ONR Assessment Report

Generic Design Assessment of the BWRX-300 – Step 2 Assessment of Sabotage, Target Analysis and Review

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Executive summary

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

This report presents the outcomes of my Sabotage, Target Analysis and Review (STAR) assessment of the BWRX-300 design as part of Step 2 of the ONR GDA. This assessment is based upon the information presented in the RP's safety, security, safeguards and environment cases (SSSE), the associated Revision 3 of the Design Reference Report and supporting documentation.

ONR's GDA process calls for an assessment of the RP's submissions, which increases in detail as the project progresses. The focus of my assessment in this step was to support ONR's decision on the fundamental adequacy of the BWRX-300 design and security 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 fundamental to the acceptability of the design and methods for deployment in Great Britain (GB). I benchmarked my regulatory judgements against the expectations of ONR's Security Assessment Principles (SyAPs), Technical Assessment Guides (TAGs) and other guidance which ONR regards as relevant good practice, such as International Atomic Energy Agency (IAEA) safety, security and safeguards standards. Where appropriate, I have also considered how I could use relevant learning and regulatory conclusions from the UK ABWR GDA to inform my assessment of the BWRX-300.

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

- The RP's methodology for the categorisation for sabotage and Vital Area Identification (VAI);
- The RP's threat application approach;
- The RP's application of its proxy Design Basis Threat (DBT) to VAI;
- The gap between the proxy DBT used within the SSSE against the UK DBT; and
- Application of the other methodologies against the expected nuclear inventory and aspects of the plant design to evidence its efficacy against SyAPs expectations.

Based upon my assessment, I have concluded the following:

- The proposed methodology for the categorisation for sabotage appears appropriate for the current GDA Step 2 and should remain applicable for the future;

- The Vital Area assessment and methodology are sufficient for the Step 2 GDA although gaps have been identified which the RP has committed to address in its forward action plan. Its outputs are sufficient to inform both the Step 2 security plan and Secure by Design (SbD);

- The RP has developed its own DBT for the generic design. Taking into account the RP's VAI philosophy, my opinion is that the outcomes of the high level Step 2 VAI analysis would not have been significantly different if the UK DBT had been applied. Because of that, I am satisfied that the use of a proxy DBT was sufficient for Step 2;

- The RP has committed to a number of future actions (in the forward action plan) during subsequent iterations of its VAI analysis. This includes the application of the UK DBT together with the UK applicable Unacceptable Radiological Consequence (URC) thresholds and categorisation of vital areas. A future BWRX-300 SSSE supporting deployment of the BWRX-300 in GB would need to demonstrate that these have been appropriately applied; and

- I have identified no other significant departure from relevant good practice applicable to the topic for Step 2 of GDA.

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

List of abbreviations

ALARP	As Low As Reasonably Practicable
ABWR	Advanced Boiler Water Reactor
BL	BaseLine
BWR	Boiling Water Reactor
C&I	Control and Instrumentation
CNS	Civil Nuclear Security
CNSC	Canadian Nuclear Safety Commission
CS&IA	Cyber Security & Information Assurance
DAC	Design Acceptance Confirmation
DBT	Design Basis Threat
DR	Design Reference
DRP	Design Reference Point
DRR	Design Reference Report
EA	Environment Agency
ESBWR	Economic Simplified Boiling Water Reactor
FAP	Forward Action Plan
FSyP	Fundamental Security Principal
GB	Great Britain
GDA	Generic Design Assessment
GE	General Electric
GEH	General Electric-Hitachi
GVHA	GE-Hitachi Nuclear Energy Americas LLC
HCVA	High Consequence Vital Area
HMG	Her Majesty's Government
IAEA	International Atomic Energy Agency
ICS	Isolation Condenser System
KSyPP	Key Security Plan Principle
MDSL	Master Document Submission List
MSQA	Management for Safety and Quality Assurance
NM	Nuclear Material
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission
NRW	Natural Resources Wales
ONR	Office for Nuclear Regulation
ORM	Other Radioactive Material
PA	Protected Area
PAAB	Protected Area Access Building
PER	Preliminary Environment Report
PSA	Probabilistic Safety Assessment
PSAR	Preliminary Safety Analysis Report
PSR	Preliminary Safety Report
RGP	Relevant Good Practice
(RE)	Responsible Engineer
RITE	Risk Informed Targeted Engagement
RP	Requesting Party

RQ	Regulatory Query
SbD	Secure by Design
SBWR	Simplified Boiling Water Reactor
SGI	(US) Safeguarded Information
SSA	Security Sensitive Areas
SSCs	Structures, Systems and Components
SSSE	Safety, Security, Safeguards and Environment Cases
STAR	Sabotage, Target Analysis and Review
SyAPs	Security Assessment Principle(s)
SyDPs	Security Delivery Principle(s)
SySSC	Security Structure, System and Component
TAG	Technical Assessment Guide(s) (ONR)
TSC	Technical Support Contractor
UK	United Kingdom
URC	Unacceptable Radiological Consequence
US	United States of America
VA	Vital Area
VAI	Vital Area Identification
WENRA	Western European Nuclear Regulators' Association

