IAEA Nuclear Energy Series

No. NG-T-3.25

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ENHANCING NATIONAL SAFEGUARDS INFRASTRUCTURE TO SUPPORT THE INTRODUCTION OF NUCLEAR POWER

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

IAEA NUCLEAR ENERGY SERIES No. NG-T-3.25

ENHANCING NATIONAL SAFEGUARDS INFRASTRUCTURE TO SUPPORT THE INTRODUCTION OF NUCLEAR POWER

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FOREWORD

The IAEA's statutory role is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". Among other functions, the IAEA is authorized to "foster the exchange of scientific and technical information on peaceful uses of atomic energy". One way this is achieved is through a range of technical publications including the IAEA Nuclear Energy Series.

The IAEA Nuclear Energy Series comprises publications designed to further the use of nuclear technologies in support of sustainable development, to advance nuclear science and technology, catalyse innovation and build capacity to support the existing and expanded use of nuclear power and nuclear science applications. The publications include information covering all policy, technological and management aspects of the definition and implementation of activities involving the peaceful use of nuclear technology. While the guidance provided in IAEA Nuclear Energy Series publications does not constitute Member States' consensus, it has undergone internal peer review and been made available to Member States for comment prior to publication.

The IAEA safety standards establish fundamental principles, requirements and recommendations to ensure nuclear safety and serve as a global reference for protecting people and the environment from harmful effects of ionizing radiation.

When IAEA Nuclear Energy Series publications address safety, it is ensured that the IAEA safety standards are referred to as the current boundary conditions for the application of nuclear technology.

An appropriate infrastructure is essential for the safe, secure, peaceful and sustainable use of nuclear power. IAEA Member States considering the introduction of nuclear power face the challenge of building the necessary infrastructure for their first nuclear power plant. The IAEA supports these Member States through increased technical assistance, review and advisory services, workshops, and new and updated technical publications.

The IAEA Nuclear Energy Series publication, Milestones in the Development of a National Infrastructure for Nuclear Power, No. NG-G-3.1 (Rev. 1), first issued in 2007 and updated in 2015, divides the introduction of nuclear power into three phases and defines three milestones, each of which corresponds to the end of a phase. It provides guidance for each phase and milestone for 19 infrastructure issues, ranging from a government's position on nuclear power to the procurement of specific equipment and services for the first nuclear power plant. The guidance provided in that publication is referred to as the Milestones approach. This guidance is supported by a set of technical publications such as the present publication, which aim to provide additional, more detailed information on activities related to the various areas dealt with as part of the Milestones approach. This guidance when transparently applied can help States create an enabling environment for nuclear power and reduce programmatic and project risk.

Safeguards is one of the 19 infrastructure issues to be addressed. Any country considering a nuclear power programme needs to plan to develop or strengthen its national safeguards infrastructure so that it can fulfil the increasing safeguards obligations associated with the introduction of nuclear power in a timely manner. Existing information relating to safeguards infrastructure is published in the IAEA Services Series and covers the full range of safeguards obligations, which are broader than those related to the introduction of nuclear power, and describes the desired end state and resulting outcomes. The IAEA Nuclear Energy Series also provides information on the concept of safeguards by design for different types of facilities.

This publication intends to place the relevant information into the phased approach of planning and implementation of a nuclear power programme used in other publications in the IAEA Nuclear Energy Series, the IAEA Safety Standards Series and the IAEA Nuclear Security Series. This publication further describes in detail the actions in connection with the implementation of safeguards that the three key organizations (the government/nuclear energy programme implementing organization; regulatory body/Member State authority responsible for safeguards implementation; and the owner/operator) will ideally take during each of the three phases of the development of a national infrastructure for nuclear power.

The IAEA wishes to acknowledge the assistance provided by the contributors to drafting and review listed at the end of the publication. The IAEA officers responsible for this publication were S. Dunlop of the Division of Concepts and Planning and M. Ceyhan of the Division of Nuclear Power.

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

Safeguards and export and import control of nuclear material and technology enable international nuclear commerce and contribute to ensuring the peaceful use of nuclear technology. They provide the requisite assurances that nuclear material and technology remain in peaceful use. A nuclear power plant requires significant quantities of nuclear material to generate electricity over a long operational lifetime. Significant quantity is a term of art for the approximate amount of a given type of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded.

A typical nuclear power reactor[1] will maintain approximately 65 significant quantities of nuclear material (e.g. low enriched uranium) in fresh fuel storage and 97 significant quantities in its core during operations. Spent fuel removed from the reactor on average every 18 months will contain approximately 36 significant quantities (of low enriched uranium and plutonium). In total, over a 60 year lifetime a typical nuclear power reactor will involve the use of something on the order of 2250 significant quantities of nuclear material.

Safeguards are a technical means to verify that this material remains in peaceful use in line with international obligations undertaken by the State. They involve a combination of domestic and international nuclear material accountancy, containment, and surveillance and inspection. Governments need to ensure that they as well as the nuclear power plant owner/operator and the regulatory body are prepared to fulfil all safeguards obligations as the nuclear power plant project develops.

National laws and regulations, and a system of accounting for and control of nuclear material, are needed to ensure that the requirements of the safeguards agreement, additional protocol (if applicable) and subsidiary arrangements are fully met. Infrastructure has to be developed in a timely fashion to ensure the provision of timely, correct and complete reports, declarations and other information to the IAEA, as well as the provision of support and timely access to the IAEA to locations and information necessary to carry out safeguards activities.

A nuclear power plant represents a long term national commitment — on the order of 100 years or more — through construction, operation, spent fuel management, decommissioning and waste disposal. Safeguards obligations will apply throughout the entire life cycle. A knowledgeable commitment to nuclear power includes a commitment to establish and maintain national safeguards infrastructure that meets the needs of this programme at all phases of its life cycle.

1.2. OBJECTIVE

This publication provides information on safeguards related activities that need to be carried out during each of the three phases of nuclear power infrastructure development. A country can use it to help ensure that:

(a) It understands the safeguards obligations associated with the introduction of nuclear power.
(b) The State or regional authority responsible for safeguards implementation (SRA)[2] and the nuclear power plant (NPP) owner/operator plan and systematically develop the necessary technical and

[1] A ~1000 MWe light water reactor.

[2] In this publication, it is assumed that an SRA exists before the country begins considering nuclear power. The SRA should be involved in the work of the government mechanism established or designated to coordinate the nuclear power programme, referred to here as the NEPIO. It is further assumed that the regulatory body that will be established by the end of Phase 2 will assume and exercise the responsibilities and functions of the SRA. Guidance on establishing an SRA can be found in Chapter 3 of IAEA Services Series No. 31 [17].

administrative competences on timescales consistent with the development of the nuclear power programme. This may require additional staffing and the development of training programmes and technical capabilities.

(c) It has, in a timely manner, adequately strengthened the SRA and its associated system of accounting for and control of nuclear material to (1) regulate and control the use of nuclear material and related activities associated with the nuclear power programme and, as necessary, all other nuclear material in the State; (2) provide correct and complete information, on time, to the IAEA; and (3) facilitate IAEA verification activities in the State through institutional arrangements and by providing access to IAEA inspectors.

Guidance and recommendations provided here in relation to identified good practices represent experts' opinions but are not made on the basis of a consensus of all Member States.

1.3. SCOPE

This publication describes the safeguards infrastructure and associated activities required for the implementation of a nuclear power programme, within the context of a country's international safeguards obligations. The safeguards infrastructure needs and activities are discussed in detail through all three phases of nuclear power infrastructure development described in the Milestones publication [1], from consideration and decision making, through programme implementation, contracting, construction, fuel delivery and preparation for NPP commissioning. Subsequent steps, including operation, spent fuel and radioactive waste management, and decommissioning are addressed to the degree necessary for informed decision making in the pre-project and project phases and timely planning.

1.4. STRUCTURE

Following this introduction, the second chapter of this publication provides an overview of some of the international instruments related to the non-proliferation of nuclear weapons that give rise to safeguards obligations and imply the need for a national system to control the export and import of nuclear material and certain equipment and technologies. The third chapter places the key safeguards infrastructure activities related to new nuclear power projects in the framework of the three phase approach (consider/plan–commit/prepare–contract/construct) defined in the Milestones publication [1] and describes the responsibilities of and interactions between the government/nuclear energy programme implementing organization (NEPIO), the regulatory body/SRA and the NPP owner/operator. References are made to the specific parts of existing IAEA publications in which detailed, relevant guidance already exists. The fourth chapter describes resources and assistance in this area that are available to States considering or embarking on nuclear power programmes. The information in this publication is enriched by, and in part derived from, case studies generously provided by five IAEA Member States with recent relevant experience in ensuring that their safeguards infrastructure was developed and adequate for new nuclear power plant projects. These case studies are included in this publication as annexes.

1.5. USERS

This publication is principally for decision makers, advisers and senior managers in governments, industry and regulatory bodies in Member States interested in introducing nuclear power. It may be of particular interest to individuals responsible for safeguards implementation at both State and facility levels, as well as for IAEA staff. Other organizations, such as NPP suppliers and organizations providing safeguards implementation assistance to countries considering or embarking upon nuclear power programmes, may use this publication to increase confidence that a country has the safeguards infrastructure necessary for introducing nuclear power or to identify areas for potential assistance.

2. NON-PROLIFERATION AND SAFEGUARDS OBLIGATIONS

Nuclear material used in the generation of electricity through fission and heat transfer could be used to manufacture nuclear weapons. Safeguards are a technical means to verify that nuclear material is not diverted to nuclear weapons or other nuclear explosive devices and is used exclusively for peaceful purposes. Through a number of international instruments, States undertake to accept the application of safeguards to nuclear material and activities on their territory or under their jurisdiction or control, including for nuclear power. For example, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) [2] requires its 186 non-nuclear weapon States Parties “to accept safeguards, as set forth in an agreement” to be negotiated with the IAEA “with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices.” A similar requirement for the conclusion of comprehensive safeguards agreements (CSAs) is set out in regional treaties establishing nuclear weapon free zones (e.g. Tlatelolco Treaty, Rarotonga Treaty, Bangkok Treaty, Pelindaba Treaty, Treaty of Semipalatinsk).

A large number of bilateral agreements on peaceful nuclear cooperation have been concluded between States for the purpose of facilitating the transfer of nuclear material and technology. These agreements are a common feature between supplier and recipient States of nuclear power plant technology and material. Most of these agreements require IAEA safeguards to be applied to any transferred nuclear material and to any material produced through or derived from any equipment or technology transferred.

2.1. SAFEGUARDS

In broadest outline, safeguards implementation at the national level comprises three main elements:

(a) Establishing and exercising regulatory control of nuclear material and related activities;
(b) Providing information to the IAEA;
(c) Facilitating IAEA verification activities.

Nuclear material accountancy and its verification in the field are at the core of safeguards implementation. In order to account for nuclear material, a State needs to know where all its nuclear material is at all times, including the uranium and plutonium commonly present in fresh or used NPP fuel, in what forms and quantities, and in which specific locations. This requires an adequate legal and regulatory framework and the effective implementation of the requirements therein that control the import, transport, possession, use, management and export of nuclear material, as well as the construction, operation and decommissioning of nuclear facilities. The concept of control extends from the State level down to the level of the operating organization, which needs to implement adequate facility level controls over the access to, use of and movement of nuclear material.

The authority established or designated to ensure and facilitate the implementation of safeguards for a State is referred to SRA. SRAs need to be able to collect correct and complete information from licensees and other entities for timely submission to the IAEA, including facility design information, import–export notifications, nuclear material accounting reports, and other declarations and reports.

At a nuclear power plant under safeguards, the IAEA uses containment and surveillance measures such as seals and cameras and conducts in-field verification activities, including inspections, to verify that the declared quantities of nuclear material are indeed in the quantities, forms and locations where they are declared to be and that there is no undeclared nuclear material or activity.

The primary documents that set out safeguards requirements and procedures are CSAs based on the document INFCIRC/153 (Corr.) [3], additional protocols based on the document INFCIRC/540 (Corr.) [4] and the subsidiary arrangements thereto. INFCIRC/153 (Corr.) [3] has been used by the IAEA as the basis for negotiating CSAs with non-nuclear weapon State and nuclear weapon State[3] Parties to the NPT. Such agreements require the establishment and maintenance of a State system of accounting for and control of nuclear material (SSAC). States with CSAs and very limited quantities of nuclear material may conclude a small quantities protocol (SQP) to their CSA, which holds in abeyance the implementation of certain safeguards procedures in Part II of the CSA and remains in effect as long as the State meets the SQP eligibility criteria. INFCIRC/540 (Corr.) [4] serves as the standardized model for an additional protocol to a CSA. An additional protocol significantly increases the IAEA's ability to verify the peaceful use of all nuclear material in a State with a CSA. It provides additional tools for verification by giving the IAEA broader access to information and locations in a State and improved administrative arrangements for designation of IAEA inspectors and issuance of long term visas. This can enable efficiencies for the IAEA, the State and facility operators.

2.2. EXPORT AND IMPORT CONTROLS

Nuclear export and import controls are practically necessary for States to implement obligations under the NPT [2], the Convention on the Physical Protection of Nuclear Material [5], the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [6], United National Security Council Resolution 1540 [7], safeguards agreements, additional protocols thereto and most bilateral nuclear cooperation agreements (NCAs). The objective of State level nuclear export and import control is to ensure that transfers of nuclear material and certain equipment and technology (whether into or out of the State) take place in a secure, safe and environmentally responsible manner. Another objective is to ensure that such transfers do not directly or indirectly assist any non-nuclear weapon State or any unauthorized person in developing or acquiring nuclear weapons. Responsible nuclear supplier States will insist on reasonable assurances that their nuclear exports will not be diverted to non-peaceful activities. Therefore, recipient States that do not apply adequate export and import controls cannot expect to receive the fullest measure of nuclear trade and cooperation.

There are a number of international regimes, initiatives and programmes to facilitate the implementation of effective nuclear export and import controls. Two of these regimes have established guidelines setting up rules for export and import controls, including the lists of materials and equipment that will be covered under those rules. The understandings of the Zangger Committee, INFCIRC/209/Rev.5 [8], are aimed at harmonizing the interpretation of nuclear export control policies for NPT parties and contain a list of nuclear material and equipment or material especially designed or prepared for the processing, use or production of special fissionable material identified as falling under the terms of Article III.2 of the NPT, the export of which is obliged to be subject to safeguards. A similar list is published as INFCIRC/254/Rev.14/Part 1 [9], which contains guidelines developed by the Nuclear Suppliers Group for the export of nuclear material, equipment and technology.

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[3] Article IX of the NPT defines a nuclear weapon State as "one which has manufactured and exploded a nuclear weapon or other nuclear explosive device prior to 1 January, 1967."

3. ENHANCING STATE SAFEGUARDS INFRASTRUCTURE FOR THE INTRODUCTION OF NUCLEAR POWER

This chapter describes key activities related to the implementation of safeguards that should be carried out during the three phases of considering, preparing for and constructing a new nuclear power plant. As described in the Milestones publication [1], Phase 1 consists of considerations before a decision to launch a nuclear power programme is taken. It culminates with the State's readiness to make a knowledgeable commitment to nuclear power. Phase 2 consists of preparatory work for the contracting and construction of a nuclear power plant after a policy decision has been taken. It culminates with readiness to invite bids/negotiate a contract for the new nuclear power plant project. Phase 3 consists of the contracting and construction related activities to implement the new nuclear power plant project and prepare for its operation. It culminates with readiness to load nuclear fuel into the reactor and operate the first nuclear power plant.

Three key organizations are involved, each with an evolving role in the nuclear power programme: the government, the owner/operator of the nuclear power plant and the regulatory body. It is assumed that the government will create a mechanism — the NEPIO — which may involve high level and working level committees to coordinate the development of the national infrastructure for nuclear power and that the SRA will be involved in this work. It is assumed that the regulatory body that will be developed in Phase 2 will assume and exercise the responsibilities and functions of the SRA.

Considering safeguards from the earliest part of the nuclear power programme planning can help ensure that international safeguards requirements are met and may lower the cost of safeguards implementation during construction and operation and reduce interference in nuclear power plant operations. It can also help avoid the need for future retrofits and changes to the nuclear power plant design to ensure that licensing requirements related to safeguards can be met. For this reason, if the future owner/operator has been identified, it should also participate in the work of the NEPIO and coordinate with other stakeholders as early as possible.

Figure 1 indicates some of the programmatic and project related steps that are important during the three phases of nuclear power infrastructure development. The safeguards activities of each of the three key organizations are placed in this context. Each activity is described in detail in this section with additional references provided.

3.1. ACTIVITIES IN PHASE 1

During Phase 1 of nuclear power infrastructure development, the government should establish or designate an existing entity to function as the NEPIO [10]. The NEPIO should coordinate the preparatory work needed to guide the country to Milestone 1, where the State would be in a position to make a knowledgeable commitment to a nuclear power programme. The SRA should participate in the work of the NEPIO. If the NPP owner/operator has already been identified, it should also participate. Among other things, the NEPIO should identify all that the nuclear power programme will require to enable the effective implementation of safeguards. If at the end of Phase 1 the country decides to commit to a nuclear power programme, specific plans to address any gaps, enhance the national safeguards infrastructure and prepare the key organizations to fulfil all their safeguards obligations should be elaborated as part of a comprehensive report defining and justifying the national strategy for nuclear power. The key safeguards infrastructure development activities in Phase 1 are as follows.

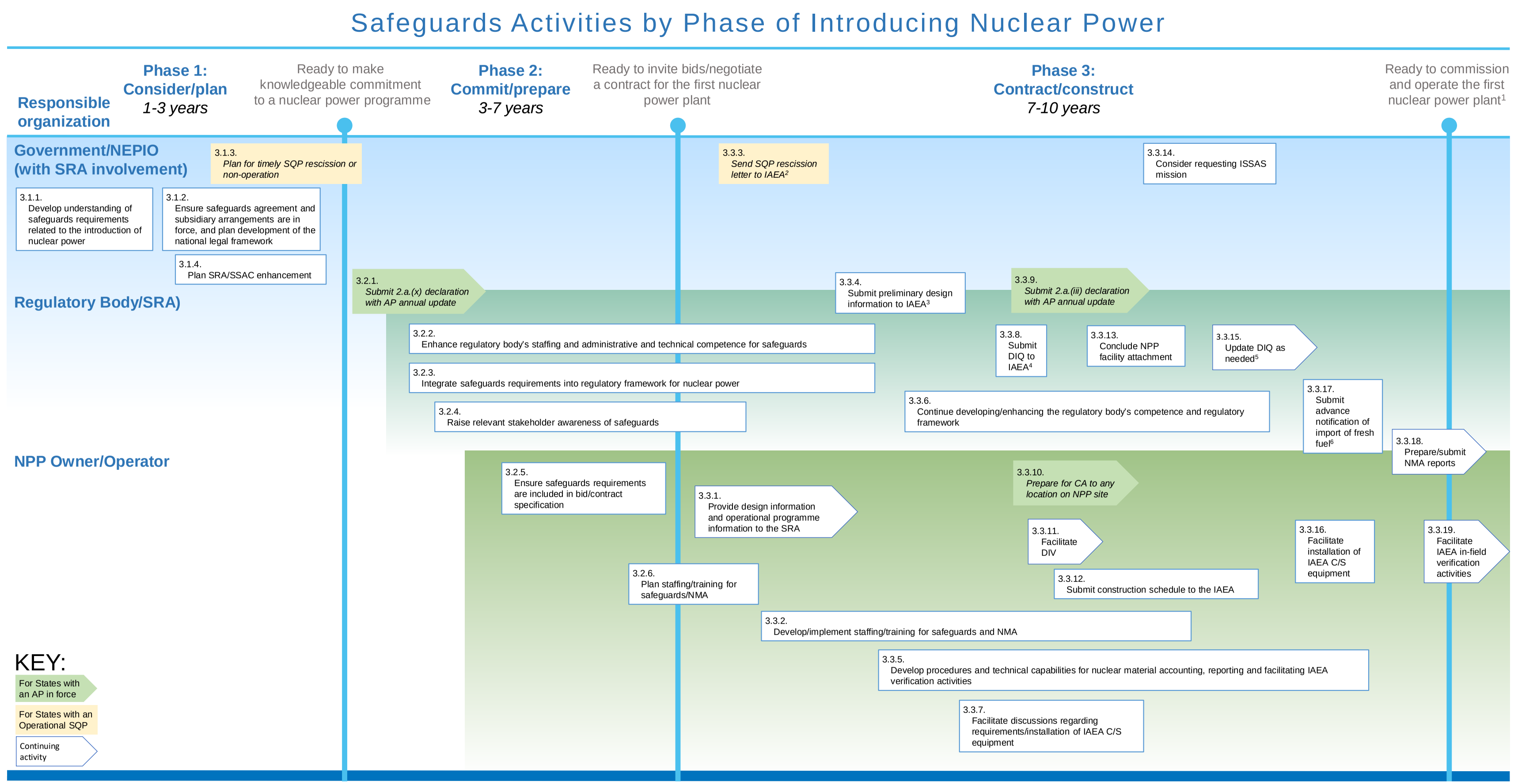

FIG. 1. Activities to establish and implement safeguards infrastructure by phase of introducing nuclear power (see List of Abbreviations for the definitions of abbreviations used in this figure) (part 1).

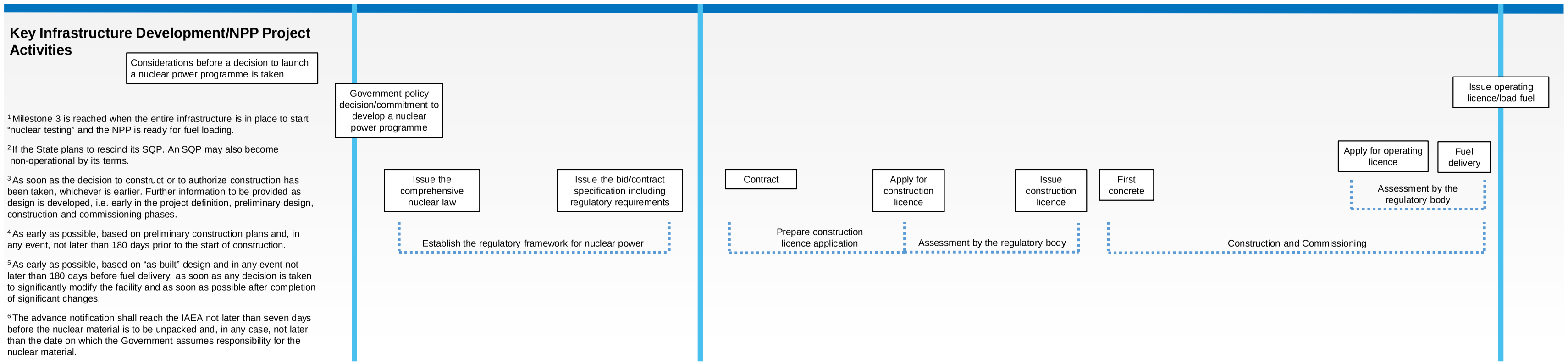

FIG. 1. Activities to establish and implement safeguards infrastructure by phase of introducing nuclear power (see List of Abbreviations for the definitions of abbreviations used in this figure) (part 2).

3.1.1. Develop understanding of safeguards requirements related to the introduction of nuclear power

The NEPIO should study the safeguards implications of implementing a nuclear power programme in detail and ensure that all relevant stakeholders, including policy makers, legislators, the SRA, regulatory bodies, export control authorities and holders of nuclear material, are sufficiently aware of the requirements and their timing to make informed decisions, assess the adequacy of the legal and regulatory framework, and develop the necessary programmes, competences and institutional arrangements. A needs analysis may be prepared, which could include the development of or enhancements to regulatory staffing and expertise, regulatory frameworks, administrative and technical systems, reporting mechanisms and access arrangements for IAEA inspectors. Meeting these needs may require changes to the national legal framework, new funding and resourcing arrangements, and engagement with new national and international stakeholders.

The NEPIO may wish to study the organizational aspects of safeguards related programmes in other States' regulatory bodies and NPP owner/operators, particularly in States that have recently embarked on nuclear power programmes. At a minimum, the NEPIO ought to familiarize itself with the activities described in this publication for Phases 2 and 3 in order to develop plans and ensure that all necessary resources will be in place, should the State decide to proceed with the nuclear power programme. A clear commitment by the government to embedding the importance of safety, security and non-proliferation in the work to develop and implement a nuclear power programme is both expected and useful. Governments may wish to specifically highlight their intentions with regards to safeguards and export controls.

3.1.2. Ensure safeguards agreement and subsidiary arrangements are in force, and plan development of the national legal framework

Most embarking countries already have a CSA in force with the IAEA in connection with the NPT. Such agreements are based on The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/153 (Corr.) [3]. A CSA is required for non-nuclear weapon State Parties to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and Parties to regional nuclear weapon free zone treaties. It is also required by the Treaty on the Prohibition of Nuclear Weapons [11]. The government will need to ensure that its safeguards agreement fulfils the requirements of any countries in which it wishes to engage suppliers of nuclear material or technologies for the project. Nuclear suppliers may require as a condition of supply a safeguards agreement with the IAEA, with an additional protocol thereto, for example.

The IAEA's Handbook on Nuclear Law [12] and Handbook on Nuclear Law: Implementing Legislation [13] provide key reference material for stakeholders involved in the process of drafting national legislation. establishing or revising a legal framework for the development and use of nuclear technology and the use of nuclear material.

While some embarking countries may have a national legal and regulatory framework in place to meet the requirements of these agreements, this legislation may need to be modified or enhanced to support the increased safeguards requirements that come with a nuclear power programme. For example, more detailed regulatory requirements for accounting for and controlling nuclear material may need to be established, and licensing frameworks may need to be adjusted. A number of legislative approaches could provide an adequate framework for safeguards implementation, depending on legal customs and existing legislation.

The NEPIO is encouraged to seek legal advice both domestically and internationally on how safeguards requirements specific to the nuclear power programme may be integrated into the national framework. IAEA peer review and advisory services such as the Integrated Nuclear Infrastructure Review (INIR) and the IAEA Safeguards and SSAC Advisory Service (ISSAS) missions commonly identify areas where a State could further develop its national legal framework to support the effective implementation of safeguards and export and import controls and ensure that the national laws are consistent with the obligations arising out of the State's safeguards agreement. The NEPIO may also seek inspiration from the legal frameworks established by other States in relation to safeguards.

The Milestones publication [1] suggests that Member States review and enact/amend all legislation that may be relevant to the nuclear power programme other than the comprehensive nuclear law. This legislation may contain provisions that affect the implementation of national safeguards system and export and import controls. Conditions 5.2 and 5.3 in Evaluation of the Status of National Nuclear Infrastructure Development [14] provide States with a summary that can help them assess their plans for development of a comprehensive national nuclear law, as well as plans to enact and/or amend other legislation affecting the nuclear power programme.

3.1.3. If applicable, plan for the timely rescission of the SQP or its non-operation

Introducing nuclear power will render a country ineligible for an operational SQP to its CSA. The timing of the ineligibility depends on the type of SQP in force. All States with an operational SQP — meaning the State currently has minimal or no nuclear activities — need to develop a plan to prepare for the moment when the implementation of safeguards procedures in Part II of the State's CSA, previously held in abeyance (or suspended), cease to be held in abeyance. This will have implications for national stakeholders that otherwise might have no connection to the nuclear power programme, such as users of small quantities of nuclear material in hospitals, universities and industries. The change in status can happen in one of two ways, at the discretion of the State:

(a) The State may rescind its SQP at any time; or
(b) The SQP will become non-operational when a State no longer meets the eligibility criteria.

The State should choose one of these paths and prepare itself and all relevant stakeholders so that it is ready in a timely fashion to fulfil all of the provisions in its CSA. The IAEA maintains a status list[4] regarding the conclusion of safeguards agreements, additional protocols and SQPs that indicates which countries have SQPs, whether the SQP is based on the original or revised standard text and for which, as far as the Secretariat is aware, the eligibility criteria continue to apply.

A rescission can be effected by an exchange of letters between the State and the IAEA constituting an agreement to rescind the SQP. The State may send a letter to the IAEA proposing to rescind its SQP, and the IAEA will accept the proposal and respond accordingly to the State acknowledging that the SQP has been rescinded. All safeguards procedures in Part II of the CSA will apply from the date the rescission is effective.

For States with an SQP based on the revised standard text (approved by the IAEA Board of Governors 20 September 2005) [15], the main new requirements will relate to nuclear material accounting and operating records at locations outside facilities (LOF) (and future facilities, including the NPP), nuclear material accounting reports, IAEA inspections and future transfers of nuclear material out of the State. This will have implications for the national stakeholders described above.

