ONR Project Assessment Report

Generic Design Assessment of the BWRX-300

Step 2 Summary Report

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Report title: Step 2 Summary Report

Dutyholder/Applicant: GE Vernova Hitachi Nuclear Energy LLC, UK Branch

Authored by: Assessment Group Lead, ONR

Assessment Group Lead, ONR

Assessment Group Lead, ONR

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GE Vernova Hitachi	Senior Project Manager, Advanced Nuclear UK Licencing Lead Regulatory Interface Office	11/12/25

Executive summary

In December 2024, following completion of Step 1, 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 Vernova Hitachi Nuclear Energy International LLC, UK Branch, the requesting party (RP). The RP is a branch company to the designer of the BWRX-300, GE Vernova Hitachi Nuclear Energy Americas LLC (GVHA), who is a provider of advanced reactors and nuclear services.

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 states the design is at an advanced concept stage of development and is being further developed in parallel to the GDA activities in the UK.

The RP has stated that, at this time, it has no plans to undertake Step 3 of GDA. Therefore, this GDA will culminate with the issue of a GDA Statement. The RP anticipates that any further assessment by the UK regulators of the BWRX-300 design will be on a site-specific basis and with a future licensee.

During the last 12 months, we have undertaken an assessment focused on the adequacy of the design, and the safety, security and safeguards cases, with the intent of identifying any fundamental shortfalls in meeting regulatory expectations. These activities are defined within our GDA guidance document, 'New Nuclear Power Plants: Generic Design Assessment Guidance to Requesting Parties', ONR-GDA-GD-006 Revision 1, August 2024.

This report has been produced:

- To summarise ONR's judgement on whether we have identified any fundamental shortfalls with the generic BWRX-300 design that could challenge future deployment in Great Britain (GB) to support issue of the GDA Statement at the end of Step 2;
- To document the completion of, and outcomes from, Step 2;
- To summarise the activities undertaken by both the RP and ONR during the step; and
- To summarise ONR's judgement on whether the objectives for Step 2 have been met.

Our assessment considered all of ONR's statutory purposes relevant to GDA (nuclear safety, nuclear site health and safety[1], nuclear security and safeguards) across 21 technical topics. We used ONR's standards and guidance as the basis for our assessments, in addition to International Atomic Energy Agency (IAEA) and other relevant international standards. We targeted our assessment and used a sampling approach, based on significance, novelty or hazard potential to determine an overall view on the adequacy of the design.

We have previously assessed BWR technology during the UK advanced boiling water reactor (ABWR) GDA from 2013-2017. Our assessment of the UK ABWR demonstrated that it is possible for BWR technology to meet ONR's expectations for safe and secure deployment in GB. As the BWRX-300 is part of an evolution of the ABWR technology, we have not sought to replicate our previously undertaken assessments where the design, approaches and methodologies are the same or very similar to those considered in the UK ABWR GDA. Instead, our focus has been on areas of novelty – such as the application of advanced construction techniques and the isolation condenser system.

We have also collaborated with regulatory colleagues in the United States Nuclear Regulatory Commission (US NRC) and the Canadian Nuclear Safety Commission (CNSC) to target and maximise the efficiency our assessment, obtain additional insights, and to share views on the BWRX-300 design.

Our assessments have concluded the following:

- The submitted Safety, Security, Safeguards and Environment cases (SSSE) have been written in support of the RP's ambition of an internationally standardised design, with minimal country-specific variations. We recognise, and welcome, that the RP has attempted to develop the SSSE with an international mindset. We positively note that it has utilised a structure aligned with the IAEA format for a safety analysis report, SSG-61, although we also observed that in some areas the SSSE still directly references US NRC requirements without explaining their applicability to other regulatory regimes or the safety claims being made.

- The SSSE submitted in Step 2 is of a high quality, providing a sound basis for us to undertake a meaningful fundamental assessment of the BWRX-300. It also captures the operating experience and expertise in the nuclear industry of GVHA. It is comprehensive, logical, and suitably structured, and we consider that it provides the RP a robust basis to support development of a future BWRX-300 project in the UK.

- The BWRX-300 design is based on established BWR technology, with the incorporation of passive features. We recognise that the passive features simplify the design and reduce the reliance on active safety systems and operators to

[1] Nuclear site health and safety is referred to as conventional health and safety to align with our guidance (ref. [1]). This area considers the management of risks arising from hazards to workers and members of the public from all work activities on nuclear licensed sites.

maintain safety, whilst still achieving the safety and security outcomes sought. It also utilises standards and approaches we have seen applied in similar circumstances.

- Overall, we judge that the BWRX-300 design submitted was sufficiently mature to enable a fundamental assessment at GDA Step 2. Our assessments did not identify any fundamental shortfalls with the design or SSSE that could be a significant challenge the BWRX-300 being developed and deployed in GB. We also did not identify any potential conflicts with relevant government policy.

We have identified a number of areas where additional substantiation, analysis or modelling will be required in a future SSSE, if a UK project is initiated. The RP should consider at what stage in the BWRX-300 design and SSSE development process these are addressed if it wants to maintain a standard international design with common supporting documentation. Waiting until UK site-specific activities could result in the design being too mature to introduce risk reduction measures without significant cost and time implications.

We have raised three regulatory observations during this GDA. These relate to diversity of the control and instrumentation systems, design for decommissioning, and unisolable loss of coolant accidents. The RP has produced credible resolution plans for the three regulatory observations, which we have agreed to. If adequately addressed, we consider the work identified by the RP should be sufficient to close the raised actions and support a future design and SSSE justification.

We are satisfied the RP has completed all of the requirements for Step 2 from our guidance for a GDA that is not progressing to Step 3.

We have not identified any fundamental safety, security or safeguards shortfalls that could prevent ONR permissioning the construction of a power station based on the generic BWRX-300 design. This is based on our assessment to date, and subject to the provision and assessment of suitable and sufficient supporting evidence as part of any future site-specific BWRX-300 regulatory interactions.

Table 1: List of abbreviations.

Term/Acronym	Description
ABWR	Advanced Boiling Water Reactor
ACoP	Approved Code of Practice
ALARA	As Low As Reasonably Achievable
ALARP	As Low As Reasonably Practicable
ATWS	Anticipated Transients Without Scram
BEZ	Break Exclusion Zone
BL	Baseline
BIS	Boron Injection System
BSL	Basic Safety Level
BSO	Basic Safety Objective
BWR	Boiling Water Reactor
CAE	Claims, Arguments, Evidence
CCF	Common Cause Failures
CDM	Construction (Design and Management) Regulations 2015
CNSC	Canadian Nuclear Safety Commission
CySPP	Cyber Security Program Plan
DAC	Design Acceptance Confirmation
DBA	Design Basis Accident
DBT	Design Basis Threat
DESNZ	Department Of Energy Security and Net Zero
DiD	Defence In Depth
DL	Defence Line
DNNP	Darlington New Nuclear Project
DPS	Diverse Protection System
DP-SC	Diaphragm Plate Steel Composite
DRP	Design Reference Point
DRR	Design Reference Report
EIMT	Examination, Inspection, Maintenance and Testing
ESBWR	Economic Simplified Boiling Water Reactor
FAP	Forward Action Plan
FMCRDs	Fine Motion Control Rod Drives
FNEF	The Future Nuclear Enabling Fund
FSFs	Fundamental Safety Functions
FSPs	Fundamental Safety Properties
GB	Great Britain
GDA	Generic Design Assessment
GSE	Generic Site Envelope
GVHA	GE Vernova Hitachi Nuclear Energy Americas LLC
IAEA	International Atomic Energy Agency
IC	Isolation Condenser
ICS	Isolation Condenser System
IRR17	Ionising Radiations Regulations 2017
LOCAs	Loss Of Coolant Accidents
MCR	Main Control Room

MDSL	Master Document Submission List
MSQA	Management For Safety and Quality Assurance
MoC	Memorandum Of Cooperation
NISR	Nuclear Industries Security Regulations 2003
NPP	Nuclear Power Plant
NPS	National Policy Statement
NRW	Natural Resources Wales
ONMACS	ONR Nuclear Material Accountancy, Control, And Safeguards Assessment Principles
ONR	Office For Nuclear Regulation
OPEX	Operating Experience
OPG	Ontario Power Generation
PA	Protected Area
PAA	Państwowa Agencja Atomistyki (The National Regulator For Poland)
PCCS	Passive Containment Cooling System
PCSR	Pre-Construction Safety Report
PD	Principal Designer
PER	Preliminary Environment Report
PIP	Project Implementation Plan
PSA	Probabilistic Safety Analysis
PSAR	Preliminary Safety Analysis Report
PSR	Preliminary Safety Report
PPS	Primary Protection System
RGP	Relevant Good Practice
RI	Regulatory Issue
RIV	Reactor Isolation Valve
RO	Regulatory Observation
RP	Requesting Party
RPV	Reactor Pressure Vessel
RQ	Regulatory Query
SAP	Safety Assessment Principle(s)
SBWR	Simplified Boiling Water Reactor
SCCV	Steel-Plate Composite Containment Vessel
SCR	Secondary Control Room
SFAIRP	So Far As Is Reasonably Practicable
SMR	Small Modular Reactor
SSSE	Safety, Security, Safeguards and Environment Cases
SSCs	Structure, System and Components
SyAPs	Security Assessment Principles
TAG	Technical Assessment Guide(s) (ONR)
UK	United Kingdom
UPR	Ultimate Pressure Relief
URC	Unacceptable Radiological Consequences
US	United States of America
US NRC	[US] Nuclear Regulatory Commission

VAI	Vital Area Identification
VA	Vital Area
WENRA	Western European Nuclear Regulators' Association

Table of contents

Executive summary 4

1. Purpose 11

2. Background 12

3. Work carried out by ONR in consideration of this request 20

4. Summary of our assessments 25

5. Conclusions and Recommendations 67

6. References 69

7. Figures 81

Appendix 1 84

Figures

Figure 1 - BWRX-300 major systems (ref. [29]) 81
Figure 2 - BWRX-300 containment structure (ref. [29]) 82
Figure 3 - BWRX-300 reactor power block and generic site layout (ref. [29])........... 83

Tables

Table 1: List of abbreviations. 7
Table 2: Step 2 requirements from Guidance to Requesting Parties (ref. [1]).......... 84

1. Purpose

1. A request was received from the Department of Energy Security and Net Zero (DESNZ), in June 2023 for the Office for Nuclear Regulation (ONR), the Environment Agency and Natural Resources Wales (NRW) to undertake Steps 1 and 2 of a Generic Design Assessment (GDA) for the BWRX-300 design.

2. 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 commenced in January 2024 and completed in December 2024.

3. Step 2 is the first substantive technical assessment step which began in December 2024 and is summarised in this report.

4. The GDA process (ref. [1]), includes the option for further detailed Step 3 assessment of a reactor technology. However, the requesting party (RP) has stated that at this time it has no plans to undertake Step 3 of GDA for the BWRX-300 design. Therefore, the outcome sought by the RP from this GDA is a GDA Statement (ref [2]).

5. The RP anticipates that any further assessment by the United Kingdom (UK) regulators of the BWRX-300 design will be on site-specific basis and with a future licensee.

6. Since December 2024 we have undertaken those activities identified for Step 2 within our GDA guidance document, Guidance to Requesting Parties (ref. [1]), with the exception of any enabling activities related to proceeding to Step 3. Our assessment has focused on the adequacy of the design, and the safety, security and safeguards cases with the intent of identifying any fundamental shortfalls in meeting regulatory expectations.

7. This report has been produced:

- To summarise ONR’s judgement on whether we have identified any fundamental shortfalls with the generic BWRX-300 design and safety, security, safeguards and environment cases (SSSE) to support issue of the GDA Statement at the end of GDA Step 2;
- To document the completion of and outcomes from Step 2;
- To summarise the activities undertaken by both the RP and ONR during the step; and
- To summarise ONR’s judgement on whether the objectives for Step 2 have been met.

2. Background

2.1. Generic Design Assessment

8. ONR is the UK's independent nuclear regulator, with the legal authority to regulate nuclear safety, civil nuclear security and safeguards, and conventional health and safety at the 36 licensed nuclear sites in Great Britain (GB). We also regulate the transport of civil nuclear and radioactive materials by road, rail and inland waterways. ONR's mission is to protect society by securing safe nuclear operations.

9. The environmental protection aspects of the generic design are assessed and reported separately by the environment agencies (the Environment Agency and NRW) whom we work with closely during GDA. Whilst we have independent responsibilities and regulate within our own legal frameworks, we recognise the benefits of building on our close working relationship to align our processes and regulatory positions when we can. The Environment Agency follows its owns published guidance for undertaking a GDA (ref. [3]), however it complements and is cognisant of ONR's guidance (ref. [1]).

10. The GDA process was developed by ONR and the Environment Agency in response to the government's 2006 Energy Review; in particular, lessons learnt from experience with new nuclear power plants (NPPs) indicated that the use of a standardised design, where the design and safety case are well developed much earlier in the project, would facilitate a reduction in the time for regulatory assessment as well as minimise any potential regulatory uncertainty for a future site licensee wishing to build such a design.

11. The objective for GDA is to provide confidence that the proposed design is capable of being constructed, operated and decommissioned in accordance with the standards of safety, security, safeguards and environmental protection required in GB. For the RP, the organisation who requested the GDA, this offers a reduction in uncertainty and project risk regarding the design and safety, security, safeguards and environmental cases so as to be an enabler to future licensing, permitting, construction and regulatory activities.

12. To fulfil this objective, the GDA process progresses in steps, with the regulatory assessments becoming increasingly detailed. The assessment considers the majority of ONR's statutory purposes, using inspectors from the full range of technical topics (for example, fault studies, civil engineering or chemistry), as defined in Guidance to Requesting Parties (ref. [1]).

13. The GDA process has three steps, noting that earlier GDAs had four steps; a change that resulted from lessons learnt and efficiency improvements implemented in 2019. This updated GDA process provided flexibility to allow Requesting Parties the opportunity to finish their GDA at Step 2.

14. The overall intent of GDA is that:

- Step 1 is the initiation step where matters such as the scope and timescales are agreed, and ONR's knowledge of the design and the RP's safety, security and safeguards cases increases;
- Step 2 is the fundamental assessment of the generic design and safety, security and safeguards cases, to identify any potential 'showstoppers' that may preclude deployment of the design; and
- Step 3 is the detailed assessment of the generic safety, security and safeguards cases on a sampling basis.

15. To date, we have completed GDAs for four designs: the EDF and AREVA UK EPR™, the Westinghouse AP1000®, the Hitachi-GE UK Advanced Boiling Water Reactor (ABWR) and the CGN/EDF/GNI UK HPR1000. These finished with the award of a Design Acceptance Confirmation (DAC) in 2012, 2017, 2017 and 2022 respectively. We are also carrying out GDAs on the Rolls-Royce SMR and the Holtec International SMR-300 designs. The Rolls-Royce SMR design was the first GDA to complete Step 2 using the revised GDA process in 2024 and has subsequently gone on to enter Step 3. The Holtec International SMR-300 is planned to complete Step 2 of GDA in 2026. Full details of completed and ongoing GDA projects are available on the joint regulators' website (ref. [4]).

16. This is the first time ONR has finished assessment at Step 2 of the revised GDA guidance. It is not possible to compare the outcomes reported here with other completed GDAs using the historic four-step process with outcomes achieved at the end of this two-step GDA, as the scope and objective of the assessments differ.

2.2. Objectives for Step 2

17. Step 2 is the first substantive technical assessment step of the GDA process and builds upon the work undertaken during Step 1. The focus of the assessment in this step is towards 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 generic design and cases.

18. One of the outcomes sought from a two-step GDA is to identify any fundamental shortfalls in the generic design. A fundamental shortfall is defined as one that could prevent ONR permissioning the construction of a NPP based upon that design; in effect where we judge that the generic design cannot meet regulatory expectations in such a manner that it cannot be operated safely, securely or to ensure safeguarding.

19. To ensure we undertook a holistic, balanced and proportionate assessment during Step 2 we mobilised all of our technical topics. In total we have performed assessments for 21 topics, and each of these is reported separately (refs [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], and [25]). Further details of the outcome from these assessments are provided in Section 4.

20. Guidance to Requesting Parties (ref. [1]) provides details of what the RP is required to do and what ONR will do during Step 2. These are repeated in Table 2 of this report, in Appendix 1. Where we have made a judgement against a requirement placed on the RP from this guidance, these are specifically cited in the text of this report.

21. A number of the requirements on the RP are to submit information to ONR. These cover matters which are necessary for undertaking GDA (such as project management activities and demonstration of adequate resources) along with matters of a more technical or regulatory nature. They are targeted at ensuring that sufficient information is provided to allow ONR to form a judgement on the fundamental adequacy of the design during Step 2.

22. The scope of buildings, activities and depth of analysis to be included in the RP's submissions to the regulators in Step 2 was agreed in Step 1 and captured in the RP's Scope of Generic Design Assessment report (ref. [26]).

2.3. Requesting party

23. For the purposes of the GDA, GE Vernova Hitachi Nuclear Energy International LLC, UK Branch, is the RP.

24. In the UK, the RP has been supported by its supply chain partner Amentum which assisted the RP in the development of the UK-specific chapters of the SSSE, and other technical documents for the GDA.

25. GE Vernova Hitachi Nuclear Energy Americas LLC (GVHA) is the designer of the BWRX-300. GVHA is a provider of advanced reactors and nuclear services. GVHA has extensive experience in the nuclear sector, having licensed and built more than 60 reactors in 10 countries (ref. [27]). GVHA is headquartered in Wilmington, North Carolina, United States of America (US).

26. 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.

2.4. BWRX-300 design

2.4.1. Design status

27. 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 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 and ESBWR have been built or operated.

28. The RP states that GVHA has designed the BWRX-300 to optimise the costs of construction, operation, maintenance, staffing, and decommissioning, whilst maintaining safety provision in line with the International Atomic Energy Agency (IAEA) expectations for five levels of defence in depth (ref. [28]).

2.4.2. International deployments and GDA stakeholders

29. GVHA is currently engaging with regulators internationally, including the United States Nuclear Regulatory Commission (US NRC) and the Canadian Nuclear Safety Commission (CNSC) in support of BWRX-300 projects at Clinch River in Tennessee and Darlington in Ontario.

30. Ontario Power Generation (OPG) is the future operator of the BWRX-300 at the Darlington site, known as the Darlington New Nuclear Project (DNNP). OPG has been granted a licence to construct by the CNSC, and GVHA are providing safety case support to OPG.

31. The Tennessee Valley Authority (TVA) is the future operator of the BWRX-300 at the Clinch River site. TVA submitted a Preliminary Safety Analysis Report (PSAR) in 2025 to US NRC as part of a construction licence application.

32. GVHA also has advanced plans for BWRX-300 deployment in Poland; one potential customer, Orlen Synthos Green Energy, has made a financial contribution to the RP’s GDA activities in the UK. During Step 2, some of our engagements with the RP were observed by Orlen Synthos Green Energy at the request of the RP.

33. The Future Nuclear Enabling Fund (FNEF) shortlisted GVHA (at the time of award the entity’s market name was known as GE-Hitachi), Holtec Britain Ltd, and Cavendish Nuclear as successful applicants for funding to mature their nuclear projects towards final investment decisions. The FNEF is a UK government fund which aims to support nuclear projects by reducing risks

and strengthening domestic supply chains. Therefore, public funding has been granted to the RP to finance part of this GDA process.

34. GVHA intends to develop a standard design to be deployed globally, with minimal country-specific variations. Some country, site and customer variations will, however, be inevitable. Notably a 60Hz power grid exists in North America and a 50Hz power grid in Europe, which will require variations to the design between deployments. In this GDA, the RP is aiming to demonstrate the suitability of the standard plant design for deployment at a generic nuclear site in GB, identifying but not providing design detail for any country or site-specific safety, security or safeguards related changes that may need to be implemented in the future.

2.4.3. Design overview

35. 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.

36. The RP has provided a design description document to regulators (ref. [29]), and also maintain a version on GE Vernova Inc’s public website (ref. [30]).

37. 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. [31]).

38. 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.

39. Of particular note is its use of natural circulation and passive cooling, rather than active components, reflecting the BWRX-300 design philosophy. The RP claims that steam condensation and gravity allow the BWRX-300 to passively cool itself for seven days without power or operator action during abnormal events, including station blackouts.

40. The RP also identifies innovation in the design to mitigate loss of coolant accidents (LOCAs). The BWRX-300 has a relatively large RPV volume, which along with a tall chimney region (necessary to support natural circulation in normal operation), provides a substantial reservoir of water above the core. The RP claims that this ensures the reactor water level is maintained above the fuel, such that the fuel cladding is within the normal operating temperature range following transients involving feedwater flow interruptions or LOCAs.

41. The BWRX-300 design incorporates double reactor isolation valves (RIVs) in series which attach directly to the RPV. These valves are designed to close as part of the response to a LOCA. The RP claims the double RPV isolation

valve configuration provides redundancy as each is capable of independently isolating a coolant pipe break.

