Office for Nuclear Regulation

ONR Assessment Report

Generic Design Assessment of the BWRX-300 – Step 2 Assessment Report - Safeguards

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Authored by: Safeguards Inspector, ONR

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Executive summary

In December 2024, the Office for Nuclear Regulation, together with the Environment Agency and Natural Resources Wales, began Step 2 of the Generic Design Assessment (GDA) with GE Vernova Hitachi Nuclear Energy International LLC, United Kingdom (UK) Branch, the Requesting Party (RP). GE Vernova Hitachi Nuclear Energy Americas LLC (GVHA) is a provider of advanced reactors and nuclear services and is the designer of the BWRX-300.

This report presents the outcomes of my safeguards assessment of the BWRX-300 design as part of Step 2 of the ONR Generic Design Assessment. This assessment is based upon the information presented in the Requesting Party's safety, security, safeguards and environment cases, the associated revision 3 of the Design Reference Report and supporting documentation.

ONR's GDA process calls for an assessment of the RP's submissions. The focus of my assessment in this step was to support the Office for Nuclear Regulation's decision on the fundamental adequacy of the BWRX-300 design and the operator's relevant submissions (referred to by the Requesting Party as the safeguards case), and the suitability of the methodologies, approaches, codes, standards and philosophies which form the building blocks for the design and generic safety, security and safeguards cases.

I targeted my assessment, in accordance with my assessment plan, at the areas that were fundamental to the acceptability of the design and methods for deployment in Great Britain (GB), benchmarking my regulatory judgements against the expectations of the Office for Nuclear Regulation's Nuclear Material Accountancy, Control, and Safeguards Assessment Principles, Technical Assessment Guides and other guidance which the Office for Nuclear Regulation regards as relevant good practice, such as International Atomic Energy Agency (IAEA) safeguards standards. Where appropriate, I have also considered how I could use relevant learning and regulatory conclusions from the UK Advanced Boiling Water Reactor GDA to inform my assessment of the BWRX-300.

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

- as the regulatory requirements of Nuclear Safeguards (EU Exit) Regulations 2019 are on the operator/licensee of the reactor, GHVA should be able to demonstrate that they have identified the commitments and assumptions on the future operator and how these will be communicated to the future operator, for example the provision of technical information in the Basic Technical Characteristics as this information becomes available during design development

- GVHA's understanding of the safeguards domestic regulatory requirements under Nuclear Safeguards (EU Exit) Regulations 2019

- GVHA's understanding of the UK's international safeguards obligations under the UK/IAEA Voluntary Offer Agreement
- GVHA's understanding of/approach to safeguards by design and International/national Relevant Good Practise
- GVHA's understanding of the requirements of the UK/IAEA Additional Protocol

Based upon my assessment, I have concluded the following:

- GVHA has demonstrated an understanding of both domestic and international regulatory requirements and expectations for safeguarding of nuclear material commensurate with the current status of the design, including an Article 2.a.(ix) declaration under the UK additional protocol
- the information that has been submitted to demonstrate an understanding of safeguards by design is consistent with ONR's expectations for the current design reference point
- I am content that sufficient information was provided during Step 2 to meet safeguards' expectations, but further details will be required on the nuclear material accountancy and control systems and safeguards relevant basic technical characteristics as the design matures

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

List of abbreviations

ABWR	Advanced Boiler Water Reactor
ACP	Accountancy and Control Plan
BTC	Basic Technical Characteristics
BWR	Boiling Water Reactor
DAC	Design Acceptance Confirmation
DR	Design Reference
DRR	Design Reference Report
DRP	Design Reference Point
ESBWR	Economic Simplified Boiling Water Reactor
FSE	Fundamental Safeguards Expectations
GB	Great Britain
GDA	Generic Design Assessment
GVHA	GE Vernova Hitachi Nuclear Energy Americas LLC
IAEA	International Atomic Energy Agency
MDSL	Master Document Submission List
NMACS	Nuclear Material Accountancy Control and Safeguards
NPP	Nuclear Power Plant
NRW	Natural Resources Wales
NSR19	Nuclear Safeguards (EU Exit) Regulations 2019
ONMACS	ONR's Nuclear Material Accountancy, Control, and Safeguards Assessment Principles
ONR	Office for Nuclear Regulation
PSAR	Preliminary Safety Analysis Report
PSR	Preliminary Safety Report
PSfR	Preliminary Safeguards Report
QNF `	Qualifying Nuclear Facility
QNM	Qualifying Nuclear Materials
RGP	Relevant Good Practice
RITE	Risk Informed and Targeted Engagements
RP	Requesting Party
SMR	Small Modular Reactor
SRA	State Regulatory Authority
SSAC	UK State System of Accountancy for, and Control of nuclear material
SSC	Structure, System and Component
SSSE	Safety, Security, Safeguards and Environment Cases
TAG	Technical Assessment Guide(s) (ONR)
TIG	Technical Inspection Guide(s) (ONR)
UK	United Kingdom
UKAP	United Kingdom Additional Protocol INFCIRC/951.add 1
UKVOA	UK Voluntary Offer Safeguards Agreement INFCIRC/951
US	United States of America
US NRC	US Nuclear Regulatory Commission

