beyond Step 2.

83. In my judgement, there are multiple engineered options the RP and/or future licensee can consider through detailed assessment and implement subject to reasonable practicability. Consequently, I am content that these are not insurmountable barriers at step 2 of this GDA.

4.2. Assessment Scope

84. My assessment scope and the areas I have chosen to target for my assessment are set out in this section. This section also outlines the submissions that I have sampled, the standards and criteria that I will judge

against and how I have interacted with the RP and other assessment topics.

85. My assessment scope is consistent with the GDA scope agreed between the regulators and the RP during Step 1 and detailed in Section 1.2 of this report. I have targeted my assessment within this scope.

86. In line with the objectives for Step 2, I have undertaken a broad review of the highest level, fundamental claims and supporting arguments related to life fire safety. To support this, I have sampled a targeted set of the claims and arguments as set out below. Where applicable, I have also sampled the evidence available to support any claims and arguments.

87. In order to fulfil the aims for the Step 2 assessment of the BWRX-300, I focused my assessment on the following items, which I consider important:

- Areas within the Power Block buildings that pose the highest life safety risks—specifically, locations where the design deviates from UK RGP (ref. [5]) regarding means of escape, compartmentation, and firefighter access. I evaluated the structural fire protection measures and internal layout to determine whether the design supports compliance with UK fire safety legislation and ensures safe egress for occupants. Additionally, I reviewed the design to confirm that it provides adequate protection and appropriate facilities for firefighting personnel.

- The non-structural fire protection arrangements (active and passive systems), when they were relevant and provided supporting mitigation for design features which do not meet recommendations contained within codes of practice in design of buildings for fire safety.

- The fire engineering contained within the RP's full responses to all Regulatory Queries (RQs), updated versions of the CFSS document (ref. [6]), which were submitted throughout the GDA process.

- The adequacy of the selected codes and standards (ref. [5]) for their intended application in the RP's design.

88. The standards I have used to judge CFS within the design of the BWRX-300 are documented in section 2 paragraph 28 and 29 and are not repeated here for conciseness.

4.3. Assessment

4.3.1. Compliance with chosen fire safety design codes

89. In line with UK legislation, fire risk management needs to be considered consistently across all areas to ensure that risk to workers and the public is reduced ALARP. It is worth noting that as UK legislation is goal based rather than prescriptive, and therefore dutyholders can adopt codes other than UK

specific ones, NFPA codes for example to demonstrate that UK legal requirements are or will be met.

90. I judge that the RP has demonstrated a good comprehension and awareness of the relevant legislation and associated guidance which relates to fire safety in the UK (ref. [55] [5] [4] [3]). The RP's Fire Safety Strategy (ref. [6]) is clearly articulated and detailed, reflecting a comprehensive understanding of the functional requirements outlined in the Building Regulations (ref. [4]).This demonstrates the RP's ability to align fire safety measures with legislative expectations effectively.

91. The RP identifies further design codes within its site CFSS (ref. [5]). These include a range of UK recognised design codes, including but not limited to:

- BS 5839-1, Fire detection and fire alarm systems for buildings - Part 1: Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises, 2017 (ref. [72])
- BS 5266-1, Emergency lighting. Code of practice for the emergency lighting of premises, 2016 (ref. [73])
- BS 9990, Non automatic fire-fighting systems in buildings. Code of practice, 2015 (ref. [74])
- BS EN 12845+A1, Fixed firefighting systems - automatic sprinkler systems - design, installation and maintenance (Incorporating corrigenda December 2015 and January 2016), 2019 (ref. [75])

92. BS 9999 (ref. [5]), BS 7974 (ref. [3]) and Approved Document B (ref. [4]) are recognised UK RGP for non-domestic buildings. The RP selected NFPA codes as their primary design codes and it has chosen the recognised UK RGP as the appropriate codes to make a comparison. I am confident that the changes required to address the departures from UK RGP, currently contained within the BWRX-300 design can be achieved, and will include clarity on the provision of fire safety systems conforming to British Standards. The RP has accepted the presence of the departures and understands the collective impact of them in relation to the risk profile in the event of a fire below grade. I am confident that engineered solutions / options can be implemented to address the current design departures to UK LFS expectations and thus further reduce the risk profile. This is an aspect of the design that will be required to be considered in detail during any future UK project phase.

