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Johanna Marttila (ed.)

Regulatory oversight of nuclear safety in Finland

Annual report 2020

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Introduction

This report is an account on regulatory oversight in the field of nuclear energy provided by the Radiation and Nuclear Safety Authority (STUK) to the Ministry of Economic Affairs and Employment (TEM) once a year as required by Section 121 of the Nuclear Energy Decree (161/1988). The report will also be provided to the Ministry of Social Affairs and Health, the Ministry of the Environment, the Finnish Environment Institute and to the environmental authorities of the nuclear facility municipalities.

The report is a summary of regulatory oversight of safety in the use of nuclear energy performed by STUK and of the related results in 2020. STUK's nuclear safety regulation, as presented in the report, covers the essential oversight data related to the design, construction, commissioning, operation and decommissioning of nuclear facilities. In addition, the report covers similar data on other uses of nuclear energy, including nuclear waste management and nuclear materials. In addition to actual oversight of safety, the report describes, among other things, the development and implementation of the regulations concerning the use of nuclear energy during the year and the main characteristics of the safety research programmes pertaining to nuclear safety and nuclear waste management in Finland.

The report appendices contain significant events at the nuclear power plants and inspection summaries of STUK's inspection programmes. In addition, a summary of the licences accordant with the Nuclear Energy Act granted by STUK in 2020, as required by the Nuclear Energy Decree, is appended to the report.

STUK's *Financial Statements and Annual Report 2020* includes an assessment of meeting the performance targets under the performance agreement between the Ministry of Social Affairs and Health and STUK also in view of regulatory oversight in the use of nuclear energy.

Contents

1 Development and implementation of the regulations

Amendments to the Nuclear Energy Act and the Nuclear Energy Decree

In 2020, STUK contributed to several of the main statute preparation projects for which the MEAE was responsible.

The preparation of the amendment bill on the security arrangements pertaining to the use of nuclear energy was continued through cooperation between the MEAE and STUK. The bill included amendments to the Nuclear Energy Act (990/1987), Section 21 of the Security Clearance Act (726/2014) and the Mining Act (621/2011). The MEAE presented Government billl (HE 8/2020) on security arrangements at the Government General Session in February 2020, where it was also approved. The amendment bill was discussed in the Constitutional Committee and the Commerce Committee. The Act amending the Nuclear Energy Act (964/2020) entered into force on 21 December 2020. The main objective of the amendment is to improve nuclear and radiation safety by responding to newly identified security threats that cannot be addressed and prevented with the powers of current legislation.

The Nuclear Energy Decree (161/1988) was amended in certain parts (1039/2020) in 2020. The amendments were related to the amendment and addition needs arising from the radiation legislation and the underlying EU Basic Safety Standards Directive (2013/59/Euratom, BSS directive) and from the Spent Fuel and Radioactive Waste Directive (2011/70/Euratom). At the same time, the regulation on security arrangements, among other things, was repealed from the Decree and included in the Nuclear Energy Act (990/1987) as basic regulation falling under the scope of legislation.

During the course of the year, STUK also participated in the REILA work group steered by the MEAE on the development of the regulation of the lifecycle of nuclear facilities, the term of which ended in summer 2020. As a result, a final report was published, and in this report, the work group concluded that initiating overall legislation reformation is necessary. This need partly arises from the lack of clarity in the current legislation but it is also caused by the changes in the operating environment.

Update of STUK's regulations issued by virtue of the Nuclear Energy Act

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 (990/1987). STUK has issued five regulations under this authorisation.

The Regulation on the Security in the Use of Nuclear Energy (STUK Y/3/2020) entered into force on December 29 2020. The regulation update was prepared by STUK at the same time as the amendment (964/2020) to the Nuclear Energy Act concerning safety regulations. STUK

has also investigated the need to update the Regulation on the Safety of Mining and Milling Operations Aimed at Producing Uranium or Thorium (STUK Y/5/2016). In this context, it has been stated that updating the regulationt would require amendments to the Nuclear Energy Act, and thus the preparation of the regulation has been suspended for the time being.

Update and implementation of the YVL Guides

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 the safety standards of the Nuclear Energy Act (990/1987), STUK may approve the procedure or solution.

As part of the update of the nuclear safety regulations, STUK's YVL Guides have also been updated. The round of updates of the YVL Guides involved mainly clarifications, changes to the regulation references and minor changes to the requirements. In the update of the YVL Guides, a particular goal was also to reduce the administrative burden. During 2020, STUK published 8 updated YVL Guides with explanatory memorandums in Finnish and English: YVL Guides C.5, E.8, E.9 and E.10 in January, YVL Guides A.1, D.3 and E.4 in March and YVL Guide E.6 in June. In addition, a new YVL Guide E.13 "Ventilation and air-conditioning equipment of a nuclear facility" was published in October. The last updated YVL Guides A.11 and A.12 were prepared together with the update of Regulation STUK Y/3/2020 and will be published in early 2021.

The YVL Guides apply to new nuclear facilities. With regard to operating nuclear facilities and those under construction, the YVL Guides will be brought into effect through STUK's separate implementing decisions. For the implementation of the updated YVL Guides, STUK has requested, 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 some implementation decisions taken based on them were completed during 2020. The remaining implementation decisions will be finalised in 2021.

STUK's comprehensive update of the nuclear safety regulations

In October 2020, STUK adopted the decision to begin the preparation of the structural and substantive update of the safety regulations on the use of nuclear energy. The aim of the renewal of the nuclear safety regulations and guides issued under the Nuclear Energy Act (990/1987) is to emphasise the licensee's responsibility and to focus the oversight based on risk-informed methods, and to make a clear difference between recommendations and binding requirements.

2 Results of regulatory oversight of nuclear facilities in 2020

The impact of the COVID-19 pandemic on the control of nuclear energy use

At the beginning of March, STUK required licensees to submit an account on how the nuclear power plants were prepared for the potential COVID-19 pandemic to ensure their operational safety, security arrangements and emergency response operations. Based on the accounts received, STUK was able to ensure that the licensees were sufficiently prepared for the pandemic. Already at an early stage, the licensees introduced extensive measures to prevent the spread of COVID-19 at the power plants.

After the restrictions caused by COVID-19 pandemic were imposed, STUK inspectors have mostly been working remotely. This reorganisation of work has not reduced or impacted the quality of the monitoring programme. Most of STUK's supervision is based on document review, and this work continued as usual remotely. Inspections have largely been carried out remotely and positive experience has been gathered in this regard. The precondition for remote inspections is that STUK receives all the information it needs from the inspection and can use this information to assess the state of safety and verify compliance with the regulations.

The COVID-19 pandemic has had the biggest impact on STUK monitoring carried out at plant sites and abroad. During the spring, STUK only carried out the inspections deemed necessary on-site at the nuclear power plants. During 2020, on-site supervision and inspections have been carried out more often than usual by STUK's local inspectors who normally work at the plant sites. Manufacturing monitoring abroad has been carried out by means of compensatory procedures, such as via remote connections and by transferring inspections from factories to the plant sites.

Despite the exceptional circumstances, the Finnish nuclear power plants have operated normally in 2020, and the measures taken to prevent the spread of COVID-19 have not been found to have had any adverse effects on the safety of their operations. Under exceptional circumstances, the responsible activities of licensees and nuclear plant personnel are emphasised and STUK has not observed any shortcomings in this regard.

2.1 Loviisa 1 and 2

STUK oversaw the safety of the Loviisa nuclear power plant and assessed its 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 by overseeing operations at the plant. On the basis of this regulatory oversight, STUK can state that as regards radiation exposure, the activities of the Loviisa nuclear power plant are safe to the employees, the population and the environment.

During the 2020 annual outages, preliminary installations for the partial replacement of plant protection were made at both plant units and Loviisa 1 also underwent an I&C replacement of one of the emergency diesel generators, the replacement of the low-frequency converters of the control rod mechanisms and the last replacement of the high-pressure safety injection system pump engine. In addition, Loviisa 1's annual outage included extensive inspections conducted every eight years (including an internal inspection of the reactor pressure vessel) and pressure tests, as well as a tightness test of the containment building supervised by STUK.

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 are presented in Appendix 3.

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 2020 was 0.54 manSv at Loviisa 1 and 0.36 manSv at Loviisa 2. Most of this accumulated from work completed during the annual outage of the plant: 0.49 manSv at Loviisa 1 and 0.34 manSv at Loviisa 2.

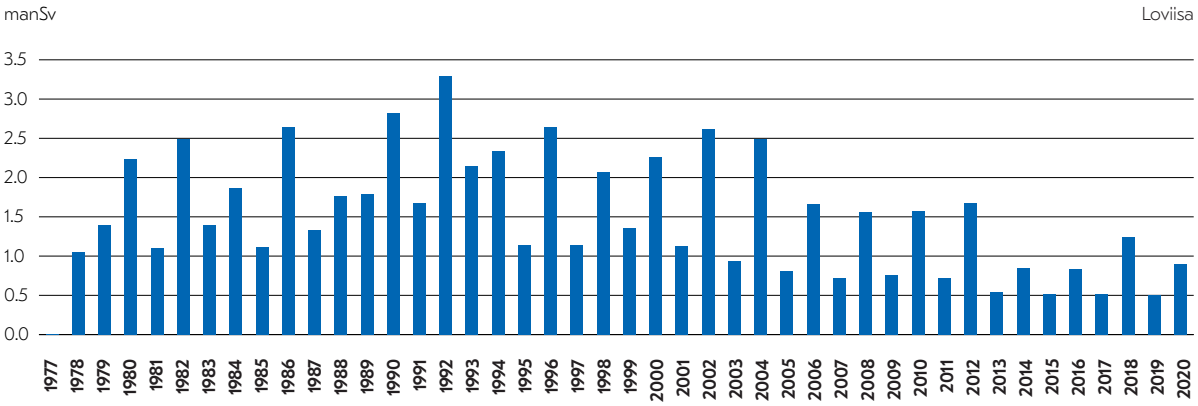

FIGURE 1. Collective occupational doses since the start of operation of the loviisa nuclear power plant.

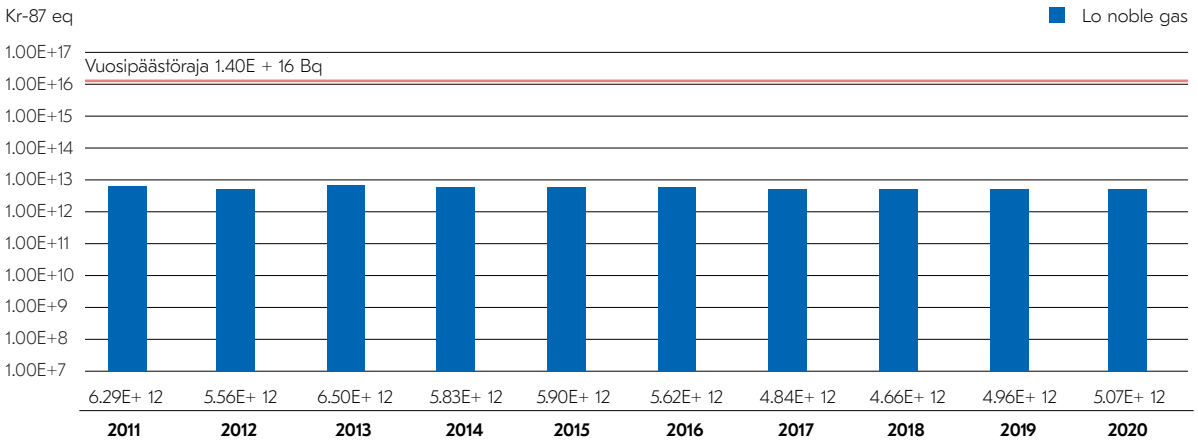

FIGURE 2. Noble gas releases to the atmosphere (Kr-87 eq), Loviisa.