The obligation of the State and the IAEA to make subsidiary arrangements will also become subject to timeliness requirements. For States with an SQP based on the original standard text (i.e. an unmodified SQP concluded prior to 20 September 2005) [16], in addition to the requirements just described, there will also be new requirements, including the submission of an initial nuclear material inventory report, provision of information on LOFs and other obligations related to IAEA inspections. Many of the reporting obligations are time-bound; for example, the initial report has to be dispatched by the State to the Agency within 30 days of the last day of the calendar month in which the SQP ceased to be operational

[4] See: Conclusion of Safeguards Agreements, Additional Protocols and Small Quantities Protocols, Status as of 31 December 2022, https://www.iaea.org/sites/default/files/20/01/sg-agreements-comprehensive-status.pdf

or was rescinded. The State will need to plan and implement the necessary enhancements to its safeguards infrastructure and SSAC to ensure all obligations can be met.

A State could also be in a situation whereby its SQP becomes non-operational by its terms. An SQP based on the revised standard text remains operational as long as the State has nuclear material in quantities not exceeding the limits stated in paragraph 37 of INFCIRC/153 (Corr.) [3] and has not taken a decision to construct or authorize construction of a facility. An SQP based on the original standard text remains operational as long as the State has nuclear material in quantities not exceeding the limits stated in paragraph 37 of INFCIRC/153 (Corr.) and has no nuclear material in a facility. The IAEA will inform the State when the State's SQP has become non-operational. For a State with an SQP based on the revised standard text, this could happen when the IAEA has information that a decision to construct or to authorize construction of a facility has been taken. Since all Part II measures will cease to be held in abeyance from this date, it is important that all stakeholders who will have new safeguards obligations prepare in advance of such a decision. This includes ensuring that institutional arrangements are in place with all relevant authorities to enable the acceptance of the designation of IAEA inspectors and the entry of inspectors and their equipment into the State.

For a State that plans to rescind its SQP in preparation for the introduction of nuclear power, a logical and practical time to plan to do so would be no later than when the owner/operator plans to apply for a construction licence. This will facilitate early preparation and the timely provision of design information for the new facility. The IAEA will need to develop a safeguards approach including equipment and activities that will need to be incorporated into the facility plans. Early provision of design information gives more time to accommodate each party's needs, leading to fewer design changes and achieving overall cost savings. This will be discussed in more detail in Section 3.3.4.

Chapter 13 of the Safeguards Implementation Guide for States with Small Quantities Protocols [17] contains additional information regarding situations that result in an SQP becoming non-operational and information about the implementation of all measures in Part II of a CSA.

3.1.4. Plan SRA/SSAC enhancement

In addition to developing the national legal framework as described in Section 3.1.2, other aspects of the SRA/SSAC will likely require enhancement as well. The extent and significance of the enhancements required will depend on the safeguards framework that already exists in the State. For a State that already has a nuclear facility — for example, a research reactor — and is already implementing all safeguards procedures in Part II of its CSA, these enhancements may be less significant than those required for a State with little or no nuclear material and an operational SQP; however, experience indicates that additional staffing and resources are almost always required when introducing nuclear power. Some key areas that will require study and attention include the State safeguards information management system, procedures for nuclear material accounting and control, arrangements for import and export controls, the domestic inspection/audit programme to ensure compliance with safeguards requirements, and resources and training.

A good strategy for this type of planning is for the NEPIO to approach the task as it will for a number of other infrastructure issues. The NEPIO should first develop its understanding of the safeguards requirements the nuclear power programme will entail, as described in Section 3.1.1. It ought to familiarize itself with the practices and approaches of a variety of countries, including those with similarly sized nuclear programmes. Attention should be paid at both the national level and the project/facility level. The NEPIO should make a detailed assessment of what infrastructure is already in place and identify any gaps or areas for enhancement. Then it should plan specific activities with responsibilities assigned to appropriate stakeholders with a timeframe that is consistent with the nuclear power project and the country's nuclear infrastructure development as a whole. The NEPIO should incorporate the existing SRA and any existing regulatory bodies with responsibilities related to safeguards into the planning from an early stage. Several Member States successfully organized their SRA/SSAC enhancement as a defined project with a project manager following a phased approach. Some specific examples are included in the case studies in the annexes.

The IAEA's Safeguards Implementation Practices Guide on Establishing and Maintaining State Safeguards Infrastructure [18] may be a useful resource during this planning phase. Among other things, it contains information on human, technical and financial resources and safeguards staffing levels for five States with varying levels of nuclear activities and facilities. It also contains a model regulation for implementing CSAs and additional protocols (Annex I), which is available in several languages.

The IAEA's Safeguards Implementation Practices Guide on Provision of Information to the IAEA [19] contains detailed considerations on establishing a State safeguards information management system (Chapter 3), as well as case studies of different States' experiences in developing such systems (Annex III).

3.2. ACTIVITIES IN PHASE 2

At the beginning of Phase 2 of nuclear power infrastructure development, the government will commit to develop the infrastructure for the nuclear power programme based upon the studies, plans and recommendations elaborated in Phase 1. Some of the key activities in this phase will include the enactment of the comprehensive nuclear law, the development of the regulatory body and regulatory framework, and the establishment of the NPP owner/operator. In Phase 2, the owner/operator will primarily engage in project development while preparing itself to evolve significantly in Phase 3 to oversee construction and commissioning and prepare for operation. In Phase 2, several of the safeguards infrastructure development activities will be the responsibility of the government and/or the regulatory body. A few activities will be the responsibility of the nascent owner/operator. This phase provides an opportunity to begin developing effective interfaces and lines of communication between the key organizations. Such institutional arrangements will become even more important during Phase 3 and, eventually, operations. Dialogue in Phase 2 on safeguards requirements can help stakeholders manage the impact of safeguards on the design and reduce risk related to the construction cost, licensing and the overall schedule.

3.2.1. If applicable, begin submitting Article 2.a.(x) declarations on the planned introduction of nuclear power with the additional protocol annual update

For States with an additional protocol in force, general plans approved by the government relevant to the development of the nuclear fuel cycle, including the planned nuclear power programme, are declarable under Article 2.a.(x) of the additional protocol as part of the initial declaration and annual updates. As the nuclear power programme is implemented, the annual updates to the 2.a.(x) declaration can include additional details that may become available from year to year until preliminary design information or a first design information questionnaire (DIQ) is prepared and submitted.

Annex XI of the IAEA's Safeguards Implementation Practices Guide on Provision of Information to the IAEA [19] includes examples of increasingly detailed 2.a.(x) declarations leading to the preparation and submittal of a DIQ.

Since the additional protocol requires that updates to 2.a.(x) declarations be provided to the IAEA by 15 May each year, it is important for the regulatory body to establish a process to ensure it receives the necessary information from all stakeholders in a timely fashion.

3.2.2. Enhance the regulatory body's staffing and administrative and technical competence for safeguards

In Phase 2, the regulatory body should take ownership of and implement the plan described in Section 3.1.4., making any adjustments it deems necessary and appropriate while maintaining effective interfaces and lines of communication with the NEPIO. The regulatory body needs to ensure that it will be ready to fulfil its evolving SRA responsibilities in Phases 2 and 3 and commissioning and operations. The regulatory body should develop its management system as needed and ensure that roles, responsibilities, organizational structure and processes, including record keeping, are well defined. Processes and procedures related to safeguards implementation should be planned, developed and documented, and the necessary supporting documentation should be maintained. Self-assessments and independent assessments of the management system should be conducted regularly to evaluate the system's effectiveness and identify opportunities for its improvement. Root cause analysis and corrective action plans can help address underlying problems, prevent recurrences and improve procedures and instructions.

IAEA Safety Standards Series No. GSR Part 2 [20] provides requirements related to management systems in organizations, including regulatory bodies. Experience from Member States in developing, applying, sustaining and improving management systems was taken into account in the development of this safety standard.

The applicability of quality management principles to safeguards implementation is discussed in Chapter 6 of the Nuclear Material Accounting Handbook (IAEA Services Series No. 15) [21] and Chapter 7 of the Safeguards Implementation Practices Guide on Establishing and Maintaining State Safeguards Infrastructure (IAEA Services Series No. 31) [18].

3.2.2.1. Staffing

Competence management should be integrated into the regulatory body's management system, and programmes to develop and manage competence within the regulatory body should cover all regulatory functions and responsibilities — including for safety, security and safeguards.

IAEA Safety Reports Series No. 79, Managing Regulatory Body Competence [22] provides general guidance on competence management, a competence model for the regulatory body, guidance on conducting a systematic competence analysis and information on methods of acquiring competence. Appendix V provides a set of considerations for applying the competence model in regulatory bodies in States embarking on nuclear power programmes.

IAEA TECDOC-1757 [23] provides a detailed methodology for the systematic assessment of the regulatory competence needs (SARCoN) for regulatory bodies of nuclear installations.

While the guidance documents referenced in the two boxes above are based largely on the requirements in the IAEA Safety Standards Series, the information and methodology are also relevant to safeguards competence. Safeguards and export and import control requirements should be incorporated into the regulatory body's programmes and processes related to competence management.

Implementation of this guidance will result in gap analysis and the identification of short and long term priorities for addressing any current or foreseen staffing and competence gaps. The gap analysis ought to consider the frequency and complexity of safeguards activities, the staffing levels required to carry out these activities and the competences of those staff. Gaps can be addressed through recruitment, reorganization and replacement, use of external support, participation in knowledge networks and/or the establishment of training and development programmes. Competence could be developed in partnership with relevant industry stakeholders, but care needs to be taken to ensure and maintain regulatory independence. The systematic approach to training (SAT) provides a logical progression from the analysis of competences required to perform specific functions to the design, development, implementation and evaluation of training.

Some examples of SRA training and development programmes related to safeguards can be found in Chapter 5 of IAEA Services Series No. 31 [18].

Processes, methodology and practices for implementing the SAT can be found in IAEA Nuclear Energy Series No. NG-T-2.8 [24].

3.2.2.2. *Administrative systems*

The SRA's administrative systems should be aligned with the type of safeguards agreement in force for the State, for example whether the country has an operational SQP or is implementing all safeguards procedures in Part II of the CSA and whether or not the country is implementing an additional protocol. The SRA needs to ensure that it develops administrative capabilities to serve the needs of the nuclear power programme, such as the ability to make timely travel arrangements, to be on-site for IAEA in-field verification activities, to maintain working hours/on-call arrangements that match the needs of the project, etc.

The SRA's systems involving the management and communication of data and information need particular attention. While not explicitly required by safeguards agreements, a safeguards information management system is helpful, recommended and, in practical terms, essential. If necessary or desirable, the SRA should decide on a strategy for implementing or enhancing its safeguards information management system. This could be done through commercial off the shelf procurement of either specialized SSAC software or generic database and workflow software in which a product can be custom designed to match a specification of national requirements, taking due account of input and feedback received from relevant stakeholders, including the owner/operator and other licensees and entities. There are also customizable nuclear material accounting software solutions available with modular structures. If sufficient resources are available, SSAC software could be developed by the SRA, potentially allowing for integration with other regulatory data systems. Whatever strategy is adopted, sufficient time should be allocated for specification, development and testing. Sustainability issues should be considered. SRAs may find it useful to plan to submit nuclear material accounting declarations in Code 10 labelled or .xml format rather than fixed format, if they are not already doing so, given the typical reporting needs of a nuclear power programme.

Chapter 3 of the IAEA's Safeguards Implementing Practices Guide on Provision of Information to the IAEA (IAEA Services Series No. 33) [19] includes detailed information regarding considerations in designing a safeguards information management system and in its Annex III also includes case studies of States' experiences in designing and establishing safeguards information management systems and related software applications to support the collection and management of information.

Chapter 4 of the same guide [19] discusses communications channels and information flows that need to be well established at formal and working levels between the SRA, the IAEA, the State's permanent mission to the IAEA and/or ministry of foreign affairs, facility and LOF operators and, if applicable, other additional protocol reporting entities in the State.

The IAEA strongly recommends that States submit safeguards related information and data in electronic format. One effective and efficient method that requires encryption is the use of the IAEA's State Declarations Portal (SDP), which establishes a secure channel for timely communication between States and the IAEA. The use of this system can save time and effort by reducing transcription errors, facilitating quality control and increasing institutional memory. The IAEA also prefers to receive additional protocol declarations in electronic format prepared using the current version of the IAEA's Protocol Reporter software.

3.2.2.3. *Technical capability*

An effective SRA should have technical capabilities aligned with the types and amounts of nuclear material present in the State and the size and nature of the State's nuclear fuel cycle. For example, a State with an operational nuclear power plant will maintain inventories of unirradiated uranium and irradiated uranium and plutonium. The SRA should make provision, as appropriate, for the establishment of technical measures to ensure the accuracy of measurements of such material. Such measures could include the ability to make or arrange for independent measurements of these types of materials and the ability to evaluate the precision and accuracy of measurement uncertainty. Handheld spectrometers can be used for attribute verification of fresh fuel. Germanium detectors can be used to verify uranium enrichment.

SRAs may also be interested in developing their theoretical and practical understanding of the function of IAEA non-destructive assay equipment commonly used for the IAEA's independent verification of nuclear materials in a nuclear power programme. This may facilitate communications with relevant entities such as the owner/operator, customs and security services to ensure the equipment's smooth acceptance into the State and into facilities. This equipment includes uranium neutron coincidence collars for fresh fuel verification and a variety of equipment used for spent fuel verification, including fork detectors for verifying highly radioactive spent fuel assemblies stored underwater in spent fuel ponds, Cerenkov viewing devices used to conduct attribute testing of the presence of spent fuel in storage pools and multichannel analysers paired with gamma detectors used for verification of uranium enrichment and radiation signatures of spent fuel.

To assure the absence of undeclared nuclear material and activities in facilities subject to safeguards, the IAEA has the right to take environmental samples in facilities, including nuclear power plants in States both with and without additional protocols in force. The SRA and the operator can request samples to be taken for their own analysis or archives. The SRA may wish to develop the capability, perhaps with support from a technical support organization or contractor, to maintain chain of custody of samples and conduct independent analysis if necessary for their own purposes.

3.2.3. Integrate safeguards requirements into the regulatory framework for nuclear power

Detailed national requirements related to safeguards implementation are usually established by regulations or set out in licences or permits. The regulations may include requirements beyond those deriving from the State's safeguards agreement in order to meet other national objectives, for example related to nuclear security or obligations in NCAs. Regulations related to the implementation of safeguards at the national level typically establish detailed requirements for licensees, incorporating obligations such as submission of reports and declarations and record keeping in the national regulatory requirements.

Chapter 3 of the Handbook on Nuclear Law [12] and Chapter 3 of the Handbook on Nuclear Law: Implementing Legislation [13] provide guidance on all aspects of licensing, including licence conditions.

Regulations and authorization with regards to safeguards implementation are discussed in detail in Sections 2.3, 2.4 and 4.3 and in Annexes II and VIII of Safeguards Implementation Practices Guide on Establishing and Maintaining State Safeguards Infrastructure (IAEA Services Series No. 31) [18].

A process for authorization of activities subject to regulatory control, which may involve the issuance of permits or licences, is an essential tool to compel licensees to meet established regulatory requirements. Additional conditions can also be specified in licences that are compulsory for licensees. With respect to safeguards implementation, for example, the regulatory body should require information from licensees in order to prepare and submit reports and declarations to the IAEA. The regulation should require that the licensee establish a system to collect and prepare such information (e.g. the requirement for establishing a nuclear material accounting system at the nuclear power plant, forms and timeliness for submission of reports and declarations, provisions for submitting design information, etc.), while the licence might prescribe details such as the content, format and timing of certain reports or data to be provided to the SRA. The licence could also specify details regarding such information as nuclear material accounting data, the format and granularity of design information, and the facility's operational programme.

Plans should be developed for the type of licences that need to be granted or amended as the nuclear power project develops. In addition, licensing integration between regulatory disciplines such as safety, security, safeguards, and import and export control should also be carefully considered to minimize overlapping or contradicting requirements. The regulatory body should communicate clearly with licence applicants to ensure that licences can be implemented efficiently and effectively while meeting the necessary regulatory control requirements.

Requirements that might be elaborated in specific licence conditions could include provisions for:

— Maintaining records, including operating records and nuclear material accounting records;

— Reporting the inventory of nuclear material and any changes to it (consistent with IAEA report content, format and timing);
— Performing measurements of nuclear material and maintaining required measurement control programmes;
— Submitting design information and any changes to it;
— Conducting physical inventory taking;
— Submitting advance notification regarding the import or export of nuclear material;
— Maintaining physical protection measures with respect to nuclear material and facilities;
— Granting of access and provision of support for IAEA activities at the operator/licensee location;
— Taking of samples and shipping of samples out of the State;
— Submitting special reports, for example regarding the loss of nuclear material in excess of prescribed limits;
— Qualification of personnel to carry out particular activities;
— Support and maintenance for IAEA installed equipment (e.g. continuity of power supply, lighting, ensuring that necessary measures are taken to protect the equipment from adverse environmental conditions, etc.).

In Phase 2, the priority regulations, conditions and guides to be developed will be those related to authorizing and overseeing nuclear power plant construction. If the regulatory body issues a licence for construction of a nuclear power plant, at a minimum the licence conditions should include provisions for submitting design information and any changes to it and granting access and providing support for IAEA verification activities at the site. The regulatory body will still have time to develop regulations, conditions and guides related to commissioning and operation. The conditions for an operating licence, while avoiding repetition of requirements set out in regulations, should cover all necessary requirements to ensure the effective implementation of safeguards.

Since effective nuclear export and import controls are important tools that support the implementation of safeguards, the national nuclear export and import control system may also need to be established or enhanced. This includes assigning agencies with clear responsibilities for regulating and controlling nuclear exports and imports. The competent authority or authorities should issue a regulation or regulations describing the application and approval processes for nuclear exports and imports and the corresponding requirements.

Safeguards regulations may need to be reviewed in Phase 3 after the selection of the NPP technology, as this may require technical modifications to certain requirements.

3.2.4. Establish effective mechanisms for communication with relevant stakeholders to raise awareness of safeguards

The SRA’s participation in the work of the NEPIO provides an opportunity to help ensure that all relevant stakeholders in the nuclear power programme develop an appropriate level of awareness of safeguards implementation issues. In Phase 2, what is especially important is that the owner/operator’s project development team has sufficient knowledge to include appropriate requirements in the bid invitation/contract specification and the ability to engage effectively with potential suppliers and the SRA.

Some States have used the opportunity provided by the nuclear power programme to enhance safeguards infrastructure in the State as a whole. For example, some States have created a safeguards working group. Such a mechanism is especially important in States with operational SQPs that need to coordinate the efforts described in Section 3.1.3. Early involvement of the main licensees in efforts to enhance the safeguards regulatory framework and the SSAC as a whole can help to clarify needs and avoid ambiguities regarding the obligations and requirements needed to secure and maintain licences.

In addition to its project development functions, the owner/operator in Phase 2 will need to prepare plans to develop its organization to supervise implementation of the engineering, procurement and construction (EPC) contract in Phase 3. This work will require some safeguards competence, and certain staff with responsibility for safeguards will need to be identified and put in place early. The SRA can help the owner/operator understand the safeguards responsibilities it will have in Phase 3 and how those responsibilities will evolve so that it can plan appropriately.

3.2.5. Ensure safeguards requirements are included in the bid invitation/contract specification

Safeguards requirements should be included in all relevant contract specifications, including for the EPC/general contract for the nuclear power plant and any additional contracts related to nuclear fuel. These specifications should seek to ensure that safeguards requirements be adequately addressed in the design documentation. There are no generic safeguards requirements included in either the European Utility Requirements or the Utility Requirements Document, so it would be useful for owner/operators to study the experience of other utilities and request information as needed.

The IAEA provides a set of safeguards considerations related to reactor design in Chapter 4 of International Safeguards in the Design of Nuclear Reactors (IAEA Nuclear Energy Series No. NP-T-2.9) [25].

The basic requirements for IAEA equipment include physical space, uninterruptible power supply and a mechanism for data transmission. Remote monitoring is seen as an effective and efficient practice that can reduce impact on NPP operators. Provisions regarding cabling and penetrations to be provided by the supplier should be included. The plant design will need to enable IAEA access for safeguards equipment maintenance and design information verification (DIV) (e.g. containment and piping) and ensure adequate illumination for visual observation and surveillance. The equipment hatch, important fuel transfer canals, missile shields and key measurement points and junction boxes should all be sealable with IAEA seals. The owner/operator may also wish to specify the requirement to share design information with the IAEA.

The safeguards requirements in a bid/contract specification for the facility may handle the following subjects:

- Limiting the number of access points into rooms where fresh or spent fuel is handled or stored;
- Fuel transport routes that are easy to monitor;
- Adequate and continuous illumination in camera controlled areas;
- Protection of safeguards surveillance devices from external hazards;
- Provision of electricity and data cabling for safeguards instrumentation;
- Facilitation of remote monitoring of safeguards surveillance equipment;
- Separation of surveillance equipment from the rest of the plant systems;
- Dedicated, accessible and environmentally controlled room for the instrumentation and control of the safeguards surveillance devices;
- Observing safeguards instrumentation status at the main control room;
- Accessibility to the surveillance devices;
- Markings of the surveillance devices;
- Clarity of the water in the fuel pools;
- Participation in the safeguards by design (SBD) process.

Chapter 7 of Safeguards Implementation Practices Guide on Facilitating IAEA Verification Activities (IAEA Services Series No. 30) [26] contains detailed information on the use of IAEA equipment in facilities, including systems installed in the facilities. The required infrastructure, such as wiring, electricity, lighting, conduit, cabling, cabinets, storage space, racks and internet connectivity, is described.

Chapter 3 of International Safeguards in the Design of Facilities for Long Term Spent Fuel Management (IAEA Nuclear Energy Series No. NF-T-3.1) [27] provides safeguards considerations in spent fuel management, including transfers of spent fuel inside the plant and wet storage of spent fuel. These could inform requirements to be included in the bid invitation/contract specification.

Considerations related to dry storage, encapsulation and geological disposal of spent fuel may be of interest for future planning.

Detailed requirements should be included in the bid invitation/contract specification and communicated to the plant designer and supplier at the design phase so that the outcome fulfils the contract and serves the purpose. The owner/operator is encouraged to ask the supplier to provide a simplified 3-D model that is sufficiently accurate to help the IAEA determine where the placement of safeguards equipment will be most efficient and effective (e.g. locations on walls, containment, etc., as needed).

Whether or not there are specific legal or regulatory requirements for SBD, as a matter of regulatory practice, the SRA and/or the NEPIO should confer with the owner/operator in preparing the bid/contract specification to encourage inclusion of requirements to incorporate IAEA safeguards considerations in the design of the facility. This practice would ensure that the supplier is directly motivated to work according to SBD principles. If requirements for safeguards infrastructure are not included in the specification, installation of safeguards instrumentation may be more complicated and costly, and safeguards implementation may be negatively affected.

Additionally, the owner/operator may wish to specify that the supplier should provide safeguards related training and human resource management support during construction and the warranty period, tools and software for storing, maintaining and reporting safeguards related data/information, and support in developing the facility level safeguards procedures as part of the management systems for construction and operation. Assuming that the owner/operator desires such services and tools, the bid invitation/contract specification should include clear provisions in order to facilitate adequate and timely delivery.

3.2.6. Plan owner/operator staffing and training programmes for safeguards, including nuclear material accounting

The owner/operator should decide how it will organize and manage programmes related to safeguards. The IAEA suggests that at the facility level, nuclear material accounting and control could be the responsibility of a nuclear material control unit consisting of a safeguards implementation officer and one or more nuclear material accountants.

Chapter 5 of Nuclear Material Accounting Handbook (IAEA Services Series No. 15) [21] describes the development of the accounting and reporting elements necessary for nuclear material accounting at the facility level.

Each of these positions will require a job description and there may be regulatory requirements regarding the qualifications and/or certification of such staff. Even in the absence of regulatory requirements, the owner/operator may wish to establish its own qualifications and/or certification programme for safeguards staff, since meeting safeguards obligations will likely be a condition for maintaining authorizations such as construction or operating licences.

The SRA and owner/operator should work together to identify potential safeguards training opportunities. The SRA or the supplier may be able to provide or facilitate some safeguards training. While certain owner/operator staff will require in-depth, job specific safeguards training, including periodic refresher training, it may be useful to incorporate basic information about safeguards in the training programmes developed at the NPP training centre to ensure that relevant non-specialist staff have general awareness about safeguards requirements and the reasons for those obligations.

Chapter 15 of Safeguards Implementation Practices Guide on Facilitating IAEA Verification Activities (IAEA Services Series No. 30) [26] contains examples of content for a comprehensive training course for facility operators on the provision of safeguards information.

3.3. ACTIVITIES IN PHASE 3

During Phase 3 of nuclear power infrastructure development, the owner/operator will negotiate the contract(s) for the EPC and commissioning of the nuclear power plant and manage the nuclear power plant project implementation. This will include applying for the required licences and supervising the construction. The activities at the nuclear power plant site will come under regulatory control, and by the end of Phase 3, nuclear fuel will have been delivered, and a licence for fuel loading/operation will have been issued by the regulatory body. The State will need to provide complete, correct and timely information to the IAEA as per the requirements of the State's safeguards agreement and subsidiary arrangements. The IAEA will begin its in-field verification activities in Phase 3 and both the owner/operator and the regulatory body need to prepare their organizations for such verification activities during construction, commissioning and operation.

3.3.1. Provide design information and operational programme information to the SRA

The owner/operator should submit preliminary design information to the SRA as soon as the decision to construct the nuclear power plant has been taken. This declaration should include information about the owner/operator; the purpose, location and type of reactor; power; and a preliminary timeline for contracting, construction, commissioning and operation. The owner/operator should update this as soon as new information becomes available and confirm annually and prior to any inspection that it is up to date. The intervals/reporting deadlines prescribed by the regulatory body for such information should be specified in regulations apart from the licensing process because no regulatory authorization related to the nuclear power plant is envisaged in early Phase 3.

One fundamental function of the SSAC is facilitating a flow of information that ensures that all required information will be provided to the IAEA within the timeframe required by the State's safeguards agreement and subsidiary arrangements. This starts with a clear understanding between the regulatory body/SRA and the owner/operator about requirements and expectations for providing and updating information about the plant and its schedule of activities. The better all parties understand the drivers and constraints for certain requirements, the easier it can be to innovate, identify potential efficiencies and incorporate all requirements regarding the provision of safeguards information in the owner/operator's core processes and procedures.

3.3.2. Develop/implement staffing/training in the owner/operator for safeguards, including nuclear material accounting

In Phase 3, the owner/operator should implement the staffing and training plan described in Section 3.2.6. Once the safeguards implementation officer or equivalent is in place, he or she should take ownership of the plan and implement it, making any adjustments he or she deems necessary and appropriate. By the end of Phase 3, the nuclear material control unit or its equivalent will need all nuclear material accountants in place, adequately trained and, if necessary, qualified to perform operational tasks. During Phase 3, the nuclear material control unit will need to provide design information and operational programme information to the SRA (3.3.1.) and update it as needed, develop procedures (and perhaps information management systems) for nuclear material accounting and reporting, and put in place procedures and institutional arrangements for facilitating IAEA verification activities (3.3.11.). All owner/operator staff with responsibilities in this regard will require appropriate training programmes.

3.3.3. If applicable, send SQP rescission letter to IAEA

In case as a result of the planning described in Section 3.1.3 a State decides to rescind its SQP, the State should send a letter to the IAEA proposing the rescission. The letter may note that if the proposal is acceptable to the IAEA, the State's letter and the IAEA's affirmative reply will constitute an agreement between the State and the IAEA to rescind the State's SQP. The SQP will be rescinded as of the date of the IAEA's reply letter, and the State should be prepared to fulfil all its obligations under its CSA, including implementing the measures in Part II in a timely manner. The IAEA can provide a model letter upon request.

3.3.4. Submit preliminary design information to the IAEA

Early provision of design information with regard to the construction of a nuclear power plant is required under any CSA. States with an operational amended SQP (i.e. an SQP based on the modified standard text) are required to provide design information to the IAEA as soon as the decision to construct or to authorize construction of a facility has been taken. States with an operational SQP based on the original standard text are required to provide design information to the IAEA six months before nuclear material is to be introduced into a facility.

The early provision of design information is an element of the IAEA's approach to a strengthened and more cost effective safeguards system. IAEA Member States repeatedly call on the Secretariat to implement safeguards as efficiently and effectively as possible. Realistically, the Department of Safeguards needs to be able to estimate its resource requirements for in-field verification three to five years in advance to ensure that the inspectorate remains correctly sized with regard to verification needs. As described below, the IAEA may begin conducting in-field verification activities within such a timeframe following a decision to construct a nuclear power plant.