93. I have also considered SAPs which complement LFS considerations, and I am satisfied that the RP has demonstrated it understands them, specifically, the engineering principles (EKP.1 to EKP.5) and engineering layout principles (ELO.1 to ELO.4). However, certain design elements, as outlined in the FAP (ref. [7]), still require further consideration to fully align with these SAPs. See sections 4.3.4 and 4.3.5 for further detail.

4.3.2. Adequacy of methodologies and approach for LFS design and analysis

94. I have assessed the general fire strategy principles described by the RP in the CFSS (ref. [6]). This document has utilised a structured methodology to identify departures from UK RGP (ref. [5]). The document has identified ten departures from UK regulatory expectations.

95. The RP has developed a seven-step strategy to compare the BWRX-300 design, with the expectations of UK regulatory standards. This strategy is outlined in the Conventional Safety and Conventional Fire Safety Summary Report (ref. [9]), which presents the following key steps which I judge to be an adequate methodology:

- Step1 - Identify and record any assumptions.
- Step 2 - Undertake a tabulated compliance assessment against BS 9999 today (ref. [5]).
- Step 3 – Graded sentencing of identified departures.
- Step 4 – Optioneering workshops.
- Step 5 – Optioneering outcomes prioritisation process.
- Step 6 – Outcome justification.
- Step 7 – Post GDA departure resolution process including FAP (ref. [7]).

96. My assessment includes all buildings within the Power Block, which consists of the Reactor Building, Turbine Building, Services Building, Reactor Auxiliary Structures, Control Building and Radwaste Building.

97. It should be noted that my assessment is based on the reference design at March 2024. Any additional design development after this time has not been considered in my assessment. This phased approach, adopted by the RP, has posed challenges in achieving compliance, particularly in relation to certain CFS departures below grade, within a Step 2 GDA scope. My assessment of the Fire Safety Design has been considered against the detail contained in the Fire Safety Strategy (ref. [6]), which I judge to be well-balanced in its approach. In my judgement, there are multiple engineered options the RP and/or future licensee can consider through detailed assessment and implement subject to reasonable practicability. Consequently, I am content that these are not insurmountable barriers at step 2 of this GDA.

4.3.3. Adequacy of building design and layout for fire safety

98. BS 9999 (ref. [5]) identifies risk profiles and sets out a minimum package of fire protection measures and management to address them accordingly

Every building should incorporate, as a minimum, the fire protection within those measures and where additional measures are incorporated, certain relaxations from guidance may be justifiable.

99. In my sampling, I identified that the RP has not fully incorporated the minimum package of fire safety measures described in BS999 (ref. [5]). Table 7-1 of the Conventional Fire Safety Strategy (ref. [6]) presents a comparison of the fire safety measures currently within the design, highlighting that the minimum package for fire safety is not fully incorporated.

100. My assessment of the design layout has been primarily focused on evaluating the adequacy of means of escape and firefighter access provisions. These aspects are critical to ensuring life safety and effective emergency response, particularly in complex or high-risk areas of the facility. The findings in this area have been a key influencing factor in forming my overall judgement on the acceptability of the fire safety strategy. I am content with the overall FSS (ref. [6]) as the RP has applied sufficient and appropriate rigor when evaluating their impact on the risk profile. I am content that the workshop approach taken by the RP has considered the notable departures against the expectations of UK RGP.