Radiation doses for the Loviisa power plant staff have decreased in the 2000s due to, among other things, the development of work methods and systems and the minimisation of parts containing highly activated substances in accordance with the ALARA principle. Radiation doses are higher in even years, when an extensive annual outage is carried out at one of the plant units (in 2020 at Loviisa 1).

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 2020 was 11.7 mSv caused by insulation work.

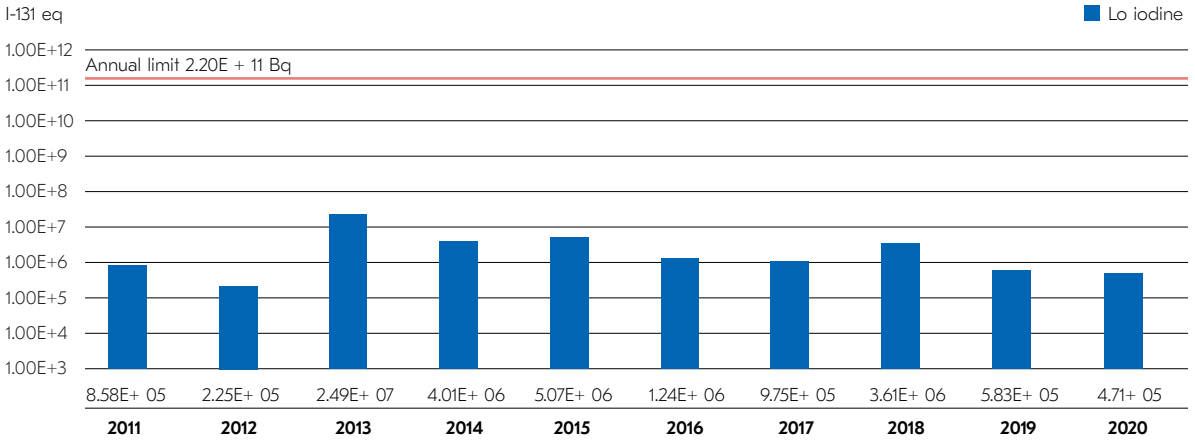

FIGURE 3. Iodine isotope releases to the atmosphere (I-131 eq), Loviisa.

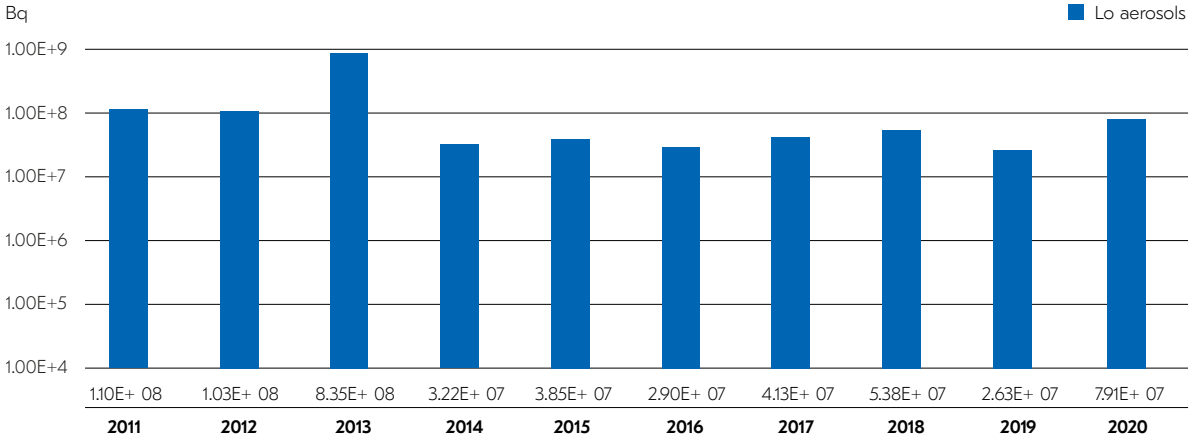

FIGURE 4. Aerosol releases to the atmosphere (Bq), Loviisa.

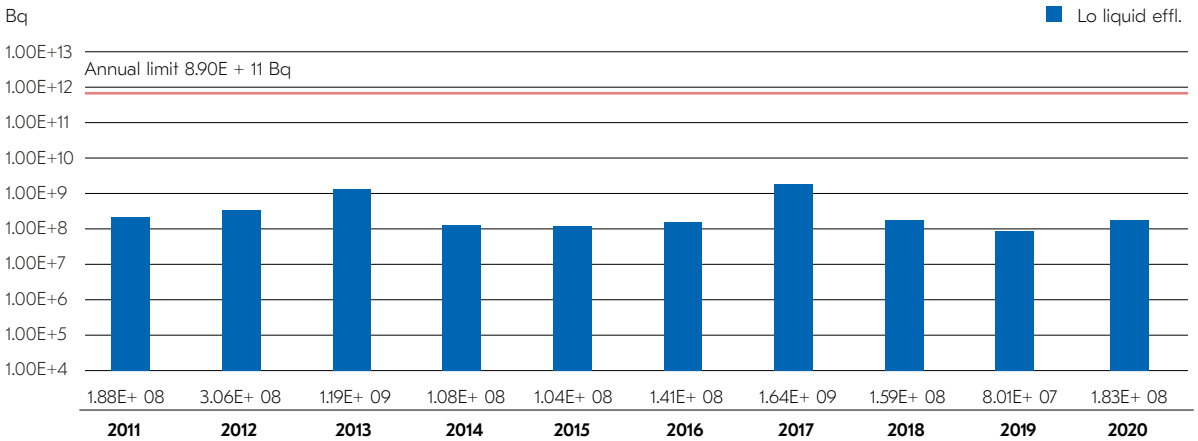

FIGURE 5. Gamma activity of the liquid effluents (Bq), Loviisa.

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 100 microsieverts set in the Nuclear Energy Decree (161/1988).

A total of approximately 450 samples were collected and analysed from the land and marine environment surrounding the Loviisa power plant in 2020. The measured concentrations were so low that they are insignificant in terms of 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 informed STUK of 8 events in 2020. In addition, STUK requested information on 5 other events identified by Fortum. One of the reports submitted by Fortum was a response to STUK's clarification request regarding the up-to-dateness of plant site documentation. As a conclusion, STUK can state that Fortum identifies operational events at the plants and initiates event investigations to determine the causes and to improve the operations of the plant and the organisation. Most of the events revealed areas for improvement in procedures and activities. The most important operational events are described in Appendix 2. The second event investigation (root cause analysis) mentioned in the Annual Report 2019 was also completed in 2020 regarding the shortcomings detected in the design and implementation of the renewal of cooling water lines of the emergency diesel generators.

By reviewing the results of the event investigations, STUK verified that Fortum had investigated the underlying causes of the events and had initiated the necessary measures to correct technical faults and deficiencies in its organisation's operations and to prevent the reoccurrence of such events. By the end of 2020, STUK had reviewed 11 reports. In two of the cases, STUK considered that investigation of the causes regarding the organisation's activities was insufficient and required supplementation to the reports. In other respects, STUK deemed Fortum's event investigations sufficient. STUK will review two reports submitted at the end of 2020 at the beginning of 2021. Based on its observations, STUK focused on the activities of individuals and the organisation in the event investigation during its periodic inspection of the management of human factors. STUK observed that the use of expertise in this area had decreased since the 2017 inspection. STUK required Fortum to strengthen the utilisation of expertise in human and organisational activities in the investigation of internal operating events.

During its 2017 and 2018 inspections, STUK had stated that there was room for improvement for Fortum to learn from Loviisa power plant's own operating experiences, as similar events kept reoccurring and there were deficiencies, for example, in the presentation of observations as well as in the definition and implementation of corrective measures. Based on its inspection findings, STUK had required that the line organisation's role in learning from its own operating experiences had to be improved. Based on the plan presented by Fortum, STUK considered it necessary to intensify its own monitoring in order to control the progress of development measures. In 2020, STUK stated via a clarification request that it is

unable to verify the adequacy of the effects of Fortum's improvement measures to remove the deficiencies. A clear and justified connection between STUK's inspection observations and the measures launched by Fortum remains unclear. STUK assessed the issue as a whole when preparing the periodic safety review of the Loviisa power plant.

According to STUK's view, the 2020 event reports submitted to STUK by Fortum brought up at least component failures, which resulted in reduction of plant unit capacity (4 events), deficiencies in Fortum's design and implementation of modifications (3 events) and a deviation from the Operational Limits and Conditions related to the cooling of spent fuel (1 event in 2020, 3 events in 2018). STUK paid attention to the small number of events reported to STUK compared to previous years and also to the fact that several events falling under STUK's supervisory responsibility were not reported to STUK without a separate request. STUK concluded that discussions must be held with Fortum on STUK's expectations regarding the submission of event reports.

Annual outages and maintenance operations

The annual outages of the power plants were implemented as planned in terms of nuclear and radiation safety. Despite the COVID-19 pandemic, the annual outages at both plant units were carried out to the extent originally planned. In addition to refuelling and modifications, a large number of maintenance measures and inspections were carried out during the annual outage to ensure the safe and reliable operation of the power plant.

One important aspect in terms of ageing management was the further work carried out on the plant's I&C reform, which was concluded in 2018.

Inspections of the pressure equipment were also carried out during the annual outage in accordance with the periodic plan approved by STUK. Tightness test of the containment building and pressure tests on the plant's primary and secondary circuits were also carried out at Loviisa 1 as well as a considerable number of additional inspections due to the observations of the Loviisa 1 reactor pressure vessel's foreign material monitoring system.

More information on the annual outages is available in Appendix 2, and a summary of the periodic 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. The on-going waste management development projects at the power plant, including for example solidification of liquid waste, repackaging of old waste barrels, design of a new repository, procurement of measurements for the clearance of metal waste from regulatory control and the development of waste accounting procedures have progressed as planned. The goal of the development projects is to improve operational efficiency and reduce the amount of waste destined for final disposal.

In June, STUK carried out a periodic inspection on the processing and storage of reactor waste, which focused on Loviisa power plant's waste management resources, competence and

instructions as well as the current measures of nuclear waste management. The inspection summary is provided in Appendix 3.

During 2020, Fortum started the disposal of solidified waste packages in the solidified waste space of the final disposal facility for low and intermediate level waste commissioned at the end of 2019. Once all the solidified waste packages have been moved to the final disposal facility, the interim storage of solidified waste packages in the maintenance waste space for low and intermediate level waste will end. The interim storage licence issued by STUK is valid until the end of 2021.

In September 2020, Fortum submitted to STUK for approval a periodic safety review of Loviisa's disposal facility for low and intermediate waste, and STUK has started to process the material.

STUK's oversight and inspections indicate that the Loviisa plant's power plant waste management has been developed in a goal-oriented manner and meets the requirements as a whole.

Nuclear safeguards

STUK granted Fortum three licences concerning the use of nuclear commodities (see Appendix 7).

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 2020, a total of 11 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 outage. Furthermore, STUK inspected the locations of the fuel assemblies in the reactors of Loviisa 1 and Loviisa 2 prior to the closing of the reactor covers. The IAEA and the Commission carried out one inspection on short notice in the material balance area at the Loviisa power plant. No remarks were made in the inspections.

The oversight and inspections by STUK indicated that the Loviisa plant fulfilled its nuclear safeguards obligations in 2020.