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1. Introduction

1. This report presents the outcome of my Sabotage, Target Analysis and Review (STAR) 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 [1], specifically chapters 2 (ref. [2]), 3 (ref. [3]) and 25 (ref. [4]), the associated revision of the Design Reference Report (DRR) (ref. [5]) 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. [6]) and ONR's risk informed, targeted engagements (RITE) guidance (ref. [7]). The ONR Security Assessment Principles (SyAPs) (ref. [8]), together with supporting Technical Assessment Guides (TAGs) (ref. [9]), have been used as the basis for this assessment.

3. This is a Major report as per ONR's guidance on production of reports (NS-TAST-GD-108) (ref. [10]).

1.1. Background

4. The ONR's GDA process (ref. [11]) calls for an assessment of the Requesting Party's (RP) submissions with the assessments increasing in detail as the project progresses. 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 is supported by its supply chain partner, Amentum, who 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 (EA) 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. Step 2 is the first substantive technical assessment step, and began in December 2024 and will complete in December 2025.

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

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

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

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

12. Prior to the start of Step 2, I have contributed to a detailed Assessment Plan which included Sabotage, Target Analysis and Review (ref. [12]). This has formed the basis of my assessment, together with that of the Protective Security and Cyber Security assessments. This Assessment Plan was 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. [13]) 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. [1], [2], [3], [4], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28] [29], [30], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48]).

15. The RP's GDA scope has been agreed between the regulators and the RP during Step 1. This is documented in an overall Scope of Generic Design Assessment report (ref. [49]). This is further supported by its DRR (ref. [5]) and the Master Document Submission List (MDSL) (ref. [50]). The GDA scope report documents the submissions which were provided in each topic area during Step 2 and provides a brief overview of the physical and functional scope of the Nuclear Power Plant (NPP) that is proposed for consideration in the GDA. The DRR 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), 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 [6] and ONR's guidance on Risk Informed, Targeted Engagements [7].

19. As appropriate for Step 2 of the GDA, information has not been submitted for all aspects within the GDA Scope during Step 2. The following aspects of the SSSE are therefore out of scope of this assessment:

- Consideration of the UK DBT to the outline design, on the basis that the surrogate threat is sufficient for the Step 2 and to demonstrate the adequacy of the methodology;
- Categorisation of the VAs, as the design does not have all the inputs needed (i.e. completed radiological consequences analysis, completed severe accident analysis, completed probabilistic safety assessment – Level 2 / Level 3 and some parts of the fault analysis), for more detail see section 4.1;
- The RP's gap analysis between the proxy DBT vs. UK DBT due to unavailability of the UK DBT to the RP (ref. [51]); and
- Consideration of the output (process is considered in section 4.3.3) from the Secure by Design (SbD) process, as this will be undertaken during subsequent stages of the design development.

20. My assessment considers the following aspects:

- The RP's methodology for the categorisation for sabotage and VAI (ref. [52]);
- The RP's threat application approach (ref. [52]) and (ref. [4]);
- The RP's application of its proxy DBT to VAI and SSCs (ref. [52]);

- The gap between the GVHA proxy DBT, Rev. 1 (ref. [53]) against the UK DBT (ref. [54]); and
- Application of the methodology against the expected nuclear inventory and aspects of the plant design to evidence its efficacy against SyAPs expectations.

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 Security Assessment Principles (SyAPs) (ref. [8]) constitute the regulatory principles against which the RP's case is judged. Consequently, the SyAPs are the basis for ONR's assessment and have therefore been used for the Step 2 assessment of the BWRX-300.

24. The International Atomic Energy Agency (IAEA) safety standards (ref. [55]) and nuclear security series (ref. [56]) 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. Furthermore, ONR is a member of the Western European Nuclear Regulators Association (WENRA). WENRA has developed Reference Levels (ref. [57]), which represent good practices for existing nuclear power plants, and Safety Objectives for new reactors (ref. [58]).

26. The relevant SyAPs, IAEA standards and WENRA reference levels are embodied and expanded on in the TAGs (ref. [9]). The TAGs provide the principal means for assessing the Vital Area Identification (VAI) aspects in practice.

27. 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. Security Assessment Principles (SyAPs)

28. To provide a judgement on fundamental adequacy of the RP's assessment regarding sabotage and vital area identification, I have drawn upon the following supporting Security Delivery Principles (SyDPs) and Key Security Plan Principles (KSyPPs) from SyAPs (ref. [8]):

- SyDP 6.2 – Categorisation for Sabotage. The RP should categorise their site and facilities for sabotage by undertaking a process of vital area identification.