Contents

1. Introduction

1. This report presents the outcome of my safeguards assessment of the BWRX-300 design as part of Step 2 of the Office for Nuclear Regulation (ONR) Generic Design Assessment (GDA). My assessment is based upon the information presented in the Safety, Security, Safeguards and Environment cases (SSSE) head document (ref. [1]), specifically Preliminary Safety Report (PSR) Chapters (refs. [2], [3], [4], [5], [6], [7], and [8]), the associated revision of the Design Reference Report (DRR) (ref. [9]) and supporting documentation.

2. Assessment was undertaken in accordance with the requirements of ONR's Management System and follows ONR's guidance on the mechanics of assessment, NS-TAST-GD-096 (ref. [10]) and ONR's Risk Informed, Targeted Engagements (RITE) guidance (ref. [11]). The ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles (ONMACS) (ref. [12]), together with supporting Technical Assessment Guides (TAGs) (ref. [13]), have been used as the basis for this assessment.

3. This is a Major report as per ONR's guidance (NS-TAST-GD-108) (ref. [14]).

1.1. Background

4. The ONR's GDA process (ref. [15]) calls for an assessment of the Requesting Party's (RP) submissions with the assessments increasing in detail as the project progresses. This GDA will be finishing at Step 2 of the GDA process. For the purposes of the GDA, GE Vernova Hitachi Nuclear Energy International LLC, United Kingdom (UK) Branch, is the RP. GE Vernova Hitachi Nuclear Energy Americas LLC (GVHA) is a provider of advanced reactors and nuclear services and is the designer of the BWRX-300. GVHA is headquartered in Wilmington, North Carolina, United States of America (US).

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

6. In the UK, the RP has been supported by its supply chain partner, Amentum, who has assisted the RP in the development of the UK-specific chapters of the Safety, Security, Safeguards and Environment cases (SSSE) and other technical documents for the GDA.

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

8. Step 1 is the preparatory part of the design assessment process and is mainly associated with initiation of the project and preparation for technical assessment in Step 2. Step 1 completed in December 2024 (ref. [16]). Step 2 is the first substantive technical assessment step and began in December 2024 and will complete in December 2025.

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

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

- the fundamental adequacy of the design and safety, security and safeguards cases; and
- the suitability of the methodologies, approaches, codes, standards and philosophies which form the building blocks for the design and cases

11. The objective is to undertake an assessment of the design against regulatory expectations to identify any fundamental safety, security or safeguards shortfalls that could prevent ONR permissioning the construction of a reactor based on the design.

12. Prior to the start of Step 2 I prepared a detailed assessment plan for safeguards (ref. [17]). This has formed the basis of my assessment and was also shared with the RP to maximise openness and transparency.

13. This report is one of a series of assessments which support ONR's overall judgements at the end of Step 2 which are recorded in the Step 2 Summary Report (ref. [18]) and published on the regulators' website.

1.2. Scope

14. The assessment documented in this report is based upon the SSSE for the BWRX-300 (refs. [2], [3], [4], [5], [6], [7], and [8]).

15. The RP's GDA scope (ref. [19]) has been agreed between the regulators and the RP during Step 1. This is documented in an overall Scope of Generic Design Assessment report. This is further supported by its DRR (ref. [9]) and the Master Document Submission List (MDSL) (ref. [20]). The GDA scope report documents the submissions which were provided in each topic area during Step 2 and provides a brief overview of the physical and functional scope of the Nuclear Power Plant that is proposed for consideration in the GDA. The DRR provides a list of the systems, structures and components (SSCs) which are included in the scope of the GDA, and their relevant GDA reference design documents.

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

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

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

19. As appropriate for Step 2 of the GDA, information has not been submitted for all aspects within the GDA Scope during Step 2. However, all safeguards-relevant aspects of the SSSE were in-scope.

20. My assessment has considered the following aspects:

- the adequacy of the overall safeguards aspects of the SSSE cases, focussing at this stage on the adequacy of the safeguards claims and arguments
- whether the BWRX-300 conceptual design is capable of enabling a future dutyholder to comply with requirements of the Nuclear Safeguards (EU Exit) Regulations 2019 (NSR19), the UK Voluntary Offer Agreement (UKVOA) and the UK Additional Protocol (UKAP)

2. Assessment standards and interfaces

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

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

2.1. Standards

23. The ONR ONMACS (ref. [12]) constitute the regulatory principles against which the RP's case is judged. Consequently, the ONMACs are the basis for ONR's assessment and have therefore been used for the Step 2 assessment of the BWRX-300. The purpose of the ONR ONMACS is to

provide safeguards inspectors with a framework for making consistent and proportionate regulatory judgements on the adequacy of an operator's compliance with NSR19. The ONMACS set out ONRs regulatory expectations for compliance with NSR19.

