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Ville Peri (ed.)

Implementing nuclear non-proliferation in Finland

Regulatory control, international cooperation and the Comprehensive Nuclear-Test-Ban Treaty

Annual report 2021

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KEYWORDS: nuclear safeguards, regulatory control, comprehensive nuclear-test-ban treaty, verification

Abstract

The regulatory control of nuclear materials, nuclear safeguards, is a prerequisite for the peaceful use of nuclear energy. In order to maintain the Finnish part of the international agreements on nuclear non-proliferation – mainly the Non-Proliferation Treaty (NPT) – this regulatory control is implemented mainly by the Nuclear Materials Safeguards section of the Finnish Radiation and Nuclear Safety Authority (STUK). In addition, the Ministry for Foreign Affairs (MFA) and Ministry of Economic Affairs and Employment (MEAE) play a central role in the state system of accounting for and control of nuclear material (SSAC). STUK cooperates nationally with the ministries, customs, border control and other domestic stakeholders in the areas of non-proliferation, export control and nuclear disarmament.

Core stakeholders in the SSAC are the operators and licence holders who have the ultimate responsibility for their nuclear materials and related activities. Finland has quite significant nuclear power production, but the related nuclear industry is rather limited. Most of the declared nuclear materials (uranium, plutonium and thorium) in Finland reside at the nuclear power plants at Olkiluoto and Loviisa. In addition, there is a shutdown research reactor in Espoo with fresh nuclear fuel still at the site. Other Finnish operators include STUK itself, the University of Helsinki and VTT's Centre for Nuclear Safety as mid-sized holders, holders of nuclear materials generated as concentrates or by-products in the mineral processing industry and 13 minor nuclear material holders.

STUK maintains a national nuclear materials accountancy system and verifies that nuclear activities in Finland are carried out in accordance with the Finnish Nuclear Energy Act and Decree, European Union safeguards regulations, and international agreements. These tasks are performed to verify that Finland can assure itself and the international community of the absence of undeclared nuclear activities and materials. In addition to this, the IAEA evaluates the success of the state safeguards system, and the European Commission participates in safeguarding the materials under its jurisdiction.

The results of STUK's nuclear safeguards accounting and verification activities in 2021 continued to demonstrate that Finnish licence holders take good care of their nuclear materials. There were no indications of undeclared nuclear materials or activities, and the inspected materials and activities were in accordance with the operators' declarations. The operators' own nuclear materials accountancy and control systems enabled STUK to fulfil its own obligations under the international agreements relevant to nuclear safeguards.

STUK and other stakeholders continued work in the difficult environment caused by the COVID-19 pandemic. Experiences from and routine developed in the previous year allowed STUK to carry on with safeguards inspection activities uninterrupted. Travel restrictions kept impacting international events, including conferences and meetings. STUK cooperated with the operators with a shared objective of ensuring health and safety during inspections and other on-site activity. STUK finished the year with 41 inspections and 71 inspection days which are in line with the long-term averages. The number of international inspections and inspection days were also at a normal level. According to the statements on inspection results and the conclusion of safeguards implementation provided by the IAEA and the Commission in 2021, the IAEA required one action from a Finnish operator.

The Nuclear Materials Safeguards section executed STUK's strategic priorities of effective oversight and regulatory work by empowering the operators to better take responsibility for their own safeguards control. For example, the operators' responsible officers are encouraged to further develop the operator's own safeguards system and their nuclear material handbooks. In the section, new and old inspectors kept developing in their responsibility areas and expanding their knowledge in, for example, nuclear legislation. In the near future, such knowledge will gain even more importance, as the project to comprehensively update Finnish nuclear legislation is already under way. The development of the safeguards instrumentation for the final disposal of spent nuclear fuel maintained its position as the highlight of the technical development work in the Finnish nuclear safeguards system. In particular, this involves the passive gamma emission tomography and passive neutron albedo reactivity measurement methods.

A major goal of all current Comprehensive Nuclear-Test-Ban Treaty (CTBT)-related activities is the entry into force of the CTBT itself. An important prerequisite for such positive political action is that the verification system of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) is functioning and able to provide assurance to all parties that it is impossible to carry out a clandestine nuclear test without detection. The FiNDC is committed to its own role in this common endeavour, so that the verification system of the CTBTO can accomplish its detection task.

Preface

Once again, the year 2021 surprised us. COVID-19 was not eliminated, but we learned to live with it. And now as every year, we have prepared the report on Implementing Nuclear Non-Proliferation in Finland with the aim of sharing our experiences and findings of the safeguards implementation with colleagues and interested parties on safeguards implementation, nuclear non-proliferation measures and to inform the Finnish National Data Centre of CTBTO activities in Finland.

The highlights of 2021 have been many:

- First, we are finally working with legislation renovation, and safeguards will be strengthened in the new Nuclear Energy Act.
- Second, our section has proved to be able to adapt to the new situation, we are ready to work both in-person and virtually, and the effect of choice is minimal. This is good sign as, in 2022, STUK is moving to new premises in Jokiniemi, Vantaa, where no one will have their own rooms and workstations.
- Third, international co-operation has been enhanced, for example co-operation with the Belgian authority FANC has started to share experiences and procedures of the safeguards by design. We have also contributed to the SATE Master of Safeguards course led by ENEN.

In addition to myself, we have seven SG inspectors and one researcher in the section, and we are supported by an assistant providing assistance in practical tasks like announcing the inspections and central nuclear material bookkeeping. They all are important contributors to maintaining and developing the national safeguards system and the SSAC. Their work is vital for the legislative objectives of all use of nuclear energy in Finland, i.e. ensuring that the use of nuclear energy does not promote the proliferation of nuclear weapons. The inspectors in the office have specific oversight tasks and duties towards individual operators and stakeholders. They work in pairs to ensure duplicate knowledge and appropriate response time. This arrangement also makes it easier for all individuals to handle their workload. My team of experts consists of

- Mr Tapani Honkamaa, Principal Advisor
- Mr Mikael Moring, Senior Inspector
- Dr Olli Okko, Senior Inspector
- Mr Timo Ansaranta, Senior Inspector
- Mr Henri Niittymäki, Senior Inspector
- Mr Ville Peri, Inspector
- Mr Topi Tupasela, Inspector
- Ms Riina Virta, Researcher

The planning and implementation of national safeguards measures towards the operators and their operations, and the evaluation and assessment of the results, findings and conclusions by the international organisations, the IAEA and EC, are in focus. Everyday work at the office and in the field forms the basis for successful outcomes. This work cannot be done without co-operation and collaboration with operators, the users of nuclear energy. Together we ensure that the use of nuclear energy in Finland is in line with international obligations.

This report has been compiled by all the staff members of the Nuclear Materials Safeguards section of STUK. I would also like to inform readers that STUK has published the Report of STUK Activities in FINSP, IPNDV and GICNT Initiatives in 2021, where international co-operation on these important non-proliferation-related activities is more precisely reported.

The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) entered into force in Finland in 1970. February 2022 marked the 50th anniversary of the Comprehensive Safeguards Agreement (CSA) between the IAEA and Finland. A lot has happened since then and a lot is ongoing. While Finland was the first with the CSA, we are again pioneers in preparing to the disposal of spent nuclear fuel by 2025. Finnish nuclear legislation is also currently under revision with STUK's SYTYKE project for preparation of new regulations and guidelines ongoing, both to be completed by 2028.

In 2022, our main task is to ensure that, in the future, too, we have available the necessary expertise and preparedness to facilitate, enable and implement safeguards as required to fulfil both national and international obligations. International co-operation in safeguards and non-proliferation ensures that we can strive for the highest standards. I myself also have a good possibility to promote and enhance this international co-operation within the ESARDA Implementation of Safeguards Working Group, which I am chairing for 2022–2023.

Comments and suggestions are welcome to improve the content and normativity of the report. I wish you all good and rewarding moments with the report.

Marko Hämäläinen,
Section Head
Nuclear Materials Safeguards

Contents

1 Implementation of nuclear non-proliferation in Finland

The regulatory control of nuclear materials, nuclear safeguards, is a prerequisite for the peaceful use of nuclear energy in Finland. For Finland to have a nuclear industry, most of which consists of nuclear energy production, it must be ensured that nuclear materials, equipment and technology are used only for their declared peaceful purposes. The basis of nuclear safeguards is the national system for the regulatory control of nuclear materials and activities. Nuclear safeguards represent an integral part of nuclear safety and nuclear security and are applied to both large- and medium-sized nuclear industry and to small-scale nuclear material activities. Along with the safeguards, the regulatory process for nuclear non-proliferation includes transport control, export control, border control, international cooperation and monitoring compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

Safeguards are applied to nuclear materials and activities that can lead to the proliferation of nuclear weapons. These safeguards include nuclear materials accountancy, control, security and the reporting of nuclear fuel cycle-related activities. The main parties involved in a state nuclear safeguards system are the users of nuclear materials, often referred to as 'licence holders' or more broadly as 'operators', and the state regulatory authority, STUK. A licence holder must take good care of its nuclear materials and the state authority must provide the regulatory control to ensure that the licence holder fulfils the requirements. The control of nuclear expert organisations, technology holders and suppliers, to ensure the non-proliferation of sensitive technology, is also a growing global challenge for all stakeholders. In Finnish legislation, all these operators are dealt with as users of nuclear energy.

Finland has quite significant nuclear power production, but the related nuclear industry is rather limited. Most of the declared nuclear materials (uranium, plutonium and thorium) in Finland reside at the nuclear power plants at Olkiluoto and Loviisa. Additionally, there is the research reactor in Espoo with nuclear materials, as well as 13 minor nuclear material holders in Finland. Most of the applied nuclear research and development activities are carried out to improve the maintenance and safety of the nuclear power plants.

1.1 International safeguards agreements and national legislation

Nuclear safeguards are based on international agreements, the most important and extensive of which is the Treaty on the Non-Proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT). The Treaty Establishing the European Atomic Energy Community (Euratom Treaty) is the basis for the nuclear safeguards system of the European Union (EU). Finland is bound by both these treaties, and also has several bilateral agreements in the area of the peaceful use of nuclear energy. When Finland joined the EU, the bilateral agreements with Australia, Canada and the USA were partly replaced by the corresponding Euratom agreements (see Appendix 3 for the relevant legislation).

Finland was the first state where an INFCIRC/153-type comprehensive Safeguards Agreement with the IAEA entered into force. The original agreement INFCIRC/155 was in force from 9 February 1972. When Finland joined the EU on 1 January 1995, this agreement was suspended and subsequently the Safeguards Agreement between the non-nuclear weapon Member States of the EU, the Euratom and the IAEA, agreement number INFCIRC/193, entered into force in Finland on 1 October 1995. Finland signed the Additional Protocol (AP) to the INFCIRC/193 in Vienna on 22 September 1998 with the other EU Member States and ratified it on 8 August 2000. The Additional Protocol entered into force on 30 April 2004, once all the EU Member States had ratified it. The scope and mandate for Euratom safeguards are defined in the European Commission Regulation No. 302/2005.

After Finland joined the EU as a Member State and thereby subjected itself to the Euratom safeguards, a comprehensive national safeguards system continued to be maintained and further developed. The basic motivation for this is the responsibility assumed by Finland for its safeguards and security under the obligations of the NPT, and to ensure fulfilment of the Euratom requirements.

The national safeguards derive their mandate and scope from the Finnish Nuclear Energy Act and Decree. The operator's obligation to have a nuclear material accountancy system and the right of STUK to oversee the planning and generation of design information for new facilities were introduced from STUK requirements into the Nuclear Energy Decree.

In 2015, the Nuclear Energy Act was amended in such a way that the government decrees on nuclear safety, nuclear waste management, emergency preparedness and nuclear security were replaced by new STUK regulations. In addition, the new STUK regulation on the Safety of Mining and Milling Operations Aimed at Producing Uranium or Thorium also entered into force on 1 January 2016.

As stipulated by the act, STUK issues detailed requirements (the YVL Guides) on safety, security and safeguards that apply to the use of nuclear energy. STUK's safeguards requirements for all users of nuclear energy during all phases of the nuclear fuel cycle are set in YVL Guide D.1 Regulatory Control of Nuclear Safeguards issued in 2013. The guide was updated in 2018, and a new version was published in 2019. Areas covered in the new comprehensive guide include the obligations and measures stemming from the Additional Protocol for the Safeguards Agreement and from recent developments. All operators must describe their own safeguards system in written form (as a nuclear materials handbook or safeguards manual), in order to facilitate their task of fulfilling their obligations and to guarantee the effective and comprehensive operation of the national safeguards system. In the new guide, there are also specific national requirements for the disposal of spent nuclear fuel in a geological repository.

In general, nuclear safeguards control applies to:

- nuclear material (special fissionable material and source material)
- nuclear dual-use items (non-nuclear materials, components, equipment and technology suitable for producing nuclear energy or nuclear weapons as specified in INFCIRC/254, Part 1)

- licence holders' activities, expertise, preparedness and competence including information security
- R&D and other activities related to the nuclear fuel cycle as defined in the Additional Protocol
- the design and construction of new nuclear facilities.

1.2 Parties of the Finnish safeguards system

The main parties involved in the Finnish safeguards system are the authorities and operators. Undistributed responsibility for the safety, security and safeguards of the use of nuclear energy rests with the operator. It is the responsibility of STUK as the state regulatory authority to ensure that the licence holders and all other operators in the nuclear field comply with the requirements of the law and the nuclear safeguards agreements. To complement the national effort, international control is necessary in order to demonstrate credibility and the proper functioning of the national safeguards system.

1.2.1 Ministries

The Ministry for Foreign Affairs (MFA) is responsible for national non-proliferation policy and international agreements. The MFA is responsible for the export control of nuclear materials and other nuclear dual-use items, including sensitive nuclear technology. The Ministry of Economic Affairs and Employment (MEAE) is responsible for the supreme command and control of nuclear matters. The MEAE is responsible for the legislation related to nuclear energy and is also the competent authority mentioned in the Euratom Treaty. Other ministries, such as the Ministry of the Interior and the Ministry of Defence, also contribute to the efficient functioning of the national nuclear safeguards system.

1.2.2 STUK

According to Finnish nuclear legislation, STUK is responsible for maintaining the national nuclear safeguards system to prevent the proliferation of nuclear weapons. STUK regulates the operators' activities and ensures that the obligations of international agreements concerning the peaceful use of nuclear materials are met. Regulatory control by STUK includes the possession, use, production, transfer (national and international), handling, storage, transport, export and import of nuclear materials and nuclear dual-use items. STUK oversees Finland's approval and consultation process for inspectors from the IAEA and the European Commission.

