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Regulatory oversight of nuclear safety in Finland

Annual report 2022

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Introduction

This report is the Radiation and Nuclear Safety Authority's (STUK) account to the Ministry of Economic Affairs and Employment (MEAE) of regulatory oversight in the field of nuclear energy, to be supplied once a year under Section 121 of the Nuclear Energy Decree (161/1988). The report is also provided to the Ministry of Social Affairs and Health, the Ministry of the Environment, the Finnish Environment Institute and the environmental authorities of the municipalities where the relevant nuclear facilities are located.

The report is an overview of the regulatory oversight of nuclear safety carried out by STUK, and of the results of this oversight, in 2022. The nuclear safety oversight by STUK discussed in this report covers the essential oversight data that relate to design, construction, commissioning preparation, operation and decommissioning planning with regard to nuclear facilities. Additionally, the report covers the equivalent data on other use of nuclear energy, including nuclear waste management and nuclear materials. In addition to the actual oversight of safety, the report describes, among other topics, how the regulations that govern the use of nuclear energy were developed and implemented during the year, as well as discussing the main characteristics of the safety research programmes in Finland that deal with nuclear safety and nuclear waste management.

The report Appendices bring together the key events that occurred at the nuclear power plants, as well as the summaries of the inspections performed under STUK's inspection programmes. Additionally, as required by the Nuclear Energy Decree, the report is accompanied by a summary of the licences that STUK granted in 2022 under the Nuclear Energy Act.

The STUK *Financial Statements and Annual Report 2022* include an assessment of how the performance targets set out in the performance agreement concluded between the Ministry of Social Affairs and Health and STUK were met, also in respect of the regulatory oversight of the use of nuclear energy. At its website, STUK also reports the estimates of the doses to which the population is exposed due to the use of nuclear energy that are not ready by the time of publishing this report.

Based on the oversight undertaken by STUK, the use of nuclear energy in 2022 did not pose a risk to the population, society, the environment or future generations.

Contents

1 Development and implementation of the regulations

Renewing STUK's organisational legislation

STUK's organisational legislation, i.e. the Act (1164/2022) and Decree (1359/2022) on the Radiation and Nuclear Safety Authority, were updated in 2022. STUK participated in the preparatory work led by the Ministry of Social Affairs and Health. This was mainly a technical update, and no major content changes were made.

From the point of view of nuclear safety, a notable amendment to the Act was the provision according to which STUK has an independent position in its statements in matters related to its field of activity and in its regulatory activities (Section 1). The provision was added to the Act in order to implement international obligations and recommendations, as well as the independence regulation required by the directives, in a clearer manner. Therefore, the question was not about changing STUK's status but expressing and confirming the actual situation at the level of law.

STUK's regulations and the YVL Guides

By virtue of Section 7 q of the Nuclear Energy Act (990/1987), STUK is authorised to issue more specific regulations on the technical details of the principles and requirements laid down in Chapter 2a of the Nuclear Energy Act. Under this authorisation, STUK has issued regulations on the safety of a nuclear power plant (STUK Y/1/2018), the emergency arrangements of a nuclear power plant (STUK Y/2/2018), the security in the use of nuclear energy (STUK Y/3/2020), the safety of disposal of nuclear waste (STUK Y/4/2018) and the safety of mining and milling operations aimed at producing uranium or thorium (STUK Y/5/2016).

Section 7r of the Nuclear Energy Act (990/1987) provides that STUK has the power to issue detailed safety requirements concerning the implementation of the safety level in accordance with the Nuclear Energy Act. According to this Section, STUK shall specify the safety requirements it sets in accordance with the safety sectors involved in the use of nuclear energy, and publish them as part of the regulations issued by STUK. STUK's nuclear safety guides (YVL Guides) are considered binding just as regulations are, but unlike with regulations, the possibility of deviating from the requirements is provided for. STUK's safety requirements are binding on the licensee, while preserving the licensee's right to propose an alternative procedure or solution to that provided for in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with Nuclear Energy Act, STUK may approve it.

STUK's nuclear safety regulations were updated as necessary during 2016–2021. The changes made to the YVL Guides in the update mainly involved clarifications, changes to the regulation references and minor changes to the requirements. The updated YVL Guides will be applied

to new nuclear facilities as they are. However, with regard to operating nuclear facilities and facilities that are currently under construction, they will be brought into effect by means of separate implementation decisions by STUK. For the implementation of the updated YVL Guides, STUK asked, via requests for clarifications sent after the publications of the guides, the licensees and licence applicants to submit a justified assessment of the fulfilment of the requirements presented in the YVL Guides. Processing of the fulfilment assessments submitted by the licensees started at STUK in late 2019, and the majority of the implementation decisions taken based on them were completed during 2020–2022.

Renewal of STUK's nuclear safety regulations

In October 2020, STUK made the decision to begin the structural and substantive renewal of its nuclear safety regulations. The structural renewal entails an examination of the regulatory levels pursuant to Section 80 of the Constitution of Finland, which involves the positioning of the requirements in relation to the Act, Decree and STUK's regulations. In addition, the binding requirements and the advisory content, such as recommendations and justifications, will be separated more clearly. In terms of the substantive renewal, the starting point is to maintain the same upper safety level. After the renewal, the phrasing and language of the safety requirements are intended to be as technology-neutral as possible and less detailed in order to ensure that the requirements do not unnecessarily limit different solutions.

Preparations for the regulatory renewal were made during 2021, for example by analysing the current state of the regulations and the needs to change them and studying regulatory renewals conducted by other authorities. Based on the preparatory work, a renewal of STUK's regulations was initiated in 2022 (SYTYKE project, 2022–2027). The key aims of STUK's regulatory renewal is to emphasise operator responsibility, to correctly dimension the requirements in terms of safety significance and to enable effective focusing of oversight based on risk significance. The aims are related to STUK's efforts to develop oversight in accordance with its strategy. During 2022, the SYTYKE project carried out goal-oriented work to identify binding requirements to be added to the Nuclear Energy Act and decrees, worked on the regulation structure and matters identified as requiring a policy, as well as interface issues. At this stage, stakeholder cooperation focused mainly on licensees and the Ministry of Economic Affairs and Employment (MEAE).

STUK's work to update the nuclear safety regulations as well as its schedule is closely connected to the comprehensive renewal of the Nuclear Energy Act because the Nuclear Energy Act and the STUK regulations based on it are linked. In terms of the Act, achieving the goals set for the regulation renewal and the development of STUK's regulatory activities requires basic regulations that include precise and clearly delineated authorities to issue regulations based on which safety requirements can be set and regulatory oversight can be implemented. In the course of 2022, STUK participated in the preparations for the comprehensive renewal of the Nuclear Energy Act (990/1987), which is the responsibility of the MEAE. STUK's experts and lawyers attended meetings on various topics and engaged in the preparation of background reports.

2 Results of regulatory oversight of nuclear facilities 2022

In accordance with its fundamental purpose, STUK has taken care of the implementation of the regulatory oversight of radiation and nuclear safety, safety assessments and the development of its regulatory activities and participated as an expert in the social debate in its field in 2022. The regulatory oversight of nuclear facilities and safety assessments carried out by STUK play a key role in social decision-making and the implementation of nuclear safety. The objective of the regulatory oversight of nuclear facilities is to ensure the safe use of nuclear energy in such a way that the operation of nuclear facilities or their possible accidents do not pose a danger to society and the environment. The oversight assesses the design, construction and operation of nuclear facilities and the safety analyses demonstrating the safety of operation of nuclear facilities, as well as the activities of the licensee's organisation and its subcontracting chain, for example suppliers manufacturing equipment for the facilities.

In 2022, the COVID-19 pandemic no longer had the same impact on the regulatory oversight of nuclear power plants as in the previous year, when it caused major changes in the oversight both at domestic nuclear facility sites and abroad. In early 2022, vaccination coverage had risen to a good level and on-site inspections and control visits were increased. In June 2022, STUK shifted from teleworking to so-called hybrid work. Inspections of licensees were largely carried out as on-site inspections or hybrid inspections, the concept of which was developed the previous year. The experiences with remote and hybrid inspections have been positive, and they have also enabled wider participation in inspections without the need to travel. The new inspection procedures that have been learnt have continued to be used since the pandemic.

The majority of STUK's oversight is based on document reviews. STUK has developed new procedures for assessing the depth of inspection of documents that better take into account the safety significance of handling the matter. STUK has also developed its other means of oversight: in addition to the traditional inspections, lightweight inspections have been carried out at the oversight targets and more use has been made of the self-monitoring of facilities.

In 2022, STUK assessed the plans related to the construction and operation of the Hanhikivi 1 plant planned by Fennovoima and the acceptability of the organisations involved in the implementation of the project, until Fennovoima decided to terminate the project in the spring.

STUK oversaw the commissioning of the Olkiluoto 3 plant unit and assessed its safety in connection with the commissioning tests. STUK oversaw the safety of the nuclear power plants in operation and prepared statements on the continuation of the operation of the Loviisa nuclear power plant units until 2050 and on the continuation of the operation of the final disposal facility for power plant waste until 2090. During 2022, STUK also started processing the periodic safety review of the Olkiluoto final disposal facility for power plant waste.

Finland is the first country in the world to start the final disposal of spent fuel, with its facility at Olkiluoto. STUK oversaw the construction of Posiva's encapsulation and final disposal facility, focusing its oversight on the design, construction, manufacture and installation of the facility as well as on demonstrating long-term safety. At the beginning of 2022, STUK also started the assessment of the operating licence application documentation for the Posiva plant.

In 2022, STUK continued to oversee the decommissioning of VTT's FiR 1 research reactor. The oversight focused on the detailed planning of the dismantling of the research reactor, the assessment of the final decommissioning plan and a safety report on the research reactor. The oversight aims to ensure that VTT has the readiness to start the dismantling phase of the research reactor as planned in spring 2023.

2.1 Loviisa 1 and 2

STUK oversaw the safety of units Loviisa 1 (LO1) and Loviisa 2 (LO2) and power plant waste management at the Loviisa nuclear power plant and assessed the operating organisation in different areas by reviewing materials provided by the licensee, carrying out inspections in line with the periodic inspection programme and the YVL Guides and overseeing operations at the plant. The descriptions of the annual outages and the most significant events are presented in Appendix 2, and the summaries of the inspections in accordance with the periodic inspection programme (KTO) are presented in Appendix 3.

The most significant issue handled by STUK in 2022 was the operating licence applications for the further use of the Loviisa power plant and the repository of low- and intermediate-level waste. Concerning these, STUK submitted to the MEAE on 26 January 2023 its statement and safety assessment, which did not identify any issues hindering the safe further operation of the plant.

On the basis of this regulatory oversight, STUK states that as regards radiation exposure, the activities of the Loviisa nuclear power plant are safe to the employees, the population and the environment.

2.1.1 Safe operation of the plant

Radiation safety of the plant, personnel and environment

The collective occupational radiation dose of the employees in 2022 was 0.210 manSv at LO1 and 0.417 manSv at LO2. Most of the doses accumulated from work completed during the annual outage of the plant (0.174 manSv at LO1 and 0.399 manSv at LO2).

The radiation doses of the Loviisa power plant's personnel have decreased in the 2000s through the development of work methods and improvement of systems, for example, and because the amount of high activated substances in components connected to the primary circuit has been significantly reduced in accordance with the ALARA principle. The radiation doses are higher in even years, which is when an extensive annual outage is carried out at one plant unit: in 2022, LO1 went through a short annual outage and LO2 an extensive annual outage.

According to the Government Decree on Ionising Radiation (1034/2018), the effective radiation dose to persons engaged in radiation work must not exceed 20 mSv per year. The actual individual radiation doses remained clearly below this limit. The highest personal dose received at the Loviisa power plant in 2022 was 8.61 mSv caused by insulation work.

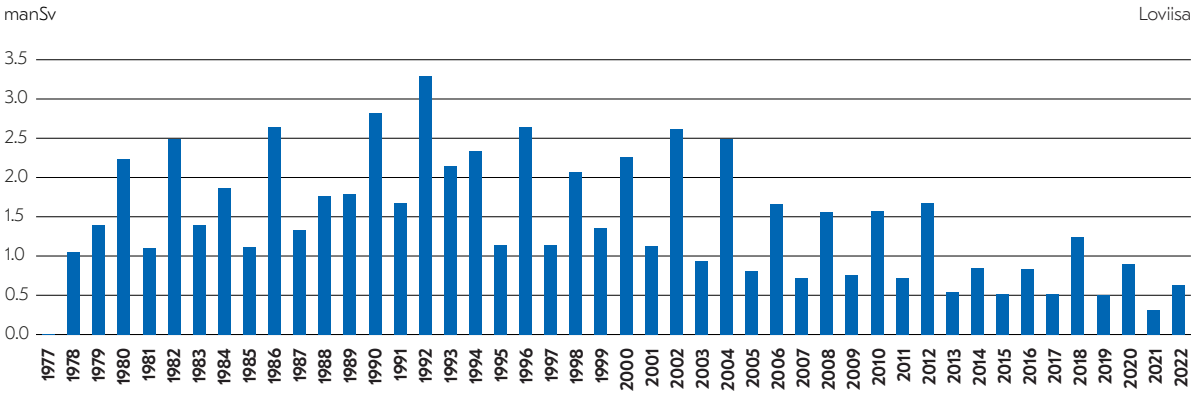


FIGURE 1. Collective occupational doses since the start of operation of the Loviisa nuclear power plant.

Radioactive releases into the air and sea remained clearly below the set limits, despite the minor fuel leak at LO2 and the planned discharge of evaporation waste. The calculated radiation dose of the most exposed individual in the vicinity of the plant was less than 1% of the limit of 0.1 mSv set in the Nuclear Energy Decree (161/1988).

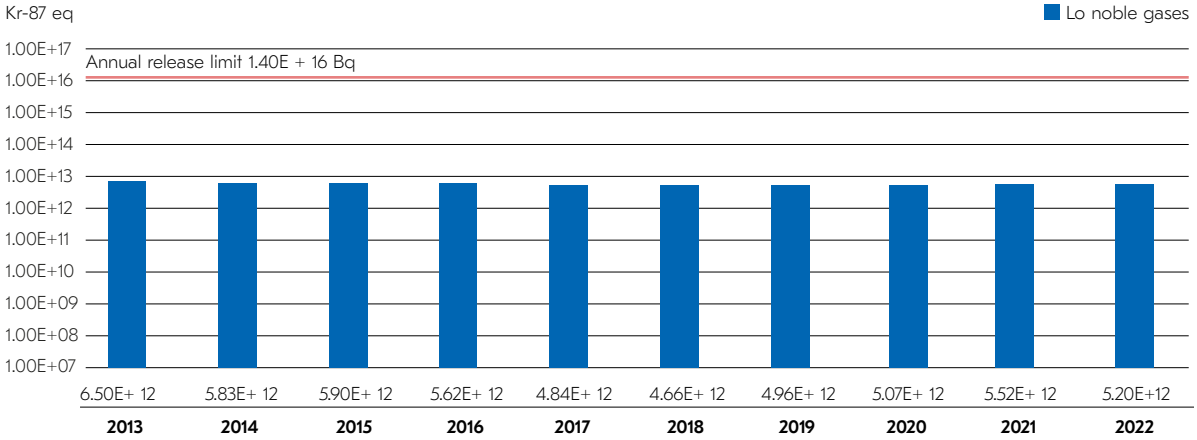


FIGURE 2. Noble gas releases to the atmosphere (Kr-87 eq), Loviisa.

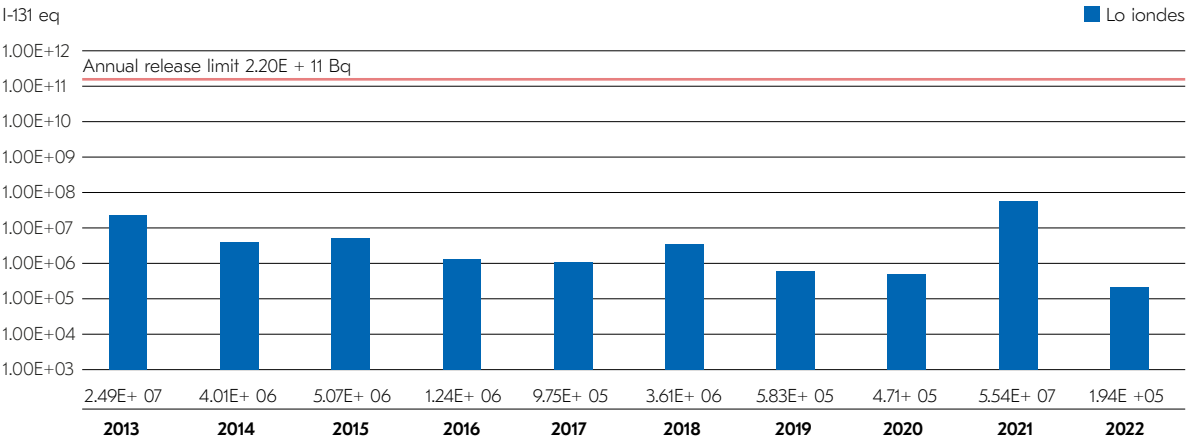


FIGURE 3. Iodine isotope releases to the atmosphere (I-131 eq), Loviisa.

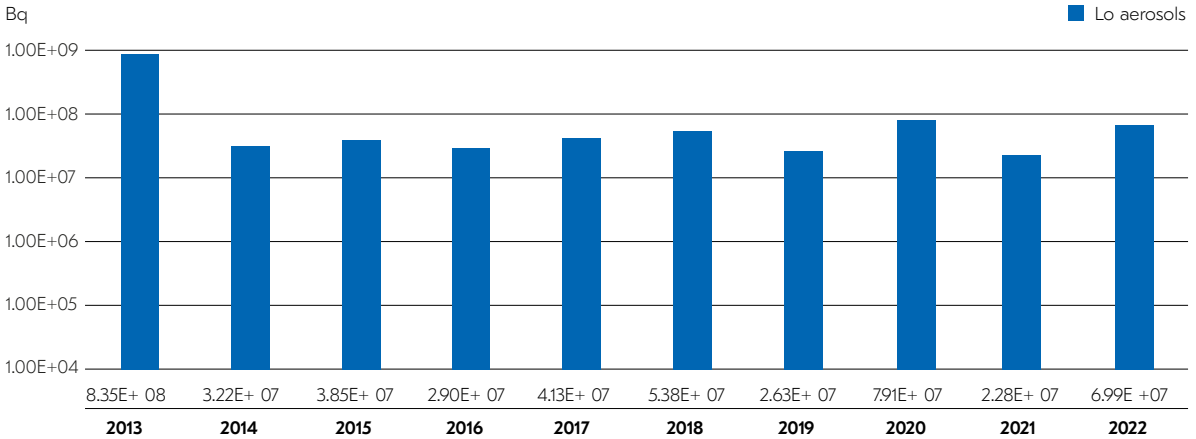


FIGURE 4. Aerosol releases to the atmosphere (Bq), Loviisa.

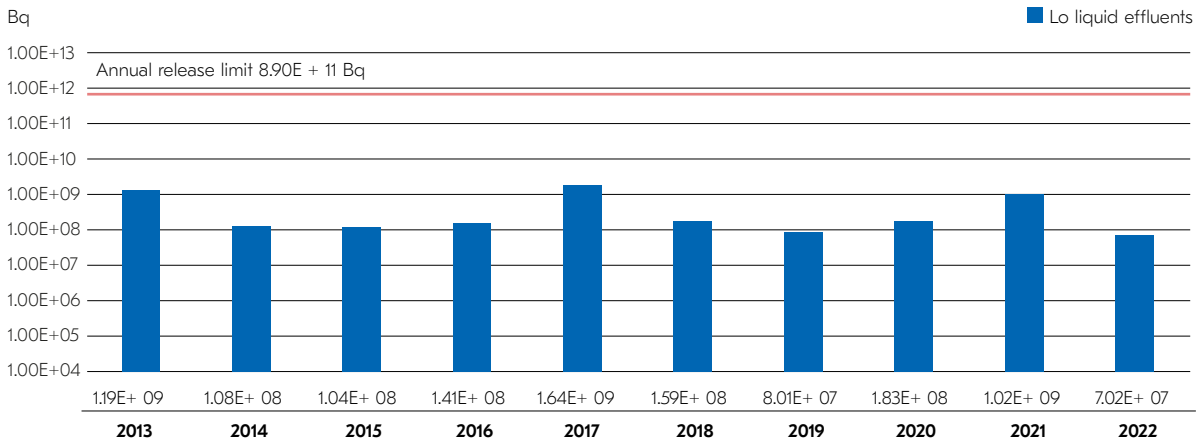


FIGURE 5. Gamma activity of the liquid effluents (Bq), Loviisa.

Radioactive releases into the air and sea remained clearly below the set limits. The calculated radiation dose of the most exposed individual in the vicinity of the plant was less than 1% of the limit of 0.1 mSv set in the Nuclear Energy Decree (161/1988). A total of approximately 420 samples were collected and analysed from the land and marine environment surrounding the Loviisa power plant in 2022. The measured concentrations were so low that they are insignificant in terms of the radiation safety of the environment or people. The exposure to radioactivity of residents in the vicinity of the nuclear power plant was also measured. No radioactive substances originating from the Loviisa power plant were detected in them.

Operational events and operating experience feedback

Fortum notified STUK of 19 events that occurred or were observed at the Loviisa power plant in 2022. As a conclusion, STUK states that Fortum identifies operational events at the plants and initiates event investigations to determine the causes and to improve the operation of the plant and the organisation. However, the events revealed targets for improvement in procedures and activities. The most important operational events are described in Appendix 2.

The number of event notifications made by Fortum to STUK in 2022 indicates that Fortum has taken into account STUK's feedback on the lowering of the threshold for the delivery of operational event reports. STUK submitted several delivery requests in 2020 and 2021 for events that it estimated it needed more information about than Fortum had submitted.

By reviewing the results of the event investigations, STUK verified that Fortum has investigated the underlying causes of the events and initiated the necessary actions to correct technical faults and deficiencies in its organisation's performance and to prevent the reoccurrence of the events. By the end of January 2023, STUK had reviewed 17 reports and two reports were under review. In two cases, STUK required the possible causes to be investigated on a wider scale and the sufficiency of the measures determined by Fortum to be assessed. In one case, STUK required additional information on the impact of the fault mechanism detected by Fortum on safety. In addition, on the basis of the results of two generic investigations it had reviewed, STUK provided feedback for the development of the

generic investigation procedure. In other respects, STUK deemed Fortum's event investigations sufficient.

STUK also utilised the results of the event investigations to discern the status of the various controlled areas and focus its control measures. In its inspections and other oversight, STUK ensured that Fortum implements the measures determined by it on the basis of the events.

STUK has required Fortum to improve learning from its own operating experience in such a way that the learning is visible as clear results, i.e. as the identification and correction of deficiencies in technology, performance and culture. In 2022, STUK observed that this was also Fortum's intention. STUK will oversee the effects of this on the organisation's joint performance and results.

STUK has taken into account the frequent and high turnover of Fortum's operating experience feedback experts in 2018–2022. This has reduced the resources available for the task and affected the results of the work. In its oversight, STUK has emphasised that the safety significance of operating experience feedback must be taken into account in the management of the situation.

Annual outages and maintenance operations

The annual outages of the power plant were implemented as planned in terms of nuclear and radiation safety. The annual outages at both units were conducted at the scale specified in the original plans. In addition to refuelling and modifications, a large number of maintenance measures and inspections were carried out to ensure the safe and reliable operation of the power plant.

Interim inspections of the welds of the LO2 reactor pressure vessel were also carried out during the annual outage. Based on the inspections, the operation of the pressure vessel is safe.

More information on the annual outages is available in Appendix 2, and a summary of the interim inspections carried out during the annual outage is included in Appendix 3.

Operational waste management

The processing, storage and disposal of low- and intermediate-level waste (operational waste) at the Loviisa power plant were carried out as planned. The volume and activity of operational waste in relation to reactor power remained low compared with most other countries. Fortum has continued to carry out development tasks related to power plant waste management, such as the development of the solidification process for liquid waste and the reassessment of the final disposal concept. The goal of the development projects is to increase operational efficiency and reduce the quantity of waste requiring final disposal.

In December 2021, STUK issued a decision on the periodic safety review of the Loviisa repository of low- and intermediate-level waste and, at the request of the MEAE, prepared a statement on the application for an operating licence for the final disposal facility during 2022. STUK's conclusion was that the Loviisa repository of low- and intermediate-level waste can continue to be used safely in the current scope. However, STUK's view is that the plans for the extension to be built for the final disposal of the power plant's decommissioning waste must be approved separately by STUK before the expansion of the plant begins. Similarly, the safety

of the entire facility after closure must be assessed before the implementation phase. The construction of the extension will be topical in the late 2040s.

The oversight and inspections by STUK indicate that power plant waste management at the Loviisa plant has been developed in a goal-oriented manner and the total arrangement meets the requirements.

Nuclear safeguards

In 2022, STUK granted Fortum two licences concerning nuclear use items (Appendix 6).

STUK approved the updated version of Fortum's nuclear safeguards manual. In the manual, Fortum describes how the nuclear safeguards of the Loviisa nuclear power plant units have been organised. Fortum submitted the nuclear safeguards reports and notifications it was responsible for in time, and they were consistent with the observations made during inspections. In addition, Fortum submitted updated basic technical characteristics to the European Commission.

In 2022, a total of seven nuclear safeguards inspections were conducted at the Loviisa power plant. STUK performed an inspection pertaining to the physical inventory verification of nuclear materials together with the IAEA and the European Commission both before and after the annual outages. Furthermore, STUK inspected the positions of the fuel assemblies in the reactor cores of LO1 and LO2 prior to the closing of the reactor covers. The IAEA and the Commission carried out one inspection at short notice in the material balance area at the Loviisa power plant.

The oversight and inspections by STUK indicated that the Loviisa plant fulfilled its nuclear safeguards obligations in 2022.

Nuclear security

In 2022, STUK carried out two KTO inspections regarding nuclear security. One covered the nuclear power plant's physical nuclear security system and the other addressed information security. The inspection of the physical nuclear security system dealt with, among other things, modifications, the training of the security organisation and the verification of competence, as well as surveillance using drones. One requirement was presented during the inspection. It was related to the principles of change planning in inspections of persons and goods. In STUK's opinion, the modifications have generally progressed well at the power plant, and they have helped to significantly improve safety. The information security inspection focused, for example, on information security events and procedures and development measures related to the maintenance of information systems. The summaries of the inspections are provided in Appendix 3.

The transport of fresh nuclear fuel to the power plant was controlled in a separate inspection in 2022, which paid attention to transport and security systems. No requirements were presented based on the inspection.

The timeliness and adequacy of the nuclear security system at the Loviisa power plant have been reviewed in connection with the periodic safety review and the application for an operating licence.

According to STUK's assessment, the nuclear security system (including information security) at the Loviisa power plant are up to date, they have been purposefully developed and Fortum has sufficient plans to ensure safety.

Fire safety

In 2022, STUK oversaw the fire safety of the power plant by means of interim inspections and site visits and by reviewing reports submitted by Fortum. Site visits were carried out to verify the fire protection system during annual outages.

The periodic inspection made positive observations related to, for example, the organisation of the plant fire brigade and the development of the guidelines. The periodic inspection summary is provided in Appendix 3.

Fire safety at the Loviisa power plant is at a good level.

2.1.2 Technical condition of the plant and preparing for exceptional events

The Loviisa power plant is undergoing a number of modernisation projects to improve the plant's safety and ensure safe operation in accordance with the new operating licence. In 2022, LO1's emergency diesel generator I&C was updated with regard to one assembly, as in 2020. The remaining LO1 assembly will be updated in 2023. Fortum has not decided to implement a similar change at LO2. The parts obtained from LO1 will be stored and used as spare parts for LO2. The cooling piping of the first emergency diesel generator was also replaced at LO1. The change will be made for other LO1 machines in the following years. A similar change was made for LO2 machines in 2018 and, due to the harmful fluctuations observed in connection with this, the rigidity and supports of the piping were changed in 2019–2021. These lessons have also been taken into account in the design of LO1.

The low-frequency converters of the control rod mechanisms were replaced in full at LO2. A corresponding modernisation at LO1 was already carried out in 2020, which will ensure the system's operability and the availability of spare parts also in the longer term.

The operational reliability of the power supplies for the pressuriser control valves' magnetic loads were improved at LO1. The magnetic loads ensure that the relief valves are opened and closed at exactly the right pressure. Similar work was carried out at LO2 in 2021.

In addition, the signals of the process computer used for plant control and monitoring are being renewed at both units. The renewal is scheduled for 2019–2023. As a significant work in terms of service life management, 12 new additional protection elements were installed in the edge positions of the fuel elements in the LO2 reactor during the annual maintenance in 2022, increasing the number of additional protection elements from 36 to 48. The addition of protective elements reduces the neutron radiation dose received by the reactor pressure vessel, which supports ensuring the adequacy of the brittle fracture margin of the pressure vessel. The corresponding protective elements for LO1 are planned to be installed in 2023. The impact of the change on the brittle fracture margins of the reactor pressure vessel will be assessed in more detail in the next periodic safety review of the Loviisa power plant, which is to be submitted to STUK by the end of 2023.