24. The International Atomic Energy Agency (IAEA) safety standards (ref. [21]) and nuclear security series are a cornerstone of the global nuclear safety and security regime. They provide a framework of fundamental principles, requirements and guidance. They are applicable, as relevant, throughout the entire lifetime of facilities and activities.

25. The relevant ONMACS and IAEA standards are embodied and expanded on in the TAGs (ref. [13]). The TAGs provide the principal means for assessing the safeguards' aspects in practice.

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

2.1.1. ONR's Nuclear Material Accountancy, Control, and Safeguards Assessment Principles (ONMACS) (ref. [12])

27. The key ONMACS Fundamental Safeguards Expectations (FSE) applied within my assessment are:

- FSE 5 Reliability, resilience, and sustainability
- FSE 6 Measurement programme and control
- FSE 7 Nuclear material tracking
- FSE 8 Data processing and control

28. A list of the ONMACS FSEs used in this assessment is recorded in Appendix 1.

2.1.2. Technical Assessment Guides (TAGs)

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

- NS-TAST-GD-096 - Guidance on Mechanics of Assessment (ref. [10])
- NS-TAST-GD-051 – The purpose, scope and content of safety cases (ref. [22])
- SG-TAST-GD-001 Issue 4 ONR Technical Assessment Guide Safeguards, January 2023 (ref. [23]). This TAG contains guidance to advise and inform ONR safeguards inspectors in the exercise of their regulatory judgement during general assessment activities

- SG-TAST-GD-002 Issue 3 ONR Technical Assessment Guide Nuclear Material Accountancy, February 2025 (ref. [24]). This TAG contains guidance to advise and inform the ONR's inspectors in the exercise of their regulatory judgement during assessment activities relating to data contained within operator inventory change reports (ICRs), material balance reports (MBRs), physical inventory listing (PILs) and special reports required by Regulations 14, 15 and 16 of the NSR19

2.1.3. National and international standards and guidance

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

- ONR-SAF-FW-001 ONR Nuclear Material Accountancy, Control and Safeguards Assessment Principles (ONMACS) Issue 6, February 2025 (ref. [12])

- SG-INSP-GD-001 ONR Technical Inspection Guide (TIG) Safeguards Issue 4, January 2023 (ref. [25]). To support inspectors undertaking compliance inspection, ONR produces a suite of guides to assist inspectors to make regulatory judgements and decisions in relation to the adequacy of compliance on the site. This technical inspection guide (TIG) is part of the suite of documents provided by ONR for this purpose

- CNSS-SAF-GD-001 Guidelines for the preparation and submission of declarations pursuant to article 2 of the additional protocol to the UK/IAEA safeguards agreement (INFCIRC/951 Add.1) Issue 2, January 2025 (ref. [26]). The purpose of these guidelines is to assist operators with the provision of information to the ONR as required under the additional protocol, INFCIRC/951 Add.1 to the United Kingdom (UK)/ International Atomic Energy Agency (IAEA) safeguards agreement, INFCIRC/951 (ref. [27])

- IAEA, NP-T-2.9 International Safeguards in the Design of Nuclear Reactors, STI/PUB/1669 (iaea.org) (ref. [28]). This publication is the second in the IAEA Nuclear Energy Series to provide guidance on the inclusion of safeguards in nuclear facility design and construction

- Applicability of IAEA Safety Standards to Non-water cooled Reactors and Small Modular Reactors (ref. [29]). The objective of this publication is to present a high level review of the applicability of IAEA safety standards to evolutionary and innovative designs (including SMRs) - in particular, to consider whether the current requirements and recommendations are applicable to these technologies and to identify any gaps. The publication also identifies specific considerations related to the interfaces between safety, security and safeguards.

- New Nuclear Power Plants: Generic Design Assessment Technical Guidance, ONR-GDA-GD-007 Revision 0, May 2019 (ref. [30])