42. Key to the claims on passive cooling is the isolation condenser system (ICS). The BWRX-300 is equipped with three separate isolation condenser (IC) trains designed to remove decay heat and eject it to the environment following a scram (emergency shutdown of the reactor achieved by stopping the fission reaction). It also minimises increases in steam pressure and maintains the RPV pressure at an acceptable level through decay heat removal.

43. As a result of these innovations, the BWRX-300 design has eliminated safety relief valves and many of the active safety systems commonly installed on earlier generations of BWRs.

44. In another change from previous BWRs, the RP states that the way in which LOCAs are managed on the BWRX-300 allows (wet) suppression pools to be removed from the design. Therefore, the BWRX-300 has a dry containment. This containment is the ultimate means of confining radioactive material following a fault and is inerted with nitrogen in most operating modes.

45. The containment structure is a vertical cylinder 17.5 metres in diameter and 38 metres high constructed with steel-plate composites. An inherent design feature of BWRs is the tall RPVs and containment structures (relative to other reactor technologies) because the steam separation and drying equipment is located inside the RPV itself. This height challenge is even greater on the BWRX-300 because of the chimney included in the design to facilitate natural circulation. The approach taken by the BWRX-300 designers to mitigate the impact of this is to deeply embed the RPV and containment structure within a cylindrical and largely below grade (below the level of the surrounding ground) reactor building. This is claimed by the RP to have advantages for mitigating the effects of aircraft impact, adverse weather, flooding, fires, and earthquakes, whilst also allowing fuel handing activities to be undertaken much closer to ground level than would otherwise be the case.

46. The major systems of the BWRX-300 design can be seen in Figure 1 in Section 7.

47. The reactor building and containment design are illustrated in Figure 2 Section 7.

48. The reactor building and the turbine building, along with the majority of the significant structures, systems and components (SSCs) are housed within the ‘power block’. The power block also includes the radwaste building, the control building and a plant services building, and includes the protected area (PA) boundary and PA access building. The site layout, including where

the power block sits within the wider site, can be seen in Figure 3 in Section 7.

2.4.4. Design maturity

49. The design submitted for GDA by the RP is stated to be at an advanced concept stage of development. The RP has maintained a fixed design for the purpose of ONR's assessment however it should be noted that GVHA has continued to develop the standard BWRX-300 design and supporting analysis in parallel to the GDA activities in the UK.

50. For this GDA, SSCs in the power block are stated to be at Baseline (BL) 1. 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.

51. The balance of plant remains at BL0 for which only plant requirements have been established, and SSC design remains at a high concept level.

2.5. Safety, security and safeguards cases

52. The RP submitted information on its strategy and intentions regarding the development of the SSSE (refs [32], [33], [34], [35]). These strategies were submitted to ONR during Step 1, however, during the course of Step 2 the RP revised and resubmitted its strategy for demonstrating how conventional health and safety risks are appropriately considered in the BWRX-300 design (ref. [33]).

53. In Step 2, the RP submitted a comprehensive SSSE for the BWRX-300 that claimed 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 Report (PSR) which also includes information on the RP's approach to safeguards and security, a Security Assessment, a Preliminary Environment Report (PER), and supporting documents.

54. The documents submitted are organised into 4 tiers of information:

- Tier 1 - the overarching documents of the SSSE

- Tier 2 - supporting information consisting of the references cited within the Tier 1 submissions linking to more detailed information

- Tier 3 - selected supporting documentation consisting of detailed evidence such as design, evaluation and analysis to demonstrate that the design intent meets the high-level claims and arguments made in Tier 1

- Tier 4 - all other information sent from the RP to the regulators such as correspondence, superseded versions of documents, Regulatory Queries (RQ), responses and public comments

55. In July 2025, all three Tier 1 volumes were consolidated and resubmitted to regulators to incorporate any commitments and clarifications identified during Step 2 regulatory engagements, or in responses to RQs and regulatory observations (ROs). This consolidated revision is the basis of the regulatory judgements reached in Step 2.

56. The assessment documented in this project assessment report is based upon the PSR with 28 chapters incorporating nuclear safety, safeguards and nuclear security (refs. [31], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57], [58], [59], [60], [61], [62], [63], [64], [65], [66], [67], [68], [69], [70], [71], [72], [73]), a Security Assessment (ref. [74]) and any supporting documents submitted on the master document submission list (ref. [75]).

57. The format and structure of the PSR largely aligns with the IAEA guidance for safety cases, SSG-61 (ref. [76]), supplemented to include UK-specific chapters such as structural integrity and chemistry. The RP has also provided a chapter on As Low as Reasonably Practicable (ALARP), which is applicable to all the other safety chapters. The RP has stated that the design and analysis referenced in the PSR reflects the status of the standard BWRX-300 design in March 2024, and in that respect is consistent with the PSAR submitted by TVA to US NRC in support of the Clinch River project.

58. Two notable exceptions to this are: PSR Chapter 8, for the electrical power aspects, which is based on a November 2024 reference to incorporate the 50Hz aspects of the design; and PSR Chapter 7 covering control and instrumentation (C&I)[2] , which is based on a September 2024 design reference to include key developments in the C&I architecture.

59. The Security Assessment and PER are for the same March 2024 design but have more limited links to any US submissions.

[2] The BWRX-300 SSSE refers to instrumentation and control (I&C) throughout. Control and instrumentation (C&I) and I&C are equivalent terms. C&I is used throughout this report to align with our guidance (ref. [1]) and UK terminology.

3. Work carried out by ONR in consideration of this request

60. Guidance to Requesting Parties (ref. [1]) details the activities that both ONR and the RP are expected to undertake. This provided the framework for ONR's work during Step 2.

61. To ensure that ONR's activities were coordinated and delivered, we produced a delivery strategy (ref. [77]) which outlines roles and responsibilities, key activities and assurance arrangements for the project. It also served as the overarching assessment plan for Step 2, specifically identifying those activities which are undertaken at project or topic level. Importantly, given the breadth of assessment undertaken during Step 2, it defined how we coordinated across each of our technical topics.

62. During Step 1, each of the 21 assessment topics produced an assessment plan for Step 2. These defined the aspects each topic intended to assess to inform their overall judgements on adequacy. As part of these plans we explicitly considered how our targeted assessment activities supported the delivery strategy (ref. [77]) and the objectives for Step 2, to ensure that we produced a holistic, joined up assessment of the generic design and SSSE. We also considered how we could use relevant learning and regulatory conclusions from the UK ABWR GDA to inform our assessment of the BWRX-300, and identified any potential opportunities for international collaboration. These assessment plans formed the basis of the assessment undertaken for each topic.

3.1. Assessment of submissions

63. The RP submitted more than 280 documents to ONR during Step 2, which have been the basis for our assessment. This included a range of documents, at all tiers within the RP's SSSE which covered all topics within the agreed scope of GDA (ref. [26]).

64. The primary objective for our assessment was to enable a judgement to be made regarding the adequacy of the generic design and SSSE, in line with the objectives for Step 2.

65. Our assessment was undertaken against the expectations in relevant standards and guidance, most notably our Safety Assessment Principles (SAPs) (ref. [78]), Security Assessment Principles (SyAPs) (ref. [79]) and ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles (ONMACS) (ref. [80]). We have also made use of international standards and guidance from both the IAEA (refs. [81] and [82]) and Western European Nuclear Regulators Association (WENRA) (refs. [83] and [84]), where relevant.

66. In addition, Appendix 3 of Guidance to Requesting Parties (ref. [1]) sets requirements on the RP for information to be submitted during Step 2. The requirements are summarised in Table 2 of this report along with reference to where they are documented in this report, as appropriate. Our assessment also determined whether these requirements had been met.

67. The main deliverable produced from each of ONR's technical topics are the Step 2 Assessment Reports (refs. [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], and [25]). These record the scope of regulatory assessment undertaken, the areas that have been targeted and the judgements made based on the submissions to date.

68. Key aspects of our assessment of the RP's BWRX-300 submissions provided for Step 2 of GDA are summarised in Section 4.

3.2. Interactions with the requesting party

69. In line with requirement [2.23] of Guidance to Requesting Parties [1], we held more than 165 interactions with the RP during Step 2, both at the project level and across the 21 individual technical topics. These interactions were held via a combination of virtual, hybrid and face to face meetings, which proved an efficient and effective way to facilitate our assessment. This included routine technical engagement, project and programme management meeting, briefings provided by the RP to improve our understanding of its ALARP process, and a targeted intervention at GVHA's headquarters in the US to look at both GVHA and the RP's Management for Safety and Quality Assurance (MSQA) arrangements.

70. Overall, the purpose of these interactions was to enable our assessment during the step, and to maintain oversight of ongoing activities. These interactions were positive, and we found the RP to be professional, responsive and open throughout and to have an appropriate focus on safety, security and safeguards.

3.3. Joint working with the Environment Agency and Natural Resources Wales

71. As a joint project, we have worked collaboratively with both the Environment Agency and NRW during Step 2, as appropriate. This included joint interactions on matters of regulatory interest to each regulator, particularly for quality assurance and aspects of radioactive waste management.

72. The Environment Agency's assessment of the environmental aspects of the generic BWRX-300 design is reported separately (ref. [85]).

3.4. International collaboration

73. The BWRX-300 has been designed with the intention of global deployment. During the period of our GDA, the BWRX-300 has also been subject to regulatory assessment and licensing activities in both Canada and the US. ONR is committed to collaborating with other regulators where possible on the assessment of reactor technologies for a range of benefits, including efficiencies for our own assessment activities in the UK, minimising the burden on the technology vendors to support regulatory engagement in different countries, to assist this RP with its objective of achieving an internationally acceptable common design, and to bring benefits and efficiencies to our international regulatory colleagues.

74. In 2024, ONR signed a Memorandum of Cooperation (MoC) with CNSC and US NRC to collaborate on advanced reactor and small modular reactor (SMR) technologies. Through this arrangement, we have frequently met with our regulatory colleagues to discuss, coordinate and share our respective BWRX-300 assessments. Also in 2024 we joined a six-party grouping that sets the direction and priorities specifically for our BWRX-300 collaboration under the MoC. The six parties are US NRC, CNSC, ONR, GVHA, OPG and TVA. The Polish nuclear safety regulator (PAA) and Orlen Synthos Green Energy have observer status.

75. To help us to navigate a complicated international landscape, and in line with requirement [2.3] of Guidance to Requesting Parties (ref. [1]), during Step 1 the RP provided a summary of international regulator interactions and future planned interactions document (ref. [86]). This identified the different timescales, variations in submissions, differing regulatory requirements and the range of stakeholders engaging with regulators on the BWRX-300.

76. The similarity and common origin of the UK SSSE (specifically the PSR) to the TVA PSAR for the Clinch River site has aided collaboration with US NRC. The October 2022 OPG construction licence application for the DNNP was supported by a PSAR produced on an earlier version of the standard BWRX-300 design to that considered by ONR and US NRC. However, CNSC has been engaging continuously with OPG and GVHA as the maturing design and safety case is readied for construction. Discussions with CNSC and access to updated information on the outcomes of regulatory interactions in Canada that go beyond what is in our GDA submissions have been a powerful confidence building measure for us in many areas where our assessment has identified there is more work to be done, and the RP could point to progress already being made in Canada.

77. Notable areas of collaboration during Step 2 have included:

- US NRC and CNSC have shared their joint report produced before ONR joined their bilateral BWRX-300 collaborations on diaphragm plate steel composite (DP-SC) advanced construction techniques (ref. [87]), and shared in a workshop additional insights and conclusions to the benefit of our civil engineering assessment of this novel design aspect (see Section 4.3.3.4).

- CNSC has provided ONR and US NRC with previews and insights into the additional demonstrations and assurances it is seeking on ‘break exclusion zones’ beyond what was included in the original submissions to the three regulators. We are supportive of CNSC’s initiatives in this area, and extra work being produced in Canada gives us confidence that limitations revealed in the GDA SSSE are not a fundamental shortfall to deployment in GB because credible solutions are already being generated elsewhere.

- We undertook an intervention of the RP’s and GVHA’s integrated quality arrangements and management processes for undertaking the GDA and controlling the BWRX-300 design at GVHA’s Wilmington offices. Afterwards, we shared our findings with the other regulators, triangulating these with similar interventions undertaken by the other regulators, and aiding the formation of a shared opinion of the management arrangements associated with the BWRX-300.

- C&I has historically been an area of significant focus for every international regulator considering a design, which has led to differences between individual deployments of the same reactor technology. Given the still evolving design status of the C&I architecture, and the relative phasing of the regulatory assessments in the three countries, no one regulator had an up-to-date picture of the latest design being developed by GVHA and the associated safety demonstrations. ONR organised a workshop for GHVA to present its latest iteration of its C&I design to all stakeholders (including to its utility partners in North America) and we have also initiated a joint regulatory workplan to document the common regulatory expectations for demonstrating the adequacy of the BWRX-300 design in the coming months and years. The objective of this collaboration is to provide the RP and GVHA with clarity on what is needed to be delivered to meet the expectations of multiple regulators, through a common design and documented safety demonstrations that only need to be generated once, whilst still facilitating acceptance in multiple regulatory regimes.

78. Further details on where our assessments have been informed by international collaboration is detailed within the body of our assessment in Section 4.3 and in the relevant topic-specific assessment reports.

3.5. Use of technical support contractors

79. During Step 2 we placed two contracts for technical support to inform our assessment. One contract was in the area of cyber security, for external resource to supplement and work alongside our internal specialists to undertake the assessment. The second contract was placed in the area of

civil engineering to provide expert technical advice on areas of novelty and safety significance associated with the construction and functions of the BWRX-300 civil structures.

80. In both cases, the work of the technical support contractors was undertaken with close supervision and direction from ONR inspectors. All regulatory judgements have been made exclusively by ONR.

3.6. Public comments

81. In accordance with requirement [2.24] from Guidance to Requesting Parties (ref. [1]), the RP has enabled a public comments process. We are satisfied the RP has met the expectations of this requirement.

82. During GDA Step 2, a total of 7 comments were received for the RP to consider (ref. [88]). None of the comments directly affected our assessment or our GDA process.

4. Summary of our assessments

83. This section provides an overview of our judgements arising from our assessment activities, to support the issue of a GDA Statement.

84. Our assessment considered all of ONR's statutory purposes relevant to GDA, including nuclear safety, conventional health and safety, security and safeguards. ONR's standards and guidance have formed the basis for our assessment (SAPs (ref. [78]), SyAPs (ref. [79]) or ONMACS (ref. [80]), and associated Technical Assessment Guides (TAGs) (ref. [89])). We have also actively considered relevant IAEA standards and requirements, given the RP's objective to have an international standardised design. Notably, the requirements set out in SSR-2/1 and SSG-61 (refs. [90] and [76]) have informed our assessment, aided by advice set out in the IAEA's Safety Report Series No. 123 (ref. [91]) on the applicability of these standards (and others) to SMRs.

85. In accordance with Guidance to Requesting Parties (ref. [1]), our assessment has focused on 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 generic cases. Any notable shortfalls or gaps against our expectations for this step of GDA have been noted in this report (along with our assessment of their significance), with further details available within the individual topic assessment reports.

86. In accordance with ONR guidance on assessment (refs. [92], and [93]), we have targeted our assessment and used a sampling approach, based on significance, novelty or hazard potential as a means to determine an overall view on the adequacy of the design. Within Step 2, our sampling has been broad and high-level. Our approach has been informed by our previous generic design assessment of the UK ABWR, and the ongoing assessments of the BWRX-300 by US NRC and CNSC (Section 3.4).

87. This section is composed of three main sub-sections. The first provides a summary of the RP's arrangements for undertaking the GDA, whilst the second summarises the key findings of our assessment of the RP's SSSE and generic design. The final sub-section provides further detailed information on our assessment of key elements of the BWRX-300 design which we consider to be pertinent to a fundamental assessment, and that may be relevant to any future regulatory activity associated with this technology. Additional detail for the basis of these judgements can be found in the individual topic reports.

4.1. RP's arrangements for undertaking GDA

88. Guidance to Requesting Parties (ref. [1]) sets out the expectation that ONR will make a judgement on the adequacy of the arrangements in place which will ensure that the design and safety, security and safeguards cases are controlled, and can be used by a future licensee.

89. In order to successfully undertake and deliver a GDA, the RP needs to have adequate arrangements in place to produce the generic design and supporting safety, security and safeguarding documents. Some of these arrangements are directly necessary to deliver GDA-specific requirements, such as for the management of regulatory questions; but for others we need confidence in the RP's processes that are a part of its own business arrangements for developing the BWRX-300 design and associated documentation.

90. We undertook some of this work to review the RP's arrangements during Step 1, the outcome of which is reported in the Step 1 summary report (ref. [94]). Our focus in Step 2 was on the implementation of these arrangements. Since this GDA is not progressing beyond Step 2, it is assumed that any UK-specific requirements and outcomes will be taken forward by GVHA or a future licensee. Therefore, we also focused our assessment on how the RP's arrangements (and any identified forward actions) are embedded into GVHA's business arrangements.

91. As the RP has stated that it does not intend to progress past Step 2 of GDA, we have not produced any assessment plans for any Step 3 assessment, or undertaken a readiness review of the evidence the RP has submitted for readiness to progress to Step 3.

4.1.1. Design reference point, GDA scope and design change control arrangements

92. It is important that the generic design assessed under GDA is clearly established, and any changes to it are subject to appropriate controls. The mechanisms to achieve this are specified in Guidance to Requesting Parties (ref. [1]) via the RP setting a design reference point (DRP) and adopting change management arrangements. The establishment of this DRP sets a baseline for the design as assessed in GDA.

93. In line with requirement [2.16] of Guidance to Requesting Parties (ref. [1]), the RP submitted Revision 3 of its Design Reference Report (DRR) during Step 2 (ref. [95]). The DRR presents the baseline design for GDA Step 2, outlining the physical system descriptions and requirements that form the design as of March 2024, the declared DRP. The DRR provides a list of the SSCs which are included in the scope of the GDA, and their relevant GDA reference design documents.

94. The DRR is supported by the Scope of Generic Design Assessment report (ref. [26]), which was submitted and agreed with regulators during Step 1. The GDA scope report gives a brief overview of the physical and functional scope of the NPP that is proposed for consideration in the GDA. The documents identified in the Scope of Generic Design Assessment report were submitted during Step 2.

95. The GDA scope report describes the RP's design process that extends from BL 0 (where functional requirements are defined) up to BL 3 (where the design is ready for construction). There have been no changes to the agreed scope, timescales, or schedule during GDA Step 2. This satisfies requirements [2.1] and [2.2] of Guidance to Requesting Parties (ref. [1]).

96. The RP's strategy was not to propose any design changes during the course of Step 2, maintaining the design consistent with the declared DRP. As a result, it did not need to propose a design change process to alter the design or SSSE submissions during the assessment period as expected by requirement [2.18] from Guidance to Requesting Parties (ref. [1]).

97. It did recognise in its Project Implementation Plan (PIP) (ref. [96]) that design changes to the BWRX-300 would occur after the declared DRP. The RP's approach to identify any future design changes coming from GDA was to capture them in forward action plans (FAPs) for addressing and implementation in a future UK site-specific project. The adequacy of these FAPs, as well as the arrangements of GVHA to manage all design changes, including those from natural design progression of the standard plant, were considered by our MSQA assessment.

4.1.2. MDSL and document management

98. The RP provided over 280 reports and submissions associated with the BWRX-300, some of which were pre-existing documents associated with the standard design and others which were produced specifically for the UK. Some reports were revised over the course of GDA. It was therefore important that robust arrangements were in place for the control of documentation submitted to the regulators.

99. Requirement [2.15] of Guidance to Requesting Parties sets some expectations for these arrangements, including the production and control of a master document submission list (MDSL). The arrangements proposed by the RP for the MDSL (along with its arrangements responding to RQs, ROs and regulatory issues (RIs)) were assessed during Step 1 and judged to be adequate (ref. [94]).

100. During Step 2, we were satisfied with how the RP applied these arrangements. The RP has provided 19 updates of the MDSL during Step 2 (ref. [75]). Revision 19 accurately identifies the complete list of submissions and their revision status that are the basis of our assessment and to which our regulatory conclusions apply.

101. Tier 4 documentation is not recorded in the MDSL, but in a separate document list. The document list captures all other information sent from the RP to the regulators such as correspondence, reading room documents, RQs, responses and public comments. The RP elected to use three tracking documents in lieu of a single document list. These were the regulatory query, regulatory observation and regulatory issue tracker (ref. [97]), the meeting and correspondence tracker (ref. [98]), and the ‘reading room’ tracker (ref. [99]).

102. The regulatory query, regulatory observation and regulatory issue tracker provided a record of the 181 RQs which have been issued by regulators and responded to by the RP, and four ROs and their associated resolution plans (three out of the four ROs were raised by ONR). We are satisfied that this met requirement [2.21] from Guidance to Requesting Parties (ref. [1]). Further details on the regulatory observations raised by ONR, and the associated resolution plans are discussed in sections 4.2 and 4.34.3 of this report.

