GE Hitachi Nuclear Energy

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BWRX-300 UK Generic Design Assessment (GDA) Chapter 28 – Safeguards

US Protective Marking: Non-Proprietary Information
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NEDO-34200 Revision B

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EXECUTIVE SUMMARY

The BWRX-300 UK Generic Design Assessment (GDA) Preliminary Safety Report Chapter 28 presents the nuclear safeguards arrangements. It sets out the arrangements that comply with the UK's international treaty obligations, relevant domestic policy, legislation, regulations, and regulatory guidance.

Nuclear safeguards are measures to prevent the proliferation of nuclear weapons by ensuring that states do not divert nuclear materials or technologies from peaceful uses to a clandestine nuclear weapons program. Safeguards are verified by the International Atomic Energy Agency (IAEA).

This GDA covers the entire BWRX-300 design lifecycle. Many of the activities identified are deferred until a prospective operator has obtained the necessary site license and become the licensee/Dutyholder.

Claims and arguments relevant to GDA Step 2 objectives and scope are summarized in Appendix A. Appendix B provides a Forward Action Plan.

ACRONYMS AND ABBREVIATIONS

Acronym	Explanation
ACP	Accountancy and Control Plan
AP	Additional Protocol
Brexit	UK withdrawal from the European Union and Euratom
BTC	Basic Technical Characteristics
CET	Central European Time
FA	Facility Attachment
FAP	Forward Action Plan
FSE	Fundamental Safeguards Expectation
GDA	Generic Design Assessment
GEH	GE Hitachi Nuclear Energy
HCU	Hydraulic Control Unit
IAEA	International Atomic Energy Agency
ISO	International Standards Organisation
MACE	Nuclear Material Accountancy and Control Expectations
MBA	Material Balance Area
NCA	Nuclear Co-operation Agreement
NMACS	Nuclear Material Accountancy, Control, and Safeguards
NNWS	Non-nuclear-Weapon State
NOS	National Occupational Standards
NPT	Treaty on the non-proliferation of Nuclear Weapons
NSR19	The Nuclear Safeguards Regulations 2019
NWS	Nuclear Weapon State
ONMACS	The ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles
ONR	Office of Nuclear Regulation (UK)
PER	Preliminary Environmental Report
PIV	Physical Inventory Verification
PSP	Particular Safeguard Provision
PSR	Preliminary Safety Report
QNF	Qualifying Nuclear Facility
QNM	Qualifying Nuclear Material
RB	Reactor Building
RGP	Relevant Good Practice
RPV	Reactor Pressure Vessel
SAP	Safety Assessment Principle

Acronym	Explanation
SBD	Safeguards by Design
SSCs	Structures, Systems, and Components
SyAP	Security Assessment Principles
TAG	Technical Assessment Guide
TEA 2013	The Energy Act 2013
TIG	Technical Inspection Guide
UK	United Kingdom
U.S.	United States
UTC	Coordinated Universal Time
VOA	Voluntary offer Safeguards Agreements

SYMBOLS AND DEFINITIONS

Term	Definition
Containment	Structural features of a facility, containers or equipment which are used to establish the physical integrity of an area or items (including safeguards equipment or data) and to maintain the continuity of knowledge of the area or items by preventing undetected access to, or movement of, nuclear or other material, or interference with the items. Examples are the walls of a storage room or of a storage pool, transport flasks and storage containers. The continuing integrity of the containment itself is usually assured by seals or surveillance measures (especially for containment penetrations such as doors, vessel lids and water surfaces) and by periodic examination of the containment during inspection, “IAEA Safeguards Glossary,” (Reference 28-1).
Surveillance	The collection of information through inspector and/or instrumental observation aimed at detecting movements of nuclear material or other items, and any interference with containment or tampering with IAEA equipment, samples, and data. Surveillance may also be used for observing various operations or obtaining relevant operational data. IAEA inspectors may carry out surveillance assignments continuously or periodically at strategic points (Reference 28-1).
Containment/surveillance device. (C/S device)	An item of equipment used to perform a C/S function and capable of providing its own C/S results (Reference 28-1).
Containment/surveillance measures. (C/S measures)	The application of containment and/or surveillance to complement nuclear material accountancy. The use of C/S measures is aimed at verifying information on movement of nuclear or other material, equipment and samples, or preservation of the integrity of safeguards relevant data. In many instances C/S measures cover the periods when the inspector is absent, thus ensuring the continuity of knowledge for the IAEA and contributing to cost effectiveness. Containment/surveillance measures are applied, for example: During flow and inventory verification, to ensure that each item is verified without duplication and that the integrity of samples is preserved. To confirm that there has been no change to the inventory previously verified and thus reduce the need for remeasurement. To ensure that IAEA equipment, working papers and supplies have not been tampered with. If necessary, to isolate (‘freeze’) nuclear material that has not been verified until it can be measured (Reference 28-1).
Qualifying Nuclear Facility (QNF)	“The Energy Act (TEA) 2013,” (Reference 28-2), and “Nuclear Safeguards Act 2018" (Reference 28-21) defines a QNF as: “A facility (including associated buildings) in which Qualifying Nuclear Material (QNM) is produced, processed, used, handled, stored or disposed of.”

Term	Definition
Qualifying Nuclear Material (QNM)	The Energy Act (TEA) 2013 (Reference 28-2) defines "Qualifying Nuclear Material" as: 1. fissionable material specified in regulations under subsection, A. i.e., fissionable material specified by the Secretary of State for the purposes of the definition of "QNM." 2. source material in the form of: A. uranium metal, alloy, or compound, or B. thorium metal, alloy, or compound, or 3. ore containing a substance from which a source material falling within paragraph 2 is capable of being derived.
System of containment/ surveillance Measures (C/S system)	A combination of containment and/or surveillance measures (see No. 8.6 of Reference 28-1). Each C/S system is designed to meet a purpose specified in the IAEA's safeguards approach. To increase reliability, a C/S system can include one or several C/S devices (see No. 8.3 of Reference 28-1). Containment/surveillance devices and containment may be used in such a way that each plausible diversion path (see No. 3.7 of Reference 28-1) is covered by at least one device (single C/S). For redundancy purposes, C/S devices may be backed up (duplicated) by a similar device. In a dual C/S system, each plausible diversion path is covered by two C/S devices that are functionally independent and are not subject to a common tampering or failure mode (dual C/S), e.g., two different types of seal, or seals plus surveillance. Dual C/S is normally applied where the verification of nuclear material is difficult to perform, in order to increase confidence in the C/S results and reduce the requirements for periodic reverification (Reference 28-1).
Seal	A tamper indicating device used to join movable segments of a containment in a manner such that access to its contents without opening the seal or breaking of the containment is difficult. A sealing system comprises the containment enclosing the material to be safeguarded, the means of applying the seal (e.g., a metal wire) and the seal itself. All three components must be examined in order to verify that the sealing system has fulfilled its function of ensuring continuity of knowledge of the identity and integrity of the material concerned. Seals in use by the IAEA include metal cap seals with tamper indicating features, as well as ultrasonic and electronic seals with fibre optic loops, and, for short term applications, tamper indicating paper tape seals. Sealing systems may be applied: 1. On safeguarded material or equipment to maintain the continuity of knowledge of the sealed contents between inventory verifications, and during shipment from one facility to another. 2. On the operator's equipment (e.g., a crane) to monitor any use that would make possible the undeclared removal of nuclear material. 3. On IAEA property (e.g., equipment, samples, standards, data) to prevent undetected tampering with it (Reference 28-1).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

REVISION SUMMARY

Revision #	Section Modified	Revision Summary
A	All	Initial Issuance
B	All	Update for end of GDA Step 2 consolidation

28 SAFEGUARDS

Introduction

The BWRX-300 UK Generic Design Assessment (GDA) Preliminary Safety Report (PSR) Chapter 28 presents the nuclear safeguards arrangements. It sets out the arrangements that comply with the UK's international treaty obligations, relevant domestic policy, legislation, regulations, and regulatory guidance.

Nuclear safeguards are measures to prevent the proliferation of nuclear weapons by ensuring that states do not divert nuclear materials or technologies from peaceful uses to a clandestine nuclear weapons program. Safeguards are verified by the International Atomic Energy Agency (IAEA).

This GDA covers the entire BWRX-300 design lifecycle. Many of the activities identified are deferred until a prospective operator has obtained the necessary site license and become the licensee/Dutyholder.

Activities within the scope of this chapter:

- Receipt of fresh fuel and other Qualifying Nuclear Material (QNM)
- Transfer of fresh fuel to the storage pool
- Transfer of fresh fuel from the storage pool to the reactor core
- Transfer of irradiated fuel from the reactor core to the storage pool and vice-versa
- Export of spent fuel from the storage pool for dry storage
- Dry storage of spent fuel on-site:
  - Additional information may be found in PSR NEDO-34198, "BWRX-300 UK GDA Chapter 26: Interim Storage of Spent Fuel," (Reference 28-3).
- Management of QNM waste and waste (potentially) bearing fissile material:
  - Additional information may be found in PSR NEDO-34174, "BWRX-300 UK GDA Chapter 11: Management of Radioactive Waste," (Reference 28-4).

The security aspects are considered within PSR NEDO-34197, BWRX-300 UK GDA Chapter 25: Security Annex," (Reference 28-5). The following activities are beyond the scope of this GDA:

- Manufacture of fuel
- Transport of fuel to/from the facility
- Final disposition of spent fuel beyond dry storage on-site

Interfaces with other chapters

To ensure a common approach for issues which have safety implications (e.g., nuclear material accountancy which is also important for criticality control) this document interfaces with other chapters relating to safety:

- PSR Chapter 13: NEDO-34176, "BWRX-300 UK GDA Chapter 13: Conduct of Operations," (Reference 28-6)
- PSR Chapter 15: NEDO-34178, "BWRX-300 UK GDA Chapter 15: Safety Analysis," (Reference 28-7)
- PSR Chapter 17: NEDO-34189, BWRX-300 UK GDA Chapter 17: Management for Safety and Quality Assurance," (Reference 28-8)

- PSR Chapter 18: NEDO-34190, “BWRX-300 UK GDA Chapter 18: Human Factors Engineering,” (Reference 28-9)

Security of the BWRX-300 reactor is considered exclusively in a separate chapter:

- PSR Chapter 25: NEDO-34197, “Security Annex,” (Reference 28-5)

It is recognized that operation of the BWRX-300 reactor may generate wastes containing quantities of QNM which will require accountancy and control as described in Section 28.3.4. This is discussed in a separate chapter:

- PSR Chapter 11: NEDO-34174, “Management of Radioactive Waste,” (Reference 28-4)

This document also interfaces with the Preliminary Environmental Report (PER), in particular the following chapters:

- PER Chapter 3: NEDO-34220, “BWRX-300 UK GDA Chapter 3: Management Arrangements and Responsibilities,” (Reference 28-10)
- PER Chapter 5: NEDO-34222, “BWRX-300 UK GDA Chapter 5: Radioactive Waste Management Arrangements,” (Reference 28-11)
- PER Chapter 7: NEDO-34224, “BWRX-300 UK GDA Chapter 7: Quantification of Radioactive Waste Disposals,” (Reference 28-12)
- PER Chapter 8: NEDO-34225, BWRX-300 UK GDA Chapter 8: Approach to Sampling and Monitoring,” (Reference 28-13)

This document also interfaces with NEDO-34162, “BWRX-300 UK GDA Safety, Security, Safeguards and Environment Summary,” (Reference 28-45), and provides further detail on how safeguards is being addressed in the design, commissioning, construction, and decommissioning of the BWRX-300.