Security arrangements

The oversight indicated that the level of security arrangements at the Loviisa power plant has remained good and the security arrangements (including information security) have been purposefully developed.

At the end of 2020, Fortum updated the plant security plan, the power plant waste repository (VLJ repository) security plan and the radiation sources security plan as well as its review on their compliance with the requirements of design basis threat in the use of nuclear energy. STUK will evaluate these documents, among other things, in connection with the plant's periodic safety review in 2021.

In 2020, STUK carried out two periodic inspections of the security arrangements concerning the nuclear power plant's physical security arrangements and information security.

Based on these inspections, no requirements concerning security arrangements or information security were presented. The summary of the inspections is provided in Appendix 3.

Fire safety

Fire safety at the Loviisa power plant is at a good level. In 2020, STUK carried out a periodic inspection regarding fire security. No requirements were issued in the inspection. The summary of the inspections is provided in Appendix 3.

Furthermore, STUK oversaw the fire safety of the power plant by means of site visits and by reviewing reports submitted by Fortum. The oversight focused on the implementation of fire protection arrangements during annual outages.

Fire safety was further improved in 2020 by permanently closing some high-risk doors at Loviisa 2 based on the results of the plant's fire PRA. This will prevent a potential fire from spreading through the door.

2.1.2 Technical condition of the plant and preparing for exceptional events

Development of the plant and its safety

Several reform projects that will improve plant safety are currently in progress at the Loviisa nuclear power plant. The most significant of these was the plant's I&C reform, which was implemented in 2016–2018. In 2020, the modernisation of I&C systems continued with smaller entities to ensure the service life of systems that were not included in the 2018 reform. Preliminary work to partially reform protection I&C systems was carried out at both plant units – the actual installation will take place during the 2021 annual outages. The low-frequency converters of the control rod mechanisms were replaced in full at Loviisa 1. As regards Loviisa 2, Fortum will make a decision on the possible replacement later. The I&C of one of the Loviisa 1's emergency diesel generators' machine units was also replaced – the I&C of the remaining three machine units will be replaced one at a time during the coming years. There are no plans for such replacements at Loviisa 2. Parts obtained from Loviisa 1 will be stored, so that they will act as spare parts for Loviisa 2, if needed.

For the part of the modifications started as a result of the assessments done due to the Fukushima accident, the installation of the make-up water system to ensure the cooling of fuel pools and spent fuel storage pools under highly exceptional circumstances, which was started in 2017, was finalised. The mechanical parts of the system were completed during the 2018 annual outage, and the pump and I&C were finalised during the 2019 annual outage. The final commissioning was completed towards the end of 2020, after all of the issues identified in the trial operations during the 2019 annual outage had been corrected. All the plant safety improvements initiated as a result of the Fukushima accident have now been completed.

Other ageing-management related modernisation projects carried out at the Loviisa power plant in 2020 included the reactor hall refuelling machine and the replacement of the cooling unit of Loviisa 1 emergency diesel unit, which has been waiting for operating experiences from

the revisions made at Loviisa 2 as a result of several leakages in 2019. Further details on the consequences of the leaks are provided in Appendix 2.

Reports and analyses

Fortum submitted to STUK seismic hazard reports updated in spring 2019, according to which the expected ground accelerations are higher than previously estimated. The ground response spectrum determined in the report is needed to prepare seismic durability assessments of buildings and equipment. The processing of the reports regarding the seismic hazard has continued in 2020. During its inspection, STUK took into account the observations of the simultaneously ongoing investigation on seismic hazard sensitivity studies (SENSEI).

Upon completion of the analyses assessing the seismic durability of buildings and equipment, Fortum will update its probabilistic risk assessment concerning the plant's seismic events. Based on the results, Fortum will further define possible corrective measures to ensure that equipment critical to safety can withstand the plant's updated design basis earthquake. STUK will investigate the issue as part of the periodic safety review of the Loviisa plant.

During 2020, Fortum has also updated a large number of analyses related to ageing management as part of Loviisa's periodic safety review. Fortum submitted the analyses to STUK for assessment at the end of 2020. The analyses include, for example, deterministic safety analysis of the reactor pressure vessel, fatigue and loading analyses, and reports on the ageing management of the main components. STUK will inspects the reports as part of Loviisa's periodic safety review during 2021.

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 2020.

The emergency exercise scheduled for May had to be cancelled because to the COVID-19 pandemic. After the epidemic settled in the summer, the plans for the emergency exercise were resumed and the exercise was held in November. During the exercise, the STUK emergency response organisation practiced the activities in an emergency situation in the STUK emergency centre with reduced staff. STUK participated in the work of the exercise planning group.

In STUK's view, Fortum has systematically developed the Loviisa power plant's emergency response operations, and the plant's emergency response arrangements comply with all the key requirements.

2.1.3 Organisational operations and quality management

STUK has supervised the Loviisa power plant's competence and resources management in 2020, as well as the evaluation of the licensee's own activities as described in the management

system. Summaries of periodic inspections focusing on human resources and competence, management system and management of human factors are presented in Appendix 3.

The periodic inspection on human resources and competence covered the system managers' resource and competence management procedures. As a result of the inspection, STUK issued a requirement that deputies must be appointed to all system managers of systems that are critical to the safety of the nuclear power plant. The inspection also covered supervisory work at the Loviisa power plant. Based on the inspection, STUK stated that the management of the power plant, Fortum Group, the power plant HR section and training group are among the parties in charge of the induction, training and operating conditions of supervisors, but the expectations and practices related to the supervisory and managerial duties at the Loviisa power plant have not been defined as a whole and systematically considering the requirements of the nuclear sector.

The periodic inspection focused on the management system covered the development of independent assessment of nuclear safety and the procedures applied by Fortum to manage the deviations and risks associated with its operations. The licensee organisation's specification principles were also discussed. Based on the inspection, STUK stated that the independent operational assessment of the licensee's Loviisa power plant has been transferred to the plant's nuclear safety unit in 2020. STUK will monitor the further development of operations under its monitoring. With regard to deviation management, STUK required Fortum to account for the delays in the performance of corrective measures related to its operations. As regards risk management, the licensee has started to develop its operations based on self-assessment.

STUK carried out an additional inspection of Fortum's management of human factors related to safety in order to verify that it meets the standards that have been further specified as a result of changes to the regulations. As a result of the inspection, STUK found that Fortum has procedures to manage human factors, for example, in the investigation of events and in the planning of major changes to the main control room, but the use of these procedures must be increased in order to ensure proper management of human factors in practice. The revised regulations require, among other things, more extensive management of human factors in the design of plant modifications, and in order to achieve this objective, Fortum must further develop its operations.

STUK's focus in the supervision of Fortum's safety culture and management has been the licensee's ability to critically evaluate the development targets of its operating culture and to lead the necessary procedure changes in such a way that everyone commits to them and they are implemented on time. In 2020, the Loviisa plant undertook a more thorough self-assessment of the safety culture than in previous years and the responsibility for establishing an overall picture of nuclear safety was transferred to the plant organisation itself in order to strengthen the commitment of line organisation, which STUK considers to be a development in the right direction. The identification of concrete change needs related to management in particular and the implementation of these changes will continue to be supervised. The management of the challenging COVID-19 situation in 2020 was consistent, and, based on STUK's oversight, safety aspects were duly considered in the decision-making during the annual outage.

2.1.4 More extensive assessments at the plant

Periodic safety review

In June 2020, Fortum submitted most of the periodic safety review reports in accordance with the terms of the Loviisa nuclear power plant's operating licence, the rest Fortum submitted at the end of 2020. Fortum has to carry out a periodic safety review at least every ten years, and the deadline for the documents now submitted was by the end of 2023. The operating licence of the Loviisa power plant is valid until the year 2027 for Loviisa 1 and until 2030 for Loviisa 2. Furthermore, in autumn 2020, Fortum submitted to STUK a periodic safety review of Loviisa's final disposal facility for low- and intermediate-level waste (VLJ repository). It is estimated that the processing of the safety reviews at STUK will take until 2022, at which point STUK will finalise its own safety review and issue its decisions.

In autumn 2020, Fortum also launched an environmental impact assessment (EIA) on the Loviisa nuclear power plant and associated the final disposal facility for low- and intermediate-level waste. The EIA programme concerns the potential extension of the use and, alternatively, decommissioning of the Loviisa nuclear power plant. STUK submitted its statement on the radiation effects of the programme stage to the Ministry of Employment and the Economy in October 2020.

2.2 Olkiluoto 1 and 2

STUK oversaw the safety of the Olkiluoto nuclear power plant and assessed its 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 by overseeing operations at the plant. Summaries of inspections included in the periodic inspection programme for 2020 are included in Appendix 3.

On the basis of this regulatory oversight, STUK can state that as regards radiation exposure, the plant's activities are safe to the employees, the population and the environment.

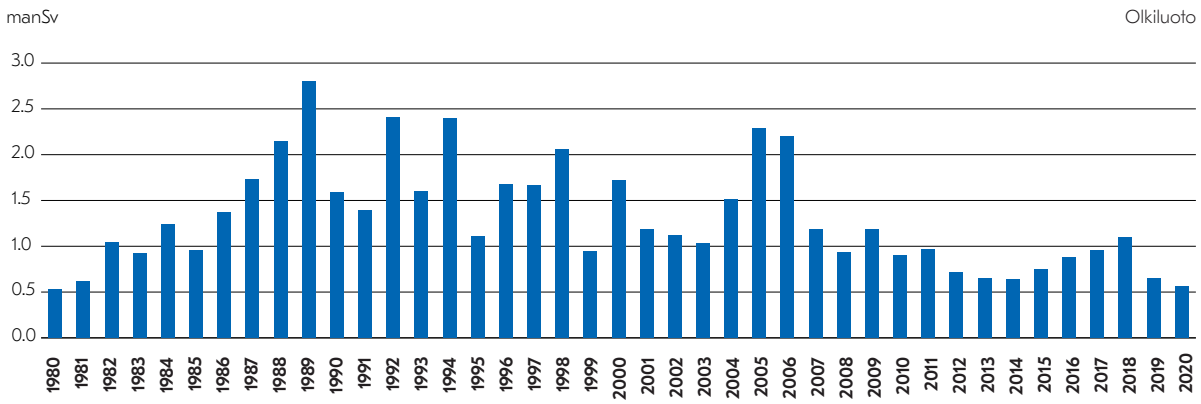

FIGURE 6. Collective occupational doses since the start of operation of the Olkiluoto nuclear power plant.

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 2020 was 0.34 manSv at Olkiluoto 1 and 0.22 manSv at Olkiluoto 2. Most of this accumulated from work completed during the annual outages (0.27 manSv at Olkiluoto 1 and 0.14 manSv at Olkiluoto 2).

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 7.8 mSv.

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 100 microsieverts set in the Nuclear Energy Decree (161/1988).