31. My assessment has considered the following aspects:

- ONR is the state regulatory authority (SRA) and manages the State System of Accountancy for, and Control of, nuclear material (SSAC) in the UK
- The legal requirements for safeguards in the UK are contained within The Nuclear Safeguards (EU Exit) Regulations 2019 (NSR19 (ref. [31]), the UK's Voluntary Offer Safeguards Agreement (UKVOA) with the IAEA (ref. [32]) and the Protocol Additional to the UKVOA (ref. [27]). ONR's regulatory expectations for safeguards are contained within the ONR ONMACS (ref. [12]) and the guidelines for the preparation and submission of declarations pursuant to Article 2 of the additional protocol (ref. [26]) which are defined as Relevant Good Practice (RGP)
- The regulatory requirements in NSR19 (ref. [31]) are for the operator/licensee of the reactor, with information only required to be provided when the decision to construct or authorise construction is made. However, there is an expectation that the RP will be able to provide generic Basic Technical Characteristics (BTC) during GDA for the generic design
- The BTC may be in the format of Questionnaire I-A Reactors as detailed in NSR19 Schedule 1 Part 1 (ref. [31]) The RP has opted to provide design information based on the IAEA's Design Information Questionnaire format, which I judge provides sufficient information to satisfy the requirements of Questionnaire I-A
- As the SRA, ONR is responsible for ensuring the UK complies with its international safeguards obligations. It is expected that GVHA will demonstrate their understanding of the UK's international safeguards requirements (refs. [32] and [27]) and be willing to enter into safeguards engagements with the IAEA to discuss any safeguards measures that are required to be applied if the reactor is selected by the IAEA for the application of safeguards
- The GDA Scope agreed with the RP reflected this approach

2.2. Integration with other assessment topics

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

33. Interactions with other topic areas were:

- Site layout. The RP should consider the effect of multiple units and compact size on safeguardability and possible safeguards equipment installation if designated for IAEA safeguards in the UK. The RP should also consider the implementation of IAEA or Euratom safeguards if being considered for construction in States subject to these safeguards regimes.

- Fuel and nuclear material management. This topic is covered in detail in the BTC and PSR Chapter 28 Safeguards - fuel/nuclear material accountancy and control. The RP should also take in account the relevant safeguards FSE and MACEs

- Design Assurance and Design Parameters. The RP should consider early submission of design information for the Basic Technical Characteristics and take into consideration possible installation of safeguards equipment and supporting infrastructure

2.3. Use of technical support contractors

34. During Step 2 I have not engaged Technical Support Contractors to support my assessment of the safeguards' aspects of the BWRX-300 GDA.

3. Requesting Party's submission

35. The RP submitted the SSSE at the start of Step 2 in four volumes that integrate environmental protection, safety, security, and safeguards. This submission was accompanied by a head document (ref. [1]), which presents the integrated GDA environmental, safety, security, and safeguards case for the BWRX-300 design.

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

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

3.1. Summary of the BWRX-300 Design

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

39. The BWRX-300 is the tenth generation of the boiling water reactor (BWR) designed by GHVA and its predecessor organisations. The BWRX-300 design builds upon technology and methodologies used in its earlier designs, including the Advanced Boiling Water Reactor (ABWR), Simplified Boiling Water Reactor (SBWR) and the Economic Simplified Boiling Water Reactor (ESBWR). The ABWR has been licensed, constructed and is currently in operation in Japan, and a UK version of the design was assessed in a previous GDA with a view to potential deployment at the Wylfa Newydd site. Neither the SBWR or ESBWR have been built or operated.

40. 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. [33]).

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

42. A qualitative measure of safeguards by design (SBD), referred to as safeguardability, is defined as "the degree of ease with which a nuclear energy system can be effectively and efficiently placed under international safeguards." While any nuclear energy system can be safeguarded given sufficient resources, the goal of these assessments is to evaluate the degree of ease with which IAEA technical objectives can be met in a cost effective fashion and to establish facilities whose process, design, and layout support the effective and efficient implementation of IAEA safeguards.

3.2. BWRX-300 Case Approach and Structure

43. The RP has submitted information on its strategy and intentions regarding the development of the SSSE (refs. [34], [35], [36] and [37]). This information was submitted to ONR during Step 1.

44. The RP has submitted an SSSE for the BWRX-300 that claims to demonstrate that the standard BWRX-300 can be constructed, operated, and decommissioned on a generic site in Great Britain 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 its approach to safeguards and security, a security assessment, a Preliminary Environment Report (PER), and their supporting documents.

45. The format and structure of the PSR largely aligns with the IAEA guidance for safety cases, SSG-61 (ref. [38]), 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 safety chapters. The RP has stated that the design and

analysis referenced in the PSR is consistent with the March 2024 Preliminary Safety Analysis Report (PSAR) submitted to the US Nuclear Regulatory Commission (US NRC). The security assessment and PER are for the same March 2024 design but have more limited links to any US or Canadian submissions.

3.3. Summary of the RP's case for Safeguards

46. The aspects covered by the BWRX-300 SSSE case in the area of safeguards can be broadly grouped under two headings which are summarised below.

- Level 1 Safeguards Claim:
  - Appropriate nuclear material accountancy is undertaken to minimise the potential for nuclear materials to be used for non-peaceful purposes
- Level 2 Safeguards Claims:
  - The design process for the BWRX-300 reactor has followed IAEA's guidance on International Safeguards in the Design of Nuclear Reactors. The RP has developed a design process for the BWRX-300 Reactor in support of GDA. This process has in-built hold-points "Gates" at which the documentation is reviewed. These reviews confirm the adequacy of the SBD information
  - The BWRX-300 reactor may be operated according to the guidance in the ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles. The RP is following the requirements of the GDA process in its submissions to Regulators. Adherence to the GDA process ensures that safeguards as set out in the ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles are met
  - The BWRX-300 design considers safeguards' interface with safety, security and waste management issues. The RP's response to the GDA process has been to produce a single report on all the required aspects of the design, allowing the interfaces between related section to be shown clearly

3.3.1. National and International regulatory requirements

47. The RP claims the BWRX-300 reactor may be operated according to the guidance in the ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles and that appropriate nuclear material accountancy is undertaken to minimise the potential for nuclear materials to be used for non-peaceful purposes.

