# INTEGRATION OF SMALL MODULAR REACTORS

# IN THE SWEDISH NUCLEAR ENERGY SYSTEM:

# A PROLIFERATION RESISTANCE STUDY

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**Abstract**

Within the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), the International Atomic Energy Agency has developed a comprehensive methodology to assess the sustainability of nuclear energy systems in terms of environmental impact, safety, proliferation resistance, waste management, infrastructure and economics. Under the framework of the newly-established competence centre in Sweden, entitled Academic-industrial Nuclear technology Initiative to Achieve a sustainable energy future, the methodology is applied to explore the potential extension of the Swedish nuclear power programme through the introduction of small modular reactors. The current work is focused on evaluating the sustainability of an envisioned Swedish nuclear energy system in the area of proliferation resistance. For this, multiple perspectives are considered, namely the applicable non-proliferation legal framework in Sweden, available nuclear technology and materials, and implemented safeguards considerations in reactor design and operating procedures. The analysis takes into account the design of modular reactor systems, deployment units and location, and mode of operation. Lastly, challenges associated with the future safeguards verification of light-water small modular reactors are addressed and technical and non-technical solutions are explored to derive recommended measures that enhance proliferation resistance. These aim at supporting designers, vendors, operators and regulators in their efforts to foster a sustainable and safe energy future.

## INTRODUCTION

Sweden’s intent to study the sustainable decarbonisation of its energy system through nuclear power is currently realised through the Academic-industrial Nuclear technology Initiative to Achieve a sustainable energy future (ANItA) [1]. This competence centre is set to investigate technical and non-technical aspects related to introducing a new player into the Swedish nuclear energy landscape, the small modular reactor (SMR). Moreover, the scope of the project covers areas such as SMR technology, applications, core design optimization, fuel performance, operation, reactor safety, waste management in SMR fuel cycles and their safeguards verification, as well as deployment possibilities and licensing. Contributing to ANItA’s plan, the current work introduces the ongoing study on non-proliferation and safeguards challenges associated with deploying SMRs in Sweden. The first step is to identify proliferation risks posed by SMR deployment and define solutions to enhance proliferation resistance (PR), as it is a recognised key point in the sustainability of a nuclear energy system [2].

To perform the proliferation resistance assessment, the INPRO methodology [2] is employed. It contains the manual on proliferation resistance [3], which describes the steps and recommendations to perform a sustainability assessment on a nuclear energy system from five perspectives: 1. the state’s legal framework in support of the international non-proliferation regime, 2. the attractiveness of nuclear technology and materials, 3. the facilitation of IAEA safeguards through facility design and construction, 4. multiple measures to deter diversion and misuse, and 5. the optimization of proliferation resistance in system design. In the present work, the first three perspectives are considered for assessing an envisioned nuclear energy system (NES), which includes the components of the current Swedish nuclear fuel cycle and an SMR deployment scenario.

Considering what is now seen as near-term deployable in Sweden, the current work focuses on modular reactor systems based on light-water reactor (LWR) technology. The assessment employs both state-level and facility-level perspectives to identify gaps in proliferation resistance. Addressing those gaps, possible safeguards and non-proliferation measures are determined to shape how integrating light-water SMRs into the current Swedish NES could enhance its sustainability with respect to proliferation resistance. The assessor is from the academic sector and is represented by the team of authors with experience in technical nuclear safeguards research and expertise on the application of safeguards. To perform the assessment with adequate input and to explore realistic possibilities of SMR deployment, the team is also forming an advisory group. The ideal advisors are representatives from areas such as the design, operation, licensing, and regulation of nuclear activities and reactors, including SMRs.

## INPRO METHODOLOGY

The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) was established by the IAEA in 2000. The programme aims to ensure that sustainable nuclear energy is available to contribute to meeting the growing energy needs of the 21st century. In support of this goal, INPRO’s activities facilitate the development of methods and tools for modelling, analysing and assessing the sustainability of advanced and innovative nuclear energy systems [4].

The INPRO methodology is a tool for assessing the sustainability of a nuclear energy system through scenario-based Nuclear Energy System sustainability Assessments (NESA). These assessments are intended to contribute to sustainable nuclear energy planning strategies at either national, regional, or international levels, considering the nuclear energy sustainability areas described in the United Nations (UN) Brundtland Commission Report [5]. Guided by these sustainable development areas, the INPRO Methodology was published in the form of nine manuals that provide instructions for performing a NESA in the areas of proliferation resistance, economy, environmental impact, nuclear safety, waste management, and infrastructure.