Claims and arguments relevant to GDA step 2 objectives and scope are summarized in Appendix A. Appendix B provides a Forward Action Plan (FAP).

28.1 International Agreements, National Regulations and Standards

28.1.1 International Agreements

The relationship between the various treaties and agreements concluded by the UK Government which form the legal basis for IAEA Safeguards in the UK is illustrated in Figure 28-1.

28.1.2 Non-Proliferation Treaty

The UK is one of the original signatories to the “Treaty on the Non-proliferation of Nuclear Weapons (NPT),” (Reference 28-14). The NPT is a landmark international treaty whose objective is to prevent the spread of nuclear weapons and weapons technology, to promote cooperation in the peaceful uses of nuclear energy and to further the goal of achieving nuclear disarmament and general and complete disarmament. The NPT represents the only binding commitment in a multilateral treaty to the goal of disarmament by the nuclear-weapon States. Opened for signature in 1968, the NPT entered into force in 1970 for an initial period of twenty-five years. On 11 May 1995, the NPT was extended indefinitely.

To further the goal of non-proliferation, and as a confidence-building measure between State parties, the NPT established a safeguards system under the oversight of the International Atomic Energy Agency (IAEA). Safeguards are used to verify compliance with the NPT through inspections conducted by the IAEA. The NPT promotes cooperation in the field of peaceful nuclear technology and equal access to this technology for all States parties, through a set of technical measures, or Safeguards, the IAEA verifies that States are honouring their international legal obligations to use nuclear material and technology only for peaceful purposes. IAEA mission covers both nuclear materials and technology (for example the Additional Protocol).

28.1.3 United Kingdom/International Atomic Energy Agency Voluntary Offer Agreement

The UK is one of the five nuclear-weapon states as defined by the NPT (the other four being the United States (U.S.) of America, China, France, and Russia (successor state to the Soviet Union)). These five states built and tested a nuclear explosive device before 1 January 1967 and are permitted to retain nuclear weapons under the terms of the Treaty.

The NPT does not require nuclear-weapon states to accept safeguards. Nevertheless, all five have Voluntary Offer Safeguards Agreements (VOA) in force placing some (or all) of their peaceful nuclear activities under safeguards.

A VOA is an agreement concluded between the IAEA and a nuclear weapon State to allay concerns of non-nuclear weapon States that the absence of safeguards from nuclear-weapon states’ civil nuclear industry would place non-nuclear weapon States’ nuclear industries at a commercial disadvantage.

The Office of Nuclear Regulation (ONR) submits nuclear material accounting reports and basic design information for those facilities offered to the IAEA for the application of safeguards.

The VOA also allows the UK to remove facilities or withdraw material from the scope of the agreement for reasons of national security.

Application of IAEA Safeguards to UK Facilities

Unlike Non-nuclear Weapons States (NNWS) who conclude comprehensive safeguards agreements with the IAEA which place all qualifying nuclear facilities under safeguards, NSR19 (Reference 28-15) requires the UK to offer all nuclear material and facilities in its civil nuclear fuel cycle for selection by the IAEA for the application of safeguards. Thus, the IAEA may (or may not) choose to apply safeguards to UK-built/operated BWRX-300.

Safeguards measures that may be required by the IAEA include:

- On-site inspections by IAEA inspectors
- Definition of Material Balance Areas (MBAs) and Key Measurement Points for nuclear material accounting and reporting
- Definition of Key Measurement Points for measuring flow and inventories of nuclear material
- Unique identifiers for nuclear material items
- Locations for surveillance, containment and monitoring, and other verification measures of nuclear material
- Review of operating records and State reports
- Annual Physical Inventory Verification (PIV), which will generally be performed during facility shutdown
- Routine interim inventory verifications (monthly, quarterly, annual, or random)
- Verification of transfers of nuclear material to and from the site
- Statistical assessment of the nuclear material balance to evaluate material unaccounted for (also known as inventory difference)
- Reactor power monitoring
- Verification of facility design at all stages from construction onward for features relevant to safeguards
- Verification of the performance of the Dutyholder/Licensee measurement system

28.1.4 United Kingdom/International Atomic Energy Agency Additional Protocol

The UK has also agreed an Additional Protocol (AP) with the IAEA, “Protocol Additional to Agreement for Application of Safeguards in Connection Treaty on Non-Proliferation of Nuclear Weapons,” (Reference 28-16) supplementing the VOA. These extend the reporting required beyond nuclear material accountancy to areas such as research and development, specified imports, and exports, and provides access to the IAEA to verify this reporting.

There are two declarations required by the AP (if the criteria in the Article apply) relevant to the BWRX-300 project:

Article 2 a. (i)

“A general description of and information specifying the location of those nuclear fuel cycle-related research and development activities carried out anywhere that are funded, specifically authorized, or controlled by, or carried out on behalf of, the United Kingdom, for or in co-operation with, or otherwise relevant to, a non-nuclear-weapon State (hereinafter referred to as “a NNWS”).”

Article 2 a. (ix)

“General plans for the succeeding ten-year period relevant to the development of the civil nuclear fuel cycle (including planned nuclear fuel cycle-related research and development activities) when approved by the appropriate authorities in the United Kingdom.”

28.1.5 United Kingdom/European Union Withdrawal Agreement

The withdrawal of the United Kingdom (UK) from the European Union at 23:00 Coordinated Universal Time (UTC) on 31 January 2020 (00:00 1 February 2020 Central European Time(CET)) (Brexit) had a significant effect on the VOA, “Agreement Between the United

Kingdom of Great Britain and Northern Ireland, the European Atomic Energy Community and the International Atomic Energy Agency for the Application of Safeguards in the United Kingdom of Great Britain and Northern Ireland in Co," (Reference 28-17) and AP, "Protocol Additional to the Agreement between the United Kingdom of Great Britain and Northern Ireland, the European Atomic Energy Community and the International Atomic Energy Agency for the Application of Safeguards in the United Kingdom of Great Britain," (Reference 28-18) in force at that time. Both were trilateral agreements between the IAEA, UK and Euratom. Fulfilment of the UK's obligations under these agreements relied on membership of Euratom which was terminated by Brexit (Reference 28-19).

Prior to Brexit, the UK Government re-negotiated the VOA (Reference 28-20) and AP (Reference 28-16) as bipartite agreements between the UK and IAEA which came into force upon Brexit.

Changes to UK domestic legislation and regulatory framework, which resulted in the ONR Safeguards Division taking over safeguards functions formerly undertaken by Euratom Safeguards, are discussed in Section 28.1.6 below.

28.1.6 United Kingdom Legislation

The legal basis for safeguards in the UK is illustrated in Figure 28-2.

The UK's withdrawal from Euratom because of Brexit led to both the renegotiation of the VOA and AP with IAEA (discussed in Section 28.1.5) and a requirement for new domestic Safeguards Regulations.

The "Nuclear Safeguards Act 2018," (Reference 28-21) granted the Secretary of State (i.e., the responsible Government Minister) power to enact "nuclear safeguards regulations." These are:

1. The "Nuclear Safeguards (EU Exit) Regulations 2019," (NSR19) (Reference 28-22) which ensures that QNM, facilities, or equipment are only available for use for civil activities (whether in the United Kingdom or elsewhere).
2. The "Nuclear Safeguards (Fissionable Material and Relevant International Agreements) (EU Exit) Regulations 2019," (Reference 28-23) and as amended 2021 (Reference 28-24) which give effect to provisions of various international agreements.
    - A QNF is defined as: "A facility (including associated buildings) in which QNM is produced, processed, used, handled, stored or disposed of" (Reference 28-21).

The BWRX-300 reactor falls within this definition.

- QNM is defined as:
    - Fissionable material specified by the Secretary of State for the purposes of the definition of "QNM"
    - Source material in the form of:
        - Uranium metal, alloy, or compound
        - Thorium metal, alloy, or compound
    - Ore containing a substance from which a source material (above) is capable of being derived (Reference 28-21)

The definition of QNM includes both fuel and other nuclear materials (where present), e.g., depleted uranium shielding material and in-core instrumentation containing quantities of uranium.

Parts of NSR19 are prescriptive and often related to enabling the UK to fulfil its international nuclear Safeguards obligations, and parts are outcome focused, in line with the extant regulatory approach applied within the UK across most industries, including nuclear.

28.1.7 United Kingdom Regulatory Framework

The legal basis for regulation of the UK nuclear industry is illustrated in Figure 28-3. The overriding legislation is The Energy Act (TEA) 2013 (Reference 28-2). TEA created the ONR as the independent regulator of nuclear safety and conventional health and safety on and around nuclear sites, civil nuclear security, safe transport of civil radioactive material and nuclear safeguards across the United Kingdom.

The “ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles (ONMACS),” (Reference 28-25) together with supporting Technical Assessment Guides (TAGs) (References 28-26 and 28-27) and Technical Inspection Guide (TIG) (Reference 28-28) are used by inspectors to assist in making regulatory judgements and decisions. The guidance covers both assessment of the operators Nuclear Material Accountancy, Control, and Safeguards (NMACS) arrangements and inspection of the implementation of these arrangements.

These arrangements are made to comply with both the UK’s national and international obligations under NSR19 and the VOA/AP.

28.1.8 Other Relevant Good Practice

The publications in the IAEA “Nuclear Energy Series,” (Reference 28-29) present good practices and advances in technology together with practical examples and experience in the areas of nuclear reactors, the nuclear fuel cycle, radioactive waste management and decommissioning, and on general issues relevant to nuclear energy.

Relevant Good Practice (RGP) can be found in the National Occupational Standards (NOS) for “Nuclear Material Accountancy and Safeguards,” (Reference 28-30). This suite of standards (Table 28-1) covers activities performed by individuals working on behalf of Dutyholders/Licensees in NMACS functions.

The measurement and accountancy systems of QNFs should comply with relevant good practice such as those set out in International Standards Organisation (ISO) standards, e.g., ISO/IEC 17025:2017, “General Requirements for Competence of Testing and Calibration Laboratories,” (Reference 28-31) and ISO 10012:2003, “Measurement Management Systems – Requirements for Measurement Processes and Measuring Equipment,” (Reference 28-32). This criterion also applies where accounting reports are based on calculations (burn-up declarations and nuclear production and loss occurring in power reactors).