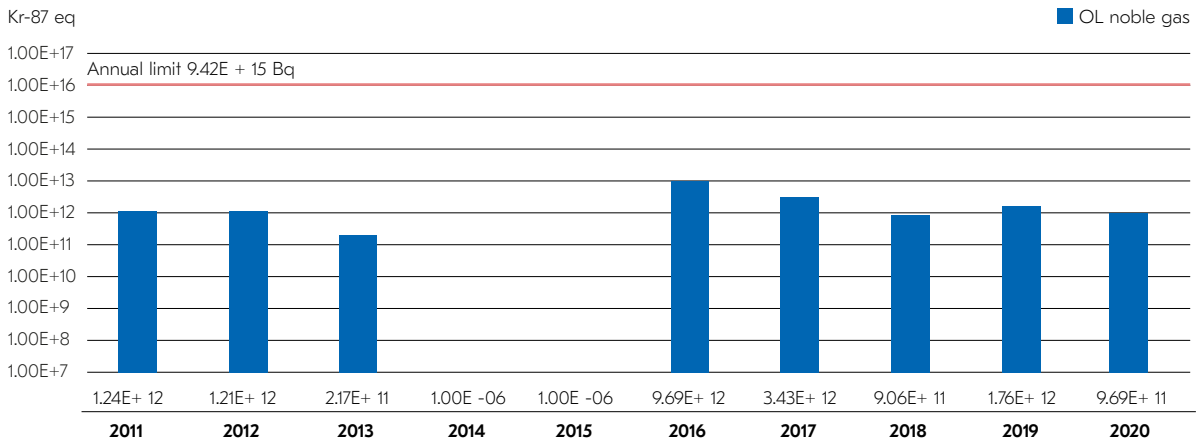

FIGURE 7. Noble gas releases to the atmosphere (Kr-87 eq), Olkiluoto.

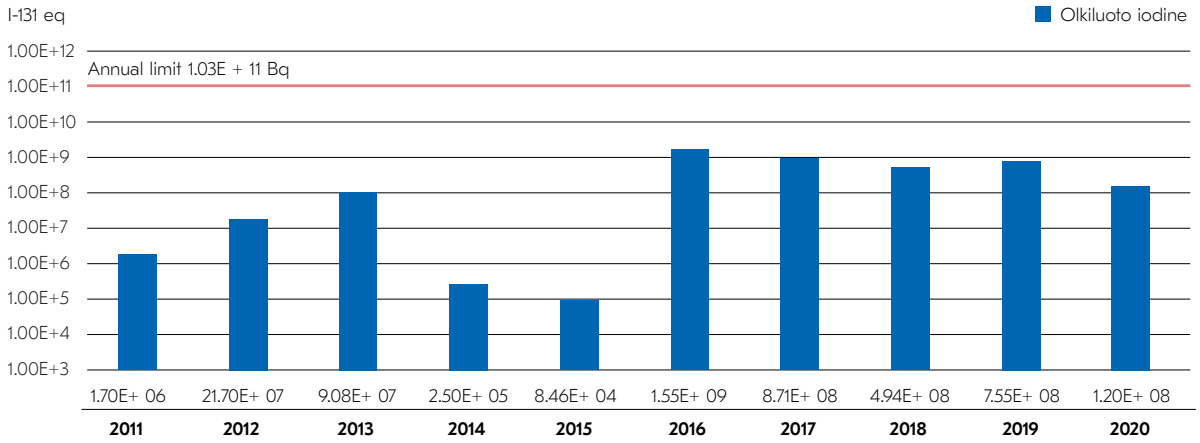

FIGURE 8. Iodine isotope releases to the atmosphere (I-131), Olkiluoto.

A total of approximately 440 samples were collected and analysed from the land and marine environment surrounding the Olkiluoto power plant in 2020. 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 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 Olkiluoto power plant were detected in them.

Operational events and operating experience feedback

TVO informed STUK of 17 events in 2020. TVO investigated these events and submitted the results of the event investigations also to STUK. One of the event investigation outcome reports was a response to STUK's clarification request regarding the situation of critical spare parts and the functioning of the spare parts management. As a conclusion, STUK can state that TVO identifies operational events at the plants and initiates event investigations to determine the causes and to improve the operations of the plant and the organisation. Most of the events revealed areas for improvement in procedures and activities. Olkiluoto 2's emergency situation

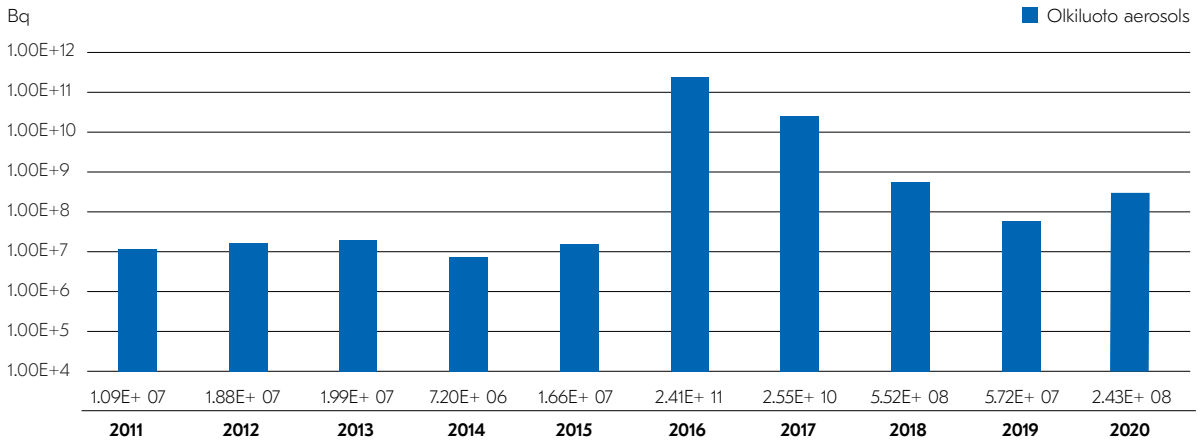

FIGURE 9. Aerosol releases to the atmosphere (Bq), Olkiluoto.

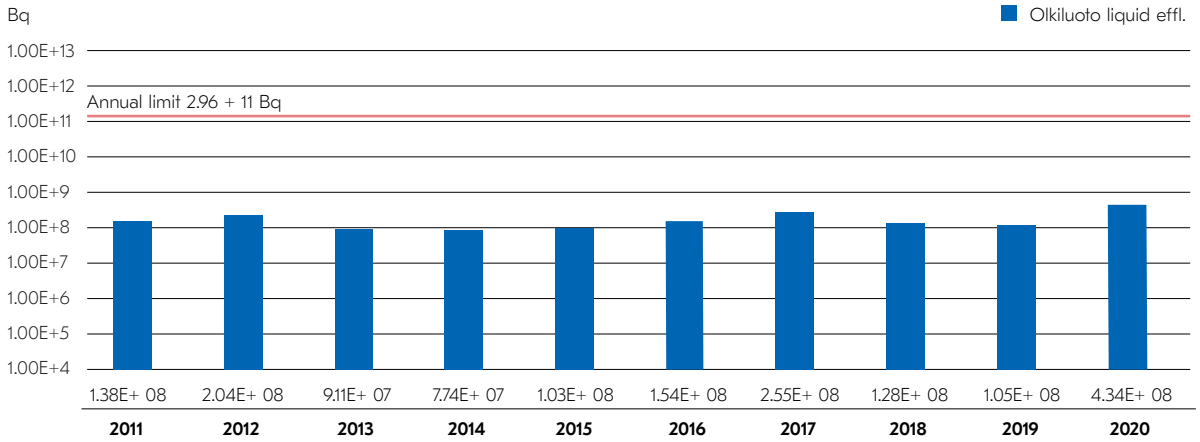

FIGURE 10. Gamma activity of the liquid effluents (Bq), Olkiluoto.

(10 December 2020) that triggered the activities of emergency response organisations at both TVO and STUK is highlighted as a single event. The most important operational events are described in Appendix 2.

By reviewing the results of the event investigations, STUK verified that TVO had investigated the underlying causes of the events and had initiated the necessary actions to correct technical faults and deficiencies in its organisation's operations and prevent the reoccurrence of such events. By the end of 2020, STUK had reviewed 14 reports. TVO decided to submit supplements to the three reports. STUK deemed TVO's event investigations sufficient. STUK will review three reports at the beginning of 2021, as TVO submitted them to STUK for processing at the end of 2020 and the beginning of 2021.

In STUK's view, some of the same topics emerge from among the 2020 events as from the events of previous years. This may possibly be due to the fact that the implementation of the measures TVO has previously launched is still underway and are yet to take effect or that TVO has failed to initiate sufficient measures based on previous events. STUK will take these observations into account in the planning and targeting of its control.

Annual outages and maintenance operations

The annual outages of the plant units were implemented as planned in terms of nuclear and radiation safety. As a result of the COVID-19 pandemic, TVO postponed some of the work planned to be carried out at Olkiluoto 1 to a later date. This way, TVO was able to reduce the number of workers involved in annual outage and thus protect the workers from contracting COVID-19. The maintenance work postponed by TVO included tasks that did not need to be completed immediately. For example, STUK approved the primary circuit pressure test required in connection with the renewal of the operating licence to be carried out during the 2021 annual outage. The decision was supported by the results of the strength analyses of the reactor pressure vessel and positive experiences from a pressure test performed at Olkiluoto 2 in 2019.

STUK monitored the annual outages from their design to the start-up of the plant units. STUK had to slightly adapt its inspection and control routines due to the COVID-19 pandemic. For example, STUK only carried out inspections deemed necessary onsite and supervised the annual outage with the help of remote connections more than before.

A large number of maintenance measures and inspections were also carried out during the 2020 annual 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 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. TVO has continued its work on harmonising the solidification processes of all three plant units and has launched an environmental impact assessment of the underground final disposal of very low-level waste.

In 2020, STUK carried out an inspection on the transfer of operational waste and fuel within the site area. The inspection focused on radiation protection aspects as well as transport and security arrangements related to the transfer. STUK also assessed the preparation and actual transfer of solidified waste from the power plant to the operational waste repository and the related TVO guidelines. No significant deficiencies were detected in the inspection, but some development needs related to guidance were identified.

Nuclear safeguards

STUK granted TVO ten licences concerning the use of nuclear commodities for the Olkiluoto plant units in operation (see Appendix 7).

TVO submitted the nuclear safeguards reports and notifications it was responsible for in time, and they were consistent with the observations made during inspections. STUK approved the update of TVO's nuclear safeguards manual. In the manual, TVO describes how the nuclear safeguards of Olkiluoto nuclear power plant units have been organised. In addition, STUK approved TVO's update of the accountancy and safeguards manual for international transfers of nuclear materials. In December, TVO submitted to the European Commission the updated Basic Technical Characteristics (BTC) of the Olkiluoto 1 and 2 plant units and the spent fuel storage.

A total of 15 nuclear safeguards inspections were carried out in the material balance areas of TVO's operating plant units and the spent fuel storage facility, including inspections of the entire power plant area and TVO's nuclear safeguards system. 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 locations of the fuel assemblies in the reactors of Olkiluoto 1 and Olkiluoto 2 prior to the closing of the reactor covers. STUK also performed periodic inspections of nuclear safeguards at both plant units and at the spent fuel storage facility. STUK also participated in an inspection carried out by the IAEA at Olkiluoto 1 on short notice in November. No remarks were made in the inspections.

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

Security arrangements

In 2020, STUK carried out one periodic inspection regarding nuclear security. Inspection targets included risk and deviation management, both in terms of physical security arrangements and information security. In order to maintain and improve both physical security arrangements and information security procedures, several development projects are ongoing and underway at Olkiluoto. STUK considers these to be good and necessary. The inspection summary is provided in Appendix 3.

The security arrangements comprise an extensive package of administrative, technical and operational procedures. The whole formed by the security arrangements is at the required level.