The INPRO Manual on Proliferation Resistance [3] takes a structured approach to assess sustainability in this area, beginning with a Basic Principle (BP), which sets the general goal to be achieved for the NES. The BP is then divided into five subsequent conditions called User Requirements (UR), which must be met by the design of the NES. These define the five perspectives of the assessment: legal framework, attractiveness of technology and materials, facilitation of IAEA safeguards, measures to deter diversion and misuse, and optimization of proliferation resistance. For each UR, there are Criteria (CR), Acceptance Limits (AL), Indicators (IN), and Evaluation Parameters (EP), which structure the assessment in the form of a questionnaire to be completed and commented on by the assessor. Each IN specifies the topic covered by a set of EPs, which the assessor needs to answer. The answers are then used to justify meeting certain ALs and CRs, potentially leading to the identification of gaps in the proliferation resistance measures implemented in the NES. Thus, the assessment methodology is designed to be used progressively, to identify and implement solutions that enhance proliferation resistance over the lifetime of the NES.

In 2023, a draft version of an updated manual on proliferation resistance was announced [6]. The draft [11] was made available to the authors and served as the primary guidance tool for performing the assessment. One of the key updates in the manual is the replacement of the term ‘innovative nuclear energy systems (INS)’ with ‘nuclear energy systems (NES)’. This change expands the applicability of the NESA to include evolutionary designs, such as LWR SMRs.

## DEFINING THE CURRENT SWEDISH NUCLEAR ENERGY SYSTEM

The national components of the Swedish nuclear energy system begin with the nuclear fuel factory in Västerås, owned by Westinghouse Electric Sweden AB. This factory is one of the nuclear fuel providers for the Swedish nuclear power plants (NPP), but fuel is also imported from international providers, such as Framatome. The fresh nuclear fuel is transported by truck or boat from the fuel factory and other fuel providers to the NPP site. It is then stored in dedicated storage locations at the site for future use in the nuclear power reactors. Sweden currently operates six reactors based on LWR technology, located at three nuclear sites: 1. Forsmark NPP, which has three boiling water reactors (BWR) in operation; 2. Oskarshamn NPP, where one BWR is still in operation and two are permanently shut down; and 3. Ringhals NPP, which currently has two pressurized water reactors (PWR) in operation, as well as a PWR and a BWR under decommissioning. All BWRs were built by the former Swedish company ASEA-ATOM (now Westinghouse Electric Sweden AB), while the PWRs were constructed by the Westinghouse Electric Company LLC (USA). Additionally, the Studsvik site in Nyköping hosts the global company Studsvik AB, which provides international services including radioactive waste treatment and nuclear fuel investigations. The site previously operated research reactors for material testing, which have since been decommissioned; however, the company still operates hot-cell laboratories.

The final component of the fuel cycle is the Central Interim Storage facility for Spent Nuclear Fuel (Clab), located at the Oskarshamn NPP site. Clab stores all the spent nuclear fuel (SNF) from Swedish nuclear reactors in water-filled pools. The company that operates Clab and deals with all the radioactive waste from the Swedish nuclear power plants is the Swedish Nuclear Fuel and Waste Management Company (SKB). After at least nine months of cooling at a nuclear site, spent nuclear fuel (SNF) can be transported by SKB to Clab for interim storage. The transport of SNF from Oskarshamn reactors to Clab, as well as from the Forsmark and Ringhals reactors to their respective harbours, is carried out by land using special transport casks from SKB. From the NPP harbours to Clab, SNF is transported exclusively by sea aboard SKB’s dedicated ship, M/S Sigrid [7]. The ship has a maximum cargo capacity of 12 transport casks. In some cases (e.g., after the early shutdown of the BWR from Ringhals), irradiated nuclear fuel is transported to another nuclear site for further use, also by sea. Other radioactive waste is transported to the Final Repository for Short-Lived Radioactive Waste (SFR), which is operated by SKB at Forsmark.