28.2 Safeguards by Design

Safeguards by Design (SBD) is the process of including the consideration of international Safeguards throughout all phases of a nuclear facility project, from the initial conceptual design to facility construction and into operations, including design modifications and decommissioning. This process is described in “International Safeguards in Nuclear Facility Design and Construction,” (Reference 28-33) and “International Safeguards in the Design of Nuclear Reactors,” (Reference 28-34). The ‘by design’ concept encompasses the idea of preparing for the implementation of Safeguards in the management of the project during all these stages. SBD does not introduce new requirements but rather presents an opportunity to facilitate the cost-effective implementation of existing requirements.

SBD provides guidance to State authorities, designers, equipment providers and prospective Dutyholders/Licensees, 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 optimize economic, operational, safety and security factors, in addition to international Safeguards. It is applicable to all aspects of the nuclear fuel cycle. 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.

28.2.1 Provision of Design Information

To enable ONR to plan its safeguards approach for a new reactor facility such as the BWRX-300 facility, NSR19 requires a rolling program for the provision of design information. This information creates confidence in the peaceful purpose of the facility, and is intended to provide an adequate lead time to:

1. Ease the incorporation into the facility design, including the design of the nuclear material accountancy system and features which make it easier to implement safeguards at the facility
2. Allow time for safeguards research and development work that may be necessary
3. Enable budgetary planning necessary for effective and efficient implementation of safeguards
4. Permit the identification and scheduling of actions which need to be taken jointly by the Dutyholder/Licensee and the ONR including:
    A. Installation of safeguards equipment during construction of the facility
    B. Verification of information on the design of the facility

The ONR advises, on an iterative basis, information regarding safeguards relevant features of the facility design is made available early in the project definition, preliminary design, construction, and commissioning phases of BWRX-300.

During the project definition phase, the ONR will be provided with an initial Basic Technical Characteristics (BTC), consisting of:

1. The identification of the facility and a short description of its general character, purpose, and nominal capacity
2. The form, location, and movement of nuclear material
3. The general layout of important items of equipment which use, produce, or process nuclear material

During the subsequent preliminary design phase:

1. Discussion occurs with the ONR on the safeguards approach to be used at the facility

2. Appropriate information on the design is provided to the ONR as the design develops
3. The design incorporates any ONR equipment or instrumentation required for safeguards purposes

28.2.2 Initial Basic Technical Characteristics

The Initial BTC is based on preliminary design information of the BWRX-300 facility, as described in:

- PSR Chapter 1, NEDO-34163, “BWRX-300 UK GDA Chapter 1: Introduction and Overview,” (Reference 28-35) for general BWRX-300 Power Block Description
- PSR Chapter 2, NEDO-34164, “BWRX-300 UK GDA Chapter 2: Site Characteristics,” (Reference 28-36) for site and facility layouts
- PSR Chapter 3, NEDO-34165, “BWRX-300 UK GDA Chapter 3: Safety Objectives and Design Rules for SSCs,” (Reference 28-37) for the Reactor Building (RB)
- PSR Chapter 4, NEDO-34166, “BWRX-300 UK GDA Chapter 4: Reactor,” (Reference 28-38) for fuel system and nuclear design
- PSR Chapter 5, NEDO-34167, “BWRX-300 UK GDA Chapter 5: Reactor Coolant System and Associated Systems,” (Reference 28-39) for the Reactor Pressure Vessel (RPV) and internal components
- PSR Chapter 9A, NEDO-34171, “BWRX-300 UK GDA Chapter 9A: Auxiliary Systems,” (Reference 28-40) for fuel storage and handling systems
- PSR Chapter 9B, NEDO-34172, “BWRX-300 UK GDA Chapter 9B: Civil Structures,” (Reference 28-41) for integrated RB design
- PSR Chapter 15, NEDO-34178, “BWRX-300 UK GDA Chapter 15: Safety Analysis (Including Fault Studies, PSA and Hazard Assessment),” for fuel pool deterministic safety analysis and the results thereof (Reference 28-7)

Design information requested by the ONR (reported on the form found in Part 1-A of Schedule 1 of NSR19) includes (see Appendix C for further details):

1. General information about the facility, such as location, owner, operator, purpose, main features, schedules for construction/commissioning/operation, operating modes, site layout, and reactor facility layout.
2. Reactor data, such as general flow diagrams, thermal and electricity outputs, number of reactor units, type of reactor and of fuelling, core enrichment, reactor coolant and moderator.
3. Description of the nuclear material, such as the fresh fuel and its enrichment, nominal weight of fuel in element/assemblies, physical and chemical form of the fresh fuel.
4. With relevant drawings attached under reference numbers, description of reactor assemblies, and fresh fuel elements.
5. Description of elements exchange in assemblies, basic accounting unit, and means of nuclear material identification, as well as other nuclear material in the facility.
6. Information on nuclear material flow, such as:
    A. Diagrams attached under reference numbers identifying, for example, Material Balance Areas, Key Measurement Points.
    B. Inventory and locations of fresh fuel, in-core fuel, irradiated fuel, refuelling, burnup, storage of irradiated fuel.

C. Reactor load factor, core loading, refuelling, and burnup.

D. Whether the irradiated fuel is processed or stored.

7. Handling of fresh and irradiated fuel information, including, fresh fuel transport and storage, locations in reactor vessel, transfer to fuel pool, nuclear material testing areas, relevant instrumentation to measure safeguards key parameters.
8. Reactor and fuel pool coolant data, such as mass flow, temperature, and pressure at major or key locations.
9. Information on nuclear material accountancy and control.
10. Measures to protect and secure nuclear material, confine, and contain safeguards equipment, and protect health and safety of inspectors during compliance.
11. Other measures that are deemed necessary or specific for the BWRX-300 facility.

This information is used by the ONR to prepare the safeguards approach and to serve as the basis for preparing a draft for inspection goals and procedures, including planning for site visits, inspections, and audits.

The BTC can be passed at the request of the RP (by the ONR) to the IAEA to consider its decision as to whether/not to implement IAEA safeguards.

28.2.3 Design Information Examination and Verification

28.2.4 Assessment of Basic Technical Characteristics

“ONR Technical Assessment Guide Safeguards,” (Reference 28-26) provides a framework for ONR to assess NMACS activities at operators’ sites. Specifically, Appendix 1 provides guidance for safeguards inspectors in the assessment of an operator’s declared BTC submission. Regulatory expectations for both the prescriptive requirements and non-prescriptive / free text elements of the BTC are listed below:

28.2.5 Regulatory Expectations - Prescriptive Requirements

1. The correct questionnaire from Schedule 1 of NSR19 has been utilized, as described in Regulation 3(1) (i.e., Part 1-A of Schedule 1).
2. The information is complete with regards to the questionnaire in Schedule 1 of NSR19.
3. All specific legal information has been correctly and adequately provided e.g., owner, operator, location.
4. Any BTC submissions or changes to BTC that have been made are in line with the timeliness requirements of Regulation 3 of NSR19, as well as those included in any other relevant domestic or international agreement e.g.:

   A. Facility Attachments (FA) should the facility be selected by the IAEA for implementation of safeguards

   B. Particular Safeguard Provisions (PSPs) made under Regulation 5 of NSR19

   C. Nuclear Co-operation Agreements (NCA)
5. That, in compliance with Regulation 8 of NSR19, amendments of a BTC that relate to the Accountancy and Control Plan (ACP) are captured in an associated amendment of the ACP and vice-versa.
6. Whether any further details, explanations, amplifications, or clarifications of any information are required based on what is declared in the Schedule 1 questionnaire.
7. Whether all the requirements within a PSP and/or FA have been complied with.

8. Is in line with the expectations outlined in any relevant site license conditions.

28.2.6 Regulatory Expectations - Non-Prescriptive/Free text

The BTC should:

1. Be structured logically using the relevant questionnaire in Schedule 1 of NSR19
2. Meet the needs of those who will use it (e.g., operators, maintenance staff, technical staff, managers accountable for safeguards, ONR and IAEA)
3. Use terms and descriptions that are understandable to the key users, where possible utilizing standard safeguards terminology and otherwise clarify/explain novel terminology
4. Be clearly owned by both those who are accountable for compliance with NSR19 and those who rely on the BTC for accurate and objective information on accountancy and control measures to make informed decisions
5. Define the envelope of the QNF BTC including, where reasonable and necessary:
    A. The expected QNM flow routes and their locations within the QNF including where QNM can be held and declared
    B. The accountancy points at which transfer of QNM custody occurs including those that will be the basis for recording the location and transfers of QNM
    C. Methods for determining the quantity of QNM transferred including where possible relevant evidence for the definition of these methods
6. Provide sufficient proportionate information on the QNF to demonstrate that the operator understands and manages the NMACS challenge and enable the ONR to determine its approach to regulating compliance with NSR19 including planning for inspections. This includes:
    A. Geographical location
    B. Numbers of buildings
    C. Design intent and current purpose or use
    D. Current lifecycle stage and status of operation
    E. Managerial structure including responsibilities:
        a. Quantities and state of QNM, i.e., amounts, physical state, container types and numbers
        b. Inventory locations
        c. Other containment requirements
        d. Reference to supporting information and its location
    F. Present the Operator accountancy arrangements to be used for both operator and ONR reporting purposes which should proportionately and where appropriate include:
        a. QNM flow and inventory measurement points
        b. Attainment of the accurate and precise accountancy and control of QNM as set down in the IAEA “International Target Values for Measurement Uncertainties in Safeguarding Nuclear Materials,” (Reference 28-42)

c. Operator safeguards equipment & measures used to ensure the completeness of flow and inventory measurements appropriate for the QNF

28.2.7 Inspection

ONR TIG “Safeguards” (Reference 28-28) contains guidance for ONR to inspect NMACS activities at operator’s sites.

The ONR verifies design information through the physical examination of the BWRX-300 facility during construction, commissioning, operation, and subsequent phases.

A design information examination is a review to determine whether further information is necessary for the ONR to establish adequate safeguards and to identify features of the facility and the nuclear material handling and storage procedures which may have an effect on the safeguards approach and methods.

A Design Information Verification is an on-site verification by the ONR to ensure that the information is sufficiently complete and correct and satisfies ONR needs as specified in the VOA (Reference 28-15). This verification is performed during a visit, which is different than other ONR inspections that are arranged for specific purposes.

Before an on-site visit, the ONR performs specific actions such as:

1. Examining the design information provided in the BTC to establish its completeness and its self-consistency
2. Determining whether any additional information or clarification is required that could affect safeguards; and requesting formally such additional information from the operator, as needed
3. Preparing a preliminary safeguards approach for the BWRX-300 facility, based on the design information included in the initial BTC and other relevant information available which considers specific features of the facility and other relevant features and elements indicated in the VOA including:
    A. Determination of possible diversion strategies, identification of possible diversion paths, and specification of the detection goals (detection times, significant quantities, and detection probabilities) to be achieved for the BWRX-300 facility
    B. Analysis of the identified possible diversion paths

28.3 Statutory Requirements

28.3.1 Declaration of Basic Technical Characteristics

Regulation 3 of NSR19 requires that the operator must declare to the ONR:

1. The preliminary BTC of the facility as soon as the decision to construct or authorize construction has been taken
2. The BTC of the facility, based on the final design for the QNF, using the relevant questionnaire shown in Part 1-A of Schedule 1 of NSR19, not later than 200 days prior to and ending on the day on which construction is started
3. The BTC of the facility as built, using the relevant questionnaire shown in Part 1-A of Schedule 1 of NSR19, not later than 200 days before the day on which QNM is first received at the facility

The operator must inform the ONR of a change in the basic technical characteristics within the period of 30 days beginning with the day on which the change is completed unless advance notification to the ONR of such a change is required by any particular safeguard provisions imposed on the operator by Regulation 5 of NSR19.