Fire safety

In 2020, STUK oversaw the fire safety of the power plant by means of inspections and site visits during the annual outage and by reviewing reports submitted by TVO. 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

For the part of the modifications started as a result of the assessments done due to the Fukushima accident, the auxiliary feedwater system's dependence on seawater cooling has been significantly reduced at the Olkiluoto plant units in operation. The modification was carried out at Olkiluoto 1 already in 2014. Abnormal vibrations and sounds were nevertheless observed during the test run in one new recirculation line. TVO has investigated the issue and solved the problems related to piping vibration, for example, by improving piping supports, which established the basis for continuing the modification work at Olkiluoto 2 as well. TVO completed the last two subsystem installations in the 2020 annual outage, after which the recirculating line modification has been implemented in all Olkiluoto 1 and Olkiluoto 2 subsystems. STUK supervised the installation work and test runs and approved the results reports. All the plant safety improvements initiated as a result of the Fukushima accident have now been completed.

In the emergency diesel generator update project, the plant's eight emergency diesel generators will be replaced and a ninth generator, enabling the replacement of diesel generators during power operation, was also introduced in 2020 In autumn 2020, the replacement of the existing diesel generators was started by replacing one Olkiluoto 1 diesel generator and initiating its disassembly and replacement work. The remaining emergency diesel generators will be installed and commissioned one by one by spring 2025. The new diesel generators can be cooled with seawater and air. The current ones can be cooled only with seawater. STUK is overseeing the upgrade and in 2020 inspected its related design documents and oversaw the manufacture and testing on site.

An alternative float chamber-based trip that meets the diversity principle has been designed for the essential function of reactor water level measurement. In conjunction with the renewal of the operating licence, TVO proposed that the modification is intended to be implemented between 2019 and 2021. At the end of 2018, TVO submitted an application to STUK for approval, according to which the work will not yet be started in the 2019 annual outages. TVO has reassessed the risks related to the installation against the possible benefits of the modification and proposes that the preparation of the implementation in accordance with the current model be interrupted for further investigation. In 2020, TVO submitted to STUK for approval failure and common cause failure analyses related to the reactor pressure vessel's surface measurement and a plan for safety improvements. However, further clarifications have been requested from TVO, based on which STUK will assess the adequacy of the measures in more detail. TVO must submit final clarifications and an action plan in spring 2021.

TVO has launched a project to renew the refuelling machines of the plant units. 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 the refuelling machines. STUK approved the conceptual plan for the new refuelling machines in February 2020. STUK will monitor the design, construction, installations and commissioning of the new refuelling machines. The project is planned to be completed during 2025.

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.

An extensive emergency exercise led by the Satakunta Rescue Department was held in December, but as a result of the COVID-19 pandemic, the exercise was shorter than originally planned. During the exercise, the STUK emergency response organisation practiced the activities in an emergency situation mainly via remote connections. STUK participated in the work of the exercise planning group.

In 2020, one situation requiring emergency response operations occurred. On 10 December 2020, an automatic isolation of the containment building occurred at Olkiluoto 2 due to an increase in the radiation level of steam pipes, which resulted in the declaration of a site area emergency and TVO's emergency organisation launched its operations in accordance with the emergency plan. The activities of the emergency organisation ended with the conclusion of the emergency situation in the early hours of 11 December 2020. TVO organisation operated mainly in accordance with the plan. A more detailed analysis is underway and TVO is preparing summary reports on both the exercise and the site area emergency and will submit them to STUK. The incident did not require any protective measures to be taken and did not pose a risk to the power plant staff or the local residents.

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

2.2.3 Organisational operations and quality management

In 2020, organisational control focused in particular on the impact of the measures taken to prevent the spread of COVID-19 on TVO organisation's ability to perform its basic task. In order to monitor the situation, STUK held regular monitoring meetings with TVO throughout the year. Nothing concerning emerged. TVO management's activities and decisions in managing the COVID-19 situation have shown consistent leadership, and, based on observations, the staff seem to be committed to observing the exceptional procedures.

TVO has recruited a large number of people in recent years. STUK's monitoring has not revealed any specific shortcomings in terms of TVO's competence or resources. The priority

of safety has been communicated very clearly in TVO's internal communication and "Safe operation" has been highlighted as a strategic theme.

Observations made during the annual outage do not reveal any significant new concerns related to TVO's safety culture. Operational decisions related to the events were appropriate and conservative. During the annual outage, strict access rights and quarantine regulations aimed at preventing the spread of COVID-19 to the plant site were applied at Olkiluoto. TVO succeeded in its operations and the experience was positive, particularly in terms of the peaceful working conditions at the control room, as access to it was restricted during the annual outage.

In 2020, STUK carried out a "Management system, management and safety culture" inspection, which addressed issues such as: TVO's ability to ensure that its suppliers have a healthy safety culture. TVO has carried out development work on being better able to assess the safety culture of suppliers in procurement, manufacturing and reception activities and disseminating information throughout the organisation. TVO has also reorganised its operations in charge of technology, such as project activities, in order to further improve them. In STUK's view, these development measures are positive and their effects continue to be monitored. The inspection also verified the implementation of the revised requirements related to the update of Guide YVL A.3 "Leadership and management for safety" at TVO. The inspection summary is provided in Appendix 3.

2.3 Olkiluoto 3

STUK oversaw the construction of the Olkiluoto 3 plant unit and TVO's preparation for the coming operation stage by reviewing materials provided by the licensee, carrying out inspections in line with the inspection programme and the YVL Guides, and overseeing operations at the plant. Summaries of the inspections included in the inspection programme for 2020 are presented in Appendices 3 and 4. Appendix 3 contains the inspections carried out as part of the inspection programme of operating plants. Appendix 4 includes inspections focused on verifying Olkiluoto 3's operational readiness for fuel loading.

The Olkiluoto 3 project is in the commissioning phase, which includes the trial operation of components and systems, other preparations for plant operation, such as the production of instructions required for operation, personnel training and the completion of emergency preparedness and security arrangements. At the same time, the construction and installation work is being finalised.

In 2020, STUK's oversight practices had to be adapted to the requirements posed by the COVID-19 pandemic. The on-site monitoring and inspections necessary for verifying Olkiluoto 3's readiness for fuel loading were carried out as planned. Suitable remote solutions were utilised more than usually in monitoring. For example, the commissioning inspections organised by the plant and several inspections related to the verification of the plant's readiness for fuel loading were carried out remotely as of spring 2020.

In spring, TVO submitted to STUK a fuel loading licence application and the related safety assessment. In August, TVO published a new project schedule, according to which the fuel

loading is scheduled for March 2021. As fuel loading was postponed, STUK required an updated fuel loading licence application and safety assessment to be submitted when the plant reached readiness for fuel loading.

Monitoring the tests and repair and modification work formed a large part of STUK's supervision operations in 2020. The oversight of test operations included the inspection of test plans and as well as the oversight of selected tests, while the monitoring of the repair and modification work included the inspection of plans and deviation reports, as well as on-site inspections.

STUK carried out several inspections of functions related to preparations for plant operation and oversaw, for example, the plant's readiness in terms of security arrangements, control room operations and the progress of the management system and operating procedures. STUK also oversaw the performance of repair, maintenance and modification work critical in terms of safety. Based on these oversight measures, STUK observed that most of TVO's procedures and operations are at a good level.

2.3.1 Processing of licensing documents

In 2020, STUK received, among other things, I&C suitability analyses, updated classification documents and Final Safety Analysis Report (FSAR) updates, as well as plans for mechanical devices and their updates.

STUK monitored the progress of the I&C component qualification and reviewed the suitability analyses of the I&C equipment and systems. According to the schedule, the suitability analyses should have been completed during the spring, but the last of them were submitted to STUK for processing in December and their processing will continue in 2021. The suitability analyses have mainly been of good quality. However, for some standalone systems, there have been uncertainties in terms of their radiation resistance, and STUK has requested corrections to the documents.

Based on the observations made during test operation and the operating experience of the two plant units of the Taishan sister plant in operation in China, changes have been made to the plant's systems. For example, inaccuracies in some measuring instruments that have been larger than estimated have led to updates to ensure that the documentation reflects the actual behaviour of the plant. In addition, the facility documentation has been updated to reflect the results of the trial operation. STUK has inspected and approved the modifications related to safety.

2.3.2 Manufacture, installation and construction

STUK continued its oversight of manufacture and installation.

STUK oversaw the test operation of emergency diesel engines during 2020 and inspected the repair and modification work of faults that surfaced in test operation. The cooling water pipes of the engines are connected to the engine with steel bellows. The redesign of the bellows started as a result of the leaks detected in the trial operation in 2019. Fast stopping of the engine in an overspeed situation required the redesign of the overspeed protection

valve. The above-mentioned changes were implemented during 2020, in addition to other necessary modifications and repairs. During the diesel test run in October, high vibration levels were observed at the diesel generator magnetising machine. The vibration issue was comprehensively investigated at the end of 2020, resulting in changes to the equipment. STUK reviewed the changes. At the end of 2020, these modifications were still underway. After the modifications have been completed, diesel test runs will be carried out to demonstrate the functionality of the modification work and the achievement of the approved vibration level. The demonstration of the functionality and conformity of the emergency diesel generators is ongoing and STUK will ensure that the matter is completed before the nuclear fuel is loaded.

During the tightness test carried out in spring 2020, TVO and the plant supplier detected a leak in a mechanical control valve of one of the pressuriser safety valves. There are a total of three pressuriser safety valves and they are required for the overpressure protection of the plant unit's primary circuit. Each safety valve has two mechanical control valves, one of which is separated. Reliable opening and closing of the safety valve depends on the reliable operation of the mechanical control valve. In order to investigate the detected leak, the control valve was opened, at which point TVO and the plant supplier noticed that the valve stem was broken.

As a result of the incident, the remaining five mechanical control valves were also opened. Cracks were visually observed on the stems of two of the control valves. The damaged parts were delivered to Framatome Technical Center in Germany for further investigation to determine the root cause of the damage. Pitting caused by impurities leads to hydrogen formation, which combined with stress causes stress corrosion in martensitic stainless steel. Impurities such as sulphur, chloride and phosphorus were found on the outer surface of the stem. As a result of heat treatment, the stem material is in a state known to be vulnerable to stress corrosion. As a result of the valve assembly, the stem is also subject to tensile stress. The investigations found that all the factors required for stress corrosion were present in the damaged part. However, the source of the impurities could not be reliably identified.

The damaged parts have been replaced with corresponding new parts and temporary procedures have been introduced to maintain the required level of cleanliness during nuclear commissioning. During the last tertile of 2020, the control valves were delivered to Olkiluoto, tested and reinstalled. During the first operating cycle of the nuclear power plant, the condition of the valves will be monitored by means of additional testing. Furthermore, the plant supplier has initiated modification planning aimed at ensuring the reliability of the control valves in long-term use.

In relation to this matter, STUK processed and approved applications regarding open requirements, such as a deviation report and plans for ensuring cleanliness during commissioning. Towards the end of the year, the plant supplier presented a design project related to the changes of the control valve. TVO will submit the plans regarding the change to STUK before fuel loading.

In the summer, TVO reported it had discovered insulation damage in conductors in the I&C cabinets. Insulation damage can cause a short circuit if the damaged area is in contact with the metal parts of the I&C cabinet or with another damaged conductor. TVO and the plant supplier inspected all the main I&C system cabinets without touching the conductors to determine the extent of the issue and repaired the damaged conductors. In addition, the conductors related

to critical safety functions were inspected by moving them inside the cabinet to see any hidden faults on the conductors.

As it is possible that some defective conductors remain in the I&C cabinets, TVO assessed their impact on plant safety, for example, during seismic events that would cause the I&C cabinets to shake, but even in such an event, the impact on the probability of reactor core damage remains small based on preliminary assessments. TVO also stated that the defective conductors had only caused a few short circuits during the commissioning test prior to the repairs. The built-in self-diagnosis of I&C system platforms detects short circuit faults and the I&C systems are designed to withstand these faults. The installation instructions related to conductors have been improved to prevent such damage in the future.