With no plans for recycling spent nuclear fuel, Sweden remains focused on an open fuel cycle. In 2022, the Swedish government approved SKB’s application to construct and operate a system for final disposal. The case is currently under review by the Land and Environment Court at Nacka District Court to finalise the permit process, after which the Swedish Radiation Safety Authority (SSM) will review the construction. The final disposal system consists of the already operating interim storage, the nuclear waste encapsulation plant, Clink, which is planned to be constructed at the Oskarshamn site, and the planned Final Repository for Spent Nuclear Fuel to be constructed at the Forsmark site.

The most recent plans to expand the Swedish nuclear reactor fleet involve Vattenfall’s SMR feasibility study at Ringhals NPP. The results indicate that the site is suitable to accommodate three to five SMRs. Vattenfall also continues to plan for the operation of a new reactor in the early 2030s, considering both large-scale reactors and SMRs [8].

## INTRODUCING THE SMR DEPLOYMENT SCENARIO

The PR assessment looks into the deployment at the Forsmark NPP nuclear site of the AP300™ SMR design from Westinghouse Electric Company LLC. The Forsmark site was chosen considering its available space for additional reactors and the existing assets which could be shared, such as personnel expertise, grid connection, and harbour facilities. The envisioned scenario regards the deployment of three AP300 SMR units, that would have a total electrical power output of 900 MWe, close to the electrical capacity of a large-scale LWR in operation in Sweden. The usage is electricity production with load following operation in support of grid flexibility and stabilisation.

The AP300 SMR design is based on Westinghouse’s AP1000® pressurized water reactor design, an already licensed advanced large-scale reactor under commercial operation. The SMR is planned to be an optimised design of the AP1000, that reduces the plant footprint and utilises similar technology, with respect to the reactor core, reactor coolant system, safety features, instrumentation and control systems, as well as plant layout. Moreover, the AP300 SMR is an advanced light water reactor design, that promises shorter construction time and cost through modularisation of reactor and containment components, facilitating their transportability.

Current available information on the AP300 design is the fuel type (low-enriched UO2), the fuel assembly array (17×17 fuel rods), and the estimated electrical capacity (300 MWe). Moreover, no information on the plant layout design was made available to the authors for the purpose of the assessment. However, considering the general interest to reduce construction costs, the authors included in the scenario the assumption that the plant layout would not include a spent nuclear fuel storage. Another assumption is that the AP300 plant would be a single-unit plant. Lastly, the design is not intended to include First of a Kind technology, so it cannot be not considered an innovative design, but it qualifies as an evolutionary design [9].

## PRELIMINARY RESULTS OF THE PROLIFERATION RESISTANCE ASSESSMENT

The present work describes the beginning of a national nuclear energy system sustainability self-assessment, conducted using the draft version of the updated INPRO manual on proliferation resistance [11]. The assessment aims to evaluate and enhance proliferation resistance sustainability within the defined Swedish nuclear energy system that includes the deployment scenario. This is achieved by addressing Evaluation Parameters (EP) to verify that the Criteria (CR) under each User Requirement (UR) are fulfilled. For any gaps identified in current proliferation resistance measures, or in cases where further investigation is needed, recommendations are provided for possible measures that could be adopted by a future Swedish NES to strengthen its sustainability.

### User Requirement 1

UR1 is State-level oriented, as it regards Sweden’s obligations, policies, commitments and their adequate implementation for meeting the objectives of the international non-proliferation regime. The first criterion CR1.1 looks into the State’s legal and policy framework, and the second criterion CR1.2, covers institutional and structural arrangements.

Sweden is party to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Treaty establishing the European Atomic Energy Community (Euratom). It also has a Comprehensive Safeguards Agreement (CSA) with an Additional Protocol (AP) in force (INFCIRC/193 and INFCIRC/193/Add.8). International safeguards imposed by the NPT, CSA and its AP, are implemented via the national legislation, such as the Nuclear Activities Act (SFS 1984:3) and Ordinance (1984:14), the Act on Inspections according to International Agreements on Non-proliferation of Nuclear Weapons (SFS 2000:140), their amendments, as well as Ordinance (2008:452) with instructions for the Swedish Radiation Safety Authority (SSM). These also structure Sweden’s State system of accounting for and control of nuclear material (SSAC). Moreover, Sweden implements Euratom safeguards directly through Regulation (EU) No 302/2005, as part of the regional system of accounting and control (RSAC). IAEA and Euratom jointly perform safeguards inspections in Sweden, while SSM can also perform inspections to verify the compliance with SSMFS 2008:3 regulations and general guidelines on the control of nuclear material. As an independent administrative authority, SSM has a mandate from the Swedish Government in the area of nuclear non-proliferation, to implement international commitments, regulate and control the handling and use of nuclear material and technology, and authorise and license nuclear activities.