28.3.2 Program of Activities

Regulation 4 of NSR19 requires the operator to provide ONR with:

1. An annual outline program of activities using the information described in Part 8 of Schedule 1 of NSR19 (APPENDIX D):
    A. Types of operations, (reactor operating programs, with planned shutdowns)
    B. Expected schedule of arrival of QNM s, stating the amount of material per batch, the form (i.e., fresh fuel), anticipated type of container or packaging
    C. Dates and duration of physical inventory taking
2. An annual outline program of activities for the following calendar year, to be received by the ONR by 30th September
3. The program of activities for the taking of a physical inventory at least 40 days before the day on which the physical inventory is taken
4. Communication without delay of any change which affects or may affect the outline program of activities and, in particular the taking of physical inventories

28.3.3 Particular Safeguard Provisions

Acting on the BTC submitted by the operator (Section 28.3.1 above) the ONR may impose Particular Safeguard Provisions (PSPs) on the operator under regulation 5 of NSR19. PSP may include:

1. Specification of boundaries for MBAs and the selection of key measurement points for tracking QNM
2. Changes to the BTC which would require advance notification
3. Procedures for recording and reporting QNM present in each MBA
4. Procedures for taking physical inventories
5. Requirements for the installation of safeguards equipment
6. Arrangements for taking samples of QNM
7. Communications required from the operator regarding the program of activities (Section 28.3.2 above)

8. Requirements for advance notification of shipments and receipts of QNM

28.3.4 Accountancy and Control of Qualifying Nuclear Material

1. Regulation 6 of NSR19 requires the operator of the facility to maintain a system of accountancy and control for all QNM present
2. This system must include in respect of the QNM:
   A. The operating and accounting records described in Sections 28.3.8 and 28.3.9 below
   B. Information on the quantities, category, form, and composition of QNM
   C. Its actual location
   D. The additional obligations set described in Section 28.3.17 below
   E. Details of the recipient or shipper in the case of transfer
3. The components of an accountancy and control system are set out in Schedule 2 of NSR19 (APPENDIX E), and an operator must implement the relevant components in a manner which is proportionate to and appropriate for the BTC of the facility as reported to the ONR as described in Section 28.3.1.
4. The operator must retain the operating and accountancy records described above for a period of at least five years, beginning with the date on which each item of information is first recorded, and must be able to produce and substantiate the information which it provides to the ONR in accordance with the requirements of NSR19.
5. The operator must make the operating and accountancy records available for inspection by the ONR at the facility. The records may be made available in electronic form if they are kept in this form by the operator.
6. The system of measurements on which the records used for the preparation of reports are based must conform with the relevant international standards.

28.3.5 Accountancy and Control Plan

1. Regulation 7 of NSR19 requires the operator of the facility produce an accountancy and control plan which sets out the accounting and control system for the QNM in the facility.
2. The operator must send the accountancy and control plan to the ONR as soon as possible and in any event not later than 200 days prior to the day on which QNM is first received at the facility.
3. The accountancy and control plan must describe in writing the arrangements and procedures adopted or to be adopted by an operator to establish and maintain the system of accountancy and control of QNM as described in Section 28.3.4 above.
4. The ONR may consider the accountancy and control plan, or any part of the plan, and may approve all or any part of the plan.

28.3.6 Replacement, Amendment and Revocation of Accountancy and Control Plan

1. Regulation 8 of NSR19 requires that in the event of a change in the basic technical characteristics of the facility, notified to the ONR as described in Section 28.3.1 above, which is relevant to the accountancy and control plan, the operator must amend the accountancy and control plan for the facility and send the amended plan to the ONR within the period of 30 days beginning with the day on which the change is made.

2. Subject to paragraph 1 above, the operator of the facility may not amend any part of the accountancy and control plan for the QNF that has been approved by the ONR without the prior written consent of the ONR.
3. The operator of the facility may at any time amend those parts of the accountancy and control plan for the QNF that have not been approved by the ONR and send a copy to the ONR.
4. The ONR may consider the amended accountancy and control plan, or any part of the plan, and may approve all or part of the plan.

28.3.7 Operation of an Accountancy and Control Plan

1. Regulation 9 of NSR19 requires that the operator must implement and comply with the arrangements and procedures in the accountancy and control plan.
2. The operator is not to be regarded as having failed to comply with those arrangements procedures by reason of any matter if the ONR has previously informed the operator in writing that matter is, in the ONR's opinion, unlikely to be prejudicial to the maintenance of the system safeguards in respect of QNM at the QNF.

28.3.8 Operating Records

1. Regulation 10 of NSR19 requires that operator must ensure that the operating records for each material balance area set out:
   A. Those operating data which are used to determine changes in the quantities and composition of QNM
   B. A list of inventory items, updated to the best extent possible, and their location
   C. The data, including derived estimates of random and systematic errors, obtained from the calibration of tanks and instruments as well as from sampling and analysis
   D. The data resulting from quality control measures applied to the accountancy system for the QNM, including derived estimates of random and systematic errors
   E. A description of the sequence of the actions taken to prepare for, and take, a physical inventory and to ensure that the inventory is correct and complete
   F. A description of the actions taken in order to ascertain the cause and magnitude of any accidental or unmeasured loss that might have occurred
   G. The isotopic composition of plutonium, including its decay isotopes, and reference dates, if recorded at the QNF for operational needs
2. The operator must send the data referred to in paragraph 1 above to the ONR within 14 days of the receipt of a written request from the ONR.

28.3.9 Accounting Records

1. Regulation 11 of NSR19 requires that the operator ensure that the accounting records for each material balance must show the following:
   A. All inventory changes, so that the book inventory can be determined at any time
   B. All measurement and counting results used to determine the physical inventory
   C. All adjustments and corrections that have been made in respect of inventory changes, book inventories and physical inventories

2. The operator must ensure that the accounting records relating to any inventory change or physical inventory for each batch of QNM show the material identification, batch data and source data.
3. The operator must ensure that the records account separately for each category of QNM.
4. For each inventory change, the operator must indicate the date of the change and, when appropriate, the originating and dispatching material balance area and the receiving material balance area or the shipper and the recipient.
5. An operator must communicate the data referred to in paragraph 1 above to the ONR on request.

28.3.10 Accounting Reports

1. Regulation 12 of NSR19 requires the operator to provide the ONR with accounting reports for each material balance as described in Sections 28.3.11 and 28.3.18 below.
2. The operator must ensure that the accounting reports contain up to date information and must correct the information at a later date if necessary.
3. On a written request by the ONR, the operator must supply further details, explanations, amplifications, or clarifications of any information set out in the relevant accounting report within the period of 15 days beginning with the day on which the operator receives the request from the ONR.

28.3.11 Initial Book Inventory

Regulation 13 of NSR19 is not applicable to this GDA because it relates to facilities which were operational prior to the time at which NSR19 came into force.

28.3.12 Inventory Change Report

1. Regulation 14 of NSR19 requires that the operator must send to the ONR an inventory change report for each material balance area, using the format set out in Part 2 of Schedule 1 of NSR19.
2. Unless otherwise specified in the particular safeguard provisions described in Section 28.3.3 above, the operator must send to the ONR an inventory change report within the period of 15 days beginning with the end of each month, in which the operator must state all inventory changes to the QNM which have occurred or become known to the operator during that month.
3. In respect of any month in which a physical inventory is taken and the physical inventory taking date is not the last day of the month, the operator must send two separate inventory change reports to the ONR:
    A. A first inventory change report containing any inventory changes up to and including the date on which the physical inventory was taken, to be sent to the ONR with the physical inventory listing and the material balance report, which are referred to in Section 28.3.13 below and are to be sent to the ONR as soon as possible and at the latest within a period of 15 days beginning with the day on which the physical inventory was taken; and
    B. A second inventory change report, to be sent within a period of 15 days beginning with the end of the month in which the physical inventory was taken, containing all inventory changes from the first day after the physical inventory was taken up to and including the last day of the month.

4. In respect of a month in which no inventory changes occur, when the operator sends the inventory change report to the ONR in accordance with paragraph 1 above, the operator must carry over the ending book inventory of the previous month.
5. In order that they may be reported as a single inventory change, small inventory changes, such as transfers of samples for the purpose of analysis, may be grouped together, unless otherwise stated in the particular safeguard provisions for the relevant QNF.
6. Inventory change reports may include comments explaining the inventory changes.

28.3.13 Material Balance Report and Physical Inventory Listing

1. Regulation 15 of NSR19 requires the operator to send the ONR a report for each material balance area containing:
   A. Material balance reports, in the format set out in Part 3 of Schedule 1 of NSR19, showing:
      a. The beginning physical inventory
      b. Inventory changes (first increases, then decreases)
      c. Ending book inventory
      d. Ending physical inventory
      e. Material unaccounted for
   B. A physical inventory listing, in the format set out in Part 4 of Schedule 1 of NSR19, showing all batches separately
2. The operator must send the reports and the listing to the ONR as soon as possible and at the latest within the period of 15 days beginning with the day on which the physical inventory was taken.
3. Unless otherwise specified in the particular safeguard provisions for the QNF, a physical inventory for each material balance area must be taken every calendar year and the period between two successive physical inventory takings must not exceed 14 months.

28.3.14 Special Report

1. Regulation 16 of NSR19 requires that the operator must send to the ONR a special report whenever the circumstances described in Sections 28.3.15 or 28.3.22 below arise.
2. The ONR may:
   A. Request further details or explanations in connection with a special report
   B. Specify, in the particular safeguard provisions for a QNF, additional requirements concerning the type of information to be supplied in a special report
3. If the ONR requests further detail or explanation in connection with a special report, the operator must send it to the ONR without delay.

28.3.15 Unusual Occurrences

1. Regulation 17 of NSR19 states that the circumstances referred to in Section 28.3.14 above are:
   A. As a result of any unusual incident or circumstances, an operator believes that there has been or might be an increase in or a loss of QNM

B. The containment of QNM has unexpectedly changed to a point where an unauthorized removal of QNM has become possible

2. The operator must submit a special report as soon as it becomes aware of any such loss or increase or sudden change in the containment conditions, or of anything which leads them.

3. An operator must also inform the ONR of the causes of an unusual occurrence described in paragraph 1.A or 1.B above as soon as the operator becomes aware of them.