The nuclear safeguards work of STUK, executed by its Nuclear Materials Safeguards section, covers most typical measures of the national authority in the state system of accounting for and control of nuclear material (SSAC), together with many other activities. STUK reviews the operators' reports (operational notifications, inventory reports), inspects their accountancy, facilities and transport arrangements on site, and performs system audits. STUK runs a verification programme for nuclear activities to assess the completeness and correctness of the declarations by the licence holders. STUK acts proactively in order to avoid or solve in advance any foreseeable issues that may be raised by the international inspectorates. Nuclear safeguards on a national level are closely linked to other functions of nuclear materials control and non-proliferation: licensing, export control, border control, transport control, combating illicit trafficking, physical protection of nuclear materials, monitoring compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT) and the Global Initiative to Combat Nuclear Terrorism (GICNT). Nuclear safety and particularly nuclear security objectives are closely complemented by safeguards objectives. For this reason, the research and regulatory units in the fields of safety, security and safeguards at STUK cooperate within the non-proliferation framework. The scope of non-proliferation work is linked to many organisational units of STUK (Fig. 1).

The distribution of the working hours of the Nuclear Materials Safeguards section in 2021 in the different duty areas is presented in Figure 2. Most of the working hours are invoiced to the operators. The duty areas are divided into direct oversight and inspections (basic operations), support functions including maintenance, development work for the regulatory functions and consultancy, including international cooperation financed by the Ministry for Foreign Affairs or the European Union. State budgetary funding usually constitutes about 5% of the total funding of the section. That was also the case in 2021. It is worthwhile mentioning that the working hours in 2021 still do not represent an average year. The continuing pandemic and subsequent postponement of some international activities meant that fewer hours than normal were directed at expert services. There was, however, significant recovery in service activity at the Nuclear Materials Safeguards section from 2020.

Nuclear non-proliferation is by nature an international domain. STUK therefore actively participates in international nuclear safeguards-related cooperation and development efforts. STUK takes part in the European Safeguards Research and Development Association ESARDA's working groups, executive board and steering committee. Current nuclear new-build projects including the final disposal facility have emphasised the need to introduce safeguards requirements at an early stage of facility design. These experiences, among others, are actively shared by STUK with the IAEA, in several international fora, and in bilateral cooperation with several countries.

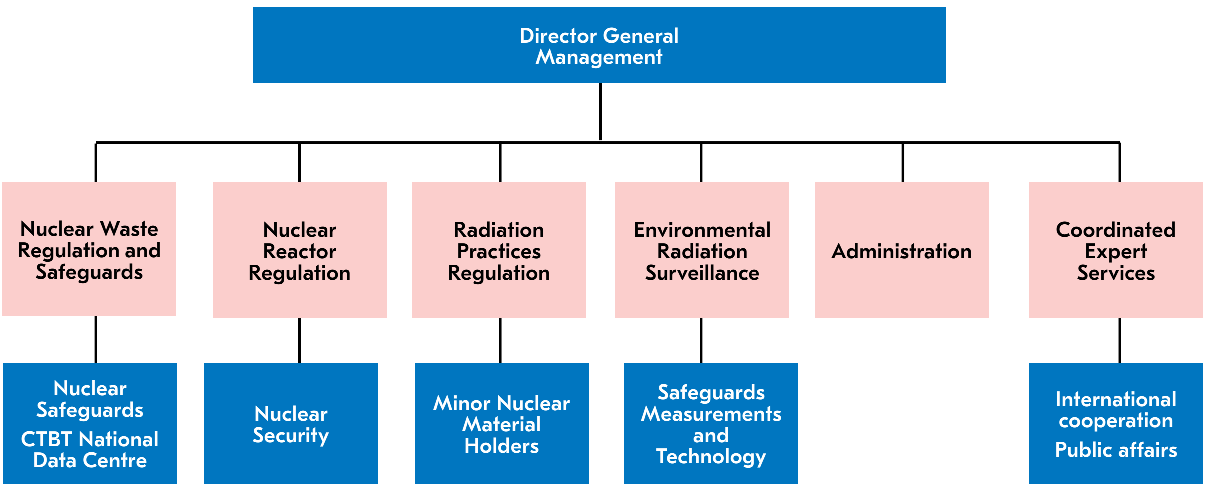


FIGURE 1. Framework to implement nuclear non-proliferation within STUK's organisation.

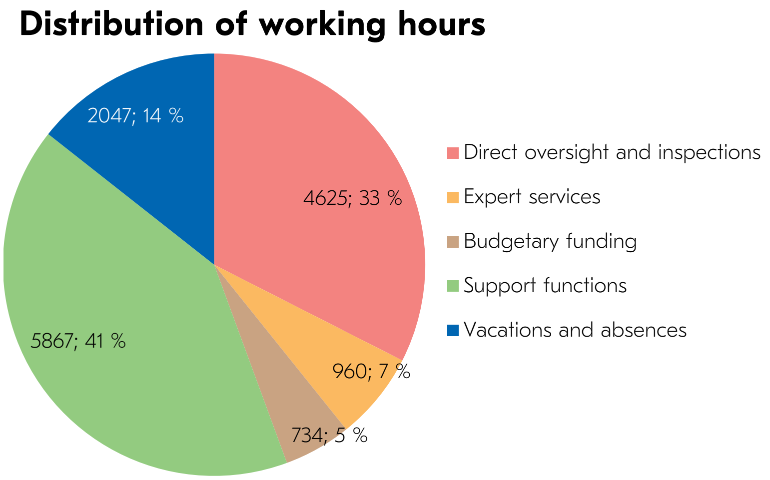


FIGURE 2. The distribution of the working hours of the Nuclear Materials Safeguards section in the various duty areas.

1.2.3 Licence holders and other users of nuclear energy

The essential parts of the national safeguards system are the licence holders and other users of nuclear energy – in nuclear terminology, often called the operators. In Finnish legislation, the term 'use of nuclear energy' encompasses a wide range of nuclear-related activities such as those defined in the Additional Protocol. These operators, in particular the licence holders, perform key functions in the national safeguards system: control of the authentic source data of their nuclear materials in addition to accountancy for nuclear materials at the facility level for each of their material balance areas (MBA). Each licence holder or other user of nuclear energy must operate its safeguards system in accordance with its own nuclear materials handbook or safeguards manual. The requirements of Finnish nuclear energy legislation, the Comprehensive Safeguards Agreement and the Additional Protocol are integrated into the handbook to facilitate implementation of safeguards at the site, including the material balance areas. Other operators too, as users of nuclear energy, are required to have a safeguards manual to facilitate safeguards implementation. The nuclear materials handbook or safeguards manual is part of the operator's quality system and is reviewed and approved by STUK.

In Finland, there are about 30 operators responsible for nuclear material accountancy and control. The major material balance areas are listed in Table 1 and described in greater detail below. Most of the nuclear materials in Finland reside at the nuclear power plants at Loviisa and Olkiluoto. The amounts of nuclear materials (uranium, plutonium) in Finland in 1990–2021 are presented in Figures 3 and 4. Currently there are six sites as referred to in the Additional Protocol: the two nuclear power plant sites, the geological repository site in Olkiluoto, and three minor sites: VTT Technical Research Centre of Finland, the Radiation and Nuclear Safety Authority STUK and the Laboratory of Radiochemistry at the University of Helsinki.

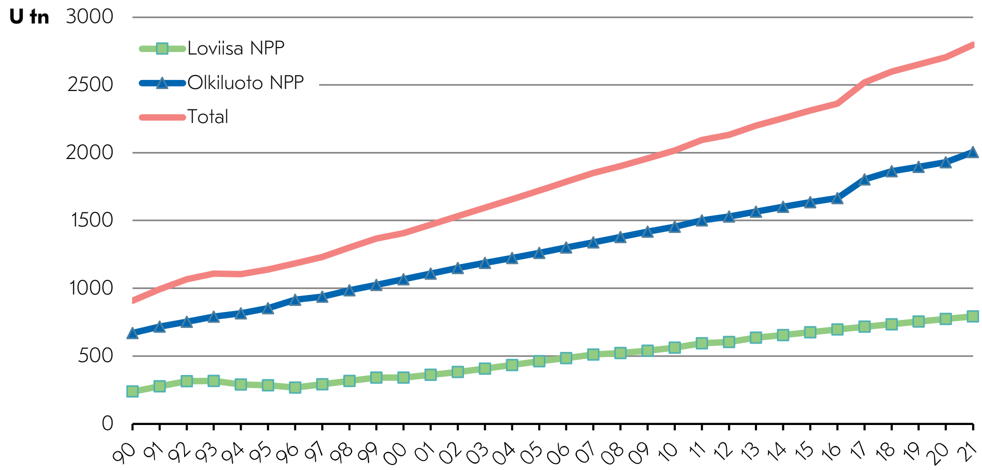


FIGURE 3. Uranium accumulation in Finland in 1990–2021.

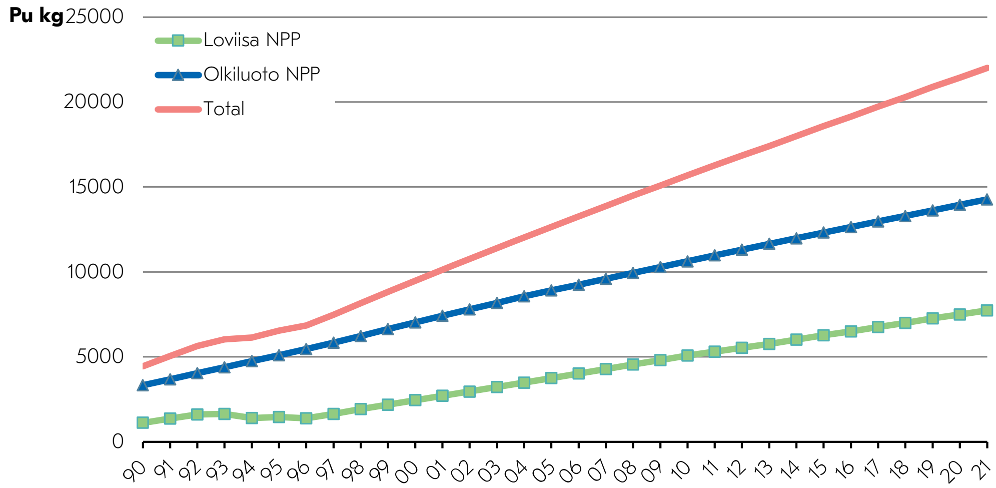


FIGURE 4. Plutonium in spent nuclear fuel in Finland in 1990–2021.

With the basic technical characteristics (BTC) submitted by a licence holder or by other operator as groundwork, the European Commission adopts particular safeguards provisions (PSP) for that licence holder. PSPs are drawn taking operational and technical constraints into account in close consultation with both the person or undertaking concerned and the relevant member state. Until PSPs are adopted, the person or undertaking must apply the general provisions of Commission Regulation No. 302/2005. A facility attachment (FA) is prepared in cooperation with the IAEA for each facility to describe arrangements specific to that facility. The status of the regulatory documents for the Finnish material balance areas is shown in Table 1.

TABLE 1. Status of regulatory documents for material balance areas in Finland at the end of 2021.

MBA, location	BTC, last upd.	Site (AP), founded	PSP, in force	FA, in force	Licence/DiP, in force (from/until)	SG Manual, approved update
WLOV, Loviisa	20.3.2020	SSFLOVI, 8.7.2004	Yes, 4.5.1998	No	Operating, LO1 until 31.12.2027, LO2 until 31.12.2030	5.3.2021
WOL1, Olkiluoto	22.11.2021	SSFOLKI, 8.7.2004	Yes, 7.6.2007	No	Operating, until 31.12.2038	4.12.2020
WOL2, Olkiluoto	22.11.2021	SSFOLKI, 8.7.2004	Yes, 7.6.2007	No	Operating, until 31.12.2038	4.12.2020
WOLS, Olkiluoto	10.12.2021	SSFOLKI, 8.7.2004	Yes, 7.6.2007	No	Operating, until 31.12.2038	4.12.2020
WOL3, Olkiluoto	7.12.2021	SSFOLKI, 8.7.2004	Yes, 17.12.2019	Yes, 30.1.2020	Operating, until 31.12.2038	4.12.2020
WOLE, Olkiluoto	28.10.2021	SSFPOSI, 31.3.2010	No	No	Construction, from 12.11.2015	No, included in WOLF manual
WOLF, Olkiluoto	29.10.2021	SSFPOSI, 31.3.2010	No	No	Construction, from 12.11.2015	22.8.2019
WFV1, Pyhäjoki	3.2.2017	No	No	No	DiP, initial 1.7.2010, supplement 5.12.2014	1.10.2021
WRRF, Espoo	16.4.2021	SSFVTTI, 8.7.2004	Yes, 9.7.1998	No	Decommissioning, from 17.6.2021 until 31.12.2030	13.4.2017
WNSC, Espoo	15.10.2021	Included 2017 to SSFVTTI	No	No	Operating, until 31.12.2026	14.12.2021
WFRS, Helsinki	15.2.2019	SSFSTUK, 8.7.2004	No	No	Not required (as an authority)	11.11.2019
WHEL, Helsinki	31.5.2021	SSFHYRL, 8.7.2004	No	No	Operating, until 31.12.2027	11.11.2021
WKKO, Kokkola	13.2.2020	No	No	No	Operating, until 31.12.2024	17.12.2020
WNNH, Harjavalta	14.5.2021	No	No	No	Operating, until 31.12.2029	15.11.2019
WTAL, Terrafame	20.5.2019	No	No	No	Operating until 31.12.2050	19.7.2018
WDPJ, Jyväskylä	2.2.2021	No	No	No	Operating, until 31.12.2024	24.9.2018

Finnish material balance areas and their status on 31.12.2021. MBA (material balance area code), BTC (Basic Technical Characteristics, i.e. Design Information), AP (the Additional Protocol), PSP (Particular Safeguards Provisions set by the European Commission), FA (Facility Attachment prepared by the IAEA), DiP (Decision-in-Principle).

Fortum (MBA WLOV)

The nuclear power plant operated by Fortum Power and Heat Oy is located on Hästholmen Island in Loviisa on the south-east coast of Finland. This first NPP was built in Finland in the 1970s to host two VVER-440-type power reactor units. These two units share common fresh and spent fuel storages. For nuclear safeguards accountancy purposes, the entire NPP is counted as one material balance area (MBA code WLOV).