- KSyPP 1 – Secure by Design. The RP should apply security controls to reduce vulnerabilities during the design stage.
- KSyPP 2 – The Threat. The PPS should be designed and evaluated using a DBT which is likely reduce the need for design changes when the UK DBT is applied in future stages.
- KSyPP 3 – The Graded Approach. The RP should design security systems using a graded approach where the most robust systems are designed to protect those areas that could give rise to the highest consequence in terms of theft of NM or ORM or the sabotage of NM or ORM and the systems protecting them.

29. A list of the SyAPs used in this assessment is recorded in Appendix 1.

2.1.2. Technical Assessment Guides (TAGs)

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

- NS-TAST-GD-096 – Guidance on Mechanics of Assessment (ref. [6]),
- CNSS-TAST-GD-11.1 – Guidance on the Security Assessment of Generic New Nuclear Reactor Designs (ref. [59]),
- CNS-TAST-GD-6.2 – Categorisation for Sabotage (ref. [60]) and
- CNS-TAST-GD-11.4.1 – Secure by Design (ref. [61]).

2.1.3. National and international standards and guidance

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

- The UK Design Basis Threat (ref. [54])
- IAEA, Identification and Categorisation of Sabotage Targets, and Identification of Vital Areas at Nuclear Facilities, Nuclear Security Series No. 48-T (ref. [62])
- IAEA, Insider Threats, Nuclear Security Series No. 8-G (ref. [63])

2.2. Integration with other assessment topics

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

33. The key interactions with other topic areas were:

- I have worked closely with the Protective Security assessor (ref. [64]) to ensure appropriate SSCs have been identified in VAI and also to support his review of the RP's Secure by Design (SbD) approach adequacy;

- Concerning blended attack, I have worked with the Cyber Security & Information Assurance (CS&IA) (ref. [65]) assessor to ensure that those areas containing critical C&I systems are identified and included in the blended attack vectors (ref. [52]);

- I have interacted with the Fault Studies and Severe Accident Analysis assessor (ref. [66]) seeking advice on the maturity of the safety analysis and its deficiencies (as presented in RP's Forward Action Plan (FAP) (ref. [67])) used to inform VAI and claims made against passive safety systems; and

- I had interactions with the Civil Engineering assessor (ref. [68]) regarding claims made against passive barriers resisting attack and/or containing radiological releases, the RP's current shortfalls are presented in the RP's FAP (ref. [67]).

2.3. Use of technical support contractors

34. During Step 2 I have not engaged Technical Support Contractors (TSCs) to support my assessment of the STAR 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 was accompanied by a header 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. The overarching security document is Chapter 25 (ref. [4]) of the SSSE. Detailed security evaluation is presented in the RP's Security Assessment Document and associated Annexes (ref. [52]).

38. This section presents a summary of the RP's security case and methodology for the vital area identification and sabotage. 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

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

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

41. 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. [15]).

42. 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.

43. Of particular relevance to security, is the RP’s claim that all critical safety SSCs are located within the Reactor Building. The reactor is located within the Power Block, which itself is located within a protected area, which the RP have included in their security case argument.

3.2. BWRX-300 Case Approach and Structure

44. The RP has submitted information on its strategy and intentions regarding the development of the SSSE (refs [69], [70], [71], [72]). This was submitted to ONR during Step 1.

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

46. The format and structure of the PSR largely aligns with the IAEA guidance for safety cases, SSG-61 (ref. [73]), 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 (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 the STAR assessment

47. The aspects covered by the BWRX-300 security case provide a holistic approach to security, which includes vital area identification, physical and cyber security measures. These measures are designed to protect identified safety SSCs against malevolent acts through the application of robust physical and cyber security measures ensuring:

- The ability to shut down the reactor and maintain sub-criticality;
- The ability to cool irradiated fuel, both in the core and in the spent fuel pool; and

- The ability to limit releases of radioactivity affecting public health and safety.

48. These aspects can broadly be grouped under the following headings:

3.3.1. Design Basis Threat (DBT)

49. The RP has developed a proxy DBT that establishes a set of characteristics, capabilities and techniques for the theft and/or sabotage of nuclear material (NM) or other radioactive material (ORM) with the aim of providing assurance that a country specific DBT is capable of being applied to the standard design without significant changes to that design. The intention of the RP is that through exposure to the country specific DBT(s), its proxy DBT and design can be continuously and iteratively matured to create a more bounding case, reducing sequential work for different country deployment.

3.3.2. Vital areas identification and categorisation for sabotage

50. The identification and categorisation of the Vital Areas (VA) is the first stage of the process that is needed to understand the vulnerability of the RP's design to acts of sabotage. These acts have the potential to result in the release of radioactive material, possibly reaching thresholds for the Unacceptable Radiological Consequence (URC).