28.3.16 Reporting of Nuclear Transformations

1. Regulation 18 of NSR19 requires that the operator must include in the inventory change report calculated data on nuclear transformations and include this data on or before the time when irradiated fuel is transferred from the reactor material balance area.

2. In addition, the ONR may specify alternative procedures for recording and reporting nuclear transformations in the PSPs.

28.3.17 Additional Reporting Obligations Arising from Relevant International Agreements and from Obligations Resulting from International Trade

1. Regulation 19 of NSR19 requires that when an operator provides the ONR with the information which is listed in paragraph (2), the operator must identify, separately for each obligation in each of the reports and notifications listed in the relevant international agreement, unless otherwise stipulated by that agreement, any QNM which is subject to a relevant safeguards obligation and must use the appropriate obligation code if one has been published by the ONR.

2. The following information is listed in this paragraph:

   A. An initial book inventory (see Section 28.3.11)

   B. An inventory change report, including an ending book inventory (see Section 28.3.12)

   C. A material balance report and a physical inventory listing (see Section 28.3.13)

   D. Advance notification of intended imports and exports (see Sections 28.3.20 and 28.3.21)

3. Where an operator:

   A. Holds QNM, which has been transferred into the United Kingdom, under obligations or requirements concerning international trade, which ensure that QNM is only available for peaceful purposes, and are respectively described in paragraph (4) (“obligations concerning international trade”) and in paragraph (5) (“requirements concerning international trade”), and

   B. Provides the ONR with the information which is listed in paragraph (2), the operator must identify, separately for each obligation and requirement concerning international trade in each of the reports and notifications, unless otherwise stipulated by the relevant obligation or requirement, any QNM which is subject to an obligation or requirement concerning international trade and must use the appropriate obligation code if one has been published by the ONR.

4. The obligations concerning international trade arise where an operator holds QNM which has been transferred into the United Kingdom before commencement day, either directly or through a third country, in accordance with any of the following:

A. The Agreement for co-operation in the peaceful uses of nuclear energy between the European Atomic Energy Community and the Government of the Republic of Kazakhstan, signed in Brussels on 5th December 2006.

B. The Agreement for co-operation in the peaceful uses of nuclear energy between the European Atomic Energy Community and the Government of the Republic of Uzbekistan, signed in Brussels on 6th October 2003.

C. The Agreement between the European Atomic Energy Community and the Cabinet of Ministers of Ukraine for Co-operation in the Peaceful Uses of Nuclear Energy, signed in Kiev on 28th April 2005.

D. The Agreement for co-operation in the peaceful uses of nuclear energy between the European Atomic Energy Community (Euratom) and the Government of the Argentine Republic, signed at Brussels, on 11th June 1996.

E. The Agreement between the European Atomic Energy Community (Euratom) and the Government of the United States of Brazil for cooperation concerning the peaceful uses of atomic energy, signed at Brasilia, on 9th June 1961; and

F. A contract, to which the operator is a party, concluded, before commencement day, on the basis of Articles 52(2), 64, 75(c) or another relevant provision in Chapter 6 of the Treaty establishing the European Atomic Energy Community.

5. The requirements concerning international trade arise where an operator holds QNM which has been transferred into the United Kingdom under the terms of a requirement, which is set out in a license issued by the ONR under the “Import of Goods (Control) Order 1954,” (Reference 28-43) or an order made by the Secretary of State under Section 1 of the “Import, Export and Customs Powers (Defence) Act 1939,” (Reference 28-44).

6. In respect of each relevant international agreement and each obligation and requirement concerning international trade, the ONR must publish on its website, and make available in writing on request, any obligation codes which must be used by an operator in respect of that relevant international agreement or obligation or requirement concerning international trade.

7. Unless specifically prohibited in the relevant international agreement or obligation or requirement concerning international trade, the separate reporting requirements set out in paragraphs (1) and (3) do not preclude the physical mixing of QNM s.

8. Paragraphs (1) to (7) do not apply to the Agreement with the IAEA nor to the Additional Protocol (Reference 28-16), entered into between the United Kingdom and the IAEA and which is additional to the Agreement with the Agency.

28.3.18 Weight Units and Categories of Qualifying Nuclear Materials

1. Regulation 20 of NSR19 requires that information regarding any quantity of QNM supplied under NSR19:

   A. Must be expressed to at least the nearest gram

   B. May be rounded down, when the first decimal is 0 to 4, and rounded up when the first decimal is 5 to 9

2. The corresponding accounting records must be kept:

   A. In grams or in smaller units

   B. In such a manner as to render them secure and reliable

3. Unless otherwise provided for in the PSP, any notification under NSR19 must include the following:
    A. The total weight of the element's uranium, thorium, and plutonium, and also, for enriched uranium, the total weight of the fissile isotopes; and
    B. Separate reports for each material balance area as well as separate line entries in inventory change reports, material balance reports and in physical inventory listings for each category of QNM.

28.3.19 Exports

Regulation 21 of NSR19 requires the operator to provide ONR with advanced notification if any QNM is exported outside of the UK where:

1. The consignment exceeds one effective kilogram: or
2. The total quantity of material transferred to the same State could exceed one effective kilogram in any 12-month period, even though no single consignment exceeds one effective kilogram.

The operator must provide notification to ONR:

1. After the conclusion of the contractual arrangements leading to the transfer
2. Using the form set out in Part 5 of Schedule 1 of NSR19
3. And must ensure that notification reaches the ONR at least 7 days before the day on which the material is to be packed for transfer

28.3.20 Imports

Regulation 22 of NSR19 requires the operator to provide ONR with advanced notification if any QNM is imported into the UK where:

1. The consignment exceeds one effective kilogram, or
2. The total quantity of imported from the same State could exceed one effective kilogram in any 12-month period, even though no single consignment exceeds one effective kilogram.

The operator must provide notification to ONR:

1. As far in advance as possible of the expected arrival of the QNM in the UK
2. At the latest, on the date of receipt by the operator and ensure that notification is received by the ONR at least 4 days before the date on which the QNM is unpacked
3. Using the form set out in Part 6 of Schedule 1 of NSR19

28.3.21 Loss or Delay During Transfer

An operator must send a special report to the ONR under regulation 16 as soon as the operator becomes aware that QNM has been or appears to have been lost during transfer or that there has been a considerable delay during transfer.

28.3.22 Communication of Change of Date

An operator must inform the ONR, without delay, of any change in the dates for packing before transfer, transport or unpacking of QNM, which have been given in the notifications provided for under regulations 21 or 22 and must provide an indication of the revised dates if known, unless the change gives rise to a special report under Regulation 16.

28.3.23 Safeguards Equipment

28.3.24 Access to Safeguards Equipment

Regulation 37 of NSR19 requires the operator to permit the ONR to have reasonable access to safeguards equipment.

28.3.25 Interference with Safeguards Equipment

Regulation 38 of NSR19 states that no person may, unless permitted by the ONR, take action in connection with the operation of any safeguards equipment in a QNF, which results in the safeguards equipment providing information on QNM that is significantly different from the information which the equipment would have provided had the action not occurred.

28.3.26 Role of the Office of Nuclear Regulation

28.3.27 Inspections by the Office of Nuclear Regulation

1. Regulation 38 of NSR19 states that for the purpose of ensuring compliance with the requirements NSR19 the ONR may:
    A. Examine the records kept by an operator in accordance with the requirements of NSR19
    B. Make independent measurements of any QNM
    C. Apply and make use of surveillance and containment measures together with any other objective methods of monitoring which the ONR considers to be reasonable
    D. Observe that samples of QNM at key measurement points for accounting purposes are taken in accordance with procedures which produce representative samples
    E. Observe the treatment and analysis of the samples and obtain duplicates of such samples
    F. Verify the functioning and calibration of an operator's instruments used to measure or control QNM, including observation of calibration activities, and assessing whether the measurements of QNM at key measurement points are representative
    G. Make such observations or measurements necessary to verify the accuracy of basic technical characteristics and any changes to them declared as described in Section 28.3.1 above
2. The ONR may write to an operator to require the operator to:
    A. Take additional measurements or samples of the QNM for the ONR's use
    B. Analyse the ONR's standard analytical samples
    C. Use appropriate absolute standards in the operator's equipment and calibrating instruments
    D. Carry out additional calibrations to the relevant equipment or instruments
    E. The ONR may apply its seals and other identifying and tamper-indicating devices to containments of QNM
3. The ONR may write to an operator to require the operator to send, within a reasonable timescale specified by the ONR, any samples of QNM which have been taken for the ONR's use to a location specified by the ONR.

28.4 Regulatory Expectations

The ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles (ONMACS) (Reference 28-25) contains a set of 10 Fundamental Safeguards Expectations (FSE) for NMACS (Table 28-2). These are defined in UK law through NSR19, in the requirements of relevant international agreements, and in relevant good practice.

The FSEs underpin all activities that contribute to sustain high standards of NMACS. They fall into two categories:

1. Strategic enablers – FSEs 1-5 are expectations focused on creation of the right conditions to support effective NMACS strategy.
2. Material controls – FSEs 6-10 are expectations focused on implementation and maintenance of effective and robust NMACS arrangements.

Strategic enablers align with the ONRs other regulatory purposes (e.g., Security Assessment Principles (SyAPs) and Safety Assessment Principles (SAPs)) and material controls focus specifically on the implementation and maintenance of NMACS arrangements.

Each FSE is accompanied by one (or more) Nuclear Material Accountancy and Control Expectations (MACE) (APPENDIX F). It is against these expectations that ONR inspectors will judge the adequacy of operators' arrangements and their implementation.

28.4.1 Strategic Enablers

This document has not considered management arrangements necessary to create the right conditions to support effective NMACS strategy. These are considered in other chapters:

- PSR Chapter 13: Conduct of Operations (Reference 28-6)
- PSR Chapter 17: Management for Safety and Quality Assurance (Reference 28-8)
- PSR Chapter 18: Human Factors Engineering (Reference 28-9)

28.4.2 Material Controls

The statutory requirements for NMACS arrangements are described in a functional manner in Section 28.3. The provision of details for their implementation and maintenance is a future activity for a prospective operator on application for a site license to operate a BWRX-300 reactor.