Most of the fuel for the Loviisa NPP is imported from the Soviet Union/Russian Federation. The spent fuel of the Loviisa NPP was returned to the Soviet Union/Russian Federation until 1996 and since then has been stored in the interim storage due to a change in Finnish nuclear

Major nuclear installations in Finland

Loviisa nuclear power plant

Plant unit	Start-up	National grid	Nominal electric power (gross/net, MW)	Type, supplier
Loviisa 1	8 Feb 1977	9 May 1977	531/507	Pressurised water reactor (PWR), Atomenergoexport
Loviisa 2	4 Nov 1980	5 Jan 1981	531/507	Pressurised water reactor (PWR), Atomenergoexport

Fortum Power and Heat Oy owns the Loviisa 1 and 2 plant units located in Loviisa.

Olkiluoto nuclear power plant

Plant unit	Start-up	National grid	Nominal electric power (gross/net, MW)	Type, supplier
Olkiluoto 1	2 Sep 1978	10 Oct 1979	920/890	Boiling water reactor (BWR), Asea Atom
Olkiluoto 2	18 Feb 1980	1 Jul 1982	920/890	Boiling water reactor (BWR), Asea Atom
Olkiluoto 3	21 Dec 2021	–	Approx. 1600 (net)	Pressurised water reactor (PWR), Areva NP

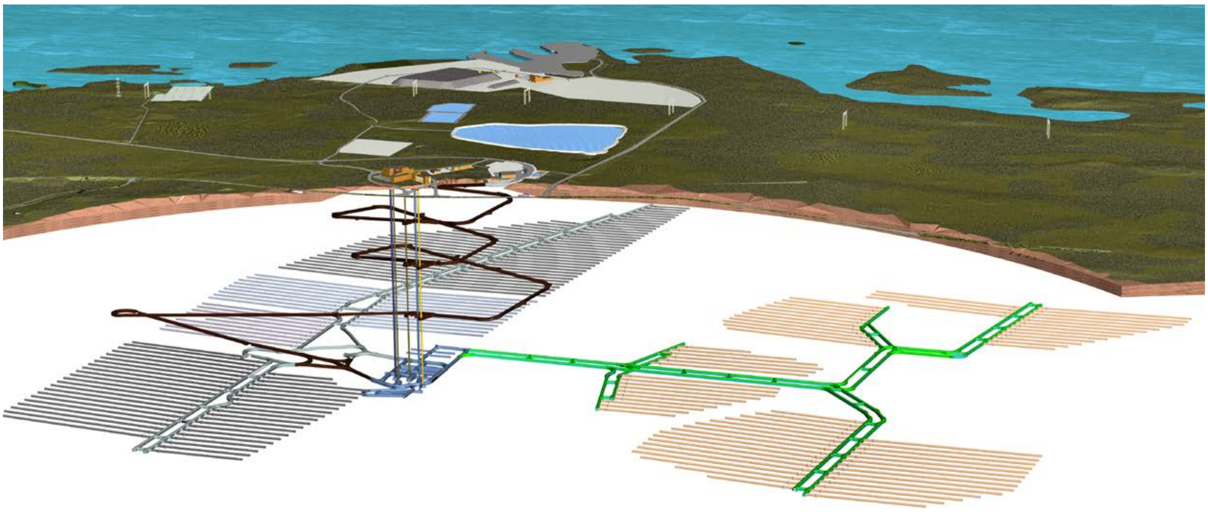
Teollisuuden Voima Oyj owns the Olkiluoto 1 and 2 plant units located in Olkiluoto, Eurajoki, and the Olkiluoto 3 plant unit under commissioning.

Hanhikivi nuclear facility project

Plant unit	Supplemented Decision-In-Principle approved	Nominal electric power, net (MW)	Type, supplier
Hanhikivi 1	5 Dec 2014	Approx. 1200	Pressurised Water Reactor (PWR), ROSATOM

Hanhikivi nuclear power plant FH1 is a power plant project of Fennovoima.

Olkiluoto encapsulation plant and geological repository



The planned facility under construction will consist of a surface facility for the encapsulation of spent nuclear fuel and a geological repository for disposal of the fuel at a depth of appr. 420 metres.

FiR 1 research reactor

Facility	Thermal power	In operation	Fuel	Triga fuel type
TRIGA Mark II research reactor	250 kW	March 1962 – June 2015	Reactor core consists of 80 fuel rods which contain 15 kg of uranium	Uranium–zirconium hydride combination: 8% uranium, 91% zirconium and 1% hydrogen

The FiR 1 research reactor, operated by VTT Technical Research Centre of Finland, was commissioned in March 1962. VTT stopped using the reactor in June 2015 and placed it in permanent shutdown. VTT submitted the operating licence application for the decommissioning phase to the Government in June 2017. The licence was granted in June 2021.

legislation, which forbids the import and export of nuclear waste in general, including spent fuel.

As per the requirements of the Additional Protocol, the Loviisa NPP site (SSFLOVI) comprises Hästholmen Island as a whole and extends to the main gate on the mainland. Particular Safeguards Provisions for the Loviisa NPP, which define the European Commission's nuclear safeguards procedures for the facility, have been in force since 1998. The Facility Attachment of the Safeguards Agreement INFCIRC/193 has not been prepared by the IAEA for the Loviisa NPP.

Teollisuuden Voima (MBAs WOL1, WOL2, WOLS, and WOL3)

Teollisuuden Voima Oyj (TVO) owns and operates a nuclear power plant on Olkiluoto Island in Eurajoki on the west coast of Finland. The Olkiluoto NPP consists of two operational reactor units, one unit under commissioning, and an interim spent fuel storage. There are four active material balance areas (MBA codes WOL1, WOL2, WOLS, WOL3) at the Olkiluoto NPP. Olkiluoto 1 was connected to the electricity grid in 1978 and Olkiluoto 2 in 1980. The Finnish Government granted a licence to construct a new nuclear reactor, Olkiluoto 3, in 2005. An operating licence for the new unit was granted to TVO on 7 March 2019. The Olkiluoto 3 reactor core was loaded with fuel elements, and first criticality was reached during 2021. The unit is scheduled to be producing energy in full power by July 2022.

Presently, the uranium in TVO's nuclear fuel is mainly of Australian, Canadian and Russian origin. This uranium is enriched in the Russian Federation or EU, and the fuel assemblies are manufactured in the EU. Spent fuel is stored in the interim storage at the site until final disposal in the Olkiluoto repository.

TVO owns most of the area of Olkiluoto Island, but the NPP site (SSFOLKI) as per the requirements of the Additional Protocol currently comprises the fenced areas around the reactor units, the spent fuel storage and the storage for low- and intermediate-level waste, and the Olkiluoto 3 construction site. Particular Safeguards Provisions for Olkiluoto 1, 2 and the spent fuel storage have been in force since 2007 and for Olkiluoto 3 since 2019. A Facility Attachment of the Safeguards Agreement INFCIRC/193 has been prepared by the IAEA for the Olkiluoto 3 unit but not for the other units of the Olkiluoto NPP.

Fennovoima (MBA WFV1)

Fennovoima was founded in 2007 as a new nuclear power operator in Finland. The government approved a Decision-in-Principle in 2010 for the new operator Fennovoima to construct a new nuclear power plant at a new site. The preliminary Basic Technical Characteristics (BTC) were submitted to the European Commission in summer 2013, and the MBA code WFV1 was assigned to the future material balance area once the selection of the future Hanhikivi site at Pyhäjoki was decided upon. Fennovoima submitted the construction licence application to the government in June 2015. Provision of the necessary information to STUK, required for a construction licence as per Section 35 of the Nuclear Energy Decree, has been delayed. At the end of 2021, Fennovoima's goal was to receive the construction licence in 2022. STUK received a large part of the preliminary safety analysis documentation from Fennovoima in 2021 and expects to receive the rest in 2022. The first Hanhikivi site declaration according to the Additional Protocol will be submitted only after the construction licence has been granted.

VTT (MBAs WRRF and WNSC)

In Finland, the most significant facility with nuclear materials outside of the nuclear power plants has long been the VTT (Technical Research Centre of Finland) research reactor FiR1 (MBA code WRRF), located in Otaniemi, Espoo. The research reactor was the first nuclear reactor built in Finland. In 2012, the Ministry of Employment and the Economy and VTT announced the plan to close down the reactor and launch the decommissioning process. The reactor was shut down and made subcritical in 2015. Irradiated fuel from the reactor was shipped to the United States in December 2020 to be used at the research reactor at the U.S. Geological Survey in Denver, Colorado. At the end of 2021, only the unirradiated fuel and some nuclear material samples remain at WRRF. After receiving the decommissioning licence in June 2021, VTT expects to start dismantling the reactor with its partners later in 2022. The dismantling phase is expected to take about one year.

Particular Safeguards Provisions that define the European Commission's nuclear safeguards procedures for the facility have been in force for VTT FiR1 since 1998. A Facility Attachment of the Safeguards Agreement INFCIRC/193 has not been prepared by the IAEA for the research reactor.

A new building, the VTT Centre for Nuclear Safety, for experimental nuclear research was built at the Espoo premises of VTT. The preliminary BTC for the new building was submitted to the Commission at the end of 2014, and the MBA code WNSC was subsequently assigned to the future material balance area in 2015. STUK granted the operating licence in 2016 for the VTT Centre for Nuclear Safety, and the first nuclear materials were moved to the new building in 2017. Both these decisions for future decommissioning and construction will have long-lasting effects, due to the need for licences, permits, contracts and environmental impact assessment. This also affects safeguards, as the nuclear materials must be kept under the control of competent personnel in both material balance areas.

The VTT site (SSFVTTI), as per the requirements of the Additional Protocol, currently consists of the whole building around the research reactor, although there are non-nuclear companies and university premises in the same building, and the building of the Centre for Nuclear Safety.

STUK (MBA WFRS)

According to the Nuclear Energy Decree, the Radiation and Nuclear Safety Authority (STUK) needs no licence as referred to in the Nuclear Energy Act for operations performed in its capacity as an authority. Nevertheless, STUK follows all the regulations and reporting practices in its capacity as a nuclear material holder. The function of handling and possessing nuclear materials at STUK is situated at a different department to the Nuclear Materials Safeguards section. The Nuclear Materials Safeguards section provides regulatory oversight for this function similarly as for other holders of nuclear materials. Small quantities of nuclear materials are stored by STUK, mainly materials no longer in use and hence taken into STUK's custody. STUK was founded in 1958 and has been located at its current premises in Roihupelto, Helsinki, since 1994. STUK's offices, laboratories and other functions will move to a new location in Jokiniemi, Vantaa, in the first half of 2022. The STUK MBA (WFRS) consists of the STUK headquarters and the 'Central interim storage for small-user radioactive waste' at the Olkiluoto NPP site.

The STUK site (SSFSTUK), as per the requirements of the Additional Protocol, consists of the premises of STUK's headquarters located in Helsinki. The storage at Olkiluoto is included in the NPP's site declaration.

The University of Helsinki (MBA WHEL)

The Laboratory of Radiochemistry at the University of Helsinki (HYRL) uses small amounts of nuclear materials. The laboratory is located on the Kumpula university campus in Helsinki. The University's internal structure was reorganised in 2017, and the current licence holder is the Department of Chemistry.

The HYRL site (SSFHYRL), as per the requirements of the Additional Protocol, comprises the whole building housing the laboratory.

Umicore Finland Oy (MBA WKKO)

The extracts of Kokkola Chemicals cobalt purification process contain uranium whose concentration qualifies it as nuclear material under the Finnish Nuclear Energy Act. The Kokkola Chemicals factory is located on the west coast of Finland and holds a licence for operations to produce, store and handle nuclear material. The current operator since December 2019 is Umicore Finland Oy Kokkola. The extraction of uranium from industrial purification processes has produced so-called pre-safeguarded materials, which are not yet suitable for fuel fabrication or isotopic enrichment and are thus not subject to conventional IAEA safeguards. The current aim is to transfer the uranium-containing residuals and adjust the processes to avoid extraction of uranium in the storage tanks. The operator reports monthly to the European Commission and STUK.

Norilsk Nickel Harjavalta Oy (MBA WNNH)

Norilsk Nickel Harjavalta Oy operates the nickel refining plant at Harjavalta in western Finland. The plant was commissioned in 1959 and expanded first in 1995 and again in 2002. The refinery of Norilsk Nickel Harjavalta employs the technique of the sulphuric acid leaching of nickel products. Uranium residuals are extracted from the nickel products and currently stored at the site. The Norilsk Nickel Harjavalta company submitted the basic technical characteristics (BTC) to the European Commission in 2010. In 2010, STUK granted a licence to extract and store less than 10 tonnes of uranium per year. The licence was renewed at the end of 2019 for a new 10-year period. The materials in Harjavalta are also pre-safeguarded and reported monthly to STUK and the European Commission.

Terrafame Oy (MBA WTAL)

In 2010, the Talvivaara Sotkamo Ltd mining company announced its interest in investigating the recovery of uranium as a separate product from its sulphide ore body at Talvivaara located in Sotkamo in eastern Finland. The Basic Technical Characteristics (BTC) were submitted to the European Commission in 2010, and the MBA code WTAL is assigned to the future uranium extraction plant that has been constructed as a separate part of the mineral processing plant. During 2015, the state-owned company Terrafame took over the mining and milling operations. At the end of 2016, the use of the uranium extraction plant was again included in the mining and mineral processing planning. STUK granted a licence for the small-scale pilot testing of the mineral processing techniques in December 2017. The licencing process included the approval of Terrafame's nuclear safeguards manual and responsible persons. The application for a full operating licence for the extraction plant was submitted to the government at the end of October 2017 and was processed by the Ministry of Economic Affairs and Employment. STUK delivered its statement on the safety of the uranium extraction plant to the ministry in June 2019. The licence was granted by the government on 6 February 2020 with a period for complaints, and finally endorsed by the Supreme Administrative Court on 24 June 2021. The MBA code WTAL is used in Terrafame's nuclear material accountancy that was initiated with the pilot tests. According to the licence conditions, the uranium extraction shall be initiated and launched within three years, by the summer of 2024.

Other nuclear material holders

There are 13 minor nuclear material holders in Finland. One of them is an actual material balance area: the University of Jyväskylä, Department of Physics (JYFL, MBA code WDPJ). The nuclear material at JYFL has been derogated and exempted by the European Commission and the IAEA. Other minor nuclear material holders are members of a Catch-All-MBA (CAM), for the purposes of international nuclear safeguards. Many of these have depleted uranium as radiation-shielding material.