3.3.2. Reducing Risk by using Safeguards By Design

48. The RP claims the design process for the BWRX-300 reactor has followed IAEA's guidance on International Safeguards in the Design of Nuclear Reactors, including early provision of design information in the format of the BTC.

3.3.3. Future Regulatory Requirements of NSR19

49. The RP claims the design process for the BWRX-300 reactor has followed IAEA's guidance on International Safeguards in the Design of Nuclear Reactors.

3.4. Basis of assessment: RP's documentation

50. The principal documents that have formed the basis of my safeguards' assessment of the SSSE are:

- PSR Chapter 28 Safeguards (ref. [7])
- Safeguards By Design Initial Basic Technical Characteristics (ref. [33])
- BWRX-300 UK Generic Design Assessment (GDA) Safety, Security, Safeguards and Environment Summary NEDO-34162 Revision C, 15 July 2025 (ref. [1])
- Volume 4 the Preliminary Safeguards Report (PSfR) (ref. [4])

3.5. Design Maturity

51. My assessment is based on the associated revision of the DRR (ref. [9]). The DRR presents the baseline design for GDA Step 2, outlining the physical system descriptions and requirements that form the design at that point in time.

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

53. The GDA Scope Report (ref. [19]) describes the RP's design process that extends from baseline (BL) 0 (where functional requirements are defined) up to BL3 (where the design is ready for construction).

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

- System interfaces established

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

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

4. ONR assessment

4.1. Assessment strategy

56. The objective of my Step 2 assessment was to reach an independent regulatory judgement on the fundamental aspects of the BWRX-300 design, relevant to safeguards as described in Sections 1 and 3 of this report. My assessment strategy is set out in this section and defines how I have chosen which matters to target for assessment. My assessment is consistent with the delivery strategy for the BWRX-300 GDA (ref. [39]).

57. The intended assessment scope for safeguards is set out in this section. This section defines the matters I have chosen to target for my assessment, the submissions that I will sample, the standards and criteria that I will judge against and how I will interact with the RP and other topics. My assessment takes cognisance of work undertaken by overseas regulators where appropriate.

58. In line with the objectives for a 2 step GDA, I undertook a high level review of the RPs SSSE and DRP to identify any key claims made on safeguards or areas where safeguards considerations may affect the design and is detailed in section 4.3.

4.2. Assessment Scope

59. My assessment scope and the areas I have chosen to target for my assessment are set out in this section. This section also outlines the submissions that I have sampled, the standards and criteria that I will judge against and how I have interacted with the RP and other assessment Topics.

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

61. In line with the objectives for Step 2, I have undertaken a broad review of the highest level, fundamental claims and supporting arguments related to safeguards. To support this, I have sampled a targeted set of the claims or

arguments as set out below. Where applicable, I have also sampled the evidence available to support any claims and arguments.

62. In order to fulfil the aims for the Step 2 assessment of the BWRX-300, I have assessed the following items, which I consider important:

- the regulatory requirements of NSR19 (ref. [31]) are on the operator/licensee of the reactor. GVHA should be able to demonstrate that they have identified the commitments and assumptions on the future operator and how these will be communicated to the future operator
- GVHA's understanding of the safeguards domestic regulatory requirements under NSR19 (ref. [31]) including the demonstration that they have a good understanding of the nuclear material accountancy of Qualifying Nuclear Material (QNM) to be processed and stored in the reactor, the locations where QNM will be held, the key measurement points and how the QNM will be accounted for, controlled and reported
- GVHA's understanding of the UK's international safeguards obligations under the UK/IAEA Voluntary Offer Agreement (UKVOA) (ref. [32]) and the potential safeguards measures which may be applied by the IAEA if the reactor is selected by the IAEA for the application of safeguards
- GVHA's understanding of/approach to safeguards by design (refs. [28] and [29]) and the RP's approach to integrating safeguards into the SSSE case (alongside safety and security)
- GVHA's understanding of the requirements of the UK/IAEA Additional Protocol (UKAP (ref. [27]) including declaring nuclear fuel cycle related research and development and generic plans for the next ten years relevant to the development of the UK civil nuclear fuel cycle

4.3. Assessment

63. Safeguards By Design (SBD) (ref. [28]) is defined as: "the provision of guidance to State authorities, designers, equipment providers and prospective purchasers on the importance of taking international safeguards into account when designing a nuclear facility or process. A voluntary best practice, SBD allows for informed design choices that optimise economic, operational, safety and security factors, in addition to international safeguards. It is applicable to all stages of the nuclear fuel cycle, from initial planning and design through construction, operation, waste management and decommissioning. For new nuclear facilities, especially novel designs or processes, the earlier the discussion of safeguards the better: SBD allows for safeguards to be built 'into' the system, rather than around it afterwards."