Table 28-1: National Occupational Standards for Nuclear Material Accountancy, Control, and Safeguards

Ref. No.	National Occupational Standard
COGNMAS1	Configure and manage a nuclear material accountancy and safeguards system
COGNMAS2	Define and deploy approved nuclear material measurement capability
COGNMAS3	Maintain and review nuclear material measurement quality control
COGNMAS4	Carry out nuclear material measurement system analysis
COGNMAS5	Identify and incorporate nuclear material accountancy and safeguards requirements in designs
COGNMAS6	Confirm the commissioning process achieves nuclear material accountancy and safeguards requirements
COGNMAS7	Identify, incorporate, and implement nuclear material accountancy and safeguards requirements in decommissioning plans
COGNMAS8	Control internal nuclear material movements on-site
COGNMAS9	Control external nuclear material movements onto and off a site
COGNMAS10	Perform stocktaking and material verification
COGNMAS11	Investigate and resolve nuclear material accountancy and safeguards anomalies and discrepancies
COGNMAS12	Enter data onto the nuclear material accountancy and safeguards system and verify data
COGNMAS13	Compilation of accounts and nuclear material accountancy and safeguards reporting
COGNMAS14	Liaise with safeguard inspectorates and other stakeholders

Table 28-2: Summary of Office of Nuclear Regulations Fundamental Safeguards Expectations for NMACS

STRATEGIC ENABLERS		MATERIAL CONTROLS	
FSE 1	Leadership and Management for Nuclear Material Accountancy, Control and Safeguards	**FSE 6**	Measurement Program and Control
FSE 2	Organizational Culture	**FSE 7**	Nuclear Material Tracking
FSE 3	Competence Management	**FSE 8**	Data Processing and Control
FSE 4	Reporting, Anomalies, and Investigations	**FSE 9**	Material Balance
FSE 5	Reliability, Resilience, and Sustainability	**FSE 10**	Quality Assurance and Control for Nuclear Material Accountancy, Control and Safeguards