Uranium may be concentrated in the mineral processing industry in intermediate or metal products with uranium concentration that fulfil the definition of nuclear material. These metal products are typical when, for example, processing sulphide ores with low uranium content and do not need to be included in the Euratom reporting because of their non-nuclear use. In the process industry, the annual quantities of processed natural uranium are in the order of several kilogrammes or even tonnes. Typically, uranium is extracted from the main products and considered as industrial waste among other extracts. According to the definitions in Finnish nuclear energy legislation, the production and possession of source material have been licensed by STUK since 2018 after the interpretation and decision of Ministry of Economic Affairs and Employment in the summer of 2018. Earlier, these kinds of operators were not licensed by STUK, but a few gold companies, for example, have reported their uranium-rich gold production to STUK. Current licence holders are Boliden Kokkola Oy and Boliden Harjavalta Oy for the production and possession of uranium-rich copper cement originating from zinc concentrates, and Dragon Mining Oy for the production of uranium-rich gold concentrates.

Posiva (MBAs WOLE and WOLF)

Posiva Oy is the company responsible for the disposal of spent nuclear fuel in Finland. It was founded in 1995 and is owned by the nuclear power plant operators TVO and Fortum. Posiva will dispose of the spent nuclear fuel produced by its owners 400 meters deep in the crystalline bedrock. Posiva was granted a licence by the government in November 2015 to construct a disposal facility. Based on the drawings presented in the application, the preliminary BTCs were prepared for the encapsulation plant (EP) and geological repository (GR) separately and submitted to the European Commission in 2013. The MBA codes assigned to the facilities are WOLE for the encapsulation plant and WOLF for the geological repository. The construction of the geological repository commenced officially in 2016 and the encapsulation plant construction in 2019. From 2003 to 2016, Posiva was building an underground rock characterisation facility called ONKALO® in Olkiluoto, and thus preparing for the construction of the disposal facility. Posiva has since started using the name ONKALO® for the whole disposal facility. The rock characterisation facility is now a part of the geological repository and constitutes the vehicle access ramp, three shafts and the technical support premises. In the IAEA safeguards approaches, it has been suggested that the geological formation should be under safeguards during the whole lifetime of the underground facility, beginning from the pre-operational phase. For this reason, long before becoming a nuclear material holder, Posiva was already required to develop a non-proliferation handbook, such as a nuclear materials handbook, to describe its safeguards procedures and reporting system.

Posiva submitted an operating licence application by the end of 2021. According to Posiva's current plans, the first canisters with spent nuclear fuel will be deposited in the mid-2020s. Cold tests of the disposal procedures are planned to start in 2023. Normal verification inspections of nuclear materials cannot be performed once the materials have been permanently disposed, so procedures related to verification inspections must be clear and necessary safeguards equipment should be installed and operational before the initiation of final disposal.

The installation, still without nuclear materials, constitutes a site according to the Additional Protocol. The Posiva site (SSFPOSI) covers the fenced area around the buildings supporting the construction of the facilities.

Other operators

Nuclear expert organisations, technology holders and suppliers that serve the nuclear and other industries are obliged to ensure that sensitive technology does not get into the hands of unauthorised parties and thereby contribute to nuclear proliferation. In Finland, these organisations and operators are required to apply for a licence for importing, transferring or possessing nuclear information that is under a particular safeguards obligation. The definition of nuclear information in the Nuclear Energy Decree encompasses the software and technology categories, product numbers 0D001 and 0E001 respectively, in the European Community regime for the control of dual-use items. The regime is discussed in more detail in Chapter 1.5. To ensure effective safeguards control of nuclear information, these operators are required to organise their own safeguards control systems, designate a person responsible for safeguards control in the organisation, prepare a nuclear safeguards manual and report the activities surrounding the licensed information to STUK annually.

The introduction of the Additional Protocol extended the scope of safeguards to the non-proliferation control of nuclear programmes and fuel cycle-related activities. These also include research and development activities, which do not involve nuclear materials but are related to the process or system development of fuel cycle aspects defined in the protocol. Additionally, the United Nations Security Council Resolution 1540 requires every state to ensure that export controls, border controls, material accountancy and physical protection are efficiently addressed, and calls on all states to develop appropriate ways to work with and inform industry and the public of their obligations. The control of nuclear expert organisations to ensure the non-proliferation and peaceful use of sensitive technology and dual-use items is a growing global challenge for all stakeholders.

Nuclear safeguards are commonly seen as the traditional nuclear material accountancy and reporting system, the main stakeholders of which are the international, regional and local authorities and the operators. In accordance with the extended non-proliferation regime and the amendments to the Finnish legislation, the universities, research organisations, companies or other operators that have activities defined in the Additional Protocol are under reporting requirements and export control. These operators (mainly VTT Technical Research Centre of Finland and a few universities) as users of nuclear energy are required to prepare a nuclear safeguards manual and to nominate persons responsible for nuclear safeguards arrangements.

1.3 IAEA and Euratom Safeguards in Finland

The IAEA and the European Commission (Euratom safeguards) both have independent mandates to operate in Finland. These two international inspectorates have agreed on cooperation, which aims to reduce undue duplication of effort. The operators report to the Commission as required by Commission Safeguards Regulation No 302/2005. It is the Commission's duty to control the licence holders' accounting and reporting systems. The Commission must draw up the particular safeguards provisions (PSP) to agree on the means of safeguards implementation, taking account of the operational and technical constraints of the licence holder.

The IAEA safeguards include traditional nuclear safeguards according to safeguards agreement INFCIRC/193, and safeguards activities in accordance with the Additional Protocol, integrated together. While this should not lead to an increase in the number of inspections, it should enable the IAEA to assure itself of the absence of undeclared nuclear activities in a state. In Finland, the integrated safeguards (IS) approach has reduced the rate of IAEA routine interim inspections. The reduction was first seen in 2009 and was a result of the state-level safeguards approach for Finland, which was negotiated during 2007 and 2008. In contrast to the reduction in routine inspections, the IAEA additionally performs 1–3 short-notice inspections per year in a state with a similar set of nuclear installations as Finland. Since 2010, the number of annual IAEA and European Commission inspections has been close to 20 with approximately 25 inspection days. The fluctuation is mainly due to the different design information verification (DIV) activities at the final disposal site during each of the years.

At the trilateral meeting (IAEA/EC/STUK) in September 2013, it was agreed that no unannounced inspections with two hours' notice time would be performed in Finland after the beginning of 2014. Thus, currently all short-notice inspections are expected to take place with 48 hours' advance notice (see info box). At reactors, the physical inventory verification includes both pre- and post-PIT inspections. At Loviisa, cask shipments are verified when the core is

IAEA regular inspections:

Facilities and spent fuel storages at nuclear power plants (NPPs):

- **Physical Inventory Verification (PIV)/Design Information Verification (DIV) 1/year**
- **Random Interim Inspection (RII) at 48 hours' notice (at least 1/year for Finland)**

Research reactor and locations outside facilities (LOF)

- **PIV/DIV 1/4–6 years**

New reactors, under construction

- **DIV and PIV later, as at the NPPs**

Repository under construction

- **PIV/DIV most likely 1/year**

Complementary access at 2/24-hour notification to verify declared activities or to detect undeclared activities.

Euratom carries out additional inspections of the research reactor and MBAs at locations outside facilities (LOFs)

open. STUK continues with annual routines consisting of approximately 40 field inspections, which enables the effective safeguards implementation of the international inspectorates.

According to the Finnish Nuclear Energy Act, STUK must participate in IAEA and Euratom inspections at Finnish facilities, so STUK has increased preparedness for short-notice and unannounced inspections and complementary access (abbreviated SNUICA). Every working day, one of STUK's inspectors is prepared to attend a possible IAEA or Euratom inspection.

The IAEA sends its statements on inspection results and the conclusion of safeguards implementation according to INFCIRC/193 and the Additional Protocol to the Commission, which amends them with its own conclusions and remarks, and forwards them to STUK. STUK sends the statements and conclusions to the operator in question for information and any required action. The IAEA annually draws conclusions confirming its confidence that all nuclear activities and materials are accounted for and are in peaceful use in Finland.

A state's declarations on its nuclear materials and activities are the basis for state evaluation by the IAEA under the obligations of the Additional Protocol. In Finland, the state has delegated its responsibility for these declarations to STUK. STUK has been nominated as a site representative, as per European Commission Regulation No. 302/2005. STUK collects, inspects and reviews the relevant information and then submits the compiled declarations in a timely fashion to the Commission and the IAEA.

Technical analysis methods are one tool for a state nuclear safeguards system to ensure that nuclear materials and activities within the state are in accordance with the licence holders' declarations, and that there are no undeclared activities. Such methods can provide information on the identity of the nuclear materials and confirm that licence holders' declarations are correct and complete with respect to, for example, the enrichment of uranium and the burn-up and cooling time of nuclear fuel. The technical analysis methods in use are non-destructive assay (NDA), environmental sampling and satellite imagery.

The declarations, inspections and other details on cooperation between the Finnish SSAC, the IAEA and the European Commission are discussed regularly. A trilateral meeting is a useful informal forum for every organisation to discuss, share information and clarify state declarations. A meeting is held at least once a year and is usually supplemented by a smaller trilateral meeting. STUK maintains active informal communication between the operators, itself, the IAEA and the Commission in day-to-day safeguards matters such as inspection arrangements.

1.4 Control of uranium and thorium production

Mining and mineral processing operations aiming to produce uranium or thorium are also under regulatory control. In order to carry out these activities, a licence and accounting system to keep track of the amounts of uranium and thorium are required. A national licence is also required to export and import uranium or thorium ore and ore concentrates. These activities are also controlled by the Euratom Supply Agency and the European Commission. Mining and milling activities and the production of uranium and thorium must be reported to STUK, the Commission and the IAEA.

1.5 Licensing and export/import control of dual-use goods

In accordance with the Finnish Nuclear Energy Act, other nuclear fuel cycle-related activities in addition to nuclear materials are under regulatory control. A licence is required for the possession, transfer and import of non-nuclear materials, components, equipment and technology suitable for producing nuclear energy (nuclear dual-use items). The list of these other items is based on the Nuclear Suppliers' Group (NSG) Guidelines (INFCIRC/254 Part 1). The licensing authority is STUK. The Ministry for Foreign Affairs is responsible for granting NSG Government-to-Government Assurances (GTGA) when necessary. The ministry usually consults with STUK before giving the assurances. The licence holder is required to provide STUK with a list of the above-mentioned items annually. Moreover, the export, import and transfer of such items must be confirmed to STUK after the action.

Finland's export control system is based on the EU regulation on dual-use items, more precisely called Regulation (EU) 2021/821 of the European Parliament and of the Council of 20 May 2021 setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items. The new regulation replaced EU Council Regulation (EC) No. 428/2009 of 5 May 2009 and is followed by the stakeholders, even though references to it have yet to be updated in the Finnish nuclear legislation. The export of Nuclear Suppliers' Group (NSG) Part 1 and Part 2 items is regulated by the Finnish Act on the Control of Exports of Dual-use Goods. Authorisation is required to export dual-use items outside the European Union as well as for the EU internal transfers of NSG Part 1 items, excluding non-sensitive nuclear materials. The licensing authority for the export of nuclear materials and dual-use items is the Ministry for Foreign Affairs except for ore and materials that contain nuclear waste for which the licensing authority is STUK. Before granting an export licence, the ministry also takes care of NSG Government-to-Government Assurances. The ministry asks STUK's opinion on all applications concerning NSG Part 1 items.

1.6 Control of nuclear material transport

The requirements for the transport of radioactive material are set in the Finnish regulations on the transport of dangerous goods. The requirements are based on the IAEA Safety Standard Regulations for the Safe Transport of Radioactive Material, SSR-6, and their purpose is to protect people, the environment and property from the harmful effects of radiation during the transport of radioactive material. Based on these regulations, STUK is the competent national authority for the regulatory control of the transport of radioactive material.

In addition to the dangerous goods transport regulations, the Finnish Nuclear Energy Act sets specific requirements for the transport of nuclear material and nuclear waste. Generally, a licence granted by STUK is needed for such transport. Usually, transport licences are granted for a fixed period, typically a few years. A transport plan and a transport security plan approved by STUK are mandatory for each consignment of nuclear material or nuclear waste. A certificate of nuclear liability insurance must also be delivered to STUK before transportation. Furthermore, a package may be used for the transport of fissile nuclear material only after the package design has been validated by STUK.

1.7 Nuclear safeguards and security strengthen each other

STUK is the national authority for the regulatory control of radiation and nuclear safety, security and safeguards (3S). All these three regimes have a common objective: the protection of people, society, the environment and future generations from the harmful effects of ionising radiation. As nuclear security aims to protect nuclear facilities' sensitive or classified information, nuclear material and other radioactive material from unlawful activities, it is clear that the majority of the activities that aim at the non-proliferation of nuclear weapons, nuclear materials and sensitive nuclear technology contribute to nuclear security. Physical and information security measures at nuclear facilities and for nuclear materials including technology, sensitive information and knowledge also contribute to non-proliferation by providing the deterrence, detection and delay of and response to nuclear security events. At the same time, nuclear material accountancy and detection measures may supplement security measures through a deterrence effect.

2 Safeguards activities in 2021

2.1 The regulatory control of nuclear materials

At the start of 2021, the previous 10 months had been an unforeseen challenge for the Finnish and international safeguards systems: first coping with the rapidly changing working environment due to the global pandemic, later adaptation to the circumstances and then focusing on carrying on work in the new normal. For the safeguards inspectors at STUK, 2021 was a year when new skills learned in 2020 were combined with the old routines. The inspection schedule returned to a more predictable form, although some postponements were made in non-urgent interim inspections. The inspectors kept mostly working from home and handled most of the paperwork remotely. STUK maintained its continuous efforts on enabling smooth access into Finland for international inspectors by having up-to-date details on entry conditions at the borders and informing the border guard about arriving inspectors. Ensuring safe visits to the nuclear power plants and other installations in Finland was also a target. This was achieved though active communication between STUK, the international inspectorates and the responsible persons at the installations who provided the protection measures and procedures against the spread of COVID-19 at the power plant or other site.

STUK fulfilled its inspection plan with some adjustments and finished the year with 71 inspection days and 41 inspections of material balance areas, sites and other operators. The number of inspection days was high due to verification campaigns with the PGET and PNAR equipment, which are counted as inspections, and design information verification inspections at the Posiva material balance areas. The number of inspections reached the general objective of 40 inspections per year. The inspection palette was again diverse with normal on-site inspections, remote inspections with videoconferencing and hybrid inspections where some participants were at the site and the rest joined in virtually from the office or from home.