4.3.4. BS 9999 compliance assessment (Gap Analysis)

101. The RP has conducted a code compliance assessment of the design in comparison with UK standard BS 9999 (UK RGP) (ref. [5]) and has documented this in Appendix 1 – Compliance Assessment (Gap Analysis) within the Conventional Fire Safety Strategy (ref. [6]). Appendix 1 identifies those aspects of the design believed to be either, compliant, non-compliant, not relevant at this stage of the design, not applicable at this stage of the design, and for information only. Appendix 2 through 9 of ref [6] provides a report on each of the departures in detail.

102. The RP's UK code compliance assessment identified ten departures in reference [6].

103. Departures 1, 2, and 3 (see list below) are closely interrelated, as each directly affects the ability of firefighters and other emergency responders to safely access the Reactor Building, particularly in below-grade areas, to manage fires or other emergencies. Consequently, as part of the ALARP demonstration, I expect these departures to be considered collectively through a holistic optioneering process so that firefighter safety is adequately and comprehensively integrated into the design. An essential aspect of the design is to satisfy the functional requirement relating to access and facilities for the fire service.

- Departure 1 - Lack of a fire-fighting shaft in basement levels and ground level of the Reactor Building
- Departure 2 - Lack of a heat and smoke control system

- Departure 3 - Lack of compartment floors in the basement levels and ground floor in the Reactor Building

104. Departures 1, 2, and 3 present both individual and combined challenges to achieving a design that reduces LFS risks to ALARP. Each poses a credible risk to the safe entry and operational effectiveness of firefighters and other emergency responders in below-grade areas of the Reactor Building. Notably, the building extends 34 m below ground, equivalent to the height of a ten-storey structure. In my opinion, this can further complicate emergency access and response under various incident scenarios. I raised this with the RP in RQ-01773.

105. I have reviewed the Requesting Party's (RP) response (ref. [76]) to RQ-01773, in which they acknowledge that the design is still evolving. The purpose of this RQ was to ensure that the RP provided clear information regarding the additional considerations required beyond Step 2 of the GDA process. This was necessary to support further assessment and optioneering of potential solutions that could demonstrate that the existing departures from UK RGP will be addressed in a manner consistent with achieving an ALARP outcome. I judged that further optioneering should be considered during subsequent phases of the GDA/licensing process to ensure the design achieves the required level of maturity and robustness. As a result, further work is required to address the outstanding CFS departures. A final resolution will need to demonstrate that the associated risks are both acceptable and reduced to a level that is ALARP.

106. The response to Regulatory Query RQ-01773 confirmed that more detailed optioneering for all identified departures will be conducted after the completion of Step 2 of the GDA. The commitment contained within the RP's response (ref. [76]) to this RQ has been included in the FAP (ref. [7]).This work will support the subsequent site-specific licensing phase. As part of this process, the RP has committed to engage all relevant stakeholders, and for the updated BWRX-300 design to be reviewed including how the various departures interact. This will help ensure that the cumulative impact of multiple departures is fully understood and appropriately addressed. I judge this RQ response and subsequent inclusion in the FAP ref.([7]) to be adequate.

4.3.4.1. Lack of a Fire-Fighting Shaft in Basement Levels and Ground Level of the Reactor Building.

107. BS 9999 (ref. [5]), and specifically, Section 6: Access and Facilities for Firefighting Clause 20 and subclause 20.1.1, recommends the inclusion of fire-fighting shafts in tall buildings, structures with deep basements, and those with large floor areas. The RP's identified departure relates specifically to the below-grade design of the facility, where the current layout does not fully align with BS999 recommendations.

108. The Reactor Building is not provided with a fire-fighting shaft and therefore it is not aligned with BS999.

109. In accordance with BS 9999-2017 (ref [5]) if a building has a height in excess of 18m and / or greater than 10m below ground then the following should be provided:

- A firefighting shaft, which consists of the following:
    - Fire-fighting stair
    - Fire-fighting lobbies
    - A dry or wet rising fire main (depending on height of the building)
    - Fire-fighters lift
    - Smoke control system

110. The Reactor Building is in excess of 10m below ground level. The proposal within the CFSS for this building, does not meet the recommendations identified as being relevant to a building with the lowermost storey in excess of 10m. I consider this to be a major departure from BS9999-2017 (ref. [5]).