Preliminary design information does not have to be provided in the form of a DIQ, although this is encouraged. Using the preliminary design information, the IAEA can plan for verification activities by developing the safeguards approach for the nuclear power plant. The IAEA can begin preparing the initial draft of the facility attachment to be concluded as described further in Section 3.3.13. The regulatory body can facilitate the process of providing guidance to the owner/operator, if needed, regarding the incorporation of IAEA equipment requirements into the detailed design of the facility.

3.3.5. Develop owner/operator procedures and technical capabilities for nuclear material accounting, reporting and facilitating IAEA verification activities

As described in Section 3.2.5, support for the development of safeguards related procedures and technical capabilities may be included in the EPC/general contract. Such procedures should be developed in line with regulatory requirements. In case the work to enhance the regulatory framework for nuclear power is not proceeding exactly in step with the nuclear power plant project, the owner/operator will have to develop such procedures as a practical matter, and the regulatory body should continue engaging all stakeholders/interested parties, including licensees, in its efforts to enhance the safeguards regulatory framework and the SSAC.

The procedures should be developed within the framework of the owner/operator's management system, including appropriate checks and controls to facilitate nuclear material accountancy and safeguards implementation. The facility level arrangements for nuclear material accountancy and control, including all the procedures, technical and human capabilities, should be reviewed/approved by the SRA to ensure that all of the regulatory requirements are met.

Chapter 5 of Nuclear Material Accounting Handbook (IAEA Services Series No. 15) [21] describes the development of the accounting and reporting elements necessary for nuclear material accounting and reporting at the facility level. This includes organizational and management considerations, as well as those related to establishing systems for measurement, measurement control, record keeping and reporting, physical inventory taking (PIT), material balance closing and physical inventory verification (PIV).

Chapter 12 of Safeguards Implementing Practices Guide on Provision of Information to the IAEA (IAEA Services Series No. 33) [19] includes detailed information regarding the owner/operator's role in the provision of information related to safeguards. The description of these functions could be useful in developing the relevant procedures.

Chapter 6 of Safeguards Implementing Practices Guide on Facilitating IAEA Verification Activities (IAEA Services Series No. 30) [26] describes activities that States can undertake at both the State and the facility level to prepare for in-field verification.

The owner/operator and the regulatory body should clarify the arrangements for accounting and reporting related to small quantities of nuclear material at the facility, for example nuclear material in fission chambers, in addition to that related to the nuclear material in nuclear fuel.

3.3.6. Continue developing/enhancing the regulatory body's competence and the regulatory framework

In Phase 3, the regulatory body should continue implementing and periodically reviewing its plan to enhance its staffing and administrative and technical competence for safeguards, as described in Section 3.2.2. The regulatory body should develop any remaining regulations, conditions and guides that will be needed in preparation for commissioning and operation. The regulatory body should ensure that its plans for its own organizational development and for the development of the regulatory framework remain aligned with the target dates for fuel delivery, fuel loading, startup and the start of commercial operation.

Several Member States have implemented a single window type approach in the regulatory body to manage interactions with licensees in an integrated manner. Several regulatory bodies have also identified and pursued potential efficiencies by integrating certain aspects of safety, security and safeguards in their authorization processes and inspection activities.

3.3.7. Facilitate discussions regarding the requirements for/installation of IAEA containment and surveillance equipment

During Phase 3, the owner/operator should facilitate discussions among itself, the supplier/design authority, the regulatory body, the IAEA and, eventually, any responsible subcontractors on the incorporation of IAEA safeguards related requirements into the construction schedule. Owner/operators and regulatory bodies in several Member States, as well as the IAEA, have found it useful to meet at least annually to ensure clarity and predictability. The owner/operator can engage more frequently, if needed, with the supplier and/or the regulatory body. The parties need to clarify requirements and responsibilities for addressing issues such as sealing of ports and doors, camera coverage, requirements for IAEA equipment location, supply, installation, operation, maintenance, data transmission, information security, etc. Modern safeguards technology is based on remote monitored and controlled cameras, seals and other instrumentation. Facilitation of these technologies requires early planning at the design stage. Information security concerns need to be taken into account. For safety and security reasons, wireless connections may be categorically prohibited. Typically, IAEA safeguards infrastructure resides on its own dedicated wired network, which is separated from all other IT infrastructure on the site. This network should be installed together with other cabling at the site to avoid any costly retrofits.

Section 4.2 of International Safeguards in the Design of Nuclear Reactors (IAEA Nuclear Energy Series, No. NP-T-2.9) [25] contains general guidance for consideration by the owner/operator and nuclear power plant supplier.

The owner/operator and the EPC/general contractor may benefit from early consideration of how to facilitate inspection activities, how to minimize the need for IAEA inspectors to revisit the facility site to clarify information collected during previous activities, how to mitigate impact on safeguards activities during unusual events, where to install backup or emergency power and how long it needs to be available, etc. It may be useful for the owner/operator and the IAEA to agree on sealable storage areas or cabinets where the IAEA can store spare equipment and other items.

3.3.8. Submit DIQ to the IAEA

The owner/operator should prepare the DIQ for submission to the regulatory body and subsequently the IAEA. According to Code 3.1.4 of a standard subsidiary arrangement, the complete DIQ based on preliminary construction plans should be submitted to the IAEA as early as possible, and in any event not later than 180 days prior to the start of construction. After receiving the initial complete DIQ, the IAEA may begin conducting DIV, as described in Section 3.3.9.

Annex II of International Safeguards in the Design of Nuclear Reactors (IAEA Nuclear Energy Series No. NP-T-2.9) [25] contains a list of information that should be included in a completed DIQ for a nuclear power plant. It is written at an introductory level for an audience with limited experience of IAEA DIQs. The regulatory body should provide guidance on the submission of relevant information to it (including format) by the owner/operator.

Part I of the IAEA's Design Information Questionnaire (DIQ) Completion Guidelines (IAEA Safeguards Technical Report Series No. 398) [28] includes explanatory notes indicating the purpose, rationale, justification and specific uses of the information in the DIQs. These notes provide guidance for completing/updating the design information for each facility type under IAEA safeguards, including power reactors. Part II contains example DIQ responses.

3.3.9. If applicable, begin submitting Article 2.a.(iii) declarations for the nuclear power plant site with the additional protocol annual update

For States implementing the additional protocol, there is a requirement to provide the IAEA with an initial declaration and annual updates, including a declaration under Article 2.a.(iii) containing a general description of each building on each site. For the nuclear power plant, this means the area delimited by the State in the relevant design information for the nuclear power plant. The description of each building has to include its use and, if not apparent from that description, its contents. The description has to include a map of the site.

The initial declarations should be submitted within 180 days of the entry into force of the additional protocol and updated declarations have to be provided to the IAEA by 15 May of each year with any updates for the period covering the previous calendar year. This means that once the State provides design information to the IAEA for the nuclear power plant, the Article 2.a.(iii) declaration for the nuclear power plant has to be provided, after the submission of the initial declarations, by 15 May of the following year. It is important for the regulatory body to put a process in place to ensure that it receives the necessary information and approvals from all stakeholders in a timely fashion.

Additional guidance related to 2.a.(iii) declarations is provided in Guidelines and Format for Preparation and Submission of Declarations Pursuant to Articles 2 and 3 of the Model Protocol Additional to Safeguards Agreements (IAEA Services Series No. 11) [29], pp. 20–33.

3.3.10. If applicable, prepare for the possibility of the IAEA implementing complementary access

For States with an additional protocol, the IAEA has the right to access to any place on the nuclear power plant site as delimited in the design information on a selective basis in order to assure the absence of undeclared nuclear material and activities. The IAEA has to give the State advance notice of access of at least 24 hours; however, if the access is sought in conjunction with DIV visits or ad hoc or routine inspections, the period of advance notice will, if the Agency so requests, be at least two hours but, in exceptional circumstances, it may be less than two hours. Advance notice has to be in writing and has to specify the reasons for access and the activities to be carried out during such access.

The IAEA may conduct visual observation, collect environmental samples, use radiation detection and measurement devices, and apply seals and other tamper indicating devices specified in subsidiary arrangements. The additional protocol provides for the possibility of managed access to meet safety or physical protection requirements or to protect proprietary or commercially sensitive information.

The SRA and the owner/operator should discuss practical arrangements regarding on-site preparation, notification, procedures, contingency planning and follow-up activities. Staff that typically facilitate access may not be available at short notice, so the owner/operator and SRA may wish to designate alternatives and define what preparations should be made. It may be useful for the SRA to carry out a mock complementary access or field trial.

Chapter 5 of Safeguards Implementing Practices Guide on Facilitating IAEA Verification Activities (IAEA Services Series No. 30) [26] provides a number of considerations related to complementary access for SRAs and owner/operators. Annexes 5 and 6 contain examples of certain States' processes and procedures for facilitating complementary access.

3.3.11. Facilitate DIV

DIV is conducted at a new facility to confirm that the facility is built as declared. Under CSAs, the IAEA's right to verify design information is a continuing right that does not expire when a facility goes into operation, is shut down, closed down or being decommissioned. DIV is conducted periodically at existing facilities to confirm the continued validity of the design information and the safeguards approach.

At DIVs during construction, the IAEA might inspect and photograph structures before concrete is poured. As the construction advances, the IAEA might walk through the plant to confirm the as-built design. The owner/operator will need to provide documentation such as floor layouts, process flow diagrams, process descriptions and construction schedule updates. Meetings are typically arranged with the SRA and owner/operator to clarify any questions.

Chapter 3 of Safeguards Implementation Practices Guide on Facilitating IAEA Verification Activities (IAEA Services Series No. 30) [26] describes the objectives of and activities carried out during DIV in detail.

3.3.12. Submit construction schedule to the IAEA

As indicated in Section 3.3.1. above, the obligation to provide design information and operational programme information is a continuing reporting obligation. Detailed requirements will be agreed in the subsidiary arrangements/facility attachment. Particularly as construction is approaching completion, the IAEA will require timely updates regarding the construction schedule. The regulatory body and the owner/operator as licensee should clarify responsibilities to ensure timely submission of the construction schedule and updates as necessary to the IAEA.

3.3.13. Conclude NPP facility attachment

The subsidiary arrangements for the safeguards agreement contain the technical and administrative procedures specifying in detail how the provisions in a safeguards agreement are to be applied. Subsidiary arrangements consist of a general part (Codes 1–10) and a facility attachment prepared for each facility in the State describing arrangements specific for that facility. In cases where several facilities are colocated and/or share a common store (e.g. for a multiunit nuclear power plant), one facility attachment may cover the whole facility group. The IAEA will prepare the first draft of the facility attachment based on its examination of the information in the initial DIQ.

The IAEA negotiates with the SRA to develop and finalize the facility attachment. The SRA should consult with the NPP owner/operator as necessary. The IAEA and the State share an obligation to ensure that safeguards will be implemented in a manner designed to avoid undue interference in the operation of the nuclear power plant and to be consistent with prudent management practices for economic and safe operation. The regulatory body should consider how the requirements of subsidiary arrangements can be incorporated into the regulatory framework, particularly if the subsidiary arrangements are not concluded until after regulations have been issued. Options available to the regulatory body include updating regulations, introducing licence conditions, or approving an NPP owner/operator's safeguards procedures that incorporate requirements from subsidiary arrangements.

3.3.14. Consider requesting ISSAS mission

The ISSAS is described in Section 4.1.2. This voluntary service enables representatives of the State to have in-depth discussions with a team of IAEA and international experts on experience and good practices regarding the technical capabilities of the SSAC and the nature and scope of cooperation between the State and the Agency in the implementation of safeguards, all of which can impact on IAEA verification effort for a State.

Recommendations and suggestions from an ISSAS mission conducted in a State upon its request are provided in a confidential report to the State, and these can provide an objective basis for setting national goals and developing an action plan to enhance SSAC capabilities. The IAEA offers customized assistance packages to help Member States address identified needs. States should request an ISSAS mission at least a year in advance of the desired dates. At a minimum, States may wish to have a review of the owner/operator's system of accounting for and control of nuclear material and capabilities in the nuclear power plant at least a year before the first fuel delivery. It would be useful to review the State level (SRA/SSAC) capabilities as well, unless this has already been done recently. This will give the owner/operator and regulatory body time to address any issues identified in line with the project.

States may wish to be aware of the recent experiences of other States regarding the choice, scope, sequencing and timing of various peer review and advisory service missions offered by the IAEA and other international, governmental and industry organizations, bearing in mind that several of them, including ISSAS, are now offering — and encouraging States to take advantage of — increased flexibility in terms of modularization and ability to tailor the scope of the review to the State's objectives. The status of implementation of recommendations and suggestions can be assessed through a follow-up advisory mission. The choice to request and, if requested, the timing of, a follow-up mission will depend on the nature of the recommendations and suggestions received. More detail can be found in Section 4.1.2.

3.3.15. Update DIQ as needed

Code 3.1.5 of the general part of the standard subsidiary arrangements stipulates that a completed DIQ for a new facility based on as-built designs is required to be submitted to the IAEA as early as possible, and in any event not later than 180 days before the first receipt of nuclear material at the facility. Code 2 of a facility attachment specifies the types of changes or modifications to the facility or associated systems that require the submission of an updated DIQ; for example, significant design changes, changes in the fuel enrichment, changes to the essential equipment list, etc.

3.3.16. Facilitate installation of IAEA containment and surveillance equipment

From the point of view of the type of containment/surveillance (C/S) system used, light water reactors can be divided for safeguards purposes into two types, depending on whether the spent fuel pool is within the reactor containment building (type I) or outside it (type II). The IAEA employs a single C/S component (surveillance) in the reactor hall at type I facilities and at least two complementary C/S components at type II facilities (e.g. pool surveillance in the fuel storage building and equipment hatch seal/surveillance in the reactor containment). At off-load refuelled reactors the C/S measures include applying seals and/or optical surveillance to ensure that there is no undetected opening of the reactor core, and the use of optical surveillance to detect diversion from the spent fuel pool or from an open reactor core. The IAEA uses C/S systems to maintain continuity of knowledge gained from the non-destructive assay of spent fuel. Surveillance systems are installed to survey spent fuel storage areas, spent fuel transfer routes and/or the reactor core when it is open for refuelling.

Section 5.3 of Design Measures to Facilitate Implementation of Safeguards at Future Water Cooled Nuclear Power Plants (IAEA Technical Reports Series No. 392) [30] describes safeguards approaches at off-load refuelled reactors.

The IAEA pays for some of the equipment installation costs, as agreed in the subsidiary arrangements/facility attachment. The owner/operator and/or the State should be prepared to fund some of the costs. Completion of the installation of IAEA C/S equipment should be a condition to be met before the regulatory body can issue the operating licence.

3.3.17. Submit advance notification of import of fresh fuel

The expected transfer of fresh nuclear fuel into the State is required to be notified to the IAEA as far in advance of the expected arrival of the nuclear material as possible. Code 7.2 of the general part of the model subsidiary arrangements provides a model notification of expected import. The State has to provide information regarding the nuclear material to be imported, including quantity of total weight by element and quantity of fissile isotope(s), if applicable, chemical composition, physical form, enrichment or isotopic composition, approximate number of items, description (type) of containers, shipping State, means of transport, point and date of assumption of responsibility by the Government of the State, expected date of arrival, material balance area where material will be unpacked and can be identified and verified, and the date(s) when the material will be unpacked.

Pursuant to Code 3.6.3., the advance notification is required to reach the IAEA not later than seven days before the nuclear material is to be unpacked and, in any case, not later than on the date on which the Government assumes responsibility for the nuclear material. The fact that some authorities may consider such information sensitive from a security point of view does not change the obligation set forth in the subsidiary arrangements. The SRA should liaise with all competent authorities sufficiently in advance to ensure that the notification is cleared for dispatch to the IAEA in a timely manner.

3.3.18. Prepare/submit nuclear material accounting reports

The standard reports to be provided by the SRA to the IAEA include:

(a) Inventory change reports (ICRs), to be dispatched:
  - Whenever fresh fuel has been imported;
  - When spent fuel has been discharged from the core to the spent fuel pool — calculations need to be made regarding uranium burnup and plutonium production;
  - Whenever spent fuel has been exported.

(b) Material balance reports (MBRs) and physical inventory listings (PILs), to be dispatched:
  - After conducting a PIT.

The owner/operator may wish to prepare test reports with the regulatory body and check the results with the IAEA prior to fuel delivery.

Chapter 8 of the IAEA’s Safeguards Implementing Practices Guide on Provision of Information to the IAEA (IAEA Services Series No. 33) [19] includes detailed information regarding the reporting of nuclear material accounting information.

3.3.19. Facilitate IAEA in-field verification activities

The IAEA has a right of access to the facility under construction to conduct multiple DIVs and ad hoc inspections. Once the facility attachment is concluded, the State and the owner/operator will have detailed information regarding the number and mode of routine inspections and the safeguards activities to be carried out during them.

Depending on timing, the IAEA may verify fresh fuel upon its arrival at the facility. The IAEA has to verify core loading, although this does not require full time inspector presence. The IAEA will typically count items and check serial numbers and may set up temporary containment and surveillance measures.

While some details of the safeguards approach may be adjusted due to State specific factors[5], a nuclear power plant owner operator could expect a routine inspection each quarter during operations. A PIT should normally be carried out once a year per the owner/operator's established procedure. The owner/operator will have to prepare an MBR/PIL to be checked by the regulatory body and submitted by the regulatory body to the IAEA. During refuelling, the IAEA will likely conduct its PIV, which may entail the installation of additional surveillance (cameras) and IAEA seals and IAEA verification of the core and pond after defuelling and refuelling. An ICR needs to be prepared, checked and submitted related to uranium burnup and plutonium production. During a PIV, all nuclear material present in a facility has to be made available and accessible for verification, and all operating records have to be available upon request.

Section 4.4 of Safeguards Implementing Practices Guide on Facilitating IAEA Verification Activities (IAEA Services Series No. 30) [26] describes specific provisions for physical inventory taking and verification.

The owner/operator and the regulatory body need to continue to ensure timely submissions of advance notifications regarding the import of fresh fuel. Fresh fuel could arrive with or without IAEA seals, depending on where and when it is most efficient for the IAEA to verify it.

As noted in Section 3.3.9., under CSAs, the IAEA's right to verify design information is a continuing right that does not expire when a facility goes into operation, is shut down, closed down or being decommissioned.

Chapter 6 of Safeguards Implementing Practices Guide on Facilitating IAEA Verification Activities (IAEA Services Series No. 30) [26] describes the activities States can undertake at both the State and facility level to prepare for in-field verification. It also describes how the IAEA provides results and observations following in-field verification activities and includes guidance on how the SRA might communicate this information to facility operators and track any corrective actions or requests.

4. RESOURCES AND ASSISTANCE AVAILABLE TO STATES

4.1. IAEA SUPPORT

The IAEA supports States embarking on nuclear power programmes through the development of guidance publications based on inputs from international experts. States can request the IAEA to conduct peer review and advisory services missions with objective evaluation methodologies derived from these guidance publications. The IAEA offers capacity building and training through several mechanisms to address gaps or issues identified.

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[5] The State specific factors are the six objective safeguards relevant factors that are particular to a State, and which are used by the Secretariat in the development of a State level safeguards approach and in the planning, conduct and evaluation of safeguards activities for that State: (1) the type of safeguards agreement in force for the State and the nature of the safeguards conclusion drawn by the IAEA; (2) the nuclear fuel cycle and related technical capabilities of the State; (3) the technical capabilities of the State or regional system of accounting for and control of nuclear material (SSAC/RSAC); (4) the ability of the IAEA to implement certain safeguards measures in the State; (5) the nature and scope of cooperation between the State and the IAEA in the implementation of safeguards; and (6) the IAEA's experience in implementing safeguards in the State.

4.1.1. Guidance

States can consult a hierarchy of documentation related to safeguards implementation, and many of these publications have been referenced in the preceding text. At the highest level are the international instruments to which the State is a Party and require the application of safeguards. At the next level is the State’s safeguards agreement with the IAEA, along with any protocols and subsidiary arrangements. At the next level are guidance publications for States published in the IAEA Services Series, principally Guidance for States Implementing Comprehensive Safeguards Agreements and Additional Protocols (IAEA Services Series No. 21) [31]. IAEA Services Series Nos 11, 13 and 15 provide guidance on additional protocol declarations [29], ISSAS missions [32] and nuclear material accounting [21], respectively. Finally, the IAEA has developed several Safeguards Implementation Practices Guides with the assistance of experts from Member States to share information about effective practices for the benefit of all States. These guides include examples, good practices, lessons learned and a number of case studies.

The Milestones publication [1] outlines 19 infrastructure issues that need to be addressed in developing a new nuclear power programme. The IAEA has collected relevant publications related to each issue and organized them into a nuclear infrastructure bibliography, categorized according to these issues.[6] The IAEA has taken the actions described in many of these publications and placed them in a nuclear infrastructure competency framework database, which can be queried by phase, issue, organization, source document or keyword.[7] The IAEA has also used these publications to create an interactive e-learning series[8] with modules covering many of the infrastructure issues, including safeguards.

Finally, the IAEA has developed several guidance publications in the Nuclear Energy Series related to SBD. The most relevant have been cited in this publication and they include IAEA Nuclear Energy Series No. NP-T-2.8, International Safeguards in Nuclear Facility Design and Construction [33], No. NP-T-2.9, International Safeguards in the Design of Nuclear Reactors [25] and No. NF-T-3.1, International Safeguards in the Design of Facilities for Long Term Spent Fuel Management [27].

4.1.2. Peer review and advisory service missions

4.1.2.1. ISSAS

The ISSAS [32] was established in 2004 and is a fundamental part of the IAEA’s efforts to assist States, upon request, to establish and maintain a system of accounting for and control of all nuclear material subject to safeguards. ISSAS provides a peer review of State safeguards infrastructure and the performance of the SSAC with respect to the recommendations contained in Guidelines for States Implementing Comprehensive Safeguards Agreements and Additional Protocols (IAEA Services Series No. 21) [31] and the obligations contained in the State’s safeguards agreement and protocols thereto with the IAEA.

The service enables representatives of the State to have in-depth discussions with a team of IAEA and international experts on experience and good practices regarding the technical capabilities of the SSAC/SRA and the nature and scope of cooperation between the State and the Agency in the implementation of safeguards, all of which can impact on IAEA verification efforts for a State. Recommendations and suggestions are provided in a report to the State, and these can provide an objective basis for setting national goals and developing an action plan to enhance SSAC/SRA capabilities. The IAEA offers customized assistance packages to help Member States address identified needs.

[6] See: https://www.iaea.org/topics/infrastructure-development/bibliography
[7] See: https://nucleus.iaea.org/competency-framework/
[8] See: https://www.iaea.org/topics/infrastructure-development/e-learning-for-nuclear-newcomers

The objectives of an ISSAS mission are:

(a) To evaluate the adequacy of the legal and regulatory framework and the administrative and technical systems of the SSAC at the State and facility/LOF level;
(b) To evaluate the performance of those systems in meeting the State's safeguards obligations pursuant to its safeguards agreements and protocols in force with the IAEA;
(c) To identify areas where further cooperation with the IAEA could increase the effectiveness or efficiency of safeguards implementation;
(d) To make recommendations and suggestions on how any gaps or weaknesses identified could be addressed to enhance the SSAC/SRA's capabilities, while recognizing good practices identified in the course of the mission.

Judgements are made on the basis of the combined expertise of the team members. The mission is not a safeguards inspection. Rather, it is a comparison made at the request of a State, of its SSAC and practices with those described in IAEA guides, which are derived from international best practices, with regard to the obligations of the State's safeguards agreement with the IAEA.

The key benefits of an ISSAS mission are to:

— Receive an independent peer review of State safeguards infrastructure in a cooperative and voluntary environment;
— Enable representatives of the State to have in-depth discussions with a team of IAEA and international experts on experience and good practices regarding the technical capabilities of the SSAC and the nature and scope of cooperation between the State and the Agency in the implementation of safeguards, all of which can impact on IAEA verification effort for a State;
— Develop an objective basis for setting national goals and developing an action plan to enhance SSAC capabilities, which can help the IAEA and other partners tailor assistance to help address identified needs;
— Develop interfaces and raise awareness of safeguards obligations among various national stakeholders;
— Provide a mechanism for identifying and disseminating good practices and lessons learned among the international safeguards community.

4.1.2.2. Integrated Nuclear Infrastructure Review

INIR [34] is a holistic peer review to assist Member States in assessing the status of their national infrastructure for the introduction of nuclear power. The review covers the comprehensive infrastructure required for developing a safe, secure and sustainable nuclear power programme.

Upon request from a Member State, the IAEA conducts an INIR mission, which is performed by a team of international experts, who have direct experience in specialized nuclear infrastructure areas, and IAEA staff. Before receiving an INIR mission team, the country has to complete a self-evaluation of the 19 nuclear power infrastructure issues included in the IAEA's Milestones approach, a comprehensive methodology that guides countries and organizations to work in a systematic way towards the introduction of nuclear power.

INIR missions enable IAEA Member State representatives to have in-depth discussions with international experts about experiences and best practices in nuclear power infrastructure development. Recommendations and suggestions are provided in a report to the Member State, enabling it to update its national action plan accordingly. By providing a comprehensive assessment of all facets of a nuclear power programme, spanning the regulatory body, utility and all relevant government stakeholders involved, INIR is a valuable tool to ensure that the infrastructure required for the safe, secure and sustainable use of nuclear power is developed and implemented in a responsible and orderly manner.

4.1.3. Capacity building and training

States considering or planning the introduction of nuclear power are encouraged to develop and maintain a national action plan for all major activities to be carried out over a defined period to reach each milestone in the development of a national infrastructure for nuclear power. The plan should outline the required inputs and resources from internal or external sources, which will normally include the support of international organizations such as the IAEA and the World Association of Nuclear Operators, as well as from bilateral partners. This support will be provided to the national institutions involved in infrastructure development activities in accordance with identified issues and gaps. To ensure that IAEA support is targeted to areas of critical need, as identified in a State's national action plan, the IAEA has been applying the concept of an integrated work plan for a number of years. The objectives of developing and implementing an integrated work plan are to:

(a) Ensure that the IAEA assistance is targeted to areas of critical need in a Member State, as identified in its national action plan and in line with recommendations from IAEA reviews (where available) and the provisions of the Milestones approach;
(b) Serve as a unified and integrated plan for an agreed period of time (normally five years or more) to facilitate the delivery of IAEA assistance through existing mechanisms where the availability of funds have already been guaranteed;
(c) Enable the various IAEA divisions, offices and sections involved in infrastructure development projects to integrate their efforts to develop jointly an appropriate package of services and assistance commensurate with available technical cooperation funding, regular budget and extrabudgetary resources, the Member State's capacity and IAEA related needs;
(d) Enable the Member State to plan the utilization of complementary assistance from other bilateral and national sources within the scope of its national action plan;
(e) Encourage the Member State to include all key organizations within the country in the discussions for the planning of the required external assistance to enable the identification of the most relevant and urgent needs and possible IAEA assistance where the funds are available;
(f) Ensure that all IAEA staff members in the country core team[9], and experts involved in related IAEA support activities, utilize a single integrated work plan for each country being assisted.

A representative from the Department of Safeguards participates in all core team and INTEGRATED WORK PLAN meetings to help identify appropriate support activities, including those available through the IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs (COMPASS). COMPASS involves partnering with States to help strengthen the effectiveness and efficiency of SRAs and their respective SSACs. COMPASS provides assistance and services tailored to a State's needs. Through COMPASS, the IAEA works with the State to identify the main areas where additional assistance will be beneficial and, on that basis, develops a customized capacity building package. This package can include State specific support in the areas of outreach, national training, procurement, legal and regulatory framework, and human resources.

Several sections in this publication suggest that States study the organizational aspects of safeguards related programmes in other States' regulatory bodies and nuclear power plant owner/operators, particularly in States that have recently embarked on nuclear power programmes. This type of activity could be arranged through the IAEA.

[9] The core team consists of the IAEA's Technical Cooperation programme management officer and technical officers who are involved in a newcomer Member State's projects and support services.

4.2. OTHER SUPPORT

In addition to the IAEA, several other organizations and programmes around the world offer technical support, resources and training related to safeguards and export control implementation.

Section 8.3 of Safeguards Implementation Practices Guide on Establishing and Maintaining State Safeguards Infrastructure (IAEA Services Series No. 31) [18] provides an overview of several relevant programmes.

Some of this support is available under the auspices of government to government cooperation, while some is available from non-governmental organizations and the private sector. States can obtain support from the vendor country and others and should also consider partnerships where regular forums can be used to exchange information and share best practices.