Inventory reports and the following verification confirmed that nuclear materials remained in their intended peaceful use and under safeguards control. The accumulation of nuclear material at the facilities is shown in figures 3 and 4 and the verified nuclear material inventories at the end of 2021 are shown in tables A2 and A3 in Appendix 1.

The implementation of the IAEA's integrated safeguards since 2008 reduces the rate of routine inspections of the international inspectorates, but includes short-notice random inspections. In 2021, the number of international inspections returned to its expected level slightly above the long-term average. The number of international inspections is rising due to active design information verification work at Posiva's disposal construction site. In 2021, the IAEA launched six short-notice inspections in Finland. The inspections contained one short-notice random inspection (SNRI) each at Olkiluoto 1, Olkiluoto 3 and the Loviisa nuclear power plant. The IAEA and Commission performed a SNRI at the Finnish Defence Research Agency, which is a CAM member. It was the first SNRI at a CAM member in Finland. Complementary access inspections according to the Additional Protocol at VTT's Centre for Nuclear Safety and at Platom complete the list of short-notice inspections at Finnish installations in 2021. The development of inspections and inspection person-days at material balance areas is presented in Figures 5 and 6. Inspections by STUK, the IAEA and the European Commission in 2021 are presented in Appendix 2.

The IAEA and the Commission provided STUK with statements on inspection results and conclusions of safeguards implementation in 2021. In total, the statements included one required action. The action was still open at the end of 2021 but will be completed in the first half of 2022 when it is due. There were no outstanding questions from the IAEA or the Commission at the end of 2021. There were no indications of undeclared materials or activities, and the inspected materials and activities were in accordance with the operators' declarations.

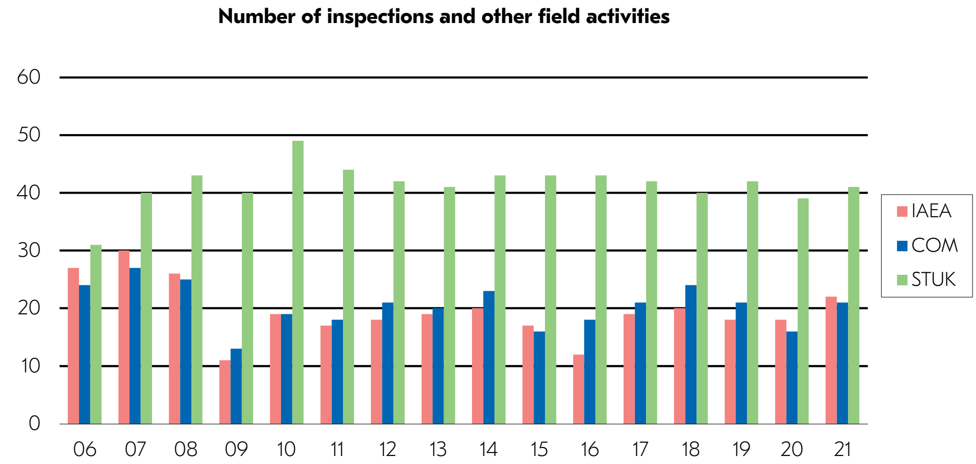


FIGURE 5. The number of inspections from 2006 to 2021.

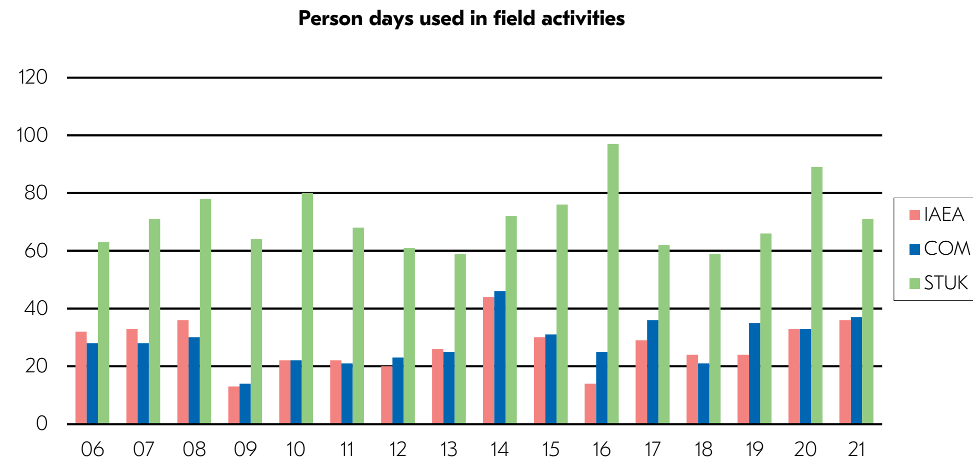


FIGURE 6. Inspection person days from 2006 to 2021.

Outside inspections, the number of live meetings between STUK and the international inspectorates remained low. Although travel restrictions were at least partially lifted, meetings and conferences were again either postponed or held virtually. Another trend was hybrid meetings where key participants would travel to the meeting location and supporting attendees would take part via videoconferencing. The implementation of safeguards in Finland was addressed at virtual meetings with the IAEA and the European Commission. During the IAEA General Conference in September 2021, Finnish delegates met with the IAEA and EC in a hybrid meeting in Vienna on the implementation of safeguards for final disposal of spent fuel. A trilateral meeting with representatives from the IAEA, the European Commission and STUK was held online in December. In addition to the inspection routines, STUK continued with two annual safeguards meetings with the major nuclear materials holders' safeguards responsible staff.

2.2 General safeguards activities

2.2.1 Additional Protocol declarations

In 2021, STUK compiled licence holders' reports using the PR3 software provided by the IAEA and submitted the annual updates for national declarations according to articles 2.a.(iii) and 2.a.(viii) on 30 March 2021, and the declarations according to articles 2.a.(i), 2.a.(iv), 2.a.(x) and 2.b.(i) on 14 May 2021. Furthermore, STUK submitted the quarterly declarations on exports that are due in February, May, August and December.

2.2.2 Approvals of new international inspectors

In 2021, a total of 11 Commission inspectors, newly appointed, were approved to perform inspections at nuclear facilities in Finland.

2.2.3 Nuclear dual-use items, export licences

In 2021, the Ministry for Foreign Affairs issued 21 export licences for NSG Part 1 items:
- 13 licences for exporting nuclear technology (technical data and training, category 0E001) to Russia (4 licences), Germany (3), Sweden (3), USA (1), the Netherlands (1) and Estonia (1).
- Seven licences to export software and relevant training (category 0D001) to the Germany (2), Russia (1), Hungary (1), China (1), USA (1) and Japan (1).
- One licence to export both software, nuclear technology and relevant training (categories 0D001 and 0E001) to China (1).

2.2.4 Transport of nuclear materials

In 2021, fresh nuclear fuel was imported to Finland from Spain, Germany, Sweden and the Russian Federation (Appendix 1, Table A1). In relation to these imports, STUK approved five transport plans and three transport packaging designs. There were no inspections of fresh nuclear fuel consignments in 2021.

2.2.5 International transfers of nuclear material

In 2021, TVO reported to STUK about its international fuel contracts, fuel transfers and fuel shipments. Based on the document inspection findings and on an audit of TVO's international nuclear material transfer accountancy and control carried out on 16 February 2022, STUK concluded that TVO had complied with its safeguards obligations when purchasing the nuclear fuel and managing its international nuclear material transfers. Other operators purchase fuel as an end-product, so their accountancy does not need to cover the purchase chain abroad.

2.3 Safeguards implementation at the operators

2.3.1 Loviisa nuclear power plant

In total, STUK performed 10 safeguards inspections at the Loviisa NPP in 2021. An NDA inspection with a PGET instrument was performed in November. The outage at the Loviisa 2 reactor unit took place during the period 23 August – 16 September and the outage at the Loviisa 1 reactor unit during the period 11–29 September. STUK, the IAEA and the Commission performed an inventory verification inspection prior to the physical inventory taking (pre-PIT) before the outages, on 11 August. The physical inventory verification after the outage (post-PIT) together with a design information verification (DIV) was carried out on 12–13 October. STUK identified the fuel assemblies in the reactor cores and item-counted the fuel assemblies in the loading ponds. The Loviisa 2 core was inspected on 31 August and the Loviisa 1 core on 19 September. A joint interim and site safeguards inspection was performed on 3 December 2021. In July 2021, a random interim inspection was carried out by the IAEA and Commission together.

On the basis of its own assessment and on the IAEA and Commission inspection results, STUK concluded that Fortum's Loviisa NPP complied with its nuclear safeguards obligations in 2021.

2.3.2 Olkiluoto nuclear power plant

In 2021 STUK granted TVO three import licences for fresh nuclear fuel for the two operating units and six licences to import non-fuel items.

The operating reactor units Olkiluoto 1 and 2 and the spent fuel storage of the Olkiluoto power plant were subject to 14 safeguards inspections in 2021, including safeguards-related technical activities. In addition, the accountancy of the uranium batches in TVO possession abroad was inspected in early 2022. In cooperation with the European Commission and the IAEA, STUK performed the inspections that comprise the physical inventory verification of the reactor units and the spent fuel storage, both before and after the annual outages, on 14-15 April and 29–30 June, respectively. STUK performed a core verification inspection of both reactor units before the reactor core lid was closed.

STUK took part in one random interim inspection at the Olkiluoto 1 unit initiated by the IAEA. STUK performed an interim safeguards inspection at both units and the spent fuel storage and a site declaration update verification inspection. STUK also carried out an NDA campaign with the PGET and PNAR equipment in July.

At the Olkiluoto 3 unit, a core verification inspection together with a physical inventory verification and design information verification inspection was carried out by the IAEA, EC and STUK on 1 April. The core was sealed by the IAEA and EC in July. STUK also took part in a random interim inspection carried out by the IAEA and EC in December. STUK received one special report from TVO. The report concerned the classification of components, which had been imported to be used at the Olkiluoto 3 unit as nuclear material. At the end of 2021, STUK was still processing the report.

Based on its own assessment and on the IAEA and Commission inspection results, STUK concluded that TVO's Olkiluoto NPP complied with its nuclear safeguards obligations in 2021.

2.3.2 The Hanhikivi nuclear power plant project

Currently, Fennovoima is an operator possessing nuclear information pursuant to Finnish nuclear energy legislation. During 2021, Fennovoima answered and fulfilled the requirements made by STUK on its inspection in November 2020. STUK also approved Fennovoima's nuclear materials responsible person and nuclear safeguards manual in 2021.

Fennovoima's project also involves a few other Finnish companies possessing nuclear information. The Finnish branch of the plant supplier, RAOS Project Oy, is the most important of these and participates in most of the meetings STUK has with Fennovoima's nuclear materials responsible persons. In December, RAOS Project sent a special report to STUK concerning the handling of classified documents. STUK approved a total of four nuclear safeguards manuals of companies involved in the Hanhikivi NPP project.

In 2021, STUK granted to different companies a total of four licences for the import, possession or transfer of nuclear information related to the Hanhikivi NPP project. Fennovoima and the other companies involved in the Hanhikivi project complied with their safeguards obligations in 2021.

2.3.4 VTT

At VTT Technical Research Centre of Finland, the preparations for the decommissioning of the research reactor FiR1 and associated activities continued. Research activities continue at the Centre for Nuclear Safety where operations had started in 2017 by moving small amounts of nuclear material used in the laboratories located in the reactor building.

STUK carried out an interim inspection at the Centre for Nuclear Safety in February. Based on its findings on the inspection, STUK required VTT to update its nuclear materials handbook. STUK approved the updated handbook in December. The Commission postponed its nuclear material inventory verification inspections of both of VTT's MBAs to September. The IAEA joined EC and STUK in the inspections. The inspection at the Centre for Nuclear Safety was performed successfully on 14 September. FiR1 was inspected the following day. In addition to the inventory verification, the inspectors verified the facilities that have been dismantled or are under decommissioning. Furthermore, the IAEA and EC carried out a complementary access inspection at the Centre for Nuclear Safety on 17 September. The inspectors examined a sample storage space and noted that it should be considered a hot cell under the Comprehensive Safeguards Agreement and the Additional Protocol. The BTC of the Centre for Nuclear Safety was updated in October 2021 to account for changes in responsible persons and to update the description of hot cells at the installation.

Based on its assessment and inspection results, STUK concluded that VTT complied with its nuclear safeguards obligations in 2021.

2.3.5 STUK

STUK's operating unit responsible for handling nuclear materials (MBA WFRS) complied with its reporting obligations in 2021. Inspections were postponed to early 2022 in order to observe the inventory before transfers to the Central interim storage for small-user radioactive waste in Olkiluoto and before STUK's move to new offices in Vantaa. It can be concluded that the operating unit at STUK fulfils the requirements for national safeguards arrangements.

2.3.6 University of Helsinki

STUK, EC and the IAEA carried out a safeguards inspection at the University of Helsinki on 16 September. The operator's bookkeeping practices had been improved since the previous inspection in 2019. However, technical details in reporting were still clarified with the Commission before and after the inspection, and the operator updated its nuclear material handbook accordingly in September. Besides, there were changes in the responsible personnel at the operator in early 2021 and, during the approval process, STUK focused both on the skills of the staff and their internal guidance documents.

On the basis of its assessment and inspection results, STUK concluded that the University of Helsinki complied with its nuclear safeguards obligations in 2021.

2.3.7 Minor nuclear material holders

In 2021, STUK inspected the annual and inventory change reports from the minor nuclear material holders. One holder gave up its inventory and ceased operations with nuclear materials. STUK approved two handbooks prepared by minor holders. Additionally, STUK took part in a random interim inspection carried out by the IAEA and EC at Finnish Defence Research Agency which is a CAM member.

On the basis of its assessment, STUK concluded that the minor nuclear material holders complied with their nuclear safeguards obligations in 2021.

2.3.8 Front-end fuel cycle operators

In 2021, Umicore Finland Oy made a contract to export uranium extracts to France, with the aim of getting rid of the uranium-containing material. The first consignments were sent in summer 2021. STUK inspected the loading of the second transport campaign in November 2021.

On the other hand, Umicore is planning to close its Belgian unit, and applied for a licence to possess and handle the uranium-feed material from Belgium at the Kokkola factory, because the current licence is valid only for the extracts. STUK granted a licence for the handling of the pre-process material in December 2021. The aim is that the uranium will end up in the waste stream and not to be extracted anymore.

At Norilsk Nickel Harjavalta Oy's plant in Harjavalta, the operating personnel changed, and STUK approved the deputy responsible manager. There were no exports nor authority inspections in 2021. The Harjavalta plant also aims to get rid of its uranium storage, but the application to return the Talvivaara-origin uranium to Terrafame was not endorsed by the Supreme Court, so the operator will have to report the extracts monthly in the future.