111. Firefighting shafts are essential for providing firefighters with a relatively safe environment to establish a bridgehead and conduct internal firefighting operations. In their absence, operational crews (guided by Dynamic Risk Assessment, DRA) are likely to adopt a defensive strategy and avoid entering the structure. This could allow a fire to go unchecked, posing significant risks in a nuclear facility where the consequences of uncontrolled fire can be severe.

112. The Reactor Building contains two stairs, Stair A and Stair B. Both stairs serve the lowest basement level and the ground floor level, both are within 2 hours fire rated enclosures. Both protected stairs are pressurised with fresh air upon detection of fire. Fire mains (wet risers) are located within both stairs. There is a single lift serving ground to minus 33.0 m (lowest level) which is within a fire rating enclosure of 2 hours. In the current design, Stair A is not separated from the accommodation by a lobby. While the area around the stairs appears to present a low fire risk, it is not currently provided with a smoke ventilation system. Stair B is accessed via Vestibule 0 (lobby), which connects to the final exit corridor. However, this vestibule is also not equipped with a smoke ventilation system. The absence of smoke ventilation in both areas will require further assessment to ensure compliance with relevant fire safety objectives, particularly in relation to protected escape routes and firefighter access.

113. In response to Regulatory Query RQ-01773, the RP has acknowledged the need for detailed optioneering to be conducted during the post-Step 2 GDA

or pre-licensing phase. The RP has committed for this optioneering process to involve all relevant stakeholders and to focus on resolving the firefighting shaft issues in the Reactor Building to support the future UK site-specific licensing phase for the BWRX-300. For context, preliminary optioneering and analysis conducted during the Step 2 GDA are documented in NEDC-34146P, BWRX-300 UK GDA Conventional Fire Safety Strategy (ref. [6]).

114. Future detailed work may identify new options for addressing the departures, while some of the preliminary options documented in the Conventional Fire Safety Strategy Report (ref. [6]) may be ruled out based on new information. To support this process, the Forward Action Plan (ref. [7]) includes a reference directing the future optioneering team to review the original report. This should ensure continuity by providing insight into the initial discussions, including the pros, cons, and mitigations considered during earlier workshops. The goal of the more detailed optioneering phase is to reach a final decision on how each departure will be addressed during the site-specific licensing phase, which may involve changes to the physical design of certain elements of the Power Block.

115. The drawings I reviewed showed no additional ignition sources or energised equipment, and the revised FSS (ref. [6]) confirmed that the areas directly accessing lifts and stairs would be kept low in combustibles and ignition sources. I also had further discussions where the RP acknowledged that effective management of these areas would be critical to maintaining this assurance.

116. In my judgement, and given the information provided in the response to RQ-01773, I am satisfied that a future licensee would have sufficient understanding of the requirement to carry out further detailed design assessment and optioneering, such that the provision of adequate Fire-fighting shafts can be addressed in line with UK RGP (ref. [5]). I am content that these matters are appropriate for consideration and resolution at those stages rather than at step 2. This is recorded within the FAP (ref. [7]).

4.3.4.2. Lack of a Heat and Smoke Control System

117. BS 9999 (ref. [5]), and specifically, Section 6: Access and facilities for fire-fighting, Clause 27, recommends that a system of smoke and heat ventilation should be provided from every basement storey that has:

a) a floor area of more than 200 m^2 or

b) a floor more than 3 m below the adjacent ground level.

118. The Reactor Building is not provided with a Heat and Smoke Control System to provide a route for smoke to escape to the open air from the basement levels during a fire situation.