51. Areas containing NM or ORM inventory and/or SSCs that are determined to be especially important to plant nuclear safety or in preventing radiological release, which would be capable of causing an URC if sabotaged are designated as VAs. In addition, locations whose loss through sabotage would significantly affect the protective security or cyber security response to a threat are also included as VAs.

52. The RP's approach is that identification and categorisation of VAs, as well as identification of target set components and target sets, is conducted independently of both the RP's proxy DBT and any credited operator actions. Therefore, no VAs, target set components, or target sets are, or have been, discounted as part of the development of the standard design (ref. [4]) and (ref. [52]). The RP also states that several smaller VAs in a general vicinity may be grouped together into a larger VA to simplify access control.

53. In Chapter 25 – Security (ref. [4]), the RP states that other areas and SSCs critical to security and operations of the plant that do not meet the regulatory definitions of a VA, are also identified, classified as, and protected as VA and/or Security Sensitive Areas (SSA).

3.3.3. Radiological doses determining Vital Area

54. GVHA recognises that countries of future deployments may utilise different determining radiological dose values at the boundary to categorise baseline, vital, and high-consequence vital areas in regard to URC. As such, the RP has recognised that country specific detailed design beyond the standard

design will be required to update the values utilised to meet country specific regulatory expectations (ref. [4]) and FAP PSR25-341 (ref. [67]).

55. If necessary, GVHA will conduct a retrospective analysis on all existing candidate VAs (if a value delta is recognised), as well as redoing a VAI process with UK specific radiological dose values to ensure no additional candidate VAs are omitted by this change (ref. [4]).

3.3.4. Secure by Design

56. The RP has adopted a secure by design approach through the identification of those safety SSCs requiring protection, identifying SSCs that provide inherent security and mitigation against threats and designing a Physical Protection System (PPS) that mitigates additional vulnerabilities identified through adversarial pathway analysis (ref. [52]).

3.4. Basis of assessment: RP's documentation

57. The principal documents that have formed the basis of my STAR assessment of the SSSE are:

- Chapter 25 (ref. [4]) – Security Annex of the PSR which outlines the overarching security case and is not protectively marked;
- The RP's Security Assessment document and associated Annexes (ref. [52]) consisting of an overarching narrative which includes an executive summary, scope, applicable standards and guidance, site characteristics, key plant systems, RP's assessment methodology, defensive strategy, and human factors engineering for security and software tools. It defines a proxy DBT encompassing threats that need to be mitigated, the identification of SSCs and areas requiring protection (Vital Areas), the physical and cyber protection systems in place to mitigate threats and the evaluation of the effectiveness of these measures; and
- Forward Action Plan (FAP) (ref. [67]), captures the commitments required for the program to progress to GDA Step 3 or to a site specific phase.

58. The Security Assessment (ref. [52]) contains Annexes which provide more detailed information to support the RP's security case:

- Appendix A – BWRX-300 Security Design Basis Threat
- Appendix B – Tables and Figures
- Appendix C – Vulnerability Analysis
- Appendix D – Vital Equipment and Vital Areas

- Appendix E – Target Set Analysis
- Appendix F – Blast and Breaching Analysis
- Appendix G – Security Computer System Cybersecurity Plan
- Appendix H – Defensive Strategies
- Appendix I – Preliminary Staffing Analysis
- Appendix J – Preliminary Engagement Analysis
- Appendix K – Scenarios
- Appendix L – Aircraft Impact Structural Response Analysis
- Appendix M – Physical Protection System Design Requirements
- Appendix N – Cross-reference to Requirements

3.5. Design Maturity

59. My assessment is based on revision 3 of the Design Reference Report (DRR) (ref. [5]). The design reference report presents the baseline design for GDA Step 2, outlining the physical system descriptions and requirements that form the design at that point in time.

60. 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. For security, this also includes the PA boundary and PA access building.

61. The GDA Scope Report (ref. [49]) describes the RP's design process that extends from baseline (BL) 0 (where functional requirements are defined) up to BL 3 (where the design is ready for construction).

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

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

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

64. The physical protection system (PPS) design is relatively mature and has been developed to provide defence in depth to those significant safety SSCs that have been identified as part of the VAI process and require protection. However, it is important to note that the PPS has been developed to mitigate threats documented within the RP’s own proxy DBT. The UK DBT will need to be applied to any VA identification and vulnerability analysis processes to ensure that the appropriate security outcome can be identified and met.

4. ONR assessment

4.1. Assessment strategy

65. The objective of my GDA Step 2 assessment was to reach an independent regulatory judgement on the fundamental aspects of the BWRX-300 design, relevant to STAR (vital area identification) 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 [74].

66. GVHA is currently engaging with regulators internationally, including the Nuclear Regulatory Commission in the US (US NRC) and the Canadian Nuclear Safety Commission in Canada (CNSC). It is proposing a standard BWRX-300 design for global deployment with minimal design variations from country to country.