Reports and analyses

Fortum has promoted measures aimed at ensuring the plant's earthquake resistance and has provided STUK with updated building response spectrum analyses during 2022, the results of which determine the earthquake acceleration loads on the equipment. In addition, in autumn 2022, Fortum submitted to STUK deterministic sustainability assessments of equipment and structures required for the safe shutdown of the plant in the event of an earthquake, using the design earthquake of 2018 as the starting point. Fortum will supplement these sustainability assessments for still unfinished projects during 2023 and assess the impact of the new design earthquake, which was defined in 2021, on the assessed durability.

In the 2022 risk analysis, Fortum updated the seismic risk assessment for the Loviisa power plant based on the 2021 seismic risk assessment and new deterministic sustainability assessments. According to the preliminary results, the relative share of seismic risk in the core damage frequency and large release frequency will clearly increase, but their share of the total risk is not predominant. The update of the seismic risk assessment will continue in 2023, for example by preparing probability-based sustainability assessments. Upon completion of the sustainability assessments and the seismic risk assessment update, Fortum will determine possible remedial measures to reduce the earthquake risk. STUK has examined the matter as part of the Loviisa plant's periodic safety assessment and the processing of the application for a new operating licence.

Emergency response arrangements

STUK oversaw the ability of the Loviisa power plant emergency response organisation to act under exceptional conditions by making inspection visits and reviewing reports and emergency response plan updates submitted by Fortum. A periodic inspection was also prepared on emergency activities, the summary of which is presented in Appendix 3. No events requiring emergency response actions took place at the Loviisa power plant in 2022.

An extensive cooperation exercise was held in December in which the Loviisa power plant was at the centre of the scenario. The exercise served as the power plant's annual emergency response exercise. More than 20 organisations, mainly from public administration, participated in the exercise. STUK's emergency response organisation practised emergency activities at STUK's security control centre. STUK took part in the efforts of the exercise planning group and assessed the activities of Fortum's emergency organisation in the context of the exercise.

In STUK's opinion, Fortum has systematically developed the emergency response activities of the Loviisa plant and the plant's emergency arrangements meet the relevant requirements.

2.1.3 Organisational performance and quality management

In 2022, STUK oversaw the safety culture and leadership, competence and resource management, and the suitability of the management system at the Loviisa power plant. The oversight focused on the progress and effectiveness of the development targets related to the organisation's operations identified and defined by Fortum in the periodic safety review of the Loviisa power plant. The oversight was conducted by means of interim inspections, numerous

follow-up meetings on development measures, verification of the training programme of the new responsible manager, annual outage oversight and the handling of operational events.

The focus of the safety culture and leadership oversight has been on verifying the licensee's capability to critically assess development targets in its own operating culture and manage the necessary changes in operating practices in a goal-oriented manner. STUK has continued to oversee the development of the independent safety oversight function of the Loviisa power plant's nuclear safety unit. On the basis of the oversight, independent evaluation activities have been actively developed, and these activities are important developments to support a questioning and self-critical culture. The development targets related to the organisation's operations identified and defined by Fortum in the periodic safety review are being worked on as planned. STUK has also required Fortum to systematically oversee and evaluate the achievement of the objectives of the development measures in question. Fortum's procedures to ensure that not only its own organisation but also the suppliers used by it operate in accordance with the expectations of a good safety culture require clarification on the basis of the inspection. In early 2022, Fortum appointed a new person as the Plant Manager and, at the same time, as the responsible manager for operation, whom STUK approved for the position. Based on the oversight, STUK finds that the Loviisa power plant's management has an understanding of the strengths and weaknesses of the plant organisation's safety culture and that the management is committed to developing leadership and the organisation's procedures systematically.

In its oversight during 2022, STUK continued to oversee the development of competence management at the Loviisa power plant. The competence management system introduced at the power plant at the end of 2021 is mainly used by the training group and supervisors. Based on the information obtained in the periodic inspection related to human resources and competence, the plant's system is not utilised in forming an overall picture of competence, so an overall picture is not formed. STUK also investigated how a perception is formed at the plant of how the supervisors' activities conform to the requirements of the nuclear sector. Information on the supervisors' activities is obtained from various sources, but Fortum has lacked an assessment procedure that gathers information. STUK oversees the development of competence management.

The periodic inspection related to the management system covered the power plant's risk management as well as the guidelines and their usability. In STUK's view, Fortum has developed its risk management in a goal-oriented manner and it assesses the plant's risks diversely. The measures aimed at improving the usability of Fortum's guidelines are still in progress, so STUK oversees their implementation.

Fortum has strengthened the technical support needed for the power plant by establishing a new organisational unit, which Fortum presented to STUK when the operations started in the summer of 2022. In the future, STUK will also oversee the operations of this unit as part of the oversight of modifications.

The summaries of interim inspections regarding safety culture and leadership, human resources and competence and the management system are included in Appendix 3.

2.1.4 More extensive assessments at the plant

New operating licences for the plant units and the repository of low- and intermediate-level waste, related periodic safety assessments and environmental impact assessment

Fortum submitted periodic safety assessments in accordance with the operating licence terms of the Loviisa nuclear power plant units and a periodic safety review of the repository of low- and intermediate-level waste by the end of 2020. The safety assessments had already initially taken into account issues related to the possible extension of the plant's operating licence.

STUK reviewed Fortum's periodic safety assessments, prepared its safety assessments mainly during 2021 and issued decisions on them: on 22 December 2021 for the final disposal facility and on 29 April 2022 for the power plant. According to the decisions, the safety status of both the power plant and the final disposal facility is good and Fortum can continue using them until the end of the operating licences in force.

Fortum also initiated an Environmental Impact Assessment (EIA) in the autumn of 2020 from the point of view of continuing the operation of the Loviisa nuclear power plant and the connected repository of low- and intermediate-level waste. STUK delivered its relevant radiation impact statement to the MEAE in November 2021. On 14 January 2022, the MEAE issued its justified conclusion on the Loviisa nuclear power plant's EIA report.

On 18 March 2022, Fortum submitted separate operating licence applications to the Government concerning the power plant (operation until the end of 2050) and the repository of low- and intermediate-level waste (operation until the end of 2090). With regard to the power plant, STUK carried out a new safety assessment concerning the extended operation at the end of 2022 on the basis of the periodic safety review and the additional studies it had requested from Fortum. STUK submitted its statements on the operating licences for the power plant and the repository of low- and intermediate-level waste to the MEAE on 26 January 2023. In its statements, STUK concluded that Fortum has the necessary prerequisites, procedures, expertise and resources to continue the safe operation of the plants and that STUK does not see any impediment to granting the licence in accordance with the operating licence applications. However, ensuring the safe operation of the plant during the new permit period requires that Fortum take care of the ageing of the plant and ensure and improve the safety of the plant in the manner it has presented. Additional needs for ensuring and improving plant safety must be assessed on an ongoing basis based on science, research results and operating experience. In accordance with the law, Fortum must carry out the next periodic safety review of the power plant by the end of 2030, when it will be seen how the currently planned changes related to ageing management have progressed and affected the plant. The most important of these is the effect of protective elements added to the edge positions of the reactor core in 2022 and 2023 on the slowing down of the radiation embrittlement of the reactor pressure vessel.

The plans for the extension to be built at the Loviisa repository of low- and intermediate-level waste for the final disposal of the power plant's decommissioning waste must be approved separately by STUK before the expansion of the plant begins. Similarly, the safety of the entire facility after closure must be assessed before the implementation phase.

2.2 Olkiluoto 1 and 2

STUK oversaw the safety of units Olkiluoto 1 (OL1) and Olkiluoto 2 (OL2) and power plant waste management at the Olkiluoto nuclear power plant and assessed the operating organisation in different areas by reviewing materials provided by the licensee, carrying out inspections in line with the periodic inspection programme and the YVL Guides and overseeing operations at the plant. Summaries of inspections included in the periodic inspection programme for 2022 are included in Appendix 3.

On the basis of this regulatory oversight, STUK states that, as regards radiation exposure, the activities of the plant are safe for the employees, the population and the environment.

2.2.1 Safe operation of the plant

Radiation safety of the plant, personnel and environment

The collective occupational radiation dose of the employees in 2022 was 0.625 manSv at OL1 and 0.161 manSv at OL2. Most of this accumulated from work completed during the annual outages (0.533 manSv at OL1 and 0.114 manSv at OL2).

According to the Government Decree on Ionising Radiation (1034/2018), the effective radiation dose to persons engaged in radiation work must not exceed 20 mSv per year. The actual individual radiation doses remained clearly below this limit. The largest annual dose at the Olkiluoto nuclear power plant was 6.47 mSv caused by mechanical maintenance work.

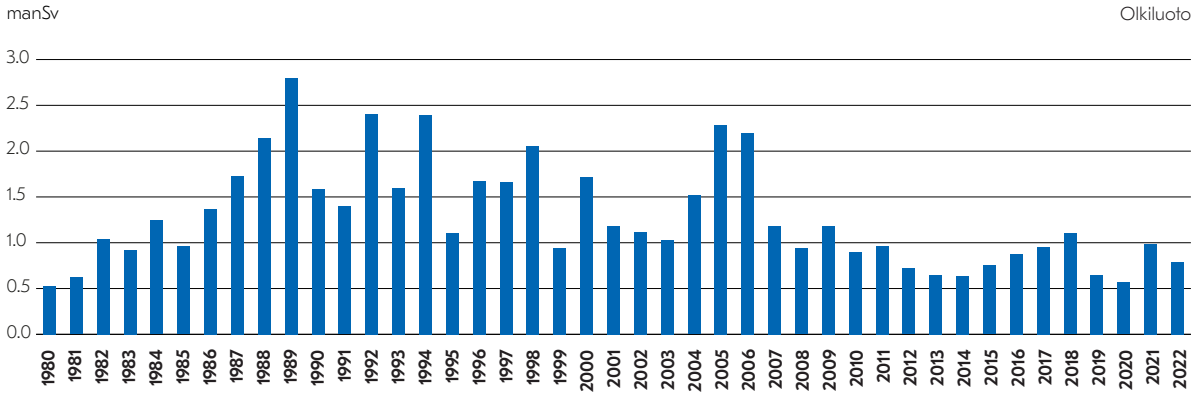


FIGURE 6. Collective occupational doses since the start of operation of the Olkiluoto nuclear power plant.

Radioactive releases into the air and sea remained clearly below the set limits, despite the extraordinary outage caused by the fuel leak at the OL1 plant in July. The calculated radiation dose of the most exposed individual in the vicinity of the plant was less than 1% of the limit of 0.1 mSv set in the Nuclear Energy Decree (161/1988).

A total of approximately 420 samples were collected and analysed from the land and marine environment surrounding the Olkiluoto power plant in 2022. Small amounts of radioactive substances originating from the plant were observed in some of the analysed environmental samples. The measured concentrations were so low that they are insignificant in terms of the radiation safety of the environment or people. The exposure to radioactivity of residents in the

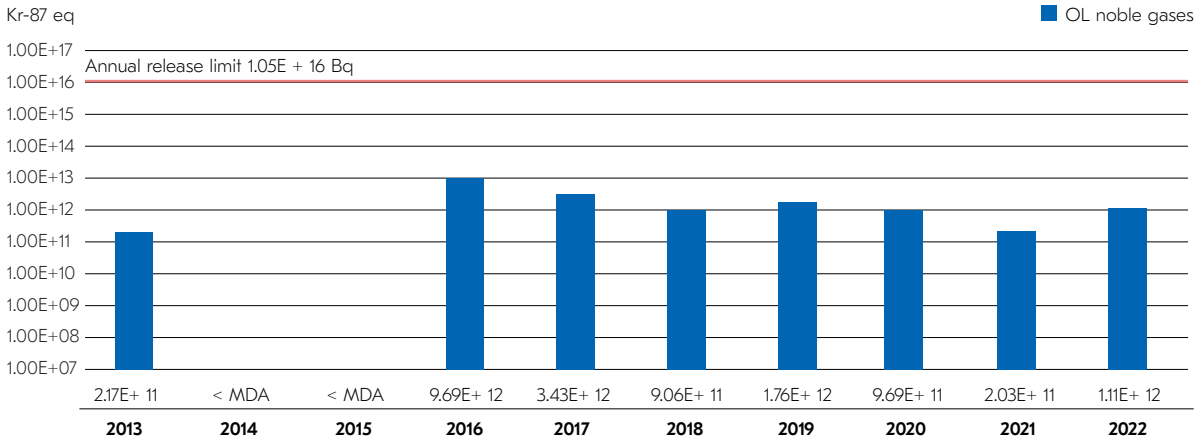


FIGURE 7. Noble gas releases to the atmosphere (Kr-87 eq), Olkiluoto. "< MDA" = below detection limit.

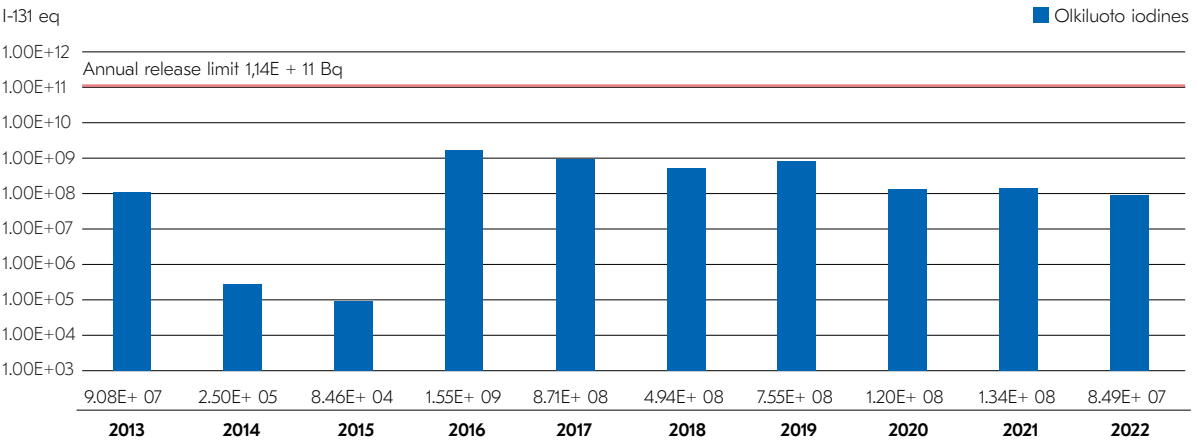


FIGURE 8. Iodine isotope releases to the atmosphere (I-131), Olkiluoto.

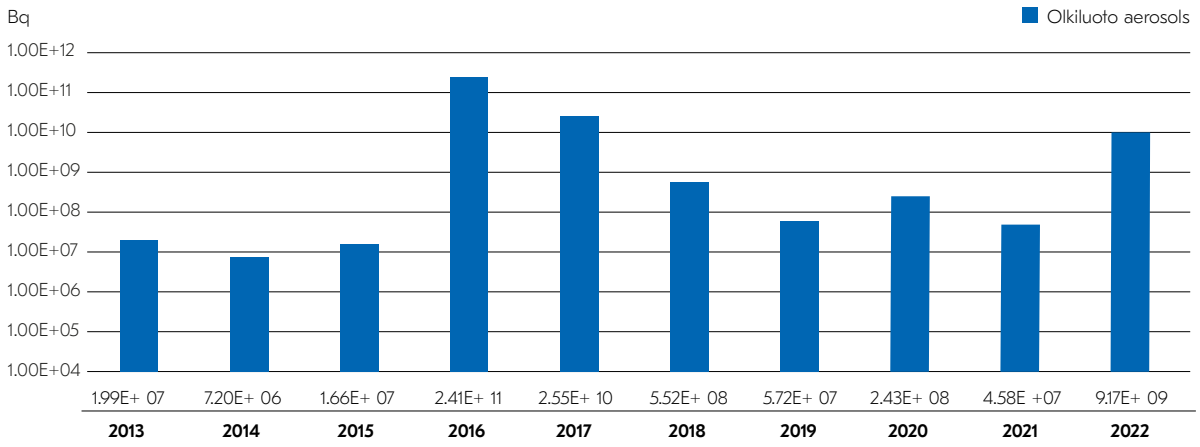


FIGURE 9. Aerosol releases to the atmosphere (Bq), Olkiluoto.

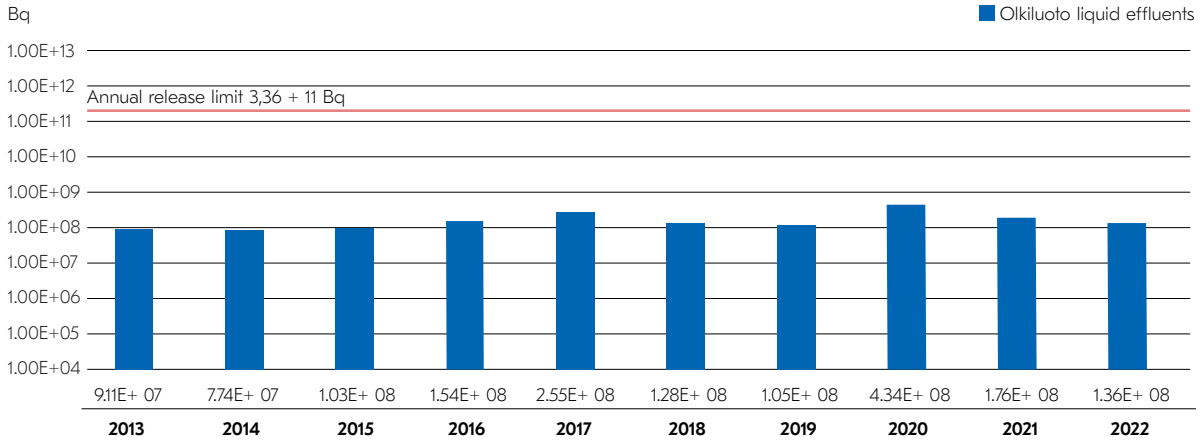


FIGURE 10. Gamma activity of the liquid effluents (Bq), Olkiluoto.

vicinity of the nuclear power plant was also measured. No radioactive substances originating from the Olkiluoto power plant were detected in them.

Operational events and operating experience feedback

TVO notified STUK of 14 events at OL1 and OL2 that occurred or were observed in 2022. In conclusion, STUK states that TVO identifies operational events at the plants and initiates event investigations to determine the causes and to improve the operation of the plant and the organisation. Most of the events revealed targets for improvement in procedures and activities.

By reviewing the results of the event investigations, STUK verified that TVO has investigated the underlying causes of the events and initiated the necessary actions to correct technical faults and deficiencies in its organisation's operations and prevent reoccurrence of the events. By the end January 2023, STUK had reviewed 11 reports and considered that TVO's event investigations were sufficient. Thee three reports submitted at the end of December and the beginning of January are still under review.

STUK utilised the results of the event investigations to discern the status of the various controlled areas and focus its control measures. For example, STUK carried out an additional inspection to find out what TVO had learned from an event related to the fire protection of

OL1, OL2 and OL3 in which the plant fire brigade operated for a long time and several times in violation of the Operational Limits and Conditions (OLCs).

TVO has discovered that people do not always learn from their own operating experience. STUK has required that TVO investigate why the operating experience feedback procedures (such as event investigations) do not always identify and correct deficiencies in technology, operations and culture, but rather the same deficiencies create new events of the same type or several different events. STUK has overseen and continues to oversee, through inspections, that TVO's development is progressing.

Annual outages and maintenance operations

The annual outages of the plant units were implemented as planned in terms of nuclear and radiation safety. The 2022 schedule included a maintenance outage at OL1 and a refuelling outage at OL2.

STUK oversaw the annual outages from their design to the start-up of the plant units. During the annual maintenance, STUK conducted the mechanical equipment inspections prescribed in the YVL Guides normally at the plant site. Unlike in 2020 and 2021, the COVID-19 pandemic no longer restricted STUK's on-site control. STUK's control activities focused on targets identified as significant in terms of safety. According to STUK's findings, the annual outages were performed safely.

A large number of maintenance measures and inspections were also carried out during the 2022 outage to ensure the safe and reliable operation of the power plant. Non-destructive in-service inspections of pressure equipment were implemented in compliance with an in-service inspection programme approved by STUK. More information about annual outages of the plant units and STUK's regulatory oversight is available in Appendix 2. During the annual outage, STUK carried out a periodic inspection of annual outages. The inspection summary is provided in Appendix 3.

Operational waste management

The processing, storage and disposal of low- and intermediate-level waste (operational waste) at the Olkiluoto power plant were mainly carried out as planned. The volume and activity of operational waste in relation to reactor power remained low compared with most other countries. The power plant pays attention to keeping the amount of waste generated as low as possible by tightly packing the waste and releasing from control waste with so low a level of radioactivity that no special measures are needed. In recent years, TVO has developed waste sorting guidelines for its own staff and contractors in order to separate potentially radioactive waste more efficiently. From the waste stream, TVO separates very low-level waste, which in the future is intended to be disposed of in a near-surface disposal facility instead of the repository of low- and intermediate-level waste. TVO continued the planning related to harmonising the waste solidification process of all three plant units and the preparation of the near-surface disposal of very low level waste.

In 2022, no interim inspections were conducted on processing, storage and record keeping related to low- and intermediate-level waste at the Olkiluoto plant units. Topic-specific

meetings have been held on issues such as the implementation of OL3's waste systems, storage arrangements for very low-level waste and the change of solidification method.

The inspection of the Olkiluoto operational waste repository dealt with the tritium concentrations detected in the repository's water samples and in the air in the rooms. According to current knowledge, tritium concentrations and emissions are quite low and have not compromised the radiation safety of workers, the environment or the surrounding population. STUK has required TVO to prepare a report on the tritium observations, their effects and how the observed deficiencies will be corrected.

The oversight and inspections by STUK indicate that power plant waste management at the OL1 and OL2 has been developed in a goal-oriented manner and the total arrangement meets the requirements – regardless of the aforementioned tritium observation.

Nuclear safeguards

STUK granted TVO nine licences concerning nuclear use items for the Olkiluoto plant units in operation (See Appendix 6).

TVO submitted the nuclear safeguards reports and notifications it was responsible for in time, and they were consistent with the observations made during inspections. In March, STUK approved the nuclear safeguards manual submitted by TVO for the entire Olkiluoto power plant. In December, STUK approved the proposal for a new deputy for the person in charge of TVO's nuclear safeguards.

A total of 19 nuclear safeguards inspections were performed on the material balance areas of TVO's operating plant units and the spent fuel storage facility's material balance area, including inspections of the entire plant site. In addition, STUK carried out two inspections of TVO's international uranium transfers. STUK performed, together with the IAEA and the European Commission, inspections on the physical inventory of nuclear materials at both plant units and the spent nuclear fuel storage facility both before and after the annual outages. Furthermore, STUK inspected the positions of the fuel assemblies in the reactor cores of OL1 and OL2 prior to the closing of the reactor covers. STUK performed interim inspections of nuclear safeguards at both plant units and at the spent fuel storage facility and also participated in inspections carried out by the IAEA and the European Commission at short notice, a total of four of which were carried out. STUK set one requirement for TVO in inspections of nuclear materials, which was related to advance notifications on the verifiability of the fuel.

In the operation inspection programme, the inspection of nuclear safeguards focused on TVO's measures in preparing for the final disposal of nuclear fuel. The inspection set five requirements for TVO, the aim of which is to ensure that TVO has the ability to fulfil its nuclear safeguards obligations in the final disposal process.

The oversight and inspections by STUK indicated that the operating Olkiluoto plant units fulfilled their nuclear safeguards obligations.

Nuclear security

In 2022, STUK carried out an on-site nuclear security inspection at Olkiluoto in accordance with the operation inspectional programme and one additional periodic inspection, which

focused on the security organisation, changes in it and its interfaces with TVO's plant fire brigade. The summaries of the inspections are provided in Appendix 3. As document inspections, STUK made, among other things, the implementation decisions concerning Guide YVL A.11 for the Olkiluoto nuclear facility. The periodic safety review of the VLJ repository also discussed nuclear security, and a statement was requested from the Ministry of the Interior's Police Department.

In June, an independent international peer review of security in the use of nuclear energy (International Physical Protection Advisory Service, IPPAS) was carried out, commissioned by the MEAE and coordinated by the IAEA. In addition to physical security system, the review includes an information security assessment module. With regard to nuclear facilities, the plant visit for the assessment focused on the OL3 power plant unit. In its oversight activities, STUK oversees how TVO handles the recommendations and proposals made by the assessment group. The assessment group also identified good practices at the facility.

The nuclear security system of the power plant comprises an extensive package of administrative, technical and operational arrangements for securing a nuclear facility from unlawful or other activities endangering nuclear or radiation safety. The overall nuclear security system at the Olkiluoto power plant are at the required level. In order to maintain and improve both physical security system and information security procedures, several development projects are ongoing at Olkiluoto.

Fire safety

In 2022, STUK oversaw the fire safety of the Olkiluoto power plant during annual maintenance inspections, document inspections and an additional periodic inspection.

The additional periodic inspection focused on the organisational change of the Safety function, of which the plant fire brigade is a part. Both the oversight during the annual maintenance and the periodic inspection focused on the plant fire brigade, as TVO detected a deviation in its operations in February 2022. The control rounds required by the guidelines to replace the disconnection of fire protection systems had been omitted on several occasions. The matter was forwarded to the international operating experience reporting system. TVO intervened firmly and has presented plans for developing the activities of the plant fire brigade. STUK will oversee the progress of the measures in 2023.

Fire safety at the Olkiluoto power plant is at an acceptable level.

2.2.2 Technical condition of the plant and preparing for exceptional events

Development of the plant and its safety

The project to update the emergency diesel generators of OL1 and OL2 continued in 2022. The project will involve updating all eight of the plant units' original diesel generators. In addition to this, an additional ninth emergency diesel generator was deployed in 2020 to enable diesel generator replacements during the power operation of the plants. By the end of 2022, one diesel generator had been replaced at OL1 and two diesel generators at OL2. The remaining diesel generators will be installed and commissioned one by one by the spring of 2025. The new diesel generators can be cooled with seawater and air. The current ones can be

cooled only with seawater. STUK oversaw the upgrade, inspected related design documents and commissioning reports over the course of 2022 and performed inspections at the suppliers' premises. At the plant site, STUK oversaw technical construction and mechanical work and the diesel generator test runs.

STUK has required TVO to equip the reactor water level measurement, which is essential in accident situations, with an alternative solution that is based on a different operating principle in order to ensure the operability of the essential safety systems in the event of a common cause failure in normal level measurement. In the context of the 2018 operating licence renewal, TVO proposed a float chamber-based trip solution that fulfils the diversity principle and suggested that the update be carried out between 2019 and 2021. However, the project did not materialise because, on the basis of the additional studies carried out by TVO, the risks related to the installation of the float-chamber solution were found to be significant compared to the potential benefits of the modification. In 2021 and 2022, TVO suggested to STUK two different safety improvements to replace float chambers. The first would improve plant safety in the event of a reactor surge, where the operation of the emergency cooling of the reactor is prevented by an unintentional maximum level limit trip. The update would involve installing manual switches in the control room for bypassing the unintentional high-level signal and thus enable the operation of the emergency cooling of the reactor. New alarms and measurements to support failure detection in level measurement would also be added to the control room. The safety improvement was implemented for OL1 in the annual maintenance in 2022, and for OL2 the change is planned to be implemented in the annual maintenance in 2023.

With the second planned safety improvement, a new surface monitoring system would be installed in the reactor, which could be used to detect the low surface of the reactor in the event of a normal surface measurement failure and automatically start safety functions. The new surface monitoring would utilise the minus branches of the current surface measurements but would be independent of the problematic reference vessel in case of turbulence and would thus be different in principle from the current surface measurement. The more detailed system design of the surface monitoring system is still under way, for example with regard to the safety functions to be connected to it. TVO aims to complete the system design in the spring of 2023, in which case the installations for trial operation could be ready by 2024 at the second plant unit. During the test run, the measurement is not connected to the safety systems. STUK has not yet established the adequacy of the safety improvements proposed by TVO but sees it as positive that the project identified as challenging has been taken forward with regard to the planning and implementation of safety improvements.

The planning of the replacement of the plant units' nuclear fuel loading machines and their manufacture proceeded as planned in 2022. The modification involves the renewal of the mechanical devices and electrical and I&C system of the refuelling machines. The reason for this modification is the reduced availability of the existing refuelling machines, the difficult availability of spare parts and challenging maintenance. The new refuelling machines are more reliable, reducing interruptions during annual outages due to disturbances in them. STUK will oversee the design, construction, installations and commissioning of the new refuelling machines. According to the current schedule, factory tests of OL1's refuelling machine will

begin in mid-2023 and installations at the plant at the turn of the year 2024. The update is expected to be completed during 2025, once the installations have been completed at OL2.

TVO has launched a large-scale project to renew the I&C systems of OL1 and OL2. The aim of the project is to support the lifecycle management of I&C systems to ensure the safe operation of the plants. The project will replace the analogue components (relays, automation cards, circuit breakers) and measuring cabinets of I&C systems with new products similar to the original. In addition, the project will replace the digital main regulators, the neutron flux measurement system and the control room process computer system. The main installations are planned to be carried out in 2025 and 2026, but work on the I&C components was already started during the 2021 annual outage. As part of the project, the relays of the reactor protection system will be replaced, the renewal of which takes into account STUK's requirement that TVO develop a procedure for overseeing the condition of the relays and the time-distribution of relay renewals so that the common failure risk arising from the ageing of the relays or other factors does not threaten the safety of OL1 and OL2. With the distributed schedule, the relays that are most critical to the operation of the protection system are replaced one subsystem at a time, with a sufficient time interval difference between each other and with relays of a different production batch.