One example of such a forum is the regional Asia-Pacific Safeguards Network, which aims to facilitate the exchange of information, knowledge and experience to strengthen safeguards capabilities in the region.

Japan’s Integrated Support Centre for Nuclear Non-Proliferation and Nuclear Security supports countries embarking on nuclear power programmes in the area of non-proliferation and nuclear security infrastructure development.

The Republic of Korea’s International Nuclear Non-Proliferation and Security Academy offers training courses on nuclear security, safeguards, export control and non-proliferation.

The US Department of Energy’s National Nuclear Security Administration International Nuclear Safeguards Engagement Program (INSEP) partners with countries and organizations to build safeguards capacity and expertise in SSACs. INSEP’s bilateral and multilateral activities cover a range of safeguards related topics, including legal/regulatory development, providing correct/complete/timely declarations and reports to the IAEA, stakeholder outreach, building strong regulatory infrastructure (e.g. licensing, inspections, enforcement), and nuclear material measurements.

The US Department of Energy’s National Nuclear Security Administration’s International Nonproliferation Export Control Program partners with countries and organizations to strengthen implementation of nuclear and non-nuclear dual use export controls, including those relevant to implementing CSAs and additional protocols. The International Nonproliferation Export Control Program provides tailored training and exercises covering a range of export control related topics, including training focused on recognizing and reporting the trade of materials and equipment listed in Additional Protocol Annex II.

Rusatom Service offers export control consulting services and training to foreign customers. Training includes both theoretical and practical aspects and can be offered in person, online or in a hybrid format. Much of Rusatom Service’s own internal compliance programme documentation can be made available in English for use or adaptation.

The European Safeguards Research and Development Association organizes training courses on safeguards and non-proliferation.

The Institute of Nuclear Materials Management’s International Safeguards Technical Division provides a forum for the exchange of information on the continuing development of international safeguards within the nuclear non-proliferation regime and for the enhancement of a broad understanding of the implementation and effectiveness of safeguards.

A number of commercial software products have been developed to support safeguards implementation, including for material control and accounting at the State level and at the facility level. Several of the Member States that provided case studies ran standard government tender processes to obtain software and consulting solutions from the private sector.

Appendix I

SAFEGUARDS INFRASTRUCTURE ACTIVITIES AND COMPETENCES IN PHASE 1

This appendix provides the list of activities, responsible organizations and required competences to establish and enhance national safeguards infrastructure to support the introduction of nuclear power in Phase 1 of the nuclear power programme (Table 1).

TABLE 1. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 1 OF THE NUCLEAR POWER PROGRAMME

Activities	Responsible organization	Competences
In order to…	…the…	…should be able to…
3.1.1 Develop understanding of safeguards requirements related to the introduction of nuclear power	Government/NEPIO (with SRA involvement)	— Explain what safeguards are and why they are important both globally and as part of implementing a nuclear power programme — Name and describe the main international legal instruments that give rise to non-proliferation and safeguards obligations — Describe the types and quantities of nuclear material used in nuclear power plants and recognize that such material could be used to manufacture nuclear weapons — Describe the need to regulate and control nuclear material and activities, provide correct, complete and timely information to the IAEA and facilitate IAEA verification activities — Describe how the IAEA applies safeguards at nuclear power plants (e.g. typical containment and surveillance measures, reporting, inspections) — Describe the main safeguards related activities of the key organizations (government/NEPIO, regulatory body/SRA, NPP owner/operator) during each phase of nuclear power infrastructure development — Describe SRA capabilities that are important with regard to oversight of nuclear power and implementation of safeguards obligations
3.1.2 Ensure safeguards agreement and subsidiary arrangements are in force, and plan the development of the national legal framework	Government/NEPIO (with SRA involvement)	— Analyse existing treaty agreements in the context of what may be required to meet the programme objectives — Drive efficient implementation of domestic processes for signing, ratifying and bringing into force international legal instruments — Reference the structure and content of safeguards agreements and their requirements related to the conclusion of subsidiary arrangements and describe how these requirements relate to the nuclear power programme — Identify and characterize domestic legal requirements needed to fulfil the safeguards obligation related to the nuclear power programme — Drive efficient implementation of domestic processes for amending/enacting national legislation — Develop implementation plans with identified resources, timelines and responsible organizations/units/persons

TABLE 1. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 1 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
In order to…	…the…	…should be able to…
3.1.3 If applicable, plan for the timely rescission of the SQP or its non-operation	Government/NEPIO (with SRA involvement)	— Identify the type of SQP (if any) that is currently operational in the State — Describe the circumstances under which the SQP will become non-operational or rescinded, and the consequences/impact of that change, including timeliness requirements — Identify all national stakeholders who would be affected by the change in SQP status and make general plans for engaging them — If applicable, drive efficient implementation of domestic processes to rescind the SQP — Communicate effectively about safeguards at all necessary levels, both in writing and orally — Develop implementation plans with identified resources, timelines and responsible organizations/units/persons
3.1.4 Plan SRA/SSAC enhancement	Government/NEPIO (with SRA involvement)	— Analyse the current status of SRA/SSAC development and compare this against what the nuclear power programme will require — Translate the results of this analysis into implementation plans with identified resources, timelines and responsible organizations/units/persons — Articulate national level needs related to safeguards (e.g. legislation, regulation, human and financial resources, etc.)

Appendix II

SAFEGUARDS INFRASTRUCTURE ACTIVITIES AND COMPETENCES IN PHASE 2

This appendix provides the list of activities, responsible organizations and required competences to establish and enhance national safeguards infrastructure to support the introduction of nuclear power in Phase 2 of the nuclear power programme (Table 2).

TABLE 2. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 2 OF THE NUCLEAR POWER PROGRAMME

Activities	Responsible organization	Competences
In order to…	…the…	…should be able to…
3.2.1 If applicable, submit annual Article 2.a.(x) declarations on the planned introduction of nuclear power with the additional protocol annual update	Government/NEPIO	— Ensure that national level policy guidance and the regulatory framework related to additional protocol implementation are sufficient to generate correct, complete and timely declarations regarding the planned introduction of nuclear power
	Government/NEPIO/ regulatory body/SRA	— Establish or enhance mechanisms to coordinate/gather correct, complete and timely declaration information from all relevant stakeholders related to planning the development of the nuclear fuel cycle
	Regulatory body/SRA	— Implement the requirement to submit Article 2.a.(x) declarations — Follow the IAEA guidelines and format for preparation and submission of Article 2.a.(x) declarations — Explain the purpose and use of the information by the IAEA
3.2.2 Enhance the regulatory body's staffing and administrative and technical competence for safeguards	Government/NEPIO /regulatory body/SRA	— Ensure adequate resources are available to the regulatory body/SRA in a timeframe aligned with the needs of the nuclear power programme
	Regulatory body/SRA	— Translate safeguards requirements into legal, regulatory, technical and administrative competences, capabilities and tasks — Translate competences, capabilities and tasks into workforce planning requirements — Analyse needs/identify gaps in workforce capacity and competence. — Acquire and maintain the necessary human resources — Design, develop, implement and evaluate training activities — Develop the regulatory body's management system, including processes and procedures related to safeguards implementation — Translate safeguards tasks into functional requirements for a safeguards information management system — Procure or develop an information management system that meets those functional requirements — Evaluate and specify technical needs (e.g. non-destructive assay) and make arrangements to procure necessary services from a technical support organization or develop capabilities within the regulatory body

Activities	Responsible organization	Competences
3.2.3 Integrate safeguards requirements into the regulatory framework for nuclear power	Regulatory body/SRA	— Formulate appropriate regulatory objectives and provisions to enable the implementation of obligations under international legal instruments, including those found in subsidiary arrangements to safeguards agreements — Integrate safeguards requirements into the NPP licensing/permitting processes — Address safeguards, security and safety in a complementary manner — Access practical experience/information related to safeguards implementation, as needed
3.2.4 Establish effective mechanisms for communication with relevant stakeholders to raise awareness of safeguards	Regulatory body/SRA	— Identify all relevant stakeholders and gauge their awareness of current and future safeguards obligations — Communicate effectively about the principles and objectives of nuclear non-proliferation, obligations under international legal instruments and national nuclear law and regulations in the field of safeguards — Coordinate working groups, organize workshops/training and collect feedback — Develop and implement plans with identified resources, timelines and responsible organizations/units/persons — Access practical experience/information related to safeguards implementation, as needed
3.2.5 Ensure safeguards requirements are included in the bid invitation/contract specification	Government/NEPIO/NPP owner/operator	— Explain the need as well as the benefits of specifying safeguards requirements in the bidding/contracting process — Describe the practical implementation of safeguards in an NPP — Describe the needs related to installing, operating and accessing IAEA safeguards instrumentation and attaching IAEA seals — Describe any needs related to human resources, systems and procedures for nuclear material accounting and safeguards implementation — Access international practices, experience and information, as needed
3.2.6 Plan owner/operator staffing and training programmes for safeguards, including nuclear material accounting	NPP owner/operator	— Translate safeguards requirements (e.g. nuclear material accountancy and reporting, facilitation of IAEA in-field verification activities, etc.) into technical and administrative competences, capabilities and tasks — Translate competences, capabilities and tasks into workforce planning requirements — Analyse needs/identify gaps in workforce capacity and competence — Plan the timely acquisition of the necessary human resources — Plan the design, development, implementation and evaluation of training activities in line with the timeframe of the project

Appendix III

SAFEGUARDS INFRASTRUCTURE ACTIVITIES AND COMPETENCES IN PHASE 3

This appendix provides the list of activities, responsible organizations and required competences to establish and enhance national safeguards infrastructure to support the introduction of nuclear power in Phase 3 of the nuclear power programme (Table 3).

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME

Activities	Responsible organization	Competences
In order to…	…the…	…should be able to…
3.3.1 Provide design information and operational programme information to the regulatory body/SRA	NPP owner/operator	— Communicate information on the design, layout, nuclear material handling/flows and operation of the NPP — Refer to the relevant articles of the safeguards agreement, subsidiary arrangements and national regulations and conditions relating to the provision of design information and operational programme information — Define responsibilities, procedures and triggers for preparing and validating design information and operational programme information — Ensure all necessary information can be authorized for submission to the SRA and the IAEA
3.3.2 Develop/implement staffing/ training for safeguards and nuclear material accounting	NPP owner/operator	— Translate safeguards requirements (e.g. nuclear material accountancy and reporting, facilitation of IAEA verification activities, etc.) into technical and administrative competences, capabilities and tasks — Translate competences, capabilities and tasks into workforce planning requirements — Analyse needs/identify gaps in workforce capacity and competence — Acquire and maintain the necessary human resources — Design, develop, implement and evaluate training activities in line with the timeframe of the project — Develop and implement plans with identified resources, timelines and responsible organizations/ units/persons
3.3.3 If applicable, send SQP rescission letter to IAEA	Government/NEPIO	— Drive/facilitate the development/clearance of the SQP rescission letter
	Regulatory body/SRA	— Formulate/draft the SQP rescission letter — Raise relevant stakeholder awareness of any new requirements — Coordinate the development/clearance of the SQP rescission letter — Use the official process/communication channel to the IAEA to dispatch the SQP rescission letter
3.3.4 Submit preliminary design information to IAEA	Regulatory body/SRA	— Refer to IAEA requirements regarding preliminary design information, including timeliness — Formulate/enforce regulations/conditions on owner/operator to provide the necessary information — Analyse the information received for correctness and completeness — Use the official process/communication channel to the IAEA to dispatch the information

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.5 Develop procedures and technical capabilities for nuclear material accounting, reporting and facilitating IAEA verification activities	NPP owner/operator	— Refer to national regulations for the content, format and timescales for the submission of accounting reports to the SRA — Develop an effective system for accounting and control nuclear material (MBAs, flow and inventory KMPs, etc.). — Maintain operating and accounting records that meet the requirements of national regulations and subsidiary arrangements — Prepare procedures for nuclear material accounting and control and physical inventory taking and for gathering and verifying information on the shipment, receipt, internal transfer and physical inventory of nuclear material that meet the requirements of the SRA — Develop/acquire and maintain appropriate software to keep nuclear material accounts and submit the necessary accounting reports to the SRA — Investigate and resolve anomalies in the nuclear material accounting and control system (e.g. loss of nuclear material) and make special reports to the SRA, if needed — Deliver outreach and awareness programmes on nuclear material accounting activities to relevant staff/departments — Respond in a timely manner to notifications regarding IAEA in-field verification activities — Communicate and enforce facility specific safety and security arrangements and procedures — Accommodate IAEA personnel, information and equipment on-site with suitable infrastructure during in-field verification activities — Receive, respond to and act upon IAEA requests and questions — Communicate and negotiate effectively

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.6 Continue developing/enhancing the regulatory body's competence and the regulatory framework	Regulatory body/SRA	— Analyse needs/identify gaps in workforce capacity and competence — Acquire and maintain the necessary human resources — Design, develop, implement and evaluate training activities — Develop the regulatory body's management system, including processes and procedures related to safeguards implementation — Evaluate and specify technical needs (e.g. non-destructive assay) and make arrangements to procure necessary services from a technical support organization or develop capabilities within the regulatory body — Formulate appropriate regulatory objectives and provisions to enable the implementation of obligations under international legal instruments, including those found in subsidiary arrangements to safeguards agreements — Integrate safeguards requirements into the NPP licensing/permitting processes — Address safeguards, security and safety in a complementary manner — Access practical experience/information related to safeguards implementation, as needed
3.3.7 Facilitate discussions regarding requirements/installation of IAEA containment and surveillance equipment	NPP owner/operator	— Establish and maintain effective communication with points of contact in the supplier, the SRA and the IAEA
	NPP owner/operator /regulatory body/SRA	— Recognize the obligation and purpose for the installation of C/S equipment and the use of IAEA seals — Anticipate potential issues for C/S installations resulting from safety, security, economics or other reasons — Identify the strategic points for application of C/S measures described in the draft facility attachment
	Regulatory body/SRA	— Liaise with the IAEA as needed — Participate in the discussions as needed — Communicate at all levels about the obligation and purpose of C/S measures — Coordinate the resolution of any issues encountered between the NPP owner/operator and the IAEA

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.8 Submit DIQ to IAEA	Regulatory body/SRA	— Refer to IAEA requirements regarding the provision of design information, including format and timeliness (as per the subsidiary arrangements) — Formulate/enforce regulation/licence conditions on owner/operator to provide all necessary information — Develop and implement procedures for the systematic review of the adequacy of design information — Analyse the design, layout, nuclear material handling/flows and operation of the NPP — Explain general reactor physics and validate nuclear production and nuclear loss calculations — Analyse the completeness and correctness of technical documents, including through national inspections — Submit design information through the official channel in a secure manner (e.g. use of encryption software and the IAEA SDP)
3.3.9 If applicable, begin submitting Article 2.a.(iii) declarations for the nuclear power plant site with the additional protocol annual update	Government/NEPIO	— Ensure that national level policy guidance and the regulatory framework related to additional protocol implementation are sufficient to generate correct, complete and timely declarations regarding the planned introduction of nuclear power
	Regulatory body/SRA	— Refer to the requirements and timescales/format for submitting additional protocol Article 2.a.(iii) declarations to the IAEA — Explain the purpose of AP Article 2.a.(iii) declarations, and their use by the IAEA — Specify/enforce regulatory requirements on the owner/operator to provide the necessary information — Deliver outreach and awareness programmes related to AP declaration requirements — Coordinate/gather/verify declaration information from the owner/operator — Use Protocol Reporter software to construct AP declarations — Submit AP declarations through the official channel in a secure manner (e.g. use of encryption software and the IAEA SDP)

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.10 If applicable, prepare for the possibility of the IAEA implementing complementary access at the NPP site	NPP owner/operator/ regulatory body/SRA	— Refer to international and national obligations related to complementary access at the NPP site — Refer to the contents of Article 2.a.(iii) declarations of the NPP site submitted by the State, including the managed access arrangements. — Recognize the purpose, role, rights, tools and methods of IAEA inspectors during complementary access — Communicate and negotiate effectively
	Regulatory body/SRA	— Ensure that the NPP operator has sufficient understanding of its role and responsibilities
	NPP owner/operator	— Respond in a timely manner to IAEA complementary access notices, including those given with 2 hours' notification or less — Identify any risks related to information protection, physical protection and safety presented by complementary access requests — Identify/negotiate potential solutions to ensure the IAEA and the owner/operator objectives can be achieved in managed access situations — Describe its role, rights and responsibilities during complementary access
3.3.11 Facilitate DIV	Regulatory body/SRA	— Deliver outreach and awareness programmes on IAEA DIV activities to the owner/operator — Refer to the legal basis and scope of IAEA DIV activities — Formulate/enforce regulations/licence conditions on owner/operator to facilitate DIV activities — Notify the owner/operator of an IAEA DIV and make all necessary administrative/technical/security arrangements required prior to site access — Write national inspection reports to document the performance of the owner/operator in facilitating DIV activities
	NPP owner/operator	— Refer to the national (e.g. regulations and licence conditions) and international legal basis and scope of IAEA DIV activities — Arrange access to the facility for IAEA inspectors and their equipment — Make all necessary administrative/technical/training (e.g. working from heights and foreign material exclusion/security arrangements required for IAEA/SRA site/facility access — Deliver outreach and awareness programmes on IAEA DIV activities to relevant staff/departments (e.g. senior management, security, safety, safeguards, reactor operators). — Define responsibilities and develop procedures for facilitating IAEA and SRA safeguards verification activities on the site

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.12Submit construction schedule to the IAEA	NPP owner/operator /regulatory body/SRA	— Refer to IAEA requirements for format and timeliness — Formulate and enforce regulations or licence conditions for/on owner/operator to provide the required information in a timely fashion
3.3.13Conclude NPP facility attachment	Regulatory body/SRA /NPP owner/operator	— Describe the content of a facility attachment and the process of negotiation — Participate as needed in discussions to conclude the NPP facility attachment — Confirm all information in the draft facility attachment — Recognize the frequency and modes of inspections to be applied at the NPP — Recognize the required services and charges for supporting inspection activities and the installation of C/S equipment, including lighting, power supply for IAEA equipment, communication and cabling work — Coordinate the specific health and safety rules and regulations to be observed by IAEA inspectors
3.3.14Consider requesting ISSAS mission	Government/NEPIO	— Recognize the benefits of hosting an ISSAS mission and the associated responsibilities — Identify stakeholders to be involved in the ISSAS mission and inform them about the benefits of hosting one — Coordinate the timing of the request and the scheduling of the ISSAS mission activities with other programme activities — Oversee the implementation of a resulting national action plan
	Regulatory body/SRA	— Coordinate the preparation of advance reference material, including a self-assessment — Organize and coordinate the main mission — Develop and coordinate the implementation of a resulting national action plan to address the findings of the ISSAS mission
3.3.15Update DIQ as needed	Regulatory body/SRA	— Refer to IAEA requirements regarding the provision of design information, including format and timeliness (as per the subsidiary arrangements) — Formulate/enforce regulation/licence conditions for/on owner/operator to provide all necessary information — Implement procedures for the systematic review of the adequacy of design information — Analyse the completeness and correctness of technical documents, including through national inspections — Submit design information through the official channel in a secure manner (e.g. use of encryption software and the IAEA SDP)

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.16Facilitate installation of IAEA containment and surveillance equipment	Government/NEPIO	— Coordinate with the relevant government entities to facilitate the receipt of the equipment in the country and its timely acceptance and installation at the NPP
	NPP owner/operator/ regulatory body/SRA	— Recognize C/S measures necessary for the verification of nuclear material, including through maintaining continuity of knowledge — Recognize the possibility of installing temporary C/S measures — Refer to the facility attachment, including provisions for the practical application of C/S in the NPP — Recognize the need to provide continuous electrical power to C/S equipment and keep a warning notice in front of the C/S to deter unintentional tampering — Anticipate potential issues for C/S installations resulting from safety, security, economic or other reasons
	Regulatory body/SRA	— Coordinate issues encountered between the operator/owner and the IAEA — Ensure that the operator has a reporting procedure to the SRA and the IAEA in case of breaking an IAEA seal (emergency cases of water leak or accident) and/or an interruption in electrical power to IAEA surveillance cameras
3.3.17Submit advance notification of import of fresh fuel	Regulatory body/SRA/ NPP owner/operator	— Refer to IAEA requirements regarding the provision of advance notification of the import of nuclear material, including format and timeliness (as per the subsidiary arrangements)
	Regulatory body/SRA	— Ensure that national regulations are adequate — Ensure that SRA procedures related to submitting advance notifications to the IAEA are adequate — Submit advance notifications to the IAEA in an approved and secure manner (e.g. through the IAEA SDP) — Coordinate advance notifications with the national entity responsible for import–export control of nuclear material
	NPP owner/operator	— Submit correct, complete and timely information to the SRA

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.18 Prepare/submit nuclear material accounting reports	Regulatory body/SRA	— Refer to requirements for the content, format and timescales for the submission of accounting reports from the State to the IAEA (subsidiary arrangements) — Receive, verify and record accounting reports from licensees in the SSAC — Submit accounting reports to the IAEA in an approved and secure manner (e.g. through the IAEA SDP) — Respond to IAEA statements of accounting anomalies and take appropriate corrective action — Take enforcement action to resolve anomalies in the SSAC — Deliver outreach and awareness programmes on NMA activities to relevant staff/departments
	NPP owner/operator	— Refer to national regulations for the content, format and timescales for the submission of accounting reports to the SRA — Maintain an effective system for accounting and control nuclear material (MBAs, flow and inventory KMPs, etc.) — Maintain operating and accounting records that meet the requirements of national regulations and subsidiary arrangements — Implement procedures for nuclear material accounting and control and physical inventory taking and for gathering and verifying information on the shipment, receipt, internal transfer and physical inventory of nuclear material that meet the requirements of the SRA — Develop/acquire and maintain appropriate software to keep nuclear material accounts and to submit the necessary accounting reports to the SRA — Investigate and resolve anomalies in the nuclear material accounting and control system (e.g. loss of nuclear material) and make special reports to the SRA, if needed — Deliver outreach and awareness programmes on nuclear material accounting activities to relevant staff/departments

TABLE 3. RESPONSIBLE ORGANIZATIONS AND REQUIRED COMPETENCES FOR PHASE 3 OF THE NUCLEAR POWER PROGRAMME (cont.)

Activities	Responsible organization	Competences
3.3.19Facilitate IAEA in-field verification activities	Government/NEPIO	— Coordinate the evaluation of the IAEA proposal for designation of inspectors and decide on the proposal — Recognize the privileges and immunities that are required to be granted to the IAEA and its staff in respect of their functions under the safeguards agreement — Coordinate with the relevant government entities to support the entry of the IAEA inspectors into the country, including the timely issuance of appropriate visas
	Regulatory body/SRA	— Refer to the subsidiary arrangements/facility attachment — Effectively enforce regulatory requirements for IAEA access among relevant owner/operators — Ensure that the owner/operator is prepared to facilitate potential verification activities — Accompany IAEA inspectors during in-field verification activities — Analyse and verify nuclear material accountancy information, including shipper–receiver differences and material unaccounted for — Manage and track the quality of IAEA in-field facilitation efforts — Write national inspection reports to document the performance of the owner/operator in facilitating in-field activities
	NPP owner/operator	— Refer to the facility attachment to identify and facilitate specific IAEA in-field verification tasks for routine inspections and follow established communication protocols — Respond in a timely manner to IAEA inspection requests, including unannounced and short notice routine inspections — Communicate and enforce facility specific safety and security arrangements and procedures — Accommodate IAEA personnel, information and equipment on-site with suitable infrastructure during in-field verification activities — Receive, respond to and act upon IAEA requests and questions — Communicate and negotiate effectively

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Annex I

CASE STUDY: BELARUS

I–1. OVERVIEW OF NEW BUILD PROGRAMME

Belarus has been a party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) since 1993. The Agreement Between the Republic of Belarus and the International Atomic Energy Agency for the Application of Safeguards in Connection with Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/495) dated 14 April 1995 is the legal basis for the application of safeguards in Belarus. INFCIRC/495 is based on INFCIRC/153.

In early 2008, a decision was taken to implement a new nuclear power programme in Belarus with a view to constructing its first nuclear power plant. Within the programme, arrangements were made for the development and improvement of the legal framework for nuclear and radiation safety.

The Intergovernmental Agreement Between the Republic of Belarus and the Russian Federation on Cooperation in the Construction of a Nuclear Power Plant on the Territory of Belarus was signed in March 2011. The Agreement lays down that the Belarusian NPP is to be a turnkey construction by the Russian Federation. The general contractor is the joint stock company Atomstroyexport JSC (JSC ASE) and the customer is Republican Unitary Enterprise Belarusian Nuclear Power Plant (at the time of the signing of the agreement, State enterprise Directorate for Nuclear Power Plant Construction was established as the operator). The Belarusian NPP consists of two power units with a total power up to 2400 (2×1200) MWe.

The AES-2006 design was chosen for the Belarusian NPP as a design with advanced nuclear features and performance indicators.

The construction of the Belarusian NPP began in 2013. Republican Unitary Enterprise Belarusian NPP is the operator of the Belarusian NPP. The operator performs commissioning, operating, limiting of performance indicators, extending the life of the plant and decommissioning, as well as establishing and maintaining the system of accounting for and control of nuclear materials and the implementation of IAEA safeguards.

Power unit 1 of the Belarusian NPP was connected to the grid in November 2021 and started commercial operation. Power unit 2 is at the stage of commissioning and is expected to be connected to the grid before the end of 2022.

I–2. SUMMARY OF PRIOR EXPERIENCE WITH SAFEGUARDS IMPLEMENTATION

According to Article 7a of its CSA, Belarus is obliged to establish and maintain the State’s system of accounting for and control of all nuclear material (SSAC) under safeguards, and being under the system’s jurisdiction results in State legislation. According to the agreement, Belarus declares the location, features and application of all nuclear material, facilities and LOFs where the nuclear material used is under the system’s jurisdiction. Belarus committed itself to permit verification from the IAEA side of all nuclear material and facilities and LOFs.

For SSAC implementation, each enterprise planning or conducting nuclear material management activities should establish and maintain the system of accounting for and control of nuclear material (SAC) with sufficient size, resources and quality for permanent control of nuclear material in place for delivery and during the transportation of nuclear material within the enterprise.

The State’s system of accounting for and control of in Belarus is an element of government regulation for safety of the use of nuclear power and is intended to:

(a) Ensure the peaceful use of nuclear material;
(b) Prevent unauthorized use and removal of nuclear material;
(c) Ensure the control of all nuclear material;
(d) Ensure the provision of reports and other information in relation to accounting for and control of nuclear material to the competent authority of the system and the provision of information about the location and quantity of nuclear material to the other republican regulatory agencies carrying out government regulation for safety in the use of nuclear power;
(e) Evaluate the book inventory and inventory changes in the LOFs;
(f) Fulfil the international obligations of Belarus in relation to the peaceful use of nuclear energy and the prevention of its use for nuclear weapons and other nuclear explosive devices.

Belarus’ SSAC includes:

— Regulatory agencies, providing for its operation at the State level and at the operator level;
— Regulations for issues related to accounting for and control of nuclear material;
— Analysis and transfer to the system’s entities of information about the inventory and its transferral;
— The system of nuclear material accounting reports.

SSAC functions are assigned to the Department of Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus (Gosatomnadzor). The Department of Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus (Gosatomnadzor) is a structural division of the Ministry of Emergency Situations of the Republic of Belarus with the rights of a legal entity that performs special functions in the field of nuclear and radiation safety.

The Ministry of Emergency Situations in its activities is under the Council of Ministers of the Republic of Belarus and liaises with State agencies in cases where it is necessary for effective operation of the regulatory body.

The following facilities were in Belarus at the time of the nuclear power plant construction: critical experimental facilities Hyacinth and Kristall at the State Scientific Institution, The Joint Institute for Power and Nuclear Research — Sosny, and others.

I–3. KEY ACTIVITIES UNDERTAKEN TO ENHANCE SAFEGUARDS INFRASTRUCTURE AND IMPLEMENT SAFEGUARDS FOR THE NEW NPP

From the beginning of the NPP construction, the operator, Belarusian NPP, was assigned with functions for establishing and maintaining the system of accounting for and control of nuclear material.