67. The UK's regulatory framework is outcome focused with security outcomes based on the categorisation for the theft and sabotage. Two of the key factors in determining the categorisation for sabotage and hence the potential Vital Area (VA) status of the design is the use of the UK DBT (ref. [54]) and the UK's definition of a URC.

68. My principal scope was established within the security assessment plan (ref. [12]). This was further elaborated in the Scope (section 1.2) of this assessment together with out-of-scope items.

69. The objective of this Vital Area Identification assessment is to gain confidence that:

- The RP has an appropriate methodology that can be applied to the design at each stage to identify and categorise vital areas;
- The methodology considers a sufficiently onerous threat such that the Step 2 provides valid output when considering the maturity of the analysis and design;
- The RP's GDA Step 2 identification of VAs are sufficient to identify security risks to the reactor design such that a meaningful security case (including blended attack and cyber security aspects) can be developed; and
- The RP has an appropriate process for identifying improvements to the design to underpin the claims made in their Secure by Design approach.

70. The UK DBT was not available to the RP during Step 2 (ref. [51]) and URC calculations are based on the RP's public access exclusion zone perimeter

and in line with NUREG-0800, 15.0.3 (ref. [75]). This is defined in the Security Assessment Document (ref. [53]) submitted by the RP and these details underpin the categorisation for sabotage methodology as presented in (ref. [52]).

71. My assessment involved engagement with the RP’s security team to understand its underpinning security strategy and the methodologies it has adopted to develop VAs. Where necessary, I have sought clarification through the issue of regulatory queries (RQs).

72. I did not assess, as I initially planned in (ref. [12]), the Categorisation of the VAs, as this was not produced by the RP within Step 2 and is a future RP commitment captured in FAP PSR25-341 (ref. [67]). The RP’s analysis and design were not mature enough to provide all the inputs needed to produce this assessment. Deficiencies (vs. (ref. [8] and (ref. [9])) included lack of: some parts of the fault analysis, completed severe accident analysis, completed probabilistic safety assessment – Level 2 / Level 3 and consequentially completed radiological consequences analysis. All of these deficiencies have been captured in the RP’s Forward Action Plan (FAP) (ref. [67]), the STAR related FAP items are recalled in the section 4.3.4 for completness. These deficiencies did not prevent me reaching a fundamental conclusion on the design for the RP’s Step 2 GDA.

73. Also, I did not assess, as I initially planned in (ref. [12]), the RP’s gap analysis between GEH proxy DBT and UK DBT. The RP was unable to produce this assessment due to unavailability of UK DBT (ref. [51]). The RP has committed to provide this analysis in FAP PSR25-339 (ref. [67]).

74. My assessment concentrated upon any aspects which are novel or where there appears to be a potential departure from relevant good practice.

4.2. Assessment Scope

75. 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.

76. 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.

77. 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 vital area identification. 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.

78. 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:

- I have assessed whether the RP has adequate methodologies in place for the categorisation of sabotage and VAI (ref. [52]). This feeds into the Protective Security assessment report (ref. [64]) as a basis for that assessment;
- Concerning the RP's proxy DBT and DBT's application (ref. [52]) and (ref. [4]), I have assessed it with regards to the UK expectation laid out in UK DBT (ref. [54]) and Categorisation for Sabotage, CNS-TAST-GD-6.2 (ref. [60]). I have assessed how the RP used a proxy DBT to identify, evaluate and possibly design out VAs. This also feeds into the Protective Security assessment report (ref. [64]) and Cyber Security & Information Assurance assessment report (ref. [65]); and
- I have evaluated the RP's application of its proxy DBT to VAI and associated SSCs (ref. [52]). This feeds into the Protective Security assessment report (ref. [64]) as the basis for that assessment and to determine the adequacy of the RP's SbD approach, physical protection system design and vulnerability assessment which are assessed separately in the Protective Security assessment report (ref. [64]).

4.3. Assessment

4.3.1. Design Basis Threat (DBT)

79. ONR guidance (ref. [59]) states that VAI within the UK should be undertaken using the UK DBT (ref. [54]) in accordance with KSyPP 2. This is to ensure the full range of current threat vectors are considered such that the potential consequences can be derived and appropriate defences provided. This expectation was highlighted in correspondence to the RP in RQ-01929 which the RP have accepted and responded accordingly (ref. [76]).

80. The RP's ability to utilise the UK DBT (ref. [54]) has been problematic due to access and handling challenges of this sensitive document (ref. [51]). The RP's supply chain partner had also not given access to the UK DBT in Step 2. Due to this, the RP could not produce the DBT gap analysis as it intended to during GDA Step 1 discussions (ref. [12]).