64. ONR's guidance: New Nuclear Power Plants: Generic Design Assessment Guidance to Requesting Parties, ONR-GDA-GD-006 (ref. [15]) contains few references to safeguards. More detailed guidance on safeguards'

expectations can be found in New Nuclear Power Plants: Generic Design Assessment Technical Guidance ONR-GDA-GD-007, Revision 0, May 2019 (ref. [30]). The latter requires updating to reflect the UK's role as the SRA responsible for the SSAC since January 2021 following commencement of regulation under NSR19. Chapter 3 of this provides guidance to RPs on ONR's expectations with safeguards expectations set out in Section 3.17. The following assessment is informed by the expectations in GD-007.

4.3.1. National and International regulatory requirements

65. The RP claims that it understands the safeguards requirements for constructing, operating and decommissioning a reactor in the UK. I have reviewed the Preliminary Safety Report Chapter 28 Safeguards (ref. [7]), Initial Basic Technical Characteristics (ref. [33]) and SSSE (ref. [1]) and judge that they demonstrate a clear and accurate understanding of the UK's obligations and how these flow down through NSR19 and regulatory guidance (ONMACS) into requirements for constructing and operating the BWRX-300.

66. I judge that, in the Preliminary Safety Report Chapter 28 Sub-section 28.1, (International Agreements, National Regulations and Standards), the RP demonstrates an understanding of the UK's national and international safeguards legislation and guidance; for example: Chapter 28 Sub-section 28.1 describes in detail the UK's international agreements and obligations: Nuclear Non-Proliferation Treaty (Sub-section 28.1.2); the UK Voluntary Offer Agreement (Sub-section 28.1.3); and the UK Additional Protocol (Sub-section 28.1.4). I judge that the RP also demonstrates in Chapter 28 an understanding that, in the UK, parts of NSR19 are prescriptive and enable the UK to fulfil its international safeguards' obligations. I judge that the RP has identified actions as being for the future licensee/operator/constructor. For example, the operator of the facility will produce an accountancy and control plan (ACP) which sets out the accountancy and control system for the QNM in the facility, and for establishing, implementing and maintaining a system of accountancy and control of QNM in each Qualifying Nuclear Facility (QNF) in Appendix E.

67. In my opinion it is correct that these actions are placed on the future dutyholder/licensee. GVHA should consider the NMACS system they intend the duty holder/licensee to utilise to account for and control QNM and the reporting structure for submitting the required NSR19 safeguards reports. I judge that the RP in Sub-section 28.3 has provided adequate information for NMACS systems as part of Step 2, however further detailed follow up will be required in any future assessment process.

68. I judge that PSR Chapter 28 Sub-section 28.1.4 adequately describes the requirements of the UKAP. I judge that the RP has demonstrated their understanding of the UKAP as they have submitted an Article 2.a.(ix) declaration (Ten Year Plans for development of the UK nuclear fuel cycle) as contribution to the 2024 annual UK calendar year Article 2 update. ONR has

reviewed the submission and judged that it contains the information required to be included in that calendar year's update.

69. I judge that the RP has demonstrated understanding of UK safeguards legislation in PSR Chapter 28 Sub-sections 28.1.6, (United Kingdom Legislation), and 28.1.7, (United Kingdom Regulatory Framework), which cover UK legislation such as The Nuclear Safeguards (Exit) Regulations 2019. This understanding is further demonstrated in that the RP acknowledges that the BWRX-300 would be a QNF using QNM if constructed in the UK. I judge that the RP has also correctly summarised the Energy Act 2013; Nuclear Safeguards Act 2018; and the Nuclear Safeguards (Fissionable Material and Relevant International Agreements) (EU Exit) (Amendment) Regulations 2021.

70. I judge that the information that has been submitted to demonstrate an understanding of domestic and international safeguards requirements is consistent with ONRs expectations for the current status of the design and should enable GVHA to further develop the generic BWRX-300 design and associated safeguards case evidence. I judge that, based on the sampled evidence assessed in this section, I have not identified any fundamental safeguards shortfalls that could prevent ONR permissioning the construction of a reactor based on the generic BWRX-300 design.