Emergency response arrangements

STUK oversaw the ability of the Olkiluoto power plant emergency response organisation to act under exceptional conditions by making inspection visits and reviewing reports and emergency response plan updates submitted by TVO. A periodic inspection was conducted in relation to emergency response activities.

In June 2022, a long exercise was organised in Olkiluoto, where over 30 continuous hours of training were conducted with a fully manned emergency response organisation. STUK's emergency response organisation practised emergency activities throughout the exercise STUK also took part in the efforts of the exercise planning group and assessed the activities of the TVO's emergency response organisation during the exercise on site. In March, TVO organised an exercise that focused on the personal cleaning and access arrangements in a fallout situation at the plant site. STUK assessed the exercise at the plant site.

No events requiring emergency response actions took place at the operating plant units of the Olkiluoto power plant in 2022. In April 2022, the commissioning tests of OL3 revealed emergency boration, which is classified as an emergency situation. As OL3 was in a controlled and safe state, the emergency situation was quickly cancelled. After the analysis of the event, changes were made to the guidelines, and the event in question will not be classified as an emergency situation in the future.

Emergency preparedness arrangements at the Olkiluoto nuclear power plant have been constantly developed, and the power plant's emergency preparedness arrangements comply with the set requirements.

2.2.3 Organisational performance and quality management

Based on STUK's oversight and control activities, TVO is committed to safety and has emphasised safety. According to STUK's observations, TVO adheres to its own procedures and the nuclear safety regulations. STUK's oversight has covered TVO's self-assessment measures, including risk assessments of organisational changes. TVO identifies the weaknesses in its operations and highlights them as necessary. This makes it possible to develop the operations in the right direction.

TVO has an advanced management system which meets the requirements imposed on corresponding systems in the nuclear sector. The consolidation of the OL1, OL2 and OL3 management systems is currently under way as a result of the commissioning of OL3. As regards TVO's organisational performance, STUK sees challenges in the management of modifications and projects even though TVO has particularly invested in its development in recent years. The inspection of the management system carried out by STUK covered, among other things, risk management procedures in which the conclusion was that TVO has guidelines for the handling and management of risks and that the inspection did not reveal any significant issues related to them. The inspection also covered the processing of documents at TVO. According to STUK's observations, it is difficult to find out from the records of the author, inspector and approver of the documents how each person has participated in the various activities. STUK concluded that TVO had a good idea of how to improve the documentation of document reviews. The inspection summary is provided in Appendix 3.

In its additional inspection of the organisational change of the Safety function, STUK concluded that TVO has identified targets of improvement in the implementation of the function and has taken the necessary measures. In addition to the measures defined by the organisational change and event investigation (deviation from the Operational Limits and Conditions with regard to fire protection) carried out at the former Corporate Security Competence Centre in the spring of 2022, TVO is launching more extensive development programmes. TVO has recognised the need to clarify instructions and responsibilities related to certain operational situations. STUK wants to ensure that the atmosphere and resource situation of the function develop in a positive direction and that TVO's change management is systematic. The inspection summary is provided in Appendix 3.

In terms of all plant units (OL1, OL2 and OL3), STUK has found the human resources and competence to be at a fairly good level. STUK carried out an audit in the early part of the year to assess the use of TVO's and Posiva's shared resources. During the inspection, it was found that both operators have procedures for cooperation but there is no experience yet of Posiva's operations during use.

With regard to OL3, human resources and competence have been overseen to ensure that they are sufficient for the commencement of the commercial operation of the plant unit. TVO's own competence analyses have also been reviewed by STUK. The maintenance personnel are in the process of transferring duties from the plant supplier to TVO. The competence and readiness of those in charge of the equipment play a key role at this stage, but the target level

set for them has not yet been achieved in all respects. However, TVO has arrangements in place to support various functions, such as contracts with the plant supplier and subcontractors and consultants, which can be utilised to supplement resources according to needs.

2.3 Olkiluoto 3

In 2022, STUK oversaw the nuclear commissioning phase of the OL3 plant unit from low power tests to full power tests. During the commissioning, the power was raised in a controlled manner and commissioning tests were carried out according to plan to demonstrate the plant's planned operation. STUK reviewed the results of the commissioning tests and approved the plant unit's trial operation to a higher power level in three stages: reactor power exceeding 5, 30 and 60 per cent of full power.

The nuclear commissioning will continue in 2023. The commissioning will be followed by the plant's regular electricity production, i.e. commercial use.

Summaries of the inspections included in the inspection programme for 2022 are presented in appendix 3. The inspection programme is common for all plant units in Olkiluoto.

2.3.1 Nuclear commissioning at power levels 0–5%

STUK granted OL3 a criticality and low-power testing licence at the end of 2021, and the plant was first started-up on 21 December 2021, when the reactor core was made critical for the first time. After the start-up of the plant, TVO and the plant supplier conducted low-power tests to ensure that the reactor core behaves as expected and that the core meets the assumptions of the safety analyses. Low-power tests were conducted using several control rod positions measuring values related to reactor physics, such as critical boron content, isothermal temperature coefficient and the control rod reactivity effect.

STUK checked the low-power test plans and instructions and oversaw the tests at Olkiluoto. In addition to this, STUK examined the results of the conducted tests. The reactor's behaviour matched the advance calculations quite accurately, and the predefined safety criteria were fulfilled.

The completed commissioning tests indicated that the plant operates as planned and it will be safe to increase its power towards the level required by the next commissioning phase. On 3 January 2022, TVO submitted an application to STUK for a permit to increase the reactor

power to more than five per cent of the full thermal power of 4,300 MW. STUK approved the application.

2.3.2 Nuclear commissioning at power levels 5–30%

In early January, the power of the OL3 reactor was gradually increased towards 30 per cent. During the power escalation, it was ensured that the plant operated as planned, and the modifications were carried out on the basis of the commissioning experience. Determining the correct adjustments of the turbine island also took time. The plant was synchronised to the grid in March, when the reactor power was 25 per cent of full power. The commissioning tests also included testing the plant's response to expected operational occurrences. With a reactor power of about 30 per cent, the plant was tested for, among other things, a turbine trip, the functionality of switching the power supply from the 400 kV grid to the 110 kV grid and the response to the loss of the external grid.

During commissioning tests, three reactor trips occurred that were not part of the tests. A reactor trip is a normal protection function used to quickly shut down the reactor and ensure that safety is not compromised. In a trip, the plant is shut down using control rods, which is ensured by adding boron to the coolant water. The automatic protection function is typically triggered when the process parameters deviate from the expected state.

The first reactor trip took place on 14 January 2022, when the steam generator's low-surface restriction function was tested at the plant. During the test, the surface of one steam generator rose above the reactor trip limit. As a result of the event, changes were made to the plant's I&C functions. In the commissioning phase, it is typical for the control functions to be tuned and needs for changes to be found.

The second reactor trip occurred on 29 January 2022, when the generator was being synchronised with the 400 kV grid. In connection with the synchronisation test, the average temperature of the reactor primary circuit decreased and, as a result, the reactor power increased from 25 per cent to 35 per cent. At this stage of commissioning, the reactor trip limit was set at 35 per cent of full power, so the power increase resulted in a reactor trip triggered by the protection function. After the event, corrective measures were taken before the trial runs were continued.

The third reactor trip occurred on 27 February 2022 due to high steam pressure on the secondary side. The event began in the secondary-side condensate system and led to the closing of the turbine bypass system. When heat could not be transferred through the bypass system to the condenser, it caused a rise in pressure and a reactor trip as well as the opening of the secondary-side steam discharge station.

The aforementioned events did not endanger safety. The events fall into the lowest category (INES 0) on the International Nuclear and Radiological Event Scale. The safety significance of these events is so low that they cannot be placed on the actual scale.

STUK checked the plans and instructions for the power tests and oversaw the most important tests at Olkiluoto. In addition to this, STUK examined the results of the conducted tests. The reactor core and primary circuit behaved as expected during the tests. The commissioning tests conducted for the plant were mainly carried out successfully and the plant behaved safely.

The completed commissioning tests indicated that the plant operates as planned and it will be safe to increase its power towards the level required by the next commissioning phase. On 23 February 2022, TVO submitted an application to STUK for a permit to increase the reactor power to more than 30 per cent of the full thermal power of 4,300 MW. STUK approved the application.

2.3.3 Nuclear commissioning at power levels 30–60%

At the end of March 2022, the commissioning of OL3 continued with tests carried out with a reactor power of 30–60 per cent of full power as well as with the implementation of the necessary modifications and determining the correct adjustments of the turbine island. During the commissioning, TVO and the plant supplier also carried out repair and inspection measures on the turbine island, which required the plant to be driven into a cold shutdown state. The repair outage started at the end of April 2022.

During the repair outage, parts that had come loose from the steam guide plates were found in the OL3 turbine-side reheater and parts that had come loose from the feed water pump filters were found in the feed water tank nozzles. Upon completion of the repairs, TVO submitted to STUK a report and justifications stating that the findings of foreign material items have no impact on nuclear safety. In connection with the power escalation after the repair outage, TVO and the plant supplier still detected the need to update the operational I&C software due to incorrect restoration of an individual backup. The event did not endanger nuclear safety. TVO submitted a report on the matter to STUK, and after the update work, the test runs continued in August with tests at the 60 per cent power level.

The commissioning tests also included testing the plant's response to expected operational occurrences: The tests carried out at the 60 per cent power level included the reactor and turbine trip tests and the test concerning transferring to house load operation, in which OL3 was disconnected from the external power grid and the plant was left to supply electricity only to the plant's own consumers. The test concerning transferring to house load operation and the separate turbine trip test were performed successfully. In the reactor trip test, it took longer than anticipated for the turbine trip to start following the situation. TVO submitted a modification plan and a safety assessment to STUK, on the basis of which the maximum delay between the reactor and turbine trips used in the safety analyses was extended. In the safety assessment, TVO analysed the impact of the turbine trip delay on the plant's behaviour in various situations. STUK assessed the impact of the change as minor and approved the change related to the initial values of the analyses and the approval criteria.

During commissioning tests for this phase, one unforeseen event occurred during the reactor trip test. The trip was tested as planned, but at the same time there was an inadvertent start-up of the safety function, where the emergency boration pumps started unexpectedly. The start-up of the safety function ensured the safe state of the plant by feeding additional boron to the reactor to stop the chain reaction, and the event was not hazardous to people or the environment. The start-up occurred due to an incorrectly triggered signal from the I&C system. As a corrective measure, a change was made to the I&C system to prevent a similar unexpected event. The INES level of the event was 0.

Reactors of the same type have previously been found to exhibit neutron flux fluctuation that is higher than expected. The fluctuation has been found to be caused by the lateral movement of the fuel assemblies due to reactor coolant flow, which slows down neutron movement in the reactor. In this regard, TVO submitted to STUK an application for modification work to be carried out at OL3. STUK approved the modification (STUK 9/G43C00/2022, 14 November 2022), which covers changes related to the operation of I&C and the safety analyses carried out to demonstrate safe use.

STUK checked the plans and instructions for the power tests and oversaw the most important tests at Olkiluoto. In addition to this, STUK examined the results of the conducted tests. Based on the measurements, the reactor core and primary circuit have mainly behaved as expected during the tests. The power distribution of the reactor core was slightly different from the advance calculations, but this is not relevant to the safe operation of the reactor. Overall, the commissioning tests conducted for the plant were mainly carried out successfully and the plant behaved safely. On 5 September 2022, TVO submitted an application to STUK for a permit to increase the reactor power to more than 60 per cent of the full thermal power of 4,300 MW. STUK approved the application.

2.3.4 Nuclear commissioning at power levels 60–100%

In September–October 2022, the commissioning of OL3 continued with tests in which the plant's power was 60–100 per cent of full power. During the trial-run period, there were also repair needs in the main feed water pump, which is why the plant was stopped and the reactor shut down in October. During inspections of the main feed water pumps, cracks were found in the impellers of the pumps in each of the four main feed water pumps. TVO, the plant supplier and the equipment supplier conducted a thorough investigation to determine the root cause of the matter and determine corrective actions. From the point of view of plant availability and electricity production, the operation of feed water pumps is essential, but they are not significant from the point of view of nuclear safety.

The plant had spare parts for only two feed water pumps. After thorough investigations, TVO and the plant supplier decided to continue the commissioning tests so that the two feed water pumps were left with cracked impellers. The loads on the pump impeller were determined by flow calculations, and the crack propagation was determined by fatigue analyses and crack growth calculations. Based on the analyses, the growth of cracks is not progressing to the extent that significant damage would occur in the pumps. The pumps will be re-inspected after the next commissioning phase, i.e. full power tests, and it can then be ensured that the estimate is correct.

Before continuing the test runs with the cracked impellers, STUK required a report from TVO in order to continue the safe operation. On the basis of the reports, the damage caused by loose parts has been prepared for. From the point of view of nuclear safety, it is estimated that loose pieces reaching the steam generator are of such a small size that they are not considered to pose a serious risk to the integrity of the steam generators. Although the studies show that the impeller does not break down, TVO and the plant supplier have investigated the safety effects of a possible loose piece on the plant and individuals. STUK had no comments regarding

the report, and TVO was then allowed to start the plant and continue commissioning tests by its own decision. The commissioning continued at the end of December with full power tests.

The commissioning tests also tested the plant's response to possible operational occurrences. The tests at full reactor power included, as planned, a test of the plant's behaviour in the event of loss of the feed water pump, a reactor trip test and a turbine trip test. STUK checked the plans and instructions for the power tests and oversaw the most important tests at Olkiluoto.

Overall, the commissioning tests carried out so far for the plant have mainly been successful, and the plant has behaved safely and as planned in terms of nuclear safety. The commissioning tests of OL3 will continue in 2023 with full power tests. After the full power tests, there will be a maintenance outage in which the condition of the impellers of the feed water pumps will be checked. After the maintenance outage, there will be a one-month commissioning-related test-run phase, after which regular electricity production, i.e. commercial use, will begin.

2.3.5 Oversight of nuclear materials

STUK granted TVO three licences concerning nuclear use items for OL3 Appendix 6). In March, STUK approved the renewal of the nuclear safeguards manual submitted by TVO for the entire Olkiluoto nuclear power plant. TVO submitted the nuclear safeguards reports and notifications regarding OL3 it was responsible for in time, and they were consistent with the observations made during the inspections.

In 2022, STUK conducted two nuclear material inspections on OL3. In April, STUK inspected OL3's nuclear material inventory together with the IAEA and the European Commission. In addition, STUK carried out its own periodic inspection of OL3 in December. No issues were found in the inspections. The oversight and inspections by STUK indicated that TVO fulfilled its nuclear safeguards obligations at OL3 in 2022.

2.4 Hanhikivi I

Fennovoima terminated the plant supply contract with RAOS Project Oy on 29 April 2022 and made this public on 2 May 2022. Later, Fennovoima withdrew the construction licence application by letter submitted to the MEAE on 23 May 2022. On 9 June 2022, the Government decided that the processing of the construction licence application for the Hanhikivi 1 nuclear power plant will expire because the applicant withdrew its application. Following the Government's decision, the MEAE sent a letter to STUK on 10 June 2022, informing it that its request for a statement had expired. STUK's oversight project that prepared the safety assessment for the construction licence phase entered the final phase, which included the controlled closure of pending issues as well as the assessment of the oversight and the gathering of lessons for the development of the regulations and oversight.

The construction licence of the nuclear facility is subject to STUK's safety assessment, which was ongoing when the Hanhikivi 1 project expired in spring 2022. In STUK's view, the fulfilment of some binding requirements at the regulatory level was open when the project expired, and the documentation submitted to STUK for processing did not yet enable the assessment of the fulfilment of the safety requirements, the conduct of the safety assessment or the preparation of STUK's statement in all respects. In addition to the submission and review of the missing documentation, the completion of the safety assessment would have required an update of the Preliminary Safety Analysis Report (PSAR) of the facility and other documentation in accordance with Section 35 of the Nuclear Energy Decree, taking due account of STUK's requests for clarification and supplementation and the progress of plant design.

During the construction licence phase, parts of the preliminary safety report describing the plant design and safety justifications were submitted to STUK delivery batch-specifically. STUK made approximately 1,000 requests for clarification of the delivery batches it processed, some of which were so significant in terms of safety that they would have required a response or even changes to plant design before STUK could have made a positive safety assessment of the matter. There was no time to prepare a request for clarification on all deliveries submitted to STUK before the expiry of the project. The total number of matters requiring clarification is quantitatively comparable to the number of requirements for the Preliminary Safety Analysis Report of the OL3 unit (approximately 1,500).

Before the expiry of the project, STUK approved the description of the quality management of the construction of the nuclear facility, the conceptual plan for in-service inspections with requirements, the plan for arranging the necessary safeguards to prevent the proliferation of nuclear weapons, the preliminary description of the arrangements for the transport of nuclear material and nuclear waste, the preliminary plan for the security of transport, the programme for the determination of the environmental baseline of the nuclear facility, the preliminary emergency plan and the plan for the decommissioning of the nuclear facility with requirements. For other documents submitted to STUK, requests for clarification or decisions to suspend the processing were made due to shortcomings in the documentation.

STUK handled the material manufacturing plans of the long-production-time components in accordance with the plant supplier's licensing plan. The components were the reactor pressure vessel, its cover and internals, core catcher, pressuriser, steam generators, main control pumps and main control pipes. The component that advanced the furthest in the process was the reactor pressure vessel: the construction plan for its forgings was discussed at STUK in the winter of 2021–2022. After minor upgrades, the manufacture of the forgings could have started in autumn 2022 at Rosatom's Energomashspetstal forge in Kramatorsk, Ukraine.

STUK was preparing to process the design documentation of the nuclear facility's base plate both by itself and with external resources, but STUK ended up processing only the documentation of preliminary tests of the so-called concrete formulae on a smaller scale than expected. No detailed plans for the base plate were submitted to STUK, but the situational picture of the planning consisted of the situation reports presented at the multi-authority meetings and the questions posed to the building control services.

Due to the incompleteness of the document deliveries and safety assessment, the request for a statement by the Advisory Committee on Nuclear Safety was not yet topical before the expiry of the project.

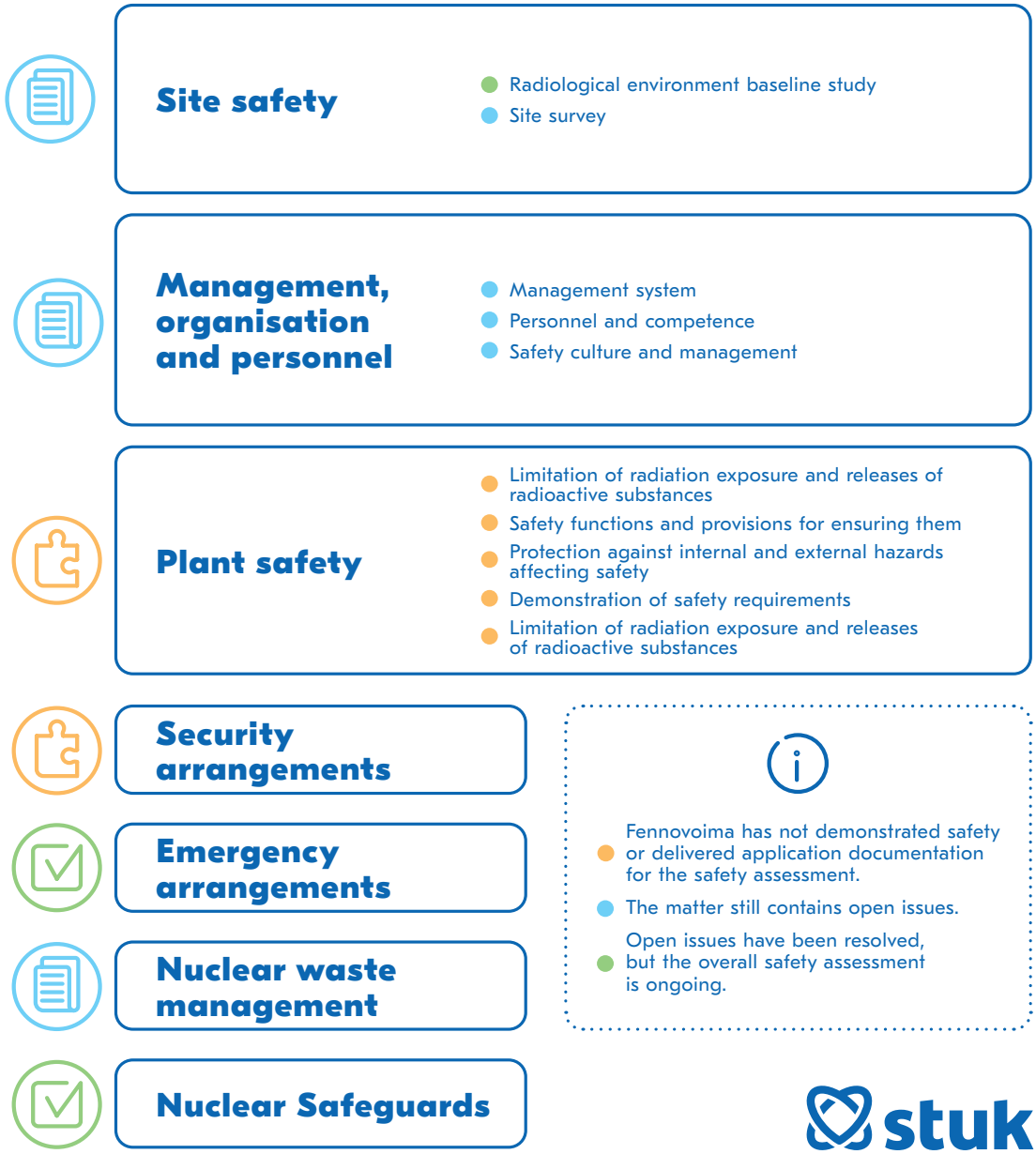


FIGURE 11. Status of Fennovoima safety assessment 1.6.2022

2.4.1 Nuclear waste management

The safety of the interim storage for spent fuel in the Hanhikivi 1 project was to be assessed in phases. As part of the application documentation for a construction licence for the nuclear power plant, Fennovoima submitted to STUK the draft plans for the interim storage for spent fuel. STUK processed the drafts and provided Fennovoima with information on the supplements needed for the construction licence at the turn of the year 2018–2019. At the end of 2021, Fennovoima submitted to STUK for review an update to the construction licence application documentation for the interim storage facility. STUK started processing the documentation in January 2022. As the interim fuel storage was part of Fennovoima's plant project but not part of the plant supply contract with RAOS Project Oy, the processing of the documentation continued in May 2022. The processing of the documentation ended on 24 May 2022, when Fennovoima announced that it had withdrawn its construction licence application. As regards nuclear waste management, work related to the closure of STUK's oversight project was still carried out in June 2022.

2.4.2 Nuclear safeguards

Fennovoima submitted the nuclear safeguards reports and notifications it was responsible for in time. After the end of the project, the nuclear safeguards obligations are mainly related to the processing, use and destruction of nuclear information subject to a licence (the licences are valid until the end of 2023). For the other operators involved in the Hanhikivi project, the licences are mainly valid until the end of 2023. The nuclear safeguards and data protection obligations of RAOS Project Oy and other licensees involved in the project will remain in force for as long as the licences are in force. In 2022, STUK carried out an inspection of RAOS Project

Oy's nuclear safeguards system, the result of which required RAOS Project Oy to update its nuclear safeguards manual, for example with regard to the processing of information.

2.5 Research reactor

On 17 June 2021, the Government granted a permit, pursuant to Section 20 of the Nuclear Energy Act, to VTT Technical Research Centre of Finland for dismantling the FiR 1 research reactor. VTT has continued the detailed planning of the dismantling of the research reactor and submitted to STUK for approval during 2022, among other things, the final decommissioning plan and safety report of the research reactor and, for information, several work and procedure instructions related to the various stages of dismantling. According to the plans, the dismantling of the research reactor will begin in spring 2023.

VTT submitted to the MEAE a waste management diagram regarding the research reactor in June 2022. The MEAE requested a statement from STUK on the document. STUK stated that the waste management diagram corresponds to the current state of the project. In STUK's view, the uncertainties related to the total cost estimate had decreased because the cost estimates for all major work phases were based on binding contracts. The timing of the total costs of waste management is still subject to some uncertainty due to the progress of the licensing of the Loviisa nuclear power plant and the final disposal facility: the nuclear power plant and the final disposal facility need new operating licences in order for Fortum to be able to receive the radioactive waste generated as a result of the dismantling of the research reactor.

In 2022, STUK carried out inspections to ensure sufficient reactor maintenance and oversight and VTT's preparedness to begin the reactor dismantling phase as planned in the spring of 2023. The research reactor underwent targeted inspections of the organisation's competence, management and operations as well as the management of radioactive waste. Based on the inspections, STUK concluded that VTT has made good progress in preparing for the dismantling phase in these areas. On the basis of the inspections, STUK required VTT to develop procedures to ensure the competence of its subcontractors and to specify instructions concerning the dismantling phase, both in terms of the terminology used and in terms of responsibilities and authorisations. In the first half of 2023, STUK will continue the inspections in accordance with its oversight programme with regard to radiation protection and emergency response and security systems. STUK has prepared a separate oversight plan for the dismantling phase of the research reactor, which will be further specified before the dismantling phase.

Concerning nuclear safeguards, the material balance area of VTT's research reactor includes nuclear materials in the Otakaari 3 building and their related activities. VTT's plant site, which is compliant with the Additional Protocol of the Safeguards Agreement, includes the buildings in the material balance areas of both the research reactor and the Centre for Nuclear Safety. In 2022, STUK started discussions with VTT on the nuclear safeguards of the dismantling phase of the research reactor, including the management of nuclear materials during the dismantling and the removal of equipment and materials subject to nuclear safeguards from VTT's nuclear material accounting in accordance with procedures approved by STUK. In 2022, STUK carried out a nuclear safeguards inspection on the material balance area of the VTT research reactor together with the European Commission and the IAEA, focusing on the timeliness of the plant's basic technical characteristics and nuclear material inventory. The oversight and

inspections by STUK indicated that the material balance area of VTT's research reactor fulfilled its nuclear safeguards obligations in 2022.

2.6 Spent nuclear fuel encapsulation plant and final disposal facility

Posiva continued the construction of the encapsulation plant and disposal facility in 2022. Posiva completed excavating the first five spent nuclear fuel disposal tunnels, with which operations will be launched in due course. The encapsulation plant building was finished, with construction of the building interior and the system installation works also getting underway. Over the course of 2022, Posiva also continued manufacture of the lifting and transfer equipment and the canister parts.

The regulatory oversight carried out during the construction stage of the spent nuclear fuel encapsulation plant and disposal facility concerns the design, manufacture, construction, installation of the nuclear waste facility and its safety-classified systems, structures and components, as well as focusing on the demonstration of long-term safety. STUK has been overseeing the commissioning of the Posiva facilities by means of inspecting the relevant commissioning plan and system test operation plans, and by performing commissioning inspections on components, structures, and systems.

2.6.1 Construction of the disposal facility

During 2022, the Posiva disposal facility saw excavation of the disposal tunnels. In the tunnels that were completed, STUK carried out rock engineering inspections and processed the disposal hole related rock engineering plans that Posiva submitted.

Construction of the encapsulation plant was completed according to plan in 2022. STUK processed several construction and fire protection related materials pertaining to the encapsulation plant. In the course of 2022, a large volume of lifting and transfer equipment construction plans was submitted to STUK for processing, some of which concerned materials that had been updated based on the requirements that STUK issued previously. An inspection body was employed to assist with the review of these lifting and transfer equipment construction plans, to balance STUK's workload.

2.6.2 Operating licence application of Posiva's encapsulation plant and disposal facility

At the end of 2021, Posiva submitted an operating licence application to the Government. In the same connection, Posiva submitted to STUK the operating licence materials required under Section 36 of the Nuclear Energy Decree. During the first months of 2022, STUK subjected the materials to a completeness check, concluding that the materials were adequate to initiate processing. STUK processed and approved the encapsulation plant and disposal facility decommissioning plan, the description of the baseline environmental radiation conditions and the environmental radiation monitoring programme. STUK submitted several requests

for clarification concerning, and discontinued the processing of, some of the operating licence application materials, as they were missing some of the required information that would allow STUK to provide a statement on the safety of the Posiva facility.

2.6.3 Organisation's activities and quality management

STUK has been overseeing the activities of Posiva's organisation by means of the inspections included in the construction inspection programme (RTO). These inspections were used to assess Posiva's nuclear safeguards related activities, management of competences, nuclear equipment installation activity, functioning and continuous improvement of the management system, and nuclear safety. A more detailed account of the inspections carried out under the construction inspection programme is available in Appendix 5.

Based on the inspections, it can be stated that Posiva's procedures in the various areas are largely at a good level. However, the procedures were found to need some specification and, where necessary, requirements were issued concerning that during the inspections.

STUK has continued to oversee Posiva's auditing activities, participating in a small number of auditing events.

2.6.4 Preparation for operating licence phase

STUK has been overseeing Posiva's preparation for the commissioning phase. This oversight has focused on examining Posiva's organisation, resources, training, guides, instructions, and related procedures. STUK approved the commissioning plan, which had been updated in compliance with the request for clarification drawn up earlier.

Additionally, STUK has launched planning of the oversight to be carried out once Posiva starts the operation phase.