119. The inability to control heat and smoke in the basement area can further exacerbate the absence of a recognised firefighting shaft, creating a

significantly more hazardous environment for emergency responders during firefighting or rescue operations. Without effective smoke and heat management, conditions in the basement may become unsafe, influencing the Fire Service Incident Commander's decision on whether it is appropriate to commit personnel to these areas. This departure is directly related to the below-grade design of the facility. Taken together, departures 1, 2, and 3 represent a significant deviation from RGP, particularly in relation to firefighter access and safety. The absence of a firefighting shaft, a heat and smoke control system, and compartmentation in the Reactor Building's basement and ground levels creates a compounded risk which, if unaddressed, can undermine the functional requirement for fire service access and facilities. These interrelated departures should be addressed collectively through a robust, holistic optioneering process to ensure that emergency response capabilities are not compromised.

120. The RP has confirmed that they understood there is more work to do with the CFS departures before a final outcome is reached to show risks due to fire are reduced to ALARP. Therefore, I expect more detailed optioneering for all departures to be undertaken after GDA Step 2. During the more detailed optioneering workshops, all relevant stakeholders should be engaged with a further developed BWRX-300 design and the potential interplay between departures will be considered to ensure any cumulative effects of multiple departures are addressed.

121. Future detailed work presents the possibility that additional options to address departures may be identified and it is also possible that some of the current options the team has already identified in the Conventional Fire Safety Strategy Report (ref. [6]) may be removed from being considered a realistic option due to new information being uncovered. To assist the future team in resolving these departures, the RP has added a reference within the FAP (ref. [7]) items to direct the future detailed optioneering team to review this Conventional Fire Safety Report (ref. [6]) and understand the original discussion of pros, cons, and mitigations captured in preliminary optioneering workshops. It is the RP's intent that the conclusion of more detailed optioneering workshops would result in a final decision on how each departure is addressed during a site-specific licensing phase.

122. In my judgement, and given the information provided in the response to RQ-01773 and above, I am satisfied that a future licensee should have sufficient context and the RP's understanding of the requirement to carry out further detailed design assessment and optioneering such that the provision of adequate heat and smoke ventilation arrangements is addressed. This is recorded within the FAP (ref. [7]).

4.3.4.3. Lack of Compartment Floors in the Basement Levels in the Reactor Building

123. BS 9999 (ref. [5]) section 31.3.1.3 requires all basement storeys to be separated by compartment floors where any storey is at a depth of more

than 10 m. With a number of uncovered floor hatches currently contained within, the design it does not fulfil this requirement. This departure has a specific relationship to design aspects relating to the design below grade and poses a specific challenge to the expectations of BS 9999 in relation to vertical and horizontal compartmentation below grade.

124. Compartmentation in basement levels is a fundamental element of any passive fire protection strategy. It serves to subdivide the building into fire-resisting zones, effectively limiting the spread of fire and smoke, preserving structural integrity, and maintaining tenable conditions for evacuation and firefighting operations. This containment is critical in below-grade environments, where access is restricted and smoke ventilation is often more challenging, thereby enhancing life safety and reducing potential fire damage.

125. Benefits include:

- Life safety and evacuation – compartmentation helps prevent fire and smoke from spreading rapidly, allowing occupants more time to evacuate safely.
- Firefighting shafts and protected areas reduce risks for emergency responders, enabling safer access for search and rescue operations.
- Critical infrastructure can be safeguarded within fire-resistant compartments to minimize operational disruption.

126. The BWRX-300 design includes a significant number of large openings particularly in floors. The RP has confirmed that more detailed optioneering, involving all relevant stakeholders, is required to satisfactorily address this departure (referenced as PSR24-88 in the FAP (ref. [7]). In my opinion, this departure (concerning both vertical and horizontal compartmentation below grade) presents a significant risk gap in the current fire safety strategy. Given its direct implications for containment, firefighter access, and life safety, the issue should be considered and resolved through a coordinated and robust design approach.