4.3.2. Demonstrating risks are reduced by Safeguards By Design

71. The RP claims that the BWRX-300 has been designed with safeguards in mind. The BWRX-300 was predominantly designed against US NRC expectations, however, the RP states it has also considered UK and IAEA guidance in its GDA submissions. I have reviewed PSR Chapter 28 Safeguards, BTC, and SSSE. I judge that these meet IAEA guidance (refs. [28]) and [29]) and UK expectations detailed in the ONMACS and TAGs. I judge that the information in the BTC demonstrates the RP has a clear understanding of safeguards by design and the design information required by NSR19. For example, the RP has provided a range of technical information to supplement the initial information in the various sections of the BTC questionnaire including plant layout, fuel design and QNM flow from receipt into through to shipment out of the MBA.

72. In BTC attachment 33-3 I judge that the RP has demonstrated understanding of material/inventory flows through presenting a potential MBA/KMP structure taking account a possible single unit QNF. I judge that the RP has underpinned this understanding, for example attachments 33-1 and 33-2 provide information on fuel movement routes and irradiated fuel movement and equipment, respectively. I judge the RP has demonstrated an understanding of potential installation of safeguards equipment; for example, BTC Attachment 33-1 states that provisions have been made for monitoring equipment such as video monitors and radiation monitors throughout the refuelling floor, to facilitate monitoring and inspection of new and spent fuel throughout its receipt, loading, unloading, and storage processes.

73. I judge that, in PSR Chapter 28 and the BTC, the RP demonstrates an understanding of the fundamental principles for safeguards by design contained in the IAEA guidance on the fundamental principles for safeguards by design. I judge that the RP has included those principles contained in NP-T-2.9 International Safeguards in the Design of Reactors (ref. [28]), and IAEA Safety Reports Series No. 123 Applicability of IAEA Safety Standards to Non-Water Cooled Reactors and Small Modular Reactors (ref. [29]).

74. I judge that in PSR Chapter 28 sub-section 28.1.3 the RP has demonstrated understanding of the application of IAEA safeguards in the UK; the RP lists examples of the potential safeguards measures that may be applied by the IAEA, such as incorporating into the design locations for surveillance, containment and monitoring equipment and supporting infrastructure in terms of consideration of siting, lighting, protection from interference, maintenance, etc., and other verification measures of nuclear material; and verification of facility design at all stages from construction onward for features relevant to safeguards.

75. I judge that in Chapter 28 sub-section 28.2.1 the RP has demonstrated an understanding of some of the main activities during the future preliminary design phase: (a) interaction with ONR on the safeguards approach at the facility; (b) appropriate information on the design is submitted to ONR as the design develops; and (c) the design incorporates any equipment or instrumentation required for safeguards purposes.

76. In the Basic Technical Characteristics (BTC) document the RP has used the format of the IAEA's Design Information Questionnaire (DIQ) to provide early design information. I judge that this early design information contains adequate safeguards-relevant information for the current design reference point of the BWRX-300 design including details at a high level on:

- Reactor MBA/KMP structure:
- The storage areas for incoming QNM
- Reactor area for details on refuelling
- Storage areas for spent fuel and other non-fuel QNM
- Description of and the flow of QNM, including non-fuel QNM

77. I judge that the RP has recognised the benefit of providing early design information to the IAEA to promote early establishment of a relationship with the IAEA, particularly if they designate the reactor in the UK or the reactor could be constructed in Non-Nuclear Weapon States (NNWS). I judge that the RP has considered the early provision of the BTC to the IAEA under SBD. The RP has confirmed that the IAEA has been provided with early design information for the BWRX-300 project in Canada.

78. I judge that the information that has been submitted to demonstrate an understanding of safeguards by design is consistent with ONRs expectations for the current status of the design and should enable GVHA to further develop the generic BWRX-300 design and associated safeguards case evidence. I judge that, based on the sample evidence assessed in this section, I have not identified any fundamental safeguards shortfalls that could prevent ONR permissioning the construction of a reactor based on the generic BWRX-300 design.

4.3.3. Future regulatory requirements of NSR19

79. The Introduction to PSR Chapter 28 sets out the activities that are within scope during this 2 Step GDA and recognises that many of the activities identified during the design lifecycle will be deferred until a prospective operator has obtained the necessary site license and become the licensee/dutyholder. I judge that the RP has correctly identified that these activities includes formal updates to the BTC information when required by NSR19, for example the submission of the preliminary BTC to ONR Safeguards as soon as the decision to construct or approve construction has been taken.

80. As the regulatory requirements of NSR19 are on the operator/licensee of the reactor, the RP should be able to demonstrate that they have identified the commitments and assumptions on the future operator. The RP has identified these future commitments in a number of submissions particularly in the BTC. The RP has provided the relevant information in the BTC where this is currently available. The RP has also identified where information is currently unavailable (for example facility location, “information not yet known”) and will need to be provided if the UK project moves beyond GDA Step 2. For example, the RP has provided technical information for the current proposed GNF2 fuel. However, the RP has noted that the information provided may be subject to minor changes dependent upon final design of initial core and future reload assemblies. The RP has also noted that non-fuel QNM will be used in any future facility, for example in detectors/monitoring devices and that a list of these will be provided in a future response in a later project phase. The RP has also identified in the BTC that the early provision of design information would permit the identification and scheduling of actions which need to be taken jointly by the Dutyholder/Licensee, the ONR, and IAEA, including (i) installation of safeguards equipment during construction of the facility, and (ii) verification of information on the design of the facility. Chapter 28 sub-section 28.1.3. discusses the potential IAEA safeguards measures that may need to be considered in future construction/commissioning phases, for example: (i) locations for surveillance, containment and monitoring, and other verification measures of nuclear material and (ii) verification of the performance of the operator measurement system (see Appendix 1 FSEs 6, 7 and 8). The RP has a number of Forward Action Plans in Chapter 28 Appendix B. I judge that the RP has identified future commitments particularly in the BTC.