2.6.5 Nuclear safeguards

With regard to final disposal, STUK carried out nuclear safeguards related activities in compliance with the national safeguards plan. Posiva submitted the nuclear safeguards reports and notifications for which it is responsible on time and in sufficient scope. On the basis of the oversight and inspections carried out by STUK, Posiva has in 2022 fulfilled the applicable nuclear safeguards obligations.

STUK subjected Posiva to an inspection with the aim of assessing Posiva's activity in order to ensure that nuclear safeguards-related activities, in every respect, are ready when the final disposal operations are launched. The inspection established that Posiva has actively carried out nuclear safeguards related activities and that they are basically going in the right direction yet, in the next few years, Posiva must continue to develop nuclear safeguards-related activity while maintaining constructive cooperation with STUK, the IAEA and the European Commission. Additionally, jointly with the IAEA and the Commission, STUK completed a review of the basic technical characteristics and conducted a technical visit to the Posiva facilities and the TVO fuel storages to plan the technical nuclear safeguards activities for the upcoming final disposal operations.

STUK continued its close cooperation with the IAEA and the European Commission, with the aim of ensuring that the plans to carry out the international nuclear safeguards-related activities for the encapsulation plant and final disposal facility will proceed in line with the design and construction of the facility while also meeting the applicable national requirements. During 2022, nearly every month, a number of technical meetings were held with Posiva, the European Commission and the IAEA on a regular basis. In March 2022, STUK participated in a management-level meeting, the aim of which was to ensure a common view with the IAEA and the MEAE as to how planning of the necessary safeguards-related activities should progress, and in September STUK, the IAEA and the Commission agreed on a technical consensus on the implementation of the safeguards-related activities. In the course of spring 2022, Posiva carried out preparatory work in respect of the technical safeguards measures to be implemented by the IAEA and the Commission, and installation of the safeguards equipment will start at the beginning of 2023.

The nuclear safeguards projects of Finland and Sweden that concern final disposal are coordinated in the framework of the EPGR forum, set up between the IAEA, the European Commission, the Swedish and Finnish authorities (SSM and STUK) and the relevant operators (SKB and Posiva), which in 2022 convened once, as well as meeting three times with a more concise composition without the Swedish parties.

Nuclear fuel that has been placed in final disposal can no longer be inspected or verified by any known means. It is therefore important for nuclear safeguards purposes that fuel be verified before encapsulation and final disposal and that this verification be documented using methods that leave no doubt as to the accuracy and completeness of the data reported. STUK's project to develop the verification methods and equipment for spent nuclear fuel to be disposed of progressed well during the year. The project is currently investigating the integration of two complementary methods, PGET (Passive Gamma Emission Tomography) and PNAR (Passive Neutron Albedo Reactivity), into one and the same modular equipment. Both devices were used to carry out fuel measurements at Olkiluoto in July 2022, and the measurements were successful for both methods. In the case of the PGET method, development continued also on the software side. The analysis algorithm was developed in cooperation with the University of Helsinki, Helsinki Institute of Physics and VTT Technical Research Centre of Finland.

2.7 Other operators

Producers of uranium, parties in possession of small amounts of nuclear use items or nuclear information subject to a licence, and research facilities participating in research of the nuclear fuel cycle are also included in the scope of regulatory nuclear energy oversight. STUK oversees that the users of nuclear energy (operators in the field) meet the set requirements, the most essential of which are competent organisation and up-to-date internal instructions. In line with the respective applications, STUK approves the responsible managers or deputies. For international nuclear safeguards, operators must also adhere to the European Commission's nuclear safeguards regulation (Euratom No. 302/2005), which requires the plant's Basic Technical Characteristics (BTC), contact information and the nuclear material inventory to be up to date.

All operators submitted the nuclear safeguards reports and notifications required from them. With regard to uranium producers and holders, STUK reviewed the reports and notifications submitted by the Kokkola and Harjavalta metal works and the Sastamala ore processing plant. There were no significant changes in the activities of these operators. In Kokkola, Umicore Oy, which intends to get rid of the uranium separated from the cobalt factory's production process, gained ownership of Freeport Cobalt Oy at the end of 2019. During 2022, most of Kokkola's uranium-containing solution was sent to France.

Among the operators that submit monthly reports to the Commission, the IAEA, the Commission and STUK inspected VTT's nuclear material inventories in the material balance areas of both the Centre for Nuclear Safety and the research reactor in June. In June, the Commission and STUK also inspected the nuclear material inventories of the University of Helsinki and STUK. As far as STUK is concerned, it was easy to inspect the entire inventory after the move at the new office, but the update of the basic technical characteristics was still in progress. The details of these were agreed during the inspection, after which the update of the BTC was submitted to the Commission.

Also in June, the IAEA and the Commission, together with STUK, verified the inventory of the Department of Physics at the University of Jyväskylä. In December, the IAEA made an additional inspection visit (called Complementary Access) to Jyväskylä to verify the nature of the operations by taking environmental samples from the university's laboratorypremises. The Commission and STUK participated in this inspection visit, which also included going through a streamlined reporting procedure. Based on the inspection, the Department of Physics was asked to update its reporting guidelines. The IAEA's positive conclusions were reported in early 2023. The Finnish bodies in possession of small quantities of nuclear materials, of which there are currently 12, fulfilled the nuclear safeguards obligations and submitted annual reports on time.

STUK inspected the annual reports on nuclear fuel cycle-related research and development activities and produced an annual report on their basis for the IAEA. In addition, STUK supplemented earlier notifications on the basis of the additional inspection visit carried out by the IAEA at Platom in December 2021 and the feedback received.

As regards the possession and processing of nuclear information subject to a licence, STUK granted two new licences in 2022 (see Appendix 6), one of which consisted of the import of nuclear information subject to the agreement between Euratom and the United Kingdom and the other of the continued possession and disclosure of nuclear information subject to licence after the completion of the Fennovoima project. In addition, STUK approved two updates to the manual and the change of one person in charge.

STUK oversaw the trial operations of Terrafame in accordance with the licence granted in 2017. As regards nuclear safeguards, Terrafame started regular reporting to STUK and the European Commission in summer 2019. The Government granted permission for extensive uranium extraction in February 2020, and the licence became legally valid in the summer of 2021. The licence states that Terrafame must begin its operations by the summer of 2024 and, well before beginning its operations, supplement the materials provided to STUK. In December 2022, STUK inspectors visited Terrafame, investigated the supplement schedule of the materials and verified the nuclear material inventory at the same time. The oversight and inspections by STUK indicated that Terrafame fulfilled its nuclear safeguards obligations in 2022.

On the basis of the inspections, as well as the reports and notifications submitted, STUK has satisfied itself that operation classified as the use of nuclear energy in Finland has been implemented in compliance with the safety obligations. In 2022, STUK approved a total of three nuclear safeguards manual updates related to these activities outside nuclear facilities.

3 Safety research

Publicly funded safety research on the use of nuclear energy has a key role in the development and maintenance of nuclear technology expertise in Finland. Without safety research programmes, developing the expertise needed in the nuclear sector to support the authorities in ensuring safety would not be possible in Finland. According to the Nuclear Energy Act (990/1987), research funded by the Finnish State Nuclear Waste Management Fund (VYR) aims at ensuring that the authorities have access to sufficient expertise and methods at their immediate disposal if it is necessary to assess the safety significance of new issues that may emerge. Two ongoing national research programmes, SAFIR2022 for nuclear safety research and KYT2022 for nuclear waste management research, were funded by VYR. Both STUK and the licensees have hired several people who have obtained their training for expert positions in the field of nuclear energy use and oversight in these and previous publicly funded research programmes. The safety research programmes also have an important role in the training of organisations that provide STUK with technical support services, such as the VTT Technical Research Centre of Finland, the University of Helsinki, the Aalto University, the Finnish Meteorological Institute, the Geological Survey of Finland and Lappeenranta-Lahti University of Technology (LUT University). The importance of research programmes is also emphasised by the fact that there is little other funding for research institutes in Finland to develop and maintain their expertise in the field.

The year 2022 was the last year of operation for the four-year research programmes SAFIR2022 and KYT2022. The planned research projects were carried out successfully and the effects of the COVID-19 pandemic on research and international research cooperation were minor. As a result of the war in Ukraine, international research cooperation with Russia was interrupted, which led to the reorganisation of some cooperation projects with the OECD/NEA. In February 2022, an international evaluation of the SAFIR2022 and KYT2022 research programmes was carried out in connection with the evaluation of the framework plan of the new SAFER2028 research programme, which was under preparation and combines these programmes. The preparation of the joint final seminar of the SAFIR2022 and KYT2022 research programmes started in summer 2022, and the seminar was carried out in January 2023.

In 2022, the SAFIR2022 safety research programme consisted of 33 projects that were selected in the autumn of 2021 based on competitive bidding. The available VYR funding for the research was around EUR 4 million. In addition to VYR funding, other funding has been required to be allocated to projects, the most significant part of which is the research institutes' own funding. The overall volume of the SAFIR2022 safety research programme is around EUR 5.4 million and approximately 36.7 research years. As shown in Figure 7, the programme is divided into four research areas of the programme: 1) overall safety and management of design, 2) reactor safety, 3) structural integrity and materials, and 4) research infrastructure. The VTT Technical Research Centre of Finland and LUT University used around

17% of the entire public funding for safety research when renewing the national infrastructure. This mainly covered the work related to the acquisition and commissioning of infrastructure-related investment objects. The SAFIR2022 research programme had specified eight Excellence projects, the long-term funding of which the SAFIR2022 management group is committed to. The Excellence projects represent the programme's research areas extensively, and their total VYR funding was nearly a third of the entire share available for free competition. The research programme covered all issues integral to nuclear safety, and it established and maintained the expertise, analysis methods and experimental readiness to resolve any unforeseen safety issues.

The SAFIR2022 research projects were guided by eight technical reference groups in addition to the four research areas: 1) overall safety and organisation, 2) plant level analyses, 3) reactor and fuel, 4) thermal hydraulics, 5) mechanical integrity, 6) structures and materials, 7) severe accidents, and 8) research infrastructure. Members of the technical reference groups were responsible for the scientific and technological guidance of the research and infrastructure of the use of nuclear energy. All of the projects included in one technical reference group were usually part of a single research area.

The projects included in the SAFIR2022 programme for 2022 meet the requirements set for VYR-funded research. The research programme had a special focus on the development of high-quality infrastructure. The project launched in 2018, making use of new infrastructure, continued in cooperation with Swedish power companies and research organisations. The project deals with investigating the radiation embrittlement of the Barsebäck pressure vessel using samples taken during the decommissioning of the nuclear power plant. This is an excellent opportunity to gain authentic operating experience data on the properties of the materials of the pressure vessel and to utilise the new research opportunities provided by the VTT Centre for Nuclear Safety.

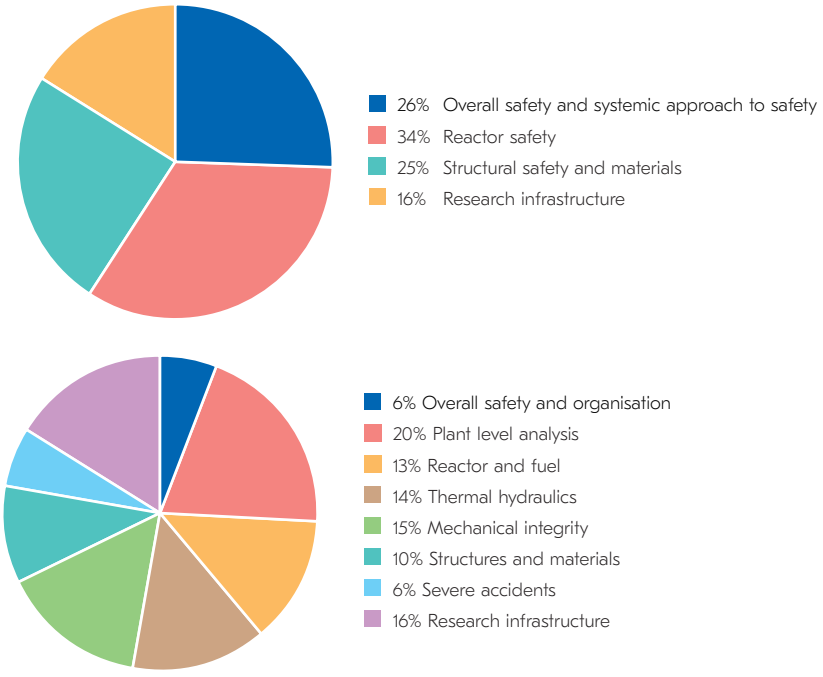


FIGURE 12. Research areas of SAFIR2022 programme and their shares of the total funding in 2022.

The SAFIR2022 programme included several projects for developing capabilities, for example for avoiding situations similar to the one that led to the accident at the Fukushima Dai-ichi nuclear power plant in 2011 or understanding the sequence of events in such accidents. The projects' subject matters ranged from design bases of nuclear facilities and the analysis of accidents to the operation of organisations during accidents and as systems comprising several organisations. An international research project that started in 2015 has offered as reliable information as possible about the course of the Fukushima Dai-ichi accident in order to create Finnish accident analyses and compare results globally.

The SAFIR2022 management group also had the opportunity to fund small projects aimed at helping the development of research projects with new topics into becoming members of the programme. This procedure has been in use since the beginning of the previous SAFIR2018 research programme, and has proven to be an efficient way to promote the creation of high-standard topical research projects. The small project in 2022 aimed to determine the risk posed to nuclear safety by strong geomagnetic storms.

A new feature in the SAFIR2022 programme was the inclusion of the eight overarching topical areas indicating the focus of the programme. The topics highlighted, among other things, the development of the assessment methods of overall safety, the modernisation of safety assessment methods, the long-term operation of plants and the requirements set by the changing environment for the safe use of nuclear energy. The themes related to overall safety and fuel life span were shared with the KYT2022 programme.

The research in the KYT2022 research programme is divided into main interacting themes: the safety of nuclear waste management, feasibility of nuclear waste management and acceptance of nuclear waste management. The programme consisted of research areas, which are important for national expertise. It was aimed at extensive, multidisciplinarily coordinated research projects, particularly regarding the research areas related to the bedrock, the performance of buffer and backfilling materials and the long-term durability of final

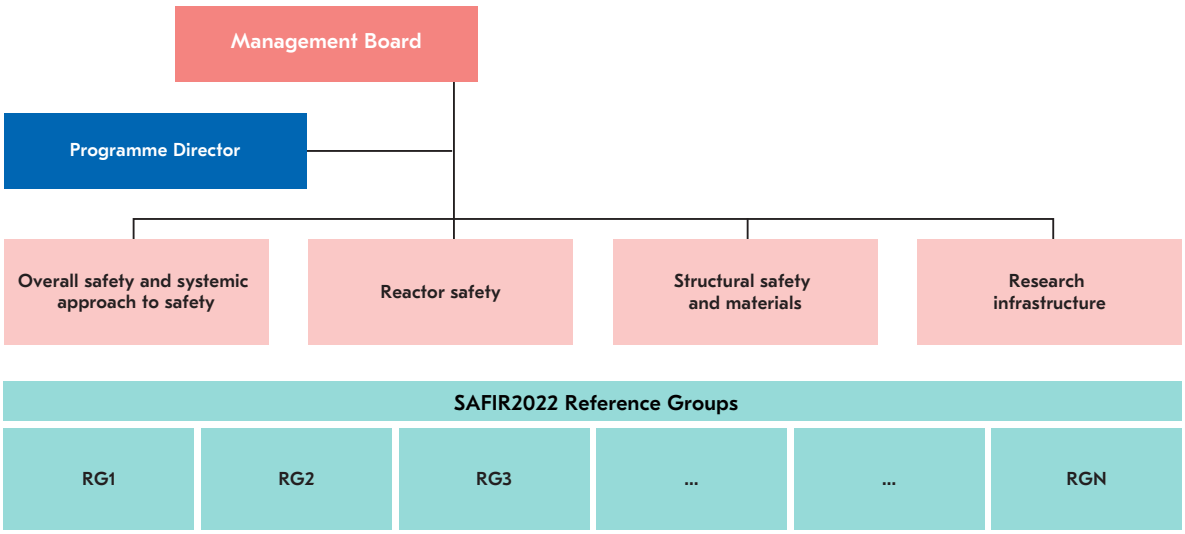


FIGURE 13. The administrative structure of SAFIR2022 research programme..

disposal canisters as well as microbiology. Research infrastructure funding was also continued in the KYT2022 programme. The research programme projects are not aimed at nuclear waste management development tasks or licensing required of individual licensees by the Nuclear Energy Act, but the results can be utilised and applied in nuclear waste management in a broader sense.

The KYT2022 management group issued financing recommendations regarding research in 2022 to the MEAE, with the help of research project assessment prepared by technical reference groups. Among other things, the assessment of the research projects focused on the suitability of each research topic for the KYT programme, the applicability of the results, the previous effectiveness, the novelty value of the project, the educational impacts of the project and cost efficiency. In 2022, the funding of the KYT2022 programme from the National Nuclear Waste Management Fund (VYR) was approximately EUR 2.0 million. In 2022, the research programme funded 35 research and infrastructure projects. The infrastructure project concerned the Centre for Nuclear Safety.

In February 2021, the MEAE initiated the planning of a new joint project for nuclear power plants and safety research regarding nuclear waste management. Chapter 7a of the Nuclear Energy Act on ensuring expertise was amended in 2020 in order to ensure that the synergies between nuclear power plants and research on nuclear waste management can be utilised. The new research programme, which is referred to as SAFER2028, will last six years. The framework plan was finished in June 2022. The planning of the new programme progressed well despite the limitations imposed by the COVID-19 pandemic. The international assessment of the SAFIR2022 and KYT2022 research programmes and the upcoming SAFER2028 research programme, conducted in February 2022, concluded that the safety research regarding Finnish nuclear power plants and nuclear waste management was of high quality and effective. The report of the assessment group has been published in the MEAE publication series. The assessment group made enriching observations about the research, and its recommendations were taken into account in the finalisation of the framework plan for the new SAFER2028 research programme.

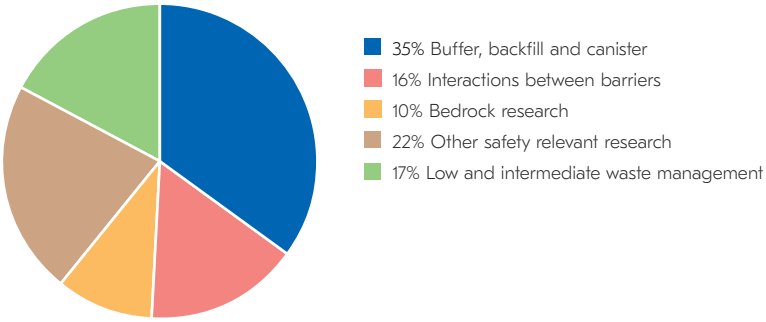


FIGURE 14. Distribution of VYR funding by research area in 2022.

The end of Fennovoima's nuclear power plant project was only known after the SAFER2028 framework plan was finished. Compared to the level of 2022, the end of the project will reduce the volume of VYR funding for nuclear power plant safety research by approximately 20% from the beginning of 2023. The end of Fennovoima's project will have only minor effects on the research needs of the research programme.

In May 2022, the MEAE appointed the SAFER2028 programme management group of end users of the research. The first call for projects for the programme was launched in August 2022. During the autumn, the programme was organised in the way outlined in the framework plan. A new feature of the programme is the component aimed at strengthening doctoral education and the structure emphasising the independence of decision-making. In order to strengthen the interaction between the SAFER2028 management group and research organisations, a stakeholder group consisting of representatives of research institutes has been established in the programme to engage in a dialogue on research challenges with the management group of the research programme.

4 Oversight of nuclear facilities in figures

4.1 Examination of matters

In 2022, a total of 2,447 matters were submitted to STUK for examination, 349 of which concerned the Olkiluoto 3 unit and 292 pertained to the spent nuclear fuel final disposal facility. The review process was completed for a total of 2,465 matters. This figure includes the matters submitted in 2022 and earlier, as well as the licences granted by STUK under the Nuclear Energy Act, which are listed in Appendix 6. The average time taken to examine matters was 82 days. The number of matters and their average examination times in 2018–2022 are illustrated in Figure 15.

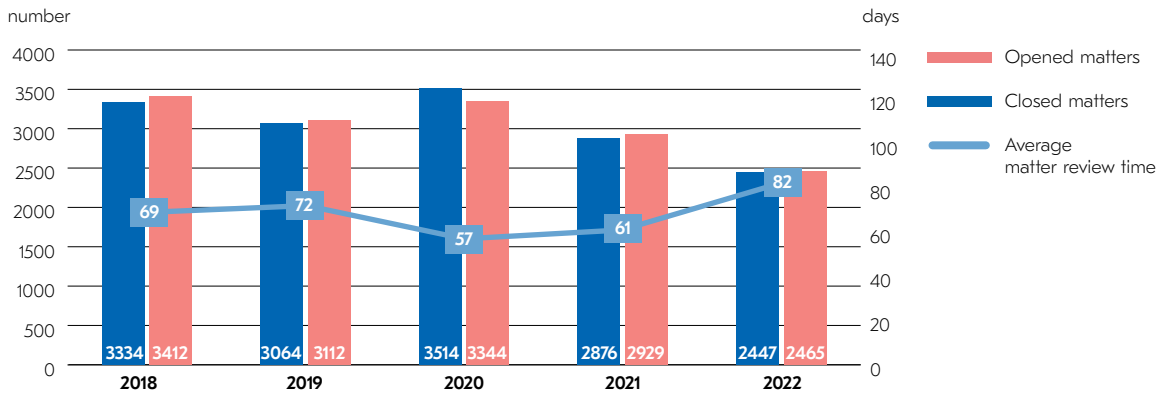


FIGURE 15. Average review time of opened and closed matters.

Figures 16–19 illustrate the distribution of the examination times of the matters pertaining to the various plant units for which approval processing was initiated, and to Posiva.

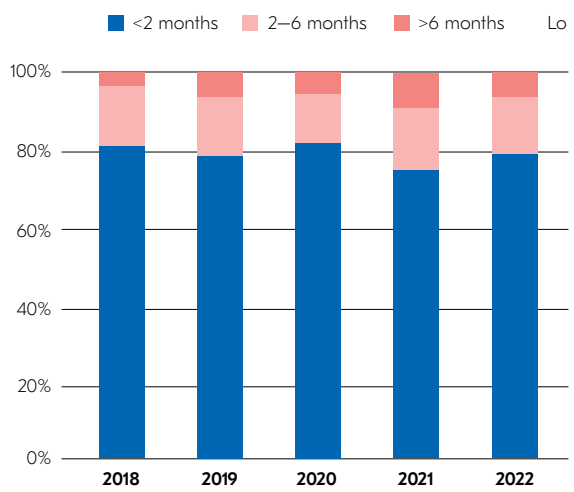


FIGURE 16. Distribution of time spent on preparing decisions on the Loviisa plant.

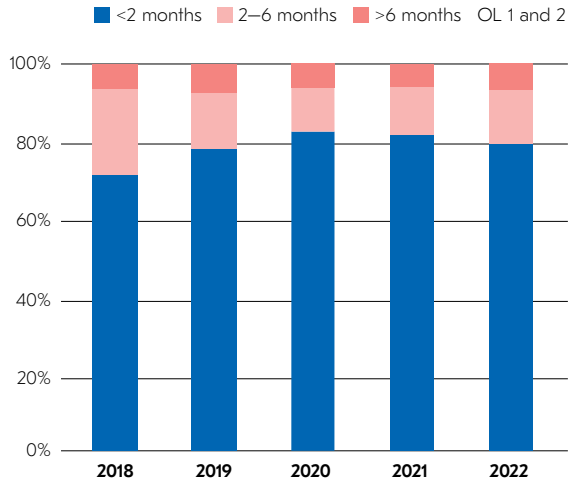


FIGURE 17. Distribution of time spent on preparing decisions on the operating plant units of Olkiluoto.

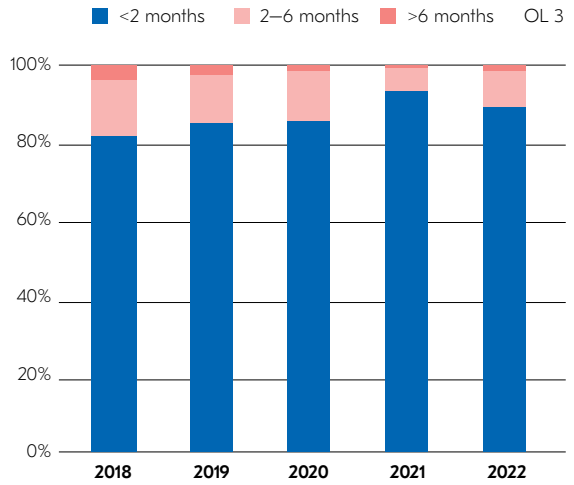


FIGURE 18. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

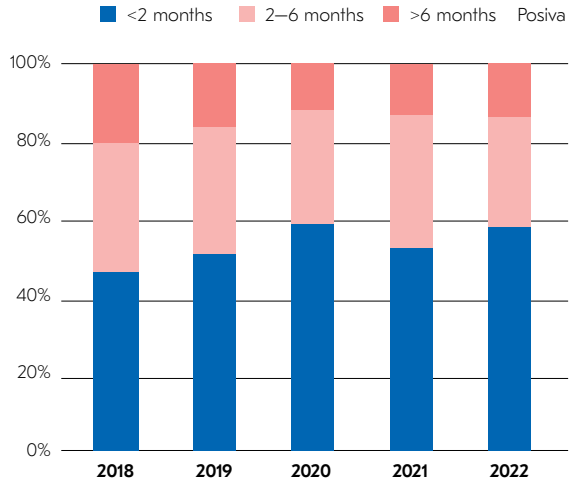


FIGURE 19. Distribution of time spent on preparing decisions on Posiva.

4.2 Inspections at nuclear facility sites and on supplier premises

Inspection programmes

For the Loviisa plant, a total 16 inspections were carried out under the 2022 periodic inspection programme (Appendix 3), and for the Olkiluoto plant these inspections numbered 17. With regard to the processing of Fennovoima's construction licence application (Appendix 4), STUK carried out one inspection. During 2022, there were a total of five inspections carried out under the construction inspection programme of the encapsulation plant and final disposal facility (Appendix 5). The key findings of these inspections are presented in the Appendices and in the chapters discussing regulatory oversight.

Other inspections at plant sites

The year 2022 saw a total of 1,629 inspection protocols completed at the plant site or on supplier premises (for inspections other than the above inspections conducted under the inspection programmes and other than the nuclear safeguards inspections, which are discussed separately). Of these inspections, 459 were part of Olkiluoto 3 oversight and 1,055 of oversight focused on other operating plants. In the course of the oversight of the construction of Posiva's final disposal facility, 43 inspections were performed.

Figure 20 illustrates the numbers of the days on which inspections were performed at the plant site in 2018–2022.

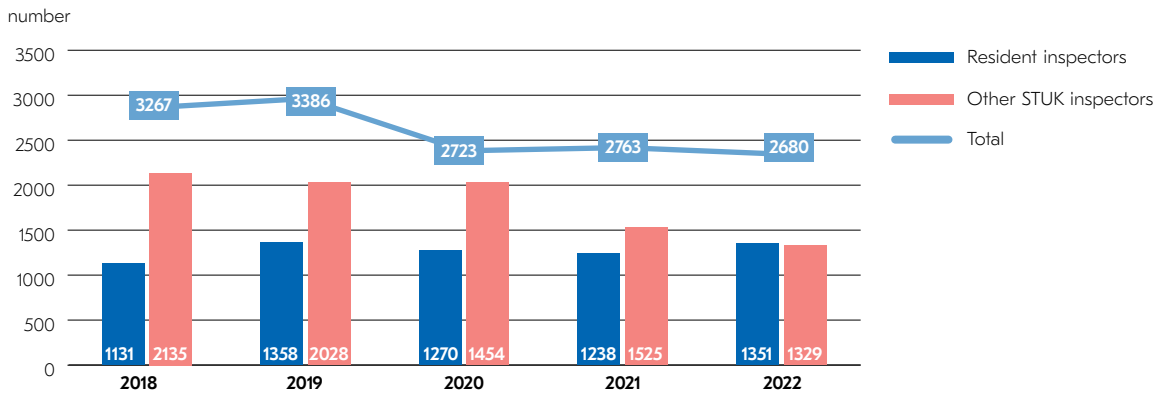


FIGURE 20. Number of inspection days onsite and at component manufacturers' premises.

4.3 Finances and resources

The performance area of regulatory oversight of nuclear safety conducts basic operations subject to a charge as well as those free-of-charge. Basic operations subject to a charge mainly consist of the regulatory oversight of nuclear facilities, with the related costs charged to those subject to this oversight. The free-of-charge basic operations encompass international and domestic cooperation, participation in legislative development, emergency response activity, and communications. The free-of-charge basic operations are publicly funded. The costs arising from the development of regulations and from support functions (for example, administration, oversight development, competence development, reporting, and participation in nuclear safety research) are carried over into the cost of basic operation subject to charge and free-of-charge, as well as to service activities, in relation to the number of the working hours spent on each function.

Consequently, the cost correlation of the regulatory oversight of nuclear safety was 100%. Achievement of the oversight cost price is ensured by adjusting, after the annual cost accounting, the invoicing with a balancing bill to correspond the actual costs incurred. The income and costs from regulatory oversight subject to a charge were EUR 19.9 million. This figure includes the environmental radiological monitoring of nuclear facilities, which was changed from a service operation into regulatory oversight in 2015. The total costs of the regulatory oversight of the use of nuclear energy were EUR 21.2 million. This figure includes the costs of regulatory oversight subject to a charge as well as the free-of-charge. The share of activities subject to a charge accounted for 94% of the total costs. Figure 21 illustrates the annual costs of the regulatory oversight of the use of nuclear energy in 2018–2022.