81. The RP used a proxy DBT to set out the capabilities of hostile actors and threats which it has used to aid identification and confirmation of the VAs. The RP's intent is to use a proxy DBT in its standard design prior to using the UK specific DBT, which it has committed to do later in the design stage beyond GDA Step 2 in FAP PSR25-339 (ref. [67]).

82. The unique characteristics of the UK DBT are used to identify the areas of the plant which if sabotaged could lead to an URC and therefore require security protection. The most important aspect of this is to determine the

specific UK DBT threat which could bring about an URC so that the features of that security protection are designed such that they successfully mitigate the specific threat. This forms the basis for the physical protection system design. Therefore, by not using the UK DBT the RP could be designating/protecting areas that it does not need to protect, or, designing protection that will not mitigate the threat.

83. I have also raised RQ-1929 and RQ-1930 to clarify the use and assumptions of the RP's proxy DBT. The RP's responses (ref. [76]) and (ref. [77]) clarified the aims and use of the proxy DBT to create 'risk reduced and robustness assurances'. I am satisfied that some of the RP's high-level assumptions, generally meet expectations – e.g. (ref. [60], [62] and [63]), such as the recognition of the insider threat, some external threats and cyber threats or blended attack (see also CS&IA assessment (ref. [65])). The RP has updated PSR Chapter 25 (ref. [4]) and the Security Assessment Document (ref. [52]) to reflect discussions in use and application of a proxy DBT.

84. In the RP's VAI methodology the candidate VAs are identified (see also section 3.3.2) in a way that "… identification and categorization of VAs … is conducted independently of both RP's DBT and any credited operator actions.". Thus, "…no VAs, target set components, or target sets are, or have been, discounted as part of the development of standard design.", (ref. [4]) and (ref. [52]).

85. Whilst using a dissimilar DBT risks vital areas being missed or identifies vital areas which may not be vital if the UK specific DBT were applied, I consider the RP's DBT to be satisfactory for Step 2 of GDA which is intended to demonstrate the effectiveness of the RP's VAI methodology only. I am therefore satisfied that the sample list of adversarial sabotage scenarios at Appendix K of the RP's Security Assessment document (ref. [52]) is sufficient to demonstrate that the RP's VAI methodology is appropriate, and, if reapplied in the future using the UK DBT would produce adequate results.

86. However, due to the nature of the RP's proxy DBT application with identification and categorisation of VAs being conducted independently of the DBT, I judge that (ref. [52]) sufficiently satisfies my expectations for GDA Step 2. A future SSSE will need to demonstrate use of the UK DBT, together with the application of UK unacceptable radiological consequence (URC) thresholds to undertake its Vital Area identification The RP has committed to use the UK DBT beyond Step 2 of the GDA and to replace Appendix A of its Security Assessment Document (ref. [52]) with the UK DBT (ref. [54]) in PSR Chapter 25 (ref. [4]) and in FAP PSR25-339 (ref. [67]),

87. **<u>Section Conclusion.</u>** A future BWRX-300 security case will need to demonstrate suitable re-evaluation of the VAI analysis. The RP recognises this and has committed to using the UK DBT in any future analysis in FAP PSR25-339 (ref. [67]). The intent at Step 2 of this GDA was for the RP to develop a VAI methodology and demonstrate the adequacy of that

methodology when applied. I am satisfied that the methodology is fit for purpose, and when reapplied using the UK DBT will produce adequate results.

4.3.2. VAI methodology & application

88. Vital Area Identification and Categorisation is the process (ref. [60]) 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 PPS and protective security arrangements will be implemented to mitigate public risk. Therefore, it is critical that suitably qualified and experienced persons develop and apply the Vital Area Identification methodology, supported by the designers and safety case authors who are developing the design of the reactor. It is anticipated that VAI is an iterative process, which needs to be reevaluated as the design evolves and as relevant criteria change.

89. A brief overview of the RP's submission is given in section 3.2, and for the VAI, additional details are presented in section 3.3.2. The RP did not produce separate documents for its VAI methodology, proxy DBT, VAI and categorisation, or other security specific submissions. Rather it has submitted an overarching security document, Chapter 25 (ref. [4]), and a detailed security evaluation in the Security Assessment Document and its associated Annexes (ref. [52]).

90. The RP's approach is that identification and categorisation of VAs, as well as identification of target set components and target sets, is conducted independently of both proxy DBT and any credited operator actions. Therefore, no VAs, target set components, or target sets are, or have been, discounted as part of the development of standard design (ref. [4]) and (ref. [52]). The VAI methodology flowchart is presented in RQ-1930 response (ref. [77]) and in both updated security documents (ref. [4]) and (ref. [52]). The RP's methodology aims to identify VAs under all operating states, as clarified in RQ-01930 response (ref. [77]).