Regarding this matter, STUK processed the scope of the conductor inspection presented by TVO and the preliminary analyses of their impact on safety. STUK made no remarks on these. At the end of 2020, TVO submitted to STUK the final analyses and STUK has started to review them.

In 2020, STUK processed a deviation report on the heat treatment during the manufacturing of steam generators and the pressuriser. The deviation report covered temperature overruns and underruns in local heat treatment during factory manufacture of steam generators and the pressuriser. The deviation was observed in connection with the development of the manufacturer's new induction-based heat treatment method. According to TVO's assessment, the heat treatment deviation has been assessed conservatively, and the deviation has no impact on the safe use of Olkiluoto 3's steam generators and pressuriser. STUK approved the deviation with requirements related to the specification the analyses of the fast fracture of the steam generators and the pressuriser. Steam generators supplied by the manufacturer have also been installed on operating French nuclear power plant units and the plant supplier will continue to investigate the temperature effects of stress relief annealing. The results of the further investigations are also important in terms of the use of Olkiluoto 3's steam generators and pressuriser. When approving the deviation report, STUK also required TVO to monitor, assess and utilise further research projects. At the end of 2020, TVO submitted to STUK a further research programme regarding this matter, but STUK's processing of the matter is still underway. The monitoring of the programme will be continued, but the matter is not an obstacle to fuel loading.

In 2020, STUK processed deviations that had emerged in the operations of material manufacturer Aubert & Duval as well as the reports on their impact on material deliveries relating to Olkiluoto 3. The manufacturer's suspicious operations have attracted wide international attention as they have led to a serious helicopter accident. The plant supplier has carried out extensive investigations on the manufacturer's activities. TVO has assessed the manufacturer's deliveries to Olkiluoto 3 in detail based on the plant supplier's reports and its own inspection visits. TVO has concluded that the deviations have no impact on the safety and usability of Olkiluoto 3's components. STUK assessed the reports and approved them at the end of 2020. However, in its decision, STUK required TVO to monitor the components made of the materials in question in accordance with the condition monitoring procedures.

2.3.3 Oversight of commissioning

The purpose of trial operation is to verify that the plant's systems, structures and components operate as planned and have been successfully installed. Large-scale trial operations at the Olkiluoto 3 plant unit began already in 2016 when mainly individual components and systems were tested. In 2018, the so-called hot functional tests were performed at the plant in which main coolant pumps were used to heat the reactor plant and turbine plant systems to the correct operating temperature and pressure. During hot functional tests, STUK inspected matters relating to the performance of the tests, such as the administration of commissioning activities in the control room, the meeting of prerequisites for starting the tests to be performed, the orientation of the personnel and the work permit practices relating to the tests. As part of the inspection, STUK oversaw the performance of the most significant tests.

STUK had previously approved the results of the heat tests in other respects, but the final results of the vibration measurements of the reactor internals were not submitted until 2020. These results are of great significance as the structure of the reactor internals is different from those of the old reactors, for example, in terms of the reactor's massive size and heavy reflector design. STUK approved the updated result report. Some tests have been postponed or they will be repeated during nuclear commissioning phase.

The biggest open issue in the hot tests was related to the higher than expected vibration of the pressuriser surge line belonging to the reactor cooling circuit. The root cause of the vibration of the pressuriser surge line has been investigated extensively. The vibrations are likely to be caused by excitations caused by turbulent currents in the primary circuit, which are close to the structural natural frequencies of the pressuriser connecting line. In order to reduce the vibrations, viscose dampers were installed in the pressuriser connecting line. The installations were completed in 2020. The verification of the vibration levels will continue after fuel loading in connection with the hot functional tests performed before the first criticality, at which point the vibration levels of the connecting line will be measured in various operational states of the plant.

STUK processed applications related to the open requirements of the pressuriser surge line. In connection with the processing, STUK required a clarification regarding the initial assumptions of strength analyses. TVO must submit clarification regarding the matter as well as the necessary analysis updates to STUK before fuel loading.

Although the plant systems' joint functional tests had already been performed in 2018, a significant number of individual system test runs were still carried out in 2020. All of the plant's systems were not needed in the hot functional tests, and some of the tests of these systems had been postponed to take place after the hot functional tests. Examples of these systems are standalone systems relating to waste management, some of the ventilation systems and the emergency diesel generators. Changes made to previously tested systems were also retested.

Commissioning inspections performed to verify the readiness for operation of various systems, equipment and buildings were continued in 2020. STUK evaluates the readiness for operation of the systems and equipment in connection with the commissioning inspections. During commissioning, the equipment are maintained to ensure their operational condition

and to evaluate the implementation of necessary maintenance measures. STUK verified the implementation of maintenance of the equipment most important to safety during 2020.

During the year, STUK reviewed several changes made to the test programmes. Some of the changes had been made on the basis of experience from other EPR units, but most of the changes were updates that corrected the test programme to reflect the actual test. In its reviews, STUK pays particular attention to having all safety-significant functions tested and to having appropriate acceptance criteria for the tests. The test programmes have been of good quality, and STUK has approved almost all of them without any requirements. Reports of the trial operation results were submitted to STUK throughout the year. The result reports have been mainly comprehensive, and STUK made no remarks concerning them.

2.3.4 Oversight of preparation for operation

In addition to the technical readiness of the plant, a prerequisite for safe operation of the plant is the organisation's ability to use the plant in a safe manner. This includes ensuring that the organisation has sufficient resources and the necessary skills and competence, activities are instructed and there are arrangements and procedures for managing different types of matters (such as emergency response arrangements, security arrangements, nuclear safeguards and maintenance operations). STUK made several inspections relating to the preparation for the operation of the plant unit. For example, STUK reviewed safety arrangements, spare parts management, emergency response operations, resource planning, the readiness of the plant's operating procedures and instructions related to severe accident management, as well as the readiness of the management system and the control room. When the operations to be inspected concerned the entire TVO and all of the plant units, the inspection was included in the periodic inspection programme of the plant units in operation. Summaries of the inspections included in the inspection programme for 2020 are presented in Appendix 4. In its inspections and other control activities, STUK paid attention to the clarification of the procedures of control room activities, the compliance with instructions, the functioning of work permit practices and the clarity of the division of responsibilities between organisations.

In spring 2020, STUK supervised the required additional demonstrations of the functionality of the control room entity with a training simulator. By means of these additional demonstrations, TVO sought complementary evidence that the control room entity contributes to the safe operation of the plant. The control room entity consists of the competence and operating practices of the control room operators, the plant's operating procedure, including transient and emergency procedures, the control room interfaces and the physical control room environment. The additional demonstrations were concluded in May and the report on the matter was finalised at STUK in the autumn, and STUK found no cause for remarks on the matter.

According to Section 7 i (2) of the Nuclear Energy Act (990/1987), only a person approved by the Radiation and Nuclear Safety Authority (STUK) for the position in question may act as a nuclear facility operator in the control room of the facility. STUK approved the first operators of Olkiluoto 3 in accordance with TVO's applications already at the end of 2018. However,

these first approvals were only valid for up to two years. Therefore, at the end of 2020, STUK supervised the updating of the licences and approved the related applications.

STUK's monitoring has not revealed any specific shortcomings in terms of TVO's competence or resources. Olkiluoto 3 has new employees especially in maintenance and operation tasks. For their part, training and on-the-job learning are still ongoing. However, TVO has taken measures, such as hired consultants and arranged for the technical unit staff to support the new employees.

STUK has monitored TVO's provisions for the COVID-19 pandemic and has assessed TVO's operational possibilities on the plant site. No concerns emerged in the course of the monitoring, for example, regarding foreign labour.

The management system of Olkiluoto 3 is a part of TVO's management system. In the autumn inspection, the OL3 management system was found to be incomplete with regard to some of the plant management instructions and related training. Their readiness will be verified during a review in early 2021 to confirm TVO's readiness for fuel loading.

Organisational changes at Olkiluoto 3 aimed at strengthening TVO's role at the plant instead of the plant supplier have continued. TVO and the plant supplier have been working in so-called joint organisations, which enable TVO to better participate in the finalisation and commissioning of the plant.

The readiness inspection of Olkiluoto 3's control room thoroughly reviewed the operating personnel's procedures in relation to their readiness for fuel loading. STUK conducted remote interviews and an online survey for operators and field operators. Based on the inspection, it can be stated that the safety culture in TVO's operations appears to be at a good level.

2.3.5 Nuclear safeguards

STUK granted TVO three licences concerning the use of nuclear commodities at the Olkiluoto 3 plant unit (Appendix 7). In December, TVO submitted to the European Commission the updated Basic Technical Characteristics (BTC) of the Olkiluoto 3 plant unit. TVO submitted the nuclear safeguards reports and notifications regarding Olkiluoto 3 it was responsible for in time, and they were consistent with the observations made during the inspections.

In 2020, STUK carried out two inspections related to nuclear commodities for Olkiluoto 3. No cause for remarks was found in the inspections. The oversight and inspections by STUK indicated that TVO fulfilled its nuclear safeguard obligations at Olkiluoto 3 in 2020.

2.4 Hanhikivi 1

In 2020, STUK did not yet have at its disposal comprehensive information on the plant and system design of Fennovoima's Hanhikivi nuclear power plant for the detailed assessment of the plant design and the analyses made and for the preparation of the safety assessment.

For the decision in principle, STUK made a preliminary safety assessment in 2014. In the suitability assessment of the AES-2006 plant alternative of the Preliminary Safety Analysis Report STUK presented that the AES-2006 plant alternative can meet the Finnish nuclear and

radiation safety requirements via design changes, additional analyses and qualification. During the construction licence process, the plant supplier has continued to change the basic design of the facility in order to meet the Finnish safety requirements. To implement the changes in basic design, the plant designers need advanced design systems to manage the requirements set for the facility and organisation and to maintain design integrity, among other things, through the procedures and tools of configuration management.

A key document for the processing of the safety case in the construction licence phase is the Preliminary Safety Analysis Report (PSAR) of the facility. In order to prepare the safety analysis report, the plant supplier and lead designer have set up a separate project (PSAR Localisation Project, PLP) to produce a safety analysis report that would meet the Finnish requirements. The PLP project has acquired extensive nuclear and radiation safety expertise from Russia, Finland and other European countries. The aim is to submit the safety report to STUK in 15 delivery batches. The parts of the report submitted to STUK thus far are based on the first stage of the plant's basic design and have not fully corresponded to the maturity required of PSAR under the Finnish requirements for the construction licence stage. The parts of the safety report will be further updated and completed later on at stage 2. STUK has issued clarification requests for all the delivery batches it has processed.

Fennovoima submitted the first delivery batch of the first stage of the preliminary safety report produced by the PLP project to STUK at the beginning of December 2019, and during 2020, Fennovoima submitted delivery batches 2, 3, 4, 5 and 11. Fennovoima plans to supplement the preliminary safety report based on STUK's feedback and as the design progresses to stage 2 in 2021.

As a part of delivery batch 2 in April, Fennovoima submitted to STUK the preliminary safety report chapters describing the site and safety classification. Based on its review, STUK issued a clarification request in July. In the clarification request regarding the plant site, the main supplementary needs are related to the descriptions of the security arrangements and the precautionary action zone in the preliminary safety report. The description of the water areas surrounding the power plant, its aquatic populations and the impact of the warming of the water caused by condensing water and climate change must also be specified. Regarding the site bedrock, STUK introduced a requirement for a monitoring programme of the movements of rock blocks and the issue of action limits for any movements.