Total of 14.1 person-years was spent on oversight of the Loviisa nuclear power plant, equal to 10.4% of the total working time of the personnel carrying out regulatory oversight of the use of nuclear energy. 16.1 person-years was spent on oversight of the Olkiluoto 1 and 2 plant units, equal to 11.9% of the total working time. In addition to oversight of the operation of nuclear power plants, these figures include the time allocated to nuclear safeguards. 12.4 person-years, or 9.1% of the total working time, was spent on overseeing Olkiluoto 3. Of the working time, 7.3 person-years, or 5.4% of the total working time, was work related to the Fennovoima plant project. The working time spent on overseeing Posiva was 10.9 person-years, or 8.1% of the total working time. One person-year was spent on oversight of the FiR 1 research reactor.

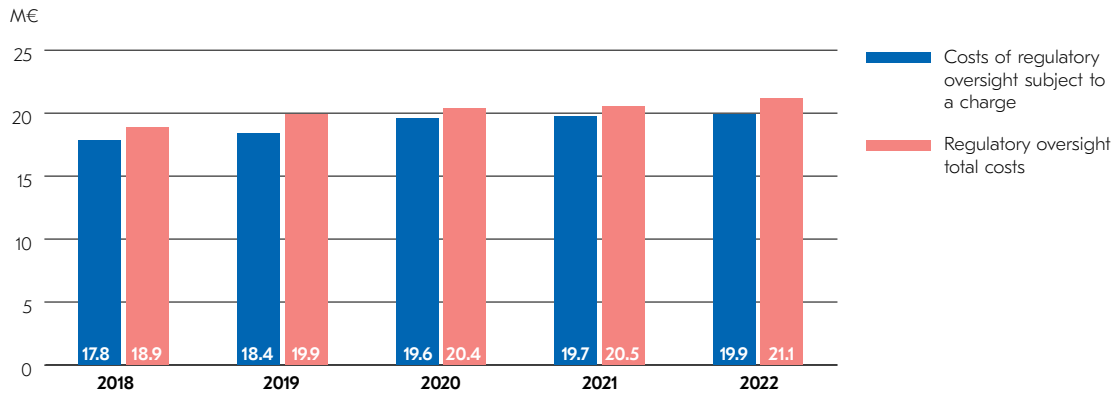


FIGURE 21. Income and costs of nuclear safety regulation.

Figure 22 shows the distribution of the working hours (expressed in person-years) of the personnel carrying out regulatory oversight of the use of nuclear energy, itemised by overseen entity, in 2016–2022.

Where necessary, STUK commissions independent assessments and analyses to support its oversight efforts. Figure 23 illustrates the procurement costs in 2018–2022. In the main, procurement in 2022 related to the following: sensitivity analyses of the seismic design bases of the plant sites; the comparison analyses and assessments to be submitted in the context of the Hanhikivi 1 construction licence application; modernisation of the refuelling machines of the Olkiluoto 1 and 2 plant units; regulatory review of the safety case of the Olkiluoto final disposal facility for low and intermediate level waste; and with regard to Posiva, assessment of the safety of the spent nuclear fuel final disposal project, as well as review of the encapsulation plant and final disposal facility lifting and transfer equipment construction plan, manufacture control and construction inspections.

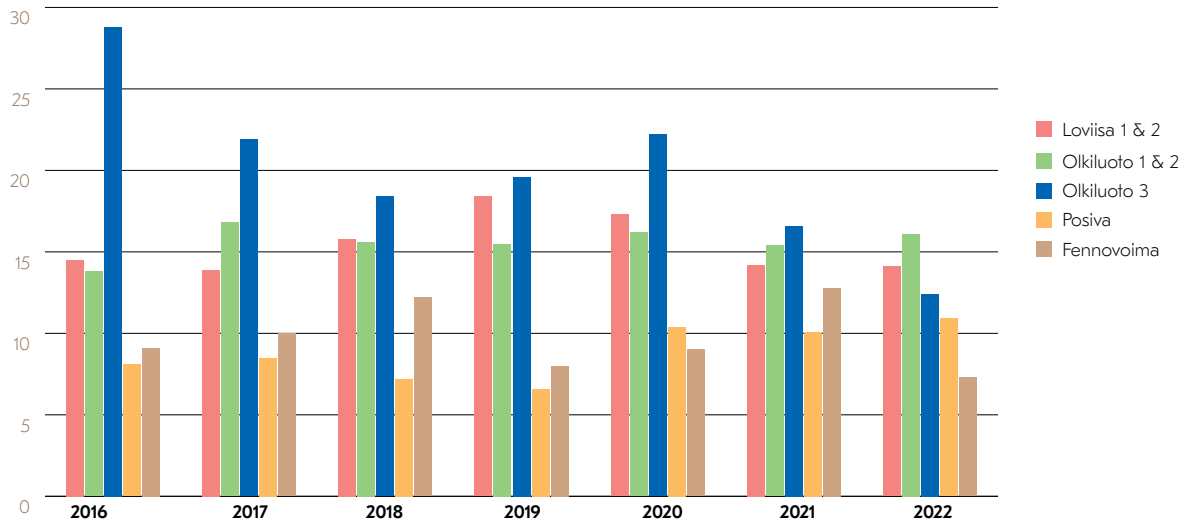


FIGURE 22. Distribution of working hours (person-years) of the regulatory personnel by subject of oversight in 2016–2022.

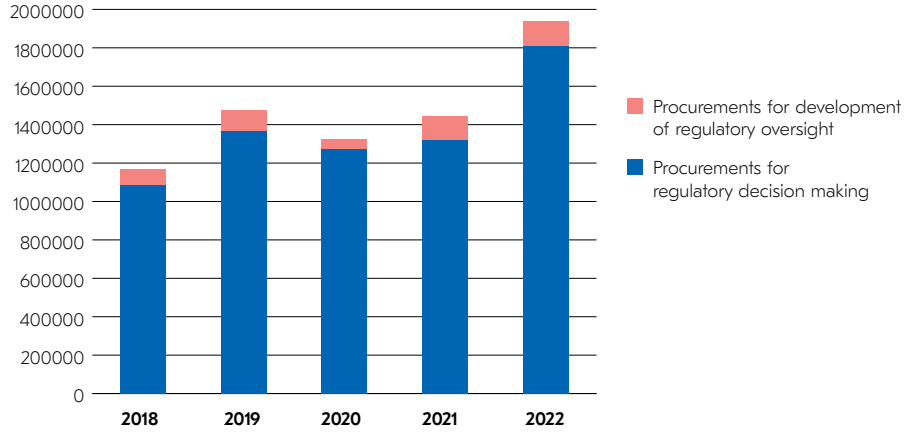


FIGURE 23. The acquisition costs of assessments and analyses.

Table 1 shows the distribution of the annual working time of the personnel carrying out regulatory oversight of the use of nuclear energy across the various performance areas. The figures do not include the work volumes of environmental radiation monitoring.

Duty area	2018	2019	2020	2021	2022
Basic operations subject to a charge	71.0	68.7	75.8	71.9	63.3
Basic operations not subject to a charge	4.8	6.3	4.0	3.0	4.1
Service activities	3.7	1.1	0.5	0.7	1.4
Regulation work and support functions	44.1	45.2	44.7	42.6	43.2
Holidays and absences	26.3	26.0	23.3	23.7	23.4
TOTAL	149.9	147.4	148.3	142.0	135.4

TABLE 1. Distribution of working time (person-years) of the regulatory personnel in each duty area.

5 International cooperation

International conventions

Non-Proliferation Treaty

The Non-Proliferation Treaty (NPT) has been in effect since 1970. 191 countries around the world are members to the treaty. The three main objectives of the treaty are the promotion of the peaceful use of energy, the non-proliferation of nuclear weapons and nuclear disarmament. According to the Non-Proliferation Treaty, nations must enter into a Safeguards Agreement with the International Atomic Energy Agency (IAEA). The first Comprehensive Safeguards Agreement (INFCIRC 155) between Finland and the IAEA entered into force on 9 February 1972. When Finland joined the EU, the agreement was replaced by the tripartite Safeguards Agreement between the countries not in possession of nuclear weapons within the European Union, the European Atomic Energy Community and the IAEA in 1995. The Additional Protocol to the Safeguards Agreement, which strengthened IAEA's oversight, entered into force in the EU in 2004.

In 2022, nine bilateral international nuclear cooperation agreements agreed by the EU were in force (Australia, Canada, Japan, Kazakhstan, South Africa, Ukraine, United Kingdom, USA, Uzbekistan). In addition, three nuclear cooperation agreements agreed by the State of Finland are in force (Russia, Saudi Arabia, South Korea). These bilateral agreements cause additional obligations for operators concerning the use of nuclear energy and reporting on it.

Convention on Nuclear Safety

The Convention on Nuclear Safety requires the presentation of a report to be prepared every three years on the fulfilment of its obligations. Since 1999, every three years Finland has been producing national reports, which are compliant with the Convention on Nuclear Safety. The latest report was produced in 2022. The fulfilment and reporting of the obligations of the convention will be assessed at an international review meeting between the contracting parties. The convention procedure also includes the possibility of asking questions about the activities of other countries. STUK evaluates, among other things, reports of our neighbouring countries and reports of countries that have engaged in international cooperation with STUK. The next meeting will take place in spring 2023. The meeting was scheduled for March 2020 but was cancelled due to the COVID-19 pandemic.

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

The review meeting for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was held in June and July 2022. The review meeting was postponed from 2021 due to the pandemic. The national report required by the

Convention was compiled during 2020 under the coordination of STUK. The report presented the matters related to Finland's nuclear waste management required by the agreement. In the country groups of the review meeting, the situation of waste management in the contracting countries is assessed. STUK chaired one country group and acted as the rapporteur in another.

The meeting reflected the war in Ukraine and the tensions between Russia and its allies and Ukraine. Several countries made statements in their national presentations condemning Russia's actions in Ukraine. A summary report of the review meeting will be published, the content of which must be agreed upon by all participating countries during the meeting. This time, there was no agreement on the content of the report: the disagreements concerned how the Russian invasion of Ukraine and its impact on the safety of nuclear waste would be expressed. Russia, supported by China and Belarus, did not want military action to be referred to without mentioning countries by the terms "human-induced actions on safety" or "military actions on safety". However, the text omitted from the summary report was included in the report of the President of the review meeting. Finland, together with 35 other Member States, submitted a statement to the President of the review meeting stating that the summary report does not reflect all the discussions in the country groups and sessions.

Convention on the Physical Protection of Nuclear Material

STUK's experts participated in the first Review Conference (RevCon) of the Convention on the Physical Protection of Nuclear Material (A/CPPNM). The conference assessed the timeliness of the Convention and its Amendment, which entered into force in 2016 and, in conclusion, accepted its adequacy in the final report.

International peer reviews

Coordinated by the IAEA, an international IRRS peer review (Integrated Regulatory Review Service) on the use of nuclear energy and radiation was carried out in Finland in October 2022. Its aim is to improve and enhance safety oversight and related general arrangements in Finland. The assessment group gave Finland 16 recommendations and 13 suggestions for developing the activities and identified three particular good practices: the overall safety assessment of the use of nuclear energy, communication and stakeholder consultation and the development of a web-based search tool.

Coordinated by the IAEA, a peer review of the management of nuclear and radioactive waste (ARTEMIS) was carried out in Finland in November–December 2022. Its objective is to provide an independent expert assessment and advice on the management and decommissioning of radioactive waste and spent fuel based on the IAEA's safety standards and guidelines and international practices. ARTEMIS was arranged temporally close to the IRRS mission so that both could make use of each other. The assessment was carried out by eight experts from the IAEA Member States, and the result was that the management of Finland's radioactive waste and spent fuel has been arranged in a safe and responsible manner. According to the assessment, Finland's nuclear waste management programme will effectively support the achievement of the climate change goals. Based on the assessment, the expert group gave Finland a mention of good practice in the progress of the spent nuclear fuel

final disposal project. In addition, the assessment group made a total of eight proposals and recommendations for improving activities.

In Finland, the third (2009, 2012, 2022) International Physical Protection Advisory Service (IPPAS) mission was carried out at the invitation of the MEAE. In the mission, the level of the nuclear security system of a Member State is assessed against the Convention on the Physical Protection (A/CPPNM) and the IAEA guidelines. In the review, Finland received recommendations for the development of security systems, and the evaluation team also identified several good practices for the further development of security systems in other countries.

International cooperation groups

The IAEA continued to develop its safety standards on nuclear safety and security in 2022. STUK had a representative on the Commission on Safety Standards (CSS) managing the preparation of the standards as well as in the committees dealing with the content of the standards, i.e. the Nuclear Safety Standards Committee (**NUSSC**), the Waste Safety Standards Committee (**WASSC**), the Radiation Safety Standards Committee (**RASSC**), the Transport Safety Standards Committee (**TRANSSC**), the Emergency Preparedness Committee (**EPReSC**) and the Nuclear Security Guidance Committee (NSGC). STUK issued statements on the IAEA safety standards under preparation.

The Nuclear Energy Agency of the **OECD (NEA)** coordinates international cooperation in the field of safety research in particular. The organisation also provides an opportunity for cooperation between regulatory authorities. STUK was represented on all main committees of the organisation dealing with radiation and nuclear safety issues. The main committees' fields of activity are nuclear safety regulation (**CNRA**, Committee on Nuclear Regulatory Activities), safety research (**CSNI**, Committee on the Safety of Nuclear Installations), radiation safety (**CRPPH**, Committee on Radiation Protection and Public Health) and nuclear waste management (**RWMC**, Radioactive Waste Management Committee).

The Multinational Design Evaluation Programme (**MDEP**) involves seven countries with the objective of improving cooperation in the field of the assessment of new nuclear power plants and developing convergent regulatory practices. Participants in the programme include only those countries with new nuclear power plants at some stage of assessment by the regulatory authorities. The OECD Nuclear Energy Agency (NEA) functions as the secretariat for the programme. The MDEP's work is organised in the Policy Group and plant-type-specific working groups, which at the moment include working groups for the VVER and HPR1000 plant types. In early 2022, STUK participated in the activities of the VVER working group, acting as chair of the group, but withdrew from the cooperation when Fennovoima ended its Hanhikivi 1 plant project.

WENRA's (Western European Regulator's Association) Reactor Harmonisation Working Group (**RHWG**) convened three times in 2022. Due to the COVID-19 pandemic, the first meeting of the year was held remotely, but the other meetings were held on site. Over the course of the year, the group's most important tasks continued the periodic assessment of reference levels and finalised a technical content description for the topic-specific peer review

prescribed by the Nuclear Safety Directive, which now focuses on fire safety and which will be conducted in 2023. STUK actively took part in the efforts of the group and in its subgroups.

WENRA's Working Group on Waste and Decommissioning (**WGWD**) convened in Brussels once in 2022. Self-assessments and peer reviews of reference levels associated with disposal were continued during the year, as were self-assessments and peer reviews of the reference level report on nuclear waste processing facilities. STUK actively took part in the group's efforts.

The SRL Steering Group, which discusses the harmonisation of WENRA's reference levels, remotely convened four times in 2022.

STUK participated in the activities of the European Nuclear Safety Regulators Group (**ENSREG** and three of its subgroups (nuclear safety, nuclear waste management and communication).

At the beginning of the year, the ENSREG Nuclear Safety Group finalised a summary report on the national measures related to the EU stress tests that had been initiated due to the Fukushima incident and the state of their implementation. The summary report is prepared every two years. The report was published in April 2022. In addition, a topical peer review under the Nuclear Safety Directive, which is conducted every six years, was prepared in 2022 on the topic of fire protection. The first peer review was conducted in 2017–2018 on the topic of ageing management of nuclear power plants. The Nuclear Safety Group developed procedures for conducting the review. The preparation of national assessment reports for the second peer review began in the summer.

The ENSREG Nuclear Waste Management Group carried out an investigation on the licensing of the decommissioning of nuclear facilities in the Member States. Based on the results, the licensing practices could be divided into three categories: 1) there is a separate licence phase for decommissioning, 2) a life cycle licence is in use, and 3) a separate licence for decommissioning is not required. In addition, a study was carried out on the practices of the Member States in the management of medical radioactive waste. In the future, the aim is to identify good practices from different countries and make recommendations based on them. In addition to its own investigations, the group discussed a study commissioned by the European Commission on the classification practices of radioactive waste in the Member States. The results discussed were preliminary, as the final report of the study had not yet been published. The study compares the practices with the Commission Recommendation of 1999 and IAEA Guide GSG-1. The processing of the results will continue during 2023, focusing on the need to regulate and instruct the classification in detail. STUK participated in the joint **IRRS** and **ARTEMIS** peer review optimisation project of ENSREG's nuclear safety and nuclear waste management groups. In addition to ENSREG, the IAEA was involved in the discussions. The work will continue during 2023, when many other countries have experience in the implementation of the missions.

The Deep geological repository regulators forum (**DGRRF**) is a cooperation forum for six nuclear and radiation safety authorities (USA, Canada, Sweden, France, Switzerland and Finland) where disposal projects for spent nuclear fuel and high-level nuclear waste are discussed from the perspective of public authorities. The workshop planned for 2020 in Finland was postponed until May 2023.

The VVER Forum is a cooperation group for authorities operating Russian VVER pressurized water-type nuclear facilities, mainly concentrating on developing oversight activities of plants operating in its member countries. STUK participated in the activities of the VVER Forum's working groups in late 2022. The annual meeting of the Forum and most of the meetings of the working groups were postponed due to the war between Russia and Ukraine.

The European Nuclear Security Regulators Association (**ENSRA**), which develops nuclear security systems through information exchange and working group work, convened twice in 2022. A representative of STUK attended the meetings.

Bilateral cooperation between authorities

STUK started regular cooperation with the French nuclear safety authority, Autorité de sûreté nucléaire (ASN), and its support organisation, Institut de radioprotection et de sûreté nucléaire (IRSN), when the Olkiluoto 3 project was launched in the early 2000s and later with the United Kingdom's nuclear safety authority, the Office for Nuclear Regulation, and the Chinese nuclear safety authority, the National Nuclear Safety Administration (NNSA). During the cooperation, the regulatory practices and requirements of the countries involved have been compared and technical solutions and construction of EPR plants under construction and in use (Olkiluoto 3, Taishan 1, Taishan 2, Flamanville 3 and Hinkley Point C) and challenges and problems in their commissioning and operation have been discussed. In 2022, STUK held several information exchange meetings with ONR, ASN, IRSN and NNSA to discuss observations related to construction, testing and operation from different EPR units. Special topics included topical issues related to nuclear fuel and mechanical components.

In early 2022, STUK continued its cooperation with the Hungarian radiation and nuclear safety authority (HAEA) on issues related to the AES-2006 nuclear power plant type. Discussions on this plant type ended when the Fennovoima plant project expired, but cooperation between the authorities has continued with regard to the VVER-440 plants in use in Paks and Loviisa.

STUK conducts bilateral cooperation in the field of nuclear safeguards, for example, with the Belgian authority (FANC). In connection with the IAEA General Conference, STUK and FANC organised a side event in 2021 on taking into account the requirements of nuclear safeguards in the planning and implementation of the use of nuclear energy (Safeguards by Design, SBD). The cooperation continued in 2022, when the first workshop on SBD was organised together with the IAEA and the European Commission. After the workshop, it was decided to continue the cooperation on the five issues agreed between STUK and FANC by starting the preparation of the next workshop, to be held in 2023, on taking into account the design requirements of nuclear safeguards in legislation and regulatory guidelines.

Cooperation for the prevention of the proliferation of nuclear weapons

The NPT Review Conference, held every five years, was held in New York in August 2022, following the postponements due to the COVID-19 pandemic. The next review conference will be held in 2026. The conference will be preceded by the annual meetings of the preparatory committee.

The Nuclear Suppliers Group (NSG) forms a multinational control system that aims to prevent the proliferation of nuclear weapons by controlling the export of materials, equipment and technology used in the manufacture of nuclear weapons. The group consists of 48 countries, and Finland is represented in the group by the Ministry for Foreign Affairs, which STUK supports by attending the meetings of the Technical Experts Group (TEG) on request.

The Finnish Support Programme to the IAEA Safeguards (FINSP) is funded by the Ministry for Foreign Affairs and coordinated by STUK. The objective of the programme is to provide support to the IAEA in tasks related to the development of oversight methods, the preparation of oversight plans and the training of the IAEA inspectors. In 2022, the support programme had 13 on-going projects. The Finnish support programme had a review meeting with the IAEA in November 2022.

There are STUK's experts in ESARDA's (European Safeguards Research and Development Association) committees, working groups and editorial committee. STUK is also a member of ESARDA's Steering Committee and Executive Board. STUK's experts served as deputy chairs of the Implementation of Safeguards working group and the Export Control working groups. ESARDA held its biennial meeting in Luxembourg in May 2022. In addition to this, ESARDA's working groups convened separately in November. The objective is to continuously oversee and respond to the needs of ESARDA's members and further the nuclear safeguards goals on a national and international level.

The tenth meeting of the EPGR cooperation group (Encapsulation Plant and Geological Repository) of the IAEA, the European Commission and representatives of Sweden and Finland took place in February 2022. The main topics of the meeting included the plans for the safeguards-by-design oversight of Posiva's encapsulation plant and the underground disposal facility and the preparations for implementation (required monitoring equipment and their installation planning). In addition to the actual EPGR meeting, two tripartite meetings (Finland, EC and IAEA) were held on the oversight of the final disposal facility and the technical consensus paper on the organisation of oversight and several technical meetings on the detailed plans for the technical oversight of the encapsulation plant.

APPENDIX 1
Objects of regulation

Loviisa nuclear power plant

Plant unit	Start-up	National Grid	Nimellissähköteho, (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 Oct1979	920/890	Boiling water reactor (BWR), Asea Atom
Olkiluoto 2	18 Feb 1980	1 July 1982	920/890	Boiling water reactor (BWR), Asea Atom
Olkiluoto 3	21 Dec 2021	–	Approx 1,600 (net)	Pressurised water reactor (EPR), Areva NP

Teollisuuden Voima Oyj owns the Olkiluoto 1 and 2 plant units located at Olkiluoto in Eurajoki, as well as the Olkiluoto 3 plant unit that is in the nuclear commissioning phase.

Hanhikivi nuclar power plant project

Plant unit	Supplemented decision-in-principle approved	Nominal electric power, net (MW)	Type, supplier
Hanhikivi 1	5 Dec 2014	Approx. 1,200	Pressurised Water Reactor (PWR), ROSATOM

The Hanhikivi FH1 nuclear power plant is a power plant project of Fennovoima Oy. When the project failed, STUK terminated the safety assessment of the construction licence application, but it will continue to pursue oversight of the information pertaining to safety and nuclear materials until the information is returned or disposed of.

Olkiluoto encapsulation plant and disposal facility

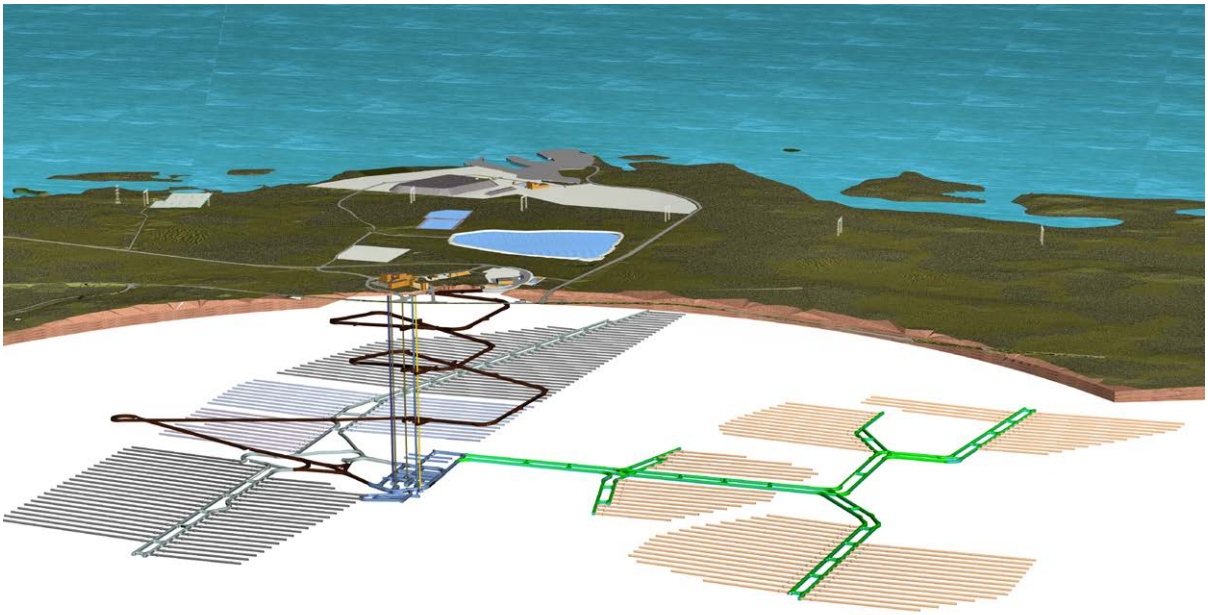


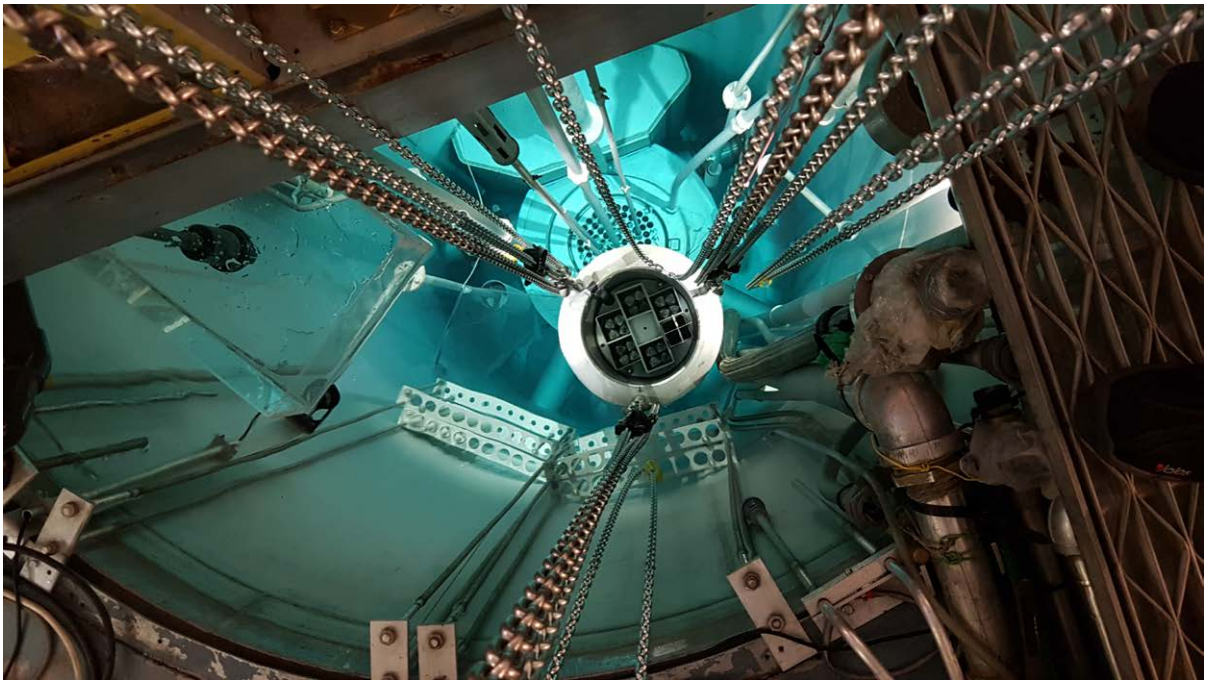
Diagram of the Olkiluoto encapsulation and disposal facility (Posiva Oy).

In November 2015, the Government granted Posiva Oy a construction licence for the Olkiluoto encapsulation plant and final disposal facility. The planned facility consists of an overground spent nuclear fuel encapsulation plant, an underground final disposal facility, and a number of other buildings that support the operation of the entire facility. As part of the underground research facility (Onkalo), starting from 2004, Posiva built an access tunnel, three shafts and, at a depth of 420–437 metres, a technical facility and a research area. Construction of the final disposal facility was launched in late 2016. For the purposes of the final disposal facility, the underground facility will be expanded with two additional shafts, and with a number of final disposal tunnels to be excavated in stages. In the relevant decision-in-principle, construction of an underground research facility was a prerequisite for the submission of a construction licence application.

Constructed above the final disposal facility, the encapsulation plant is an overground facility for the encapsulation of spent nuclear fuel. Construction of the encapsulation plant was launched in summer 2019. From the encapsulation plant, capsules will be transferred along an elevator shaft to the final disposal facility for final disposal in the disposal holes drilled in underground tunnels.

Posiva submitted an operating licence application to the Government at the end of 2021. Operations will start after the plant has been test-run and the operating licence granted, estimated to be in 2025.