Export control of dual-use items is regulated nationally through the Act (2000:1064) and Ordinance (2000:1217) on the Control of Dual-Use Items and of Technical Assistance. At EU level, the relevant legislation is Regulation (EU) 2021/821 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items (recast) and its amendment, the Delegated Regulation (EU) 2023/66. SSM is responsible to examine and authorise exports of nuclear materials, facilities and equipment as described in Annex I to the Regulation (EU) 2023/66, containing the common list of dual-use items subject to controls within the EU. The list is updated according to dual-use controls agreed internationally within export control groups, such as the Nuclear Suppliers Group, the Wassenaar Arrangement, and the Missile Technology Control Regime. Sweden is also a recognised member of these groups, including the Zangger Committee.

In support of the non-proliferation regime, Sweden implementsnuclear security measuresthrough different laws, such as the Act on Transport of Dangerous Goods (2006:263), the Protective Security Act (2018:585), and the Installations Protection Act (2010:305). It is also party to the Convention for the Physical Protection of Nuclear Material (CPPNM) and its Amendment, addressing the physical security of nuclear materials and facilities during use, storage and transport for peaceful purposes. Moreover, Sweden is a partner to the Global Initiative to Combat Nuclear Terrorism (GICNT), it endorsed the Proliferation Security Initiative (PSI), committing to impede and stop the trafficking of weapons of mass destruction (WMD), and it is one of the initiators of the Joint Statement on Mitigating Insider Threats (INFCIRC/908). At EU level, the UN sanctions regime introduced through UNSC Resolution 1373 (2001), for preventing or suppressing activities that support terrorist acts, is regulated through Regulation (EC) No 2580/2001. Other drivers that support non-proliferation are the Comprehensive Nuclear-Test-Ban Treaty (CTBT), ratified by Sweden in 1998, and contributing to the activities related to the Treaty’s Organization (CTBTO), through monitoring stations in Stockholm and Hagfors. Sweden also participates in the Incident and Trafficking Database (ITDB), with SSM as Point of Contact.

The Permanent Mission of Sweden to the United Nations submitted, on 29th of April 2020, the most recent national report concerning the implementation of the United Nations Security Council (UNSC) Resolution 1540 (2004) [10]. The resolution imposes binding obligations to adopt legislation for preventing the proliferation of weapons of mass destruction (WMD). The report submitted by Sweden contains comprehensive information on such legislation, composed of EU regulations, Swedish laws and regulations, as well as their enforcement and related penalties. After initial examination, the information found in the report reflects Sweden’s compliance with UN/S/RES/1540(2004), but also with the UN/S/RES/1887(2009) on non-proliferation and nuclear disarmament, with internationally agreedborder controls, export and trans-shipment controls, as well as withthe requirements of the (CPPNM) and its Amendment. However, the report suggests some shortcomings and contains references to EU regulations that were recast after the date of the report, which need to be updated. As more analysis of the report is needed, the authors refrained from further discussing the content of the report and how it affects the sustainability in PR of the Swedish NES, in the current work.

With regard to the multi-lateral ownership of a NES, a measure that can support non-proliferation, the current Swedish NPP operators are owned by different actors, such as the state-owned power company Vattenfall AB, the Finnish energy company Fortum, and by the German energy company Uniper SE. The NPP operators jointly own SKB. Additionally, the nuclear fuel used in Sweden is either imported or manufactured from imported nuclear material. Its trade follows the regulations and guidelines of the Euratom Supply Agency (ESA) and IAEA.

Bilateral cooperation agreements between countries are also considered extrinsic measures to enhance PR. The Declaration between France and Sweden on a renewed Strategic Innovation Partnership for Sustainable Digital and Resilient Societies was recently signed in 30 January 2024, and it covers areas such as nuclear energy, climate neutrality, and new nuclear reactors. Another recent agreement is the Strengthened partnership between the United Kingdom and Sweden, signed 13 October 2023, which covers areas like non-proliferation and arms control, the Quad Nuclear Verification Partnership, civil nuclear energy and technology, new nuclear energy technologies, potential for SMRs, and regulatory exchange in enabling SMR deployment.