The request for clarification concerning the security classification required that it shall be possible to bring the plant into a controlled state specified in Regulation STUK Y/1/2018 with safety class 2 systems and into a safe state specified in the above-mentioned Regulation with safety class 3 systems.

During the second tertile, Fennovoima submitted to STUK the third delivery batch of the preliminary safety report. The third batch included descriptions of systems implementing the transfer of the reactor decay heat. A clarification request based on the processing of the chapter on the decay heat removal systems was made in October. The maturity of the submitted material was not yet at a sufficient level for the construction licence stage and compliance with Finnish requirements could not yet be verified in all respects.

In October, Fennovoima submitted to STUK for approval seven chapters on safety systems implementing the diversity principles (delivery batch 4). The processing of the chapters on

safety systems implementing the diversity principle was ongoing at the end of the year. Based on the submitted material, STUK is not yet able to assess, among other things, the adequacy of the consideration of internal and external threats in plant design.

The preliminary safety report parts concerning the plant's nuclear waste management and systems were also submitted in October (delivery batch 11). At the end of December, Fennovoima submitted the parts of the preliminary safety report on drainage systems and turbine plant systems, as well as the parts concerning operation and technical specifications (delivery batch 5). The processing of these delivery batches was ongoing at the end of the year.

Discussions with Fennovoima continued on the submission of the plans related to the construction licence application in stages and the objectives of various stages in order to form a better overall picture. Thus far, the processing of the construction licence data in stages has been challenging for STUK, as the submitted data packages do not always form a clear independent entity, progressing from the presentation of principles to details. STUK has also emphasised to Fennovoima the importance of timely and sufficient consideration of STUK's previous requirements in plant design – the measures taken based on STUK's requirements and the observations of the Government's decision-in-principle stage have progressed slowly from the point of view of STUK's inspection and safety assessment. Furthermore, there continue to be challenges in the management of the technical configuration in the project, which have been reflected to STUK as the need to verify, among other things, the correctness of the output and result data between different design areas.

In 2020, STUK continued to evaluate the management systems and operations of Fennovoima and other organisations involved in the implementation of the project through reviews to ensure that their practical operations are in line with what is presented in the management systems and meet the requirements. STUK launched the inspections included in the regulatory inspection programme (RKT) in September 2015. The inspections are planned every six months, and in 2020, STUK carried out eight inspections according to its inspection programme. The results of the inspections will be used by STUK when preparing a safety assessment and statement on the construction licence application.

Summaries of the inspection programme's inspections related to the processing of the construction licence carried out in 2020 are presented in Appendix 5.

2.4.1 Management systems, quality management and safety culture

Fennovoima was reorganised in the spring of 2019 and is currently developing procedures in line with its new management principles. STUK monitored the development of operations in the inspections of the inspection programme related to the processing of the construction licence. The description of the core processes of Fennovoima's new organisation for the management system was started in 2019 in connection with the reorganisation, and the work continued in 2020. STUK monitored the progress of the work in topical meetings and in the review of management and inspection procedures. Fennovoima has developed its management system, and most of the top-level processes have now been described. In its new operations, Fennovoima strives to allocate responsibilities more clearly than before.

2.4.2 Plant site and technology

During 2020, Fennovoima continued to evaluate the results of the geological surveys and compiled summary reports of them. Open issues in the safety assessment of the geological surveys by STUK include the observation of the plant site's brittle deformation zones in the establishment of the design bases for the foundations and condition monitoring of the buildings and structures significant to safety.

In the autumn, Fennovoima presented to STUK in a meeting in a preliminary manner the geological survey reports aiming at justifying the design bases of the foundations and placing of the facility at the plant site. STUK has commented on the reports in a preliminary manner and is waiting for their official submittal. STUK has made use of the expertise of the geologists at the University of Turku to evaluate the results.

In its meetings regarding mechanical equipment and manufacturing technology with Fennovoima and the plant supplier, STUK discussed, among other things, the changes in Russian design and manufacturing standards, as well as the content and situation of future document deliveries. In 2020, Fennovoima submitted to STUK for processing a report related to the verifiability of the reactor pressure vessel for the part of the so-called Long Lead Items (LLI), which STUK approved. The requirements specifications of the so-called core catcher related to the management of severe reactor accidents were also submitted to STUK for processing and their processing is scheduled to be completed in early 2021.

STUK and Fennovoima's experts on mechanics and manufacturing have discussed the updated requirements of the YVL Guides relating to the welding and NDT methods, personnel qualifications, reporting requirements for the destructive testing laboratories, new certification of the main coolant pump forgings and surface welding and the connection of steel structures to concrete structures.

Framatome has been chosen by the plant supplier as the supplier of safety-classified main I&C systems. The licensing and phasing of I&C systems have been presented to STUK at meetings. No information has yet been provided to STUK on the design and delivery scope of Framatome.

Fennovoima has progressed in the commissioning of weather monitoring systems for the plant site. It has been possible to start collecting weather data at the site. In the next phase, Fennovoima will set up a connection from the weather monitoring system to the Finnish Meteorological Institute. The procurement of fixed environmental radiation dose rate measurement stations has also progressed.

STUK has emphasised in topical meetings, review of document deliveries and RKT inspections that the radiation doses during the operation of the nuclear power plant can be

significantly influenced by both material choices and layout design of the plant, so the early phase solutions of system design play a major role.

As regards the management of safety-related human factors, Fennovoima has determined the practices of the supply chain by auditing the supplier in charge of the matter. According to the audit, the management of safety-related human factors is not yet as such at the level of STUK's requirements.

2.4.3 Security arrangements

Security arrangements for Hanhikivi 1 and its operating environment have not yet been submitted to STUK.

In February, STUK approved Fennovoima's application for the processing and storage of safety-classified official documents (SC III and SC IV) in a special room in Salmisaari designated for the purpose in question.

2.4.4 Nuclear waste management

STUK assesses the safety of the interim storage for spent fuel in two stages: In the first phase, Fennovoima submitted to STUK the draft plans of the interim storage for spent fuel as part of the construction licence documentation for the nuclear power plant. STUK processed the material and provided Fennovoima with information on the supplements needed in the construction licence phase at the turn of the year 2018–2019. In the second phase, following the granting of the construction licence, Fennovoima will submit to STUK detailed design documentation describing the interim storage systems. Fennovoima cannot start building the storage until STUK has approved the design documentation. In addition to this, Fennovoima will submit to STUK in the construction licence phase reports on the nuclear waste management strategy, construction feasibility of the interim storage and site surveys.

2.4.5 Nuclear safeguards

Fennovoima submitted the nuclear safeguards reports and notifications it was responsible for in time. At this stage of the project, the nuclear safeguards obligations relate to the import, receipt, handing over for processing and export of licensed nuclear information. The subcontractors of Fennovoima and plant supplier Rosatom must also obtain the necessary licences for information processing.

In 2020, Fennovoima applied for approval of the nuclear safeguards manual and the person in charge of nuclear safeguards. These matters continue to be processed by STUK.

2.5 Research reactor

STUK issued a statement to the Ministry of Employment and the Economy (MEAE) on 2 April 2019 on the operating licence application submitted by VTT Technical Research Centre of Finland in June 2017. In STUK's view, VTT meets the requirements of the Nuclear Energy Act (990/1987) with regard to the permanent shutdown state of the research reactor. The safety of the decommissioning phase has also been adequately demonstrated for the purpose of granting the licence, but detailed plans for the dismantling phase of the research reactor need to be further specified before the dismantling of the reactor is started. VTT must, among other things, submit the Final Safety Analysis Report regarding the decommissioning phase to STUK for approval before the start of the dismantling phase. In STUK's view, VTT's plans regarding nuclear waste management of the decommissioning process were not sufficiently complete and detailed to ensure the safe and smooth treatment, storage and final disposal of the generated nuclear waste. In addition, the security arrangements of the research reactor need to be developed to meet changing needs, conditions and threat assessments. According to current knowledge, the Government will continue to process VTT's operating licence application in 2021.

In June 2020, VTT submitted a waste management scheme for the research reactor and in September 2020 a nuclear waste management plan to MEAE, which requested STUK to provide a statement on the documents. Regarding the waste management scheme, STUK concluded that the agreement VTT and Fortum signed on nuclear waste management and disassembly of the reactor in spring 2020 has significantly reduced the risks previously associated with VTT's financial preparation. Furthermore, the preparation plan took into account both the return of spent fuel to the United States and potential interim storage at the Loviisa power plant. Uncertainty regarding the timing of costs remained in the waste management plan, as the schedule for returning the spent fuel to the US was not known. However, STUK considered the cost and price information provided by VTT to be acceptable.

Regarding the nuclear waste management plan, STUK concluded that VTT has made significant progress in planning its nuclear waste management measures. The agreement between VTT and Fortum on the implementation of decommissioning and the organisation of nuclear waste management significantly reduced uncertainties related to the implementation of nuclear waste management measures and schedules. According to the nuclear waste management plan, the dismantling of the FiR 1 research reactor will start in autumn 2022 and be completed by the end of 2023. In its nuclear waste management plan, VTT presented two options for the management of spent fuel: return to the United States and interim storage at the Loviisa power plant. In its statement, STUK concluded that the date of returning the spent fuel to the United States is no longer as critical for the commencement of the dismantling of the reactor, as the agreement between VTT and Fortum includes the possibility of storing the spent fuel of the FiR 1 research reactor at the Loviisa power plant.

Inspections in accordance with the periodic inspection programme have been continued at the research reactor. The inspection activities will continue in the current scope until the dismantling of the research reactor begins. STUK has prepared a separate inspection plan for the dismantling phase. In addition, STUK has completed the processing of licences enabling

the transport of spent fuel to the United States and the review of the documents related to the planning of the transport. The transport of the spent nuclear fuel from the research reactor to the United States was carried out at the end of December 2020.

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 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 2020, STUK carried out one nuclear safeguards inspection on the material balance area of the research reactor. The oversight and inspections by STUK indicated that VTT fulfilled its nuclear safeguards obligations in 2020.

2.6 Spent nuclear fuel encapsulation and disposal facility

In 2020, Posiva continued the construction of nuclear facilities. The excavation of the central tunnel, shafts and canister reception area continued at the disposal facility. The construction of the encapsulation plant progressed and the first safety-classified structures were completed during the year.

The regulatory oversight during the construction stage of the nuclear fuel encapsulation and disposal facility covers the design, manufacture, construction and installation of the nuclear waste facility and its safety-classified systems, structures and components, as well as demonstrating long-term safety. At a later stage, the oversight will also target commissioning, at which time STUK will oversee Posiva's operations during commissioning, review test plans and test results, and perform commissioning inspections of components, structures and systems.

2.6.1 Construction of the disposal facility

In the excavation of the disposal facility, Posiva continued excavating the central tunnels. In addition, during 2020, Posiva excavated shafts and the canister reception area. During 2020, Posiva submitted to STUK for processing rock engineering plans concerning the disposal area's central tunnel and disposal tunnels. STUK carried out rock construction inspections in the completed tunnels.

During 2020, Posiva had challenges in producing rock engineering planning materials of sufficient quality. Related requirements have been presented in STUK's decisions regarding the materials, and Posiva is carrying out development measures to correct the shortcomings.

2.6.2 Construction of the encapsulation plant

Posiva began the construction of the encapsulation plant in summer 2019. In 2020, the construction of the encapsulation plant proceeded as planned. Construction and fire engineering documents regarding the encapsulation plant were processed at STUK. All structural data regarding the encapsulation plant was reviewed during 2020. Inspections

related to the construction of the encapsulation plant at the construction site were transferred to an inspection organisation.