FiR 1 research reactor



Plant	Thermal power	In operation	Fuel	TRIGA reactor's fuel type
TRIGA Mark II research reactor	250 kW	03/1962 – 06/2015	reactor core contains 80 fuel rods with 15 kg of uranium	uranium–zirkonium hydrid combination: 8% of uranium 91% of zirkonium and 1% of hydrogen

The use of VTT's FiR 1 research reactor in Otaniemi, Espoo, started in March 1962. VTT ended the use of the reactor in June 2015, and the reactor was placed into a permanent shutdown state. VTT submitted the operating licence application regarding decommissioning to the Government in June 2017. The licence was granted in June 2021.

Other objects of regulatory oversight

In accordance with Section 2 of the Nuclear Energy Act, the scope of the regulatory oversight of the use of nuclear energy also covers nuclear materials, which can be found, for instance, at some research laboratories and in industry. This oversight also covers nuclear devices, equipment and information, as well as nuclear fuel cycle-related research and development activities and the transport of nuclear materials and nuclear waste. The regulatory oversight of the use of nuclear energy also covers mining and milling operations aimed at producing uranium or thorium. Terrafame's uranium extraction plant belongs to this group. Uranium bearing semi-finished products from the metal-working industry fall within the scope of the regulatory control of the use of nuclear energy when the concentration that is defined for nuclear material is exceeded in an industrial process or product.

APPENDIX 2
Significant events at nuclear power plants

Loviisa power plant

Loviisa annual outages, 7 August–16 October 2022

Fortum carried out on Unit 2 of the Loviisa nuclear power plant an outage procedure, performed at four-year intervals, during which the fuel was replaced and a number of more extensive modifications were implemented, the reactor was emptied of all fuel and the reactor pressure vessel welds were subjected to detailed inspection. On Unit 1, Fortum carried out a so-called short annual outage procedure, whereby the company replaced some of the fuel in the reactor with fresh fuel, carried out necessary repairs, and continued works to make possible the ageing management and improved safety of the plant.

The annual outages at the Loviisa nuclear power plant started with the stopping of the Loviisa 2 unit (LO2) on 7 August 2022. The annual outage of Loviisa 1 (LO1) began on 17 September 2022. The following is a list of the most safety-relevant annual outage modifications.

- Both plant units:
  - the main works for the replacement of the process computer used for controlling and monitoring the plant (preliminary works were carried out in 2019–2021). At LO1, this also meant that the modification was deployed. LO2 will see the finishing works and the introduction carried out in 2023.
  - immediately at the start of the annual outage: test runs concerning, and introduction into use of, the modernisation of the neutron flux monitoring that is performed during fuel loading, in order for the new monitoring system to be operational during the 2022 fuel transfers (the actual modification was carried out during the 2021–2022 operating cycle).
- Loviisa 2:
  - replacement of the low-frequency converters of the motors of all control rods – an equivalent modification was carried out at LO1 in 2020.
- Loviisa 1:
  - improvement of the redundancy of the power supplies of the magnetic loads of the pressuriser control valves. For LO2, this modification was completed in 2021
  - replacement of the cooling water pipes of one emergency diesel generator. This modification will be implemented for the other LO1 emergency diesel generators in the coming years. At LO2, an equivalent replacement was carried out in 2018–2021.

- third phase of the emergency diesel generator I&C update, consisting of modernisation of the control system of one diesel generator (for the last emergency diesel generator. The intention is to carry out the replacement during the 2023 annual outage; Fortum has not made a decision on the implementation of an equivalent modernisation for LO2).

One important ageing management-related job concerned the additional protection elements installed in the LO2 reactor to replace 12 fuel elements, which reduces the neutron radiation dose to which the reactor pressure vessel is exposed, supporting the ensuring of the adequacy of the pressure vessel brittle fracture margin. For LO1, similar protection elements are intended to be installed in 2023.

The LO1 annual outage was completed approximately one week later than planned. This was caused by a leak in the seal water pipe of the primary circuit main control pump (see below for a more detailed description). The leak was due to a new type of connector, provided in the ongoing annual outage, that had become detached. As a precautionary measure, before plant start-up, Fortum replaced all connectors of this type with the type used previously.

STUK inspected and approved the plans for the works carried out during the annual outages, including the repairs of the above main control pump seal water pipe, as well as overseeing the performance of these works and approving the outcome.

The 2022 annual outage was overseen by approximately 30 STUK experts. They ensured that Fortum took appropriate care of radiation and nuclear safety during the annual outage works.

During the annual outages, under the periodic inspection programme, STUK also carried out an inspection that was focused on the annual outages. No safety deficiencies that would have required immediate intervention by STUK emerged during the inspection. The relevant inspection summary is provided in Appendix 3. Based on the inspection and the oversight performed by STUK, the annual outages were carried out safely, and all planned safety-relevant works were completed successfully.

Leak in the main control pump seal water line in the Loviisa 1 annual outage

In the afternoon of 5 October 2022, the LO1 annual outage detected a small leak on the primary circuit in the main control pump seal water line, when the plant was increasing the pressure level ahead of the primary circuit tightness test. The tightness test ensures the tightness of the systems part of the primary circuit before plant start-up.

As a consequence of this event, Fortum immediately interrupted the pressure test, and the pressure and the temperature in the primary circuit were lowered to allow for inspection and repair. As this event occurred during annual outage, the reactor is then already in a safe state, with subcriticality ensured and residual heat production at a very low level.

After detection of the leak, the containment was evacuated of the people who were there in order to ensure their personal safety. No one was injured, and measurements confirmed that the people who exited the containment were not contaminated. An event like this does not cause a release into the environment, because the leak occurs inside a leaktight containment, from which air is extracted only after filtering.

This is a deviation of low safety significance. The event did not pose any risk to humans, the environment or the plant. On the international INES scale, this event is rated 0, no safety significance.

However, the event had a major impact on the annual outage schedule (about one week). In addition to this leak repair, wetting of the main control pumps and the moisture in the process room resulted in significant cleaning and maintenance needs.

The leaky connector on the seal water line was of a new type, and during this annual outage such connectors had been installed on two serviced main control pumps. As a precautionary measure, Fortum replaced all of these with the models used previously. STUK oversaw the connector replacement installations and the other leak repair works, granting permission to start up the plant only when it was safe to do so.

After the annual outage, concerning this event, Fortum submitted to STUK an event report together with the relevant root cause analysis. On the basis of the investigation carried out by Fortum, the root cause of this event was that the modification had been furthered in spite of a failure to tighten the new connectors fully correctly. Fortum had already investigated the installation method before installation, detecting differences from the normal tightening method, but as the connections passed all pressure tests that were performed (at high overpressure) in these contexts, the tightening method used was considered adequate. In future, Fortum will be investigating in greater detail the suitability of this connector for applications of this type, while also taking broader account of the lessons learned now in how it manages modifications.

Leaky flange connection of the pressuriser pilot line at Loviisa 2 and related repair, 1–4 October 2022

LO2 was in a state of power operation after the annual outage when, on 27 September 2022, Fortum detected some increased concentrations of the radioactive nuclides 135Xe and 133Xe in a containment indoor air sample. This was indicative of a leak on the primary circuit inside the containment. Fortum investigated the situation and, during an inspection round on 30 September 2022, detected a small leak in the pressuriser control valve flange connection. To repair the leaky connection, Fortum decided to bring the plant unit to a cold shutdown. The shutdown was started on 1 October 2022, with the cold shutdown being achieved the next day. Fortum replaced the seal, and the actual flanges were not found to be damaged. After this repair, Fortum started up the plant.

During the event, all safety systems were operable, and the event had a very low impact on plant safety. This was an extremely small coolant leak, and the radioactive substances released by the leak were filtered during ventilation of the containment.

Fortum reports that the immediate cause of the event was a leaky flange connection. The seal had been installed askew on the flange connection, allowing steam to slowly make its way into the seal and, finally, to leak out.

Fortum finds that the root cause of the event was a defective original design. A different flange design would facilitate installation of the seal, making it less prone to misinstallation. By way of remedy, Fortum will design and implement a new flange connection, as well as

exploring the possibility to increase the screw torque in order to ensure the integrity of the connection.

Defects in 6kV circuit-breaker torque motors

The Loviisa power plant 6kV switchgear circuit breakers were replaced in 2009–2013. In 2014, a defect was detected in one of these switchgear circuit breakers. A gearwheel in the circuit-breaker torque motor had failed, preventing automatic reloading of the circuit breaker.

Fortum started to monitor any possible defects that might occur in the circuit breakers. The next time a similar fault occurred was in 2018. Fortum contacted the circuit breaker manufacturer and, in a joint effort with the manufacturer, steps were taken to improve the preventive maintenance of the circuit breakers, through means such as better lubrication. In spite of this, similar defects continued to occur, at a rate of approximate two instances every year.

Following these defects, Fortum in 2021 decided to replace the circuit-breaker torque motors during the 2022 and 2023 annual outages. In spring 2022, however, two faults occurred in the circuit breakers, on two consecutive days. Fortum concluded from this that there might be an increasing incidence of circuit-breaker defects in future. As a result, Fortum rapidly replaced the torque motors of the safety system related circuit breakers during power operation in two subsystems. Some of the remaining torque motors were replaced during the 2022 annual outages, with the rest to be replaced during the 2023 annual outages. The new torque motors feature increased gearwheel durability.

The defects in the torque motors of the 6kV switchgear circuit breakers were detected quickly and successfully, and did not pose any hazard to the safety functions. Replacement of the torque motors in the two subsystems prevented the – albeit unlikely – occurrence of common-cause failure in the safety systems in the event of an accident.

Situations in breach of Operational Limits and Conditions

In the course of 2022, five events were detected to be in breach of the Operational Limits and Conditions (OLCs), all of which were classified as INES 0 on the International Nuclear and Radiological Event Scale (INES) and all of which were without safety significance.

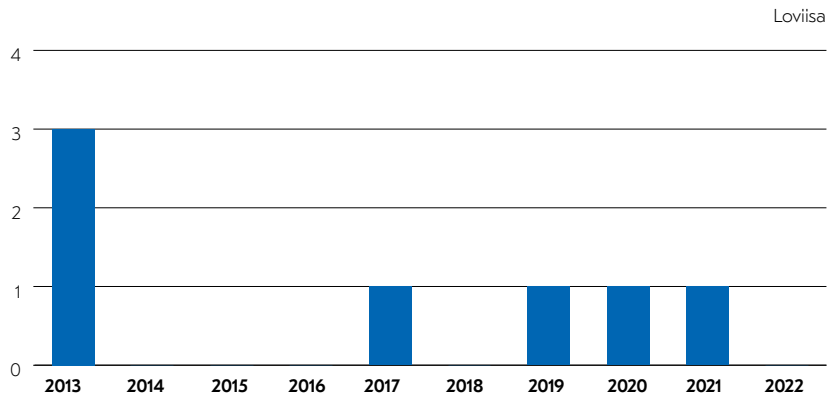


FIGURE A2.1 INES classified events at the Loviisa plant (INES Level 1).

- On 27 August 2022, the Loviisa 2 annual outage intended to test a nitrogen bottle line control valve associated with the interlocking of the doors of an ice condenser. The corresponding LO2 and LO1 valves are located in the same room. A contractor inadvertently separated and detached the valve belonging to LO1, which was being power operated. This resulted in a situation that breached the OLCs, as one of the two LO1 subsystems was separated. Following shutting of the bottle valves, the pressure in the nitrogen line dropped, which triggered an alarm in the Loviisa 1 control room, based on which the detached control valve was returned back to its place and the bottle valves were opened. The situation was restored successfully in about one hour. The event weakened the reliability of the serious accident management related safety function but would not, however, have prevented the fulfilment of the safety function.
- In the context of planning to start the interim inspections of the level measurements of the make-up water tanks of the Loviisa 2 plant make-up water supply system on 13 May 2022, Fortum detected that the work would cause level measurement inoperability, which according to the OLCs is not allowed during the power operation of LO2. The work was not carried out. In the same connection, however, it was found that the preventive maintenance procedures in question had previously been carried out on the corresponding LO1 level measurements during power operation in 2019 and 2021 and on the LO2 level measurements in 2020, in breach of the OLCs. The event was investigated by Fortum, establishing that the reason for this was that a modification of the safety functions of the secondary circuit, which was performed in 2018 and also covered level measurements, did not take account of the preventive maintenance procedures in assessing the OLC effects which that modification has. A contributing factor was that the OLC modification template at that time did not guide towards performing an examination of the preventive maintenance programmes. Based on the event, Fortum checked all OLC modifications of this type, and updated its guides, instructions and process descriptions.
- On 20 September 2022, during the Loviisa 1 annual outage, Fortum detected that there was no cooling to one of the heat exchangers of the residual heat removal system, a requirement under the OLCs. This loss of cooling was due to separation of the normal cooling water route owing to repair works on a service cooling water system valve, ongoing at the same time. As the event emerged, the separation required by the valve repair works was returned such that it was possible to return the plant to a state that conformed to the OLCs. The OLCs require that both heat exchangers be in working order in this cold shutdown state. The situation remained in breach of the OLCs for approximately one day. However, it was possible to remove residual heat from the shut-down reactor normally, as the other subsystem of the residual heat removal system was in working order. The root cause of this event was that the impact that the separation had on the cooling provided to the residual heat exchanger had not been identified in the planning carried out ahead of the valve repair. Additionally, the work passed the verifying inspections to which the work was subject. The shortcomings can partly be attributed to haste, as the relevant operation limitations were approved as close to the allowed point in time as possible, and there was a high number of work orders that had to be processed at the same time. Fortum will take account of these issues in training, while

in future distributing the processing of the annual outage work orders across a longer time period before the next annual outages.

- On 18 July 2022, the shift supervisor found out that the work orders of the interim inspections of the fuel pool cooling system flow measurements were not included in the OLC circulation, despite them being devices to which the OLCs apply. In the periodic inspection of the flow measurements, the measurement transmitter is separated, preventing the proper functioning of the stop signal, which protects the fuel pool cooling pump and which warns about the flow being too low. During the periodic inspection, however, this procedure does not influence the other redundant pump that is in use. Should it be necessary to deploy the pump of this redundancy during the work, the measurement could be restored quickly. On investigating this, it was established that interim inspections of this type had been carried out in a similar manner in 2018–2022. The function in question was changed when installing the new I&C in 2016, at which time the issue had been overlooked. Fortum will ensure that preventive maintenance will be developed to conform to the OLCs, and it will review all service places that were modified at the time of the I&C update in 2016–2018. This is in order for Fortum to ensure that, in the service place data and preventive maintenance data, appropriate consideration is given to the OLC requirements.

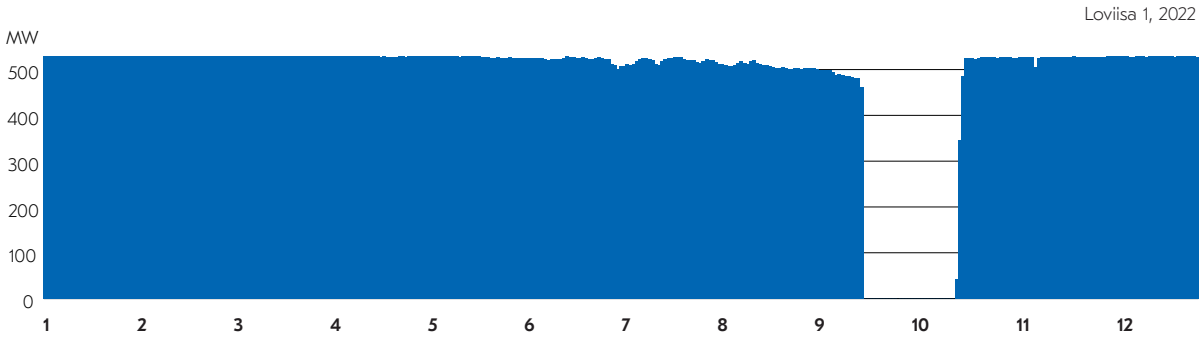


FIGURE A2.2 Daily average gross electrical power of the Loviisa 1 plant unit in 2022.

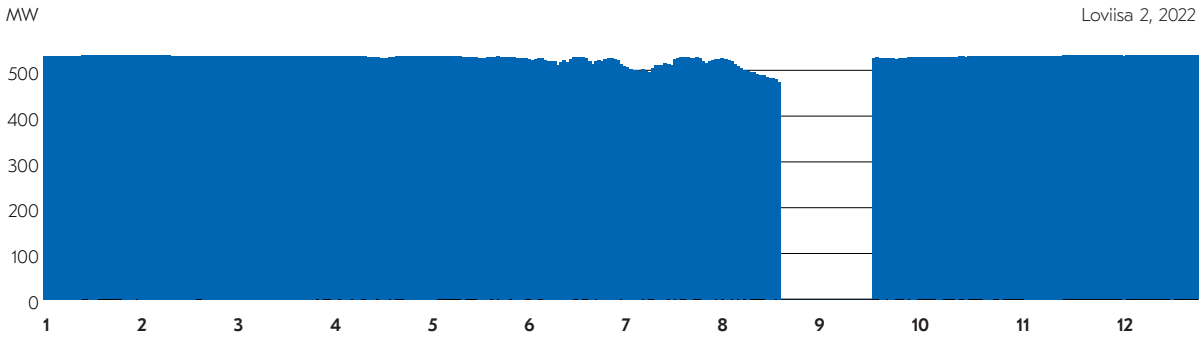


FIGURE A2.3 Daily average gross electrical power of the Loviisa 2 plant unit in 2022.

- In the Loviisa 2 2022 annual outage, in the course of lowering the level of one steam generator whereby water is routed to the chemical supply system tank, it was detected that a residual heat removal pump stopped due to low suction pressure. One valve, connecting the feedwater tank to the chemical supply system tank, had been mistakenly left open, also causing the level to drop in the feedwater tank that serves as the source of water for the residual heat removal pump. The measures to drop the level of the steam generator had been started at the wrong section of the user manual, skipping the procedures on the previous page of the manual. The operating shift detected this event immediately and initiated measures to remedy the situation. At the same time, maintenance work was ongoing on the other feedwater tank, meaning that the plant unit was in breach of the OLCs for approximately 30 minutes, as neither feedwater tank was in the condition required by the cold shutdown. 30-minute inoperability of the residual heat removal system does not pose any risk to fuel integrity, and it does not give rise to a need to start the back-up residual heat removal system, which is why the event as such was not relevant for plant safety. The residual heat removal back-up systems were operable, as required by the OLCs. The remedial measures included Fortum going through the event with the relevant working group and it will organise training in order to identify the risks associated with water transfers.

Olkiluodon power plant

Olkiluoto annual outages, 24 April–10 June 2022

In terms of nuclear and radiation safety, the annual outages of the plant units were implemented as planned. The strict measures applied in 2020 and 2021 to contain the spread of coronavirus infections had, for the most part, been abandoned, and the COVID-19 pandemic did not pose any major challenge to the implementation of the annual outages. The annual outages took place between April and June. The programme for OL1 included a maintenance outage (actual duration: 32 days), and for OL2 there was a refuelling outage (actual duration: 9 days).

For OL1, in addition to the normal maintenance and inspection works part of the refuelling outage, the significant works included replacement of the pumps of the shut-down reactor cooling system, maintenance of two seawater channels, and replacement of the containment penetration modules. The shut-down reactor cooling system has two pumps, both of which were replaced with a new type during the OL1 maintenance outage. A similar replacement was carried out in 2021 for OL2, replacing only one of the pumps. It was identified at that time that, from a structural and radiation protection perspective, replacement of the pumps is extremely challenging. However, the work on OL1 was carried out extremely well, drawing on the lessons learned the previous year. The reinforcement of the seawater channels was also carried out well, and in this work too the experience gained from the corresponding work performed on OL2 in 2021 was evident. The OL1 main control room was fitted with bypass switches for the unnecessarily high-level tripping of reactor level measurement, a significant safety improvement. Additionally, a number of measurements and alarms indicating level

measurement failure were implemented. The bottom of the OL1 reactor pressure vessel was inspected successfully.

A visual inspection of the steam separator, carried out during the OL1 maintenance outage, detected a crack in the separator pipe of the steam separator lid. TVO submitted to STUK a report on this observed crack, concluding that the observation does not preclude starting the plant up from the annual outage. The report claims that it is not foreseeable that the crack will grow, and the crack will not negatively affect plant safety, not even in the event that it – against expectations – continues to grow. STUK approved TVO's report, subject to two requirements. STUK required that the faulty area be inspected in the following three annual outages and that the positions of the outer edge of the standpipes be inspected for both plant units in the 2023 annual outage. STUK also required that TVO take the necessary steps to prepare to repair the steam separator during the 2023 annual outage, should the crack be observed to have grown beyond the relevant criterion to be set in advance. A plan for this repair, and the criterion for the implementation of the repair, must be submitted to STUK before the 2023 annual outages.

STUK oversaw the annual outages from the time of their design to the start-up of the plant units. During the annual outage, STUK conducted the mechanical equipment inspections laid down in the YVL Guides as normal, and STUK's resident inspectors carried out general oversight at the plant site. During the annual outage, STUK also carried out a KTO inspection that was focused on the annual outage. The relevant inspection summary is provided in Appendix 3. As a whole, the quantity of the oversight activities that STUK performed at the plant site returned to the pre-COVID-19 pandemic level.

According to STUK's oversight, the annual outages were carried out safely. With regard to the events that occurred during the OL1 annual outage, TVO decided to launch two event investigations, the reports of which were submitted to STUK. The first concerned an installation error made in the maintenance of the control rod actuators. The second event investigation focused on a water leak in the turbine plant whereby, while making maintenance preparations for the seawater channels, the level in the discharge channel was allowed to rise and water overflowed to the turbine plant through an open manhole. The safety significance of both events was low but, regarding the events, several issues were identified for development, for example in respect of the work instructions and work permit procedures.

Deviation from OLCs with regard to fire protection

In early 2022, TVO detected some ambiguities in how firewatching rounds were carried out at the OL3 plant unit. TVO's instructions and the OLCs require that firewatching rounds be performed at three-hour intervals during separation of any of the fire protection systems. Due to maintenance works, the OL3 fire water and spray systems were separated from one emergency diesel generator on 14 February 2022. TVO found on 16 February 2022 that some firewatching rounds had been recorded as performed even though not all rounds had been performed and some rounds were inadequate. Following these observed shortcomings, TVO launched an event investigation in order to understand the extent of the defective approach and the reasons for it, as well as the related effects on plant safety, and to fix the relevant operational failures.

In the course of the investigation, it was found that the fire brigade shifts, at all plant units, were extensively impaired by equivalent defective approaches, and that they had continued for many years. Judged on the basis of this investigation, the fire brigade's activities were affected by a defective safety culture. A total of three similar events whereby there was a failure to carry out some fire-protection rounds were identified (one at OL1, one at OL2 and one at OL3). As, during these events, the monitoring rounds had not been carried out in compliance with the OLCs, potential fire safety relevant deviations could have gone undetected and the resulting potential fires might not have been prevented. However, the safety significance of these events was assessed to be low because, due to the functioning fire compartments, the consequences of any possible fire would have remained local and they would not have posed a risk to the safety of the plant.

Several human and culture factors were identified as having contributed to the event. The remedial measures included that TVO immediately stepped up the guidance and control of the firewatching rounds. The other measures concern remedying the fire brigade's practices, ensuring the development of competences, determining the relevant expectations for the firewatching rounds, and monitoring the development of the operating culture.

On the International Nuclear and Radiological Event Scale (INES), STUK rated the event at level INES 1, indicating that it is an anomaly with safety significance. Rating the event as INES 1 is justified based on the shortcomings that were observed in the safety culture. In the autumn, STUK carried out an extraordinary KTO inspection, reviewing the progress made with the measures that TVO determined following this event. The relevant inspection summary (Organisational transition of the safety function) is provided in Appendix 3.

Situations in breach of Operational Limits and Conditions

During 2022, a total of six situations were observed to be in breach of the OLCs. The safety significance of these events was estimated to be low.

- In February 2022, TVO detected some ambiguities in how the firewatching rounds required under the OLCs were carried out. A more detailed description of this event is provided in the Section 'Deviation from OLCs with regard to fire protection' of this Appendix. The INES level of the event is INES 1.
- On 16 September 2022, repairs carried out at the OL2 plant unit on a venting system control valve also caused, in breach of the OLCs, the failure of another control valve that was in use. In the planning ahead of the repair, it had not been identified that the pressure control system sends a pre-set value, determined based on reactor power, to the isolation amplifier of a certain valve only, from which it is then relayed to the controls of the other valve. When, in order to calibrate the isolation amplifier, the pre-set value relay coming from the pressure control system was detached from the isolation amplifier board of one valve, the pre-set value received by the other valve was also reset to zero and the valve closed, leading to a situation where the pressure control function was not operable as required by the OLCs. After repairing the fault in the valve that was worked on, the other valve also returned to the OPEN position. All in all, the situation remained in breach of the OLCs for 18 minutes. The safety significance of this event was low. Failure of the control lines did not prevent reactor pressure control, as the turbine condenser was available throughout the entire event. The

deviation was not relevant for reactor overpressure protection. Defective planning of the work was identified as the root cause of this event. The INES level of the event was INES 0.

- On 8 October 2022, the back-up nitrogen supply of the drive motors of the neutron flux measurement system detectors was found to have failed in two subsystems at the OL2 plant unit. The failure was due to an incorrect position of the valves of the back-up nitrogen bottles. On the basis of the investigations conducted by TVO, the valves have been in an incorrect position ever since the OL2 annual outage carried out in April 2022. This situation that was in breach of the OLCs ended on 8 October 2022 when the valves were turned to the correct position. The safety significance of the event was estimated to be low. The incorrect position of the valves would not have affected the operation of the system in the event of any possible need, as the pressurised nitrogen that is needed to drive the detectors in question was, throughout the entire deviation, available as normal from another system. There would be a need for a back-up nitrogen supply, for example, if the main supply line were to sustain a pipe breakage. TVO investigated the causes that contributed to the event, identifying shortcomings in the alignment procedure intended to prevent events of this type. The INES level of the event was INES 0.
- On 14 October 2022, the protection conditions controlling the radiation level in the reactor hall were mistakenly prevented at the OL1 plant unit, which breaches the OLCs. During this event, calibration of one off-gas stack radiation measurement by means of a radiation source was ongoing. In the context of calibration, a number of situations have occurred previously whereby radiation scattered from an external radiation source has caused unnecessary activation of the reactor hall protection functions. In order to prevent initiation of unnecessary protection conditions, TVO has been developing the radiation protection of external radiation sources in order to prevent radiation scatter. Additionally, for the purposes of the calibration carried out in 2020, TVO sought from and was granted by STUK an OLC exemption to prevent this protection condition. The calibration carried out in 2021 established that the renewed radiation protection alone was adequate and there was no need to prevent the protection condition. However, in the calibration carried out in October 2022 , the protection condition was prevented, and an exemption for this had not been sought from STUK. The safety significance of this event was low. Prevention of the protection condition resulted in prevention of the automatic start-up of the reactor building emergency ventilation in the event of need. However, the reactor building emergency ventilation had been activated manually before cross-coupling. As the function resulting from this protection condition was active during the event, prevention of the condition was not relevant for the fulfilment of the safety functions. Defective work planning and defective independent verification, among other things, were identified as the factors contributing to this event. The INES level of the event was INES 0.
- On 27 October 2022, TVO detected that some parameters of a speed control relay of the fuel transfer machine used at the spent fuel interim storage had been modified during fault repair. As a result, the speed control did not comply with the OLCs. The situation started on 1 December 2021 when the fault was repaired and the parameter modified. When the fault was investigated, another fault causing an OLC-non-compliant situation also emerged, regarding correction of the transfer machine bridge. There had been some peaking in the

transfer machine speed control measurement signal, causing the measured value to rise above the set limit, whereupon the safety function activates and brings the machine to an abrupt halt. This peaking was attempted to be remedied in different ways, unsuccessfully. In December 2021, the speed control parameters were modified such that the transfer machine could be driven without any abrupt halts caused by signal faults. Following this parameter modification, the speed control equipment no longer worked as required by the OLCs.
The third OLC-non-compliant situation was identified in the inoperability of the transfer machine safety relay in a situation where the transfer machine ends up askew. The transfer machine may end up in an askew position because, during expansion of the KPA storage in 2014, the transfer machine rails were extended by adding on the new storage side a rail section that is 1mm wider than, and that has a profile not identical to the other sections of the rail system. This has a low impact on radiation safety. A fuel handling accident did not occur, but both the inoperability appearing in the speed control stop function and the rail width difference increase the risk of a fuel bundle colliding with the pool structures. The most serious possible consequence of a collision was that one fuel element might have been damaged. Both human errors and defective implementation of the modifications were identified as factors contributing to these events. The INES level of the event was INES 0.