There were the following regulations in the field of accounting for and control of nuclear material in Belarus:

(a) The Law of the Republic of Belarus, On the Use of Atomic Energy;
(b) Resolution of the Council of Ministers No. 224, Regulations on the Procedure for the State’s System of Accounting for and Control of Nuclear Material of the Republic of Belarus;
(c) Resolution of Committee of the Republic of Belarus for the Supervision of Safety Practices in Work in Industry and Nuclear Power under the Ministry of Emergency Situations and Population Protection against the Chernobyl NPP Consequences dated 28 February 1995, IAEA Safeguards Implementation;
(d) Resolution of Committee of the Republic of Belarus for the Supervision of Safety Practices in Work in Industry and Nuclear Power under the Ministry of Emergency Situations and Population

Protection against the Chernobyl NPP Consequences dated 28 February 1995, Structure of State's System of Accounting for and Control of Nuclear Material;

(e) Technical Code of Common Practice 533-2014 (02300) approved by the Ministry of Emergency Situations, Procedure of Accounting for and Control of Nuclear Material Reports Provision to the Competent Governmental Agency.

Therein the requirements for procedures for accounting for and control of nuclear material were not specified (e.g. book inventory, nuclear material measurement, etc.). This presented a great challenge for establishing the system of accounting for and control of nuclear material at the NPP.

The regulations of the Russian Federation were taken, but the Russian Federation legislation was used cautiously as an analogue for Belarusian legislation because the Russian Federation is a nuclear weapon State and its international obligations differ from those of Belarus.

In the absence of Belarusian regulations and not being able to use the Russian Federation legislation fully, we used the practices of neighbouring States in the field of accounting for and control of nuclear material, specifically those of Ukraine, as a State that receives enhanced IAEA safeguards implementation reports and like Belarus is a non-nuclear weapon State.

I–4. CHALLENGES ENCOUNTERED, LESSONS LEARNED AND GOOD PRACTICES

A graded plan for establishing the system of accounting for and control of nuclear material (SAC) at the Belarusian NPP was developed based upon the practices of Ukrainian and Russian NPPs. The main activities/accomplishments were as follows.

I–4.1. Establishing a separate department for accounting for and control of nuclear material

In the Belarusian NPP design documentation, this department could be found as a laboratory for accounting for and control of nuclear material, the functions of which were accordingly establishing and maintaining the system for this. Initially, there were four personnel, which was not sufficient. The design documentation was changed and the staff at the laboratory now comprises six persons.

I–4.2. Personnel recruitment and training

In working to establish the safeguards systems, it was necessary to call upon experienced personnel. We could do this by inviting specialists with great experience of maintaining systems of accounting for and control of nuclear material to the Belarusian NPP.

Further, according to the National Programme for Nuclear and Radiation Safety Training, the International Sakharov Environmental Institute has an educational programme of Nuclear and Radiation Safety, with a subqualification of Accounting for and Control of Nuclear Material that enabled us to have qualified personnel in the laboratory now.

The personnel were trained by the educational programmes of the IAEA and others. In 2018 the IAEA and the US Department of Energy organized a workshop on reports, documentation and Code 10 in the Belarusian NPP by invitation from Belarus.

The heads of the laboratory and the division have been licensed to conduct work in the field of nuclear power use: accounting for and control of nuclear material and spent nuclear material provision.

I–4.3. Equipment procurement for nuclear material measurement and reports and records

Non-destructive testing equipment for spectrometry and a weight measurement complex were procured and delivered for confirmatory measurement.

Special purpose software, Automated System of Accounting for and Control of Nuclear Material, was procured, delivered and put into service at the Belarusian NPP.

With the purpose of the control of nuclear material, seals were procured and procedures for application were determined.

I–4.4. Local regulations development at the Belarusian NPP

The operating documentation specifying the procedure for maintaining the system of accounting for and control of nuclear material at Belarusian NPP was developed and put into service. The instructions determining responsible persons for procedure of accounting for and control of nuclear material were developed as related to assigning the inventory custodian and persons responsible for maintaining the accounting for and control of nuclear material, for seals management, and for maintaining reports and records.

I–4.5. Initiating changes to Belarus regulations in the field of accounting for and control of nuclear material

There was no regulatory document specifying the procedures for maintaining the system of accounting for and control of nuclear material at the facility in Belarus. By the initiative of Belarusian NPP, the document setting the main requirements and criteria of accounting for and control of nuclear material at the facility was developed. The main requirements and criteria relate to :

- The list and minimum quantity of nuclear material liable to governmental accounting;
- Identification of the starting point, and conditions for the exemption and termination of nuclear material accounting and control;
- Requirements for the methods and frequency of physical inventory taking;
- Reasons for unscheduled physical inventory taking and its procedure;
- Requirements for the nuclear material measurement system.

Annex II

CASE STUDY: FINLAND

II–1. OVERVIEW OF NEW BUILD PROGRAMME

II–1.1. Nuclear reactors Olkiluoto 3 (OL3) and Hanhikivi-1

Teollisuuden Voima Oyj (TVO) is a Finnish nuclear power company with more than 40 years of experience in the safe and reliable production of electricity. In February 2005, the Finnish government gave permission to TVO to build a new nuclear reactor. Finland was the first Western European country in 15 years to make this decision. The construction of the Olkiluoto 3 (OL3) unit began in 2005. The start of commercial operation has been postponed. It is expected that commercial operation will start in 2022.

In 2010, the Parliament of Finland ratified the decision in principle for TVO to build a fourth reactor unit in Olkiluoto (OL4). On this project, SBD was in the picture from the start. TVO included safeguards requirements in the bid invitation specification. For managing all safeguards related issues, TVO created the plan for implementation of safeguards and export control for the project. This plan formed the basis for how the company would have handled safeguards and export related issues with the supplier after the contract had been signed. However, the OL4 decision in principle was forfeited in 2015, because TVO did not submit the construction licence application.

Parallel to the OL4 decision, the Finnish parliament also ratified a decision in principle for the newly established power company, Fennovoima Ltd, to build a new reactor. Fennovoima chose Rosatom's pressurized water reactor model AES-2006, which is the latest evolution of water cooled, water moderated power reactor (VVER) plant designs. Fennovoima followed the same principles as TVO with the OL4 unit. As a result, safeguards requirements are included in the contract, so it is on the supplier to prepare the necessary reservations for safeguards instrumentation and its usability in the facility. In June 2015, Fennovoima submitted the construction licence application to the Ministry of Employment and the Economy. Provision of the necessary information to the Finnish Radiation and Nuclear Safety Authority (STUK), as required for the construction licence as per the Nuclear Energy Decree, is still ongoing. While the government process for the construction licence application was ongoing, Fennovoima cancelled the contract with the supplier and withdrew its construction licence application in 2022.

II–1.2. Disposal of spent nuclear fuel

A new safeguards approach that has not been applied previously in IAEA safeguards will be introduced in connection with the final disposal project for the nuclear material, implemented by the nuclear waste management company Posiva [II–1].

The schedule for the preparation of spent nuclear fuel for final disposal was defined in a Government decision in 1983. In accordance with the objectives set in the decision, the site for final disposal should be selected by the end of 2000, the construction of the disposal facility should be started at the beginning of the 2010s and disposal should begin around 2020. This final disposal of spent nuclear fuel in geological formations is expected to serve the overall good of Finnish society. This decision led to the development of a geological repository in several phases. The site selection phase took 15 years, owing to information from geological site investigations and a geoscientific monitoring programme. The decision in principle application to locate the preliminary designed repository near the Olkiluoto nuclear power plant was filed by Posiva in 1999. The decision was endorsed by the Finnish Parliament in 2001. The decision in principle was based on the plan to excavate an underground rock characterization facility first and later convert it to a nuclear facility if the hosting rock turned out to be suitable for disposal. Posiva started to excavate the underground research facility ONKALO [II–2] in 2003. It was planned that ONKALO would be part of the repository, but it had no construction licence pursuant to the Nuclear Energy Act. The construction licence application for the nuclear facility was submitted in 2012, and the construction licence was granted in 2015. The casting of the first concrete of the encapsulation plant took place in summer 2019. Posiva plans to apply for the nuclear operating licence in 2021 and receive it in 2024. At the time of writing, the operation is expected to start in 2025, which is only five years later than in the initial 1983 decision.

II–2. SUMMARY OF PRIOR EXPERIENCE WITH SAFEGUARDS IMPLEMENTATION

Finland became a non-nuclear weapon State in 1947 upon the signing of the Paris Peace Treaty, which stipulates that "Finland shall not possess, construct or experiment with any atomic weapon". During the cold war period, Finland, as a neutral country, mitigated the tensions between the blocs. Concerns over a conflict between major powers promoted Finland's active role in the development of non-proliferation. Finland also became a strong proponent of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and CSAs. Finland's role was important when the model CSA (INFCIRC/153) was drafted. Finland was also the first country with whom the IAEA negotiated a CSA (INFCIRC/155), signed in July 1971. The agreement remained in force until Finland signed a new safeguards agreement upon becoming a Member State of the European Union (EU) in 1995 (INFCIRC/193). Finland's non-proliferation history was described in detail in a recent study [II–3].

Earlier Finland had one research reactor (Triga Mark type) and two NPPs, with two reactors in each, coming into operation 1977–1981. Finland has had a fully operational State system of accounting for and control of nuclear material (SSAC) for decades to take care of international commitments.

However, the new projects in this millennium have challenged the Finnish SSAC. The experience and knowledge to identify the safeguards requirements and raise awareness of them is vital. The need to exchange information and share the output is not only enabling the effective implementation of safeguards but is also promoting the safe use of nuclear energy.

II–2.1. Olkiluoto 3 project

Safeguards by design were not taken into account during the bidding and design process for OL3 in the beginning. In fact, when TVO released the invitation to tender for the third unit, safeguards or safeguards equipment were not mentioned in the bid specifications [II–4]. Therefore, when the potential plant suppliers sent their bids for OL3, none of them contained any safeguards related issues. As a result, because plant contracts are composed on the basis of bids, the safeguards perspectives were not included in the contract.

The plant contract was a turnkey type contract. This type of contract is quite practical and common, if the operator does not have adequate personnel or experience to build nuclear power plants. Another major feature of this kind of contract is that all changes in the contract may become expensive. Further, the changes may be difficult to execute, because practically all of the site work is the responsibility of the supplier, and the operator is not allowed to do any work at the site if not specially required in the contract. However, the operator has ultimate responsibility for the facility operations, which cannot be delegated away.

The safeguards came into the picture when TVO sent its first Basic Technical Characteristics (BTC) document for the unit to the European Commission in 2008. The document has been revised many times, since the details of the plant and TVO's accountancy practices concerning the unit have become clearer. TVO's practice has been to check the need to update the BTC at least once per year, and this is also the new authority requirement in Finland once the new set of regulatory guides are adopted for TVO's units.

The BTC was followed by the first meeting between the IAEA, the European Commission, the STUK, TVO and the plant supplier Areva concerning OL3 safeguards surveillance equipment in 2008. Many similar meetings followed over the years, but the final layout of the cameras and seals was agreed in 2011. Remote data transfer was not fully accepted at that time in Finland due to IT security concerns. Therefore, reservations needed by remote data transfer, such as cable installations, penetrations, external connections and server requirements were not taken fully into account.

The locations for the seals were decided based on TVO's presentations and the BTC, where it showed how the fuel is handled inside the unit and what the transfer routes are. Other aspects were also considered. The layout of the reactor hall was such that the lifting of large components over the fuel transfer routes would be normal practice. This required the installation of two cameras at opposite ends of the reactor hall.

The locations for the seals were determined such that they can seal the most significant places in the plant, such as the reactor and the access route for the spent fuel. At the same time, some extra effort was seen to ensure that these sealing methods will not have an impact on operation of the plant and that the sealing locations are accessible without specialized equipment. One example of this is that, when planning the sealing point for the spent fuel route, the mostly stationary lift gate was chosen instead of the more commonly used swing gate or the docking point of the spent fuel transfer cask.

Throughout the whole safeguards surveillance system project, the remote data transmission requirements have caused many extra problems. This is mainly due to the very strict IT security requirements that have been implemented for OL3. Generally, all outside connections to the unit have been categorically prohibited unless they are indispensable. This means that all of the outside connections need to be justified and that their impact on the safety of the plant has to be clarified. Therefore, even though the safeguards surveillance equipment is a somewhat isolated system inside a nuclear power plant, it will have an impact at the plant level, and it has to be considered in the IT security plans concerning the whole unit.

Alongside the authorities' safeguards activities, TVO has also planned how to implement the new unit in its own safeguards system. Normally, in Europe the basic requirements for the operator's safeguards practices come from the Particular Safeguards Provisions (PSP), which have been set by the European Commission. Preparation of the PSP takes time, so TVO has already included its plans in the OL3 BTC before issuance of the PSP. These practices have been adopted from TVO's other operating nuclear units with small modifications, when it has been sensible or necessary.

Large parts of the accountancy system are the same as for other units, but the most important part of the accountancy — the accountancy and reporting software — was not compatible with the new unit. Therefore, a new, dedicated version of the software was seen to be necessary and its development started in 2009. The software came into operation in 2017, when the first fuel arrived at the facility.

II–2.2. Relevant experience from spent fuel disposal project

As mentioned previously, construction of underground parts of the facility started in 2003, but the nuclear construction licence was only filed in 2012. This led to the situation where Finland had a nuclear facility construction project ongoing de facto, but not de jure. Legislation facilitated the regulatory oversight role of STUK, but internationally the state of affairs was not optimal. STUK as a regulatory authority was concerned that the IAEA would not be able to positively conclude that the underground tunnels are really built as declared. A DIQ was not provided by the operator, and the situation was further complicated by the fact that spent fuel disposal facilities had no DIQ developed, and existing DIQ templates did not fully meet the specific needs. Before provision of the DIQ, the IAEA had difficulties in mandating its inspections and reserving resources to implement safeguards in the facility. In November 2003 STUK sent a letter to the IAEA informing the Agency about the start of construction, invited the IAEA to the site and cooperated with it via the safeguards support programme mechanism (ASTOR and SAGOR tasks).

In this context, the national safeguards approach of applying long term monitoring data collected for the safety case to support safeguards reporting in the preoperational phase in a cost effective and non-intrusive manner was developed and launched in 2003. The approach follows the SAGOR recommendations [II–5]. The focus has been on the generation of credible regulations for documenting construction and adjoining geoscientific monitoring records and State findings that have to survive over the more than 100 year disposal project. The proposal to submit geoscientific findings to the IAEA was published in 2006 [II–6]. Even data from site investigations were submitted to the IAEA, but no formal communication was initiated.

The IAEA also noted the problem and requested that Finland declare ONKALO as an additional protocol site 2.a.(iii) instead of the long term plan 2.a.(x), as declared by Finland since 2004, or provide a DIQ to the IAEA. A new DIQ template was drafted and tested for the first time in 2009. The IAEA took this test as an official submission and initiated its internal processes. Meanwhile, in Finland, Posiva thought that the submission was only for testing. This gap between different understandings was eventually closed in 2012, when the nuclear construction licence application for the final disposal facility in 2012 was filed by Posiva. Right after that, Posiva submitted its first official DIQ, leading to the establishment of two MBAs, the encapsulation plant (W0LE) and the geological repository (W0LF).

The current SBD process was presented by Murtezi et al. in 2018 [II–7]. The focus has been on the safeguards equipment and infrastructure to be installed at the encapsulation plant. The plant design has been revised twice since the licence application, hence the detailed plan for safeguards equipment has been modified after communication with the operator and according to the facility's needs. Mutual benefits can only be achieved through good communication and cooperation. The casting of first concrete of the encapsulation plant took place in summer 2019, and during the construction it is essential to communicate the timing of installation of the safeguards equipment within the project's schedule.

II–2.3. Hanhikivi-1 project

Taking into account the lessons learned in the Olkiluoto projects and understanding the requirements for safeguards and the combination of safeguards with security and safety, it is especially important with a completely new operator to start a dialogue on safeguards matters and measures as early as possible. In Finland, this is underlined by the requirement presented in a regulatory guide [II-8] to provide preliminary design information within 60 days from the decision in principle. This requirement was first implemented in 2013, taking into account lessons learned from the OL3 and Posiva projects. The preliminary design information includes information about the owner of the facility; the operator of the facility; and the facility's purpose, location, type, foreseen power output (in reactor facilities) and expected commissioning date (preliminary timetable for the project). This information needs to be provided to STUK and to international inspectorates (in Finland, to the European Atomic Energy Community (Euratom) and via Euratom to the IAEA) to create the material balance area and to enable the supervision of the project and start of the SBD process.

Preliminary design information was submitted by Fennovoima to the European Commission in summer 2013, once the future Hanhikivi site at Pyhäjoki had been selected. Early provision of this information was at that time voluntary, since the above mentioned STUK regulatory guide had not yet been issued. Fennovoima concluded that it was also to their benefit to provide information as early as possible. Fennovoima submitted the construction licence application to the Government in June 2015. At the time of writing, Fennovoima expects the construction licence to be granted in 2021. The first Hanhikivi site declaration (according to the additional protocol) will be submitted once the construction licence has been granted.

The need to have a safeguards manual as part of the applicant's quality management system at an early phase is seen as necessary in Finland. It is a valuable tool for the regulatory authority to ensure that the operator (user of nuclear energy) understands its duties and is able to provide necessary information for the planning and implementation of safeguards thereafter. Dedicated persons responsible for safeguards at the operator are necessary in conducting practical measures and to be contact points for the authorities. The duties of the responsible persons include informing their superiors about necessary safeguards demands and requirements. One task is to ensure that safeguards measures are included in the bids and in evaluation of tenders. These persons need good contacts with plant designers, too.

As the requirements will vary from State to State and from facility to facility, it is necessary to arrange localized training and workshops to discuss the safeguards requirements and how to include them in all phases of a nuclear project. STUK has organized a few workshops with Fennovoima, where requirements were clarified to the Fennovoima staff as well as management. Safeguards relevant documentation has also been reviewed as part of the licensing process. In addition to this national oversight, workshops on SBD and international requirements were organized with the IAEA and the European Commission. Vendors and staff from subcontracted organizations have also participated in these workshops. As the safeguards methods and equipment are not familiar to newcomers, a visit to the IAEA safeguards laboratories was organized in 2017. Workshops and informal meetings on development of the design and the whole project will be organized as often as is seen to be necessary. The experience gathered by the new operator was presented at the IAEA Safeguards Symposium 2018 [II-9]. This continuous interaction shows how awareness about safeguards needs has increased among all of the nuclear stakeholders.

II–2.4. Import–export control

In Finland, the nuclear energy industry is heavily dependent on imports. Finland does not have any nuclear fuel production or industry for manufacturing the components used in nuclear facilities. Further, Finland currently does not have nuclear fuel manufacturing and equipment manufacturing capacity related to nuclear fuel technology. Hence Finnish nuclear exports are largely related to nuclear datasets.

The export control of nuclear material is based on the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Safeguards ensure that the nuclear materials, equipment and technology in the State are used solely for peaceful purposes and that the risk of the spread of nuclear weapons is limited effectively.

The national monitoring of nuclear material is the responsibility of the STUK. The IAEA and Euratom supervise the international transfer of nuclear material. At the international level, the Nuclear Suppliers Group (NSG) and the Zangger Committee are operating institutes. The Zangger Committee has 36 members and was established to harmonize the interpretations of the export control policy laid down in the NPT. The Nuclear Suppliers Group is another international level working group that has worked to limit the proliferation of nuclear weapons by means of conditions for export of nuclear material, combined nuclear safeguards and security. Finland belongs to the Zangger Committee and the NSG.

Bilateral agreements on cooperation in the field of atomic energy can play an important role in import–export control. These agreements facilitate the licensing process, since they provide the necessary guarantees, and the time consuming process of exchanging diplomatic notes can be avoided.

II–3. KEY ACTIVITIES UNDERTAKEN TO ENHANCE SAFEGUARDS INFRASTRUCTURE AND IMPLEMENT SAFEGUARDS FOR THE NEW NPP

Experience from the OL3 and Posiva projects taught STUK that the necessary regulatory framework was not in place and that the legislation was not up to date. To facilitate safeguards implementation, the legislation was updated in 2008 and the following text was introduced into the Nuclear Energy Decree (translated from Finnish) [II–10]:

> "The use of nuclear energy shall be planned and executed such that the obligations on nuclear safeguards laid down in and issued by the virtue of the Nuclear Energy Act and laid down in and issued by the virtue of the European Atomic Energy Community (Euratom) Treaty are complied with.. A nuclear facility or other place in which nuclear energy is used may contain no premises, materials or activities of significance to safeguards that are not included in the notified information. The licence holder or other user of nuclear energy shall have an accounting and reporting system for nuclear material and other nuclear commodities which ensures the correctness, scope and continuity of information in order to implement the safeguards necessary for the non-proliferation of nuclear weapons."

This was the first step to include SBD as a clear requirement for all use of nuclear energy in Finland. With STUK's duties and supervisory rights described in the Nuclear Energy Act and the Decree, this forms a clear basis for how to implement SBD thereafter.

According to Section 7r of the Nuclear Energy Act (990/1987), the STUK specifies detailed safety requirements for the implementation of the safety level in accordance with the Nuclear Energy Act. These requirements are called YVL guides. STUK issued a new version of regulatory control of nuclear safeguards in 2013, which included the more detailed requirements for the operator's safeguards system and its implementation. The major improvement was the requirement for the applicant to provide preliminary design information to STUK and the European Commission not more than 60 days after the decision in principle [II-8]. This information is to be updated as soon as more specific design information becomes available. Further, interaction between regimes and national safety, security and safeguards and description of regulatory supervision and the IAEA and European Commission roles were added.

STUK also started to arrange specific training for the nuclear operators in Finland, together with the IAEA and the European Commission. Operators were represented by safeguards and security staff and responsible managers. Contents of new regulatory guides were also discussed.

These improvements are bearing fruit in new projects, especially the Hanhikivi-1 project.

II–4. CHALLENGES ENCOUNTERED

If the facility designers are not familiar with the required safeguards measures, the need for communication cannot be underestimated. The design basis and plant suppliers for commercial nuclear facilities often come from countries where the practical safeguards and security solutions are different from those in the country of destination.

Two Finnish institutions, Lappeenranta-Lahti University of Technology and Technical Research Centre, have created a small modular reactor concept, and both concepts are unique in that sense that they are only designed to produce relatively low temperature district heat. The designs are at the conceptual phase, but the realization of those plans also requires the application of new safeguards approaches and possibly also new safeguards technologies.

Finnish Research Reactor (FIR-1) is now at the decommissioning state. Further, old operating power plants have made small changes. These kinds of projects may also require attention from the safeguards point of view. A good example is covering the spent fuel storage pools with heavy lids, which are only meant to be opened when the fuel is taken away for disposal. SBD of those lids should involve consideration of many aspects (sealability, camera usage, inspection planning, verification possibilities, etc.). However, these SBD aspects were not involved in the discussions when such a decision was made and the lids were designed. Safeguards had to be adapted to the new situation. The end result is acceptable but could have been better.

II–4.1. Import–export challenges

Lessons learned from the new facility under construction and its supervision indicate the necessity to have better guidance for the import and export challenges during the project. This is the phase when, for instance, unlawful imports of nuclear materials may occur. These are usually not of great safeguards importance, but they are very important to consider while continuing the new build project and implementing the SBD as a whole.

II–5. LESSONS LEARNED AND GOOD PRACTICES

In view of our experiences as presented above, we conclude that:

(a) Cooperation and collaboration between all parties are essential, and roles and responsibilities should be clearly determined;
(b) It is good to increase general knowledge about safeguards with determination;
(c) Interactions between safeguards, security and safety have to be understood and taken into account in all phases (from planning and design to decommissioning);
(d) A support network has to be set up;
(e) Active (proactive) State regulatory authority is in a key position and can serve as a point of contact;
(f) Training of all stakeholders (including the regulator) is essential;
(g) Regular meetings between all actors are particularly important;
(h) Early communication regarding specific requirements for safeguards implementation at the facility is important;
(i) Including safeguards requirements in the bid helps the process and clarifies the roles of the operator and plant supplier;
(j) Provision of the first DIQ right after the decision to build the facility is a good practice, which can be made a legal requirement;
(k) SBD does not solely concern technology, you can run also into trouble with the implementation of safeguards concepts or even with legal interpretations;
(l) SBD should also be applied when nuclear facilities are modified or decommissioned.

II–6. CONCLUSION

National and international cooperation are essential in facilitating effective safeguards at all levels. New operators have less experience and knowledge concerning integrating safeguards, security and safety than operators that have been in the field for a long time, although the need for cooperation applies to all.

The best way to reduce project risks in nuclear design and building projects is to include all requirements and to consider all issues from an early point when there can be more flexibility in selecting options. Cooperation and communication play an important role in understanding all necessary safeguards related requirements at an early phase. In principle, this could mean that at the starting point the establishment of the safeguards requirements is most probably based on bilateral agreements, with this being transferred to the IAEA at the earliest phase.

An SBD process involving all stakeholders at an early phase is a good practice. Finnish legislation and especially STUK safeguards regulation push in this direction. All stakeholders should also be aware at all phases from design, licensing, construction, operation and decommissioning. It is important to identify safeguards implications in all phases. Finland is an example of a small country handling this control regime effectively, although it has taken many decades to raise awareness at the licensee and State levels.

Ultimately, nuclear waste management also has to be solved. Finland is a pioneer in solving problems related to high activity nuclear waste disposal. This requires long term undertakings, and the ONKALO construction project is one, with its roots dating back to the 1970s. Deep commitment to the responsible use of the nuclear materials and finally nuclear energy is essential for a State planning to build nuclear energy infrastructure. This includes a strong policy level principle of preventing the proliferation of nuclear weapons and measures for nuclear material safeguards at an early phase. The most important consideration when building, for instance, an underground disposal repository is to enable all essential information to be communicated at an early phase, so that the excavated rock caverns are known. They should be documented and carefully supervised to eliminate any secret tunnels or other spaces. This is SBD in practice.

The disposal facility is a new type of facility globally with specific safeguards challenges. The implementing company chose a technically pragmatic solution to first construct an underground rock characterization facility and then later convert it into a nuclear facility if the hosting rock was found to be suitable for disposal. This approach led to legal problems in the research phase of the project, since the status of the facility and consequently roles and mandates of the players were not clear. Those issues were addressed when the facility obtained legal nuclear status. The selected approach was eventually successful because of open and proactive communication. However, if these safeguards concerns and legal issues had already been discussed during the planning phase of the project and before the construction of the research facility began, the process would have been much easier. Further, the authorities in Finland have drawn their own conclusions to avoid this this kind of stepwise licensing with undefined status in future.

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Annex III

CASE STUDY: TÜRKİYE

III–1. OVERVIEW OF NEW BUILD PROGRAMME

III–1.1. Akkuyu NPP

Akkuyu NPP, the first NPP project in Türkiye, is under development in Mersin Province on the southern coast of the country. The NPP is designed under the build–own–operate model and comprises four 1200 MWe VVER units. The NPP is being developed and is owned and operated by Akkuyu Nuclear Joint-Stock Company. The expected operational life of Akkuyu NPP is 60 years. Once the NPP goes into the operational stage, it is expected to generate 35 billion kWh of electricity per year.

The timeframe for the Akkuyu NPP is as follows:

(a) In May 2010, the Russian and Turkish governments signed an agreement called the Agreement between the Government of the Russian Federation and the Government of the Republic of Turkey on Cooperation in Relation to the Construction and Operation of a Nuclear Power Plant at the Akkuyu site in the Republic of Turkey in order to cooperate in the construction and operation of an NPP.
(b) In February 2011, Akkuyu Nuclear JSC applied to the Turkish Atomic Energy Authority (TAEK) to be recognized as an owner, and TAEK approved the recognition.
(c) In March 2011, site investigations were initiated by Akkuyu Nuclear JSC in order to update the site characteristics and parameters in the scope of the national procedures in the Decree on Licensing of Nuclear Installations.
(d) In October 2011, Conditions for Akkuyu Site Licence was declared by TAEK as complementary to the site licence.
(e) In August 2012, TAEK Atomic Energy Commission approved Novovoronezh-2 Nuclear Power Plant, which is located in the Russian Federation, as the reference plant for Akkuyu NPP.
(f) In August 2014, the contract of procurement of technical support was signed between TAEK and UJV Rez, a.s. of the Czech Republic for safety aspects.
(g) In November 2014, TAEK Atomic Energy Commission approved the List of Licensing Basis Requirements, Guides and Standards and its Approval Conditions for Akkuyu Nuclear Power Plant-Revision 2.
(h) In February 2017, the site parameters report with the last updated version was approved by TAEK.
(i) In June 2017, the electricity generation licence was granted by the Energy Market Regulatory Authority until 15 June 2066 (49 years).
(j) In October 2017, a limited work permit was granted to Akkuyu Nuclear JSC for Akkuyu NPP Unit 1.
(k) In December 2017, an official construction initiation ceremony was held at the Akkuyu NPP site within the scope of the limited work permit. Construction and assembly works for all facilities of the nuclear power plant, with the exception of buildings and structures related to the safety of the nuclear island, are carried out under a limited construction permit.
(l) In April 2018, a construction licence was granted for the Akkuyu NPP Unit 1 and full scale construction work for the construction of Unit 1 officially started.
(m) In November 2018, a limited work permit was given to Akkuyu Nuclear JSC for Akkuyu NPP Unit 2.
(n) In March 2019, the concrete pouring works for the reactor building foundation of Akkuyu NPP Unit 1 were completed.
(o) In August 2019, in line the decision of the Board of the Nuclear Regulatory Authority (NDK), the main construction licence for Akkuyu NPP Unit 2 was given.