At both installations, the operators reported on their planned activities and monthly inventories according to safeguards requirements. On the basis of its assessment, STUK concluded that these operators complied with their nuclear safeguards obligations in 2021.

The metal processing industry was required to be licensed for its uranium-rich intermediate products in 2017 as described in Chapter 1.2. Following its obligations, the zinc and copper production unit of the Boliden company reported that it had processed 1,007 kg of natural uranium originating from zinc concentrates in 2021. The uranium ends up in waste streams during the processing. Dragon Mining reported 13.7 kg of uranium in its gold production at its Sastamala mineral processing unit originating mainly from the Jokisivu mine. The uranium, of source material grade, is not used in industrial processes. STUK concluded that these operators complied with their nuclear safeguards obligations in 2021.

In 2021, Terrafame continued its monthly reporting, which had been initiated in 2019 after storing the first uranium extracts. After the decision of the Supreme Administrative Court on 24 June 2021, the licence to build the uranium extraction plant was endorsed. STUK and European Commission inspected the mining site on 30 September. The IAEA joined the inspection with a technical visit. The IAEA was provided with a sample of the uranium extract to decide on the future safeguards activities. The holder of the new licence announced that there would be a feasibility study before investing on the plant development. According to licence decision, the plant must be commissioned within three years, i.e., at the latest in 2024. STUK concluded that Terrafame complied with its nuclear safeguards obligations in 2021.

2.3.9 The disposal facility for spent nuclear fuel

The construction of the encapsulation plant by Posiva has been proceeding according to plan. The roof wetting ceremony was held on 9 December 2021. At the geological repository, mainly the excavation of the central tunnels and the deposition tunnels in the deposition area continued. The construction works for the infrastructure of the technical premises involved a large workforce underground, even limiting daytime access for visitors. The construction areas were segregated to avoid or limit possible COVID-19 infections.

In 2021, three major technical meetings between the IAEA, the EC, STUK and Posiva were held remotely to finalise the technical details of the equipment selection, emplacement, and connections of safeguards equipment at the EP and GR. This work is almost finished and Posiva has implemented the equipment infrastructure requirements (EIR) in its construction drawings. Several almost monthly smaller technical meetings were also held on these issues between the four parties. This Safeguards-by-Design process can be expected to continue during the construction of the installations.

In November 2021, the IAEA and Commission carried out an extensive design information verification campaign to verify the underground premises constructed since the previous inspection in 2020. In addition, the status of the construction of the encapsulation plant was verified and the hoist and ventilations buildings with shaft connections underground were visited. During the inspection, a hybrid meeting between the IAEA, the EC, STUK and Posiva was arranged to focus on the future procedures and expected operator's advance declarations or notifications. This work will continue in 2022.

On the basis of its assessment and inspection results, STUK concluded that Posiva complied with its nuclear safeguards obligations in 2021.

2.3.10 Other operators

Research organisations and universities provided STUK with their annual declarations on research and development work. After its review, STUK prepared the annual declaration based on the Additional Protocol to the IAEA within the time limit of 15 May.

The IAEA carried out two Complementary Access inspections to verify the declarations. The first was on 17 September at the VTT site to, among other activities, verify the R&D work carried out at the site, mainly at the Centre for Nuclear Safety. The second was carried out at Platom Mikkeli office on 20 December to verify the answers provided to IAEA by STUK and Platom in 2020 concerning the exports of UF-6 sampling autoclaves in the past. In addition, research and development work related to UF6 handling was addressed.

3 Development work in 2021

3.1 Development of working practices

In STUK's current strategy period, which extends from 2018 to 2022, its activities as a regulator and expert organisation are guided by effectiveness. Methods for achieving this include risk-oriented commensurable oversight and flexible and efficient working methods. Increased emphasis on operator responsibility forms the basis of this strategy. The competence and well-being of STUK's personnel is seen as the foundation for reaching these objectives. In 2021, the Nuclear Materials Safeguards section of STUK maintained its pursuit of the strategic goals by developing the competencies of the inspectors and empowering the operators and licence holders to better take responsibility for their own safeguards control. This work will continue until the end of 2022.

The section consists of a section head, one researcher and seven inspectors who are responsible officers for the facilities, installations and other nuclear material or nuclear-related activities. Measures in inspector development include continuing job rotation and better handling workload by pivoting from a system based on responsible officers and deputies towards responsible officer pairs for facilities. The section has continued to take advantage of opportunities to learn from and teach national and international institutions and experts in webinars, training courses and conferences. Part of this approach is a contribution to the international multidisciplinary tasks supporting safeguards, safety and security. For STUK, each chance to present best practices and challenges from the Finnish national safeguards system is also a chance for introspection, finding recurring patterns in the system and reminding yourself of the past successes and failures.

In early 2020, one new inspector joined the section and, along with another newly appointed inspector, started undergoing a new training and mentoring programme to become responsible safeguards officers. Special arrangements with inspections and working from home due to COVID-19 restrictions again delayed the formal inspector training. In 2021, however, the new inspectors were working independently in their own responsibility areas, having grown into their roles through experience in the field and the office. All inspectors, new and old, continued strengthening their knowledge of the national nuclear legislation, international agreements and advancing development projects. Shared daily coffee breaks, section meetings every two weeks and virtual face-to-face discussions helped integrate new members into the section and keep the team spirit in the section at high levels.

The change in oversight and increased emphasis on operators' responsibility are aiming for increased trust and a culture in which operators accept the responsibility for safety and find and propose viable solutions for ensuring and improving safety. An up-to-date nuclear materials handbook as an integral part of the operator's quality management system, ensuring the availability of competent safeguards personnel in the operator's organisation, and understanding the benefits of efficient safeguards are key elements of success. STUK has encouraged the operators to find and implement best practices by, for example, taking an active part in international safeguards seminars and working groups. The major licence holders such as nuclear power plants with mature and well-functioning safeguards systems are motivated to keep improving even the smallest details and to take care of the continuity of know-how and competence of personnel. The safeguards meetings with the licence holders play a significant role in maintaining a working relationship between STUK and the licence holder and discussing ideas. Points of improvement and best practices are actively brought up by STUK during inspections.

In 2021, there were more and more meetings and pre-work for the new updated nuclear legislation. In this pre-phase, the preconditions for all use of nuclear energy in Finland have been thoroughly considered, i.e. fulfilment of the international obligations and national objectives to ensure that use of nuclear energy does not promote the proliferation of nuclear weapons and to underline that only peaceful use of nuclear energy is allowed. With this in mind, we need to develop our own expertise, make use of our experiences, be open to new ideas and develop the capacity to present the necessary requirements clearly and comprehensibly to all users of nuclear energy, both nuclear power plants and, for example, hospitals that use small amounts of nuclear material in their operations.

3.2 Support programme for the IAEA safeguards

The Finnish Support Programme for the IAEA Safeguards (FINSP) is financed by the Ministry for Foreign Affairs and coordinated by STUK. The objective of FINSP is to provide the IAEA with support in well-managed tasks related to the development of safeguards verification methods, safeguards concepts and IAEA inspector training. Some of the tasks are presented here, focusing on those that involved several members of the Nuclear Materials Safeguards section. More details on the support programme are available in the annual report describing FINSP activities, which can be found online at https://www.julkari.fi/handle/10024/144218.

In June, STUK held a virtual Training and Mentoring workshop for nine trainees from a scholarship programme at the IAEA. The workshop was the continuation of a similar workshop that was held in the previous year. STUK had received encouraging experiences and great feedback from the previous workshop, which enabled its experts to better focus on the subjects that might be of interest and importance for the trainees. The objective of the training remained the same: firstly, to share best practices from the Finnish SSAC with newcomers, and secondly to offer mentoring opportunities to the trainees. The training was held within the scope of the Support Programme. STUK expects to continue this kind of support in the future.

In November, two NDA training courses (Non-Destructive Assay) and one CIE course (Comprehensive Inspection Exercise) were held in Finland to support IAEA's training of inspectors. In the NDA training courses held in Loviisa NPP, inspectors were trained to use four different NDA verification instruments. For the first time, the PGET instrument was included in the course. The FINSP has been involved in the development of the PGET for 20 years. In the CIE course held in Olkiluoto NPP, new IAEA inspectors were trained in various safeguards inspection activities in an authentic power plant environment.

FIGURE 7. IAEA inspectors examining PGET results from an NDA training exercise at Loviisa spent fuel storage. Photo: Fortum.

3.3 Spent fuel disposal and GOSSER R&D project

The disposal of spent fuel requires that safety, data security and other security arrangements and the safeguards required to prevent the proliferation of nuclear weapons be properly implemented on a national level. For this purpose, STUK launched GOSSER (Geological Disposal Safeguards and Security) to finalise the Finnish concept of safeguarding the geological disposal of spent nuclear fuel in 2016. The first project period ended in 2018 and the final report was prepared to describe the national safeguards concept for spent fuel disposal in Finland. The continuation project covers the years 2019 – 2022.

According to the national safeguards concept prepared, it is proposed that all fuel be verified in a comprehensive manner with the available system comprising a PGET and PNAR (Passive Neutron Albedo Reactivity) verifier. The NDA concept and ownership are discussed with the EC and the IAEA. A principal agreement exists that the measurement data will be shared with all parties.

R&D of PGET and PNAR were continued in 2021. Two measurement campaigns were arranged in 2021. At Olkiluoto, in July 2021, PGET and PNAR measurements were done with the IAEA and EC. In November 2021, STUK performed a PGET measurement campaign in the Loviisa spent fuel storage. Both campaigns were successful. Multiple papers relating to NDA development were published and both verification systems were discussed at the joint INMM/ESARDA annual meeting (Virta et al., 2021, Tupasela et al., 2021).

Challenges of and proposed solutions to safeguards of spent fuel disposal, including the verification methods, were some of the main topics of a side event organised by Finland at the IAEA General Conference in September. The side event and accompanying white paper on the world's first spent fuel repository (Honkamaa et al., 2021) presented the process of establishing a comprehensive nuclear waste management framework in Finland and the arrangements necessary to fulfil the safety, security and safeguards requirements of spent fuel disposal. Finland and STUK have spearheaded the development of the regulatory process and verification methods for spent fuel disposal as the first country in the world to move forward with large-scale geological final disposal.

In terms of safety, security and safeguards (3S), STUK will verify that Posiva performs underground activities according to approved plans and STUK will utilise the same inspection effort to collect relevant information for all three S's. STUK is developing its internal processes in this regard. For its independent conclusions, STUK will make use of the information collected by its resident inspectors, the inspection programme and the operator's environmental and geoscientific monitoring networks. Examples of information most relevant to safeguards are data proving that the canisters have been placed undamaged in the correct positions as declared to STUK and data showing that backfilling and sealing have been done in the approved manner. In 2020, STUK also commissioned a study on the use of geophysical methods applied to site characterisation for safeguards purposes. The study consisting of an extensive literature survey on most relevant methods applied at proposed repository sites as well as those recently used at the Olkiluoto repository and in its vicinity was published in 2021 (Heikkinen, 2021).

3.4 International cooperation for Nuclear Non-Proliferation

The state's regulatory authority plays an important role in implementing safeguards on a national level and in contributing to and participating in international fora to share experiences and interact with other parties. Participating in international events with a suitable contribution is also the best training for safeguards inspectors. Resources are limited so the selection of the events is important.

International cooperation and events kept being affected by the COVID-19 pandemic in 2021. After a difficult first year in the situation, however, more and more events were successfully held virtually in videoconferencing. Nevertheless, some events were still postponed to a later date.

International organisations ESARDA and INMM

STUK is a member of the European Safeguards Research and Development Association (ESARDA) and has appointed experts to its committees and most of the working groups. STUK is a board member of the ESARDA Executive Board and the Editorial Committee. At the end of 2021, a STUK expert was the Chair of the Export Control Working Group and another the Vice Chair of the Implementation of Safeguards Working Group. ESARDA's annual meeting was held for the first time as a joint annual meeting of ESARDA and the Institute of Nuclear Materials Management (INMM) virtually from August 23 to September 1. STUK's experts contributed to the meeting with several presentations and papers (see references) and in panel discussions. ESARDA WGs also convened virtually in November to discuss current topics more precisely.

Co-operation with other state authorities

STUK and the Belgian nuclear safety authority FANC organised a two-day workshop with the IAEA and EC on the Safeguards by Design (SBD) concept in April. The workshop and related cooperation fall within the scope of the Implementation of Safeguards Working Group but are organised separately. In short, Safeguards by Design is an approach wherein international safeguards are considered early in any design process of a nuclear facility. In a broader sense, it is awareness of the impact and importance of safeguards in the nuclear operator, designer and authority communities. Based on the findings of the workshop, Finnish and Belgian experiences with the implementation of safeguards in nuclear projects and further discussions between their experts, STUK and FANC prepared a white paper on the benefits and possible further improvement of the implementation of the SBD concept (M'Rad Dali et al., 2021). The paper was presented at a side event on SBD at the IAEA General Conference in September and published in the ESARDA Connector journal.

Together with Swedish authority SSM, STUK also organised an annual bilateral SG meeting in January 2021. At this meeting, current SG topics such as the current status of safeguards implementation in spent fuel disposal projects were presented and discussed. Due to COVID-19, it was not possible to meet in person, but on the other hand, organising the meeting virtually made it easier to participate and contribute with all the Nuclear Materials Safeguards section staff.

Services for authorities abroad

Two EU-funded projects were launched in 2016 to support the nuclear regulators in Vietnam and Tanzania as these countries are aiming at nuclear power and uranium mining, respectively. The kick-off meetings were held in 2016 and the cooperation was scheduled to continue for at least 2–3 years. The project to support the regulator in Vietnam was finalised in 2019. After the nuclear regulator of Tanzania (TAEC) published its safeguards regulation in 2019, the safeguards-related tasks of that project were finalised at the beginning of 2020 before the pandemic lockdown. The remaining issues concerning the licencing of uranium production and transport were discussed in remote workshops in early 2021. The project was finalised in the spring of 2021.

STUK together with the US Department of Energy National Nuclear Security Administration (NNSA) organised a virtual Middle East regional workshop on international nuclear safeguards best practices in January. The workshop was aimed at officials and experts responsible for implementing international safeguards within their country or facility in the Middle East or North Africa. The objective of the workshop was to build expertise and discuss best practices and experiences in setting up and developing a national safeguards system. STUK's experts especially contributed by providing insight into building and maintaining the SSAC and by promoting efficient communication within the national system.