103. Over the course of Step 2, the RP has also made available submissions provided to US NRC and CNSC that have been produced by GVHA and/or TVA and OPG (its utility customers in the US and Canada). This documentation was not formally submitted to ONR for assessment and thus was not captured on the MDSL. It was made available through an online portal (the ‘reading room’) to provide additional confidence and assurance on the progression of the design and analysis since March 2024. This supplementary information was recorded in the ‘reading room’ tracker (ref. [99]).

104. We are content that the RP’s arrangements for document control were sufficient for GDA.

4.1.3. Management system

105. The RP developed management systems to support Step 2 of the GDA based on GVHA's existing management system (certified to ISO 9001:2015) and GVHA's Quality Assurance Program Description (endorsed by US NRC). Additional GDA-specific documentation was also provided by the RP in response to specific queries raised over the course of our assessment. We found the documentation, where sampled, to be adequate. We also observed that the RP had a robust system of audits in place which provided additional assurance in the processes being applied.

106. GVHA is an experienced company in the nuclear sector which has existing arrangements for the control of its design and engineering activities. In developing its management arrangements for GDA, the RP has effectively adopted these arrangements, meeting requirement [2.17] from Guidance to Requesting Parties (ref. [1]). During Step 2, we undertook an intervention at GVHA’s office (ref. [100]) to gain confidence in how any design or SSSE

commitments, assumptions or requirements made by the RP over the course GDA will be taken forward in the standard design or captured for a future UK-specific project. This included a process for identifying any changes required during BL2 and keeping adequate records to inform any UK-specific design including the FAP. GVHA also demonstrated how it was managing commitments and requirements stemming from the construction and associated regulation of BWRX-300s at the DNNP in Canada.

107. Our interventions gave us confidence in how the FAP actions generated by the RP over the course of GDA would be adequately embedded into GVHA's design process for appropriate consideration in the future. Over the course of Step 2, we also saw examples of how the RP used the FAP actions to capture self-identified commitments or improvements to be addressed in the future, as well as the means to address regulatory feedback in post-GDA activities. Our confidence in both the FAP process and its application informs our regulatory conclusions on the significance of any shortfalls against regulatory expectations identified during Step 2.

4.1.4. Transfer of the safety, security and safeguards case to an operating regime

108. The RP has submitted a SSSE which includes a PSR and PER. The PSR has been developed by the RP with the intent that it will be sufficient to enable the regulators to come to a view on whether the BWRX-300 could be commissioned, operated, and decommissioned in GB on a site bounded by the generic site envelope while maintaining the safety and security of people and the environment. Whilst it does have some future commitments for what a future SSSE will include, it is not claiming to provide the information expected by ONR in a Pre-Construction Safety Report (PCSR) that could be the basis of a Step 3 GDA DAC or the future permissioning of first nuclear island concrete on a licensed site.

109. The format of the PSR largely aligns with the IAEA guidance for safety cases, SSG-61 (ref. [76]), supplemented to include UK specific chapters such as structural integrity and chemistry, which we consider to be a positive addition.

110. As identified in Section 4.1.3, we have undertaken an MSQA intervention at the GVHA headquarters in Wilmington, which has provided us confidence in GVHA's arrangements for controlling the design for the DNNP and therefore the potential approaches which would be applied to a UK-specific project.

111. The US NRC has a prescriptive regulatory framework detailed in the Code of Federal Regulations. Title 10 Parts 1-199 refer to nuclear regulation with Part 50 specific to new build applications. This provides a set of requirements which an applicant must demonstrate it complies with in order to get a licence in the US. However, a goal setting approach is utilised in the UK, where the law requires that the dutyholder reduces risk so far as is

reasonably practicable (SFAIRP), and ONR sets a series of principles and expectations that are used to judge whether this has been achieved. These regulatory expectations are principally detailed in the SAPs, SyAPs, ONMACS and TAGs which have been benchmarked against IAEA standards.

112. The notable development to the PSR that would be necessary for a site-specific PCSR is to demonstrate why risks are reduced ALARP. The PSR sets out a strategy for how this would be done for the BWRX-300 (see section 4.3.3.21) but its application will need to be demonstrated. For example, there is currently only a commitment to consider in the future how numerical targets based on those set out in ONR's SAPs will be used to support ALARP arguments.

113. The PSR has assumed a credible generic site envelope (GSE) for deployment of a BWRX-300 in GB, but a future site-specific PCSR will still need to consider whether local aircraft crash, seismicity, and flooding challenges are bounded by this GSE.

114. It will also be necessary to demonstrate how the BWRX-300 design complies with UK-specific legislation and requirements, such as the Construction (Design and Management) (CDM) Regulations (ref. [101]) .

115. For security, categorisation for sabotage will need to be undertaken using the UK Design Basis Threat (DBT)[3], taking into account site specific factors. This too is acknowledged by the RP.

116. We judge that the SSSE has provided adequate clarity of the key limits and conditions that come from the safety case that will need to be demonstrated or complied with during operation. We would not have expected detailed Technical Specifications to have been available in Step 2, and there remains a large amount of additional design and analysis work to be undertaken to support the full suite of limits and conditions that will need to be identified. However, we judge that what has been provided is proportionate for the objectives of Step 2. Similarly, a future site-specific PCSR will need demonstrate more detailed consideration of examination, inspection, maintenance and testing (EIMT) requirements but we note that the RP has shown awareness of this future requirement throughout its SSSE.

117. One of the vehicles used by the RP to set out its strategy for developing the SSSE is its safety case manual (ref. [101]). This provides a good awareness of what will be required in a future site-specific PCSR, and we are content that it provides a credible approach that a future licensee could follow to support BWRX-300 deployment in GB. We were also satisfied in Step 2 that

[3] A DBT describes the capabilities of potential insider and external adversaries who might attempt unauthorised removal of nuclear and other radioactive material or sabotage. The operator's physical protection system is designed and evaluated on the basis of the DBT.

this document is consistent with requirement [2.19] from Guidance to Requesting Parties (ref. [1]).

4.2. Summary of our assessments on the BWRX-300 design and SSSE

118. The SSSE has been written in support of the RP's ambition of an internationally standardised design, with minimal country-specific variations. We recognise, and welcome, that the RP has attempted to develop the SSSE with an international mindset. We positively note that it has utilised a structure aligned with the IAEA format for a safety analysis report, SSG-61 (ref. [76]), although we also observed that in some areas the SSSE still directly references US NRC requirements without explaining their applicability to other regulatory regimes or the safety claims being made.

119. The SSSE submitted in Step 2 is of a high quality, providing a sound basis for us to undertake a meaningful fundamental assessment of the BWRX-300. It also captures the operating experience and expertise in the nuclear industry of GVHA. It is comprehensive, logical, and suitably structured, and we consider that it provides the RP a robust basis to support development of a future BWRX-300 projects in the UK.

120. The BWRX-300 design is based on established BWR technology, with the incorporation of passive features. We recognise that the passive features simplify the design and reduce the reliance on active safety systems and operators to maintain safety. It also utilises standards and approaches we have seen applied in similar circumstances, such as the UK ABWR GDA (see Section 4.3.14.3.1).

121. Overall, we judge that the BWRX-300 design submitted was sufficiently mature to enable a fundamental assessment at GDA Step 2, and the RP provided sufficient information to meet requirements [2.9], [2.11] and [2.12] from Guidance to Requesting Parties (ref. [1]). Our assessments did not identify any fundamental shortfalls with the design or SSSE that could prevent ONR permissioning the construction of a power station based on the design. We also did not identify any potential conflicts with relevant government policy.

122. Notable outcomes from our assessments which informed these regulatory conclusions include:

- We acknowledge that the RP has adopted an internationally-recognised approach to both defence in depth and categorisation of safety functions and classification of structures, systems and components important to safety, consistent with IAEA SSR 2/1 (ref. [90]) and SSG-30 (ref. [102]) respectively. Our assessments conclude that the RP's general approach to applying the defence in depth concept and seeking multiple independent barriers to fault progression is adequate for Step 2. We judge the approach outlined in the SSSE to be adequate for Step 2;

- We judge that the RP's approach to fault and sequence identification is adequate for Step 2, and that the RP has identified measures to protect against those faults. Appropriate conservative deterministic safety analysis (DSA) has been performed for the majority of design influencing plant states and the compliance with recognised acceptance criteria provides the basis for a future safety case to demonstrate that the radiological consequences are likely to be consistent with numerical targets, as identified in ONR's SAPs;

- We judge that the RP has set out a suitable approach for demonstrating that large and early releases have been practically eliminated, which aligns with SSG-88 - Design Extension Conditions and the Concept of Practical Elimination in the Design of Nuclear Power Plants (ref. [103]), and takes into account both deterministic and probabilistic considerations. The application of this approach and demonstrating the objectives sought from practical elimination for the BWRX-300 remains an important requirement for a future SSSE;

- Key hazards have been identified, with the SSSE providing indicative strategies, methodologies and approaches in the consideration of internal hazards. We judge that this provides adequate assurance for Step 2 of the design's intent to mitigate internal hazards risks;

- We judge that the BWRX-300 design and SSSE has demonstrated application of important considerations to enable a safe and secure design. These include the hierarchy of controls, application of engineering key principles and segregation, and redundancy. We have identified some areas where additional work will be required by the RP relating to its demonstration of diversity for the C&I architecture, ICS, and shutdown systems. However, these shortfalls are being addressed either by work currently being undertaken on the BWRX-300 standard plant design, a credible RO resolution plan, or self-identified FAPs for inclusion within a future BWRX-300 case. Our assessment of the wider GVHA corporate arrangements gives us confidence that these actions will be incorporated into a UK-specific project;

- The BWRX-300 design includes redundant mechanical, electrical and C&I components for key safety functions, such as reactor shutdown and decay heat removal. This also includes independent power supplies and signal processing. We are satisfied that the BWRX-300 design incorporates suitable redundancy, including redundant safety trains and diverse SSCs, which collectively reduce the likelihood of common cause failures;

- If a future UK BWRX-300 project takes account of the key findings identified in Section 4.3 of this report, it should provide a sound basis for a future SSSE to demonstrate that the BWRX-300 design could meet regulatory requirements in the areas of defence in depth and categorisation and classification. Additional work will be required to ensure that the considerations arising from the UK DBT are adequately analysed, however we have confidence from the methodologies presented within the SSSE that this should be possible;

- The RIVs are a crucial aspect of the BWRX-300 design. We recognise and welcome the innovation and functionality they provide. We are satisfied that the optioneering process for the RIVs presented by the RP has been undertaken early in the design process to consider nuclear safety performance requirements, EIMT requirements, and supplier engagement. We also note that the RP plans to undertake functional, dynamic, and hydrodynamic testing to demonstrate the RIVs will meet design requirements post-GDA. A future SSSE will need to provide additional justifications of the structural integrity classification applied to them, and substantiate the significant reliability claims attributed to them.

- Key SSC architecture, functions and requirements have been presented during Step 2 to enable a meaningful assessment. Our assessments conclude that for the main civil engineering structures, the layout, structural form, proposed geometries, and functional performance are adequately underpinned for the required design life. Issues such as corrosion protection, in-service inspection and testing programs, and ageing management have been considered to ensure the structures can fulfill their intended functions throughout the designs service life and decommissioning period;

- We judge the advanced construction techniques proposed to construct significant portions of the BWRX-300, notably the use of DP-SC for the reactor building and containment structure to be adequately justified and their benefits clearly articulated;

- The SSSE has provided sufficient evidence for Step 2 that the containment can deliver its required functions in normal and accident plant states, aided by the continuous operation of the Passive Containment Cooling System (PCCS). However, areas for additional substantiation to be provided in future SSSEs have been identified;

- We judge the methodologies adopted for seismic and geotechnic analysis to be adequate. The ground profiles and resulting ground parameters all reflect North American geology and seismic spectra. However, we are assured that the approach set out in the SSSE demonstrates consideration of a range of potential ground conditions for future deployment of the BWRX-300 design, that would likely bound a future GB site;

- We judge that the SSSE demonstrates consideration of ageing and degradation and the need to enable EIMT activities, whilst ensuring doses to operators and the public are minimised. We have identified additional work required for a future BWRX-300 UK project with relation to design for decommissioning, but the production of a credible resolution plan provides confidence that this can be addressed; and

- The BWRX-300 utilises a chemistry regime that is similar to that which was proposed for the UK ABWR and judged acceptable in ONR's GDA of that design. We judge that the RP has identified appropriate chemistry requirements to support functionality of the ICS and PCCS, and that risks of stagnation have been appropriately considered.

123. We have raised three ROs during this GDA which are published on the GDA website (ref. [104]):

- RO-BWRX300-001: Demonstration of independence and diversity in the BWRX-300 I&C architecture (ref. [105]);

- RO-BWRX300-003: Design for decommissioning (ref. [106]);

- RO-BWRX300-004: Safety case for un-isolable and non-isolated pipe-breaks larger than 19mm diameter (ref. [107]).

124. During Step 2, the RP produced resolution plans to address the multiple actions contained within these three ROs. With the exception of one action for RO-BWRX300-001, the RP has proposed to address the issues identified ahead of, or as part of, any future site-specific PCSR submission. Whilst ROs were originally conceived as a vehicle for securing improvements during GDA to facilitate the issue of DAC, in the case of this GDA which is finishing at Step 2, we are content that the agreed resolution plans provide sufficient assurance that issues raised are understood and will be given appropriate consideration as the BWRX-300 design continues to develop away from the UK.

125. The RP provided a delivery plan (ref. [108]) during the course of Step 1 that adequately addressed the first of four actions set out in RO-BWRX300-001.

126. The Environment Agency has raised a fourth RO (RO-BWRX300-002) on segregation of waste (ref. [109]), which we have contributed to and support.

127. Regulatory Observations are areas where we have identified a potential regulatory shortfall which requires action and new work by the RP for it to be resolved. None of the issues captured in the ROs are judged to be a fundamental barrier to the BWRX-300 deployment in GB.

4.3. Matters arising from our assessments

128. This section provides an overview of the main findings from our assessment of the BWRX-300 design and associated SSSE which we consider to be pertinent to a fundamental assessment, and that may be relevant to any future regulatory activity associated with this technology.

129. Our assessment has involved 21 topic areas, all undertaking a coordinated assessment of the SSSE and the design. The following subsections are not intended to capture all aspects of the assessments undertaken, which are detailed in the topic assessment reports referenced in Section 3.1. However they do provide a view on those aspects we consider most significant, novel or pertinent to support our overall view on the adequacy of the BWRX-300.

4.3.1. BWR technology

130. We have previously assessed BWR technology during the UK ABWR GDA from 2013-2017 (ref. [110]). This included an assessment of the main design features of BWR technology such as the hydraulic insertion of control rods from beneath the reactor core, a direct cycle configuration with activated steam passing through the turbine, off-gas system and internal vessel components such as the core, fuel assemblies and steam separators.

131. Our assessment of the UK ABWR demonstrated that it is possible for BWR technology to meet ONR’s expectations for safe and secure deployment in GB. As the BWRX-300 is part of an evolution of the ABWR technology, we have not sought to replicate our previously undertaken assessments where the design, approaches and methodologies are the same or very similar to those considered in the UK ABWR GDA. Instead, our focus has been on areas of novelty.

132. We have highlighted as relevant throughout the report where the RP has provided evidence that the BWRX-300 is an evolution of the ABWR design, and where the same or very similar analysis tools and methodologies are used and remain valid, and how this has informed our judgements.

4.3.2. Safety, security and safeguards case

4.3.2.1. Structure of the SSSE

133. The RP has structured the SSSE using a claims, arguments, evidence (CAE) approach centred on the fundamental objective that:

“The BWRX-300 is capable of being constructed, operated, and decommissioned in accordance with the standards of environmental, safety, security and safeguard protection required in the UK.”

134. This fundamental objective is broken down into claims structured in 3 levels. Level 1 claims relating to environment, safety, security, and safeguards, Level 2 area related sub-claims, and Level 3 (chapter-level) sub-claims.

135. The BWRX-300 Safety Case Development Strategy (ref. [35]) describes the overarching CAE structure. The RP claims three fundamental safety functions (FSFs) for control of reactivity, fuel cooling and confinement of radioactive materials, which the RP claims are consistent with IAEA SF-1 - Fundamental Safety Principles (ref. [111]).

136. The RP claims that if the FSFs are performed successfully, the physical barriers to radioactive release (such as the containment) maintain their integrity.

137. The RP’s Safety Strategy (ref. [32]) also identifies fundamental safety properties (FSPs) which are claimed to provide assurance that the FSFs will be performed with the expected reliability when required; and that their successful performance can be confirmed by operating staff.

138. Consistent with the expectations set out in requirement [2.7] of Guidance to Requesting Parties (ref. [1]), the safety strategy (ref. [32]) adequately describes a process for identifying hazards and faults, and how deterministic and probabilistic analyses are conducted to derive barriers, and the safety requirements on such barriers.

139. The RP has not adopted a formal referencing system for sub-claims and arguments. These are instead presented in a narrative form, using requirements as an alternative for sub-claims. These requirements are managed according to the RP’s Requirements Management Plan (ref. [112]) for future substantiation.

140. The Requirements Management Plan (ref. [112]) describes the process whereby links are created to establish relationships between requirements and design decisions. By using these links, the RP claims a requirement can be traced downward to find all the design features that have been established to fulfil it. This was sampled during the MSQA assessment and found to be adequately demonstrated (ref. [100]).

141. We are satisfied that the RP has documented its process for identification of functional requirements and non-functional requirements. The narrative form used addresses the aspects identified within IAEA SSG-61 (ref. [76]) as appropriate for the current level of design maturity. However, the traceability from the deterministic safety analysis to engineering requirements within the SSSE is complex. A future BWRX-300 safety case should consider improving the traceability from its safety analysis to engineering requirements.

142. The RP has built upon the long-established practice of ensuring a NPP is ‘safe by design’ by also demonstrating in the SSSE a ‘secure by design’

approach. It has identified those safety SSCs that require protection from security threats, as well as SSCs that provide inherent security and mitigation against threats. It has also designed a physical protection system that mitigates additional vulnerabilities identified through adversarial pathway analysis. We are satisfied that this approach to secure by design and developing physical security arrangements is adequately and logically described in the SSSE.

143. The RP produced a Cyber Security Program Plan (CySPP) (ref. [113]) to support Chapter 25 of the PSR [70]. The CySPP provides a programme approach to the design and protection of C&I infrastructure from a cyber security perspective, and describes the RP's cyber security plan and methodology to support the design, operation and protection of the BWRX-300.

144. The CySPP also defines the RP's approach to cyber security risk management. It highlights the standards that have been used in the design development, and establishes how digital C&I, at a high-level, will be protected. It defines key roles and responsibilities for those within the organisation who have cyber security responsibility, and defines the interfaces with other programmes, such as physical security, personnel security and human factors engineering.

145. The CySPP provides us with confidence that the approach taken by the RP and the design provisions included in the BWRX-300 should allow a future UK operator to deliver an approved security plan that complies with the Nuclear Industries Security Regulations (NISR) 2003, meeting requirements [2.5], [2.10] and [2.20] from Guidance to Requesting Parties (ref. [1]).

146. We consider that the RP has demonstrated an understanding of the benefits of an early application of a safeguards by design approach, consistent with our expectations. The RP has also engaged with the IAEA. This further demonstrates that it recognises the importance of safeguards by design and supports the development of safeguards measures as the design matures.

4.3.2.2. Defence in depth

147. International consensus is that the appropriate strategy for achieving the overall safety objective for a nuclear facility is through the application of the concept of defence in depth. The design should provide a series of independent barriers (inherent features, equipment and procedures) aimed at preventing faults, and ensuring appropriate protection or mitigation of accidents in the event that prevention fails (ref. [78]).

148. This is the same for security, where the primary protection system should be designed to provide several layers and methods of protection.

149. The RP has chosen to adopt a Defence Line (DL) hierarchy concept that is derived from the IAEA five-layer model outlined in IAEA SSR 2/1 (ref. [28]).

As a starting position, we are fully supportive of any technology vendor adopting an of IAEA-consistent approach to defence in depth as an effective way to ensure a robust design and accompanying safety case. Our focus in Step 2 was therefore to look at its application and the implications for the BWRX-300 design.

150. We consider that the RP's general approach to applying the defence in depth concept and seeking multiple independent barriers to fault progression as set out in its safety strategy (ref. [32]) and summarised in Chapter 3 of the PSR (ref. [39]) is appropriate for use in the UK. Its application to the BWRX-300 design was sufficiently described in the SSSE for us to undertake a fundamental assessment, consistent with requirement [2.8] of Guidance to Requesting Parties (ref. [1]).

151. The SSSE defines the five BWRX-300 layers as: DL1, 2, 3, 4a, 4b. Independence is claimed between DL2 and DL3, and between DL3 and DL4a.

152. Our initial review identified some challenges to our expectations that became specific areas for targeting within our assessment:

- The ICS is claimed to deliver cooling and pressure protection functions across multiple DLs despite the claims of independence between levels. This is discussed more in Section 4.3.3.3.
- The SSSE assumes the insertion of the control rods, albeit initiated and actuated by different parameters and C&I platforms, as the means of providing reactor shutdown across multiple DLs. This is discussed more in Section 4.3.3.7. We also note that CNSC has sought additional substantiation of the high reliability claims made on the control rods
- Different C&I platforms are claimed to actuate safety systems across the various DLs, but we have sought additional assurances that these platforms are diverse. This is discussed more in Section 4.3.3.17.