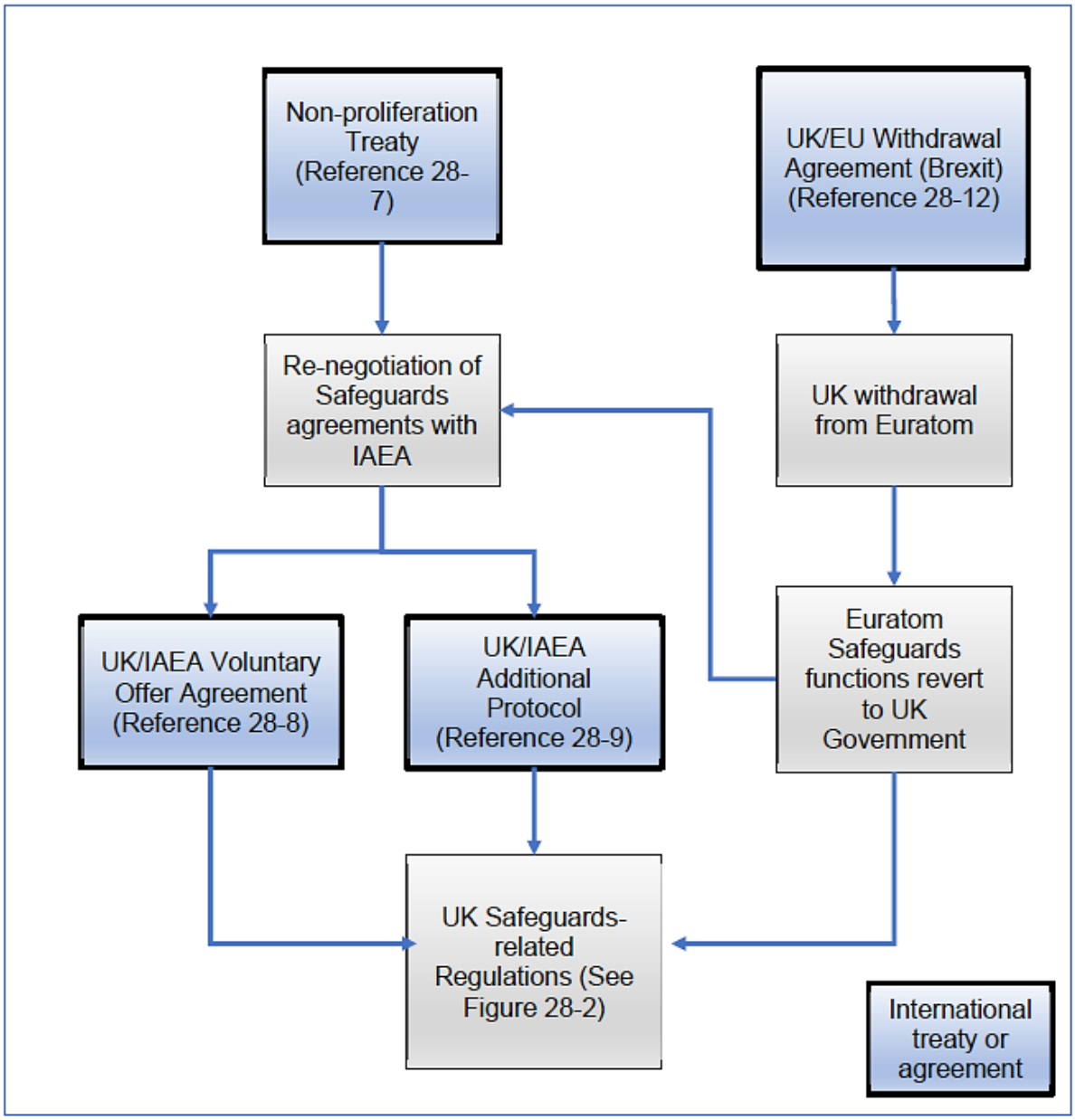

Figure 28-1: International Legal Basis for Safeguards in the United Kingdom

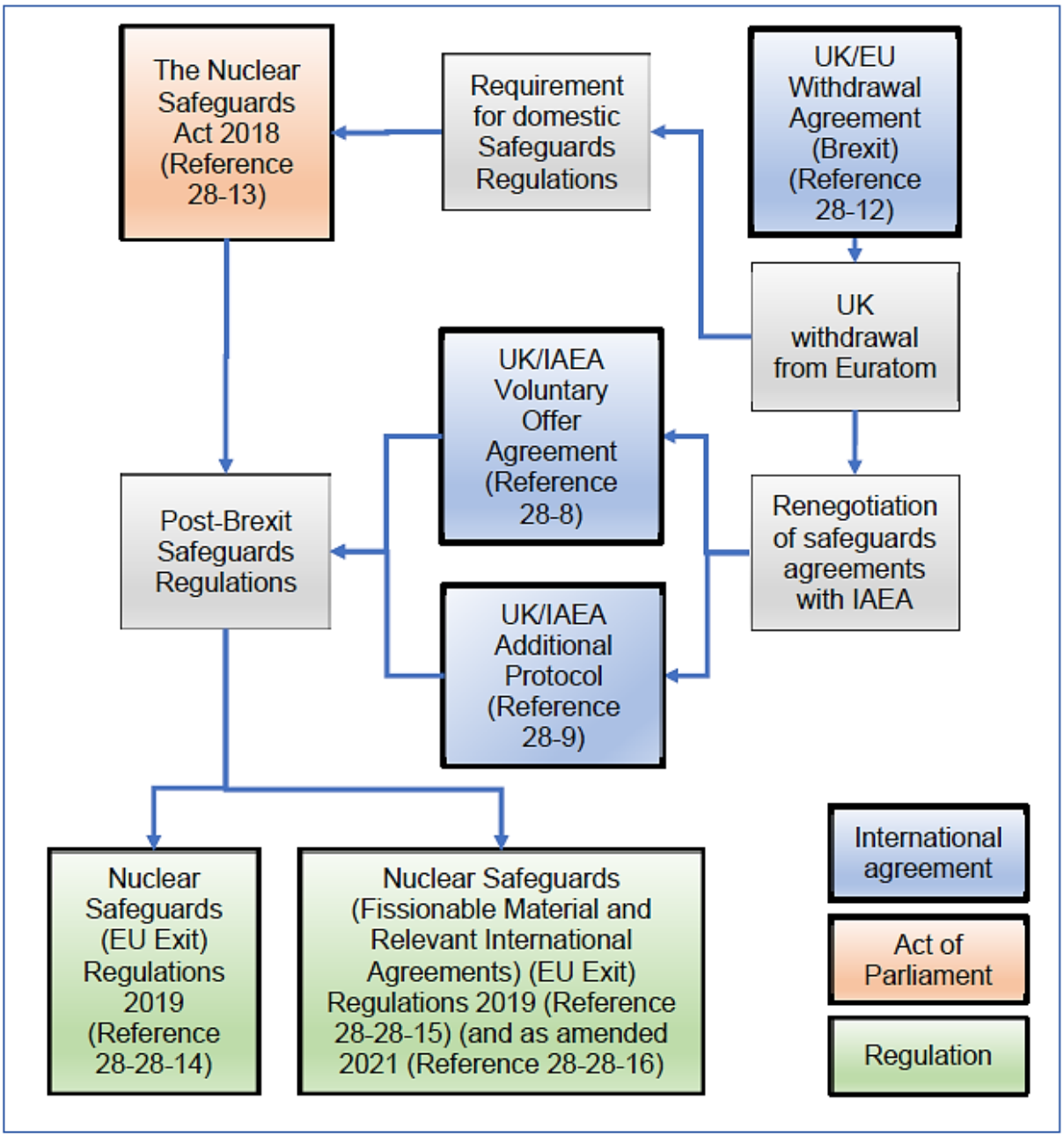

Figure 28-2: Legal Basis for United Kingdom Safeguards Regulations

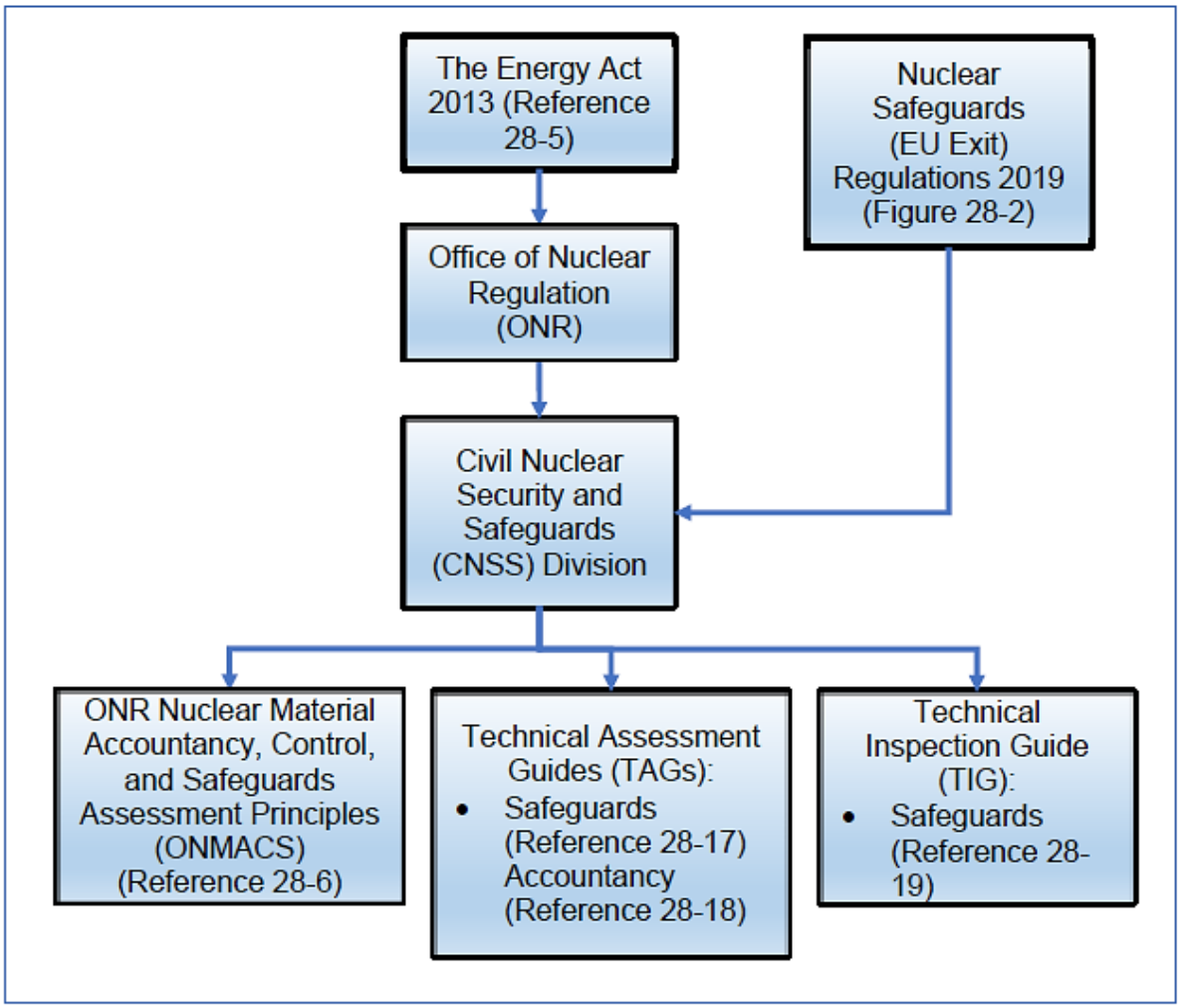

Figure 28-3: Legal Basis for Regulation of the United Kingdom Nuclear Industry

28.5 References

28-1 IAEA, “IAEA Safeguards Glossary,” International Nuclear Verification Series No. 3, Vienna, 2022.

28-2 H.M. Government, “The Energy Act (TEA) 2013.”

28-3 NEDO-34198, “BWRX-300 UK GDA Chapter 26: Interim Storage of Spent Fuel,” Rev B, GE Hitachi Nuclear Energy, Americas, LLC.

28-4 NEDO-34174, “BWRX-300 UK GDA Chapter 11: Management of Radioactive Waste,” Rev B, GE-Hitachi Nuclear Energy, Americas, LLC.

28-5 NEDO-34197, “BWRX-300 UK GDA Chapter 25: Security Annex,” Rev B, GE-Hitachi Nuclear Energy, Americas, LLC.

28-6 NEDO-34176, “BWRX-300 UK GDA Chapter 13: Conduct of Operations,” Rev B, GE Hitachi Nuclear Energy, Americas, LLC.

28-7 NEDO-34178, “BWRX-300 UK GDA Chapter 15: Safety Analysis (Including Fault Studies, PSA and Hazard Assessment),” Rev B, GE-Hitachi Nuclear Energy, Americas, LLC.

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APPENDIX A CLAIMS, ARGUMENTS AND EVIDENCE

Table A-1: Claims, Arguments and Evidence

Level 3 Chapter Claim	Chapter 28 Argument	Sections and/or reports that evidence the arguments:
4. Appropriate nuclear material accountancy is undertaken to minimize the potential nuclear materials to be used for non-peaceful purposes.		
4.1 The design process for the BWRX-300 reactor has followed IAEA's guidance on International Safeguards in the Design of Nuclear Reactors.	GE Hitachi 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.	28.2: Safeguards by 28.2.1: Provision of Design Information 28.2.2: Initial Basic Technical Characteristics 28.2.3: Design Information Examination and Verification
4.2 The BWRX-300 reactor may be operated according to the guidance in the ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles.	GE Hitachi is following the requirements of the GDA process in its submissions to Regulators. Adherence to the GDA process ensures that the Safeguards as set out in the ONR Nuclear Material Accountancy, Control, and Safeguards Assessment Principles are met.	28.4: Regulatory Expectations 28.4.1: Strategic Enablers 28.4.2: Material
4.3 This chapter considers safeguards' interface with safety, security, and waste management issues.	GE Hitachi 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.	28: Interfaces with other chapters

APPENDIX B FORWARD ACTIONS

Table B-1: Forward Actions

FAP ID	Finding	Forward Actions	Delivery Phase
PSR28-307	There are two declarations required by the UK/IAEA AP relevant to the BWRX-300 project	Article 2 a. (i) declaration: "A general description of and information specifying the location of those nuclear fuel cycle-related research and development activities carried out anywhere that are funded, specifically authorized or controlled by, or carried out on behalf of, the United Kingdom, for or in co-operation with, or otherwise relevant to, a non-nuclear-weapon State (hereinafter referred to as "a NNWS")."	No action required - COMPLETE
PSR28-308		Article 2 a. (ix) declaration: "General plans for the succeeding ten-year period relevant to the development of the civil nuclear fuel cycle (including planned nuclear fuel cycle-related research and development activities) when approved by the appropriate authorities in the United Kingdom."	Within Step 2 - COMPLETE
PSR28-309	To enable ONR to plan its safeguards approach for a new reactor facility such as the BWRX-300 facility, NSR19 requires a rolling program for the provision of design information.	During the project definition phase, the ONR will be provided with an initial Basic Technical Characteristics (BTC)	Within Step 2 - COMPLETE

APPENDIX C QUESTIONNAIRE FROM PART 1-A OF SCHEDULE 1 OF NSR19

QUESTIONNAIRE FOR THE DECLARATION OF THE BASIC TECHNICAL CHARACTERISTICS OF A QUALIFYING NUCLEAR FACILITY.

I-A. REACTORS

Date: ……

NB:

1. The reply ‘not applicable’ can be given to questions which are not applicable. The ONR is still entitled to request any additional information it considers necessary in connection with the relevant questionnaire in accordance with regulation 3(5).
2. The declaration, duly completed and signed, should be forwarded to the ONR in electronic form in accordance with regulation 3(5).

IDENTIFICATION OF THE QUALIFYING NUCLEAR FACILITY

1. Name
2. Location, exact address with telephone and fax numbers and e-mail address
3. Owner (legally responsible body or individual)
4. Operator (legally responsible body or individual)
5. Present status (e.g. under construction, in operation or closed down)
6. Purpose and type
7. Operating mode influencing its production (shift system adopted, approximate dates of operating periods in year, etc.)
8. Area layout (map showing the installation, boundaries, buildings, roads, rivers, railways, etc.)
9. Layout of qualifying nuclear facility:
    A. Structural containment, fences, and access routes
    B. Storage area for incoming QNM
    C. Reactor area
    D. Test and experiment area, laboratories
    E. Storage area for outgoing QNM
    F. Disposal area for QNM declared as retained or conditioned waste
10. Additional data per reactor:
    A. Nominal thermal output
    B. Material that is either source material or fissionable material
    C. Initial core enrichments
    D. Moderator
    E. Coolant

GENERAL ARRANGEMENTS AT THE QUALIFYING NUCLEAR FACILITY, INCLUDING THOSE RELATING TO MATERIAL USE AND ACCOUNTANCY, CONTAINMENT AND SURVEILLANCE

Description of Qualifying Nuclear Material

11. Description of the use of QNM
12. Outline drawings of fuel assemblies, fuel rods/pins, fuel plates etc., in sufficient detail to indicate general structure with overall dimensions. (Provisions for pin exchange should be described, if applicable, and an indication given if this is a routine operation.)
13. Fuel material (including material in control or shim assemblies, if applicable):
    A. Chemical composition or main alloy constituents
    B. Average enrichment per assembly
    C. Nominal weight of QNM per assembly, with design tolerances
14. Cladding material
15. Method of identifying individual assemblies, rods/pins, plates etc., if applicable
16. Other QNM used in the QNF (briefly state material, purpose, and method of use, e.g., as booster rods)

Flow of QNM

17. Flow sheet showing points where QNM is identified or measured; material balance areas and inventory locations used for material accountancy; and the estimated range of QNM inventories at these locations under normal operating conditions.
18. Expected nominal fuel cycle data, including:
    (a) Reactor core loading
    (b) Expected burn-up
    (c) Annual refuelling amount
    (d) Refuelling interval (on-load or off-load)
    (e) Forecast of throughput and inventory, and of receipts and shipments

Handling of Qualifying Nuclear Material

19. Layout of the fresh fuel storage area, drawings of fresh fuel storage locations, and description of packaging
20. Drawings of fresh fuel preparation and/or assay room and reactor loading area
21. Drawings of transfer equipment for fresh and irradiated fuel, including refuelling machines or equipment
22. Drawings of reactor vessel showing location of core and openings in vessel; description of method of fuel handling in vessel
23. Drawing of core showing general layout, lattice, form, pitch, and dimensions of core; reflector; location, shapes, and dimensions of control devices; experimental and/or irradiation positions
24. Number and size of channels for fuel assemblies and control devices in the core
25. Spent fuel storage area:
    A. Drawing of storage area

B. Method of storage

C. Design storage capacity

D. Drawing of equipment for handling irradiated fuel

E. Minimum cooling time before shipment of spent fuel

F. Drawing and description of shipping cask for spent fuel (e.g., to determine whether sealing is possible)

26. QNM testing area (if applicable):

A. Brief description of the activities performed

B. Description of main equipment (e.g., hot cell, fuel assembly de-cladding and dissolving equipment)

C. Description of shipping containers for QNM and of waste and scrap packaging (e.g., to determine whether sealing is possible)

D. Description of storage area for non-irradiated and irradiated QNM

E. Drawings of the above, if not covered elsewhere.

Coolant Data

27. Coolant flow diagrams as required for heat balance calculations (indicating pressure, temperatures, and mass flow rates at main points)

ACCOUNTANCY AND CONTROL OF QUALIFYING NUCLEAR MATERIAL

Accountancy System

28. Description of accountancy and control system for QNM (describe item and/or mass accountancy system, including assay methods used and assessed accuracies, supplying specimen blank forms used in all accountancy and control procedures). Period during which such records must be retained should be stated.

Physical Inventory

29. Description of procedures, scheduled frequency and methods for operator's physical inventory taking (both for item and/or mass accountancy, including main assay methods and expected accuracy); access to QNM in the core and to QNM which is irradiated and outside the core; expected radiation levels.

OTHER INFORMATION RELEVANT TO APPLICATION OF SAFEGUARDS

30. Organisational arrangements for accountancy and control of QNM.

31. Information on the health and safety rules which have to be observed at the QNF, and with which the inspectors must comply.

APPENDIX D PART 8 OF SCHEDULE 1 OF NSR19

OUTLINE PROGRAMME OF ACTIVITIES

Communications should cover the next calendar year.