81. The RP has identified the following high level commitments:

- Section 1 of the RP's GDA SSSE states that the Preliminary Safeguards Report (PSfR) will be developed into a site-specific safeguards report at a future licensing stage. An overview of the safeguards case is provided in Section 9 of the PSfR

- Chapter 28 Sub-section 28.4.2 states that the statutory requirements for NMACS arrangements are described in a functional manner in Sub-section 28.3. The RP identified provision of detailed information for their implementation and maintenance as a future activity for a prospective operator on application for a site license to operate a BWRX-300 reactor

- The BTC Introduction Section recognises the requirement for future actions for example, enable the incorporation into the facility design, including the design of the nuclear material accountancy system, features which make it easier to implement safeguards at the facility. BTC Section 32, Other Nuclear Material in the inventory, recognises that non-fuel QNM will be used in the facility, for example in radiation detectors/monitoring devices. A list of such QNM will need to be provided in a future response in any future project phase. BTC Sections 26, Reactor Assemblies, and 27, Description of fresh fuel elements, state that the information provided for fuel in BTC Sections 26 and 27 is subject to minor changes depending on final design of initial core and future reload assemblies

- The RP has also recognised that the IAEA may designate the BWRX-300 for application of safeguards in the UK. Sub-section 28.1.3 describes a number of the safeguards measures that may be implemented, such as on-site inspections and Physical Inventory Verifications. The Chapter 28 Definitions Table includes information on safeguards monitoring measures such as containment/surveillance and seals

- The RP has stated that the BWRX-300 is a tenth generation BWR technology, claiming that safeguards requirements are well established for practices of nuclear material accountancy and prevention of material diversion. In addition, the RP claims that the choice of a well-established fuel design provides confidence that nuclear material safeguards principles can be demonstrated for BWRX-300

82. I judge that the information that has been submitted to demonstrate an understanding of future regulatory requirements of NSR19 is consistent with ONR's expectations for the current status of the design and should enable GVHA to further develop the generic BWRX-300 design and associated safeguards case evidence. I judge that, based on the sample evidence assessed in this section, I have not identified any fundamental safeguards

shortfalls that could prevent ONR permissioning the construction of a reactor based on the generic BWRX-300 design.

5. Conclusions

83. This report presents the Step 2 Safeguards assessment for the GDA of the BWRX-300 design. The focus of my assessment in this step was towards the fundamental adequacy of the design and safeguards case. I have assessed the SSSE chapters and relevant supporting documentation provided by the RP to form my judgements. I targeted my assessment, in accordance with my assessment plan (ref. [17]), at the content of most relevance to safeguards against the expectations of ONR's ONMACS, TAGs and other guidance which ONR regards as relevant good practice, such as IAEA Safeguards By Design guidance (refs. [28] and [29]).

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

- the RP has demonstrated understanding of both domestic and international regulatory requirements and expectations for safeguarding of nuclear material commensurate with the current status of the design, including an Article 2.a.(ix) declaration under the UK additional protocol.
- the information that has been submitted to demonstrate an understanding of safeguards by design is consistent with ONR's expectations for the current design reference point; for example through the information provided in their preliminary Basic Technical Characteristics.
- I am content that sufficient information was provided during Step 2 to meet safeguards' expectations

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

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Appendix 1 – Relevant ONMACS Fundamental Safeguards Expectations (FSE) considered during the assessment.

ONMACS Fundamental Safeguards Expectations (FSE)	**ONMACS FSE** title
FSE 5	Reliability, Resilience and Sustainability The NMACS regime should be designed as such to ensure it is resilient, sustained and remains relevant and proportionate throughout the entire lifecycle of the facility
FSE 6	Measurement Programme and Control Where measurements are designed to be performed, there must be robust systems to ensure the appropriate performance of measurement systems that provide data for the purpose of NMACS
FSE 7	Nuclear Material Tracking The NMACS system should be designed to be able to provide identification, quantity and characteristics to track and QNM in the QNF at any time
FSE 8	Data processing and Control Operators must implement and maintain data processing systems that can produce the NMACS reports, and records required under NSR19 that incorporate technical and procedural controls to protect the confidentiality, integrity, and availability of sensitive nuclear information.