153. In all three areas, we concluded that, in principle, there is no reason why an adequate safety case could not be made for the BWRX-300. However, further substantiation will be needed in future versions of the SSSE.

154. Demonstrating through deterministic and probabilistic arguments the adequacy of the defence in depth provision is a key aspect of meeting the IAEA's requirements for large and early releases to be practically eliminated. The RP has not provided an overall demonstration of practical elimination within its Step 2 submissions; however we judge that application of defence in depth within the BWRX-300 design, coupled with the RP's proposed approach to apply in the future, gives confidence that that a future case for practical elimination can be made.

155. The RP has documented its security arrangements to ensure there is a physical protection system design based on layers of defence designed to detect and delay adversaries in order that a response force can neutralise the threat. The layers of defence primarily relate to the PA perimeter and reactor building, with a security infrastructure to monitor and assess alarms, to support a response.

156. Overall, we consider that the RP's approach to applying the defence in depth concept and seeking multiple independent barriers to fault progression to be adequate.

4.3.2.3. Approach to categorisation and classification for safety

157. In support of requirement [2.6] of Guidance to Requesting Parties, Chapter 3 of the PSR (ref. [39]) describes the approach to categorisation of safety functions and classification of SSCs applied to the BWRX-300 design. We assessed this approach to categorisation and classification during Step 1, and the outcome is recorded in the Step 1 summary report (ref. [94]). This 3-tier approach aligns with our expectations and IAEA standards as outlined in SSG-30 (ref. [102]). We consider that our conclusions from Step 1 remain valid.

158. During Step 2 we have assessed the application of the RP's categorisation and classification methodology in more detail. For the Step 2 assessment, we judge that the categorisation and classification process has been adequately applied to a wide range of at-power plant states. This has resulted in SSC requirements, such as levels of redundancy, reliability and equipment qualification consistent with our expectations.

159. However, limitations with the deterministic analysis presented in the SSSE has constrained the RP's application of the categorisation and classification methodology to reactor plant states at-power and has not allowed it to be extended to shutdown states and 'non-reactor' plant. The RP has acknowledged this gap in its review of its approach to categorisation and classification against UK expectations (ref. [115]) and has committed to developing its approach if a future site-specific project were to be undertaken. The RP has also self-identified in Chapter 3 of the PSR (ref. [39]) that there is no provision in the BWRX-300 approach to categorisation of safety functions to assign a normal operation safety function to anything other than Safety Category 3, unless it is a high integrity component.

160. A future BWRX-300 SSSE would need to address these identified limitations. However, given the adequate approach demonstrated within the SSSE for at-power reactor operations, we judge that the SSSE has adequately applied an internationally recognised approach to categorisation of safety functions and classification of SSCs which should result in appropriate design features and safety case.

4.3.2.4. Categorisation for theft and sabotage, and vital area identification

161. The UK's regulatory framework for civil nuclear security is outcome focused, setting expectations that those outcomes are achieved by physical protection systems which provide defence in depth against categorised theft and sabotage threats. Therefore, we have based our assessment on sabotage categorisation for existing UK nuclear power plants and the RP's own vital area identification (VAI). Having considered the information documented in the RP's Security Assessment (ref. [74]) relating to VAs and armed response, and outcomes required for existing UK NPPs, we have chosen to use physical protection system Outcome 1 to form our judgements. This requires the most robust physical protection system design.

162. The key factors that determine the categorisation for sabotage for a licensed facility are the identification of vital areas (VAs) through the use of the UK DBT and application of the UK thresholds for unacceptable radiological consequences (URC). For theft, the key factors are type, quantity and form of Nuclear Material and Other Radioactive Material.

163. The UK DBT (ref. [116]) was not available to the RP during its overseas development of the standard BWRX-300 design and during the Step 2 GDA engagements with ONR. Instead, the RP developed its own proxy DBT, using URC thresholds based on an assumed public access exclusion zone perimeter (a boundary defined by RP for which it assumes public entry will be strictly prohibited to protect people and assets from hazards). Established IAEA tables were used as a basis for the categorisation for theft (ref. [117]). We acknowledge that this has had an impact on determining the required physical protection system outcomes.

164. The level of enrichment of fuel to be used in the reactor is similar to that used in existing operating reactors in the UK. We are satisfied that the SSSE adequately categorises the proposed fuel in the reactor design, and we consider the RP's methodology for categorisation for theft to be adequate for Step 2. We note that the RP's categorisation has been limited to the reactor building, however, the RP acknowledges that there is further categorisation to be undertaken.

165. VAI is the process of identifying the areas at a nuclear facility around which protective security measures should be provided to reduce the risk to the public from an URC arising from sabotage. If VAs are not properly identified, then it is likely that insufficient, ineffective or inappropriate physical protection systems and protective security arrangements will be implemented to mitigate public risk.

166. In line with requirement [2.10] of Guidance to Requesting Parties (ref. [1]), the RP has undertaken analysis of areas containing nuclear material or other radioactive material which, if sabotaged, could be capable of causing an URC. The RP has designated these areas as VAs. It has also designated

areas whose loss would significantly impact the security response to a threat to be a VA.

167. The RP did not produce separate documents for its VAI methodology, proxy DBT, VAI and categorisation, or other security specific submissions. Instead, it submitted an overarching security document, Chapter 25 (ref. [70]), and a detailed security evaluation in the Security Assessment and its associated Annexes (ref. [74]). The RP's identification and categorisation of VAs, as well as identification of target set components and target sets, has been conducted independently of both the proxy DBT and any credited operator actions. Therefore, no VAs, target set components, or target sets were discounted as part of the development of the standard design (refs. [70] and [74]).

168. Recognising the limitations of not being able to access the UK DBT, the categorisation analysis will need to be conducted in a future BWRX-300 SSSE using the UK DBT and URC thresholds, which the RP has committed to undertake under its FAP (ref. [118]).

169. Despite this limitation, we consider that the RP has developed an adequate set of VAI arrangements capable of producing accurate outputs once the UK-specific inputs have been applied.

4.3.3. Adequacy of the BWRX-300 design

4.3.3.1. Design parameters

170. The major technical parameters of the generic BWRX-300 design are defined within the SSSE and GDA scope report (ref. [26]). The BWRX-300 operates at similar pressures and temperatures to other BWRs, but due to its smaller power output it has fewer fuel assemblies and control rods, which allows for a smaller RPV diameter. The fuel assembly and control rod designs are based on established BWR technologies, with similar performance and safety requirements.

171. We have seen satisfactory evidence throughout the SSSE that the key parameters which inform the design are appropriately defined and substantiated for the current level of design maturity. This includes the architecture and sizing of key SSCs that perform the fundamental safety functions of cooling, criticality and containment.

172. We are satisfied with the RP's approach to the development of limits and conditions (ref. [61]), noting that it is still under development. Full identification of all limits and conditions is not expected at this stage of GDA.

173. The RP acknowledges that more work is needed to substantiate and underpin the design parameters as the design and analysis matures, and to demonstrate the traceability from the key parameters to the design. However, we are content that the foundations for this are soundly based.

4.3.3.2. Radiation protection

174. BWRs present some new or different radiation protection challenges to most of the reactors built and operated in the UK previously. However, many of these challenges were examined in detail as part of the UK ABWR GDA and shown to be acceptable. As a result, in this GDA we did not set out to address these points again.

175. Our targeted Step 2 assessment of the radiation protection aspects of the SSSE has concluded that operational experience (OPEX) and international guidance have been used to inform radiological protection objectives and design requirements; and that the RP has established a suitable process for assessing design changes and improvements to reduce exposures ALARP as the design progresses. The RP has also used OPEX to inform the shielding design and requirements, alongside industry recognised codes and approaches to assess shielding provisions.

176. The methodologies used to derive the source terms reported in the SSSE, and which have informed the design of the BWRX-300 to date, are conservative and adequate for that purpose. However, the RP has recognised that a future safety case that can demonstrate that doses to workers are reduced ALARP will need a full suite of substantiated source terms to underpin updated shielding and dose analyses.

177. We consider that the RP's approach for dose assessment is consistent with our expectations, and that the SSSE provides confidence that the BWRX-300 should be capable of being operated within regulatory dose limits outlined in the Ionising Radiations Regulations 2017 (IRR17) (ref. [119]) and below the Basic Safety Levels (BSLs) for Targets 1, 2, and 3[4]. A future BWRX-300 case will need to provide sufficiently detailed dose assessments to demonstrate compliance with all dose limits outlined in IRR17 and further justification that doses to workers and the public have been reduced ALARP.

4.3.3.3. Isolation condenser system

178. The ICS is designed to remove decay heat from the reactor and control the pressure within the RPV when the reactor is isolated from its normal heat sink. In the event of a design basis accident (DBA), it will be operating following the hydraulic insertion of the control rods and the closure of the RIVs to isolate the RPV from the main condenser.

179. The ICS functions through natural circulation. Steam from the reactor vessel condenses in the ICS heat exchangers and the resulting subcooled water is returned to the reactor. This maintains core water level and prevents

[4] *ONR's SAPs set out numerical targets which quantify ONR's risk policy and assist us in making proportionate regulatory decisions and targeting our resources to where the risks and hazards are greatest. Each is set in terms of a Basic Safety Level (BSL) and a Basic Safety Objective (BSO). It is ONR's policy that a new facility or activity should at least meet the BSLs.*

overheating. The ICS heat exchangers are submerged in dedicated pools of water which provide the ultimate heat sink. The RP claims the ICS, in conjunction with the large steam volume, has sufficient capacity for adequate overpressure protection, enabling safety relief valves to be eliminated from the BWRX-300 design.

180. These claims and design intent make the ICS crucial to safe operation. It is required to deliver its identified safety functions across several levels of defence in depth, necessitating very high levels of confidence in both its effectiveness and reliability in all circumstances. As a result, the ICS was a priority target for regulatory assessment across multiple topic areas.

181. Our assessments concluded that the SSSE provides adequate demonstration that the ICS will be effective in delivering its claimed safety functions for a range of plant states. The supporting thermal hydraulic analysis presented within the SSSE is sufficient for the purposes of Step 2. Our confidence in the analysis results is informed by our confidence in the methodologies applied by the RP. These methodologies have been assessed during our Step 2 assessment of the BWRX-300 and considered by CNSC during its licensing activities at the DNNP. They are also consistent with those used on the US NRC-certified ESBWR.

182. To support its reliability claims, in addition to the ICS's simplicity and reliance on natural phenomena, the RP has highlighted that the ICS is designed with in-built redundancy. There are three separate IC trains, each of which can be initiated by two mechanically diverse valves and redundant C&I systems. For DBAs, only a single IC train is needed to operate, although some more extreme and unlikely events require additional trains.

183. The RP has presented Level 1 probabilistic safety analysis (PSA)[5] modelling to demonstrate that the ICS can achieve the claimed levels of reliability across all the postulated initiating events, plant states and levels of defence in depth. We judge that the RP's PSA modelling is adequate and supportive of the claims being made although we do note some limitations and simplifications within it. Notably it does not attempt to model the failure of the ICS to deliver its safety function if successfully actuated (for example, the failure of natural circulation due to absence of adequate thermal gradients has not been postulated).

184. The PSA shows the ICS is a risk-significant SSC which has a vital role in delivering the BWRX-300 safety strategy. The insights from PSA modelling have led the designers of the BWRX-300 to propose an additional diverse means of managing the RPV pressure for very unlikely design extension

[5] Level 1 PSA identifies and quantifies the risks from accident sequences that could lead to core damage.

conditions (DECs)[6] in which the reactor fails to scram (so called ‘anticipated transients without scram’ or ATWS). The design includes an ultimate pressure regulation (UPR) component on each ICS train that initiates automatically on high RPV pressure (above the ‘standard’ ICS pressure setpoints for DBAs). Its design intent is to reduce the likelihood of a high-pressure melt ejection that could occur if the RPV fails during a severe accident whilst still at high pressure. This in turn could lead to containment failure due to the combined effects of a rapid pressure increase within the containment, and a phenomenon called direct containment heating, both of which are extremely difficult to protect against.

185. The SSSE supplied in Step 2 does not provide design details for the UPR, deterministic analysis to demonstrate its effectiveness, or PSA modelling of its reliability. However, the RP has made various commitments in the SSSE, and during our Step 2 dialogue, to continue to design and substantiate this additional system. Its inclusion within the design does not negate the importance of the ICS. Therefore, whilst we welcome the ongoing work to develop the UPR, it remains important that future safety cases provide additional substantiation to support the claims on the ICS, as part of routine design and safety case development. Amongst the examples of this cited in our individual topic reports are:

- Further substantiation of the reliability figures attributed to the ICS;
- Additional consideration of pH control within the ICS pools to benefit heat exchanger integrity and retention of radionuclides within ICS pools in the event of a heat exchanger leak; and
- Strengthened evidence that the ICS design qualification and engineering analysis undertaken for the ESBWR is valid specifically for the BWRX-300 design.

4.3.3.4. Modularisation and compact layout

4.3.3.5. Modularisation

186. There is limited modularisation within the BWRX-300 design as presented in the SSSE. The most significant applications of modularisation are through the use of a DP-SC construction technique, and the use of off-site factory-based construction where feasible.

187. The BWRX-300 design is proposing the use of some limited modularisation construction techniques in some other areas to support construction and

[6] Design extension conditions are plant states more severe but less frequent than DBAs. It is common practice to consider two types of DECs: DEC-A refers to plant states without core melting whilst DEC-B refers to plant states that progress to core melt.

reduce risk in design, such as automated welding and the use of equipment on skids.

188. We are content that the generic construction approach proposed by the RP incorporates operational experience and demonstrates an awareness of the CDM Regulations (ref. [120]).

189. The DP-SC system will be used to form the reactor building structural basemat, cylindrical exterior wall, Steel-Plate Composite Containment Vessel (SCCV), RPV pedestal, fuel and cooling pools, and refuel floor of the reactor building. The RP proposes that individual DP-SC modules will be fabricated and formed into pre-engineered segments forming walls, cylinders, and floors offsite, in a controlled environment (certified fabrication shop).

190. On site, the reactor building will be constructed inside the shaft by lowering prefabricated DP-SC assemblies into position. These are then filled with self-consolidating concrete that the RP claims flows easily and fills congested areas without the need for vibration, whilst minimising the risk of voids.

191. The RP claims the DP-SC system provides advantages to the design (ref. [121]), notably:

- Additional stiffness, which provides benefits during rigging, and transportation. Additionally, the elimination of formwork and rebar installation is claimed to reduce labour demands and construction schedules; and
- Improved quality, reduction in schedule, site man-hours and weather-related delays and an increase in overall safety due to prefabrication, pre-assembly, modularisation and off-site fabrication.

192. The use of DP-SC is novel for the UK but it is an evolution and applies learning from experience in the deployment of similar techniques on other nuclear projects (some of which have been previously accepted by ONR, notably Westinghouse’s AP1000®). Specifically, in a BWRX-300 context, it has already been subject to regulatory assessment by US NRC and CNSC, and therefore our GDA assessment has been able to take into account their joint assessments in this area (ref. [87]).

193. Our assessment of the RP’s proposed use of DP-SC has been detailed, ranging from the analysis and design methodologies through to constructability considerations. We have reviewed the RP’s finite element model outputs, and this has provided confidence that the section sizes, characteristics and geometries that underpin the layout proposed by the RP are sufficient.

194. We acknowledge the benefits cited by RP such as the increase the structural stiffness and strength. We also note some of the wider claims made by the

RP on the DP-SC, such as increased missile and blast resistance, and increased shielding capability. These enable a reduction in wall thickness when compared to traditional reinforced concrete designs.

195. Rather than a separate liner as used in traditional containment, the RP is proposing that DP-SC faceplates are welded to achieve a leak-tight containment barrier on the inside of the SCCV. A future BWRX-300 safety case would need to demonstrate adequate consideration of structural integrity requirements (see section 4.3.3.16 for further detail on structural integrity requirements).

196. During our Step 2 engagements, the RP explained how GVHA and its utility partners in North America are using mock-ups to enable early identification of any constructability challenges with its novel approach. The RP has also provided us evidence of how the ongoing development of the design process is incorporating integrated constructability reviews involving the BWRX-300 design team and the constructor and fabricators. Our judgement is that this ongoing work will benefit the early identification of potential constructability challenges arising from modularisation, to the benefit of any future UK project.

197. We have shared our findings with the US NRC and CNSC at a meeting in April 2025 (ref. [122]). From the discussions, we gained assurance that our assessment outcomes are consistent with the views of US NRC and CNSC (ref. [87]), and that there is alignment on the areas deemed important as the BWRX-300 design continues to develop.

198. Overall, we consider that the RP has adequately considered the constructability challenges of the use of DP-SC, taking into account inspectability and ageing. We consider the design approach to be robust, and the RP has provided compelling arguments for the use of DP-SC in place of more traditional construction approaches.

4.3.3.6. Layout

199. The BWRX-300 design is intended to have a smaller physical footprint with a more compact system layout than is typical for a large scale NPP. This is enabled by its smaller power output and a requirement for fewer safety systems and pools of water.

200. In Step 2, our assessments have sought to understand how the layout has been informed by the various requirements that are placed upon it, across each of the topics. Our considerations spanned from the reactor building layout, through to where individual SSCs may be located. Our main focus has been on the RP’s approach to layout and potential hazards which may affect radiological safety, compliance with life fire safety, safeguards and security requirements.

201. The RP has adequately demonstrated for civil engineering structures that the layout, structural form, proposed geometries, and functional performance are adequately underpinned.

202. The fundamental layout considerations adopt engineering key principles and adequately consider segregation and separation. We are satisfied that key hazards have been identified, with the RP providing indicative strategies, methodologies and approaches in the consideration of internal hazards. For GDA Step 2, we consider that this provides assurance of the design's intent to mitigate internal hazards risks.

203. The BWRX-300 radiation zoning scheme presented in PSR Chapter 12 (ref. [48]) defines external dose rate limits for zones ranging from A (not a radiation area) to J (very high radiation area) in line with US NRC requirements (ref. [123]) and IAEA (ref. [124]) guidance for reactor design. For the purposes of UK deployment, the RP proposes designating zone A as a supervised areas and zones B to J (where dose rates may be above 6 μSv/h) as controlled areas which aligns with the IRR17 approved code of practice (ACoP), which we consider to be adequate for Step 2 GDA.

204. The BWRX-300 design does not specify a contamination zoning scheme, however we consider that the RP's arrangements and conceptual design adequately identify areas of plant where there is potential for increased levels of contamination (e.g. leaks and spills) in which to focus radiological protection measures (e.g. ventilation, drainage) to minimise exposures and limit the spread of contamination. A future safety case will need to establish a contamination zoning scheme for the BWRX-300. However, the RP recognises the need for this further work and has committed to undertake this in its FAP.

205. The RP has stated that the design footprint and layout include provision for both 50Hz and 60Hz aspects of the design, including electrical equipment and cabling, which may be larger for 50Hz equipment. We judge that the RP is appropriately considering the need to provide sufficient space around electrical equipment important to safety to facilitate routine EIMT activities.

206. We judge that the RP has adequately considered security requirements within the layout and has designated areas for computer-based systems important to security, a central alarm station and secondary alarm station. The RP has also identified the need for robust power distribution and back-up to support the security infrastructure.

207. Our assessments have identified that the design would require additional consideration of the adequacy of means of escape and firefighter access provisions in a future iteration of the BWRX-300 case. The RP has acknowledged this and has committed to undertake this for a future UK design.

208. The RP has acknowledged that the smaller footprint poses a potential risk to any safeguards measures that may need to be incorporated, for example cameras, monitors and remote data transmission equipment. However, the RP has identified a potential Material Balance Area and Key Measurement Point structure, ensuring there is provision within the design for robust nuclear material accountancy. Recognising the maturity of the design, we are satisfied that the RP has demonstrated sufficient awareness of safeguards at the design stage, such that monitoring equipment could be incorporated into the design where necessary.

209. The design of the BWRX-300 spatially segregates the main control room (MCR) and secondary control room (SCR) between the control building (Seismic Category 2) and the reactor building (Seismic Category 1A) respectively. This offers benefits by separating the MCR from internal reactor building hazards, however, it is situated within a location that features a lower level of seismic withstand than the reactor building. It is typical in modern NPP designs that both the MCR, SCR, and linking route share the same degree of hazard protection, to maximise the survivability of the MCR operators, and enable the evacuation from one to the other.

210. A future BWRX-300 case should demonstrate that the MCR location, and the evacuation route to the SCR, are suitably protected against design basis seismic events or air crash events. The RP has acknowledged within its safety strategy that further analysis is required via a habitability and operability analysis, and therefore we do not consider this a fundamental shortfall.

4.3.3.7. Reactivity control and ATWS

211. Our Step 2 assessment activities have concluded that the RP has presented a coherent and structured SSSE for the fuel and core design, supported by mature methodologies and analytical tools, and OPEX from similar BWR designs.