91. As all of the necessary inputs to the categorisation for sabotage from the safety case were not mature enough (see section 4.1 and 1.2 for the brief discussion), the RP did not categorise its vital areas in accordance with SyDP 6.2 and KSyPP3. Instead, it undertook as much of the preliminary work as possible providing vital area locations, location, identity and reasoning (ref. [51]). This is a deviation from VAI relevant good practice expressed in both UK (ref. [60]) and (ref. [8]) and international IAEA guidance (ref. [62]). However, the RP's VAI methodology itself does describe the process for sabotage categorisation according to SyDP 6.2 and KSyPP 3. Therefore, the categorisation analysis will need to be conducted in a future BWRX-300 SSSE using UK URC thresholds, which the RP has committed to undertake under FAP PSR25-341 (ref. [67]). I find this satisfactory and sufficient for Step 2.

92. The RP has based its initial URC calculations on its public access exclusion zone perimeter and in line with NUREG-0800, 15.0.3 (ref. [75]), instead of the UK specific thresholds (ref. [8]) and (ref. [60]), which is not in line with expectations as set out in (ref. [59]). The RP's initial URC calculations supports the VAI analysis contained in (ref. [52]), demonstrating that RP's approach will be feasible, in future, once the UK specific thresholds are used. This has been added as a commitment in FAP, PSR25-341 (ref. [67]). I have queried specific thresholds for URC in RQ-1930, and RP have asserted (ref. [77]) that due to its VAI process (identification and categorisation of VAs conducted independently of the proxy DBT) no additional VA would be identified in design using the UK specific URC thresholds. Furthermore, as a consequence of my discussions with the RP and RQ-1930 (ref. [77]), the RP has updated the VAI output to include a table to support Vital Area and Target set development in Appendix D of its Security Assessment Document (ref. [52]). This Table (once populated) will contain all candidate VAs, and their categorisation. It will be a summary of Appendix D with all the candidate VAs, reasoning for their inclusion to VAs or exclusion. I am satisfied with this.

93. Due to lack of details needed for the final VA categorisation, until demonstrated otherwise I have conservatively judgged that all the areas identified as vital are High Consequence Vital Area (HCVA). This is required in order to inform the physical protection system design assessment in the accordance with SyDP 6.3. A future BWRX-300 SSSE supporting deployment of the BWRX-300 in GB will need to demonstrate that re-evaluated VAs and their completed categorisation have been done appropriately. This is recognised by the RP and captured in its FAP PSR25-339 (ref. [67]) and I find it appropriate.

94. In the RP's VAI methodology the candidate VAs are identified (see also section 3.3.2) in a way that "… identification and categorization of VAs … is conducted independently of both RP's DBT and any credited operator actions.". Thus, "…no VAs, target set components, or target sets are, or have been, discounted as part of the development of standard design.", (ref. [4]) and (ref. [52]).

95. Based on the RP's philosophy for the VAI development, use of proxy DBT vs. UK specific DBT in VAI is of lower importance, as it would not change the identified candidate VAs. The RP have confirmed this in responses to RQs (RQ-1929 (ref. [76]), RQ-1930 (ref. [77]) and RQ-1931 (ref. [78])). Not using the UK DBT is still a significant deviation from VAI relevant good practice for a GDA (see also DBT section 4.3.1), as one of the goals of the VAI and classification is to identify the specific threat vectors that could lead to an URC. This cannot be done without UK DBT usage. A future BWRX-300 security case will need to reassess the candidate VAs and their classification. I am satisfied that the RP acknowledges this and has captured it in FAP PSR25-339 and PSR25-341 (ref. [67]).

96. **<u>Section Conclusion.</u>** Whilst the RP's submission does not fully meet the expectations as set out in (ref. [8]), (ref. [59]) and (ref. [60]) due to lack of VA categorisation and use of non UK DBT, the commitments in FAP PSR25-339 and PSR25-341 (ref. [67]) have been made which will close those gaps in the future. I have not identified gaps that would render the RP's submission invalid. The presented methodologies for VAI and classification should also remain fit for purpose for future, post Step 2 GDA use. I judge that RP's presented case is sufficiently adequate for the Step 2 GDA.

4.3.3. Secure by Design

97. Secure by Design (SbD) is a Key Security Plan Principle. While not a core element of my assessment, I sampled this aspect of the SbD to support Protective Security assessment (ref. [64]) of the RP's approach adequacy and to gain confidence in the completeness of the VAI process for the current GDA step.

98. Through discussions with the RP, I was able to understand how the Responsible Engineer (RE) for security interacted with RE's from other disciplines to develop the design and deconflict where necessary. The RP describes how the Chief Engineer's Office conducts and documents formal design reviews periodically and at the end of each stage of the design process (Conceptual Design, Preliminary Design and Detailed Design) and how security is integral to this process. This discussion has led to an update in the security Chapter 25 (ref. [4]) to include these clarifications, and I am satisfied with it.