Presently covered information suggests that Sweden’s decisions on international collaboration, structural arrangements, and national legal framework implement and support the non-proliferation regime. This builds a comprehensive structure of extrinsic proliferation resistance measures that support the sustainability of the Swedish NES. Moreover, the EU membership strengthens even more the sustainability of the NES in PR, as EU regulations cover essential parts of the non-proliferation regime. This is also supported by the yearly Broader Conclusion on Sweden’s compliance with the CSA and the AP in force, drawn by the IAEA, as well as the annual safeguards conclusions drawn by the European Commission on implementing Euratom safeguards.

To conclude, the assessment results for criterion CR1.1 and CR1.2 suggest that Sweden’s legal framework and institutional and structural arrangements are covering non-proliferation commitments, are in accordance with international standards, and facilitate the effective implementation of IAEA safeguards, export controls, and nuclear security measures. However, to meet CR1.1 further analysis is required on implementing the UN Resolution 1540 (2004). Meeting criterion CR1.2 also requires further examination on several EPs, which reflect recommended PR measures, such as requesting an IAEA SSAC Advisory Service Mission and ensuring sufficiency in resources within the regulatory authority [11].

### User Requirement 2

UR2 is both State-level and facility-level oriented, because it concerns the attractiveness of the nuclear technology (CR2.1) and the nuclear material (CR2.2) employed in the NES. According to the methodology, the attractiveness for proliferation is considered high in the case of remote handling capabilities (e.g., hot cells at Studsvik site) and moderate for the fabrication of uranium oxide fuel (e.g., Westinghouse nuclear fuel factory in Sweden). The two exemplified components of the Swedish NES were not assessed within the current work, but general recommendations can be considered by the regulator and operators, such as reviewing the Basic Technical Characteristics declarations of each facility to ensure that all relevant equipment is properly declared, and ensuring that all nuclear material is kept under control and is properly accounted for during all fabrication and handling steps. Furthermore, the current performed assessment considers the attractiveness of nuclear material only for the fresh nuclear fuel of the Swedish NES, in terms of its chemical and physical form (uranium dioxide pellets) and its type (indirect use – low enriched uranium). With respect to these parameters, the SMR deployment scenario would not raise the attractiveness of the nuclear fuel employed in the NES, because the same type of nuclear fuel is currently employed in Swedish nuclear power plants. Lastly, the quantity of nuclear material and the SNF content are not included in the work; therefore, further analysis is needed to derive a conclusion on meeting UR2.

### User Requirement 3

UR3 concerns the incorporation in the NES of intrinsic features and extrinsic measures that facilitate IAEA safeguards. For this part of the assessment, the authors studied the application of safeguards at the Forsmark NPP, within an informative meeting with the safeguards officers at the nuclear site. This was done to reason how the applied procedures, infrastructure and personnel experience could enhance PR in the deployment scenario. The current approach is to give recommendations based on the experience of a large-scale reactor operator in Sweden and on the requirements described by the methodology. The recommendations are meant to support designers and SMR operators in obtaining a final product that allows IAEA to effectively (CR3.1) and efficiently (CR3.2) execute all planned safeguards activities.

The assessment shows that criterion CR3.1 is met for the Forsmark NPP, as safeguards inspectors can adequately verify nuclear material flows, inventories, and design information, they can access livestreams from surveillance equipment, as well as gather correct and complete accounting information containing item counting, fuel assembly maps and thermal power outputs of the reactors. Also, the safeguards officers at the plant developed a handbook on nuclear safeguards control, containing all internal procedures that incorporate laws, SSM and Euratom regulations, quality control instructions, and special control regulations for the nuclear facility. For example, in the case of a short-notice outage, the operator procedures provide for the correct removal of the mechanical and electronic seals, for which approval has to be obtained from Euratom and IAEA, in advance. The metal cap of the mechanical seal must be kept and the time of detaching the electronic seal must be written down to be verified during the next inspection. Another example is when a damaged fuel rod has to be removed from a fuel assembly. In such cases, specialised equipment is brought to the plant from the fuel provider. The equipment must undergo a safety analysis before the fuel rod is removed, and the results are declared in a report.