In particular, communications should include the following information:

1. Types of operations, e.g., anticipated throughput of proposed campaigns with indication of type and quantity of fuel elements to be fabricated or reprocessed, enrichment programmes, reactor operating programmes, with planned shutdowns
2. Expected schedule of arrival of QNM s, stating the amount of material per batch, the form (UF6, UO2, fresh or irradiated fuels, etc.), anticipated type of container or packaging
3. Anticipated schedule of waste processing campaigns (other than repackaging, or further conditioning without separation of elements), stating the amount of material per batch, the form (glass, high active liquid, etc.), anticipated duration and location
4. Dates by which the quantity of QNM in products is expected to be determined, and dates of dispatch
5. Dates and duration of physical inventory taking

This communication, duly completed and signed, must be sent to the ONR in accordance with regulation 35.

APPENDIX E SCHEDULE 2 OF NSR19

THE COMPONENTS OF AN ACCOUNTANCY AND CONTROL SYSTEM

The components of an accountancy and control system, referred to in regulation 6(3) of NSR19, are set out below:

1. A structure of material balance areas in which the physical inventory of QNM in each area and the transfers of QNM into and out of each area can be determined. This structure should be designed to maximise the control of QNM flows and physical inventories
2. Defined roles and responsibilities, that are assigned, and communicated to the staff of a QNF to meet the obligations contained in these Regulations
3. Quality assurance and quality control measures that detect, describe, address, and reduce sources of errors in and poor performance of the system
4. A programme of measurements that provides accurate, suitably precise, and representative information that quantifies and characterises QNM
5. A measurement control programme that validates and provides traceability for measurement results and their uncertainties and ensures that measurements comply with the relevant international standards or are equivalent in quality to those standards, for example by assessing, approving, recording, and calibrating measurement procedures
6. The ability to track and document the movement of QNM through receipts, packaging, re-packaging, processing, storage, and shipment in a timely manner. The system should show the location, characteristics, and containment of all QNM
7. The ability to unambiguously identify batches of QNM in whatever containers, process vessels, or equipment they may be located in. The locations in which QNM can be held, as well as positions within these areas, should also be identifiable
8. An inventory control system to regularly check the agreement between records of QNM, and between those records and the physical reality, and take appropriate action to manage discrepancies as they arise by investigating, documenting, reporting, and resolving such discrepancies
9. The ability to manage anomalies consistent with the loss or gain of a significant amount of QNM, or any other situation corresponding with regulation 17 (unusual occurrences), in a timely manner by, for example, recognising, investigating, and documenting such anomalies. The system should define personnel responsibilities and authorities to carry out the actions required by regulation 16 (special reports)
10. Data processing procedures that store, trace, identify, and produce the information required by these Regulations, and that are required to facilitate the checking of data against the physical reality
11. Reporting and notification procedures that transmit the information required by these Regulations through appropriate channels to the ONR and according to appropriate deadlines
12. Receipt and shipment procedures that check the quantity and characteristics of QNM entering or leaving a QNF against the accountancy information that must accompany such receipts and shipments. These procedures should also allow for the introduction or extraction of QNM to or from the tracking, identification, and inventory control processes described above
13. A Physical Inventory Taking (PIT), that is carried out in accordance with regulation 15(3) and 31(4)(b) at least every calendar year, with the period between two successive physical inventory takings not exceeding 14 months

14. Procedures for a PIT that describe the responsibilities of those involved, the methods they should use, the records that should be kept, the associated measurement uncertainties and material balance tests (where appropriate), the reporting that must be made to the ONR, and the steps for authenticating any information made available to inspectors under these Regulations
15. A List of Inventory Items (LII), generated from a PIT, that facilitates inspector verification of information provided to ONR against the physical reality. The LII should include information on the mass and composition of QNM per item, as well as its location, containment, identity, and type

APPENDIX F FUNDAMENTAL SAFEGUARDS EXPECTATIONS AND ASSOCIATED NMACS EXPECTATIONS

Table F-1: FSE 1-5 (Strategic Enablers) and Associated MACE

FSE 1	**Leadership and Management for NMACS**	**Operators should implement and maintain organizational capability for NMACS underpinned by strong leadership, robust governance, adequate management, and accountability of NMACS arrangements incorporating internal and independent evidence-based assurance processes.**
MACE 1.1	Governance and Leadership	Governance and leadership at all levels should focus the organization on achieving and sustaining high standards of NMACS and on delivering the characteristics of a high reliability organization.
MACE 1.2	Capable Organization	The organization should have the capability to implement and maintain the NMACS arrangements for its undertakings.
MACE 1.3	Decision Making	Decisions made at all levels in the organization affecting NMACS should be informed, rational, objective, and prudent.
MACE 1.4	Organizational Learning	Lessons should be learned from internal and external sources to continually improve leadership, organizational capability, the management system, NMACS decision-making and performance.
MACE 1.5	Assurance Processes	There should be evidence-based assurance processes in place to inform strategy through the governance process, which welcomes challenge from across the organization.
FSE 2	**Organizational Culture**	**Operators should encourage and embed an organizational culture that recognizes and promotes the importance of NMACS.**
MACE 2.1	Maintenance of a Robust NMACS Culture	There should be evidence-based assurance processes in place to inform strategy through the governance process, which welcomes challenge from across the organization.
FSE 3	**Competence Management**	**Operators should implement and maintain effective arrangements to manage the competence of those with assigned NMACS roles and responsibilities.**
MACE 3.1	Analysis of NMACS Roles and Associated Competencies	Analysis should be carried out of all tasks important to NMACS and used to justify the effective delivery of the NMACS functions to which they contribute.
MACE 3.2	Identification of Learning Objectives and Training Needs	An analysis of roles, tasks and competencies should be used to generate learning objectives, which inform the development of a set of training needs and are used to derive the criteria, or standards, against which the trainee is assessed during and/or after training.

MACE 3.3	Measurement of Competence	Operators should implement and maintain a process of assessment, which provides confidence that all personnel whose actions have the potential to impact upon NMACS meet defined competence expectations.
MACE 3.4	Organization of and Support to the Training Function	Training and competence assurance of personnel with NMACS roles should be given due priority by operators.
FSE 4	**Reporting, Anomalies, and Investigations**	**Operators must implement and maintain arrangements for the timely and accurate reporting of information required by NSR19. Arrangements for the investigation, resolution and reporting of discrepancies and anomalies must be in place.**
MACE 4.1	Reporting	Operators should implement and maintain arrangements for the monitoring, reporting and review of NMACS performance, which includes the effectiveness of meeting NMACS requirements and identifying trends.
MACE 4.2	Anomalies and Investigations	Operators should have an approach that recognizes, investigates, and manages NMACS discrepancies and anomalies in a timely manner and documents their treatment. Such investigations should aim to establish in a timely manner the accountancy evidence that all material is properly accounted for and under control.
MACE 4.3	Corrective Actions	Operators should have arrangements and procedures in place to deal with NMACS incidents, events, anomalies, and discrepancies, which include escalation, investigation, and corrective action arrangements to resolve incidents. Procedures should aim to prevent reoccurrence of NMACS incidents, events, anomalies, and discrepancies and ensure wider dissemination of learning from experience.
FSE 5	**Reliability, Resilience and Sustainability**	**Operators should design and support their NMACS regime to ensure it is reliable, resilient, sustained and remains relevant and proportionate throughout the entire lifecycle of the facility.**
MACE 5.1	Reliability and Resilience	Operators should incorporate reliability and resilience into the design of systems for the purposes of NMACS.
MACE 5.2	Examination, Inspection, Maintenance and Testing	Systems and components for the purposes of nuclear material accountancy and control should receive regular and systematic Examination, Inspection, Maintenance and Testing (EIMT).
MACE 5.3	Sustainability	Operators should ensure that the constituent parts of its NMACS regime are sustained and supported over time to ensure it continues to achieve the required outcomes.

Table F-2: FSE 6-10 (Material Controls) and Associated MACE

FSE 6	**Measurement Program and Control**	**Where measurements are performed, operators must implement and maintain robust arrangements to ensure the appropriate performance of measurement systems that provide data for the purposes of NMACS.**
MACE 6.1	Measurement Control Program	A system must be implemented for accountancy areas where QNM is processed, to ensure the effectiveness of measurement and analytical systems and the quality of resulting data that is generated for NMACS purposes.
MACE 6.2	Traceability and Validation	Measurements performed for the purposes of NMACS must be conducted to have traceability and should be validated appropriately.
MACE 6.3	Precision and Accuracy	Where measurements are performed for the purposes of NMACS, a program must be established for providing sufficiently accurate and precise quantification and characterization of the QNM subject to measurement.
FSE 7	**Nuclear Material Tracking**	**Operators must implement and maintain an NMACS system that is able to provide identification, quantity, characteristics and track any QNM in their facilities at any time.**
MACE 7.1	Inventory Control	Operators must ensure that procedures and arrangements are established and implemented to ensure any processing and/or transfers of QNM are controlled, recorded, and verified appropriately.
MACE 7.2	Identification of QNM	Operators must ensure that arrangements and procedures are in place to enable the unique identification of all QNM within the MBA.
MACE 7.3	NMACS Discrepancies	Operators should ensure that arrangements are in place that recognize and investigate NMACS discrepancies whilst recording their management. Related MACE: 4.2 and 8.3
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.**
MACE 8.1	Data Processing Capabilities	Operators must have the appropriate capabilities in place to ensure that the reports and records required under NSR19 can be produced in the correct format, within the required timescales.
MACE 8.2	Compilation of Nuclear Material Accounts	Operators should ensure that the appropriate arrangements and procedures are in place to ensure the effective management of their nuclear material accounts.
MACE 8.3	Records Management	Operators should ensure that the appropriate arrangements are in place to effectively manage the control of NMACS documentation and data.

FSE 9	**Material Balance**	**Operators must have arrangements in place to ensure that QNM shipped, received, processed, and stored within facilities is subject to robust NMACS arrangements that guarantee traceability, include arrangements for physical inventory taking and, where appropriate, material balance evaluation.**
MACE 9.1	On/Off Site Movements of QNM	Operators must ensure that the appropriate arrangements are in place to ensure that QNM shipped from sites and external receipts of QNM onto sites are controlled and subject to effective and robust NMACS arrangements that guarantee traceability.
MACE 9.2	Physical Inventory Taking	Operators must ensure that the appropriate PIT arrangements are in place to ensure that all QNM within an MBA is recorded accurately through measurement or derived estimates, as specified in Regulation 15 of NSR19. Related MACE: 7.1
MACE 9.3	Material Balance Evaluation	Operators must ensure that where appropriate, arrangements are in place to ensure that Material Balance Evaluation (MBE) is carried out to determine if any non-zero IDs can be explained by measurement uncertainty or reflects other causes.
FSE 10	**Quality Assurance and Control for NMACS**	**Operators must implement and maintain quality assurance and quality control measures for NMACS.**
MACE 10.1	NMACS Performance Measures	Operators should ensure that the appropriate arrangements are in place to ensure that NMACS performance is monitored and reviewed.
MACE 10.2	Quality Assurance and Control Measures	Operators should ensure that key NMACS tasks incorporate quality assurance and quality control measures.