(p) In November 2020, the construction licence for Unit 3 was granted by NDK. Construction started in March 2021.
(q) In May 2020, Akkuyu Nuclear JSC applied for a construction licence for Akkuyu NPP Unit 4.
(r) In October 2021, a construction licence for Unit 4 was issued by NDK. Construction started in July 2022.

III–1.2. Sinop NPP

Sinop NPP, the second nuclear power plant project, is planned to be built in Sinop Province on the coast of the Black Sea. As a result of an intergovernmental agreement signed with Japan, it was decided to construct the power plant and start construction in 2017. In accordance with the agreement, the consortium will operate power plants in Japan, France and Türkiye (on behalf of the public from Türkiye, Electricity Generation Company will own 49% and two Japanese companies will own 21%, with French side shares comprising 30%).

The Atmea-I type pressurized water reactor, developed in a joint venture between Japanese Mitsubishi Heavy Industries and French Areva, will be used in Sinop NPP. The power plant is planned to have a total installed capacity of 4480 MWe with four reactor units of 1120 MWe. After the results of feasibility studies, Türkiye agreed with the Japanese side to not continue cooperation regarding this matter due to the schedule and pricing of the nuclear power plant in Sinop.

III–2. SUMMARY OF PRIOR EXPERIENCE WITH SAFEGUARDS IMPLEMENTATION

Türkiye signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in 1969 and approved it in 1979. As required by the NPT, Türkiye concluded a CSA with the IAEA in 1981, followed by an additional protocol that was signed in 2000 and put into force in 2001. The IAEA has drawn the broader conclusion for Türkiye each year since 2012. In July 2018 the Council of Ministers enacted Decree Law No. 702. In virtue of this new law, the Turkish Nuclear Regulatory Authority (Nükleer Düzenleme Kurumu — NDK) was established and the former regulatory role of the Turkish Atomic Energy Authority was ended. All of the regulatory duties, responsibilities and authorities were transferred to NDK. The new law intended to improve the regulatory system in Türkiye and achieve full compliance with international requirements. The new nuclear law also contains provisions for the transfer of personnel, budget, effective protocols and agreements, together with the continuing projects related to the regulatory activities, to NDK.

NDK became the responsible SRA for carrying out the liabilities concerning safeguards (i.e. State system of accounting for and control of nuclear material in Türkiye) later than the date on which the new nuclear programme had initiated. Responsibilities in the scope of safeguards were previously carried out by the Nuclear Safety Department of TAEK, but as of July 2018, with the new law, the SSAC is carried out by the Security and Safeguards Department of NDK. As of January 2021, 14 personnel are employed in the Security and Safeguards Department.

To improve the competence of NDK a technical support organization, Nuclear Technical Support Joint Stock Company (NÜTED), has been established by the new nuclear law as a government owned company. At least 51% of its shares will be owned by NDK. NÜTED has the responsibility to provide all necessary technical support organization services to NDK. Hiring staff and capacity building for NÜTED will be implemented in parallel to the needs of NDK. Established to provide all kinds of technical support that NDK may need in the performance of its duties, NÜTED is also subject to the provisions of private law and may employ specialized and competent personnel in the field of specialized public institutions and organizations when necessary. In this context, technical support, which is needed for the increased workload through Akkuyu Nuclear Power Plant, can be provided by NÜTED.

In the time period when the new nuclear programme was initiated, the terms of the nuclear safeguards were known because Türkiye had experience related to nuclear safeguards, having two research reactors, a nuclear fuel pilot plant and multiple LOFs (universities, nuclear research institutions, industrial radiography firms, waste units and hospitals) that have small quantities of nuclear material, including shields containing depleted uranium.

III–2.1. Regulatory framework related to safeguards

The Nuclear Material Accounting and Control Regulation was first published in 1997 based on the CSA (before the ratification of the additional) and revised in 2012 (including additional protocol requirements). As a first technical regulation of NDK, the Safeguards Regulation, which was prepared based on the CSA, additional protocol and IAEA guidelines, was published 25 January 2020 in the Official Gazette within the framework of the new law.

The IAEA has been implementing safeguards inspections for all nuclear facilities and nuclear materials within Türkiye to verify that there is no diversion of nuclear material and that all nuclear activities in Türkiye are for peaceful purposes. Apart from the IAEA inspections, the SRA has been conducting its own national inspections. In order to guarantee that nuclear activity is for peaceful purpose, a permanent and well organized system is obligatory, which can maintain the SSAC, provide the support necessary for the IAEA’s safeguards activities and implement independent safeguards inspections for nuclear transparency. As an independent nuclear regulatory authority designated by the Republic of Türkiye, NDK has been running safeguards implementation projects to fulfil national duties on nuclear safeguards. NDK conducts inspections and checks the status of nuclear materials that each facility has in possession. NDK also holds training courses on safeguards of small quantities of nuclear materials in order to improve understanding of the safeguards system.

III–3. KEY ACTIVITIES UNDERTAKEN TO ENHANCE SAFEGUARDS INFRASTRUCTURE AND IMPLEMENT SAFEGUARDS FOR THE NEW NPP

III–3.1. Implementation of safeguards activities for Akkuyu NPP

In line with the developments regarding the new nuclear power plant project, Türkiye submitted an Article 2.a.(x) declaration with additional protocol (AP) annual updates in 2008 and 2009. After the agreement was signed on cooperation in relation to the construction and operation of a nuclear power plant at the Akkuyu Site with the Russian Federation, the preliminary design information was submitted to the IAEA in 2010. Then a preliminary DIQ was submitted to the IAEA. Based on preliminary construction plans, a DIQ for Akkuyu NPP Unit 1 was submitted to the IAEA in 2017. In time, the DIQ has been updated according to the construction plan and also comments from the SRA and IAEA. DIQs for the units at Akkuyu NPP, the Fresh Fuel Storage Facility and the Spent Fuel Storage Facility were submitted to the IAEA in a timely manner, in any event, not later than 180 days prior to the start of construction. In terms of additional protocol requirements, an Article 2.a.(iii) declaration was submitted to the IAEA with the additional protocol annual update before the construction licence for Unit 3 was granted in 2020.

Additionally, DIV is performed by the IAEA periodically at a facility throughout all of its life cycle stages. After the issuance of a construction licence for Akkuyu NPP Unit 3, the IAEA performed an initial DIV to Akkuyu NPP to facilitate discussions regarding the requirements for/installation of IAEA C/S equipment and to confirm the correctness and completeness of the information provided in the DIQ. Bilateral and trilateral working group meetings for discussions regarding requirements/installation of IAEA C/S equipment have been ongoing to facilitate implementation of IAEA safeguards since August 2019. Early cooperation is highly recommended by the IAEA because this will be useful in early submissions and discussions of the DIQs, and the integration of the IAEA C/S system in the design of the new NPP units.

III–3.2. ISSAS

The first condition for enhancing safeguards infrastructure is to be aware of the strengths and weaknesses of SSAC by performing a situation analysis. A milestone step to analyse the SSAC system is the ISSAS. An ISSAS mission was held from 14–18 June 2010, when the new build programme started in Türkiye. The mission reviewed many SSAC issues at the State level, including legislation, authority, responsibility, independence, resources, qualification and training, and specifically the organizational structure of a revised national nuclear material accounting and control system to be adapted to the expected nuclear programme in Türkiye, the administrative and technical systems at both the State level and the facility level, and the performance of those. The final report was submitted to the SRA by the IAEA in September 2011.

Türkiye's SSAC was found to be tailored to the current nuclear programme and to enable the country to meet its safeguards obligations. Türkiye's SSAC was reviewed, and no noteworthy problems were found by the mission; however, recommendations were made on some issues, such as physical protection, export and import control, procedures to counter illicit trafficking of nuclear materials, etc.

III–3.3. Working group for NPP safeguards

In respect of the safeguards measures to be implemented at Akkuyu NPP, a working group has been established for the purpose of discussing the issues required to be solved between the project company and the SRA. The working group carried out work concerning DIQs by arranging meetings with the project company periodically and aided the delivery of the relevant documents to the IAEA in a complete manner. The working group held trilateral meetings with the IAEA and the project company regarding containment and surveillance systems to be established at Akkuyu NPP in the later stages. Thanks to the working group, it has been ensured that the works for safeguards are carried out in a scheduled and timely manner.

III–3.4. Secure electronic communication and SDP

The establishment of a secure electronic communication system is another key activity that improves the safeguards infrastructure. Due to the procedures used (confidential accounting reports delivered from the SRA to the Ministry of Foreign Affairs and then delivered by courier to the Permanent Mission of Türkiye in Vienna and finally the IAEA), sometimes NMA reports (ICR, MBR, or PIL) were not reaching the IAEA within the deadlines specified in subsidiary arrangements, even though they were sent by the SRA as soon as possible. Encrypted secure electronic communication was established between the SRA and the IAEA at the beginning of 2013 to prevent nuclear material accounting and control (NMAC) report delays. This was also recommended by the ISSAS mission.

Secure electronic communication was used until the IAEA launched a new web based system (the SDP) in 2017, which makes communication and the submission of AP declarations and NMA reports by States easier and more secure. Türkiye was one of the first States to use the SDP for its NMA reports and additional protocol declarations. The SDP provides efficient and modern information exchange that saves both time and effort and secures sensitive information when sending reports. It also reduces the paper based steps, but it depends on the State; for example, even though reports and declarations are submitted via the SDP, they are also delivered to the IAEA through the Türkiye Permanent Mission in hard copy forms. This allows the reports and declarations to be controlled by the IAEA. While format checking of reports could previously only be carried out through the quality control verification software, the SDP provides a consistency check using the NMA reports submitted previously to the IAEA in the system. Further, information requests and explanations can easily be sent reciprocally from the messages section in SDP. In summary, during the transition to the new nuclear power programme, the establishment of a secure electronic communication system following the utilization of SDP can be considered to be another key activity in facilitating safeguards implementation and improving the national safeguards infrastructure.

III–3.5. Integrated Nuclear Infrastructure Review (INIR)

Another important mission is the Integrated Nuclear Infrastructure Review (INIR) mission to assess the status of national infrastructure for the introduction of a new nuclear power programme. The review covers the comprehensive infrastructure required for developing a safe, secure and sustainable nuclear power programme. By providing a comprehensive assessment of all facets of a new nuclear power programme, including nuclear safeguards, spanning the regulatory body, utility and all relevant Government stakeholders involved, INIR is a key activity to enhance the nuclear infrastructure required for the safe, secure and sustainable use of nuclear power. The Ministry of Energy and Natural Resources called for the IAEA's assistance and invited an INIR mission to Türkiye in 2012. A self-evaluation report was submitted in August 2013 for the 19 nuclear power infrastructure issues included in the IAEA's Milestones approach, an extensive methodology that guides countries to work in a systematic way towards the introduction of the new nuclear power programme. The INIR mission was conducted 4–14 November 2013 in Türkiye within the framework of the new nuclear power programme.

III–3.6. Technical support and assistance

Training courses and technical support are important steps towards improving the safeguards infrastructure and optimizing the workload for other facilities and LOFs in the State during the development of the new nuclear power programme. In this context, training courses on NMAC were first organized by the regulatory authority for research reactors and LOFs. Further, participation in international training courses and workshops that are organized by the IAEA was ensured and with the support of the IAEA, national and regional NMAC training courses were arranged in Türkiye. All these activities not only raise awareness on safeguards, but also allow national obligations to be fulfilled completely and in a timely manner. If the reports and notifications from facilities and LOFs are appropriate, the workload of the SRA is alleviated and the SRA can allocate time for the new nuclear power programme's safeguards issues. To facilitate the complete preparation of NMA reports and AP declarations, quality control verification control software and Protocol Reporter software were delivered to facilities and LOFs, and technical support for the use of this software was provided.

III–3.7. New nuclear regulatory authority

TAEK was affiliated with the Ministry of Energy and Natural Resources (MENR) administratively. Decisions for authorization regarding licensing of nuclear installations are not subject to the approval of MENR. Due to the limited nuclear programme and activities in Türkiye, TAEK used to perform both regulatory functions and research activities on the utilization of atomic energy. Its dissolution by the enactment of Decree Law 702 on 9 July 2018, which was the most important step for the Government and the regulatory body to establish an independent regulatory body and put a national policy in place that covers a wide range of issues. As the national nuclear power programme evolves, a new nuclear regulatory body NDK, responsible for nuclear safety, nuclear security, and nuclear safeguards was established by the enactment of Decree Law 702.

Figure III-1 presents a timeline for the key activities in establishing or enhancing the national safeguards infrastructure required for the nuclear power programme.

FIG. III–1. Timeline for key activities in enhancing the safeguards infrastructure required for the nuclear power programme.

III–4. CHALLENGES ENCOUNTERED

Throughout the process of developing the national capacity to enhance safeguards infrastructure, the following challenges were faced:

(a) Drafting the safeguards guidelines and procedures and principles from scratch was harder than including safeguards in the law or the regulation when setting up the legislation because they describe the implementation in more detail for safeguards staff, facilities and LOFs.
(b) It took time and effort for the SRA to educate the responsible persons at the facilities or LOFs or the NMAC personnel about the instructions so that they could contribute to the reviewing process.
(c) Translation: translating the related documents from English to Turkish using the proper Turkish technical terminology related to safeguards was challenging. Further, language problems were encountered in the documentation of a new nuclear power programme due to translation from Russian to English.
(d) The LOFs' understanding of safeguards: some LOFs, especially those with depleted uranium containers, did not have a clear understanding of safeguards. Further, they did not understand why the SRA requested information that they have already provided to the Department of Radiation Practices or the Department of Radiation Protection at the SRA.
(e) NMAC staff leaving the facility and LOFs: continuity of experience and knowledge sharing is a challenge due to the desire of personnel to seek higher educational degrees abroad, or to transfer to other jobs, or to be assigned to another university.
(f) Different safety and safeguards approaches between the SRA and the NPP company presented a challenge.

III–5. LESSONS LEARNED AND GOOD PRACTICES

Throughout the process of developing the national capacity to enhance safeguards infrastructure, the following lessons were learned:

(a) Before initiating the drafting process, the SRA should identify what is needed for safeguards obligations, and consider reviewing safeguards related regulations and guidelines from other countries that have the same safeguards agreements in force with the IAEA;
(b) Consultation with relevant experts from different international organizations and programmes should be considered;
(c) Having a clear view of what the SRA wants to obtain from the facilities and LOFs (reporting (when under which format), the organization put in place for NMAC, etc.) in order to implement safeguards;
(d) Requirements should be very clear so that there are no ambiguities between the SRA and the facilities and LOFs regarding the safeguards obligations and requirements;

(e) Training and tutoring management, namely giving repeated training opportunities to staff from other sections who might work in safeguards issues one day;
(f) Early cooperation with the SRA and the IAEA is highly recommended — this will be useful in early submissions and discussions of the DIQs, and the integration of the IAEA C/S system in the design of the new NPP units (SBD);
(g) Attending IAEA international courses and interacting with IAEA experts and other experts from other States is very useful, especially while you are setting up the new safeguards programme, while national workshops or training courses are also key activities and present a good opportunity to discuss best practices and recommendations — these activities also help in getting things right from the start with feedback.

The good practices identified for the process of developing the national capacity to enhance safeguards infrastructure are as follows:

(1) There is a mandatory training programme for new NDK staff members. More specific training programmes are arranged for Security and Safeguards Department personnel and the staff are also being trained through IAEA training courses.
(2) Most of the inspectors are nuclear regulatory experts who have passed a challenging examination that covers nuclear security, safety, safeguards and radiation protection.
(3) There are students from various engineering disciplines being educated in foreign universities whose expenses are covered by the Government and they will be ready to work for NDK in a couple of years.
(4) With respect to the safeguards measures to be implemented at the Akkuyu NPP, a working group has been constituted for the purpose of discussing the issues that need to be resolved between the project company and the SRA.
(5) A secure electronic communication system has been established between some facilities, some LOFs and NDK.

III–6. CONCLUSION

In developing a new safeguards programme, it is very important to have a clear roadmap with a timeline including all milestones of the project, regulatory requirements and IAEA requirements. This is necessary to guarantee proper implementation of the new programme and ensures compliance. In this context, the SRA should make extensive use of the IAEA's assistance to States services and material. For example, launched in 2020, COMPASS is a new IAEA initiative that involves partnering with States to help them strengthen the effectiveness of their SRA and of their respective SSAC. COMPASS will begin with a pilot phase involving a few countries, including Guatemala, Malaysia, Rwanda, Türkiye and Uzbekistan. Upon successful completion of this pilot phase, the initiative will be made widely available to other States. To sum up, it is expected to involve working in close cooperation with the IAEA about safeguards issues for the new NPP project. NDK will continue to do its utmost to ensure the peaceful use of nuclear energy through a proactive approach.

If we needed to summarize the goal to be reached in a single sentence, it would be: open minded safeguards culture is more effective than pure declaration based approaches and obligations.

Annex IV

CASE STUDY: UNITED ARAB EMIRATES

IV–1. OVERVIEW OF NEW BUILD PROGRAMME

In 2008, the United Arab Emirates (UAE) published the Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy, which evaluated nuclear power with other energy options and concluded that nuclear power was “a proven, environmentally promising and commercially competitive option which could make a significant base-load contribution to the UAE’s economy and future energy security” and could eventually provide about one quarter of the country’s electricity. The UAE consequently embarked on its nuclear power programme and invited bids for the construction of its first nuclear power plant.

On 27 December 2009 the recently established Emirates Nuclear Energy Corporation (ENEC) selected the Korea Electric Power Corporation as the prime contractor for the construction of four APR-1400 reactors at Barakah, located in the Al Dhafra Region in the west of the Abu Dhabi Emirate. The Korea Electric Power Corporation group also involved Samsung, Hyundai and Doosan, as well as Westinghouse, whose System 80+ design (certified in the United States of America) had been developed into the APR-1400. The Shin Kori 3 and 4 nuclear power plants in the Republic of Korea served as the reference plants.

The Federal Authority for Nuclear Regulation (FANR) was established in 2009 as the UAE’s nuclear regulator and SRA.

ENEC began the construction of Unit 1 of the Barakah NPP in 2012, with the construction works for Units 2, 3 and 4 commencing in 2013, 2014 and 2015, respectively. ENEC established Nawah Energy Company in 2016 for the operation and maintenance of the Barakah NPPs. FANR issued the operating licence to Nawah for Barakah Unit 1 in February 2020 and for Unit 2 in March 2021. Unit 1 successfully achieved 100% of the rated reactor power capacity in December 2020 and commercial operation started 6 April 2021. Fuel loading at Barakah Unit 2 was completed in March 2021 and the plant is scheduled to achieve full power by September 2021. By March 2021, 94% of the construction works for Barakah Unit 3 and 88% of those for Barakah Unit 4 had been completed. Unit 3 is scheduled to become commercially operational in 2023, and Unit 4 in 2024.

IV–2. SUMMARY OF PRIOR EXPERIENCE WITH SAFEGUARDS IMPLEMENTATION

The UAE acceded to the Nuclear Non-Proliferation Treaty (NPT) in 1995 and brought into force a CSA with an SQP in 2003. The national authority responsible for safeguards implementation at that time was the UAE’s Ministry for Foreign Affairs and International Cooperation. Since the original SQP holds in abeyance most of the provisions of Part II of the CSA, including those relating to detailed nuclear material accounting and inspections, the UAE’s activities and experience in the area of IAEA and national safeguards prior to the launch of the UAE’s nuclear programme were minimal.

In the area of national nuclear export controls, the major challenges were the UAE’s strategic location between the East and West, the large number of ports and free trade zones, a business friendly environment, its role as one of the world’s major trade hubs and the activities of illicit nuclear procurement networks such as A.Q. Khan’s nuclear black market, which was exposed in 2004. The network was prolific because its members’ activities were dispersed across countries with inadequate export controls and camouflaged behind front companies. Just as in most other countries, nuclear export controls were in their infancy in the early/mid-2000s and required urgent action resulting from United Nations Security Council Resolution 1540.

IV–3. KEY ACTIVITIES UNDERTAKEN TO ENHANCE SAFEGUARDS INFRASTRUCTURE AND NUCLEAR EXPORT AND IMPORT CONTROLS AND IMPLEMENT SAFEGUARDS FOR THE NEW NUCLEAR POWER PLANT

IV–3.1. Establishment of the legal framework

The Federal Law by Decree No. 6 concerning the peaceful use of nuclear energy was enacted in 2009, establishing the Federal Authority for Nuclear Regulation (FANR) as the UAE's SRA and the legal framework for the UAE's evolving nuclear programme.

The UAE signed the additional protocol (AP) in 2009, which entered into force 20 December 2010. During the implementation of the SQP the AP was the tool that provided the IAEA with access to the UAE's nuclear programme through the AP's complementary access provisions. Further access was also provided to the IAEA through technical visits concerning preparatory arrangements for IAEA containment/surveillance installation. Following the receipt of the fuel for Barakah Unit 1 in February 2017, the UAE's SQP became non-operational and full scope safeguards started to be implemented. This included the submission of the initial inventory to the IAEA and its verification by IAEA inspectors at Barakah NPP and the UAE's many LOFs.

FANR drafted several regulations for controlling the evolving nuclear sector. In the areas of nuclear safeguards and export controls these were FANR-REG-10 (Regulation for the System of Accounting for and Control of Nuclear Material and Application of Additional Protocol) and FANR-REG-09 (Regulation on the Export and Import Control of Nuclear Material, Nuclear Related Items and Nuclear Related Dual-Use Items).

FANR issued a construction licence to ENEC for Units 1 and 2 of Barakah NPP in 2012 and for Units 3 and 4 in 2014, which also contained provisions related to safeguards and export controls.

IV–3.2. Manpower development

Due to the lack of domestic expertise in the nuclear field at that time, both FANR and ENEC relied heavily on foreign experts, while at the same time implementing an 'Emiratization policy', offering diverse training opportunities to young Emiratis interested in working in the evolving nuclear field.

FANR's capacity building efforts included the steadfast support of the Government's Emiratization initiative. Long term career opportunities for Emirati employees at FANR were achieved through focused recruitment, training and development programmes. In early 2016, FANR launched the Developee Programme as part of its strategy to build long term sustainability by developing Emirati talent in the nuclear sector. Through this programme FANR recruits young Emirati science, technology, engineering and mathematics graduates from UAE and international universities for a year long nuclear regulatory development programme. The programme provides them with the fundamental knowledge needed to understand the technical concepts applicable to nuclear engineering, radiation protection and regulation. Since its inception, 17 engineers and physicists have graduated from this programme, and have developed into competent FANR staff. Following the success of this programme, any direct hires in FANR's Operations Division also need to undergo this programme and follow a focused development plan, depending on FANR's subject area. Recently, FANR graduated two Emiratis in the field of regulatory legal framework, providing the fresh law graduates with the fundamental knowledge necessary to understand concepts relevant to the laws, legislation and agreements related to FANR and the UAE's peaceful nuclear programme. The Developee Programme has helped FANR to establish a well trained workforce, reducing its reliance on foreign expertise and ensuring its mission of developing competent Emiratis in the nuclear field and various technical fields.

FANR has also benefited from a close relationship with the United States of America. In particular, the US Department of Energy has provided 'commodity identification training' for FANR staff and UAE customs authorities. This training is highly practical and supports the UAE's export control system and the implementation of the AP.

IV–3.3. Establishment of a safeguards system by FANR and ENEC

FANR established a safeguards department with the required competences to satisfy the UAE’s obligations arising from the CSA and AP, and the nuclear export control requirements resulting from the UAE’s voluntary adherence to the Nuclear Suppliers Group (NSG) Guidelines. First, experience was needed to deal with the immediate task of meeting the UAE’s safeguards obligations — particularly with respect to the AP and its requirement to submit an initial declaration to the IAEA. Second, a source of in-house knowledge was required to expedite the development of a national workforce and so create a sustainability domestic nuclear regulatory capability through the Emiratization process. Specialized training programmes were developed aimed at developing an Emirati cadre in nuclear safeguards.

Additionally, the effects of staff turnover were mitigated by adopting a two pronged approach that consisted of specialized development programmes for the UAE’s young workforce, coupled with a structured approach towards knowledge management within the organization. The immediate and high priority tasks that were supported by Emiratis and led by staff with prior knowledge and experience included the creation of a safeguards information management system, including SSAC software to meet the IAEA Code 10 reporting requirements, the development of FANR regulations on safeguards and export control in English and Arabic, the establishment of a licensing process and the implementation of a FANR national inspection and verification regime.

FANR created a nuclear material accounting system to manage the licensees’ reports involving nuclear material and activities declarable under the AP. This development of the State system of accounting for and control of nuclear material (SSAC) also involved regular engagement with the IAEA and contracting software vendors to develop FANR’s information management systems.

FANR established arrangements with national competent authorities in order to organize short notice access by IAEA safeguards inspectors as required by the AP, which was essential for ensuring that IAEA inspectors’ access proceeded without delay.

FANR conducted regular technical meetings with the IAEA Department of Safeguards to develop and monitor a safeguards implementation roadmap, conclude subsidiary arrangements, deliver national safeguards workshops, and support the design and installation of IAEA containment and surveillance systems at the four Barakah NPP units.

FANR’s success in establishing and maintaining a strong safeguards function also benefited from adopting the IAEA milestones approach. Engagement with national and international partners, in conjunction with the specialized Emirati development programmes, made important contributions to sustainable capacity building.

ENEC also needed to establish and develop its safeguards programme. ENEC created a Safeguards and Export Control Department, initially with just three employees. At the beginning ENEC employed safeguards experts and subject matter experts (SMEs) with IAEA safeguards experience to ensure efficient implementation of the programme from the early stages of the Barakah project by addressing the regulatory requirements and implementing the best practices from the IAEA’s international safeguards.

IV–3.4. Establishment of a nuclear material licensing and inventory system

After FANR’s establishment, FANR Safeguards staff visited companies and other entities known to use or suspected of using small quantities of nuclear material. Information gained from other FANR departments, particularly from the radiation safety department, provided safeguards staff with an initial list of companies to investigate. Other potential holders of nuclear material were identified through web searches, ‘yellow pages’ and referrals to companies from the companies being visited. The visits provided information on and introductions to safeguards, the IAEA and the relevant FANR regulations. Furthermore, the visits provided explanations on how to submit ICRs and make licence applications to FANR for the regulated activity of the possession, use, manufacture or handling of nuclear material. This approach resulted in the identification of many new users of nuclear material and in a dramatic improvement in regulatory performance.

In view of the UAE's oil based economy, oil companies and industrial radiography companies were the largest group of users of nuclear material — typically in the form of depleted uranium to shield the ionizing radiation from high activity radiation sources. In addition, many other types of entities — medical centres, food authorities, universities, companies dealing with aircraft dismantling and scrap metal companies — were also found to possess nuclear material. Several of the industrial radiography companies possessed items that were disused and difficult to identify (e.g. due to missing or heavily corroded labels) and which had apparently been previously used to transport or act as emergency storage for radiation sources. The procurement by FANR of a handheld gamma spectrometer (HM-5) for detecting the presence of nuclear and other radioactive materials and identifying the respective radioisotopes proved highly beneficial in allowing FANR Safeguards inspectors to verify the presence or absence of nuclear material. FANR was also able to acquire photographs and specifications of old style gamma cameras (projectors) through partnerships and relationships with other SRAs — allowing nuclear material to be identified prior to the purchase of the HM-5.

These early visits by FANR Safeguards staff transitioned to biannual inspections by the newly trained and certified FANR Safeguards inspectors and resulted in the issuance of official FANR inspection reports.

FANR Safeguards currently has approximately 75 licensees using nuclear material at LOFs. FANR Safeguards inspections at LOFs are being conducted on an increasingly risk informed basis where the inspection activities and frequency are part of a graded approach. The grading is based on the quantity and type of nuclear material held by the licensee, the number of nuclear material transactions, and the licensee's history of regulatory compliance, scope of activities and staff turnover (a high level is often followed by deteriorating regulatory performance). This approach has improved FANR Safeguards' efficiency while removing the inspection burden from companies that present a relatively low risk to the UAE's compliance with its international safeguards obligations.