212. Whilst the BWRX-300 has a smaller core and lower power output compared to other BWRs, the fuel assembly design it utilises (GNF2) is a closely related and improved version of the GE14 fuel assessed as part of UK ABWR GDA. The RP claims that while the exact configuration of the BWRX-300 reactor core will be new, it will be similar to those regularly seen in the BWR operating fleet, and the performance of all principal aspects have been proven in fleet application.

213. We are satisfied that the core monitoring system is similar to those previously deployed in other designs (and assessed by ONR), but any differences in the detail will need to be justified in future generations of the BWRX-300 safety case.

214. The BWRX-300 design incorporates a multi-layered approach to reactivity control, consistent with the RP's approach to defence in depth. During Step 2, we targeted the RP's approach to reactivity shutdown and ATWS.

215. The primary reactivity control mechanism is the fine motion control rod drives (FMCRDs). These are electro-hydraulic mechanisms capable of both fine and rapid movement. Reactor scram is executed via high-pressure hydraulic insertion, powered by nitrogen-water accumulators in hydraulic control units, each serving two FMCRDs. The design is very similar to the system assessed as part of the UK ABWR GDA.

216. The FMCRDs are complemented by supplementary reactivity control through gadolinia-bearing fuel rods (a burnable neutron absorber), and the boron injection system (BIS), designed to provide an independent and diverse shutdown capability.

217. Chapter 15 of the PSR (ref. [51]) details a comprehensive set of DSA for DBAs and DECs. However, it has not presented DSA of any ATWS sequences where the control rods failed to insert.

218. It is our expectation that these sequences will need to be analysed in the future, accompanied by safety justifications of the adequacy of the current design provision.

219. Whilst the analysis is incomplete and the SSSE needs improvement, the BIS does provide the BWRX-300 with a diverse means of shutdown. As described in the SSSE submitted during GDA, the BIS is a manually actuated Class 3 system and is not currently claimed within the DSA. However, we became aware over the course of Step 2 that the BIS design proposed for the DNNP in Canada has evolved, notably through automated actuation and additional DSA to demonstrate its effectiveness to act (in conjunction with the UPR and containment venting) during ATWS.

220. The RP has acknowledged the gaps in the SSSE for ATWS and has committed to further work concerning the BIS though a FAP item.

221. Therefore, whilst there are some significant gaps in the SSSE submitted in GDA that will need to be addressed in the future, the RP's acknowledgment of this, the design provision already included within the design (but just not demonstrated/claimed), and the additional work that has been done in Canada, gives us confidence it should be possible to demonstrate the adequacy of the BWRX-300 for deployment in GB in a future BWRX-300 safety case.

4.3.3.8. Containment

222. The BWRX-300 containment consists of a SCCV which is a vertical, cylindrical structure, approximately 17.5 metres in diameter and 38 metres high. This SCCV is completely enclosed by the deeply embedded reactor

building, and the RP has stated that it is designed to safely contain radioactive materials and withstand the pressure from a DBA.

223. In a change from some previous generations of BWRs, the inclusion of the ICS and RIVs has allowed for a ‘dry’ containment and the elimination of suppression pools from the design. Like other BWRs, the SCCV is inerted with nitrogen in most operating modes. The SCCV design also includes safety components, like personnel/equipment hatches and containment penetrations, and features an annular gap between the SCCV and the surrounding building for inspection and maintenance.

224. The containment is one of the areas that the DP-SC approach to construction is employed, and our conclusions set out in Section 4.3.3.4 apply to this feature of the containment.

225. During large LOCAs (including steam line breaks) a finite mass of water and energy is released into the SCCV before the RIVs isolate the break. Overpressure and over-temperature protection of the containment is provided by the PCCS, which does not require initiation as it is continuously available.

226. We are content that PSR has presented appropriate DSA of these events to demonstrate the sizing of the PCCS and the integrity of the SCCV, with appropriately conservative input and availability assumptions made.

227. The RP has used the TRACG and GOTHIC codes to undertake this analysis for both DBA and DEC-A plant states. These computer codes are judged appropriate for this purpose, with our assessments of the SSSE submitted in GDA additionally benefiting from information shared with us by regulatory colleagues from the US and Canada (ref. [125]) and ref. [126]). We also have confidence in these codes and their application from our detailed assessment of them in the UK ABWR GDA.

228. The PCCS also removes heat from the containment during smaller unisolable LOCAs. However in these circumstances it is not required to play a significant role in decay heat removal. Cool water from the equipment pool outside of containment flows through the PCCS pipework, removing heat from the containment, and the warmer water is returned to the equipment pool. The RP claims that heat is naturally transferred via the containment closure head above the RPV to the reactor cavity pool. It also claims that due to the limited energy release from the break, and the other natural losses, the bulk temperature of the equipment pool does not reach boiling temperature and does not require makeup to fulfil its safety function during the mission time for any design basis fault. We judge these claims to be credible.

229. In addition to conservatively demonstrating the robustness of the containment for DBA and DEC-A plant states, the RP has also extended its considerations out to DEC-B plants states. Within the Step 2 submissions,

due to the immaturity of the design for severe accident scenarios, it has focused on identifying severe accident sequences for analysis which can inform the design of BWRX-300 safety features against the need to prevent containment failure. These sequences have been identified from the Level 1 PSA. The approach taken is judged to be acceptable and we are satisfied appropriate safety features have been identified to protect the containment from the relevant phenomena that could challenge it. The performance of these safety features will need to be substantiated in future versions of the SSSE.

230. The Level 2 PSA[7] presented by the RP is also constrained by gaps and limitations in design maturity and analysis. During Step 2, performance analysis to determine the point at which the containment will fail in a severe accident was not available. Containment failure has been assumed in multiple accident sequences, such as overpressure and hydrogen deflagration, but conservative assumptions and expert judgement have been used to set the point of failure within the Level 2 PSA modelling. Whilst these assumptions will need to be substantiated, we are content that the RP has undertaken adequate analysis for Step 2 to demonstrate that risks of containment failure are low.

231. The SSSE describes how the reactor cavity pool is in direct contact with the containment head. This is a change from the approach taken in the previously assessed UK ABWR which has a dry containment head. The water replaces the solid blocks proposed on the UK ABWR, providing an equivalent shielding function but greater operational flexibility. As part of our assessment, we sought additional assurance from the RP that this new approach would not challenge the integrity of the containment head. The RP has provided us with confidence that appropriate chemistry control of the reactor cavity pool can ensure this; however a future BWRX-300 SSSE will need to describe and substantiate the engineered systems that will provide this chemistry control.

232. A significant amount of additional design and safety case substantiation work will need to be presented in a future SSSE to demonstrate the resilience of the containment for extreme events. However, the conservatism in the analysis for DBAs and DEC-As, the work already completed to identify the phenomena that could challenge containment's integrity (and mitigate them), and the Level 2 PSA's conclusions on the risk of containment failure, have led us judge that there is no reason why these limitations cannot be successfully addressed in the future. We judge the containment design to be adequate for Step 2..

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[7] Level 2 PSA builds upon the results of Level 1 PSA, considering the phenomena that could result in containment failure following a severe accident to determine the likelihood of a range radioactive release categories.

4.3.3.9. Protection against external hazards

233. The RP has identified the protection provided against external hazards within the PSR in Chapter 15.8 (ref. [59]). The RP states that the reactor building acts as the primary hazard shield against external hazards, including aircraft impact, seismic activity or explosions. The RP states that the reactor building external walls and roof structure are designed such that in the event of aircraft impact, there is no perforation and integrity is maintained (ref. [127]). As most of the reactor building is below grade (see Section 4.3.3.10) the potential impact area for external hazards is significantly reduced.

234. Due to the level of maturity of the design submitted to ONR in GDA, the SSSE does not provide an assessment of external hazards and combined hazards which could be protected by a hazard shield. However, it has provided some examples of how external hazards considerations have been incorporated into the decisions to embed the reactor building below grade.

235. We consider that the RP has provided sufficient evidence within the SSSE that the BWRX-300 design adequately addresses the requirement for protection from external hazards. A future BWRX-300 case should further develop the external and combined hazards assessments to ensure adequate protection can be provided against these hazards.

4.3.3.10. Building below grade

236. Our assessment during Step 2 has focused on the civil engineering elements of embedment, as these deviate from previously proven and operational BWR designs, and safety from a life fire perspective.

237. The RPV head is approximately 22 metres below grade due to constraints arising from the location of the steam lines on the RPV which are at grade elevation to aid with the prevention of water hammer (a pressure surge, or high-pressure shockwave that propagates through a piping system when a fluid in motion is forced to change direction or stop abruptly) and to reduce flooding risks from penetrations though the outer reactor building wall. In order to remove and replace the control rod drives, additional space is also needed under the RPV bottom head. The basemat is therefore located at approximately 34 metres below grade.

238. This deep embedment provides greater protection of SSCs against a range of external hazards. It also results in a centre of mass located below grade level, increasing stability, and reducing seismic demands due to less amplification of seismic demands at deeper elevations.

239. We have confidence that the RP has considered challenges associated with below grade construction, such as corrosion protection, in-service inspection and testing programs, and ageing management. This will ensure that the

structure can fulfill its intended functions throughout its design service life and decommissioning period.

240. The RP has recognised the challenges to life fire safety due to building below grade and the differences between US, Canadian and UK requirements and have identified a number of areas that will require addressing for a UK design, such as means of escape for operators and access for emergency responders. The RP has undertaken preliminary optioneering to document potential solutions for these areas and has confirmed that more detailed optioneering will be undertaken for a UK specific design, which will include consideration of any cumulative effects.

241. Overall, we are satisfied that there are benefits (indeed a necessity) for major portions of the BWRX-300 structure being constructed below grade and the RP has demonstrated positive awareness of the challenges this brings. The SSSE provides sufficient evidence for Step 2 of all these points, including for example how inspection activities will be undertaken.

4.3.3.11. Generic site envelope

242. The GSE provides parameters that are intended to bound potential future GB site conditions. For the purposes of this GDA, the GSE is based upon existing potential GB sites defined in the National Policy Statement (NPS) for nuclear power generation (EN-6 (ref. [130])). At the time of this GDA, EN-6 was only applicable to GW-scale nuclear projects capable of being deployed in the UK by the end of 2025, which does not apply to the BWRX-300 design. The new NPS for nuclear energy generation (EN-7) is intended to be applicable to nuclear power stations expected to be deployed in the UK beyond 2025 (ref. [131]). EN-7 has not been published at the time of authoring this report.

243. Therefore, the RP has defined a UK GSE for the BWRX-300 design considering the eight GB sites set out in EN-6 (ref. [130])). The GSE was initially defined in Step 1 in the Generic Site Envelope and External Hazards Identification Report (ref. [132]). Chapters 2 and 15.8 of the PSR supersede some of the information contained within this report.

244. The RP has assumed that the generic site is a coastal GB site using a once through cooling system with seawater as the ultimate heat sink (ref. [132]).

245. The RP asserts that all initiating events with potential for significant radiological consequences, including internal and external hazards, have been identified and assessed. The RP has stated that site-specific hazards that are not applicable to generic characterisation will be addressed upon site selection.

246. The RP has evaluated climate change considerations through to 2100. The RP has evaluated impacts on various environmental parameters, including temperature, rainfall, wind, and sea level, using the UK Climate Projections

2018 (UKCP18). Where UKCP18 data was unavailable, we consider that the RP has employed the best available alternatives.

247. Overall, we consider that the GSE bounds the sites set out in the NPS for nuclear power generation (EN-6) for those hazards within the scope of GDA and for seismic hazards. We consider that relevant hazard scenarios have been considered and the potential effects of climate change have been adequately evaluated for Step 2.

4.3.3.12. Radioactive waste

248. Radioactivity is an inevitable byproduct of operating any nuclear reactor and we expect this to be appropriately managed and minimised ALARP. During Step 2 we have assessed the RP's case for its approach to radioactive waste management as outlined in Chapter 11 of the PSR (ref. [47]).

249. The radioactive waste store is not included within the scope of GDA, and as a consequence, the RP has presented limited information regarding its waste management strategy for the design. Commensurate with the design maturity, the strategy lacks key details such as appropriate container selection and key waste management and storage facilities. A future BWRX-300 case would need to demonstrate that these elements have been adequately considered.

250. The RP has identified the waste types associated with the BWRX-300 design but has also highlighted a significant level of uncertainty associated with the waste arising projections due to uncertainty with respect to the source terms. From the information provided in the SSSE, and recognising the limitations in the waste strategy, the waste types do not appear to be novel compared to what we previously assessed during the UK ABWR GDA. The RP has also submitted an expert view from Nuclear Waste Services (ref. [133]), with regards the disposability of Intermediate Level Waste and spent fuel. We therefore consider that the RP can make corresponding disposability cases in a future iteration of the BWRX-300 SSSE.

251. The management and disposal of spent ion-exchange resins as described in the SSSE has the potential to result in the mixing of waste of differing categories, resulting in waste dilution. We have therefore contributed to an RO raised by the Environment Agency regarding segregation of waste (RO-BWRX300-002) (ref. [109]). Further detail can be found within the Environment Agency's Fundamental Assessment Report (ref. [85]). We consider that the RP has provided a credible resolution plan, which if implemented, would provide substantiation for its methodology for segregation of ion exchange resins.

252. Overall, recognising the exclusion of the radioactive waste building from the scope of GDA has constrained the information submitted by the RP, we judge the RP's approach to radioactive waste management to be adequate.

4.3.3.13. Fuel and nuclear material management

253. The overall approach to fuel management for the BWRX-300 design is consistent with international BWR designs. New fuel is imported into the facility before being transferred to the reactor. Used fuel removed from the reactor is subject to short-term pool cooling ahead of interim dry storage of spent fuel pending transport to a future geological disposal facility.

254. Detailed design of the layout and design of the buildings and systems which support the management of fuel during its lifecycle is ongoing and was not submitted in Step 2. While the RP has provided some initial identification and analysis of hazards and faults, a full safety analysis of fuel handling and storage has not been produced. Our focus in Step 2 was therefore to gain confidence in the design of the major SSCs related to fuel management and the arrangements for criticality control.

255. A number of items of equipment are involved in fuel handling including a polar crane and the refuelling machine. The design and requirements for each of these were not fully defined in the GDA submissions. The aim of the BWRX-300 designers has been to provide a fuel route that minimises the lift height of significant lifts of nuclear fuel; something we welcome. We also noted that the proposed lift route had been chosen to prevent dropped loads onto the spent fuel rack or SSCs, which demonstrates its spent fuel cask route has considered principles of prevention to reduce fault effects. Notwithstanding this we noted that the SSSE applies a non-safety classification to the lifting equipment, however, the RP has committed in its FAP to further work on consequence analysis to ensure the correct safety classification is determined for the UK. We judge that a change in categorisation should not impact the fundamental design of the polar crane.

256. Out of core criticality safety is maintained by limiting the number of fuel bundles outside of fuel storage areas (limited to two by the number of lifting devices) and the use of boronated stainless steel in the spent fuel pool storage racks.

257. The RP has provided consequence analysis of a drop of an irradiated fuel assembly onto the top of the core resulting in fuel damage and radioactive release for dropped loads during refuelling operations, but not for other fuel movements. It is the RP's intent to assess these areas in more detail during any potential future UK project. Appropriate consideration of the BWRX-300's RPV being comparatively taller and narrower to other BWR designs will need to be shown.

4.3.3.14. 50/60 Hz operation and Grid Code compliance

258. As part of our Step 2 assessment, we have reviewed the RP's electrical systems architecture requirements document (ref. [134]), and have concluded that it provides a comprehensive set of requirements for the design of the electrical systems in the BWRX-300.

259. The structure of the architecture document clearly identifies the requirements of each individual system, whether that be, for example, the emergency power system, cable raceways lighting, as well as defining the basis for each requirement.

260. The design presented within Chapter 8 of the PSR (ref. [43]) is a 50 Hz design, however the architecture document supports the development of BWRX-300 designs for both 50 Hz and 60 Hz operation, and the structure of the document makes clear where requirements are applicable to only one system frequency, or one regulatory jurisdiction. This is because the BWRX-300 design was initially developed to operate on a 60 Hz electrical grid.

261. The RP has not yet developed a full compliance plan for the UK Requirements for Electrical Installations (ref. [135]). However, it submitted for information the compliance plan that was developed to support the BWRX-300 design for Canada (ref. [136]). We consider that this provides a clear hierarchical breakdown of the codes and standards at national and international level to be used, and the justification for their use. We judge that a similar review approach would ensure an appropriate justification for the design in the UK.

262. We judge that the RP has considered, where appropriate, aspects such as the single failure criterion, independence and limits of operation related to electrical engineering. Whilst the architecture document (ref. [134]) is currently focused on alignment to North American regulatory requirements, we judge that these are consistent with UK expectations.

263. Noting that the RP has identified a FAP action to ensure the detailed design of the electrical installation is reviewed against relevant UK expectations, we judge that, for the purposes of Step 2, the BWRX-300 architecture is capable of being connected to a nominal 50Hz electrical system.

264. 50 Hz operation is not the only requirement a NPP wishing to connect to the GB transmission system has to meet. The National Energy System Operator’s (NESO) Grid Code (ref. [137]) sets out a series of requirements that are not only important commercially but can also have implications for safety. Whilst ONR (ref. [138]) and IAEA (ref. [139]) expectations are that a facility should be able to provide power from on-site sources to support delivery of the controlled and safe state, the normal, or preferred power supply, is from the offsite power supply, if available. In addition, it is important to ensure that technical compliance with the operational requirements of the Grid Code (ref. [137]), including the ability to provide frequency response, do not challenge nuclear safety. Therefore, we have considered whether the BWRX-300 is able to connect to the UK transmission system without affecting nuclear safety.

265. The RP has undertaken a BWRX-300 UK Grid Code Assessment (ref. [140]), describing how it has identified the performance or capability

requirements of the Grid Code (ref. [137]) and then reviewed them to 'identify requirements that are inherently met and those where gaps exist'.

266. The RP's analysis identified areas where it could not show the extant BWRX-300 design meets Grid Code requirements. It is confident some of these can be resolved by further study on a 50 Hz design. Others are related to the inherent characteristics of the BWR technology. The RP's Grid Code assessment (ref. [140]) sets out how the difficulty with providing frequency response is a result of dynamic behaviour of the boiling water reactor technology; due to it adopting a 'turbine follows boiler control scheme' meaning fast modulation in response to grid frequency changes is not feasible. Our previous GDA electrical assessment of the UK ABWR design (ref. [141]) highlighted similar findings.

267. For these areas, the RP has identified that further technical discussions should be held with the relevant UK regulators (not just ONR) as part of any future UK deployment of a BWRX-300. This will allow the developers of any UK site-specific BWRX-300 project to determine if a design solution can be implemented or a derogation from the requirements sought by the Grid Code is necessary. The RP has captured this need for further work and discussions as a commitment in its FAP (ref. [118]).

268. Clarity on a strategy acceptable to the UK electricity regulator and system operator should be developed for any future site-specific project. However, for the purposes of Step 2, we consider that the RP has taken due consideration of compliance with the Grid Code.

4.3.3.15. Reactor coolant circulation

269. The thermal-hydraulic configuration of the BWRX-300 closely resembles that of conventional BWRs, with the notable exception that it operates without recirculation pumps or associated coolant piping. Instead, core coolant circulation is achieved through natural circulation.

270. Chapter 27 of the PSR (ref. [72]) explains that although this reliance on natural circulation is a change from the approach adopted by, for example, the UK ABWR, BWRs utilising natural circulation, have been designed, operated and subject to review by other international regulators.

271. The RP states that within the BWRX-300 design, the tall chimney between the top guide plate and steam separator enhances natural circulation. We judge it to be credible that the resulting flow rate is inherently self-regulating and varies with reactor power, as fluid density in the core and chimney region changes with thermal output. We were also satisfied that the list of initiating events, the operational starting point for accident transients, and the modelled behaviour of the reactor during an accident transient is appropriate for the BWRX-300's utilisation of natural circulation.

4.3.3.16. Reactor pressure vessel and in-containment pipework

272. The BWRX-300 RPV is a vertically oriented, cylindrical steel vessel with a hemispherical bottom head, and a flanged top head to accommodate internal components such as the steam separators and to allow for refuelling. The RPV is taller than other existing BWR RPVs to facilitate natural circulation without the need of forced-flow pumps.

273. The RPV design is such that the level of all large nozzles (greater than 19 mm diameter) is significantly above the active fuel. RIVs are attached directly to the RPV integral nozzles via bolted flange connections to the RPV. Bolted flange connections are also used to connect to the outboard piping. Each RIV consists of two valves in a single body that are independently capable of isolating the respective line. They are designed to automatically actuate via diverse C&I, to be single failure tolerant and to fail-safe in the event of a loss of power. The BWRX-300 design intent is that positioning of the large nozzles, the increased volume of water in the RPV and the successful operation of the RIVs will significantly limit the consequences of LOCAs and prevent uncovering of the core.