- On 27 December 2022, in the context of planning the safety measures for the preventive maintenance packages of the emergency diesel generators of the OL1 and OL2 plant units, TVO found that, in two subsystems, as a consequence of separation of the diesel generator, the number of the filters selected for use in reactor building emergency ventilation did not comply with the relevant OLC requirement. Under the OLCs, the reactor building emergency ventilation flow must be connected through at least two filters. Additionally, the OLCs set out that the heaters of these filters must be operable. TVO detected that the there is separation of the emergency diesel generator of the subsystem on which maintenance is carried out during the preventive maintenance conducted during power operation performed annually on the diesel generators, and that, when this is so, one of the subsystems of the power distribution system does not enjoy operable emergency power supply. As a consequence of this, the operability requirement of one emergency ventilation heater is not met with regard to the emergency power supply. As a consequence of this event, prevention of the spread of radioactive materials was inadequate with regard to the emergency power

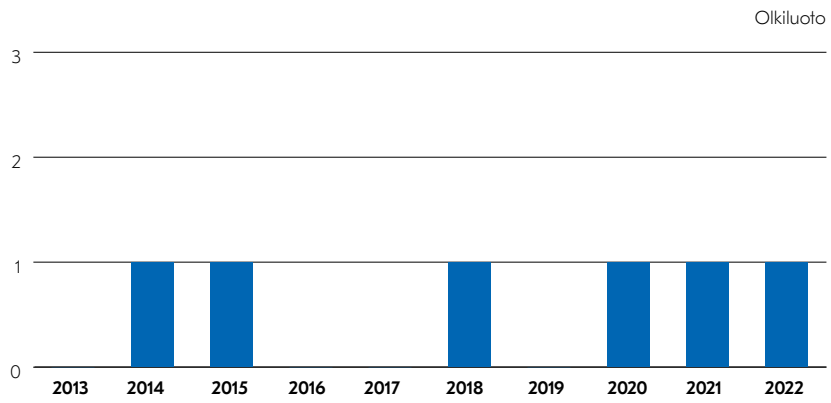


FIGURE A2.4 INES classified events at the Olkiluoto plant (INES Level 1).

supply of one of the heaters of the filter selected for use in emergency ventilation during the preventive maintenance of two subsystems. The preliminary INES level of the event is INES 0, that is to say, the safety significance of the event is low. No events occurred where there might have been need to supply emergency power during the preventive maintenance of the diesels. The investigation of the event, and determination of the related causes and remedial measures, was still ongoing in early 2023. TVO will submit a report on the event to STUK for approval.

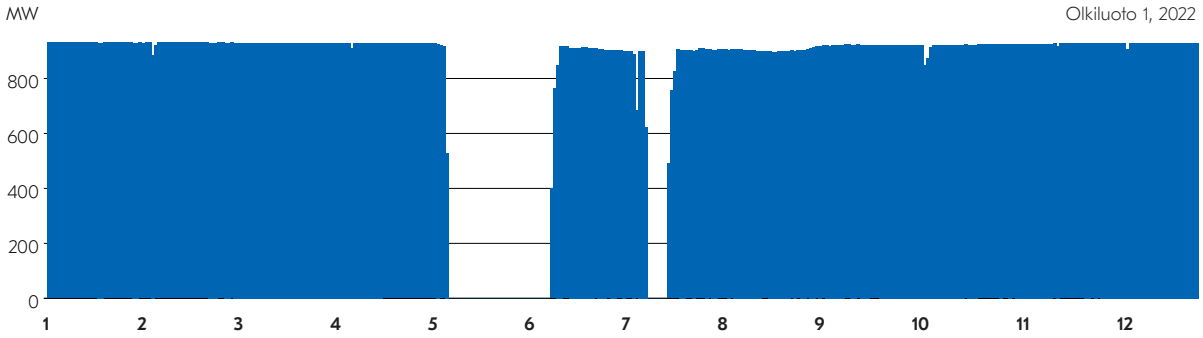


FIGURE A2.5 Daily average gross electrical power of the Olkiluoto 1 plant unit in 2022.

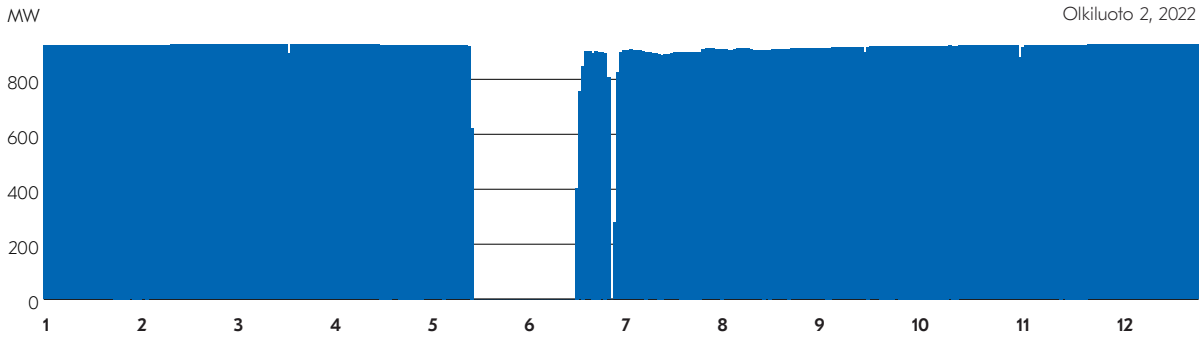


FIGURE A2.6 Daily average gross electrical power of the Olkiluoto 2 plant unit in 2022.

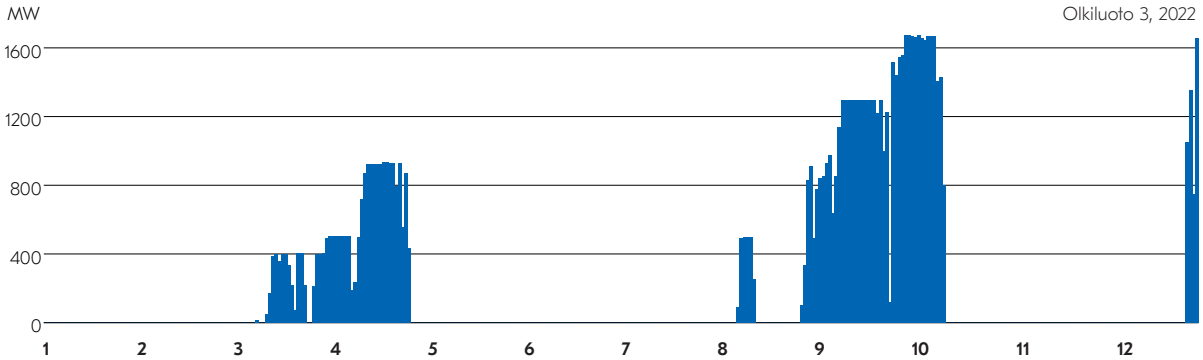


FIGURE A2.7 Daily average gross electrical power of the Olkiluoto 3 plant unit in 2022.

APPENDIX 3
Periodic inspection programme of nuclear power plants 2022

The inspections included in the periodic inspection programme focus on safety management, the main operational processes and procedures, and the technical acceptability of systems. These inspections verify that the operation, maintenance, safety assessment and protection activities of the relevant facility comply with the requirements laid down in the nuclear safety regulations. The 2022 inspections did not observe any material deficiencies that would have an impact on the safety of the personnel, environment or any facilities.

	Inspections in 2022	
Basic programme	**Loviisa 1 and 2**	**Olkiluoto 1, 2 and 3**
I&C technology		
Human resources and competence	x	
Management and safety culture	x	
Management system	x	x
Disposal facilities		x
Chemistry		x
Mechanical technology	x	x
Interim storage of spent nuclear fuel		
Operating experience feedback	x	x
Operation	x	
Plant maintenance	x	x
Fire protection	x	
Utilisation of the PRA		x
Structures and buildings		x
Electrical technology		x
Radiation protection	x	x
Nuclear security	x	x
Safety design	x	
Safety functions	x	x
Emergency response arrangements	x	x
Power plant waste	x	
Annual outage	x	x
Nuclear safeguards		x

Basic programme	Inspections in 2022	
	Loviisa 1 and 2	Olkiluoto 1, 2 and 3
Special subjects		
Human resources and competence, Posiva—TVO joint inspection		x
Organisational transition of the safety function		x
LOMAX data and role in management of functions	x	

Inspections under the periodic inspection programme at the Loviisa plant

In the first tertial, at the Loviisa nuclear power plant, STUK carried out four inspections under the periodic inspection programme. Two of these inspections were on-site inspections, and two were a combination of a remote and an on-site inspection, so-called hybrid inspections.

In the second tertial, at the Loviisa nuclear power plant, STUK carried out six inspections under the periodic inspection programme. Five of these inspections were carried out at the plant site, and one was a combination of a remote and an on-site inspection, a so-called hybrid inspection.

In the third tertial, at the Loviisa nuclear power plant, STUK carried out six inspections under the periodic inspection programme. Four of these inspections were carried out at the plant site, one was a remote inspection, and one was a combination of a remote and an on-site inspection, a so-called hybrid inspection. One inspection – Safety functions – was postponed until 2023, because there were no issues to be verified in this thematic area that were acute in terms of safety, and STUK's resources were focused on the other Loviisa oversight activities.

LOMAX data and role in operational control, 26–27 January 2022.

This inspection focused on LOMAX (Loviisa Maximo), the Loviisa power plant enterprise resource planning system, which is a key part of the power plant's management system and operational control. In terms of its impact, LOMAX is a powerful tool, used to ensure, for instance, quality management and safety. The inspection investigated the procedures for developing and maintaining LOMAX, related instructions, LOMAX use training, and the processing of LOMAX-related events and observations. Additionally, it was verified how an individual maintenance task functions in concrete terms when controlled by LOMAX.

In STUK's opinion, the situation with the thematic area inspected was appropriate. The development of LOMAX, in particular, appears to be on track, which was evident in a decreased number of change requests concerning the system in recent years; there are now fewer change needs identified by end users, and the data system has been refined to be suitable for the operations concerned. STUK will continue to supervise the observations made as to LOMAX usability, and especially when a new LOMAX version will be launched. On the basis of the inspection, STUK issued one requirement regarding mapping of the LOMAX related competence requirements.

Fire protection, 29–30 March 2022

This inspection focused on the structural and active fire protection arrangements, and operative fire-fighting, at the nuclear power plant. The inspection concerned the following topics: the organisation; training and equipment of the plant fire brigade; plant procedures; inspections and maintenance of the active fire protection systems; ageing management; modifications and repairs; inspections carried out by the licensee and other organisations; and operating experience activities.

Fortum has made a number of updates to the procedures, especially to the guidelines on fire doors and penetrations. The new position of Deputy Chief Fire Officer is a major change in the plant fire brigade organisation. STUK welcomes these changes as good.

On the basis of the inspection, fire safety at the Loviisa nuclear power plants is at the required level. The inspection did not issue any requirements. Highlighted observations include several positive observations and a statement about the fact that the rules of procedure do not define the post of Deputy Chief Fire Officer to be a safety duty, and no justification for this omission was put forward.

Operating experience activities, 5–7 April 2022

This inspection focused on learning from the Loviisa power plant's own operating experience. STUK inspected a small number of procedures for the internal operating experience activities (e.g. trend analyses, investigation of the recurrence of events, and impact assessments) and how they are employed. By these procedures, Fortum can identify and remedy major weaknesses in the technology, activities and culture, and can form a situational picture of how the operating experience process functions and what the related development needs are.

As a conclusion from the inspection, STUK noted that Fortum is putting in a great deal of effort to investigate and remedy deficiencies and trends in the technology, activities and culture. Additionally, Fortum is developing the internal operating experience activities.

On the basis of the inspection, STUK required that the licensee take action in respect of two issues that emerged during the inspection, associated with improving the impact of the operating experience feedback. STUK required that Fortum ensure more detailed investigation and effective remedying of the major deficiencies and trends it identifies. Additionally, STUK required that event investigations be developed in such a way that the causes of recurrence must be investigated and logged more systematically (where recurrence is observed) while also investigating and logging more systematically the scale at which the cause factors of events occur.

Radiation protection, 5–7 April 2022

In 2022, the radiation protection inspection performed under the periodic inspection programme focused on dosimetry. This inspection included a blind test performed by STUK, assessing the Fortum dosimetry laboratory's ability to determine the dosimeters that STUK had irradiated. The test revealed no factors that would indicate any shortcomings in the result analysis performed by the dosimetric service.

In May 2021, STUK granted Fortum indefinite approval for the dosimetric service that is in use at the Loviisa nuclear power plant. The inspection concerned here verified that the conditions for this approval continue to exist.

The inspection issued a requirement concerning how the relevant renewed dosimetry standard should be addressed for the purpose of approving the dosimetric service. Additionally, STUK required that Fortum determine the radiation protection measures that need to be carried out for the rooms located beneath the spent fuel building.

Mechanical technology, 2–3 May 2022

This inspection assesses the functions performed by the power company to ensure the integrity and reliable functioning of mechanical equipment and structures (including pressure equipment, valves, pumps, fans, piping, cranes and diesel generators), with due consideration of operating experience and the relevance of this equipment to the overall safety of the plant.

This inspection focused on the timeliness of the welding procedure specifications; the subject matters that are critical in terms of fatigue in the long term; the functioning of the qualification related sections of the inspection systems (YVL E.5); the condition of and the inspection procedures for the viscous dampers installed at the plant; and the status of the observations registered by the Loviisa 1 primary-circuit loose parts monitoring (LPM) system.

Fortum has the necessary plans in place regarding updating of the fatigue analyses and how to prepare for the repair or replacement of components, also with regard to any possible extension of the operating licence. Load monitoring is being developed, and the most critical subject matters have been included comprehensively in the relevant risk-informed inspection programmes. The old test pieces no longer fully serve their purpose, which is why it is vital to ensure that the operations take account of the regular inspection of the pieces and timely procurement of any possible new ones. The viscous dampers are to be added to the inspection programme of supports – previously, they were inspected on a spot-check basis in the context of the condition monitoring inspections. Fortum will continue to investigate the ultimate cause of the loose parts observations made in respect of the Loviisa 1 primary circuit.

As a conclusion from the inspection, STUK notes that generally the procedures, which the licensee employs in the inspection area of mechanical technology are appropriate and they satisfy the requirements laid down in the law and in the relevant official regulations. On the basis of the inspection, STUK required that Fortum submit to STUK the welding procedure specification qualification plan, together with the related timetable.

Nuclear security – physical protection, 9–13 May 2022

This inspection focused on the plant's nuclear security, considered to include the appropriate structural, technical, operational and organisational arrangements to detect, delay and prevent illegal or unauthorised activity.

As a conclusion from the inspection, STUK notes that, with regard to nuclear security, the licensee's human resources, competence, and training and exercise activities, as well as the timeliness of the relevant instructions, are appropriate and adequate at the Loviisa nuclear power plant. The inspection detected several good practices. As part of normal oversight, STUK will supervise the progress made with the issues that were recorded as observations during the inspection.

On the basis of the inspection, one requirement was issued, concerning presentation to STUK of the plan to develop the inspection of vehicles, people and goods. Currently, the

licensee's procedures for nuclear security as a whole are, however, appropriate and they satisfy STUK's requirements and the provisions set.

Nuclear security – information security, 10–13 May 2022

The 2022 KTO inspection focused on the internal and external resourcing for the information security at the Loviisa nuclear power plants, as well as on information security incidents and the procedures for and development measures concerning the maintenance of information systems. With regard to resourcing, the inspection covered the training provided to people, as well as the technical development projects launched by the organisation.

On the basis of the inspection, the amount and competence of the personnel, and the timeliness and guidance of the relevant guides and instructions, are adequate. Fortum's information security training course forms a comprehensive package. The voluntary training events offered to the personnel have been welcomed positively by staff. Fortum also carries out systematic monitoring measures to develop the information security of external resources. The development projects presented during the inspection, and the plans that relate to them, take good account of the various sectors of information security and future technical needs.

The licensee's procedures for information security are appropriate, and they satisfy STUK's requirements and the provisions set. STUK did not issue any requirements based on the inspection.

Power plant waste, 31 May–1 June 2022

This inspection examined the observations made in the previous inspection about power plant waste, the development made after that and the relevant measures and notable events. The condition of the waste processing and storage facilities, and the radiation levels, classifications and markings of these facilities, were examined during a plant walkdown.

Resourcing of the Power Plant Waste group has been developed in accordance with the personnel plan drawn up in 2019. The resource situation has improved markedly as compared with the date of the previous KTO inspection and is currently good. Fortum has the adequate competences and the necessary organisation to take care of the power plant waste. The relevant instructions and guidelines are up to date. For the FSAR (Final Safety Analysis Report, to be maintained continuously), some deficiencies were observed with regard to the solidification plant data, but Fortum has initiated measures to remedy the issue.

The volume of waste for final disposal has stabilised at about 100 drums a year. Some 75% of the maintenance waste is for clearance.

There remain some challenges in the operation and maintenance of the solidification plant. The greatest challenges relate to investment needs, resourcing, and the ageing management of the facility. A number of measures to bring matters under control have been initiated. For Fortum, the longer-term aim is to render production at the solidification plant routine-like, which would also allow the production volumes of the ingot moulds (concrete vessels containing solidified waste) to be increased. Increased production volumes are necessary in order to achieve an adequate storage capacity for liquid wastes, including in the preparation of unexpected events. As part of continuous oversight, STUK will monitor how the situation develops.

Summing up the inspection, STUK notes that the licensee's procedures for power plant waste management are appropriate and satisfy the requirements set for them. STUK did not issue any requirements based on the inspection.

Human resources and competence, 1–3 June 2022

The topics examined at this inspection were the following: operational planning of the plant training group; development of supervisory work; utilisation at the plant of the safety research on the organisation's activities; development of Human Factors Engineering (HFE) competence; utilisation of the data available from the competence management system; and preparation for extension of the operating licence from the viewpoint of competence and resource management.

On the basis of this inspection, in its guides and instructions, Fortum has determined the relevant expectations for those working as supervisors in the nuclear sector. Information on the work of supervisors is collected in various ways, but there is no described procedure for developing an overall picture at the plant of the nuclear-sector conformity of the work carried out by superiors. STUK issued a requirement that Fortum is to define a procedure for this.

Development of the HFE programme is well on track, and HFE has gained more visibility at the plant than previously.

The limited access rights of the competence management data system constitute a practical barrier to developing an overall picture of competence at the plant. Additionally, on the basis of the inspection, it appears that the competence management process responsibilities have not been unambiguously defined between the training group, the HR function and management.

In the context of preparing the continuing licence application, Fortum provided a verbal account of the procedures it employs for assessing competence and resources. At the inspection, Fortum was unable to present any documentation on the above issues. STUK will verify the matter during a separate topic-specific meeting to be held at a later time.

As a conclusion from the inspection, STUK notes that Fortum has in place the necessary procedures for assessing and developing the competencies it has determined, yet information is not used comprehensively at the plant level to form an overall picture.

Safety design, 13–14 June 2022

This inspection focused on Fortum's modification process. In particular, STUK reviewed how security-relevant modification needs are identified and prioritised, and how modification proposals are processed and promoted into modification projects, considering Fortum's decision to apply for an extension to the operating licence. Additionally, STUK looked into the latest changes made in, and the status and development ideas relating to, the modification process instructions and resources.

On the basis of the inspection, Fortum has in place guided procedures for processing and prioritising modification proposals, as well as for implementing modification projects. The inspection did not reveal any deficiencies with regard to compliance with these procedures. Fortum is also developing the procedures further.

At the inspection, STUK paid attention to whether time-based (urgency) prioritisation adequately ensures the resources needed for, and the timely implementation of, the necessary security improvements. STUK will oversee the implementation of the prioritisation of modification projects, and the progress made with the projects, during normal oversight and at the following KTO inspections.

STUK did not issue any requirements based on the inspection.

Annual outage, 7 August–16 October 2022

The annual outage inspection assessed and verified the actions that were taken during the annual outages to maintain safety and to manage and control the activities during the annual outage. Inspectors from several fields of technology, with predefined designated inspection targets, from STUK's Nuclear Reactor Regulation section participated in the inspection. Additionally, STUK also carried out general oversight at the plant site, for example by way of regular facility walkdowns and by overseeing the progress made with the planned works. Furthermore, STUK oversaw the prioritisation of safety in the licensee's decision-making process. Among other areas, STUK focused oversight on mechanical technology, electrical and I&C technology, construction technology, radiation protection, and operational safety. Loose parts management was an oversight topic on which all STUK inspectors focused.

The particular subject matters that this annual outage inspection concerned included kick-off meetings and shift change related practices. The other subject matters included loose parts management generally; heavy lifts in the reactor halls; work radiation protection procedures; monitoring of the area of chemistry; decontamination activities; and the following modifications: the I&C update of the process computer of the control room and, for Loviisa 1, the update of the cooling water pipes of one emergency diesel generator and the I&C update of another.

In the regulatory oversight focused on loose parts management, STUK verified Fortum's procedures during the annual outage both at the controlled areas of the plant units and in the turbine halls, while also completing a joint inspection round with the people responsible for loose parts at Fortum. On the basis of the observations that STUK made, loose parts management is on track and has improved further. STUK considers it important that any observations made in loose parts management continue to be examined with due seriousness, while also ensuring the systematic development of operations.

By means of reviewing the related camera recordings, STUK oversaw heavy lifts performed in the reactor halls of both plant units. STUK verified that the heavy lifts were performed in compliance with the new updated lift plans.

No deviations requiring immediate intervention by STUK were observed in Fortum's activities during the annual outage. During the annual outages, two events occurred where a fitter proceeded to carry out work tasks at the wrong plant unit.

On 5 October 2022, the Loviisa 1 ramp-up experienced a failure of the seal water line of the main control pump, causing a delay of more than one week with the ramp-up. Following this event, as a precautionary measure, Fortum replaced all equivalent connectors and will investigate the root cause of the leak in an examination to be carried out after the annual

outages. STUK inspected the changes made, before authorising Fortum to start up the plant from the annual outages.

On the basis of the annual outage inspection, STUK required that, in the annual outage summary report to be submitted to STUK, Fortum include the changes that were observed in the results of the radiation dose measurements carried out during the annual outage. Additionally, STUK required that, in its event investigation of the main control pump seal water line leak, Fortum analyse not only the relevant factors that relate to the actions taken by the organisation but also how successful Fortum's actions after detection of the leak were.

Management system, 26–28 October 2022

At the management system inspection, STUK assessed how the licensee maintains, assesses and develops, and how the licensee complies with, its management system. The particular topics of this inspection included risk management at the Loviisa power plant and, with regard to the development targets determined by Fortum in the context of the periodic safety review, usability of the relevant guides and instructions.

Risk management at the Loviisa power plant is comprehensive, the appropriate guidelines are in place, and the necessary responsibilities have been awarded. Risk management is linked to the direction of the division, and there is regular reporting to the division. The plant has an designated Risk Engineer who coordinates the risk management process and facilitates risk assessments. Investments are being made in risk management and its development, use of assessment procedures is diverse and inclusive, and Fortum has developed a tool that is suitable for the purpose. On the basis of the inspection, STUK has no comments on risk management.

On the basis of the inspection, STUK was able to form a situational picture of how Fortum promotes the safety-culture development target that concerns usability of guides and instructions. Fortum is currently carrying out a related review under the WANO1 project (associated with the World Association of Nuclear Operators peer review). The final report of this review and the related recommendations were completed in December 2022. Fortum will be presenting the review results and measures to STUK at a later date. The inclusion of HuP (Human Performance) procedures in guides and instructions has been reviewed, and the guide/instruction-specific procedures have either already been included in the guides and instructions or this will be achieved during the next update. Currently, Fortum does not have a project ongoing to develop the package of plant guides and instructions and their usability. On the basis of the inspection, STUK has no comments on the solutions employed to develop Fortum's package of guides and instructions. In the context of the regulatory oversight it carries out, STUK will oversee the efforts taken to develop the usability of the guides and instructions.

STUK did not issue any requirements based on the inspection.

Emergency response arrangements, 8–9 November 2022

This inspection covered the nuclear power plant's emergency response arrangements, guidelines, facilities, equipment and training. The subjects matters covered in the 2022 inspection included changes in the emergency response organisation, as well as emergency

response training and emergency response exercises, including the experience and feedback gained from them. The inspection reviewed the development projects that relate to emergency response arrangements while, with regard to equipment, examination focused particularly on emergency response activity-related radiation measurements in the control rooms, as well as on the activity of the external measurement patrol.

There has been active training and development activity, and monitoring thereof conforms to the relevant plans. Since the previous inspection, some revisions have been made to the emergency response plan. The Loviisa power plant's external radiation monitoring network and weather monitoring system were operable throughout the entire duration of the period under review. The radiation measurement devices used in the emergency response activities are in proper order, an adequate number of them are available, and they are positioned in appropriate locations at the plant. Update of the transfer of emergency response data has not been completed within the planned timetable, but the old data transfer system works on STUK's new premises.

On the basis of the inspection, the emergency response arrangements at the Loviisa power plant are at the required level. No requirements were issued on the basis of the inspection.

Plant maintenance, 7–8 November 2022

The aim of this inspection was to verify that the licensee is taking proper care of the operability of systems, structures and devices in the short and long term. The inspection assessed the adequacy of the resources, functions and tasks associated with the condition monitoring and maintenance of both plant units in order to ensure the safe operation of the plant units under the design-based operational and environmental conditions.

On the basis of the inspection, the Loviisa plant has adequate human resources for maintenance tasks in all fields of technology, and the same applies to service life management. The update status of the top-level maintenance guides is good, with only a small number of guides in various guide groups late or under processing. Fortum is taking steps to develop its training materials and, for example, an eLearning package has been prepared on the modification process. Based on the feedback received, more time is now being allocated to contractor induction.

Fortum has defined several different indicators to assess and guide its activities, with the equipment reliability index, introduced in 2017 and employed to monitor the reliability and condition of equipment and to guide the maintenance activities, serving as a good example.

The inspection reviewed Fortum's status summary of the Loviisa power plant ageing management programme database and of the systems and time-limited analyses not yet included in the system. With regard to inclusion of the time-limited analyses, the work still remains incomplete, but it has progressed since the in-service inspection, which STUK carried out on this subject matter in August 2022. Fortum aims to include the missing systems in the database during 2023. STUK will monitor how the matter progresses, requiring that, to support oversight, Fortum submit to STUK the summaries presented at the inspection. In its principle, Fortum's ageing management assessment is continuous and contains the necessary tools and procedures.

Update of Fortum's vibration monitoring system was concluded for both plant units in November 2022. This work covered the main control pumps, turbines, generators and main seawater pumps. In addition to improved operational security, the update provided more tools for analysing vibration situations. Additionally, Fortum utilises a portable vibration measurement system and a thermal camera to control the condition monitoring (operability) of equipment.

The situation with critical spare parts was previously examined against Guide YVL A.8, and it was additionally desired that the current inspection provide an overview of Fortum's own criticality classification and how it is applied to the management, and the principle governing the procurement, of spare parts. The inspection assessed the situation with spare parts for two example systems selected on a risk-based basis: the backup emergency feedwater system, and the emergency diesel common to the plant units. As for the backup emergency feedwater system, the technology in many of its components and parts is obsolescent, and for them Fortum has been forced to procure replacement components. Procurement has been affected by delays, owing to issues such as prioritisation and the long duration of planning and design. In spite of low spare parts reserves, Fortum has, with regard to repair times, been able to work within the limits laid down in the OLCs. Fortum has raised the criticality category of the spare parts of the above emergency diesel, while also launching efforts to map the spare parts needed in 2022, with the aim of improving spare parts readiness. Through the oversight it carries out, STUK will supervise the progress Fortum makes with these measures.

In technological obsolescence management, Fortum utilises a specific database, allowing the company to not only identify critical components but also to take account of the challenges faced in procurement. Criticality classification is used to guide decision-making in terms of procurement.

On the basis of the inspection, maintenance and ageing management at the Loviisa power plant are organised in compliance with the applicable requirements. The human resources for maintenance and lifetime management are at an adequate level, and the timeliness of the top-level guides is good. The last systems will be included in the plant ageing management database in the course of 2023. Fortum has sufficiently addressed the challenges posed by the technical and commercial ageing and obsolescence of components.

Operation, 15–16 November 2022

This inspection assessed and verified the activities of the Loviisa power plant Operations unit. As there have been some major developments in terms of human resources at the Operations unit in recent years (including retirement of old Operations Engineers and recruitment of new ones, and possible reinforcement needs in view of the continuation of the operating licence), the particular subject matters that this inspection concerned included the training provided to new Operations unit staff, the unit's action plans, and proactive human resources management.

On the basis of the inspection, no deviations requiring intervention by STUK were observed in Fortum's activities. STUK established that the training plans are appropriate, the training packages take account of the upcoming changes at the plant (for example, as concerns the use of the simulator), and the necessary recruitment processes to meet the needs of the possible continued operation of the plant are ongoing.

The other topics included the timeliness and guidance of guides and instructions, especially the instructions provided for a scenario where the process computer is unavailable; the relevant operational indicators, and expansion of the field operators' role to cover maintenance tasks. The timeliness and guidance of the relevant guides and instructions are in proper order. There were no comments on the operational indicators; the outcomes of these indicators in 2021 and 2022 were for the most part good. STUK considers appropriate the procedure whereby, to avoid duplication of tasks, some maintenance tasks were transferred to the Operations unit, as long as this does not affect performance of the Operations unit's core tasks.

On the basis of the inspection, operation at the Loviisa power plant is organised in compliance with the applicable requirements. No requirements were issued on the basis of the inspection.

Management and safety culture, 23–25 November 2022

This inspection examined the following topics: the progress made with the safety culture development measures identified by Fortum in the periodic safety review; development of the self-monitoring carried out by the Nuclear Safety unit; the new responsible manager's views on the needs to develop management and the safety culture; and the steps taken to ensure that suppliers comply with good safety culture.

On the basis of the inspection, Fortum has carried out measures for each of the safety culture areas it has identified as needing development, and it was possible to verify that the management are committed to improving these issues. However, there is no systematic plan in place to measure and monitor the change that takes place in each of the safety culture areas identified as needing development. Regarding this, STUK issued a requirement.