127. The RP has included a commitment in the FAP (ref. [7]) to conduct detailed optioneering with all relevant stakeholders to determine how basement compartmentation in the Reactor Building will be addressed. This work is intended to support the future UK site-specific licensing phase for the BWRX-300. For context, preliminary optioneering and analysis carried out during the Step 2 GDA for CFS are documented in NEDC-34146P, BWRX-300 UK GDA Conventional Fire Safety Strategy (ref. [6]). The existence of these initial options does not preclude the future optioneering team from identifying improved or alternative solutions as new information becomes available.

128. In my judgement, and given the information provided in the response to RQ-01773, I am satisfied that a future licensee should have sufficient context and understanding of the requirement to carry out further detailed design assessment and optioneering such that the provision of adequate compartmentation arrangements is progressed. This is recorded within the FAP (ref. [7]).

4.3.4.4. Departures 4 to 10

129. The remaining seven departures (see list 4 to 10 below) have been discussed at length in the RP / ONR formal level four engagements. Departures 4 and 5 - Lack of subdivision in the hallways in the Control Building. Two corridors in the Control Building exceed BS 9999: 2017 (ref. [5]) expectations in length without initial subdivision:

- Hallway 0, 3100 – located on the ground floor (0.0m level)
- Hallway 6.1, 3200 – located on level 6.1m

130. Through the optioneering process, the RP determined that installing subdividing doors in these corridors was the most appropriate solution. This modification brings the design into compliance with Section 18 of BS 9999:2017 (ref. [5]) and eliminates the need to further address Departures 4 and 5. I agree with the RP that in this instance no further optioneering is considered necessary. It is noted that physical design changes to the BWRX-300 Standard Plant will not occur until the post–Step 2 Generic Design Assessment (GDA) phase. In my judgement the proposed solution adequately resolves this departure. I am content that the RP has provided a clear intention to implement this solution in future project design phases and has articulated this in the FAP ref. ([7]). This is referenced as PSR 24-387.

- Departure 6 - Lack of Subdivision in the hallway connecting the Turbine Building and the Service Building.

131. The Turbine Building and the Service Building are connected by a hallway (TB-SB Hallway, 5201) located at level 6.1m. This hallway exceeds 12 m in length and does not include a subdivision. Although this was initially identified as a departure, the hallway functions solely as an auxiliary connection between the two buildings. It does not serve as a typical corridor connecting multiple rooms, nor does it form part of the essential means of escape for either building. Based on this functional assessment, I concur with the RP that the provision of a subdivision is unnecessary. Adequate justification has been provided, and no further action is required.

- Departure 7 - Non-compliant single maximum travel distance from the RWST (Refueling Water Storage Tank) and CST (Condensate Storage Tank) room in the Turbine Building.

132. The travel distance from the RWST and CST Room 2181 in the Turbine Building (Ground Level 0.0m) was measured at 30.4 m, exceeding the maximum travel distances recommended in BS 9999:2017 (ref. [5]). During

the optioneering process, the RP proposed the addition of a second exit in the affected rooms. This solution brings the travel distance within the acceptable limits defined in Section 6 of the standard and fully addresses Departure 7. The option is both compliant with BS 9999 and straightforward to implement. As a result, the RP recommends its inclusion in the UK site-specific licensing phase. No further optioneering is considered necessary. It is noted that physical design changes to the BWRX-300 Standard Plant will not occur until the post–Step 2 Generic Design Assessment (GDA) phase. In my judgement the proposed solution adequately resolves this departure. I am content that the RP has provided a clear intention to implement this solution in future project design phases and has articulated this in the FAP ref. ([7]). This is referenced as PSR 24-388.

- Departure 8 and 9 - Non-compliant single and two-ways maximum travel distances from the condenser area and shield area in the Turbine Building.