Today, FANR conducts approximately one safeguards inspection per quarter at the Barakah NPP site, in addition to preparing for and participating in the IAEA inspections. In the first quarter of each year FANR also verifies the correctness of the Barakah NPP site declaration before submitting the annual AP update to the IAEA.

In the early years, FANR issued 'safeguards only' licences to authorize companies to conduct regulated activities with nuclear material. However, in recent years FANR has adopted a more integrated approach to regulation and now issues integrated licences that cover safeguards, safety and security (so called 3S licences). In addition, inspections at LOFs are also conducted in a 3S manner, with a multidisciplinary inspection team. FANR recommend that 3S integration be considered at an early stage in the establishment of the SRA — as transition carries significant challenges.

In order to ensure complete, as well as correct, AP declarations, FANR Safeguards has initiated a nationwide project to identify existing and potential engineering companies in the country's many Free Zones that may have the capabilities to conduct any of the activities listed in Annex I of the AP. This required collaboration with each of the Free Zone Authorities and related licensing entities. Such collaboration was facilitated by establishing a technical working group. The working group is being used to identify and facilitate access to the relevant Free Zones companies so that FANR can provide awareness training and other forms of outreach. The outreach addresses such issues as facilitating IAEA complementary access and the development of compliance programmes to ensure that FANR Safeguards are notified of actual or potential AP Annex I activities.

FANR Safeguards has also taken several steps to ensure that academic researchers/institutions are aware of AP reporting requirements concerning nuclear fuel cycle research and development not involving nuclear material. These include regular interactions and meetings, national workshops and periodic reviews of scientific papers/presentations.

IV–3.5. FANR’s National Safeguards Training Programme

In order to reinforce and complement the information provided during the FANR visits, inspections and outreach activities, FANR Safeguards conducted a series of national safeguards workshops in cooperation with the IAEA. The IAEA provided detailed presentations on nuclear non-proliferation, the safeguards international legal framework, IAEA verification activities and on how IAEA work builds confidence that States are honouring their non-proliferation commitments. In addition, the workshops included practical group exercises on nuclear material accounting and the licensing process, outputs of which have supported the development of FANR’s 3S licensing system. The preparation of regulatory guidance documents on how licensees can meet the requirements of the FANR safeguards regulation proved very beneficial. Furthermore, FANR Safeguards conducts one to one meetings with entities and smaller workshops with entities intending to handle nuclear material or with those that are performing their safeguards activities below the expected standard.

IV–3.6. FANR’s engagement with national entities

In order to meet the UAE’s international safeguards obligations and policy commitments, it was necessary for FANR Safeguards to engage and cooperate with other national competent authorities. For example, FANR cooperates with the Department of Economic Development, sharing information in order to identify companies potentially involved in activities regulated by FANR. FANR also cooperates with the General Civil Aviation Authority in order to ensure that depleted uranium contained as counterweights in scrapped aircraft is placed under regulatory control and that the nuclear material is reintroduced into the safeguards system.

IV–3.7. FANR’s engagement with the IAEA and other national and international partners

From the outset, FANR established a strong working relationship with the IAEA’s Safeguards Department that was structured around routine technical meetings at IAEA headquarters and technical safeguards visits to the UAE. During the technical meetings the IAEA was briefed on the development of the UAE’s safeguards related activities — including construction progress at Barakah NPP — and provided technical clarifications as FANR developed its safeguards infrastructure. Additionally, technical meetings between the IAEA and FANR were used to prepare for national workshops, to prepare for an ISSAS mission, to agree on how to submit LOF design information, to make arrangements for the implementation of containment and surveillance at Barakah NPP, to test SSAC software used for preparing accounting reports and to prepare the subsidiary arrangements.

The IAEA also conducted the Expert Mission on Safeguards Implementation at Barakah NPP that was targeted at both the Barakah NPP senior management team and those involved in the routine conduct of safeguards activities. This mission was instrumental in successfully operationalizing the CSA and AP in the UAE.

International engagement with regulatory authorities in other States is also an important aspect of developing and continuously improving the UAE safeguards arrangements. Engagement takes various forms, including participation in UAE national workshops by foreign regulators and convening bilateral meetings to discuss topics of regulatory interest.

Due to the fact that Barakah NPP is being constructed by a prime contractor from the Republic of Korea, FANR has developed a particularly strong relationship with Republic of Korea’s counterparts — the Nuclear Safety and Security Commission and the Korea Institute of Nuclear Non-proliferation and Control. This relationship is based around annual and technical meetings, which are used to share regulatory practices and streamline administrative matters relating to the transfer of nuclear material, equipment and technology from the Republic of Korea to the UAE. Recent initiatives have included joint studies to identify international best practices in the field of nuclear non-proliferation. These joint studies are also expected to support the development of young safeguards professionals through the preparation of academic style papers and to generally contribute to continuous and practical improvement of national regulatory systems.

Relationships that strengthen the nuclear non-proliferation regime were also realized through a number of NCAs concluded with various States. Today, FANR Safeguards has developed a policy for the efficient and effective implementation of international engagement and cooperation. This policy stems from the strategic objective to implement safeguards to the highest standards. This requires the prioritization of needs, the identification of suitable partnerships, the coordination of resources and gaining access to the necessary funding.

IV–3.8. Establishment of national nuclear export controls

Since the exposure of the A.Q. Khan nuclear black market, significant changes have been made in the UAE in the area of national nuclear export control. In 2007, following the requirements of United Nations Security Council Resolution 1540, the UAE created the Committee for Controlling the Transfers of Strategic Commodities. As stipulated in the Policy of the United Arab Emirates on the Evaluation and Potential Development of Peaceful Nuclear Energy, the UAE voluntarily committed to abide by the Nuclear Suppliers Group (NSG) Guidelines, the international standard for nuclear export controls, and seeks to participate in the NSG.

Upon its establishment in 2009, FANR took over responsibility for nuclear export control from the Committee. The Export and Import Control (EXIM) section within FANR’s Safeguards Department was charged with implementing the UAE’s nuclear export control activities. In 2014, FANR brought into force the Regulation on the Export and Import Control of Nuclear Material, Nuclear Related Items and Nuclear Related Dual Use Items (FANR-REG-09), which specifies FANR’s licensing, notification, reporting and inspection requirements for nuclear material, equipment and related technology, as specified in Part 1 and Part 2 of the NSG Guidelines. It provides the legal basis for controlling all nuclear related imports, exports, re-exports, transits and trans-shipments on the UAE's territory, including its more than 45 Free Zones and Special Zones. FANR thus not only controls nuclear exports, but all nuclear transfers, including the large number of transits and trans-shipments that occur on a daily basis. FANR-REG-09 was updated in early 2021 to further enhance FANR’s ability to control nuclear transfers and to take into account recent implementation practices.

Since the inception of FANR’s EXIM section, its staff have acquired a wealth of knowledge and experience in nuclear non-proliferation, international safeguards, the NSG Guidelines, customs procedures, identification of commodities, licensing, inspection, risk assessment and analysis of procurement networks.

FANR’s EXIM section has established a mechanism to control the transfer of strategic goods into and out of the State in cooperation with the Federal Customs Authority (FCA) and the seven local customs administrations across the UAE’s 64 border crossings, including the Free Zone Areas. Close cooperation with the FCA and the local customs administrations is essential for identifying the transfer of regulated items. FANR has provided the FCA with a list of controlled items categorized by certain HS Codes to be shared with the local customs administration, which have been added to the customs risk engine. When a company initiates the customs clearance process, the transfer of items falling under the controlled HS Codes is stopped and the company is referred to FANR for approval.

EXIM staff then evaluate the technical specifications of those items in order to determine whether they fall within the specifications of the NSG Guidelines. They also review the supporting documentation, such as the customs declaration, airway bill, bill of lading or commercial invoice. If the items turn out to be controlled, the company will then be required to apply for a FANR licence. This entire process is being handled through an electronic system (the NuTech Portal) on the FANR website.

In addition, the UAE customs administrations of the seven Emirates submit quarterly customs statistics for transferred items to FANR, which are used to identify any unlicensed or unauthorized transfers of controlled items. The statistics are also used for scheduling EXIM inspections.

FANR's EXIM section cooperates and exchanges information with other licensing authorities in the State, such as the Committee (now responsible for implementing export controls for all other strategic goods not covered by the NSG Guidelines), the seven Emirates' Economic Departments, the Ministry of the Interior, the Ministry of Defence, the Ministry of Climate Change and Environment, the Ministry of Health and Prevention, and others.

FANR has concluded memoranda of understanding with several States for the exchange of information on nuclear related dual use items. FANR is informed as soon as an export licence to the UAE is granted to exporters from those States, and follows up to ensure that the importer obtains a FANR licence prior to the import. FANR also cooperates with United Nations (UN) staff responsible for the implementation of United Nations Security Council Resolutions and liaises with the Committee to report any sanctioned activities or entities.

FANR's EXIM section holds regular awareness and outreach sessions with different audiences, such as licensees, companies potentially dealing with controlled items and the Federal Customs Authority, along with local customs officials and other government entities. These sessions have raised awareness about FANR's mission and the UAE's legal requirements related to nuclear export controls. FANR also provides commodity identification training to customs inspectors, as they are the country's first line of defence.

Since 2014 FANR has conducted annual events on nuclear export control practices bringing together national and international experts and stakeholders. The objectives of such events are to highlight the latest developments in this field, exchange information and learn from real case studies. These events have received very positive feedback from the participants.

IV–3.9. ENEC's Department of Safeguards and Export Controls

ENEC established a Department of Safeguards and Export Control in 2012, tasked with creating a safeguards plan to oversee the implementation of safeguards during construction and commissioning through to operation of the Barakah project. The first task was to develop a roadmap to evaluate and plan a way forward and to ensure that the safeguards programme was implemented efficiently to support the verification of the initial inventory, the first fuel delivery for Barakah Unit 1 and the operation of the unit. The roadmap was set up, focusing on developing three main pillars: plant, people and processes. The major identified tasks included:

— Development of ENEC safeguards and export control procedures;
— Procurement of a nuclear material accountancy and control system;
— Provision of initial design information to the IAEA;
— Discussions with the IAEA on the installation of a containment and surveillance system;
— Safeguards Department staff recruitment, training and development.

IV–4. CHALLENGES ENCOUNTERED, LESSONS LEARNED AND GOOD PRACTICES

The launching of a large nuclear programme such as the Barakah project with limited national experience in the nuclear field resulted in a steep learning curve for all national entities involved in this programme. This lack of national expertise in the nuclear field was the primary challenge in setting up the Safeguards related infrastructure at FANR. This challenge was overcome by hiring foreign safeguards experts and by making a structured and determined effort to develop the UAE's national expertise in safeguards, non-proliferation and export controls.

The Emirati staff of FANR's Safeguards Department are now well trained and experienced and knowledgeable about the implementation of the obligations resulting from the UAE's CSA and AP, and the UAE's nuclear export control requirements based on the implementation of the NSG Guidelines.

Cooperation with and support from the IAEA has been instrumental in building up the UAE's safeguards infrastructure. Regular communication, including substantive technical meetings, between FANR Safeguards and the IAEA's Department of Safeguards continue to be very important for identifying and overcoming challenges and smoothly facilitating IAEA safeguards activities.

Cooperation with other national authorities responsible for licencing and controlling activities relevant for Safeguards and nuclear export controls was also essential for identifying and licensing such activities and ensuring the proper reporting of such activities to the IAEA.

In the area of national nuclear export controls, it has become much more difficult for illicit nuclear procurement networks to carry out their activities in the UAE and severe punishment for past cases will serve as a deterrent. However, illicit activities cannot be completely excluded, as has been demonstrated by the fact that some UAE companies still appear on other States' sanctioned entities lists. Tracking the financing of such activities is not within FANR's jurisdiction and FANR's cooperation with the relevant competent authorities is essential. The UAE's huge number of trading companies and its oil sector, which utilizes many nuclear related dual use items or items with technical specifications just below the control limits, as well as the UAE's role as a major trade hub with a large number of daily transfers, provide further challenges.

Regarding ENEC, its Safeguards and Export Control Department consisted of three people in 2013. The roadmap identified the need for a steadily increasing number of personnel as each of the four units moved towards full operations. This requirement was finalized and approved.

In line with UAE Government policy, ENEC also introduced an Emiratization Policy in which the company is committed to create employment opportunities for UAE nationals and to ensure the implementation of retention programmes, making ENEC (and later Nawah) the employer of choice for UAE nationals. This policy supports the commitment to build UAE national capabilities through continuous learning and professional development programmes.

ENEC's Safeguards and Export Control Department was able to recruit Emirati staff and has ensured that their learning has been enhanced by participation in national and international training courses. The Department uses Safeguards, Accountancy and Export Control courses offered by the IAEA and other international organizations for all new staff. ENEC/Nawah and FANR also hold regular sessions, outside the scope of the formal FANR inspection regime, to ensure alignment, mutual understanding and avoidance of unexpected situations.

ENEC developed an export control process in 2014 with implementing procedures to manage all aspects of the import of nuclear material, equipment and technology authorized by FANR for the Barakah NPP Units 1 and 2 construction licences. In April 2014, ENEC imported the first equipment — the Unit 1 reactor vessel shell. In the following years, ENEC has imported a very large quantity of equipment under the construction licences for the four Barakah NPP units.

ENEC/Nawah have identified the following good practices:

(a) ENEC/Nawah sought guidance from international organizations during the project, predominantly the World Association of Nuclear Operators and the IAEA. Additionally, experienced nuclear professionals from other countries were recruited to support ENEC and Nawah, not only to contribute to the Barakah project, but also to train, coach and mentor UAE nationals in all aspects of nuclear energy, science and technology. The activities and progress of ENEC's Safeguards and Export Control Department were reviewed in all assessments by these bodies.

(b) In setting up a new safeguards programme, it is important to have a clear roadmap with timelines including all milestones of the project and the relevant regulatory and IAEA requirements. This is necessary to ensure proper implementation of the programme and ensures compliance with national and international regulations.

(c) Early engagement with the national nuclear regulator (FANR) and the IAEA is highly recommended. It has been demonstrated at the Barakah Plant that IAEA involvement in the early stages of the project resulted in high quality outcomes, mutual understanding and transparency. This was clearly demonstrated in the early submissions and discussions of the DIQs, and in the integration of the IAEA containment and surveillance system into the design of the Barakah units (‘SBD’).

(d) It is important to plan and select the NMAC vendor carefully, to specify clear requirements concerning the IAEA guidelines, regulatory and security requirements, and to implement and advance systems that support accurate and timely recording and reporting.

(e) Making use of national and international training courses for the qualification of employees is very valuable. Attending IAEA courses is important, especially while the safeguards programme is being set up. Interaction with IAEA experts and SMEs from other States is beneficial in this respect.

(f) Conducting or participating in national level workshops is also important, as this provides unique opportunities to discuss best practices and recommendations. These training and information exchange opportunities support the design and implementation of the safeguards programme and getting things right the first time.

(g) It is important to have close cooperation with the export control team of the contractor/supplier and to monitor all upcoming transfers of nuclear material and equipment and related technology closely, as well as shipments that are in transit. The contractors’ export control procedures have to reflect all transfer requirements detailed in FANR-REG-09 as well as the Barakah NPP construction licences.

(h) It is recommended to establish a system that contains relevant information on all equipment delivered to the nuclear site, including the exact location of each item.

(i) It is indispensable to make extensive use of IAEA assistance to States services and material.

IV–5. CONCLUSION

The process of creating a national safeguards system is a significant undertaking and benefits from a project orientated approach. It has included establishing an SRA (FANR), developing a national legislative framework, recruiting and developing experienced staff with safeguards and export control competences, educating stakeholders, cooperating with national and international partners, in particular the IAEA, and making special arrangements for safeguards implementation at the Barakah NPP.

The establishment and enhancement of a State’s safeguards infrastructure that meets a State’s international obligations requires a competent regulatory authority, significant resources, forward planning and a commitment from the Government. By meeting these requirements, developing a close partnership with the IAEA and embracing a policy of transparency, the effectiveness and efficiency of the UAE’s safeguards system was ultimately confirmed by the ISSAS in 2014.

In the area of national nuclear export controls, the UAE now has strict national legislation in place to control all nuclear related transfers and has upgraded its capabilities to detect illicit transfers. However, there is no room for complacency, as such transfers may still occur. In addition to a sound national export control infrastructure, international collaboration and the sharing of information and experience are indispensable for detecting and preventing the activities of illicit procurement networks.

Figure IV–1 presents a timeline for key activities to establish or enhance the national safeguards infrastructure, including export control, required for the nuclear power programme.

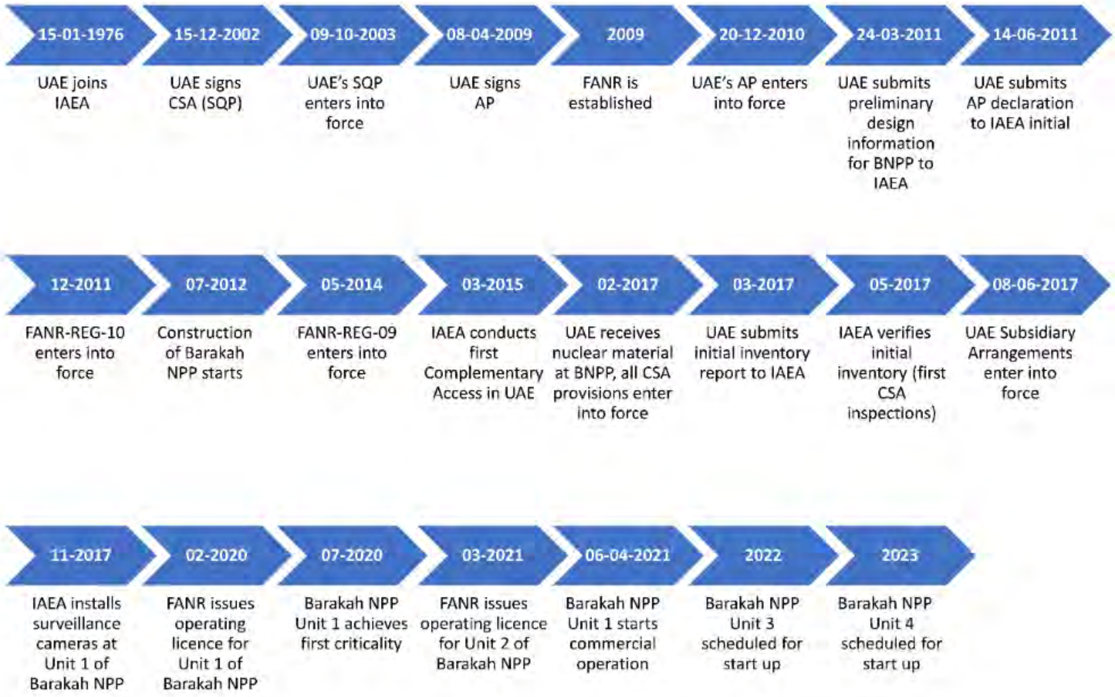

FIG. IV–1. Timeline for the UAE's nuclear programme and safeguards and export control.

Annex V

CASE STUDY: UNITED KINGDOM

V–1. OVERVIEW OF SAFEGUARDS ENHANCEMENT PROGRAMME

Prior to January 2021, the United Kingdom (UK) was party to the Euratom Treaty and a trilateral voluntary offer agreement (VOA), with accompanying additional protocol, between the UK, Euratom and the IAEA.[1] The UK's civil nuclear programme — consisting of more than 70 MBAs and more than 100 LOFs — was subject to Euratom safeguards reporting requirements and inspections. Under these arrangements, Euratom acted as the regional system of accounting for and control of nuclear material (RSAC), fulfilling most of the UK's safeguards obligations to the IAEA.

Following a referendum in 2016, the UK decided to leave the EU and, as a result, the Euratom Treaty. The UK's safeguards agreements with the IAEA needed to be replaced and the UK needed to establish a State system of accounting for and control of nuclear material (SSAC) to replace the Euratom RSAC. The UK government announced that this SSAC would be established by the UK Office for Nuclear Regulation (ONR), who would also act as the new SRA. The ONR established the UK SSAC Project to deliver this new safeguards regime in summer 2017, with a timeline for delivery determined by the UK Government decision to leave the EU by 29 March 2019. Subsequent agreement between the UK and the EU incorporated a transition period up to 31 December 2020 in which Euratom provisions would still apply. At the end of this transition period ONR began to operate the SRA for safeguards within the UK SSAC, and the UK SSAC Project closed in March 2021 after a period of post-implementation review and washup.

V–2. SUMMARY OF PRIOR EXPERIENCE WITH SAFEGUARDS IMPLEMENTATION

Prior to the UK SSAC Project, ONR's role in safeguards implementation was limited. ONR was primarily responsible for the regulation of nuclear safety and security in Great Britain, at 36 licensed sites and across transport by road and rail. ONR's role in delivering the UK's safeguards obligations regarding nuclear material accountancy and inspections was primarily facilitative. ONR had oversight of nuclear material accounting reports submitted to Euratom, and supported Euratom and IAEA inspections in the UK. The ONR had no State level nuclear material accountancy capability and carried out no domestic safeguards inspections. Euratom fulfilled all nuclear material accounting reporting and declaration obligations under the trilateral VOA. While ONR's role in implementing the trilateral additional protocol (AP) was more substantive, it was limited to those declarations not related to nuclear material accountancy (such as nuclear fuel cycle related research and development). Reflecting this limited role in safeguards implementation, ONR's safeguards capacity prior to the UK SSAC Project consisted of six safeguards specialists and one delivery support officer. ONR's safeguards roles prior to and after January 2021 are illustrated in Figures V–1 and V–2.

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[1] INFCIRC/263.

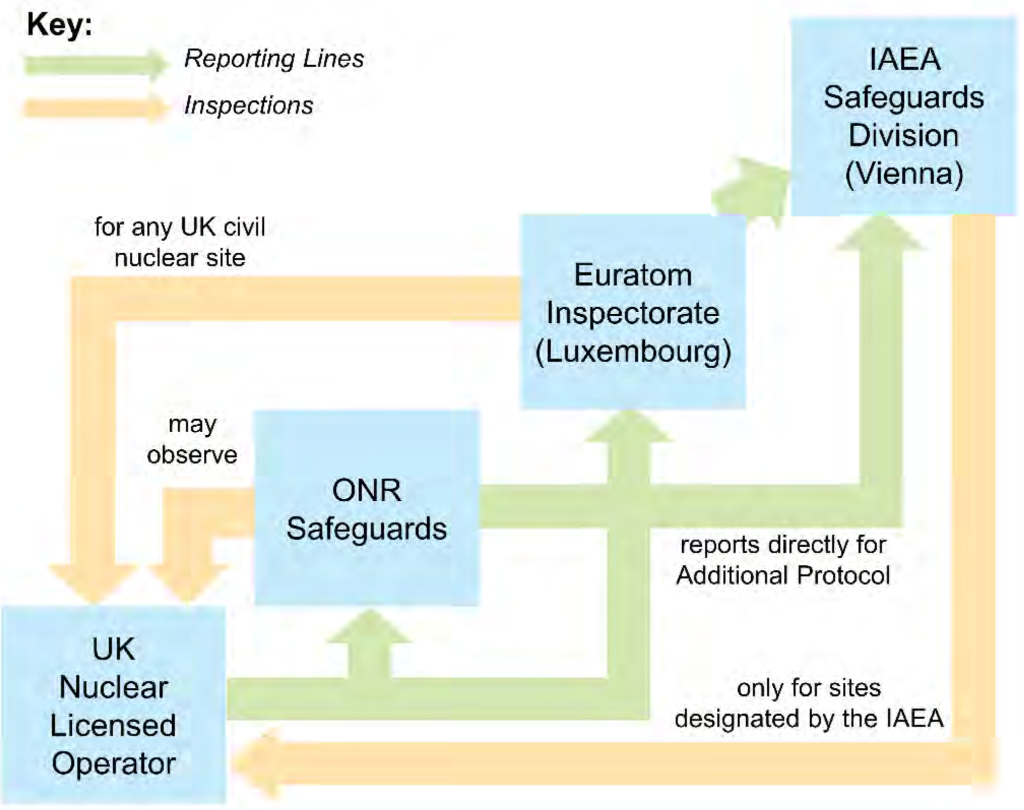

FIG. V–1. UK safeguards responsibilities before its exit from Euratom.

V–3. KEY ACTIVITIES UNDERTAKEN TO ENHANCE SAFEGUARDS INFRASTRUCTURE AND IMPLEMENT SAFEGUARDS

V–3.1. UK safeguards policy and governance

The UK SSAC Project formed part of a broader government led programme of work within the UK Department for Business, Energy and Industrial Strategy (BEIS). The Euratom Exit Programme was established to ensure that the UK's nuclear industry continued to thrive and operate to the highest international standards following the UK's exit from Euratom. This programme incorporated two governance sub-structures:

(a) The International Negotiations Project Board, which sought to negotiate the UK's withdrawal from the Euratom Treaty and negotiate a new framework of NCAs, including with the EU;
(b) The Safeguards and Domestic Implementation Project Board (SDIP), which sought to establish a new bilateral VOA and AP with the IAEA, and ensure that domestic measures were in place to fulfil the UK's new safeguards agreements. It was responsible for putting new domestic safeguards legislation in place through the UK Parliament and for oversight of the UK SSAC Project.

The UK SSAC Project contributed to two priorities of the Euratom Exit Programme, namely enabling the UK to meet its international commitments on nuclear safeguards and maintain the its reputation as a responsible nuclear State, and minimizing negative impacts on the UK's ability to trade in the nuclear sector.

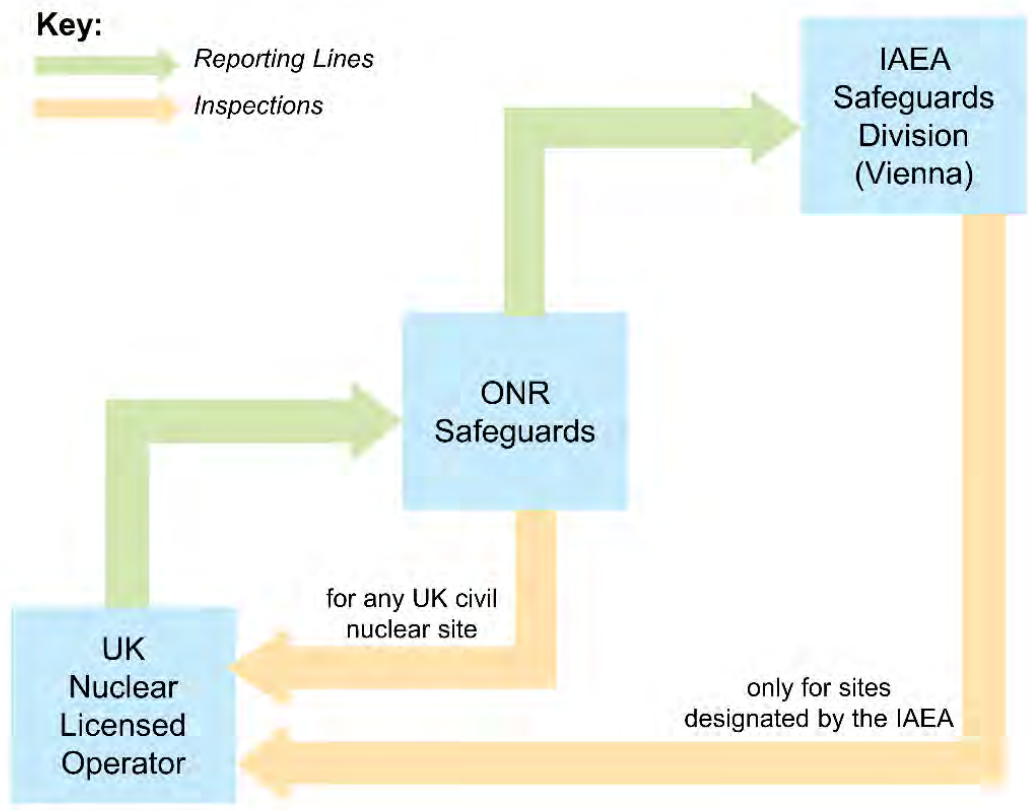

FIG. V–2. UK safeguards responsibilities after exit from Euratom.

To ensure that these priorities were delivered in line with Government policy, the UK SSAC Project was represented at both the SDIP and Euratom Exit Programme Governance structures. ONR provided a single monthly highlight report on its progress for discussion at both the SDIP Board and the Euratom Exit Programme Board. The ONR also established the UK SSAC Project Board, which met monthly to coordinate delivery of the UK SSAC within ONR and between ONR and the UK Government, and to help identify and manage risks to delivery. The UK SSAC Project Board included representation from the BEIS SDIP.