In March, STUK took part in a virtual seminar on building resilience in safeguards implementation as an expert organisation. The participants of the seminar represented state safeguards authorities from the Asia and Oceania regions. The seminar focused on experiences, lessons and good practices in preparing for unforeseen events, not least coping with the challenges posed by the rapid change of the operating environment caused by the COVID-19 pandemic. STUK contributed with presentations and expert opinions and feedback in panel discussions.

NPT Preparatory Committee

The Non-Proliferation Treaty entered into force in 1970. The NPT Treaty includes more than 190 countries around the world. The Treaty Review Conference is held every five years, the previous one in 2015. The next conference was planned to be held in 2020 but was postponed first to 2021 and later to 2022 due to the COVID-19 pandemic. Before the Review Conference, preparatory meetings will be held. Preparations for a strong Finnish presence at the conference and its side events are well under way.

NSG – Nuclear Suppliers Group

The Nuclear Suppliers Group (NSG) is a multilateral export control regime and a group of nuclear supplier countries that seek to prevent nuclear proliferation by controlling the export of materials, equipment and technology that can be used to manufacture nuclear weapons. It has 48 participating governments. Finland is represented in the NSG forum by the Ministry for Foreign Affairs. NSG meetings were again cancelled due to the pandemic.

GICNT – Global Initiative to Combat Nuclear Terrorism

Nuclear Security activities often include cooperation between multiple authorities. Nuclear Security also has a strong international aspect. The Global Initiative to Combat Nuclear Terrorism, GICNT, established in 2006, is one of the most important international fora for nuclear security. Currently 89 states and six international organisations participate in the work of GICNT. Member states' nuclear security capabilities and cooperation are developed, for example by holding exercises. In 2021, Finland served on GICNT's Leadership Team and as interim chair of its Nuclear Detection Working Group. The Finnish Ministry for Foreign Affairs coordinated Finland's GICNT activities and STUK served as the ministry's technical advisor.

IPNDV – International Partnership for Nuclear Disarmament Verification

The International Partnership for Nuclear Disarmament Verification (IPNDV) was established on the initiative of the United States in 2014. The other participants of IPNDV come from both nuclear and non-nuclear weapon states. A third phase of IPNDV started at the beginning of 2020. The IPNDV develops methods and procedures for the verification of nuclear disarmament. Finland has been participating in the IPNDV since its inception. STUK's tasks in IPNDV have always been connected to the development of technological verification methods. In 2021, among other things, Finland contributed to the report made from the Belgium measurement campaign.

For more information on GICNT and IPNDV, please see the annual report on FINSP, GICNT and IPNDV initiatives available online at https://www.julkari.fi/handle/10024/144218.

4 National Data Centre for the Comprehensive Nuclear-Test-Ban Treaty (FiNDC)

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is an important part of the international regime for the non-proliferation of nuclear weapons. The CTBT bans any nuclear test explosions in any environment. This ban is aimed at constraining the development and the qualitative improvement of nuclear weapons, including the development of new advanced types of nuclear weapons.

The CTBT was adopted by the United Nations General Assembly and was opened for signature in New York on 24 September 1996. It will enter into force after it has been ratified by the 44 states listed in its Annex 2. These 44 states participated in the 1996 session of the Conference on Disarmament and possess nuclear power or research reactors.

A global verification regime is being established in order to monitor compliance with the CTBT. The verification regime consists of the following elements: the International Monitoring System (IMS), a consultation and clarification process, on-site inspections and confidence-building measures. The Provisional Technical Secretariat (PTS) of the CTBT Organisation (CTBTO) is co-located with the IAEA in the Vienna International Centre (VIC). The IMS is more than 90% ready with 312 out of 337 stations installed at the end of 2021. The worldwide station network provides data access to more than 140 countries through the International Data Centre (IDC) run by the PTS in Vienna. In addition to monitoring compliance with the treaty, the data from the IMS is used in disaster mitigation. The CTBTO actively provides data to the global Tsunami Warning System and, since 2012, the CTBTO has been a member of the Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE) and a co-sponsor of the Joint Radiation Emergency Management Plan of the International Organisations (JPLAN) led by the IAEA. Within this framework, the CTBTO is responsible for gathering and providing close-to-real-time radionuclide monitoring data to the IAEA and other participating organisations.

Finland signed the CTBT on its inaugural day in 1996 and ratified it less than three years later. In addition to complying with the basic requirement of the CTBT of not carrying out any nuclear weapons tests, Finland actively takes part in the development of the verification regime.

In the CTBT framework, the Finnish national authority is the Ministry for Foreign Affairs. STUK has two roles: it operates the Finnish National Data Centre (FiNDC) and one of the 16 radionuclide laboratories in the IMS (RL07). The most important task of the FiNDC is to inspect data received from IMS and inform the national authority about any indications of a nuclear test explosion. The radionuclide laboratory contributes to the IMS by providing

Comprehensive Nuclear-Test-Ban Treaty (CTBT) Status (31 December 2021). In 2020, no new countries signed or ratified the treaty

- **CTBT Member States 185**
- **Total Ratifications 170**
- **Annex 2 Ratifications 36**

support in radionuclide analyses and in quality control of the radionuclide station network. The third major national collaborator is the Institute of Seismology at the University of Helsinki, which runs an IMS seismology station (PS17 in Sysmä) and provides interpretation of waveform events in the IMS system.

4.1 International cooperation the foundation of CTBT verification

Before the opening of the CTBT in 1996, the world had seen more than 2,000 nuclear tests. In the more than 20 years since then, there have been only eight, six of which were by the DPRK. Since 2017, no activities pointing to clandestine nuclear testing have been detected by the network or otherwise. This is a strong indicator of the de facto strength of the treaty that has yet to come into force.

The continuation of the COVID-19 pandemic made 2021 another abnormal year for any international cooperation. The twice-per-year meetings of Working Group B (WGB) were still shortened and fully remote and produced only procedural reports. This mode of meeting has greatly hampered the possibilities for the WGB to fulfil its tasks as the technical working group of the Preparatory Commission. In the autumn, the CTBT arranged remote workshops where FiNDC also participated actively. By participating in the work of WGB and its subsidiaries (workshops and expert groups), the FiNDC can provide technical expertise to the CTBTO, while also attending to Finnish national interests.

4.2 The analysis pipeline a well-established daily routine

During 2021, the PTS still had to work in remote mode for extensive periods of time, and so did FiNDC. Visits to IMS stations by PTS staff have also been limited during 2021. Even with most people working remotely, however, the data flow from the IMS to the FiNDC has been steady. The FiNDC routinely analyses all radionuclide measurement data generated at IMS radionuclide stations across the world. The analysis pipeline for the air filter monitoring data is linked to the LINSSI database and equipped with an automated alarm system to enable efficient and fully automated screening of the data. In 2021, FiNDC and the Finnish laboratory started preparations to move their servers and the data link from Vienna to the Finnish governmental IT provider VALTORI. Radioxenon measurements are especially important for CTBT verification because xenon, as a noble gas, may also leak from underground tests, which seldom release particulate matter. The CTBT is in the process of updating its IMS xenon measurement systems to new technologies. The IDC has also developed new and well-functioning tools to analyse xenon measurement data from these new systems and is providing these tools to interested NDCs. FiNDC started the process of migrating its xenon data analysis capabilities to the systems provided by the NDC. The operational stations generated more than 1,000 gamma and beta-gamma spectra per day for the FiNDC analysis pipeline to handle. The pipeline is well-established and has been running stably for many years.

Xenon radioisotopes released from medical isotope production facilities and NPPs are regularly measured all around the globe. Anthropogenic nuclides with CTBT relevance, mainly ^{99}Tc, 131I from medical isotope production and ^{137}Cs from the Chernobyl and Fukushima fallouts, are regularly measured at some particulate stations.

5 Summary

In 2021, STUK continued its regulatory authority role in the Finnish SSAC. It supervised the use of nuclear materials, regulated the operators' activities and verified that the obligations of international agreements concerning the peaceful use of nuclear materials and activities were met. Most of the practical work comprised reviewing operator applications, reports and notifications, but also carrying out periodical and ad hoc inspections for safeguards purposes. STUK prepared the national reports according to the safeguards agreement and its additional protocol. These activities, alongside continuously parallel development activities and international cooperation in the fields of safeguards and non-proliferation, are described in this report.

The Nuclear Materials Safeguards section of STUK had adapted to the rapidly changing working environment in the previous year and, in 2021, was able to efficiently carry out its duties in the new normal. Whereas in 2020 the pandemic had resulted in the postponement or even cancellation of events and non-urgent inspections, in 2021 more and more could be held remotely, virtually or in a hybrid form with on-site and remote participants. STUK also continued its cooperation with the IAEA, European Commission and Finnish stakeholders and other government institutions to keep developing nuclear safeguards in Finland. Fine examples of continuing development work amid the restrictions are the fuel verification campaigns using the PGET and PNAR equipment at the Finnish nuclear power plants and the steadily advancing development of safeguards for the world's first spent fuel repository in Olkiluoto.

STUK's personnel continued to mostly work from home. The section addressed challenges related to remote work with regular virtual video meetings. As a result, office work, including reviewing reports and issuing licences, was again little affected by the circumstances.

In the field, STUK continued with national safeguards measures and activities on 71 inspection days and in 41 inspections. Since 2010, the number of annual IAEA and European Commission inspections has been around 20. Active preparations for final disposal keep the number of international inspections at a higher level than the short-term average. The implementation of the IAEA integrated safeguards since 2008 in force in Finland reduces the total number of annual routine inspections of the international inspectorates but includes short-notice random inspections. The Nuclear Materials Safeguards section has an inspector on duty for short-notice inspections.

As usual, the majority of safeguards inspections in 2021 were carried out on the material balance areas of the Finnish nuclear power plants (NPP), 10 at Loviisa NPP and 18 at Olkiluoto NPP. The number of short-notice inspections according to the IAEA state-level approach for Finland was higher than usual: one short-notice random inspection was carried out at Olkiluoto 1, another at Olkiluoto 3 and one also at Loviisa. A random inspection was also performed at the Finnish Defence Research Agency which is a CAM member. Such an inspection was the first of its kind at CAM members in Finland, and the first international inspection of a CAM member since the late 1990s. Additionally, a complementary access was performed at VTT's Centre for Nuclear Safety and at Platom. STUK performed one non-destructive assay measurement campaign at both NPPs. Given that final disposal of nuclear fuel is one of the most pressing issues in safeguards and will continue to be in the near future, inspection activity at Posiva in Olkiluoto was high with four inspections and 12 inspection days by STUK. STUK performed an interim inspection at VTT Centre for Nuclear Safety in February. The accountancy inspections and physical inventory verifications at the VTT Research Reactor FiR1 and Centre for Nuclear Safety that were postponed from 2020 to 2021 were performed in September. After a remote inspection in 2020, the accountancy inspection at the University of Helsinki was carried out on site.

The results of STUK's nuclear safeguards inspection activities continued to demonstrate that the Finnish licence holders take good care of their nuclear materials, even when facing challenges caused by a continuing global health crisis. The inspected materials and activities were in accordance with the operators' declarations. Questions regarding the operators' declarations were resolved. In their statements on inspection results and the conclusion of safeguards implementation in 2021, the IAEA and European Commission required one action from a Finnish operator. The action was still open at the end of 2021 but will be completed in the first half of 2022 when it is due. By means of their nuclear materials accountancy and control systems, the operators enabled Finland to fulfil its own obligations under the international agreements relevant to nuclear safeguards and non-proliferation.

Safeguards development work continued at STUK in 2021. The main development project is the GOSSER project whose current and second phase will continue until 2022. In the current phase of the project, the development of the practical safeguards implementation of the national safeguards concept for the spent fuel disposal is the ultimate target. The project continued with successful measurement campaigns and other R&D work. The Nuclear Materials Safeguards section continued developing the competences and maintaining the workload of its inspectors in the challenging environment of pandemic restrictions. Likewise, the operators were encouraged to ensure the competences of their responsible persons and maintain effective internal safeguards systems. The work to update the Finnish nuclear legislation picked up in 2021 and will require STUK's safeguards staff members to further develop their expertise and be open to new ideas.

A major goal of all current Comprehensive Nuclear-Test-Ban Treaty (CTBT)-related activities is the entry into force of the CTBT itself. To reach this goal, major steps must be taken in the political arena, and an important prerequisite for positive political action is for the verification system of the CTBTO to be functioning and able to assure all parties that it is impossible to carry out a clandestine nuclear test without detection. The FiNDC is committed to its own role in the common endeavour so that the verification system of the CTBTO can accomplish its detection task. While still incomplete, the verification system has clearly demonstrated its ability to detect nuclear tests.

The outcome of the supervision and activities carried out in 2021 is that implementation of nuclear non-proliferation in Finland has achieved its objectives.