99. The Protective Security assessor gained more detail about SbD in RQ-1916 response (ref. [79]).

100. I am highlighting the following example for which I believe is good application of SbD. The GVHA has moved critical systems, Isolation Condenser System (ICS) pools and the Spent Fuel Pool away from the external wall due to security considerations (ref. [4]). In the Protective Security assessment (ref. [64]) there are more examples and details.

101. It was evident, to me, that the inherent value and benefits of these design changes due to security considerations had been recognised and factored into the security design and vulnerability assessment. The examples provided, together with supporting analysis demonstrate how the security hierarchy of controls has been considered by the RP. This demonstrates an understanding that proposed changes need to be considered holistically and proportionately. In my opinion this satisfies Secure by Design KSyPP 1.

102. I consider it important that the RP can adequately demonstrate effective integration of security in the design process to provide confidence that the development of the design will capture GB specific requirements, such as the application of UK DBT and that the RP can demonstrate an integrated security design.

103. **Section Conclusion.** I am of the opinion, that the RP has adequately demonstrated that it adopts an effective SbD approach to developing its security arrangements.

4.3.4. Key Commitments for Further Development

104. During GDA Step 2, the RP made the following key commitments, which are captured fully in PSR Chapter 25 (ref. [4]) and in FAP (ref. [67]), regarding the VAI. These are:

- PSR25-339 – Concerning use of UK DBT and VA re-evaluation:
  - Licensee / DevCo leading UK specific detailed design must use the UK-DBT beyond Step 2 of GDA. This includes any UK specific requirements to move into more detailed design or assessment for either further GDA steps or site-specific design.
  - Appendix A of the Security Assessment will be replaced at this point by UK-DBT and a vulnerability gap analysis of standard design utilising the UK threat interpretation must be completed.
  - All further future security work for UK specific detailed design requiring use of a threat interpretation will used this updated Appendix.
- PSR25-341 – Concerning the UK URC thresholds and VAs categorisation:
  - Licensee / DevCo leading UK specific detailed design beyond standard design will be required to update the determining radiological dose values at the boundary to categorise baseline, vital, and high-consequence vital areas in regard to URC meet the UK regulator expectations (SyAPs OS-SNI Annex B, table 1) and conduct a retrospective analysis on all existing candidate VAs; as well as conducting a VAI process with these figures to ensure no additional candidate areas are created by the change.
  - In addition, other areas critical to, and sensitive to, security and operations of the plant that do not meet the regulatory definitions of a Vital Area, are also identified, classified as, and protected as Vital Areas and/or Security Sensitive Areas (SSA).
- PSR25-342 – Concerning the Categorisation and Classification of Security SSCs:
  - Commitment upon Licensee / DevCo to iteratively complete categorization of security functions and classification of SSCs important to security alongside development of detailed design for UK specific deployment.

105. In my opinion, the RP has identified appropriate forward actions and has adequately captured these. The robustness of the RP's forward action plan process has been assessed within the ONR Management for Safety and Quality Assurance (MSQA) assessment report (ref. [80]). A future security case will need to demonstrate that these FAP items have been delivered to ensure the VAI analysis is of an adequate standard.

5. Conclusions

106. This report presents the Step 2 Sabotage, Target Analysis and Review 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 security 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. [12]), at the content of most relevance to STAR assessment against the expectations of ONR's SyAPs, TAGs and other guidance which ONR regards as relevant good practice.

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

- The proposed methodology for the categorisation for sabotage appears appropriate for the current GDA Step 2 and should remain applicable for the future;
- The Vital Area assessment and methodology are sufficient for the Step 2 GDA although gaps have been identified which the RP has committed to address in its forward action plan. Its outputs are sufficient to inform both the Step 2 security plan and Secure by Design (SbD);
- The RP has developed its own DBT for the generic design. Taking into account the RP's VAI philosophy, my opinion is that the outcomes of the high level Step 2 VAI analysis would not have been significantly different if the UK DBT had been applied. Because of that, I am satisfied that the use of a proxy DBT was sufficient for Step 2;
- The RP has committed to a number of future actions (in the forward action plan) during subsequent iterations for the VAI analysis. This includes the application of the UK DBT together with the UK applicable Unacceptable Radiological Consequence (URC) thresholds and categorisation of vital areas. A future BWRX-300 SSSE supporting deployment of the BWRX-300 in GB would need to demonstrate that these have been appropriately applied; and
- I have identified no other departure from relevant good practice applicable to the topic for Step 2 of GDA.

108. 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 security shortfalls that could prevent ONR permissioning the construction of a power station based on the generic BWRX-300 design.

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Appendix 1 – Relevant SyAPs considered during the assessment

SyAP reference	SyAP title
SyDP 6.2	Categorisation for Sabotage
KSyPP 1	Secure by Design
KSyPP 2	The Threat
KSyPP 3	The Graded Approach