Criterion CR3.2 is focused on facility design, so without information on the AP300 SMR plant layout, the specific EPs cannot be addressed. Firstly, INPRO recommends using the safeguards-by-design process from an early stage to ensure that safeguards equipment requirements are met and retrofits are avoided. Such requirements consider the availability of space for installing containment and surveillance equipment, radiation detectors, different sensors, as well as for enabling continuous power supply and data transfer. Secondly, the recommendations resulting from the study are: supplying surveillance equipment with additional power supply, ensuring that the data on nuclear fuel transfers is compatible with the software used at different nuclear facilities, and that the appointed safeguards officer has enough knowledge about reactor operation to properly manage the safeguards system for the nuclear reactor site.

Lastly, one requirement for meeting CR3.2 is that the “projected person-days of verification work on the facility are equal to or lower than a comparable facility” [11]. It was suggested to the authors that some parameters to be considered for approximating this time are: employing a new type of SNF storage (e.g., dry storage) for the deployment scenario, the number of cores, the amount of received and sent transfers, the number of reactor outages for refuelling, new software employed, different fuel type than the one used for the current BWRs at the site, and the number of material balance areas employed at each facility. To perform such an estimation, the AP300 could be compared, in terms of design adequacy for implementing facility-specific safeguards measures, with an existing large-scale LWR (e.g., AP1000 under a similar safeguards regime or an operating LWR in the Swedish NES). One suitable tool that could be employed is the Facility Safeguardability Analysis (FSA) [12], which is also suggested in the PR manual draft [11]. The tool contains a safeguardability questionnaire developed for reactor designers to evaluate if their new or modified designs pose new challenges for their safeguards verification. This supports spotting related solutions while implementing a safeguards-by-design process (SbD). As the questions are mostly connected to the facility design layout, the FSA can also be appropriate for identifying necessary intrinsic features for enhancing PR in the design.

The given examples can be considered good practices to enhance proliferation resistance within the deployment scenario and also to sketch a related facility-level safeguards approach. Moreover, the elimination of the spent fuel from the SMR plant layout proves to be impractical for the Swedish case, as current requirements for licensing the Clab facility set out a minimum period of nine months for initial cooling before transporting the SNF to the interim storage [7]. Given the operating license of Clab, its planned lifetime of sixty years (until 2050) and its maximum capacity of storing 11000 tonnes of SNF, as well as the uncertain timeframe for disposing of current SNF inventories, it is not certain if it could also store SNF from the three additional SMRs. Thus, designers and operators considering this scenario should introduce a safeguards approach for the storage of SNF from SMRs through an SbD process, in collaboration with the regulatory authority, IAEA and Euratom. One possible solution would be to use the current SNF pools at the site, which might interfere with the current safeguards verification of the existing large-scale reactors. Another solution, which would require a feasibility study, is building a common SNF pool for the 3 SMRs, or reserving space at the site for building a dry interim storage area.

Completely meeting UR3 at both State-level and facility-level, would require assessing all nuclear installations in the Swedish NES, in connection to the considered deployment scenario, and how the interaction between these facilities could impact PR. For this, future studies on the application of nuclear safeguards at the Studsvik site, the interim storage facility, and the nuclear fuel factory are desired.

## CONCLUSION AND OUTLOOK

The beginning of a nuclear energy system sustainability assessment in the area of proliferation resistance was described. The INPRO methodology is employed to assess proliferation risks and safeguards challenges for the deployment of SMRs in Sweden, and for identifying relevant solutions for their safeguards verification. At its finalisation, the assessment is expected to lead to a set of guidelines, including those presented in the current work, which are intended to assist regulatory bodies, SMR vendors, designers, and operators in planning for sustainable new nuclear energy strategies for Sweden. The assessment started by introducing the Swedish legal framework implementing international non-proliferation commitments, describing the current Swedish nuclear fuel cycle, and introducing an SMR deployment scenario. A case study was presented on how large-scale reactor operators in Sweden could help define future safeguards strategies for introducing SMRs at existing or new nuclear sites. User Requirements 4 and 5 were not addressed in the work, but are intended to be covered in future studies on optimising and incorporating multiple proliferation resistance measures into the NES design to deter diversion and misuse. The assessment is planned to continue by performing a comprehensive review of the NES that covers both the front end and back end of the State, considering diversified SMR deployment scenarios, the available nuclear material and technology within the nuclear energy system, as well as the decommissioning of SMRs.

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