274. In other respects, the design, substantiation, manufacture, and performance requirements of the BWRX-300 RPV are very similar to those assessed in the UK ABWR GDA and judged suitable for deployment in GB. We are satisfied that the RP has considered irradiation embrittlement effects on the RPV and has provided sufficient evidence within the SSSE to support the development of a robust process for material selection and properties consistent with previous BWR designs. We are satisfied that the BWRX-300 design considers access for inspection and maintenance of the RPV, for example, taking into account the location of the bottom head welds for in-service inspection.

275. The SSSE claims the RIVs can be considered as part of RPV. Both the RPV and RIVs are stated to be designed in accordance with the rules and requirements of ASME Boiler Pressure Vessel Code Section III (ref. [142]). However, the SSSE also states that the RP has not yet systematically applied the structural integrity categorisation and classification scheme it proposes for the UK to the RPV and RIVs. The RP has acknowledged that further consequence analysis of component failure needs to be undertaken, which may require changes to the classification of SSCs, including designating some components ‘high integrity’. A high integrity classification is needed where failure is intolerable and for which no physical protection is provided, or protection is not reasonably practicable. Our expectation is that the RPV and RIV bodies will be obvious candidates for such a designation.

276. Although it has still to be applied, the RP did put forward its proposed approach and methodology for specifying high integrity component requirements. The consistency of this approach with regulatory expectations therefore became a focus of our Step 2 assessment.

277. The RP has produced a topical report on its RPV structural integrity substantiation methodology (ref. [143]), which outlines the approach at a component level. It references the approach previously assessed and judged acceptable by ONR as part of the UK ABWR GDA (ref. [67]). The RP has suggested some updates to its methodologies to adapt the UK ABWR approach for application to the BWRX-300 design and potentially removing the intermediate classification present in the UK ABWR methodology.

278. Our conclusion at the end of Step 2 is that RP's proposed approach for the categorisation and classification of structural integrity requirements, including for high integrity components, is consistent with UK and international expectations. However, a future BWRX-300 safety case will need to include an update and finalisation of the proposed approaches and then demonstrate its application and implementation results in appropriate component reliability.

279. ONR's SAPs (ref. [78]) set an expectation that the extent of high integrity pipework is limited. The BWRX-300 design philosophy of placing RIVs directly onto the RPV so that LOCAs can be tolerated is consistent with this expectation and therefore welcomed. However, a future SSSE will need to provide additional arguments and substantiation to that included in the GDA submissions for pipework failures within containment (described as being part of a 'break exclusion zone' or BEZ).

280. Chapter 15.7 (ref. [58]) of the PSR acknowledges that the methodology for application of BEZ for the BWRX-300 will require updating prior to production of a future site-specific safety case. Through our collaboration with CNSC, we have been made aware of similar discussions being undertaken in Canada with OPG to modify the BEZ approach for the DNNP. The outcome of CNSC's review, and the subsequent actions being proposed for the DNNP were provided to ONR for information. We have therefore not sought to replicate the work of CNSC within our Step 2 assessments. This information has provided us with confidence that the RP has credible methodologies and approaches to resolve the limitations we have identified in the GDA submissions.

281. In the context of the approach to designating components high integrity not yet being systematically applied, the BEZ methodology still being under review in both UK and Canada, and limited substantiation in the SSSE for the reliability claims made on the RIVs (and the systems which actuate them), our judgment is that the deterministic safety case set out in Chapter 15.5 of the PSR (ref. [56]) is currently incomplete for un-isolable LOCAs (a break between the RPV nozzles and the RIVs) and non-isolated LOCAs (a break in a downstream pipe coincident with a common cause failure of the RIVs). It is recognised that the design intent of the BWRX-300 has always considered these scenarios, however the GDA SSSE does not set out what the safety case is for these LOCAs. It is therefore unclear what claims and arguments are being made, what evidence or analysis is currently available

and what still needs to be provided to support the claims set out (for example the future application of high integrity classification and BEZ processes, and showing the relevant components achieve the desired performance and reliability requirements).

282. This conclusion led to RO-BWRX300-004 (ref. [107]) being raised during Step 2. The RP has provided a credible Resolution Plan (ref. [145]) that commits to producing submissions that respond to the actions within the RO after Step 2 as part of any future site-specific BWRX-300 regulatory interactions. These commitments are reflected in the consolidated SSSE supplied in July 2025.

4.3.3.17. Approach to C&I, monitoring and protection systems

283. Chapter 7 of the SSSE (ref. [42]) describes the BWRX-300 C&I architecture. It can be summarised as follows:

- Several C&I systems in DL2 provide safety functions for normal plant control and to respond to frequent events;
- The primary protection system (PPS) in DL3 automatically initiates safety features when plant conditions go beyond normal limits; and
- The diverse protection system (DPS) in DL4a provides a backup means of initiating safety features in case there is a failure of the PPS.

284. The C&I architecture aligns with the proposed plant level defence in depth concept, outlined in Section 4.3.2.2; independence is claimed between the PPS and DPS, and between the PPS and C&I systems in DL2. This independence is fundamental to ensuring the reliable initiation of BWRX-300 safety features, such as core cooling by the ICS.

285. Diversity is a key element of the demonstration of independence between systems. Therefore, our assessment for Step 2 focused on this area. Diversity introduces deliberate differences between C&I systems to reduce the likelihood that any common failures (systematic faults) are triggered at the same time. This is of particular importance to digital C&I systems, where owing to their inherent complexity, it is generally not possible to prove that a system contains no latent systematic faults. This uncertainty increases concern that any residual faults could be common in multiple systems and triggered at the same time. This is also applicable to cyber security as diversity reduces the likelihood (or with suitable technology selection avoids altogether) common vulnerabilities being present in otherwise independent systems.

286. In Step 2, we did not expect the RP to be able to fully demonstrate how diversity supports the claim of independence. However, we did expect high level independence claims to be established and for there to be confidence from the RP’s submissions that the design is likely to support a future safety

case demonstration of sufficient protection against potential common cause failures (CCFs).

287. In its March 2024 design reference (and indeed in its ongoing live development work happening in parallel to GDA) the RP had not selected specific C&I platforms to implement the C&I systems due to the maturity of the design. However, the RP did identify high-level technology choices and selected digital technology for the PPS, DPS and for the C&I systems in DL2. This approach differs from NPP designs that have previously been assessed in the UK, which have included a non-software-based back-up protection system.

288. We sampled how the RP had made strategic choices in relation to equipment diversity in the BWRX-300 design. Early concepts of BWRX-300 had an analogue DPS, which has evolved to a digital platform as presented in the SSSE.

289. The RP explained that US NRC's requirements set out in NUREG/CR-6303 (ref. [148]) and NUREG/CR-7007 (ref. [149]) have been used to inform design decisions, including a preliminary diversity assessment (ref. [150]) using the semi-quantitative methodology provided in NUREG/CR-7007 to provide confidence that sufficient diversity could be demonstrated. It stated that GVHA intends to update this in a final diversity assessment at a later design stage. It is our view that NUREG/CR-6303 and NUREG/CR-7007 provide a useful framework to consider the factors contributing to C&I diversity, and they recognise that NUREG/CR-7007 also provides a semi-quantitative assessment methodology which may provide insights for design refinement, but these alone are not a mechanism for a suitable safety case demonstration of diversity. ONR's views are aligned with US NRC BTP 7-19 (ref. [151]), which states "this method has not been benchmarked and should not be used as the sole basis for justifying adequate diversity." Our expectations are that potential CCFs should be systematically identified, and specific design decisions and features should be incorporated which eliminate these where possible, or provide adequate mitigation.

290. Whilst we acknowledge that the RP has made high-level claims of diversity between C&I systems in its response to our regulatory queries, we do not consider that the strategic decisions, design principles and supporting processes which underpin these diversity claims have been clearly identified. This would need to be adequately demonstrated if a future BWRX-300 project proceeds in GB. As a result, we raised a Regulatory Observation (RO-BWRX300-001 (ref. [105]) to address this.

291. The RP has provided a Resolution Plan (ref. [152]) which sets out how it intends to deliver the four actions we identified in RO-BWRX300-001. The resolution plan (ref. [152]) commits to producing submissions to respond to these actions after Step 2, with the exception of the delivery plan, which was submitted in Step 2 (ref. [108]).The delivery plan sets out a well-defined

strategic set of activities which should support the RP to clarify the strategic decisions, principles and processes for realising C&I diversity, ultimately culminating in an assessment of potential technology options and a justification of those selected for the C&I systems. If implemented, we consider that the actions outlined in these plans will support a future design and safety case demonstration of the elimination, or suitable mitigation, of CCFs between C&I systems.

292. The RP presented the current position on C&I diversity for the DNNP in a meeting with CNSC, ONR and US NRC. As discussed in section 3.4 this has been identified as an area of ongoing international collaboration.

4.3.3.18. Design for decommissioning

293. An adequate decommissioning strategy is important for all NPPs to minimise worker dose uptake and reduce the risk of facilities causing legacy challenges long after their designed operational functions have ended. Integrating decommissioning considerations into the design phase means that materials and layouts can be chosen to minimise contamination, simplify dismantling, and limit the generation of radioactive wastes. This allows for safer dismantling, effective waste management, and potential repurposing of structures, preventing long-term hazards and liabilities.

294. We consider that the RP has adequately defined the end state of any potential site to be a “brownfield” industrial end-state free of industrial and radiological hazards. The RP has stated that contamination levels will be below release levels both above and below ground, and structures will be reduced to ground level minus one metre and back-filled with clean soil, rubble, or concrete to prevent subsidence.

295. During Step 2, we targeted the RP’s management system to investigate the consideration of decommissioning, and to establish whether BWRX-300 design incorporates features to facilitate decommissioning at the concept design stage. These are established expectations set out in UK and IAEA guidance (ref. [153]) which state that, at the design stage of a new facility, the designer or the licensee should ensure that decommissioning considerations are taken into account. Equivalent statements are also identified in the WENRA decommissioning safety reference levels (ref. [83]).

296. The SSSE identifies several examples of design criteria intended to reduce and manage contamination by material selection and design features, however a decommissioning disassembly plan that identifies the design features necessary to enable it was not included, and the RP conceded it had not yet been developed. It stated that BWRX-300 detailed decommissioning plans would not be developed until a specific project reached BL3 (the site-specific detailed design stage).

297. Whilst we would not necessarily expect a fully substantiated demonstration that decommissioning has been factored into the design at Step 2 of GDA,

we judged that the absence of any such information was not aligned with UK or International guidance, and subsequently raised RO-BWRX300-003 (ref. [106]).

298. We agreed an acceptable resolution plan with the RP (ref. [154]) for the gaps against our expectations, as set out in the RO. From what we have assessed in Step 2, we have no reason to believe a BWRX-300 cannot be appropriately decommissioned, and if the RO is addressed in a timely manner as the BWRX-300 design develops elsewhere, it should be possible for a future SSSE for a BWRX-300 project sited in the UK to reduce the potential for future risks arising from decommissioning activities.

299. In addition to targeting the specific design features necessary to enable the development of the decommissioning and disassembly plan, we have also targeted the management arrangements to be used to ensure that the identified features are incorporated into the design.

300. This information is not currently captured within the SSSE, however, we are satisfied from our assessment of the RP's design assurance arrangements that there is a robust management system in place within the GVHA organisation that will ensure any requirements are incorporated into the design. Further detail on the RP's requirements management system is identified in section 4.1.3.

4.3.3.19. Conventional health and safety risks

301. Our focus during Step 2 has largely been on how the RP's approach now to the design of the BWRX-300 will allow duties under the CDM Regulations 2015 (ref. [120]) to be demonstrably met in the future. Design decisions and processes at this early stage can have an important role to ensure the design complies with GB legislative requirements and can ultimately demonstrate conventional health and safety risks are reduced SFAIRP. The conventional safety risks are addressed in chapter 24 of the PSR (ref. [69]) with additional information provided in the conventional health and safety strategy (ref. [33]).

302. Our engagements with the RP revealed it had not appointed CDM dutyholders during Step 2. We consider that clarification of the client dutyholder can be made in later project phases, noting that the client is required to have suitable arrangements for managing the project, including the allocation of sufficient time and resources.

303. The RP has demonstrated understanding of the requirements for having a Principal Designer (PD) and competent contractors involved in the early stages of the design. The PD, once appointed, is required to plan, manage, monitor and co-ordinate the pre-construction phase. The RP's supply chain partners have given competent advice to the RP regarding CDM dutyholders and their appointment during GDA, and this is reflected in appropriate statements and commitments in the SSSE.

304. Given no specific BWRX-300 project or site in GB has been identified at this time, we are satisfied with the extent to which conventional health and safety risks are addressed in the SSSE and level of awareness the RP has demonstrated for what will need to be put in place for a future project.

4.3.3.20. Safeguards

305. The focus of our safeguards assessment in Step 2 was gaining confidence that the RP demonstrably has sufficient understanding of UK and international safeguards requirements, and establishing the extent to which the BWRX-300 design can meet these requirements. Recognising that the implementation of adequate safeguards arrangements and facilities will largely be for the future, we also considered how GVHA, the BWRX-300 designer, intends to identify safeguards related commitments and assumptions for inclusion in the future design activities and communicating to a future UK operator of a BWRX-300.

306. Our Step 2 conclusions are positive with respect to all these aspects. We are content that the RP has demonstrated an understanding of both domestic and international regulatory requirements for safeguards sufficient for the current design maturity. An example of this awareness is that an Article 2.a.(ix) declaration under the UK additional protocol has been made. Our assessment also found that GVHA recognises the benefits of an early application of a safeguards by design approach to facility design, and it has robust arrangements for capturing relevant assumptions and commitments.

4.3.3.21. Approach to ALARP

307. The key duty in GB health and safety legislation is for the dutyholder to demonstrate that risks have been reduced SFAIRP. In nuclear safety, this term is used interchangeably with ALARP. For Step 2 of GDA, a full demonstration of ALARP is not possible due to the maturity of the design and supporting safety analysis. Therefore, our assessment focus in Step 2 has been on the approach adopted, application in the design to date including the rationale for key design decisions that have already been made, and how the RP proposes to incorporate these methodologies into the design and safety demonstrations going forward.

308. The ALARP principle is not applied to nuclear security. Instead, ONR’s SyAPs identify a set of defined outcomes that a dutyholder should demonstrate through a graded and proportionate approach to security, tailored to the potential consequences and the attractiveness of nuclear assets to adversaries. In parallel to our assessment of ALARP, we have also assessed the RP’s understanding of the graded approach for security.

309. In line with requirement [2.4] from Guidance to Requesting Parties (ref. [1]), the RP has included consideration of ALARP within the individual chapters of the PSR, and has also included a dedicated chapter (ref. [72]) which

outlines its approach and future activities. The graded approach is also adequately considered within the PSR Chapter 25 on security (ref. [70]).

310. We consider that the BWRX-300 design provides a good foundation for the RP to demonstrate risks have the potential to be reduced ALARP within a future safety case. Chapter 27 of the PSR (ref. [72]) sets out the 'ALARP Evaluation' process that a future project would use to demonstrate that risks are reduced ALARP. This process comprises 3 phases which incorporate risk assessment and design decision making processes:

- Phase 1: Holistic review of BWRX-300
- Phase 2: Specific review of potential improvements (options)
- Phase 3: Holistic evaluation of the ALARP position

311. The RP has already undertaken a Phase 1 ALARP review in parallel to Step 2 of GDA. This has involved identifying gaps against relevant good practice (RGP) to be taken forward as FAP items for a Phase 2 ALARP review (including those originating from ONR's findings). We judge this process, if followed, would provide a sound basis for development of a suitable ALARP demonstration within a future site-specific safety case.

312. The RP has not identified any potential design improvements to its submitted design reference as a result of preparing for GDA Step 2 or as a result of its engagements with regulators in Step 2 to be included into its next major design maturity milestone for the standard BWRX-300 plant (BL2). It has identified some changes it will need to make for UK-deployment (for example the 50 Hz design) and in several areas it knows the design will continue to evolve (for example severe accident safety features). It has also identified potential improvements to the SSSE as a consequence of GDA, which it has assigned to a future UK-site specific BL3 stage.

313. It is our understanding that the RP and GVHA intend to demonstrate the international standard BWRX-300 design will continue to consider IAEA safety standards (ref. [28]), including at the BL2 phase, which will be reached after GDA, but before any UK-site specific activities start. These safety standards include the requirement for ALARA (as low as reasonably achievable) to be integrated into the design. A continued commitment during BWRX-300 design development to international standards should reduce the risk of any significant design changes being required in a UK BL3 design phase. However there remains a risk that additional time and cost will be incurred if a BWRX-300 site-specific project starts in the UK and no explicit consideration has been given to the SSSE commitments and GDA FAPs until BL3. Design for decommissioning is a key example of this, where retrospective consideration at BL3 could result in significant design changes.

314. As described in Section 4.1.3, we have concluded from our engagements that GVHA has a robust management system which incorporates nuclear

safety, security and safeguards considerations into its design change process. We have assessed to what extent the RP and GVHA are making balanced engineering decisions, and we consider that, although not explicitly defined as ALARP, GVHA is embedding risk reduction considerations within the design. One example of this is the BIS discussed in section 4.3.3.7.

315. In summary, we consider that the RP has demonstrated adequate consideration of ALARP and the graded approach for Step 2, recognising that a full ALARP demonstration will need to be provided within a future UK site-specific PCSR. If the RP wants to maximise the value of GDA to achieve its goal of a widely accepted standard design, supported by common documentation where possible, it should take into the account the matters arising from our assessment as it takes forward other projects elsewhere.

5. Conclusions and Recommendations

5.1. Conclusion

316. This report summarises our assessment of the generic BWRX-300 design at the end of Step 2 of the GDA and builds on our report produced at the end of Step 1.

317. This is the first time ONR has finished assessment at Step 2 of the revised GDA guidance. It is not possible to compare the outcomes reported here with other completed GDAs using the historic four-step process as the scope and objective of the assessments differ.

318. In this step we have undertaken an assessment of the fundamental adequacy of the design and SSSE. The objective was to identify shortfalls which could preclude future deployment of that design in GB. This has been undertaken by 21 assessment topics covering the full range of ONR's statutory purposes.

319. Based on the work carried out by ONR, we consider that the RP has completed all of the requirements for Step 2 from our guidance [1].

320. Our assessments have concluded the following:

- The submitted SSSE has been written in support of the RP's ambition of an internationally standardised design, with minimal country-specific variations. We recognise, and welcome, that the RP has attempted to develop the SSSE with an international mindset. We positively note that it has utilised a structure aligned with the IAEA format for a safety analysis report, SSG-61, although we also observed that in some areas the SSSE still directly references US NRC requirements without explaining their applicability to other regulatory regimes or the safety claims being made.

- The SSSE submitted in Step 2 is of a high quality, providing a sound basis for us to undertake a meaningful fundamental assessment of the BWRX-300. It also captures the operating experience and expertise in the nuclear industry of GVHA. It is comprehensive, logical, and suitably structured, and we consider that it provides the RP a robust basis to support development of a future BWRX-300 project in the UK.

- The BWRX-300 design is based on established BWR technology, with the incorporation of passive features. We recognise that the passive features simplify the design and reduce the reliance on active safety systems and operators to maintain safety, whilst still achieving the safety and security outcomes sought. It also utilises standards and approaches we have seen applied in similar circumstances.

- Overall, we judge that the BWRX-300 design submitted was sufficiently mature to enable a fundamental assessment at GDA Step 2. Our assessments did not identify any fundamental shortfalls with the design or SSSE that could be a significant challenge to the BWRX-300 being developed and deployed in GB. We also did not identify any potential conflicts with relevant government policy.

- We have identified a number of areas where additional substantiation, analysis or modelling will be required in a future SSSE, if a UK project is initiated. Some of these areas for further substantiation have also been requested by other regulators, or are likely to need addressing before a BWRX-300 project returned to the UK. The RP should consider at what stage in the BWRX-300 design and SSSE development process these are addressed if it wants to maintain a standard international design with common supporting documentation. Waiting until UK site-specific activities could result in the design being too mature to introduce risk reduction measures without significant cost and time implications; and

- Based on the work carried out by ONR, we consider that the RP has completed all of the requirements for Step 2 from our guidance.

321. We have not identified any fundamental safety, security or safeguards shortfalls that could prevent ONR permissioning the construction of a power station based on the generic BWRX-300 design. This is based on our assessment to date, and subject to the provision and assessment of suitable and sufficient supporting evidence as part of any future site-specific BWRX-300 regulatory interactions.

5.2. Recommendation

322. Recommendation 1: ONR should publish a Step 2 GDA Statement for the generic BWRX-300 design which indicates that, based upon our assessment to date, we have not identified any fundamental shortfalls with the design.

6. References

[1] ONR, New Nuclear Power Plants: Generic Design Assessment Guidance to Requesting Parties, ONR-GDA-GD-006, Issue 1, August 2024, https://www.onr.org.uk/media/iexmextu/onr-gda-gd-006.docx.

[2] ONR, BWRX-300 Generic Design Assessment Step 2 Statement, Issue 1, December 2025, ONRW-2019369590-21420.