6 Publications

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7 Abbreviations and acronyms

AP
: Additional Protocol to the Safeguards Agreement

BTC
: Basic Technical Characteristics

CA
: Complementary Access

CTBT
: Comprehensive Nuclear-Test-Ban Treaty

CTBTO
: Comprehensive Nuclear-Test-Ban Treaty Organization

CV
: Verification of fuel in the reactor core

DiP
: Decision-in-Principle

DIV
: Design Information Verification

DPRK
: Democratic People's Republic of Korea

DU
: Depleted uranium

EC
: European Commission

EIR
: Equipment Infrastructure Requirements

EP
: Encapsulation Plant

ESARDA
: European Safeguards Research and Development Association

EU
: European Union

Euratom
: European Atomic Energy Community

FA
: (1) Facility Attachment according to the Safeguards Agreement (INFCIRC/193), (2) Fuel Assembly

FiNDC
: Finnish National Data Centre for the CTBT

FINSP
: Finnish Support Programme to the IAEA Safeguards

FiR1
: Shutdown TRIGA Mark II type research reactor under the responsibility of VTT in Espoo, Finland

GICNT

Global Initiative for Combating Nuclear Terrorism

GR

Geological Repository

HEU

High-enriched uranium, 20% or more of U-235

IAEA

International Atomic Energy Agency

IMS

International Monitoring System of the CTBTO

INFCIRC

Information Circular (IAEA document type, e.g. INFCIRC/193, Safeguards Agreement, or INFCIRC/140, the Non-Proliferation Treaty)

INMM

Institute of Nuclear Materials Management

IPNDV

International Partnership for Nuclear Disarmament Verification

IS

Integrated Safeguards

KTO

STUK's periodic inspection programme for facilities in operation

LEU

Low-enriched uranium, less than 20% of U-235

LINSSI

An SQL database for gamma-ray spectrometry

LOF

Location Outside Facilities

LUT

Lappeenranta-Lahti University of Technology

MBA

Material Balance Area

MEAE

Ministry of Economic Affairs and Employment

MFA

Ministry for Foreign Affairs

NDA

Non-Destructive Assay

NPP

Nuclear Power Plant

NPT

The Treaty on the Non-proliferation of Nuclear Weapons (INFCIRC/140, "Non-Proliferation Treaty")

NSG

Nuclear Suppliers' Group

OECD

Organisation for Economic Co-operation and Development

ONKALO®

Originally underground rock characterisation facility (for the disposal of spent nuclear fuel), now officially the whole underground final disposal facility

PGET

Passive Gamma Emission Tomography

PIT

Physical Inventory Taking

PIV

Physical Inventory Verification

PNAR

Passive Neutron Albedo Reactivity

PSP

Particular Safeguards Provisions

PTS

Provisional Technical Secretariat (to the Preparatory Commission of the CTBT)

Pu

Plutonium

RII

Random Interim Inspection

RKT

STUK's inspection programme relating to the review of the construction licence application

RL07

Radionuclide Laboratory in the CTBT IMS network hosted by STUK (FIL07)

RTO

STUK's construction inspection programme (CIP)

SA

Subsidiary Arrangements

SAFKA

STUK's internal nuclear material database

SBD

Safeguards by Design, a concept of early adoption of international safeguards in nuclear projects and awareness of safeguards in the nuclear community

SMR

Small Modular Reactor

SNRI

Short Notice Random Inspection

SNUICA

Short notice and unannounced inspections and complementary access, on-call inspector

SSAC

State system of accounting for and control of nuclear material

Th

Thorium

TVO

Teollisuuden Voima Oyj

U

Uranium

UI

Unannounced Inspection

VTT

VTT Technical Research Centre of Finland Ltd

WGB

Working Group B (of the CTBTO)

YVL Guide

Regulatory Guide on Nuclear Safety (STUK requirements on safety, security and safeguards, in Finnish Ydinvoimalaitosohje)

APPENDIX 1
Nuclear materials in Finland 2021

TABLE A1. Summary of fresh nuclear fuel receipts in 2021.

To	From	FA	LEU (kg)
Olkiluoto 1, WOL1	Spain	100	18 047
Olkiluoto 2, WOL2	Sweden	100	17 517
Olkiluoto 3, WOL3	Germany	80	42 670
Loviisa NPP, WLOV	Russian Federation	168	21 033

FA = fuel assembly; LEU = low-enriched uranium.

TABLE A2. Fuel assemblies on 31 December 2021

MBA	FA/SFA *)	LEU (kg)	Pu (kg)
Olkiluoto 1, WOL1	1 259/673	214 361	1 093
Olkiluoto 2, WOL2	1 256/696	211 165	1 091
Olkiluoto 3, WOL3	245/0	130 784	0
Olkiluoto, spent fuel storage, WOLS	8 155/8 155	1 372 253	11 757
Loviisa NPP, WLOV	6 639/5 869	773 571	7 493

MBA = material balance area, FA = fuel assembly, SFA = spent fuel assembly
*) Fuel assemblies (FA) in the core are accounted as fresh fuel assemblies
(Loviisa NPP 313 FAs per reactor and Olkiluoto NPP 500 FAs per reactor in units 1 and 2 and 241 FAs in unit 3)

TABLE A3. Total amounts of nuclear materials on 31 December 2021

MBA	Natural U (kg)	Enriched U* (kg)	Depleted U (kg)	Plutonium (kg)	Thorium (kg)
WOL1	–	210 812	–	1 069	–
WOL2	–	214 404	–	1 116	–
WOL3	–	173 455	10.5	–	–
WOLS	–	1 406 151	–	12 086	–
WLOV	–	793 307	–	7 735	–
WRRF	92.8	6.28	0.005	< 0.001	–
WNSC	0.407	2.23	0.019	< 0.001	0.045
WHEL	2.34	0.293	0.004	0.002	1.08
WFRS	346	0.537	209	< 0.001	3.47
WTAL	1.36	–	–	–	–
WKKO	1 100	–	–	–	–
WNNH	3 588	–	–	–	–
Minor holders	0.209	< 0.001	631	< 0.001	0.263

MBA = material balance area, WRRF = VTT Research Reactor, WNSC = VTT Centre for Nuclear Safety, WHEL = University of Helsinki, WFRS = STUK, WTAL = Terrafame Oy in Sotkamo, WKKO = Umicore Finland Oy in Kokkola, WNNH = Norilsk Nickel Harjavalta Oy, U = uranium. *) Less than 150 g total of high-enriched uranium, mainly used in detectors.

APPENDIX 2
Safeguards field activities in 2021

			Inspections			Inspection person days		
MBA/operator	**Date**	**Inspection type**	**IAEA**	**COM**	**STUK**	**IAEA**	**COM**	**STUK**
TVO	22.1.	International NM transfers			1			2
WOL1	17.2.	RII	1	1	1	1	1	1
WNSC	19.2.	Interim			1			2
WOL3	1.4.	CV, PIV, DIV	1	1	1	1	1	1
WOL1, WOL2	14.–15.4.	Pre-PIT PIV	2	2	2	2	2	2
WOL1	8.5.	OL1 CV			1			1
WLOV	26.5.	System inspection (KTO) with security inspection			1			2
WOL2	12.6.	OL2 CV			1			1
WOL1, WOL2, WOLS, WOL3	29.6.–1.7.	Post-PIT PIV, DIV (WOL1, WOL2 and WOLS) and seals (WOL3)	4	4	4	4	4	4
WOLS	26.–30.7.	Verification (PGET and PNAR)			1			8
WOLS	27.7.	Technical activities, site survey	1		1	1		1
WLOV	29.7.	RII	1	1	1	1	1	2
WOLE, WOLF	30.7.	Technical activities, site survey	1	1	1	1	1	1
WLOV	11.8.	Pre-PIT PIV	1	1	1	1	1	1
WLOV	31.8.	LO2 CV			1			1
WNSC	14.9.	PIV		1	1		1	1
WRRF	15.9.	PIV, DIV	1	1	1	2	1	2
WHEL	16.9.	PIV	1	1	1	2	1	2
WNSC	17.9.	CA	1	1	1	2	1	1
WLOV	19.9.	LO1 CV			1			1
Finnish Defence Research Agency, CAM SF0410CA	29.9.	RII	1	1	1	1	1	1
WTAL	30.9.	PIV, DIV	1	1	1	2	1	2
WLOV	12.–13.10.	Post-PIT PIV, DIV	1	1	1	2	4	2
WKKO	4.11.	PIV			1			1
WLOV	8.11.	Verification (PGET)			1			1
WOLE, WOLF	16.–19.11.	DIV, site	2	2	3	10	15	11
WOL1, WOL2, WOLS	25.11.	Interim inspection, site			4			4
WLOV	2.–3.12.	System inspection (KTO)			1			6
WLOV	3.12.	Interim inspection, site			2			4
WOL3	8.12.	RII	1	1	1	1	1	1
Platom	20.12.	CA	1		1	2		1
Total			22	21	41	36	37	71

APPENDIX 3
International agreements relevant to nuclear safeguards in Finland

Valid legislation, treaties and agreements concerning safeguards of nuclear materials and other nuclear items in Finland (Finnish Treaty Series, FTS):

Treaties and international organisations to which Finland is a party:

Treaty on the Non-proliferation of Nuclear Weapons; adopted in London, Moscow and Washington on 1 July 1968 (1970), INFCIRC/140 (FTS 11/70).

The Treaty establishing the European Atomic Energy Community (Euratom Treaty), 25 March 1957:

- Regulation No 5, amendment of the list in Attachment VI, 22 December 1958
- Regulation No 9, article 197, point 4 of the Euratom Treaty, on determining concentrations of ores, 2 February 1960.

The Comprehensive Nuclear-Test-Ban Treaty (FTS 15/2001). This treaty was ratified by Finland on January 15, 1999 but will not enter into force before it is ratified by all 44 states listed in Annex II of the Treaty.

International Atomic Energy Agency (since 1958).

Nuclear Energy Agency of the OECD (since 1976).

International Energy Agency (since 1992).

Safeguards Agreements based on Non-Proliferation Treaty:

The Agreement with the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, the Republic of Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of Netherlands, the European Atomic Energy Community and the International Atomic Energy Agency in Implementation of Article III, (1) and (4) of the Treaty on Non-Proliferation of Nuclear Weapons (INFCIRC/193), 14 September 1973. Valid for Finland from 1 October 1995.

The Protocol Additional to the Agreement between the Republic of Austria, the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, the Hellenic Republic, the Republic of Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of Netherlands, the Portuguese Republic, the Kingdom of Spain, the Kingdom of Sweden, the European Atomic Energy Community and the International Atomic Energy Agency in Implementation of Article iii, (1) and (4) of the Treaty on Non-Proliferation of Nuclear Weapons, 22 September 1998. Entered into force on 30 April 2004.

Finland is a party to the following international conventions among others (the year when the convention entered into force for Finland is given in brackets):

Convention on the Physical Protection of Nuclear Material; opened for signature in Vienna and New York on 3 March 1980 (1989).

Amendment to the Convention on the Physical Protection of Nuclear Material; as amended on 8 July 2005 (2016).

Convention on Early Notification of a Nuclear Accident; opened for signature in Vienna on 26 September 1986 (1987).

Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; opened for signature in Vienna on 26 September 1986 (1990).

Convention on Third Party Liability in the Field of Nuclear Energy; adopted in Paris on 29 July 1960 (1972).

Convention Supplementary to the Paris Convention of 29 July 1960 on Third Party Liability in the Field of Nuclear Energy; adopted in Brussels on 31 January 1963 (1977).

Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material; adopted in Brussels on 17 December 1971 (1991).

The 1988 Joint Protocol Relating to the Application of the Paris Convention and the Vienna Convention; adopted in Vienna on 21 September 1988 (1995).

Convention on Nuclear Safety; opened for signature in Vienna on 20 September 1994 (1996).

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, adopted on 29 September 1997 in Vienna (2001).

Nordic Mutual Emergency Assistance Agreement in Connection with Radiation Accidents; adopted in Vienna on 17 October 1963 (1965) Agreement on common Nordic guidelines on communications concerning the siting of nuclear installations in border areas; adopted on 15 November1976 (1976).

The Agreement between Finland and Sweden on the guidelines to be followed while exporting nuclear material, technology or equipment, 4 March 1983 (FTS 20/1983).

Agreements relating to early notification of nuclear events and exchange of information on safety of nuclear facilities with Denmark (1987), Norway (1987), Sweden (1987), Germany (1993), the Russian Federation (1996) and Ukraine (1996).

Convention on Environmental Impact Assessments in a Transboundary Context (Espoo, 1991).

As of 1 January 1995, Finland has been a member of the European Atomic Energy Community (EAEC or Euratom). Consequently, the following agreements are applied in Finland:

The Agreement between the Government of Republic of Finland and the Government of Canada and Canada concerning the uses of nuclear materials, equipment, facilities and information transferred between Finland and Canada (FTS 43/76). Substituted to the appropriate extent by the Agreement with the Government of Canada and the European Atomic Energy Community (Euratom) in the peaceful Uses of Atomic Energy, 6 October 1959, as amended.

The Agreement between the Government of Republic of Finland and the Government of Australia concerning the transfer of nuclear material between Finland and Australia (FTS2/80). Substituted to the appropriate extent by the Agreement between the Government of Australia and the European Atomic Energy Community ty concerning transfer of nuclear material from Australia to the European Atomic Energy Community, 21 September 1981.

The Agreement for Cooperation with the Government of the Republic of Finland and the Government of the United States concerning Peaceful Uses of Nuclear Energy (FTS 37/92). Substituted to the appropriate extent by the Agreement for Cooperation in the Peaceful Uses of Nuclear Energy with European Atomic Energy Community and the USA, 12 April 1996.

The Agreement for Cooperation in the Peaceful Uses of Nuclear Energy Between the European Atomic Energy Community and the Government of Japan, 27 February 2006.

The Agreement Between the European Atomic Energy Community and the Cabinet of Ministers of Ukraine for Cooperation in the Peaceful Uses of Nuclear Energy, 28 April 2005.

The Agreement for Cooperation in the Peaceful Uses of Nuclear Energy Between the European Atomic Energy Community and the Government of the Republic of Kazakhstan, 4 December 2006.

The Agreement for cooperation in the peaceful uses of nuclear energy between the European Atomic Energy Community (Euratom) and the Government of the Republic of Uzbekistan, 21.10.2003.

The Agreement for cooperation in the peaceful uses of nuclear energy between the European Atomic Energy Community (Euratom) and the Government of the Argentine Republic, 30.10.1997.

The Agreement between the Government of the Republic of South Africa and the European Atomic Energy Community (Euratom) for Cooperation in the Peaceful Uses of Nuclear Energy, 31.7.2013.

The Agreement between the European Atomic Energy Community (Euratom) and the Government of the United States of Brazil for cooperation concerning the peaceful uses of atomic energy, 24.6.1965.

Bilateral Safeguards Agreements made by Finland:

The Agreement between the Government of the Republic of Korea and the Government of the Republic of Finland for Cooperation in the Peaceful Uses of Atomic Energy, entered into force on 1.1.2015 (FTS 5/2015).

The Agreement with the Government of the Russian Federation and the Government of the Republic of Finland for Cooperation in the Peaceful Uses of Atomic Energy, entered into force on 6.4.2015 (FTS 32/2015).

The Agreement on Cooperation in the Field of Peaceful Uses of Atomic Energy Between the Government of the Kingdom of Saudi Arabia and the Government of the Republic of Finland, entered into force on 3.6.2017 (FTS 48/2017).

The Agreement with the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the Republic of Finland for Co-operation in the Peaceful Uses of Atomic Energy (FTS 16/69). Articles I, II, III and X expired on 20 February 1999.

The Agreement with the Government of the Russian Federation (the Soviet Union signed) and the Government of the Republic of Finland for Co-operation in the Peaceful Uses of Atomic Energy (FTS 39/69). Articles 1, 2, 3 and 11 expired on 1.12.2004.

The Agreement between the Government of the Kingdom of Sweden and the Government of the Republic of Finland for Co-operation in the Peaceful Uses of Atomic Energy 580/70 (FTS 41/70). Articles 1, 2 and 3 expired on 5.9.2000.

The Agreement on implementation of the Agreement with Finland and Canada concerning the uses of nuclear materials, equipment, facilities and information transferred between Finland and Canada (FTS 43/84).

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