133. In the current design, travel distances in the Turbine Building exceed the maximum limits recommended in Section 6 of BS 9999:2017 (ref. [5]) in the following cases:

Condenser Area 2271 (Level 6.1m):

- Single travel distance to the room exit: approximately 79 m
- Closest two-way travel distance to outdoors: approximately 105 m

Shield Area 2371 (Operating Floor, Elevation 13.0m):

- Single travel distance to the room exit: approximately 67 m
- Closest two-way travel distance to outdoors: approximately 94 m

134. These rooms are not occupied during normal operations due to high radiation levels and therefore do not pose a risk to building occupants under standard conditions. They are, however, accessed during maintenance periods, which are currently outside the scope of this assessment.

135. I acknowledge the RP’s position that conducting detailed optioneering at this stage is not feasible, as the maintenance strategy (including defined tasks, temporary wall access points, and occupancy parameters) has yet to be established.

136. The RP has clarified that optioneering will be undertaken during the UK site-specific licensing phase, once these variables are determined. Since modifications to the BWRX-300 Standard Plant design will not occur until after Step 2 of the GDA, the selected option has been recorded in the FAP ref. ([7]) for final decision-making during site-specific licensing. This is

referenced at as PSR 24-388. Therefore, no further action is necessary at this point in the GDA process.

- Departure 10 - Lack of a protected corridor in a final exit in the Control Building from Stair B in the Reactor Building.

137. The final exit corridor in the Control Building (Hallway 0, 3100) is currently unprotected. The RP has determined that no optioneering can be undertaken at this stage, as this issue is inherently linked to Departure 1, which concerns the absence of a firefighting shaft in the basement and ground levels of the Reactor Building. The RP accepts that the resolution of Departure 1 is expected to influence or redefine the approach to Departure 10. In my judgement I am content that the RP has provided confidence that this departure can be resolved in the future and has adequately articulated the departure in the FAP. This is referenced as PSR 24-389.

138. I am satisfied that the approach taken by the RP offers appropriate routes for departures from UK RGP (ref. [5]) to be considered and resolved in the future. See Appendix 3 for Identified Departures Against the BS 9999 (Extract from Conventional Fire Safety Strategy (ref. [6]). I am satisfied that the generic safety, security and safeguards cases have had appropriate scope and structure and have been sufficient to support a meaningful GDA from a LFS perspective.

5. Conclusions

139. This report presents the Step 2 CFS assessment for the GDA of the BWRX-300 design. The focus of my assessment in this step was towards the fundamental adequacy of the design and safety case predicated on the Conventional Fire Safety Strategy (ref. [6]). I have assessed the SSSE chapters and relevant supporting documentation provided by the RP to form my judgements. I targeted my assessment, in accordance with my assessment plan (ref. [2]), at the design considerations of most relevance to life fire safety risks, using as reference expectations of British Standards, TAGs and other guidance which ONR regards as relevant good practice in this context.

140. Based upon my assessment, I have concluded the following:

- The RP has identified adequate fire safety design principles to support the construction and operation of its design.

- The RP has identified and used suitable UK design codes and standards to support the assessment of the departures between the original US and Canadian codes to support construction and operation of its design.

- The RP has not yet demonstrated that the risks to CFS posed by the generic design are ALARP or the design meets expectations in RGP such as UK codes and standards for CFS. The RP has nevertheless identified relevant departures, and committed to their resolution in the FAP (ref. [7]) post-Step 2 GDA. These issues should be addressed holistically post–Step 2 GDA or the subsequent site-specific licensing phase.

- The departures from UK RGP concerning LFS pertain primarily, but not entirely, to below-grade design features across the Power Block. Specifically, they relate to the lack of design compliant firefighting shafts, the lack of both vertical and horizontal compartmentation, and the lack of smoke and heat ventilation. I am content that the RP understands the requirements of UK RGP and has undertaken preliminary optioneering and recorded the departures and potential solutions within the FAP. They have also provided sufficient confidence that these issues can be resolved holistically in the future during any post step 2 process.