[3] Environment Agency, New nuclear power plants: Generic Design Assessment guidance for Requesting Parties, 2023www.gov.uk/guidance/new-nuclear-power-stations-assessing-reactor-designs.

[4] ONR, Generic Design Assessment (GDA) of new nuclear power stations, October 2025, https://www.onr.org.uk/generic-design-assessment.

[5] ONR, AR-01348, BWRX-300 Step 2 Assessment Report - Fault Studies and Severe Accidents, Revision 1, December 2025, ONRW-2126615823-7711.

[6] ONR, AR-01366, BWRX-300 Step 2 Assessment Report - Civil Engineering, Revision 1, December 2025, ONRW-2126615823-8118.

[7] ONR, AR-01367, BWRX-300 Step 2 Assessment Report - Electrical Engineering, Revision 1, December 2025, ONRW-2126615823-7654.

[8] ONR, AR-01602, BWRX-300 Step 2 Assessment Report - MSQA, Revision 1, December 2025, ONRW-2126615823-7060.

[9] ONR, AR-01363, BWRX-300 Step 2 Assessment Report - Control and Instrumentation, Revision 1, December 2025, ONRW-2126615823-7837.

[10] ONR, AR-01358, BWRX-300 Step 2 Assessment Report - Chemistry, Revision 1, December 2025, ONRW-2126615823-7703.

[11] ONR, AR-01361, BWRX-300 Step 2 Assessment Report - Conventional Fire Safety, Revision 1, December 2025, ONRW-2126615823-5968.

[12] ONR, AR-01580, BWRX-300 Step 2 Assessment Report - Conventional Health and Safety, Revision 1, December 2025, ONRW-2126615823-7691.

[13] ONR, AR-01359, BWRX-300 Step 2 Assessment Report - Cyber Security, Revision 1, December 2025, ONRW-2126615823-7836.

[14] ONR, AR-01351, BWRX-300 Step 2 Assessment Report - External Hazards, Revision 1, December 2025, ONRW-2126615823-7469.

[15] ONR, AR-01350, BWRX-300 Step 2 Assessment Report - Fuel and Core, Revision 1, December 2025, ONRW-2126615823-01350.

[16] ONR, AR-01368, BWRX-300 Step 2 Assessment Report - Human Factors, Revision 1, December 2025, ONRW-2126615823-8121.

[17] ONR, AR-01354, BWRX-300 Step 2 Assessment Report - Internal Hazards, Revision 1, December 2025, ONRW-2126615823-4321.

[18] ONR, AR-01364, BWRX-300 Step 2 Assessment Report - Mechanical Engineering, Revision 1, December 2025, ONRW-2126615823-7759.

[19] ONR, AR-01356, BWRX-300 Step 2 Assessment Report - Nuclear Liabilities, Revision 1, December 2025, ONRW-2126615823-8080.

[20] ONR, AR-01615, BWRX-300 Step 2 Assessment Report - Physical Security, Revision 1, December 2025, ONRW-2126615823-7221.

[21] ONR, AR-01349, BWRX-300 Step 2 Assessment Report - Probabalistic Safety Analysis, Revision 1, December 2025, ONRW-2126615823-7783.

[22] ONR, AR-01352, BWRX-300 Step 2 Assessment Report - Radiation Protection, Revision 1, December 2025, ONRW-2126615823-5989.

[23] ONR, AR-01355, BWRX-300 Step 2 Assessment Report - Safeguards, Revision 1, December 2025, ONRW-2126615823-8000.

[24] ONR, AR-01360, BWRX-300 Step 2 Assessment Report - STAR, Revision 1, December 2025, ONRW-2126615823-8075.

[25] ONR, AR-01365, BWRX-300 Step 2 Assessment Report - Structural Integrity, Revision 1, December 2025, ONRW-2126615823-6061.

[26] GE-Hitachi, NEDC-34148P, Scope of Generic Design Assessment, Revision 2, September 2024, ONRW-2019369590-13525.

[27] GE Vernova, Large boiling water reactors, October 2025, available at <https://www.gevernova.com/nuclear/carbon-free-power/large-reactors>.

[28] International Atomic Energy Agency, Safety of Nuclear Power Plants: Design, Specific Safety Requirements, No. SSR-2/1 (Rev. 1), https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1715web-46541668.pdf.

[29] GE-Hitachi, 005N9751, BWRX-300 General Description, Revision F, December 2023, ONRW-2019369590-7908.

[30] GE Vernova Inc, 005N9751, BWRX-300 General Description, Revision F, December 2023, https://www.gevernova.com/content/dam/gepower-new/global/en_US/images/gas-new-site/en/bwrx-300/005N9751_Rev_BWRX-300_General_Description.pdf.

[31] GE-Hitachi, NEDO-34166 BWRX-300 UK GDA Chapter 4 - Reactor, Rev C, 15 July 2025, ONRW-2019369590-22500.

[32] GE-Hitachi, 006N5064 - GE Hitachi Safety Strategy, Revision 6, March 2024, 2024/10561.

[33] GE-Hitachi, NEDC-34145P - BWRX-300 UK GDA Conventional Safety Strategy, Revision 1, August 2024, ONRW-2019369590-13984.

[34] GE-Hitachi, NEDC-34142P - BWRX-300 UK GDA Security Design Assessment Strategy, Revision 0, May 2024, ONRW-2019369590-9733.

[35] GE-Hitachi, NEDC-34140P - BWRX-300 UK GDA Safety Case Development Strategy, Revision 0, June 2024, ONRW-2019369590-10299.

[36] GE-Hitachi, NEDO-34162 BWRX-300 UK GDA - Safety Security Safeguards Environment Summary, Rev C, 15 July 2025, ONRW-2019369590-22495.

[37] GE-Hitachi, NEDO-34163 BWRX-300 UK GDA Chapter 1 - Introduction, Rev B, 11 July 2025, ONRW-2019369590-22413.

[38] GE-Hitachi, NEDO-34164 BWRX-300 UK GDA Chapter 2 - Site Characteristics, Rev B, 15 July 2025, ONRW-2019369590-22496.

[39] GE-Hitachi, NEDO-34165 BWRX-300 UK GDA Chapter 3 - Safety Objectives and Design Rules for SSCs, Rev C, 15 July 2025, ONRW-2019369590-22497.

[40] GE-Hitachi, NEDO-34167 BWRX-300 UK GDA Chapter 5 - Reactor Coolant System and Associated Systems, Rev B, 11 July 2025, ONRW-2019369590-22393.

[41] GE-Hitachi, NEDO-34168 BWRX-300 UK GDA Chapter 6 - Engineered Safety Features, Rev B, 11 July 2025, ONRW-2019369590-22395.

[42] GE-Hitachi, NEDO-34169 BWRX-300 UK GDA Chapter 7 - Instrumentation and Control, Rev B, 11 July 2025, ONRW-2019369590-22414.

[43] GE-Hitachi, NEDO-34170 BWRX-300 UK GDA Chapter 8 - Electrical Power, Rev C, 15 July 2025, ONRW-2019369590-22501.

[44] GE-Hitachi, NEDO-34171 BWRX-300 UK GDA Chapter 9A - Auxiliary Systems, Rev B, 11 July 2025, ONRW-2019369590-22415.

[45] GE-Hitachi, NEDO-34172 BWRX-300 UK GDA Chapter 9B - Civil Structures, Rev B, 11 July 2025, ONRW-2019369590-22416.

[46] GE-Hitachi, NEDO-34173 BWRX-300 UK GDA Chapter 10 - Steam Power Conversion, Rev B, 11 July 2025, ONRW-2019369590-22417.

[47] GE-Hitachi, NEDO-34174 BWRX-300 UK GDA Chapter 11 - Management of Radioactive Waste, Rev B, 3 July 2025, ONRW-2019369590-22201.

[48] GE-Hitachi, NEDO-34175 BWRX-300 UK GDA Chapter 12 - Radiation Protection, Rev B, 3 July 2025, ONRW-2019369590-22203.

[49] GE-Hitachi, NEDO-34176 BWRX-300 UK GDA Chapter 13 - Conduct of Operations, Rev B, 15 July 2025, ONRW-2019369590-22502.

[50] GE-Hitachi, NEDO-34177 BWRX-300 UK GDA Chapter 14 - Plant Construction and Commissioning, Rev B, 15 July 2025, ONRW-2019369590-22503.

[51] GE-Hitachi, NEDO-34178 BWRX-300 UK GDA Chapter 15 - Safety Analysis, Rev B, 11 July 2025, ONRW-2019369590-22392.

[52] GE-Hitachi, NEDO-34179 BWRX-300 UK GDA Chapter 15.1 - Safety Analysis - General Considerations, Rev B, 11 July 2025, ONRW-2019369590-22391.

[53] GE-Hitachi, NEDO-34180 BWRX-300 UK GDA Chapter 15.2 - Identification Categorization Grouping of PIEs and Accident Scenarios, Rev B, 15 July 2025, ONRW-2019369590-22505.

[54] GE-Hitachi, NEDO-34181 BWRX-300 UK GDA Chapter 15.3 - Safety Objects and Acceptance Criteria, Rev C, 15 July 2025, ONRW-2019369590-22506.

[55] GE-Hitachi, NEDO-34182 BWRX-300 UK GDA Chapter 15.4 - Safety Analysis - Human Actions, Rev B, 15 July 2025, ONRW-2019369590-22507.

[56] GE-Hitachi, NEDO-34183 BWRX-300 UK GDA Chapter 15.5 - Deterministic Safety Analysis, Rev B, 15 July 2025, ONRW-2019369590-22509.

[57] GE-Hitachi, NEDO-34184 BWRX-300 UK GDA Chapter 15.6 - Probabilistic Safety Assessment, Rev B, 15 July 2025, ONRW-2019369590-22508.

[58] GE-Hitachi, NEDO-34185 BWRX-300 UK GDA Chapter 15.7 - Internal Hazards, Rev B, 15 July 2025, ONRW-2019369590-22510.

[59] GE-Hitachi, NEDO-34186 BWRX-300 UK GDA Chapter 15.8 - Analysis of External Hazards, Rev B, 15 July 2025, ONRW-2019369590-22511.

[60] GE-Hitachi, NEDO-34187 BWRX-300 UK GDA Chapter 15.9 - Summary of Results of the Safety Analyses, Rev B, 15 July 2025, ONRW-2019369590-22512.

[61] GE-Hitachi, NEDO-34188 BWRX-300 UK GDA Chapter 16 - Operational Limits Conditions, Rev B, 15 July 2025, ONRW-2019369590-22513.

[62] GE-Hitachi, NEDO-34189 BWRX-300 UK GDA Chapter 17 - Management for Safety and Quality Assurance, Rev 1, 15 July 2025, ONRW-2019369590-22514.

[63] GE-Hitachi, NEDO-34190 BWRX-300 UK GDA Chapter 18 - Human Factors Engineering, Rev B, 15 July 2025, ONRW-2019369590-22515.

[64] GE-Hitachi, NEDO-34191 BWRX-300 UK GDA Chapter 19 - Emergency Preparedness and Response, Rev B, 15 July 2025, ONRW-2019369590-22516.

[65] GE-Hitachi, NEDO-34192 BWRX-300 UK GDA Chapter 20 - Environmental Aspects, Rev B, 11 July 2025, ONRW-2019369590-22394.

[66] GE-Hitachi, NEDO-34193 BWRX-300 UK GDA Chapter 21 - Decommissioning and End of Life Aspects, Rev B, 11 July 2025, ONRW-2019369590-22418.

[67] GE-Hitachi, NEDO-34194 BWRX-300 UK GDA Chapter 22 - Structural Integrity of Metallic System Structures and Components, Rev B, 3 July 2025, ONRW-2019369590-22202.

[68] GE-Hitachi, NEDO-34195 BWRX-300 UK GDA Chapter 23 - Reactor Chemistry, Rev C, 11 July 2025, ONRW-2019369590-22419.

[69] GE-Hitachi, NEDO-34196 BWRX-300 UK GDA Chapter 24 - Conventional Safety and Fire Safety Summary Report, Rev B, 3 July 2025, ONRW-2019369590-22204.

[70] GE-Hitachi, NEDO-34197 BWRX-300 UK GDA Chapter 25 - Security, Rev B, 3 July 2025, ONRW-2019369590-22205.

[71] GE-Hitachi, NEDO-34198 BWRX-300 UK GDA Chapter 26 - Spent Fuel Management, Rev B, 11 July 2025, ONRW-2019369590-22401.

[72] GE-Hitachi, NEDO-34199 BWRX-300 UK GDA Chapter 27 - ALARP Evaluation, Rev B, 11 July 2025, ONRW-2019369590-22420.

[73] GE-Hitachi, NEDO-34200 BWRX-300 UK GDA Chapter 28 - Safeguards, Rev B, 3 July 2025, ONRW-2019369590-22206.

[74] GE Hitachi, GE Hitachi 006N6248 BWRX-300 Security Assessment, Revsion 2, 15 July 2025, ONRW-2019369590-22483.

[75] GE-Hitachi, NEDO-34087, BWRX-300 UK Generic Design Assessment Master Document Submission List (MDSL), Revision 19, November 2025, ONRW-2019369590-25137.

[76] IAEA, Format and Content of the Safety Analsyis Report for Nuclear Power Plants, Specific Safety Guide No. SSG-61, September 2021. www.iaea.org.

[77] ONR, Delivery Strategy for the Generic Design Assessment of the GE Hitachi BWRX-300, Issue 1, 17 July 2024, ONRW-2019369590-11067.

[78] ONR, Safety Assessment Principles for Nuclear Facilities (SAPs), 2014 Edition, Revision 1, January 2020. www.onr.org.uk/media/pobf24xm/saps2014.pdf.

[79] ONR, Security Assessment Principles for the Civil Nuclear Industry. 2022 Edition, Version 1, March 2022. ONR. www.onr.org.uk/media/g05fszjn/security-assessment-principles.pdf.

[80] ONR, ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles (ONMACS), ONR-CNSS-MAN-001, Issue No. 6, February 2025. https://www.onr.org.uk/media/wawbf3li/onr-saf-fw-001.docx.

[81] IAEA, Safety Standards. www.iaea.org.

[82] IAEA, Nuclear Security series. www.iaea.org.

[83] WENRA, Safety Reference Levels for Existing Reactors 2020. February 2021. www.wenra.eu.

[84] WENRA, Safety Objectives for New Nuclear Power Plants and WENRA Report on Safety of new NPP designs - RHWG position on need for revision. September 2020. www.wenra.eu.

[85] Environment Agency, Step 2 Fundamental Assessment Report, December 2025, ONRW-2019369590-24373.

[86] GE-Hitachi, “M240060, BWRX-300 UK GDA Step 1 Summary of International Regulator Interactions and Future Planned Interactions,” March 2024, ONRW-2019369590-8683.

[87] US NRC & CNSC, Joint Report on GEH BWRX-300 Steel-Plate Composite (SC) Containment Vessel (SCCV) and Reactor Building Structural Design White Paper, June 2023, https://www.nrc.gov/docs/ML2310/ML23100A032.pdf.

[88] GE-Hitachi, NEDO-34336, Public comments tracker, September 2025, ONRW-2019369590-23768.

[89] ONR, Technical Assessment Guides (TAG). www.onr.org.uk/publications/regulatory-guidance/regulatory-assessment-and-permissioning/technical-assessment-guides-tags/nuclear-safety-tags/technical-assessment-guides-tags-nuclear-safety-full-list/.

[90] IAEA Safety Standards, Safety of Nuclear Plants: Design, Specific Safety Requirements, No. SSR-2/1 (Rev.1). www.iaea.org.

[91] IAEA, Applicability of IAEA Safety Standards to Non-Water Cooled and Small Modular Reactors, Safety Reports Series No. 123, 2023. www.iaea.org.

[92] ONR, Guidance on Mechanics of Assessment, NS-TAST-GD-096, Issue 1.2, December 2022. www.onr.org.uk/media/documents/guidance/ns-tast-gd-096.docx.

[93] ONR, ONR-RD-POL-002 - Risk-informed and targeted engagements (RITE), May 2024, CM9 Ref 2024/16720.

[94] ONR, GE-Hitachi, BWRX-300 Project Assessment Report - Generic Design Assessment of the GE Hitachi BWRX-300 – Step 1 Summary Report, ONRW-2019369590-13756 Revision 1, November 2024.

[95] GE-Hitachi, NEDC-34154P BWRX-300 UK GDA Design Reference Report, Rev 3, April 2025, ONRW-2019369590-20194.

[96] GE-Hitachi, BWRX-300 UK GDA Project Implementation Plan, NEDC-34150P, Revision 3, June 2025, ONRW-2019369590-22121.

[97] GE-Hitachi, NEDC-34288P, BWRX-300 UK Generic Design Assessment RQ, RO, and RI Tracker, Revision 5, June 2025, ONRW-2019369590-22147.

[98] GE-Hitachi, NEDC-34286P, BWRX-300 UK Generic Design Assessment Meeting and Correspondence Tracker, Revision 6, November 2025, ONRW-2019369590-25471.

[99] GE-Hitachi, NEDC-34287P, BWRX-300 UK Generic Design Assessment Reading Room Tracker, Revision 6, November 2025, ONRW-2019369590-25472.

[100] ONR, GE-Hitachi BWRX-300 - Contact Record - MSQA Level 4 Evaluation, April 2025, ONRW-2126615823-7263.

[101] Health and Safety Executive, Managing health and safety in construction, Construction (Design and Management) Regulations 2015, Guidance on Regulations, L153, 2015. www.hse.gov.uk/pubns/priced/l153.pdf.

[102] GE-Hitachi, NEDC-34357P, BWRX-300 UK Generic Design Assessment (GDA) Safety Case Manual Specification, April 2025, Revision A, ONRW-2019369590-20154.

[103] IAEA, IAEA Safety Standards, Safety Classification of Structures, Systems and Components in Nuclear Power Plants, Specific Safety Guide, No. SSG-30. www.iaea.org.

[104] IAEA Safety Standards, Design Extension Conditions and the Concept of Practical Elimination in the Design of Nuclear Power Plants, Specific Safety Guide No. SSG-88. www.iaea.org.

[105] ONR, https://www.onr.org.uk/publications/regulatory-reports/generic-design-assessment/ge-hitachi-bwrx-300-regulatory-observations-and-resolution-plans, 2025.

[106] ONR, RO-BWRX300-001 - Demonstration of independence and diversity in the BWRX-300 I&C architecture, Revision 1, 20 June 2025, ONRW-2126615823-7689.

[107] ONR, RO-BWRX300-003 - Design for Decommissioning, Issue 1, July 2025, ONRW-212661523-7921.

[108] ONR, RO-BWRX300-004 - Safety case for un-isolable and non-isolated pipe-breaks larger than 19mm diameter, Revision 1, July 2025, ONRW-2126615823-7940.

[109] GE-Hitachi, M250315, Submission of BWRX-300 UK GDA, RO-BWRX300-001 Delivery Plan, 29 August 2025, ONRW-2126615823-8533.

[110] Environment Agency, RO-BWRX300-002, Segregation of Waste, 2025.

[111] ONR, Summary of the GDA Assessment of Hitachi-GE Nuclear Energy, Ltd.'s UK ABWR Nuclear Reactor and ONR's Decision to Issue a Design Acceptance Confirmation, December 2017, https://www.onr.org.uk/media/nv3pdrmg/uk-abwr-gda-dac-assessment.pdf.

[112] IAEA, IAEA SF-1 Fundamental Safety Principles, 2016.

[113] GE-Hitachi, 005N9036 BWRX-300 Requirements Management Plan, Rev 6, April 2024, ONRW-2019369590-17795.

[114] GE-Hitachi, 006N6731, BWRX-300 Plant Cyber Security Program Plan, Revision 2, October 2024, ONRW-609516046-1621.

[115] GE-Hitachi, NEDC-34161P Comparison of BWRX-300 Approach to Categorisation & Classification with UK Expectations, Revision 0, 6th September 2024.

[116] HMG, UK Design Basis Threat, 2003.

[117] IAEA, NSS No 13 - Nuclear Security Recommendations on Physical Protection of Nuclear material and Nuclear Facilities, Revision 5, October 2025, https://nucleus-apps.iaea.org/nss-oui/Content/Index?type=PublishedCollection&collectionid=m_d7a29675-7df3-49a8-8867-4eee91d752c3.

[118] GE-Hitachi, NEDC-34274P, Revision 2, GE Hitachi BWRX-300 UK GDA Forward Action Plan, July 2015, ONRW-2019369590-22522.

[119] HSE, Ionising Radiation Regulations 2017, Approved Code of Practice, L121, January 2018. www.hse.gov.uk.

[120] GE-Hitachi, GEH Response to Regulatory Query RQ-01718, 31 March 2025, ONRW-609516046-1286.

[121] ONR, ONR-CNSC / US NRC Civil Engineering Meeting on DP-SC - ONRW-2019369590-20580, 2025.

[122] NRC, NUREG 10 CFR 20.1003 Definitions., March 2021. www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-1003.html.

[123] IAEA, Radiation Protection Aspects of Design for Nuclear Power Plants, Specific Safety Guide No. SSG-90, May 2024. www.iaea.org.