Independent nuclear safety assessment activities and reporting has been developed actively, and there is balance between independence and the development that takes place together with the line organisations. STUK finds that these assessment activities are vital to support a self-critical culture that questions development.

The responsible manager's review reflected the aim of forming a situational picture of safety at the plant by utilising various channels and specialists. Additionally, the desire to pragmatically develop management and the safety culture was evident.

Fortum has in place a host of procedures that can be used to ensure that the activities of suppliers of safety-relevant products or services comply with a good safety culture. However, there remains room to develop these procedures and how they are employed. The package of procedures whereby suppliers' good safety culture is ensured has not been documented, and development of the procedures has not been coordinated together with, for example, safety culture specialists. Regarding this, STUK issued a requirement.

Inspections under the periodic inspection programme at the Olkiluoto plant

In the first tertial, at the Olkiluoto nuclear power plant, STUK carried out three inspections under the periodic inspection programme. One of these inspections was an on-site inspection, and two were a combination of a remote and an on-site inspection, so-called hybrid inspections. In the second tertial, one inspection carried out under the inspection programme was an on-site inspection and one was a hybrid inspection. In the third tertial, STUK carried out 13 inspections under the periodic inspection programme: nine of these inspections were on-site inspections, one was a remote inspection and three were hybrid inspections. The inspection that concerned safety functions was postponed until 2023 because there were no issues to be verified in this thematic area that were acute in terms of safety, and STUK's resources were focused on the other Olkiluoto oversight activities.

Radiation protection, 1–3 March 2022

In 2022, the radiation protection inspection performed under the periodic inspection programme focused on dosimetry. This inspection covered all the plants units OL1, OL2 and OL3. The inspection included a blind test performed by STUK, assessing the TVO dosimetry laboratory's ability to determine the dosimeters that STUK had irradiated. The test revealed no factors that would indicate any shortcomings in the result analysis by the dosimetric service.

In May 2021, STUK granted TVO an approval, remaining in force for an indefinite period of time, for the dosimetric service in use at the Olkiluoto nuclear power plant, with Doseco Oy the key operator in this. The inspection concerned here verified that the conditions for this approval still exist.

In addition to dosimetry, the inspection discussed the situation with alpha measurements, the experience gained from them and the follow-up plans regarding alpha measurements.

On the basis of the inspection, two requirements were issued concerning data transfer between the power company and the STUK dose register. Among other issues, STUK noted that the number of estimated doses in 2021 was greater than in previous years. Even though, in an assessment, doses can nearly always be based on electronic dosimeters, measures must be taken to reduce the number of estimated doses.

Human resources, and competence management (Posiva/TVO joint inspection), 30–31 March 2022

The inspection concerning human resources and competence management was carried out as a joint inspection, performed on Posiva under the construction inspection programme (RTO) and on TVO under the periodic inspection programme (KTO). The inspection had as its aim to assess the plans drawn up on the use of Posiva and TVO's common resources, as well as evaluating their adequacy, coverage and appropriateness in the commissioning and production phases of the spent nuclear fuel final disposal facility.

Posiva's commissioning and production organisations were found to be still incomplete. Some of the necessary human resources have been determined and recruited, but as a whole some of the organisation's personnel figures remain to be determined. The role cards to be prepared for Posiva's personnel, and the role-specific training packages, are not fully ready

yet. STUK considers it important that the personnel taking part in the production phase be recruited and trained, and their induction be completed, well before the production phase.

Posiva and TVO were found to have well-functioning and transparent procedures in place to manage their common resources and to meet Posiva's resource needs.

TVO has prepared an account of and a self-assessment report on the use of radiation safety experts. This account and the self-assessment do not concern Posiva, and the inspection could not form an overall picture of whether the requirements laid down in Section 32 of the Radiation Act concerning the use of a radiation safety expert are satisfied. The inspection issued Posiva a requirement that the use of radiation safety experts also be assessed in Posiva's activities. TVO was not issued any requirements on the basis of the inspection.

Plant maintenance (OL3), 30–31 March 2022

This inspection that focused on OL3 plant unit maintenance had as its aim to verify that TVO is taking proper care of the operability of systems, structures and devices in the short and long term. The selected inspection targets were used to assess whether the resources, functions and tasks associated with the condition monitoring and maintenance of the OL3 plant unit are adequate in order to ensure the safe operation of the plant unit under the design-based operational and environmental conditions.

Recruitment of equipment owners, particularly for I&C and electrical positions, is proving challenging. Recruitment is ongoing for a total of four of the 35 equipment owner positions. STUK sees the new recruitments and the vacant equipment owner positions as a challenging issue, because the launch of the commercial operation of the plant is approaching, whereupon responsibility for the plant will transfer to TVO. STUK welcomes the fact that TVO has invested in the recruitment of equipment owners. On TVO's own five-tier scale, a total of 10 equipment owners do not satisfy objective 3 set for the equipment owners' competence. Regarding all of these, TVO notes that the competence is available elsewhere in the organisation.

The OL3 ageing management programme document package is currently in the finalisation phase at TVO. This programme must have STUK's approval before launching commercial operation. As part of STUK's normal oversight of the OL3 unit maintenance activities, STUK will be supervising the progress made with the issues it recorded as observations at the inspection.

As a conclusion from the inspection, STUK notes that the OL3 plant maintenance activities comply with the relevant regulations. STUK does not issue any requirements on the basis of the inspection.

Annual outage (OL1/OL2), 24 April–10 June 2022

This inspection that focused on annual outages assessed and verified some of the actions that relate to the implementation of the annual outages of the TVO plant units OL1 and OL2. Inspectors from several fields of technology participated in the inspection. They monitored the activities, conducted plant walkdowns, interviewed employees and oversaw the progress of the planned work. Plant walkdowns paid special attention to loose parts management.

In this year's inspection, the subject matters included the following:

- radiation protection of workers;
- electrical technology: sequence tests for the renewed emergency diesel generators;
- I&C technology: in particular, the annual outage implementation related actions in I&C obsolescence and related management;
- construction technology works and inspections;
- activities of the TVO fire protection organisation;
- kick-off meetings and shift changes;
- verification of the implementation of the measures determined in the course investigating operational events;
- examination of annual outage faults and observations independently of operation and maintenance;
- use of digital X-ray imaging to inspect safety-classified mechanical components;
- loose parts management.

On the basis of the inspection, STUK issued no requirements. No deviations requiring immediate intervention by STUK were observed in TVO's activities during the annual outage. The inspection produced several positive observations, including about good practices and operational development based on experience from previous years.

As a conclusion from the inspection, it can be noted that TVO's annual outage activities complied with the relevant requirements and that they were carried out successfully – safely and according to pre-determined plans.

Nuclear security, 16–23 May 2022

The 2022 nuclear security inspection performed under the periodic inspection programme focused chiefly on the OL1/OL2 nuclear power plant units. This inspection covered themes such as the OL1/OL2 plant gate activity, implementation of the VLJ repository security arrangements, maintenance of the security surveillance systems, information security and a number of other topical issues. The inspection was conducted by way of personal interviews and monitoring of the activities.

Based on the inspection, STUK issued four requirements. They concern security surveillance procedures and general access rights management. As a whole, the licensee's nuclear security arrangements comply with the applicable statutes.

Emergency response arrangements, 6–7 September 2022

This inspection that focused on emergency response arrangements covered themes such as the personnel situation of the emergency response organisation; planned training events; the situation with Posiva's emergency response arrangements; operational events that are relevant for emergency response arrangements; and the situation with the facilities, equipment and devices used for emergency response arrangements.

Based on the inspection, TVO's emergency response arrangements are at the required level. There has been active training activity and development, and their monitoring has conformed to the relevant plans. After the previous inspection, some revisions have been made to the

emergency response plan. Development of the Olkiluoto emergency response arrangements has been active. The Olkiluoto power plant external radiation measurement network has been affected by disturbances, with some of the stations suffering from long interruptions, but the measurement network would have shown adequate performance in the event of an emergency situation. The weather monitoring system remained operable throughout the entire period under review. The emergency response data transfer link to STUK has been renewed and it functions. A number of errors were detected at some of the emergency response data transfer data measurement points from OL3, for which remedies were implemented. Based on the inspection, one requirement was issued concerning going through the emergency response equipment and equipment lists and bringing them up to date.

Operating experience activities, 14–15 September 2022

STUK carried out a follow-up inspection in order to verify what efforts TVO had taken to address the recurrence of events, based on the requirements issued at the 'Operating experience activities' inspection the previous year. On the basis of the information obtained at the inspection, STUK noted that one of the two requirements issued at the previous inspection remains open, because the measures taken by TVO's management to steer the improvement of the operating experience process remain incomplete. STUK will continue to monitor these development efforts by way of an inspection to be carried out in 2023.

Chemistry, 20–23 September 2022

The 2022 chemistry inspection covered the following inspection themes: the recent changes in the chemistry organisation and working conditions; chemical conditions, and migration of activities; and continuously operating analysers, and decontamination activity. This inspection included a plant visit.

Based on the inspection, STUK noted that the hydrochemistry maintenance activity complies with the relevant regulations. For this topic, STUK issued four requirements. TVO is required to submit to STUK an account, which it is to prepare on the impacts of condensate forward pumping and condenser replacement on hydrochemistry. After introduction of the project at the plant, the feedwater oxygen concentration has not remained within the previously followed limit presented by EPRI, and it has been necessary for the plant to prepare action limits for pump use. STUK finds that there has thus been a major change in hydrochemistry. The inspection paid attention to how the OLC chemistry parameters are monitored and reported. STUK issued a requirement that TVO must indicate in the operational daily report the method used in the reporting of the data that contain any chemistry OLC parameters, and that TVO is to add to the annual report the durations and causes of any observed incidents that exceed or fall below the relevant OLC parameters. The inspection reviewed the relevant indicators for Olkiluoto 3. TVO is already generating a great deal of useful data, which STUK can utilise in the course of its oversight. STUK issued a requirement to prepare an annual index to illustrate the efficiency of how well the hydrochemical conditions in the Olkiluoto 3 secondary and reactor circuit are maintained in relation to impurities and corrosion products.

Based on the inspection, STUK noted that the OL1 and OL2 decontamination functions comply with the applicable regulations. The inspection could not establish how the monitoring of decontamination efficiency is implemented, based on which STUK issued a requirement for TVO to prepare an account assessing the comprehensiveness of the relevant guides and instructions and the decontamination methods set out in them. Additionally, based on the inspection, TVO does not yet have a clear understanding of how the OL3 decontamination facilities will be used or how much resources the OL3 decontamination works will require. Harmonisation of the instructions for decontaminating the various plant units is still in the planning phase.

Mechanical technology, 4–5 October 2022

The 2022 mechanical technology inspection covered the following inspection themes: timeliness of the welding procedures; condition of the viscous dampers installed at the plant units; monitoring and inspection procedures for fatigue-relevant critical targets; preventive maintenance and inspection procedures for the SC3 and EYT equipment with the highest risk significance; and the procedures for transportable pressure equipment. Additionally, there was a review of some preventive maintenance procedures planned for the time period after launching the commercial operation of OL3.

As a conclusion from this inspection, the licensee's activities, insofar as they were examined during the inspection, complied with the requirements. No requirements were issued on the basis of the inspection.

OL3 operation, 4–5 October 2022

The OL3 operation inspection covered the following inspection themes: control room activities; procedures for plant status management; periodic testing; status review of the STUK requirements for which responsibility has been awarded to the Operations unit; and the Operations unit's readiness for launching commercial operation. The inspection paid a plant visit to the OL3 main control room, where the following were verified: the status of alarms; aggregate alarms and their processing; timeliness and number of documents; and the situation at the control room in general.

Based on the inspection, TVO's activities in the control room are appropriate. Plant status management was found to be at an acceptable level based on the inspection. Some of the plans and guidelines for adopting new procedures were, at the time of the inspection, still under preparation, and the relevant schedules and plans to complete them are in place. STUK welcomed TVO's plan to carry out a self-assessment of the functioning of the plant status management processes and to perform an impact assessment on the event investigation measures that are associated with plant status management.

Based on the inspection, the procedures and guidelines for the periodic tests that fall under OL3 Operation's responsibility are appropriate. The OL3 Operations unit's readiness for launching commercial operation was found to be at an acceptable level. For all issues that remain open, clear time limits have been set and the measures defined.

On the basis of the inspection, STUK issued no requirements. At the inspection, STUK highlighted four observations, for example with regard to finalising certain instructions. The good competence level of the shifts and, in particular, of the shift managers, as well as the procedures employed by the shifts, were among the positive observations highlighted.

Final disposal facilities, 5–6 October 2022

The inspection focusing on the Olkiluoto operational waste repository (VLJ repository) examined the high tritium activities in the VLJ repository leak water and atmosphere, detected for the first time in the spring of the same year. In the light of the importance of the issue, the inspection examined tritium as a separate section, with TVO's and STUK's radiation protection experts discussing TVO's observations, measurement methods and their validation, and the plans to determine the source of the tritium. The other topics examined included the TVO organisation and resources.

Before the inspection, STUK expressed concerns over the recent replacement of some of the key people associated with VLJ repository operation, studies and monitoring. However, TVO has successfully recruited competent personnel for these positions, and good progress has been made with the induction provided to these people. Additionally, TVO has began to increasingly take advantage of Posiva's experts in the monitoring of the VLJ repository rock mechanics and hydrology. In the monitoring of groundwater chemistry, TVO relies on its own human resources, while also taking advantage of external laboratories.

At this inspection, STUK highlighted the issue of calibration of the measurement devices and sensors used for monitoring the VLJ repository. The situation did not satisfy the requirements set out in TVO's internal guidelines for measurement device calibration. TVO's LATU system can also help make the calibration process of the VLJ repository measurement devices systematic, traceable and transparent.

At this inspection, STUK expressed concerns about the operability of the VLJ repository monitoring-related measurement devices. A large number of failed measurement devices has been reported, whereas the number of installed replacement devices remains low. TVO presented some of the procurement procedures employed at the Olkiluoto plants, as well as the prioritisation-induced delays caused in them. STUK welcomed the fact that TVO has taken advantage of Posiva's rock mechanics and hydrology experts and that is has initiated assessments of the criticality of the VLJ repository monitoring-related measurement devices. For example, with regard to rock movement, it is vital to be able to monitor the potential movements occurring in certain geological zones using an adequate number of rock mechanics monitoring devices.

Based on the inspection, STUK issues TVO three requirements, of which two concerned tritium. TVO is required to establish the relevant limits of quantification for the mobile tritium sampling equipment and to assess the existing validation documentation of this equipment in compliance with TVO's instructions and guides. The other requirement concerning tritium provides that TVO is to investigate the origin of the tritium found in the VLJ repository and the effects that it has on the workers and the population, as well as to draw up plans for the future monitoring of the tritium found in the VLJ repository leak water and atmosphere and an assessment of why the TVO organisation showed a belated response to the tritium

observations. The third requirement provides that TVO is to determine a location code for all monitoring-related VLJ repository measurement devices and sensors that require calibration, as well as introducing them into the device management system.

Nuclear safeguards, 11–12 October 2022

The main topic of the nuclear safeguards inspection concerned TVO's preparation for the final disposal of spent fuel (resources, procedures, instructions, responsibilities). Additionally, the accountancy and decommissioning procedures for other nuclear use items were inspected.

STUK noted that TVO has identified several measures that are relevant for nuclear safeguards in order to prepare for the final disposal of spent fuel. On the basis of the observations made during this inspection, STUK issued five requirements. Four concerned the handling of and the measurements carried out on the fuel to be finally disposed of at the KPA storage, as well as the fuel input and measurement data. Additionally, a requirement was presented regarding the handling and accountancy of other nuclear use items.

Organisational transition of the safety function, 11–12 October 2022

This was a supplementary inspection carried out under the inspection programme, focusing on the execution and effects of the organisational transition completed in the area of corporate safety in spring 2022, as well as on the other development measures that TVO has taken recently regarding this topic. The inspection examined the effects of the transition with regard to, in particular, the plant fire brigade and the security arrangements function. As part of these, the following themes were also examined: the clarity of responsibilities and management relationships; personnel resources; the current state of the workplace atmosphere and safety culture; practical development measures; and subcontractor operational guidance and scrutiny procedures.

Based on the inspection, TVO identified development needs for the plant fire brigade and the security arrangements, and it started putting in place measures. In addition to the measures determined by the organisational transition that was completed at the former corporate safety competence centre in spring 2022, and by one event investigation (deviation from the OLCs with regard to fire protection), TVO will be launching more extensive development programmes. Regarding this theme, STUK issued two requirements. STUK will be supervising the issues examined during this inspection in the course of the oversight it carries out, as well as at the inspection visits scheduled for spring 2023. STUK wishes to ensure that the measures determined by TVO will lead to positive development and that TVO's change management is systematic.

Electrical technology, 19–20 October 2022

The electrical technology inspection covered TVO's electrical technology systems, organisations and instructions. The inspection reviewed the licensee's guides, instructions, procedures and measures to ensure the conformity of the electrical systems.

As a conclusion from this inspection, STUK notes that TVO's electrical technology resourcing, guides, instructions and activities are at a good level. Based on the inspection, STUK recorded three observations and issued one requirement. This requirement concerns

how the approval criteria of an OLC test were recorded; TVO's performance of the actual test was commendable. The observations that were presented concerned compilation of the relevant electro-technical design requirements, provision of work-planning instructions for electro-technical repairs, and implementation of the periodic tests for the emergency diesel generators. STUK will oversee the work to be carried out based on these observations as part of the normal operations oversight.

Plant maintenance (OL 1/2), 25–26 October 2022

The inspection that focused on plant maintenance assessed the adequacy of the resources, guides, instructions, functions and tasks associated with the condition monitoring and maintenance of the OL1 and OL2 plant units to ensure safe operation.

The maintenance human resources situation has improved from last year, and is now at a good level. TVO has hired three strength engineering specialists to replace the two who will be retiring. Additionally, as a long-term strategy, TVO has increased presence at vocational education and training institutions. The update situation with TVO's maintenance manual and the instructions part of it was found to be good. STUK noted that the memorandum illustrating TVO's strength-engineering resource and competence requirements should illustrate in greater detail the internal training provided to TVO's own experts and how their qualifications are maintained.

TVO will develop system operability assessment calculation with the aim of providing a better description of the actual inoperability of equipment locations. TVO is planning to introduce the equipment reliability concept in ageing management by 2025 or sooner. In the annual ageing management monitoring report, the situation with a small number of subject matters, selected based on their risk significance, was examined for the feedwater and auxiliary feedwater systems.

Based on the inspection, STUK issued one requirement, whereby TVO is to submit to STUK for information the strength engineering resource and competence memorandum that it will update.

Structures and buildings, 2–3 November 2022

This inspection concerned the use, condition monitoring, maintenance and ageing management of structures and buildings, as well as seawater channels and tunnels. The inspection assessed TVO's procedures and functions, also reviewing the results of the inspections that TVO had carried out, as well as the modifications completed.

Based on the inspection, the majority of the interim inspections, repairs and modifications concerning the construction technology of the Olkiluoto power plant have been carried out as planned. STUK finds that the use, condition monitoring, maintenance and ageing management of the structures and buildings are all at an adequate level. STUK did not issue any requirements based on the inspection, but recorded a total of five observations. For these, STUK will be supervising how the situation develops. The observations concerned some shortcomings in the TVO inspection schedule planning, improving the traceability of the equipment responsibility area reports, incompleteness of the remedial measures of one

operational event report, practices for the outturn-level final documentation, and the approval criteria for the OL1 and OL2 containment tightness tests.

Management system, 22–23 November 2022

This inspection concerned assessment of the functioning of the TVO integrated management system.

TVO's risk management process has been developed in accordance with the principles laid down in standard SFS-ISO 31000. The TVO risk management team comprises three persons, with a total combined experience of four years in their current tasks. In the context of orientation with their tasks, the risk management process has been found to contain a number of areas needing improvement. The risk management team drafts risk management-related matters and refers them to the risk management group, which typically convenes four times a year. Operating under the aegis of the management group, the risk management group coordinates firm-level risk management. It is tasked with, among other things, ensuring that all risks are examined appropriately.

STUK noted that TVO has in place guided procedures for the examination and management of risks, and in the course of the inspection it did not find anything major to comment on regarding them. Based on the inspection, two requirements were issued. It was required that the documents to be submitted to STUK be developed to include more comprehensive data on inspectors and those granting approvals, including their respective areas of responsibility. It was also required that the preventive supplier audit list be submitted to STUK on an annual basis.

APPENDIX 4

Inspections in 2022 pertaining to the processing of Fennovoima's construction licence application

STUK inspected and assessed the management systems of Fennovoima and the other organisations participating in the implementation of the project. STUK also carried out inspections at these organisations to ensure that their concrete activities comply with what is specified in the management systems and that these activities meet the necessary requirements. In September 2015, STUK launched the inspections that are part of the inspection programme which relates to processing of the construction licence (RKT). In 2022, STUK carried out one inspection under its inspection programme before the project failed.

Held in the first tertial of the year, the inspection concerned power and emergency power supply systems. The inspection topics were the following: electrical-technology human resources, and the overall status of this area of technology; processing of the construction licence application at Fennovoima; electrical-technology works at the plant site; and oversight of electrical works at the plant site. STUK also inspected the overall status of the processing of the emergency power supply equipment, as well as Fennovoima's human resources and the drafting at Fennovoima of the part of the construction licence application that discusses emergency power supply equipment. The areas that were inspected had been administered well at Fennovoima, and no requirements were issued on the basis of this inspection.

APPENDIX 5
Construction inspection programme of the encapsulation plant and final disposal facility 2022

The licensing and construction oversight project (PORA) for Posiva's spent nuclear fuel final disposal project continued the inspections in 2022 in the construction inspection programme (RTO). The inspections aimed to assess the functioning of Posiva's management system, the adequacy and appropriateness of the relevant procedures for carrying out and controlling the construction of the plant, as well as for taking account of the relevant safety requirements.

The 2022 programme included five inspections, focused on the topical major functions that are relevant to safety during the construction phase. The number of inspections remained at the previous year's level.

under the construction inspection programme in 2022, STUK delivered the licensee with advanced tasks regarding the theme of the inspection. The advanced concerned self-assessment or some other matter that was to be analysed before the actual inspection against the appropriate safety requirements. The purpose of these advance exercises is to achieve the strategy goals that relate to emphasising the licensee's responsibility, to coaching-oriented oversight and to focusing the inspection area, in particular, on the aspects and overall arrangements that are significant in terms of risk.

The following provides a brief description of the inspections, as well as listing the key observations based on which STUK required Posiva to carry out improvements and developments. The inspections assessed installation of Posiva's nuclear equipment with regard to, for example, the lifting and transfer equipment and mechanical equipment, as well as competence management, nuclear safeguards, security arrangements and the management system.

Installation of nuclear equipment, and mechanical equipment

This inspection focused on the installation of the nuclear equipment at Posiva's encapsulation plant and final disposal facility; the inspection examined installation procedures, management and instructions, as well as the operation of the organisation. The aim of the inspection was to ensure that Posiva has both the organisational and the administrative prerequisites to carry out nuclear installation at the encapsulation plant and final disposal facility, as well as that the installation quality control and oversight procedures are appropriate. STUK noted that Posiva has in place the installation organisation necessary for the installation of equipment and the related procedures for managing the installation activities carried out at Posiva's plants. The

nuclear equipment installation activities at Posiva's plants appear to be well organised. STUK issued a requirement concerning the instructions provided for Posiva's installation activities. The inspection also identified some ambiguity in the inspection invitations sent to quality inspectors, which is why STUK required that Posiva clarify its procedures in these respects to make them compliant with the relevant practices.

Posiva and TVO's common resources in the final disposal commissioning and production phase, and Posiva's competence management procedures

STUK carried out a joint inspection on human resources and competence management for Posiva and TVO. The inspection assessed the progress made with the planning and implementation of the training provided to Posiva's commissioning and production organisation, and it also covered the procedures that TVO and Posiva have in place to ensure the adequacy of their common resources in the activities of their respective organisations. The inspection established that the commissioning and production organisations are still incomplete and, to some extent, the number of personnel? in the organisation remains to be defined. Additionally, the role cards to be prepared for Posiva's personnel, and the role-specific training packages, are not fully ready yet. The personnel taking part in the production phase must be recruited and trained, and their induction must be completed, well before the production phase.

However, Posiva and TVO appear to have well-functioning and transparent procedures in place for managing their resources and for meeting Posiva's resource needs. On the basis of the inspection, STUK required that Posiva assesses the use of radiation safety experts and that it also provides appropriate instructions for this in its´ documentation.

Nuclear security

Of the subject matters that STUK inspected, all but one fulfilled every nuclear security requirement to which they are subject at this point of the life cycle of the nuclear facility. The inspection also recorded seven observations that aim for improvement.

Nuclear safeguards

This inspection reviewed Posiva's plans regarding the nuclear safeguards procedures applied in the commissioning phase and in operation. The inspection assessed whether Posiva has the necessary expertise and adequate capabilities for the efficient implementation of nuclear safeguards. The inspection established that Posiva has actively carried out nuclear safeguards-related activities and that the development is going in the right direction. Based on the inspection, STUK did not issue any requirements but emphasised that, in the next few years, Posiva must continue to develop the implementation of nuclear safeguards and must maintain cooperation with STUK, the IAEA and the European Commission in order to ensure that, when the final disposal operations are launched, nuclear safeguards activities will be ready for this in every respect.

Management system

This inspection assessed the measures that Posiva has taken to ensure that its activity complies with the management system, as well as evaluating Posiva's measures for maintaining the management system and for continuously improving it. The inspection assessed Posiva's internal audit activities, performance indicators for processes, and procedures for management reviews. On the basis of the inspection, Posiva's functions for the most part satisfies the requirements defined for the review and improvement of the management system. However, Based on the inspection, STUK required that Posiva assesses the establishment of the relevant safety and quality management-related key indicators in relation to the knowledge generated by the organisation, and that it develops its performance in order to form a situation awareness of safety and quality management.

APPENDIX 6
Licences granted by STUK in accordance with the Nuclear Energy Act in 2022

Teollisuuden Voima Oy

- STUK 2/C42214/2022, 15 March 2022: OL1 and OL2 – Import licence application for fuel transfer machine gripper frame. Date of expiry: 31 December 2022.
- STUK 4/C42214/2022, 18 March 2022: OL1 and OL2 – Import licence application for pump housings of main control pumps. Date of expiry: 31 December 2022.
- STUK 6/C42214/2022, 18 March 2022: OL1 and OL2 – Import licence application for orifice plates. Date of expiry: 31 December 2022.
- STUK 1/G42214/2022, 18 March 2022: OL3 – Import licence application for source-area neutron flow detector. Date of expiry: 31 December 2022.
- STUK 8/C42214/2022, 19 September 2022: OL1 e 45 "T" – Import licence application. Date of expiry: 31 December 2023.
- STUK 1/D42214/2022, 28 September 2022: OL2 e 43 "C" – Import licence application. Date of expiry: 31 December 2023.
- STUK 9/C42214/2022, 14 November 2022: OL1 and OL2 – Application to amend import licence 4/C42214/2022. Date of expiry: 31 December 2024.
- STUK 10/C42214/2022, 14 November 2022: OL1, OL2 – Application for licence for possession of sample assemblies. Date of expiry: 31 December 2038.
- STUK 11/C42214/2022, 14 November 2022: OL1 and OL2 – Application to amend import licence 2/C42214/2022. Date of expiry: 31 December 2023.
- STUK 2/G42214/2022, 19 December 2022: OL3 – Application to amend import licence STUK 5/G42214/2021. Date of expiry: 31 December 2023.
- STUK 3/G42214/2022, 19 December 2022: OL3 – Application to amend import licence STUK 1/G42214/2022. Date of expiry: 31 December 2023.
- STUK 12/C42214/2022, 21 December 2022: OL1 and OL2 – Import licence application for pressure frames. Date of expiry: 31 December 2023.

Fortum Power and Heat Oy

- STUK 2/A42214/2022, 12 May 2022: Import licence application, material from Sweden concerning design and manufacture of nuclear fuel. Date of expiry: 31 December 2026
- STUK 4/A42214/2022, 12 October 2022: Import licence application, CASMO-5 software and related documentation from Sweden. Date of expiry: 31 December 2030.
- VTT Technical Research Centre of Finland
- STUK 2/F42214/2021, 11 January 2022: Possession and transfer licence for OL3 fuel information. Date of expiry: 31 December 2025.
- STUK 1/Y42214/2022, 1 February 2022: Import and possession licence application for TRAFIC software. Date of expiry: 31 December 2024.
- STUK 3/F46201/2022: Export licence – Return of radioactive waste to Sweden. Date of expiry: 31 December 2022.
- STUK 5/F46201/2022: Export licence – Return of radioactive waste to Sweden (re-processing due to changed mode of transport replaced licence STUK 3/F46201/2022). Date of expiry: 31 December 2022.

Others

- STUK 10/Y42214/2021, 4 January 2022: Elomatic Oy's licence application for the transfer of information that is subject to a particular safeguards obligation, relating to Fennovoima Oy's Hanhikivi 1 project. Date of expiry: 31 December 2023
- STUK 4/Y42214/2022, 8 April 2022: Platom Oy's licence application for possession (and transfer) of archived design documentation of a terminated project. Date of expiry: 31 December 2031.
- STUK 6/Y46201/2022, 13 June 2022: Transport licence (DMS s.r.o) – Transport of fresh fuel through Finland. Date of expiry: 31 December 2026.

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