- The plant layout submitted by the RP provides a sound foundation for further design development. Although several areas still require refinement to fully meet applicable standards and requirements, the FAP (ref. [7]) clearly outlines the necessary focus areas for post-Step 2 design activities within the GDA process. Based on this, I am satisfied that there are no fundamental issues at this stage that would prevent construction or operation.

- I welcome the overall quality and detail contained in the documentation provided by the RP. In particular, I consider that the quality of the Conventional Fire Safety Strategy (ref. [6]) has signficantly contributed to a positive and professional GDA process in relation to CFS.

141. Overall, based on my assessment, and subject to the provision and assessment of suitable and sufficient supporting evidence in either a future Step 3 GDA or during site specific activities, I have not identified any fundamental safety shortfalls that could prevent ONR permissioning the construction of a power station based on the generic BWRX-300 design.

6. References

[1] GE-Hitachi, NEDC-34154P, BWRX-300 UK GDA Design Reference Report, Revision 3, April 2025, ONRW-2019369590-20193.

[2] Step 2 Life Fire Safety Assessment Plan for the Generic Design Assessment of the GE Hitachi BWRX-300 ONRW-2126615823-4134, ONR.

[3] British Standard 7974; - Application of fire safety engineering principles to the design of buildings.

[4] HMG, The Building Regulations 2010, https://www.legislation.gov.uk/uksi/2010/2214/contents.

[5] BS 9999 Fire Safety in the design, managementand use of buildings - 2017, British Standards Institute, 2017.

[6] GE-Hitachi Topical Report NEDC-34146P, Revision 4 BWRX-300 UK GDA Conventional Fire Safety Strategy, 2025, ONRW-2019369590-19771.

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Appendix 1 – Relevant SAPs considered during the assessment.

SAP reference	SAP title
EKP1 to 5	Engineering Key Principles
ELO 1 to 4	Layout

Appendix 2 – Identified Departures against BS 9999:2017.

Departure no.	Building	Departure Title
1	RB	Lack of a fire-fighting shaft in the Reactor Building.
2	RB	Lack of Basement Smoke Venting in the Reactor Building. The Reactor Building is not provided with a Heat and Smoke Control System to provide a route for smoke to escape to the open air from the basement levels during a fire event.
3	RB	Lack of Compartments Floors in the Basement Levels in the Reactor Building. Basements floors are not compartment floors, including the ground floor over a basement due to risers (Chase A/B) are not fire rated and Hatches are opened. Risers are hatches are opened and therefore all floors are connected
4	CB	Lack of subdivision of corridors/hallways exceeding 12m in the Hallway 0, 3100, located at the ground floor 0.0m located in the Control Building.
5	CB	Lack of subdivision of corridors/hallways exceeding 12m in the Hallway 6.1, 3200, located at level and 6.1m located in the Control Building.
6	TB-SB	Lack of subdivision of corridors/hallways exceeding 12m in the TB-SB Hallway, 5201, located at level and 6.1m (hallway connecting the Turbine Building and the Service Building).
7	TB	Measured travel distances exceed maximum travelled distances recommended in BS 9999 in from the RWST (Refuelling Water Storage Tank) Room and CST (Condensate Storage Tank) Room to the exit of the room (one-way travel distance) at ground level 0.0m in the Turbine Building.

8	TB	Measured travel distances exceed maximum travelled distances recommended in BS 9999 from the Condenser Area 2271 to the exit of the room (one-way travel distance) and to final exit (two-ways travel distance) at ground level 6.1m in the Turbine Building.
9	TB	Measured travel distances exceed maximum travelled distances recommended in BS 9999 in from the Shield Area 2371 to the exit of the room (one-way travel distance) and to final exit (two-ways travel distance) at ground level 13.0m in the Turbine Building.
10	CB	Lack of a protected corridor in a final exit in the Control Building from stair B in the Reactor Building.