[124] NRC and CNSC, Joint Report on GE Hitachi's Containment Evaluation Method, April 2022. www.nrc.gov/docs/ml2209/ml22091A201.pdf .

[125] NRC, Regulatory Audit Report of the GE-Hitachi Nuclear Energy Americas, LLC Topic Report NEDC-33922 BWRX-300 Containment Evaluation Method, 2 March 2022, (Record ref. 2024/22621).

[126] GE-Hitachi, Submission of BWRX-300 UK GDA, GE-Hitachi Response to Regulatory Query (RQ)-01897 - Civil engineering - Malicious Aircraft Impact Combinations of Safety Functions and Analysis Acceptance Criteria, M250140, May 2025, ONRW-609516046-1900.

[127] Department of Energy and Climate Change, National Policy Statement for Nuclear Power Generation (EN-6), Volume I of II, July 2011. www.gov.uk/government/publications/national-policy-statement-for-nuclear-power-generation-en-6.

[128] Department for Energy Security and Net Zero, Draft National Policy Statement for nuclear energy generation (EN-7), February 2025, https://www.gov.uk/government/consultations/draft-national-policy-statement-for-nuclear-energy-generation-en-7.

[129] GE-Hitachi, NEDC-34138P BWRX-300 UK GDA Generic Site Envelope and External Hazards Identification, Rev 1, June 2024, ONRW-2019369590-10300.

[130] Nuclear Waste Services, LTR/WMIDA-582826885-13386, GDA Step 2 Expert View on the Disposability of Wastes and Spent Fuel, 2025.

[131] GE-Hitachi, BWRX-300 Plant Electrical Systems Architecture Requirements and Design Plant Specification, 006N5115, Revision 4, ONRW-2019369590-14877.

[132] BSI, Requirements for Electrical Installations, BS7671:2018 [www.bsigroup.com].

[133] GE-Hitachi, BWRX-300 Plant Electrical Systems Nuclear Regulations and Standards Compliance Plan, 006N5200, Revision 1, June 2024, ONRW-2019369590-15736.

[134] National Energy System Operator, Grid Code, Issue 6, Revision 33, June 2025, https://dcm.nationalenergyso.com/.

[135] ONR, New Nuclear Power Plants: Generic Design Assessment Technical Guidance, ONR-GDA-GD-007, Revision 0, May 2019 [www.onr.org].

[136] IAEA, Design of Electrical Power Systems for Nuclear Power Plants, Specific Safety Guide SSG-34, March 2016. [www.iaea.org].

[137] GE-Hitachi, BWRX-300 UK Grid Code Assessment, 009N6414, Revision 0, April 2025, ONRW-2019369590-20559.

[138] ONR, Step 4 Assessment of Electrical Engineering for the UK Advanced Boiling Water Reactor, ONR-NR-AR-17-018, Revision 0, December 2017 [www.onr.org.uk/media/nyqezc2b/onr-nr-ar-17-018.pdf].

[139] ASME, Boiler and Pressure Vessel Code, Section III, ” https://www.asme.org/codes-standards/bpvc-standards, Section III-4 Construction of Nuclear Facility Components, 2023.

[140] BWRX-300 UK GDA RPV Structural Integrity Substantion Methodology - 22 November 2024 - ONRW-2019369590-15022.

[141] GE-Hitachi, M250301, Submission of BWRX-300 UK GDA RO-BWRX300-002 Resolution Plan, September 2025, ONRW-2126615823-8637.

[142] Lawrence Livermore National Laboratory, NUREG/CR-6303, Method for Performing Diversity and Defense-in-Depth Analyses of Reactor Protection Systems, December 1994, https://www.nrc.gov/docs/ML0717/ML071790509.pdf.

[143] Oak Ridge National Laboratory, NUREG/CR-7007, Diversity Strategies for Nuclear Power Plant Instrumentation and Control Systems, December 2008, https://www.nrc.gov/docs/ML1005/ML100541256.pdf.

[144] GE-Hitachi, 008N1105, Safety Class 2 H20 Diverse Protection System Platform Suitability Assessment, Revision A, December 2023, ONRW-609516046-1724.

[145] US NRC, NUREG-0800, Branch Technical Position 7-19, Guidance for evaluation of defense in depth and diversity to address common-cause failure due to latent design defects in digital safety systems, Revision 8, January 2021, https://www.nrc.gov/docs/ML2033/ML20339.

[146] GE-Hitachi, M250288, Submission of BWRX-300 UK GDA RO-BWRX300-001 Resolution Plan, 11 July 2025, ONRW-2126615823-7938.

[147] International Atomic Energy Agency, SSG-47, Safety of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities, 2018.

[148] GE-Hitachi, M250300, Submission of BWRX-300 UK GDA RO-BWRX300-003 Resolution Plan, ONRW-2126615823-8695, 2025.

7. Figures

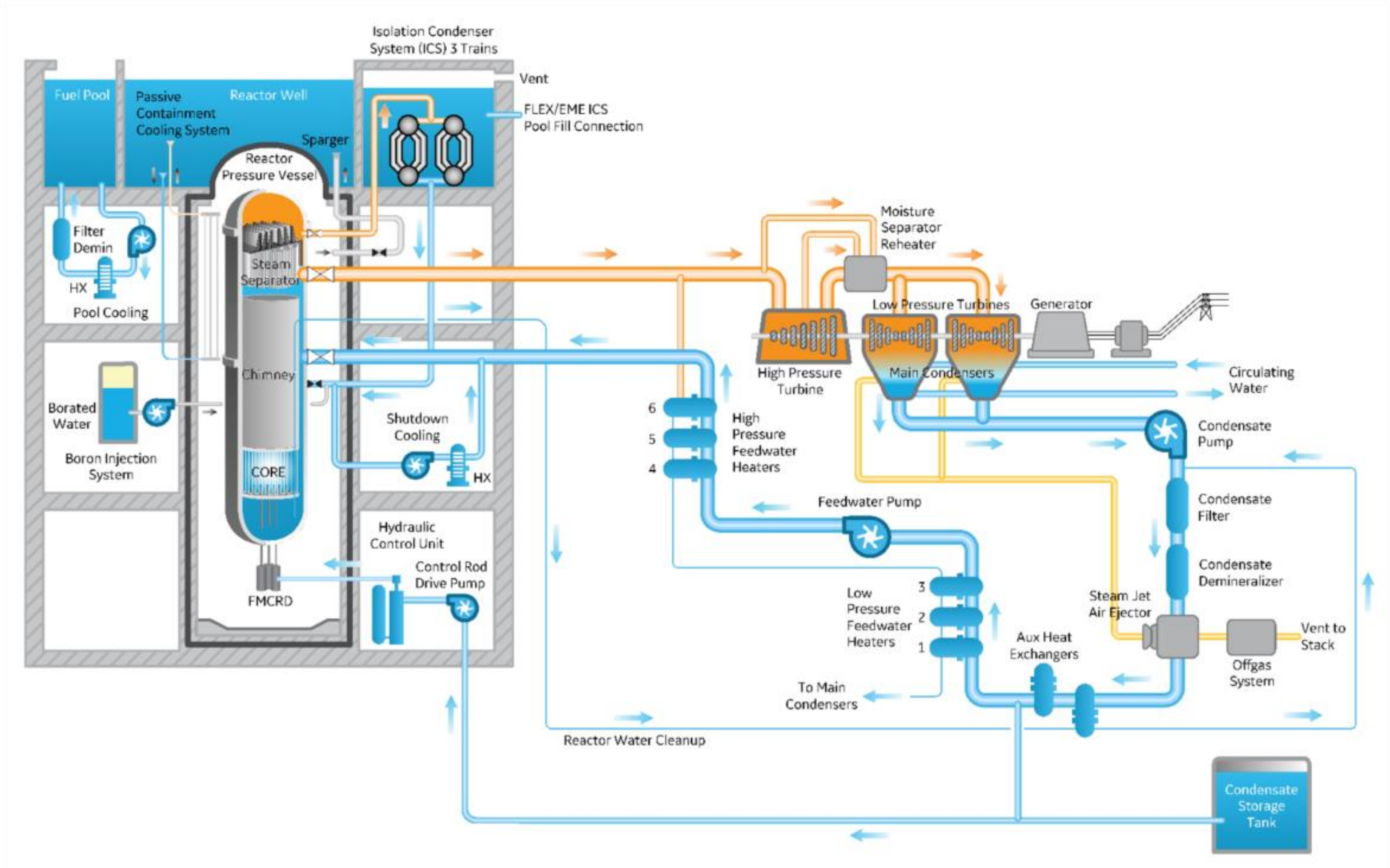

Figure 1 - BWRX-300 major systems (ref. [29])

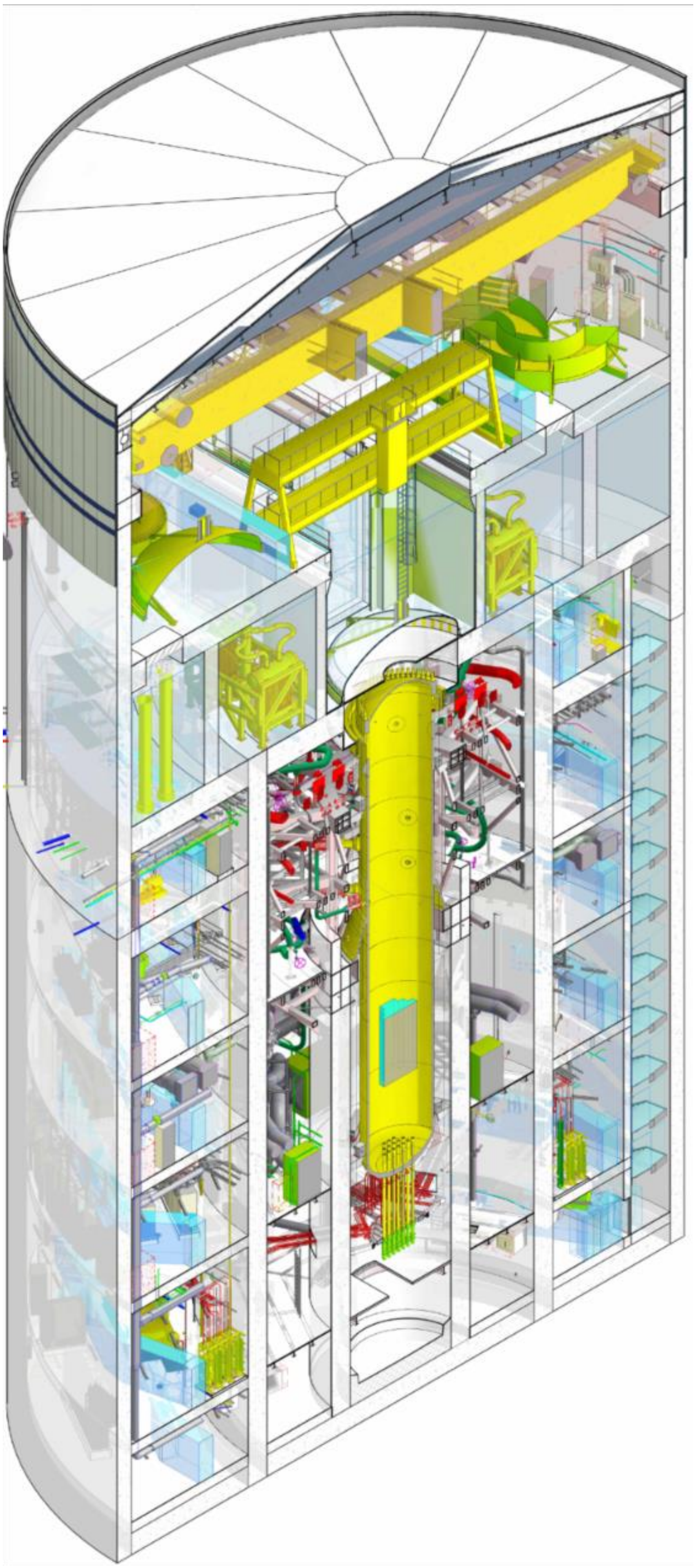

Figure 2 - BWRX-300 containment structure (ref. [29])

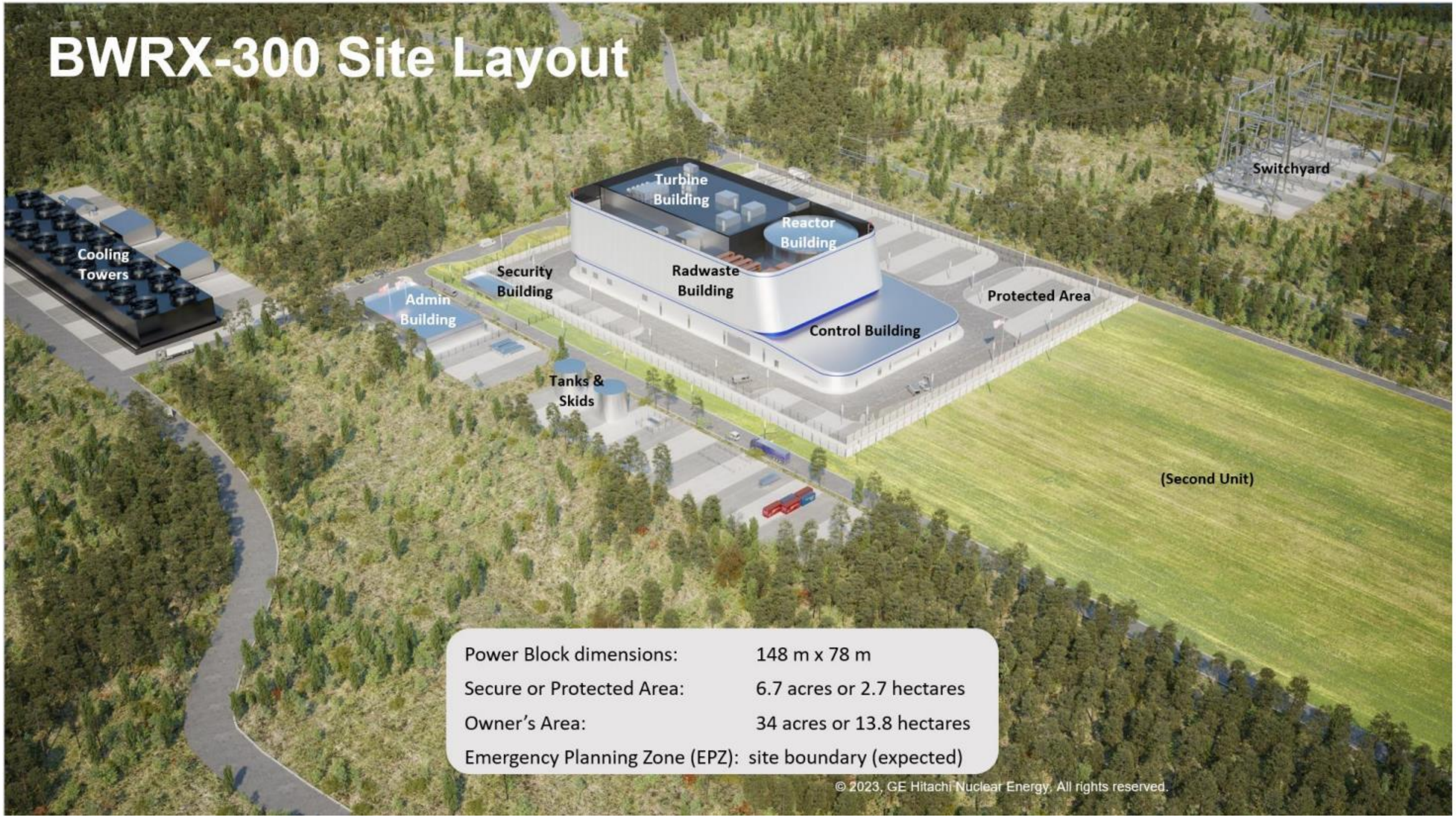

Figure 3 - BWRX-300 reactor power block and generic site layout (ref. [29])

Appendix 1

Table 2: Step 2 requirements from Guidance to Requesting Parties (ref. **[1]**)

	Requirement on the RP during Step 2	Section
[2.1]	**Agree with ONR** any changes necessary to the GDA scope, to ensure that the assessment remains meaningful	4.1.1
[2.2]	**Agree with ONR** any changes to the overall GDA timescales and associated schedule, including subsequent Steps	4.1.1
[2.3]	**Submit to ONR** any additional relevant information which arises due to on-going assessments performed by other regulators on the proposed design, including any significant findings and any changes made or proposed as a result	3.4
[2.4]	**Submit to ONR** a demonstration that the proposed design is likely to reduce risks to human health to ALARP	4.3.3.21
[2.5]	**Submit to ONR** a demonstration that the proposed design is likely to be compliant with the Nuclear Industries Security Regulations (NISR)	4.3.2.1
[2.6]	**Submit to ONR** a demonstration of the application of the RP's categorisation of safety functions and classification of structures, systems and components within the proposed design	4.3.3
[2.7]	**Submit to ONR** a schedule of faults (including internal events, internal and external hazards), including protection and mitigation measures and the links this has to the associated engineering	4.3.2.1
[2.8]	**Submit to ONR** a demonstration of the application of the RP's approach adopted to defence in depth and the hierarchy of controls, including consideration of matters such as common cause failure, segregation, redundancy and diversity within the proposed design	4.3.2
[2.9]	**Submit to ONR** a demonstration of how the RP's own design, security and safety principles have been adopted in the proposed design	4.2
[2.10]	**Submit to ONR** information on the methodologies to be adopted for the identification of Vital Areas, the analysis of cyber security risks and the approach to security related defence in depth	4.3.2.1and 4.3.2.4

	Requirement on the RP during Step 2	Section
[2.11]	**Submit to ONR** the agreed submissions, which align with the expectations given in the discipline technical guidance (Ref. 5), in accordance with the GDA scope. This should include: a. Sufficient detail for ONR to satisfy itself that relevant Assessment Principles (SAP and SyAPs) are likely to be satisfied b. A safety and security case 'head document', or equivalent, which provides the overall safety and security narrative and structure; including a demonstration that the design will meet the safety and security objectives before construction or installation commences, and that sufficient analysis and engineering substantiation has been performed to prove that the operational plant will be adequately safe and secure c. Details on the methodologies, approaches, codes, standards and philosophies used and a justification that these are consistent with what would be considered as Relevant Good Practice (RGP). Identification and explanation of any deviations, including how these have been resolved or demonstrated to reduce risks to ALARP d. Supporting safety analysis, including deterministic and probabilistic safety analyses to cover the GDA scope e. Details of the verification and validation of any software or computer codes used within the supporting analysis f. Detailed descriptions of system architectures and key structures, systems and components, their safety or security functions, and reliability and availability requirements b. Identification of the safe operating envelope and the operating regime that maintains the integrity of that envelope	4.2
[2.12]	**Submit to ONR** the documentation identified within the resolution plans produced in response to the gap analysis against regulatory expectations	4.2

	Requirement on the RP during Step 2	Section
[2.13]	**Submit to ONR** information regarding any outstanding information in the generic safety and security cases that remains to be developed and its significance	N/A
[2.14]	**Agree with ONR** a schedule of generic safety and security case information which will be submitted to ONR prior to the start of Step 3	N/A
[2.15]	**Continue** to maintain and update the Master Document Submission List (MDSL) in accordance with the RP's arrangements produced during Step 1, at regular intervals throughout the Step	4.1.2
[2.16]	**Submit to ONR** the first Design Reference Point (DRP) in accordance with the RP's arrangements produced during Step 1. Continue to update this as necessary throughout the Step.	4.1.1
[2.17]	**Submit to ONR** a demonstration that the arrangements for capturing assumptions, commitments and requirements from the safety and security cases have been applied. Continue to apply these arrangements throughout the Step	4.1.3
[2.18]	**Continue** to apply the DR change control arrangements throughout the Step. **Submit to ONR** any design change information specified under these arrangements	N/A
[2.19]	**Put arrangements in place** for developing the safety case into a site-specific Pre-Construction Safety Report which clearly demonstrates that this can be achieved by a future licensee. **Submit to ONR** a description of those arrangements and a demonstration of their adequacy for GDA	4.1.4
[2.20]	**Put arrangements in place** for developing the security case into a Nuclear Site Security Plan for the operating site, which clearly demonstrates that this can be achieved by a future licensee. **Submit to ONR** a description of those arrangements and a demonstration of their adequacy for GDA	4.3.2.1
[2.21]	**Submit to ONR** responses to any questions raised by ONR during its assessment (RQs, ROs and RIs)	4.1.2
[2.22]	**Submit to ONR** information regarding its intentions for evolution of its GDA resources and a demonstration of the on-going sufficiency of resources to be applied through the Step	N/A
[2.23]	**Continue** to facilitate meetings between ONR and relevant RP's personnel to share information and discuss technical matters	3.2

	Requirement on the RP during Step 2	Section
[2.24]	**Continue** to facilitate the public comment process including hosting a public website, containing relevant and updated generic safety and security cases, and responding to comments made by the public.	3.6
[2.25]	**Undertake** a review of its readiness to begin Step 3 and **submit to ONR** evidence to support the outcomes	N/A