V–3.2. UK SSAC Project goals, funding and management

ONR set out to establish the UK SSAC in two phases. The first phase aimed to ensure that the UK would be in a position to meet its international obligations from 29 March 2019, as outlined in the new bilateral VOA and AP between the UK and the IAEA, and reporting obligations agreed under new NCAs with other States. It focused the project on establishing domestic legislation for nuclear material accounting reporting, and the technical and human resources within ONR to collect, analyse and transmit accounting reports and declarations.[2] It also focused the project on establishing human resources to facilitate IAEA inspections in the absence of the joint approach previously implemented between Euratom and the IAEA.

The second phase built upon Phase 1 to deliver a more comprehensive nuclear safeguards regulatory regime with broader coverage and effectiveness, in line with Government policy. It aimed to mature ONR's

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[2] The ONR did not have to develop a new capability to process and transmit additional protocol declarations unrelated to nuclear material accountancy as it fulfilled these declarations prior to the UK's exit from Euratom.

safeguards regulatory functions by strengthening the capability and capacity of domestic safeguards inspectors, and by providing guidance on the enforcement of domestic safeguards regulations. It also aimed to integrate this new regulatory function into the normal business mechanisms and governance structures of ONR's other regulatory functions.

The full objectives for the project were captured in project initiation documents, and included:

— Undertake effective information management and reporting to ensure that the UK continues to meet its international nuclear safeguards obligations;
— Receive and process the accounting declarations made by nuclear operators (over 100 declarations every month);
— Report to the IAEA in a timely manner in accordance with the VOA and AP, and as required to comply with the terms of the international NCAs;
— Facilitate IAEA inspections at MBAs agreed as part of the VOA;
— Grow ONR's inspection capability to provide comprehensive assurance on operators' arrangements for nuclear material accountancy and control and the implementation of these arrangements;
— Merge the existing (Euratom Treaty) business as usual safeguards activity into the scope of the UK SSAC from 30 March 2019 until the Euratom Treaty ceased to apply;
— Mature the ONR safeguards capability so that by December 2020 it can fulfil its role as an independent SRA delivering a comprehensive safeguards regime covering all aspects of inspection, assessment, accountancy and reporting without any degradation in standards;
— Develop performance indicators that enable the UK SSAC and its stakeholders to evaluate performance in respect of the activities highlighted in the point above.

These objectives were further elaborated in a target operating model, which illustrated all aspects of what a 'successful' UK SSAC would do, how it would it do this, and what capabilities it would need to do this.

The costs of carrying out the UK SSAC Project were set out in a charging agreement between ONR and BEIS and were included in BEIS's own Euratom Exit Programme outline business case. This provided an agreed budgetary envelope in which the UK SSAC Project could operate through to its conclusion on 31 March 2021. ONR and BEIS worked together to define a detailed annual budget within that envelope, and ONR provided forecasts of expenditure and details of actual expenditure to BEIS on a monthly basis through the SSAC Project Board.

The project itself was managed using the PRINCE2 and MSP methods.[3] It was owned by a Senior Responsible Office in ONR, who delegated its management and delivery to a Project Lead. The Project Lead was supported by a Project Manager, and subject matter experts in process development, IT procurement and development, regulatory policy and communications. The broader project team comprised the core of the new ONR safeguards team, including both experienced ONR inspectors, new recruits into the new safeguards inspector and nuclear material accountant roles, and ONR training and development and delivery support professionals. The team was supplemented by interim contractors and secondees from the UK nuclear industry with expertise in nuclear safeguards, nuclear material accounting operations and reporting.

The work of the UK SSAC Project was structured into separate workstreams, some of which focused on individual aspects of operating an SSAC, while others cut across the entire SSAC. Each workstream

[3] PRINCE2 is an acronym for 'projects in controlled environments', which is a process based project management method used extensively in UK Government and the private sector. MSP is an acronym for 'managing successful programmes'.

had an assigned lead who was responsible for defining and monitoring delivery of project tasks. The workstreams are listed below, with some of the key challenges encountered discussed in Section V–4:

— **Project management**, supporting the Project Lead in defining and monitoring project tasks, milestones, risks and delivery;
— **Policy and advice to UK Government**, providing safeguards advice to and coordinating stakeholder communications with the UK Government;
— **Technology**, developing the ONR Safeguards Information Management and Reporting System (SIMRS) and associated IT operations;
— **Operations**, building the capacity and competence of the ONR safeguards team and establishing its operational structures and management processes;
— **Guidance**, formulating and communicating ONR's regulatory expectations for safeguards in the UK;
— **Assurance**, providing structured and independent assurance of project delivery to the Senior Responsible Officer and UK Government.

V–4. CHALLENGES ENCOUNTERED

V–4.1. Policy and subject matter expert (SME) advice

The UK SSAC Project maintained a close working relationship with BEIS during the UK SSAC Project. The UK Government had to make policy decisions regarding its expectations for the new SSAC, as well as regarding the international and domestic legal frameworks that would underpin it. These decisions had to be informed by safeguards subject matter expertise to ensure that they aligned with good practice and the practicalities of safeguards implementation. These decisions also had to be informed by consultations with relevant stakeholders, and ultimately communicated effectively to those stakeholders. A dedicated workstream, led by a policy professional in ONR, oversaw the provision of advice in this regard and acted as a single point of contact between ONR and BEIS.

The new legal framework for safeguards had to be established quickly in an environment already crowded with new agreements and legislation to pass through Parliament. ONR provided technical advice regarding the standard contents of IAEA safeguards agreements (set out in IAEA INFCIRCs 153/540), subsidiary arrangements to those agreements, and the minor deviations from these templates in the UK's trilateral voluntary offer agreement (VOA). By opting for a 'technical update' of the VOA — minimizing any deviations from past documents — the UK was able establish new safeguards agreements quickly. ONR also attended the negotiations of new NCAs to ensure that the obligations established by those agreements could be monitored and implemented through the developing SSAC. The UK has now finalized new NCAs with Australia, Canada, Euratom and the United States of America.

ONR's SME advice also helped shape BEIS's approach to the domestic legal framework for safeguards. The Nuclear Safeguards Act received Royal Assent on 26 June 2018, amending The Energy Act 2013 to formalize ONR's new safeguards purpose and allowing the Government to make more detailed safeguards regulations for ONR to enforce. Those regulations comprise the Nuclear Safeguards (Fissionable Material and Relevant International Agreements) (EU Exit) Regulations 2019 and the Nuclear Safeguards (EU Exit) Regulations 2019 (NSR2019) that describe the detailed legal framework including the operators' and ONR's duties under these regulations. Both were the subject of extensive engagement with operators and other stakeholders (e.g. non-governmental organizations) and a public consultation process before completing the Parliamentary process at the end of January 2019. The UK's domestic legal framework for safeguards is outlined in Figure V–3 below.

ONR provided SME advice to BEIS in the drafting of NSR2019 to ensure that it met the Government policy goal of minimizing disruption to UK operators. This ensured that while NSR2019 broadly reflects European Commission Regulation 302/2005, it functions within the UK legal framework and ONR's

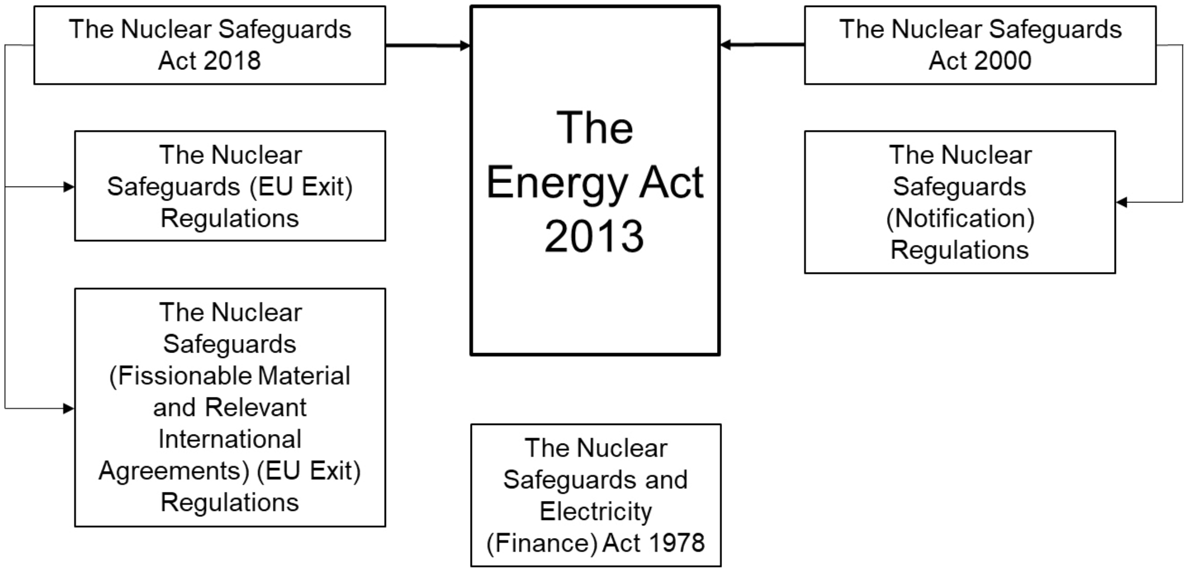

FIG. V–3. The UK's domestic legal framework for safeguards.

approach to enforcement. ONR's advice also prompted a new feature in NSR2019: a requirement that operators produce, maintain and implement an accountancy and control plan. The accountancy and control plan facilitates a move to a more outcome focused regulation, in line with ONR's other regulatory purposes that require nuclear operators to demonstrate the safety and security of their operations against relevant good practice.

ONR also developed a joint communications and outreach approach with BEIS. This aimed to keep stakeholders informed of project progress and changing regulatory requirements, while gathering insights and feedback from them to improve the project. While the UK nuclear industry was the primary target of this approach, secondary stakeholders, including the UK Parliament, media and advocacy organizations were also considered. BEIS and ONR worked together to identify and utilize engagement opportunities (such as professional groups or events), host industry consultation and project update workshops, and communicate consistent messages regarding the project. This ensured that ONR and BEIS worked constructively with project stakeholders, despite the pressured and highly scrutinized environment in the lead-up to the UK's exit from the EU.

V–4.2. Technology

Given that Euratom was the UK regulator for safeguards for many decades, there was no need for the UK to maintain a comprehensive State level nuclear material accountancy capability. As a result, ONR needed to establish a nuclear material accountancy system to enable the upload, editing and creation of NMA reports required by NSR2019, but which could also translate those domestic reports into the format required by the new bilateral VOA, which can be submitted to the IAEA by ONR on behalf of the UK. The system also needed to reliably handle and process several hundred thousand lines of NMA data per year.

The Safeguards Information Management and Reporting System (SIMRS) was developed for this purpose and includes the functionality to store all received and issued NMA reports, and the capability to interrogate the data that those reports contain, perform validation of their format and content, and perform transit matching of nuclear material transfers between UK operators. SIMRS had to serve as the NMA hub of the SSAC connecting UK operators with ONR, providing safeguards staff with NMA information and connecting ONR with international stakeholders (as illustrated in Figure V–4).

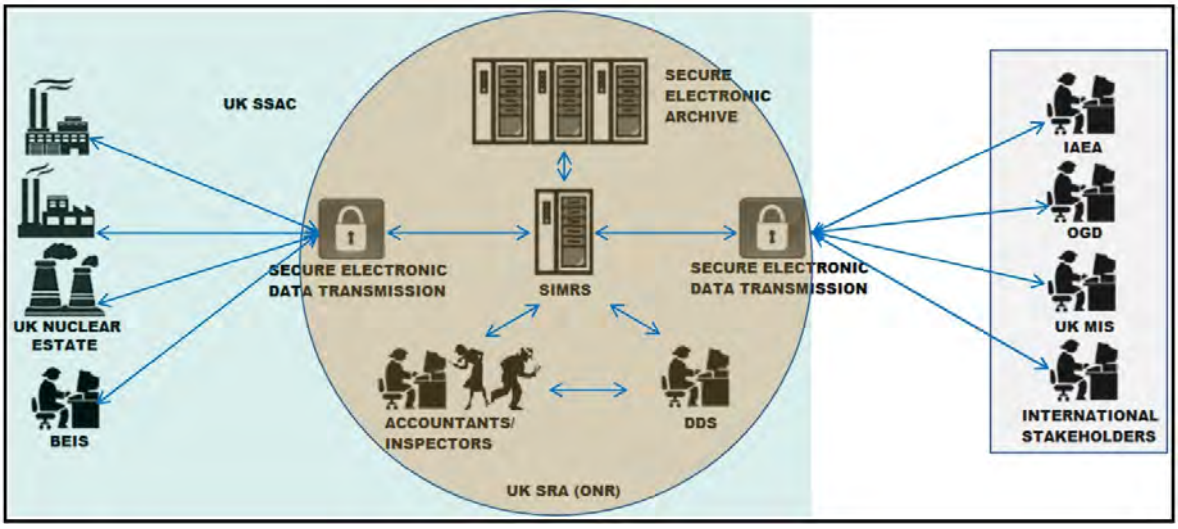

FIG. V–4. The ONR Safeguards Information Management and Reporting System (SIMRS).

To enable the development of SIMRS, ONR selected an IT supplier with experience in the development of State level NMA systems and in producing NMA reports for submission to the IAEA.[4] A key aspect underpinning the development of SIMRS was early engagement with both Euratom and the IAEA on a technical level regarding common nuclear material accountancy issues and the translation and conversion of domestic NMA reports for onwards transmission to the IAEA. As discussed above, one of the aims of the SSAC project was to minimize disruption to the UK operator community. Given this, there were some implementation challenges, including:

- Maintaining the existing MBA structure and codes domestically (which is reflected in UK operators' facility nuclear material tracking systems) but agreeing a new set of MBA codes for IAEA reporting under the new bilateral VOA. SIMRS does this translation automatically;
- Accommodating a significant volume of historic information within operator NMA systems, including traceability for modifications and corrections to that data. Under the new bilateral VOA, no corrections can be carried out prior to the implementation date of the new regime, so a technical solution for handling corrections was agreed with the IAEA and implemented in SIMRS.

The operation and testing of SIMRS was managed systematically to increase complexity and volume over a period of many months. This allowed ONR to test its operating procedures, instructions and to examine the limits of the system. ONR worked closely with the IAEA to examine and assess the output from SIMRS during testing and identified areas for improvement through IAEA feedback.

V–4.3. Operations: capacity and capability

Prior to the UK's announcement to leave Euratom, the ONR safeguards function consisted of seven staff members, comprising six safeguards specialists and one person working on delivery support. A baseline assessment at the start of the project indicated that ONR had to expand its capacity to 26 safeguards specialists to meet its objectives as an SRA. The niche expertise required for safeguards meant that ONR could only recruit a few individuals with existing safeguards knowledge and experience. To meet its operational capacity needs ONR had to focus more on growing its own safeguards capability and the associated regulatory competence. To do this, ONR followed a SAT to:

[4] Information regarding the SIMRS tender including questions asked by suppliers can be found here: https://www.digitalmarketplace.service.gov.uk/digital-outcomes-and-specialists/opportunities/6388

— Understand the breadth and depth of skills, knowledge and experience required by the UK SRA;
— Understand ONR's initial capacity and capabilities to meet these requirements;
— Design training approaches to address any shortfalls in capability;
— Deliver those training approaches;
— Evaluate the delivery of that training and the resulting capability improvements.

The SAT is recognized as a model for assisting in identifying training needs and for designing, planning, implementing and evaluating training programmes. It is widely used by States with major nuclear power programmes and is recognized by IAEA guidance as good practice for both regulators and operators [V–1, V–2]. It provided a methodical, flexible and repeatable approach to ensuring that all relevant capabilities were identified and delivered. It also provided transparent assurance that ONR's training framework is appropriate and effective over time.

Using the SAT, ONR used an array of existing internal and external training opportunities, as well as new bespoke training mechanisms, to deliver its capability requirements. ONR and the IAEA worked together to deliver three tailored training events exploring the IAEA's expectations for NMA and inspection facilitation, and the legal basis for IAEA safeguards. ONR also attended generic IAEA training courses on SSACs. Existing ONR courses on effective regulation also helped ONR ensure that its staff could enforce new safeguards regulation according to ONR policies and regulatory good practice. ONR created bespoke classroom based courses on the domestic and international legal framework for safeguards, and the properties and verification of safeguards relevant nuclear materials. ONR also took a structured approach to learning on the job by creating mentoring and coaching guides to help new starters understand NMA, SIMRS and new processes in collaboration with more experienced colleagues.

V–4.4. Operations: inspections

ONR's approach to enforcing new safeguards regulatory requirements has to meet government expectations regarding the coverage and effectiveness of the regulatory regime and accepted good practice for regulation in the UK.

With this in mind, ONR developed a domestic inspection and enforcement regime that is outcome focused: proportionate to the risks of non-compliance and targeted appropriately towards those risks. This regime focuses regulatory attention on principles such as the proliferation attractiveness of nuclear material, the strategic importance and configuration of a facility, and the adequacy of an operator's nuclear material accountancy and control system. It also accommodates the government goal of minimizing disruption for operators by incorporating prescriptive requirements for NMA reports based on European Commission Regulation 302/2005. The safeguards regulatory framework is further underpinned by ONR's longstanding regulation of nuclear safety and security, affording safeguards inspectors with regulatory intelligence from ONR's safety and security activities to target safeguards interventions, in addition to carrying out joint interventions where synergies exist.

The ONR Safeguards' inspection framework consists of several distinct inspection types, which can be split into the three categories summarized below:

(a) Compliance inspections, which are undertaken to provide evidence based assurance that operators are complying with their statutory obligations under NSR2019, and include, for example, physical inventory verification, examination of NMA source documentation and inspection of facility design information;
(b) Safeguards systems based inspections that target the systems, structures and components that directly support nuclear material accountancy and control across a site or facility (such as measurement or information processing systems);

(c) ONR safeguards inspection activities alongside the facilitation of IAEA safeguards verification activities under the bilateral VOA.

This inspection framework is integrated into a broader safeguards delivery framework that incorporates both on-site inspection and facilitation of IAEA activities with NMA analysis, reporting and declarations. The delivery framework is led by a Delivery Lead, overseeing an Inspection and Assessment Lead and a Nuclear Material Accounting and Reporting Lead. All are supported by a Professional Lead, who is responsible for maintaining the technical standards and capabilities of the safeguards team.

ONR tested this operational structure in the period leading up to the UK's exit from Euratom at 23:00 GMT on 31 December 2020 to ensure that it met the UK and ONR's expectations for effective regulation, as well as the UK's obligation to facilitate IAEA in-field activities. By planning, preparing, executing and writing up 'trial inspections' within this operational structure inspectors learned how to work within ONR's broader operational frameworks while building their regulatory capabilities. ONR carried out 16 trial inspections during the UK SSAC Project.

V–4.5. Guidance

ONR's Enforcement Policy Statement requires that regulatory requirements and actions taken to enforce them are transparent to those being regulated, and that ONR enforces these requirements consistently across all operators. ONR had to draft a framework of guidance documents that explains its expectations for compliance with new safeguards regulations and helps inspectors to interpret these regulations consistently. Operators also had to understand this guidance and how it relates to their day to day activities.

To achieve this, ONR enlisted its new safeguards inspectors to review existing relevant good practice on safeguards implementation[5] and produce draft documents explaining ONR's expectations for operator's arrangements for nuclear material accountancy and control, and ONR's approaches to inspecting and assessing those arrangements. ONR actively sought input and comment from the UK nuclear industry by explaining the draft documents and circulating them for comment. ONR also integrated drafts of the guidance into its trial inspections (discussed above) to see how usable they were during and after regulatory interventions. As a result, ONR managed to draft, review and revise its framework of guidance before new regulatory requirements entered into force. ONR continues to collect comments on this framework during its implementation to inform planned reviews in 2023.

ONR also had to ensure that its existing framework of generic regulatory guidance — including on how to make enforcement decisions and on how to respond to incidents on-site — recognized ONR's new safeguards function. ONR safeguards inspectors identified a set of core regulatory guidance documents that the safeguards team would need to draw on and provided comments on how they could be adjusted to recognize safeguards.

V–5. LESSONS LEARNED AND GOOD PRACTICES

V–5.1. Peer learning

Learning from our international peers and counterparts has been an important feature of the project. During the development of the UK SSAC, ONR and BEIS have participated in benchmarking activities with other SRAs to compare and contrast the UK's developing SSAC capabilities and gain some assurance that these are in line with international good practice. Benchmarking work included engagements with:

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[5] In particular, good practice produced by the European Safeguards Research and Development Association (ESARDA) and EU Commission recommendations on Regulation 302/2005

— Canada, the Canadian Nuclear Safety Commission (CNSC) — November 2018;
— France, Euratom Technical Committee — France (CTE), Protection and Nuclear Safety Directorate of the CEA (French Alternative Energies and Atomic Energy Commission) (DSN), Institute for Radiological Protection and Nuclear Safety (IRSN) — March 2019;
— Finland — Radiation and Nuclear Safety Authority (STUK) — June 2019.

The UK and ONR are also considering how and when to take advantage of the ISSAS, which provides a comprehensive review of a State's SSAC by a team of technical and legal experts. These voluntary peer reviews cover all aspects of an SSAC to identify good practices and make recommendations to further strengthen a State's implementation of safeguards.

V–5.2. Independent assurance

The UK SSAC Project incorporated layers of internal assurance that ensured that the outcomes were technically sound, aligned with regulatory good practice and met the UK Government's objectives for it. These layers included a Technical Acceptance Panel that ensured key regulatory deliverables (such as guidance or processes) were fit for purpose, consistent, delivered to a common standard and widely adopted. They also included project management oversight (discussed below) that ensured that the outputs of the project delivered on ONR and BEIS's objectives and provided a transparent and traceable view on delivery.

ONR augmented these internal assurance mechanisms with independent reviews by a central Government authority (the UK Cabinet Office Infrastructure Projects Authority, IPA) to identify problems or risks in the project and to propose mitigations. The IPA conducted two operational readiness reviews; the first prior to the end of Phase 1 of the UK SSAC Project in December 2018, and the second in July 2020 prior to the end of the project. The recommendations generated by this independent assurance were critical in providing assurance of ONR's approach to the UK SSAC Project and to keeping the project on course for success.

V–5.3. Project management

The project management approach of the UK SSAC project became very effective and secured delivery to specification, time and budget. Despite the time pressures involved in the UK's exit from the EU, ONR took the time to build a proper project initiation document to set out the desired outcomes and outputs of the project, and to link these to the strategic policy drivers behind the project. Detailed work plans were developed, with the work breakdown required to deliver milestones clearly identified. Delivery against these plans was monitored weekly, with project managers securing evidence of completion of all tasks in the plan, keeping a focus on delivery. The recruitment of skilled temporary external resources to manage and oversee the SSAC Project, and the acquisition of dedicated project management tools (including software) helped the project become an exemplar in ONR. The UK SSAC Project was subsequently recognized as the public sector Project of the Year by the UK chapter of the Project Management Institute.

V–5.4. Stakeholder engagement

Any project with a high public, government and industry profile requires coordinated and effective stakeholder engagement. The UK SSAC Project maintained close alignment between ONR and BEIS communications by working together (including from each other's offices), using a common communications plan, and establishing coordinated 'lines to take'. ONR identified and characterized project stakeholders early on and invested the time to work constructively with them. This involved taking the time to explain what the project was doing and why, but also taking the time to listen to how the project would affect the UK's nuclear industry. ONR continues to engage constructively with stakeholders in the new SSAC regime — both inside and outside Government — to ensure that the regime remains effective.

V–5.5. Policy coordination

Translating Government policy and strategy into practical deliverables is a challenge for every new policy, and ONR had to work well with BEIS to articulate and agree on practical deliverables. This involved articulating policy outcomes and how a safeguards regulatory approach could deliver those outcomes. It also involved understanding the impact of those outcomes for all stakeholders. Having a single point of contact on both sides channelling information into and out of the SSAC project was key and critical to managing messages into ONR, allowing others to focus on delivery. It also harboured an honest and trusting relationship between the project and its Government sponsors, which allowed for both parties to challenge each other as necessary. Having someone in the project that understands how the Government works is an asset, as is having someone in Government that understands how the regulator works.

V–5.6. Operational testing

ONR took advantage of opportunities to test the operation of its SSAC prior to its formal implementation. A structured programme of 'like live' reporting to the IAEA gave ONR the opportunity to identify and address any issues with the format, content, submission routes and delivery pace of NMA reports to the IAEA. It also allowed ONR to build the capabilities of new staff by involving them in testing. With both the team and system in development simultaneously, ONR could quickly identify any issues affecting throughput and workflow and make changes to benefit the team and how they worked. Securing a subject matter expert in system testing further bolstered the control, structure and depth of testing and was a means to increase resilience through clearly defined testing strategies and training for the wider team. The assistance offered by the IAEA in the months running up to deployment to allow ONR to submit declarations through the IAEA SDP and conduct checks on the accuracy of submissions was vital, not only in allowing the correction of some last minute errors, but in demonstrating a clear ability to move from project to deployment.

Similarly, trial inspections gave ONR the opportunity to work informally with the operators it would soon regulate to improve and build a shared understanding of the future regulatory regime. It also helped ONR test its governance structures to ensure that mechanisms were in place to plan and monitor regulatory interventions, and to manage any issues arising from those interventions. By taking every opportunity to test the new SSAC — with both the IAEA and UK operators — all stakeholders had a high degree of confidence that ONR safeguards were ready to do the job at the end of the project.

V–5.7. Resources

It became clear early in the project (and through the IPA 'critical friend' reviews discussed above) that, at the time, ONR had limited in-house capability in key areas, including IT procurement and implementation, and in programme integration. In response, ONR sourced specialist expertise from the contract market, supplemented later with additional resources in project management and operating system design. The project also turned to the nuclear industry to provide a seconded resources expert in nuclear material accounting, avoiding any conflict of interest. Securing highly capable resources in these areas with professional expertise and commitment, with appropriate oversight from the project leadership, was essential to the project's success. Integrating the future cadre of safeguards specialists into the design and delivery of the UK SSAC Project also ensured that its success was shaped by and will be maintained by its longer term custodians.

V–6. CONCLUSION

The UK SSAC project presented ONR and the UK with complicated challenges that had to be overcome in a relatively short period of time. The UK had to establish a new SSAC to fulfil new safeguards obligations across the broad range of nuclear facilities already operating in the UK, despite limited existing capability and capacity to do this. ONR cooperated closely with its sponsoring Government department and collaborated with the UK civil nuclear industry to develop a UK SSAC and to establish ONR as the SRA for safeguards. The project based approach to this work provided a valuable framework in which to establish a common understanding of what had to be achieved, how it was being achieved and what its achievement would mean for all stakeholders. It also helped ONR overcome the challenges of establishing a new domestic and international legal framework for safeguards, building its capacity and capabilities to regulate that framework, and to put in place operational structures and technologies to fulfil new safeguards obligations. In overcoming these challenges, ONR identified a number of lessons learned that are discussed above and may help other States enhance their national safeguards infrastructure to support the introduction of nuclear power.

REFERENCES TO ANNEX V

[V–1] INTERNATIONAL ATOMIC ENERGY AGENCY, Managing Regulatory Body Competence, Safety Reports Series No. 79, STI/PUB/1635, IAEA, Vienna (2014).

[V–2] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Power Plant Personnel Training and its Evaluation: A Guidebook, Technical Reports Series No. 380, IAEA, Vienna (1996).

LIST OF ABBREVIATIONS

AP	additional protocol
C/S	containment/surveillance
COMPASS	IAEA Comprehensive Capacity-Building Initiative for SSACs and SRAs
CSA	comprehensive safeguards agreement
DIQ	design information questionnaire
DIV	design information verification
EPC	engineering, procurement and construction
EU	European Union
ICR	inventory change report
INFCIRC	information circular
INIR	Integrated Nuclear Infrastructure Review
ISSAS	IAEA Safeguards and SSAC Advisory Service
KMP	key measurement point
LOF	location outside facilities
MBA	material balance area
MBR	material balance report
NCA	nuclear cooperation agreement
NEPIO	nuclear energy programme implementing organization
NMA	nuclear material accounting
NPP	nuclear power plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
PIL	physical inventory listing
PIT	physical inventory taking
PIV	physical inventory verification
SAT	systematic approach to training
SBD	safeguards by design
SDP	State Declarations Portal
SQP	small quantities protocol
SRA	State or regional authority responsible for safeguards implementation
SSAC	State system of accounting for and control of nuclear material

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Key

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