A large number of construction plans for hoisting and transfer equipment were submitted to STUK in 2020. The inspection organisation is also used to help inspect these documents in order to balance the review workload.

2.6.3 Oversight of requirements set at the construction licence phase and Posiva's development work

During the construction licence application review, STUK set requirements on Posiva that must be taken into account during the construction or before submitting the operating licence application. STUK has systematically monitored compliance with the requirements set based on the construction licence application review and Posiva's plans to ensure compliance with the requirements.

Posiva has taken into account the requirements set by STUK during the construction licence review in the system design. According to the schedule it has produced, Posiva has submitted system design documents to STUK for review. During 2020, STUK has processed a wide range of system documents from various fields including, for example, design documents on rock caverns, engineered barriers, radiation measurements, hoisting and transfer equipment and I&C systems.

Posiva has ongoing projects for demonstrating long-term safety and for the designing and development of engineered barriers. STUK has monitored the progress of the projects, and they have been discussed at meetings with Posiva. With its oversight, STUK ensures that the project plans and programmes have sufficiently taken into account the requirements set by STUK in connection with the construction licence review.

2.6.4 Organisational operations and quality management

STUK has overseen the activities of Posiva's organisation in inspections included in the construction inspection programme. The inspections assessed Posiva's nuclear facilities' preparation for production, monitoring programme, security arrangements, design activities, procurement and product control, as well as nuclear safeguards. Inspections under the construction inspection programme are covered in further detail in Appendix 6.

The inspections carried out under the construction inspection programme have covered the activities of the organisation. Human resources monitoring has shown that resourcing procedures have been improved and competence has been built for example in areas such as Human Factors Engineering (HFE) and radiation measurement.

In 2020, the monitoring of the management system focused on the design documentation review procedures at Posiva. Posiva has previously had challenges in producing high-quality rock engineering design documentation for STUK. The procedures and compliance with them have been covered, among other things, by means of a procurement and product control inspection falling under the management system inspection. The inspection showed that

Posiva is currently taking measures that have the potential to improve the quality of the design documentation submitted to STUK.

STUK has continued to supervise Posiva's auditing activities. Due to the COVID-19 pandemic, the auditing activity has been smaller than in previous years, but Posiva has been able to continue some of its activities.

2.6.5 Preparations for the operating licence phase

Posiva has submitted operating licence application documents to STUK in advance for comments This was done to streamline the processing of the actual operating licence application documents. During 2020, Posiva submitted to STUK for pre-review chapters of the final safety analysis report, topical reports and reports on the safety case of long-term safety. STUK compiles comments on the documentation for Posiva to be taken into account when preparing the actual operating licence application documentation.

2.6.6 Nuclear safeguards

STUK implemented nuclear safeguards for the final disposal in compliance with the national regulatory plan. STUK inspected the site which was reported by Posiva to be compliant with the Additional Protocol of the Safeguards Agreement and the construction activities in two periodic inspections of nuclear safeguards.

STUK granted Posiva an import licence for fuel element models and fuel channels and, in connection with the preparations for the operating licence phase, commented on Posiva's clarification of the arrangement of the necessary safeguards to prevent the proliferation of nuclear weapons.

Posiva submitted the nuclear safeguards reports and notifications it was responsible for in good time. The oversight and inspections by STUK indicated that Posiva fulfilled its nuclear safeguards obligations in 2020. STUK carried out one nuclear safeguards inspection under the construction inspection programme, which was focused on Posiva's nuclear materials accountancy currently under preparation. Five requirements were issued during the inspection concerning Posiva's future operations, as the majority of nuclear safeguards reporting obligations only apply to Posiva once the plant is in possession of nuclear materials.

STUK further intensified its cooperation with the IAEA and the European Commission aimed at ensuring that the plans on arranging the international nuclear safeguards for the encapsulation plant and disposal facility will proceed in line with the design of the facility and also meet national requirements. During 2020, 7 technical discussions and 3 technical meetings were held with Posiva, the European Commission and the IAEA as well as one executive level meeting between STUK and the IAEA on the oversight arrangements of the encapsulation plant and the disposal facility. Almost all meetings, with the exception of the executive meeting, took place as remote meetings. The IAEA and the European Commission's surveillance and monitoring equipment plan for the encapsulation plant is finished with the exception of the last few details and is now included in Posiva's plant design. The IAEA and the Commission have also presented a draft of the surveillance and monitoring equipment plan

for the final disposal facility, the practical implementation of which is still under discussion. At the end of 2020, directors from the IAEA's nuclear safeguards department visited Olkiluoto to familiarise themselves with the facilities under construction at the encapsulation plant and disposal facility.

The Safeguards projects of final disposal in Finland and Sweden are coordinated on the EPGR forum of the IAEA, the European Commission, the Swedish and Finnish authorities (SSM and STUK) and the operators (SKB and Posiva). The EPGR forum convened once during the year.

Nuclear fuel placed in final disposal can no longer be inspected or verified by any known means. Therefore, it is important for nuclear safeguards that fuel be verified before encapsulation and final disposal and that the verification be documented using such 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 investigates the integration of two complementary methods PGET (Passive Gamma Emission Tomography) and PNAR (Passive Neutron Albedo Reactivity) into one modular equipment. Measurements were performed in Loviisa in June 2020 using PGET and PNAR equipment was used in Olkiluoto in October 2020. The measurements were successful with both methods. In the case of the PGET method, development continued also on the software side. The performance of the analysis algorithm was studied in cooperation with the University of Helsinki and VTT. A cooperation project was also launched with the IAEA.

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.

With regard to uranium producers, STUK reviewed the reports and notifications submitted by the Kokkola and Harjavalta metal works and the Sastamala ore processing plant. The responsible persons for each of these operators remained unchanged and there were no significant changes in their operations. In Kokkola, the ownership of Freeport Cobalt Oy was transferred to Umicore Oy at the end of 2019, so in 2020, STUK reviewed the nuclear safeguards manual of the new operator and carried out an inspection in Kokkola. At the same time, the monitoring and reporting procedures of the concentration of uranium in the copper cement at Boliden Kokkola Oy's zinc factory were inspected.

All operators submitted the nuclear safeguards reports and notifications required from them. The Commission postponed and subsequently revoked its own nuclear safeguards and material balance area inspections due to travel restrictions caused by the COVID-19 pandemic. Of these operators reporting to the Commission, STUK inspected the nuclear material

inventory of the University of Helsinki remotely with only one representative of the operator present in the laboratory. As a result of the inspection, the reporting practices for small batches of nuclear material were specified. In 2020, the University of Jyväskylä (JYFL) applied for the approval of a new responsible manager. STUK interviewed the candidate remotely before approving the candidate. In October, the IAEA and the Commission, together with STUK's safeguards section, verified the compliance and accounting of the nuclear safeguards system related to STUK's own activities. Several suggestions for improvement were made during the inspection. Of the parties in possession of small amounts of nuclear use items, DEKRA Industrial Oy and Kiwa Inspecta Oy supplied radiation shields containing depleted uranium back to the manufacturers. The parties in possession of small amounts of nuclear use items fulfilled their nuclear safeguards obligations and submitted their annual reports on time.

STUK inspected the annual reports on nuclear fuel cycle related research and development activities and produced a report on their basis for the IAEA. The IAEA requested a report on the equipment manufacturing and autoclaves delivered from Finland in accordance with the Additional Protocol, to which STUK responded in cooperation with the equipment supplier.

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 nuclear safeguards obligations.

STUK supervised the trial operations of Terrafame Oy 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 oversight and inspections by STUK indicated that Terrafame fulfilled its nuclear safeguards obligations in 2020.

In the autumn of 2017, Terrafame submitted an application to the Finnish Government for starting the extraction of uranium in the uranium extraction plant built earlier in the mine area. STUK issued a statement about the licence application regarding Terrafame Oy's mining and milling operations on 10 June 2019. STUK found that the conditions for the granting of a licence under Articles 5 to 7 and Article 21 of the Nuclear Energy Act (990/1987) were fulfilled in view of its line of business, but that Terrafame would have to supplement the safety analysis report submitted in connection with the application before it could launch operations. The Government granted Terrafame licence on 6 February 2020. In addition, in spring 2020, STUK approved Terrafame's manager responsible for uranium extraction and his deputy. One of the candidates was interviewed remotely by video connection and the other was interviewed as a normal interview before the issue of COVID-19 restrictions. The licence to commence operations includes conditions relating to nuclear safety and potential nuclear waste. According to these conditions, Terrafame has to update its report on the decommissioning of its uranium recovery plant on based on operational and maintenance experience from the first three years, monitor the accumulation of plant waste at the uranium recovery plant and the implementation of waste management, and to report the results to the Radiation and Nuclear Safety Authority annually. The company must also update its waste management reports based on the experience gained during the first three years of operation, carry out a periodic safety assessment of uranium recovery in accordance with the Nuclear Energy Act (990/1987) every 15 years, and supplement the documents submitted to the Radiation and Nuclear Safety Authority well in advance before launch of operations. In March 2020, appeals against the

granted licence were filed at the Supreme Administrative Court. The operation can only be started once the licence is valid and STUK has carried out a safety inspection covering the entire uranium production activity on the site. The amount of semi-finished uranium produced is estimated to be no more than 250 tonnes of uranium per year.

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. 2020 was the second year of operation of the new four-year research programmes SAFIR2022 and KYT2022. The planned research projects were carried out successfully and the short-term effects of the COVID-19 pandemic on research and international research cooperation have not been significant.

Without safety research programmes like SAFIR and KYT, 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 comprehensive nuclear expertise. 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 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 SAFIR2022 safety research programme consists of 36 projects that were selected in the autumn of 2019 based on a competitive bidding. The available VYR funding for the research was around EUR 4.2 million. The volume of the SAFIR2022 safety research programme is around EUR 6.4 million and approximately 42.4 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 will use around 16% of the entire public funding for safety research when reforming the national infrastructure. This mainly covers the work related to the acquisition and commissioning of infrastructure-related investment objects. VYR finances equipment investments from a separate research-related funding portion aimed at the renewal of hot chambers at the VTT Centre for Nuclear Safety and the thermohydraulic test equipment of LUT University. In 2020, the funding was channelled to VTT in the manner required by the Nuclear Energy Act (990/1987), and it amounted to EUR 2.74 million. The research programme covers all issues integral to nuclear safety, and it will establish and maintain the expertise, analysis methods and experimental readiness to resolve any unforeseen safety issues.

The SAFIR2022 research projects are controlled by eight steering groups in addition to the four research areas. The steering groups take care of the academic control of research. Members of the supporting groups were appointed from organisations relating to the research of the use of nuclear energy. The support groups are: 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. The projects for the support groups were assigned based on the research areas. All of the projects included in one support group are usually part of a single research area.

The projects included in the SAFIR2022 programme for 2020 meet the requirements set for VYR-funded research. The research programme has 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, first, to gain authentic operating experience data on the properties of the materials of the pressure vessel and, second, to utilise the new research opportunities provided by the VTT Centre for Nuclear Safety.

The SAFIR2022 projects include several projects for developing capabilities, e.g. for avoiding situations similar to the one that lead to the accident at the TEPCO Fukushima Dai-ichi nuclear power plant in 2011 or understanding the sequence of events in such accidents. The projects' subject matters range 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 TEPCO Fukushima Dai-ichi accident in order to create Finnish accident analyses and compare results globally.

In addition to the above, the SAFIR2022 management group may fund small projects aimed at helping the development of research projects with new topics into becoming members of

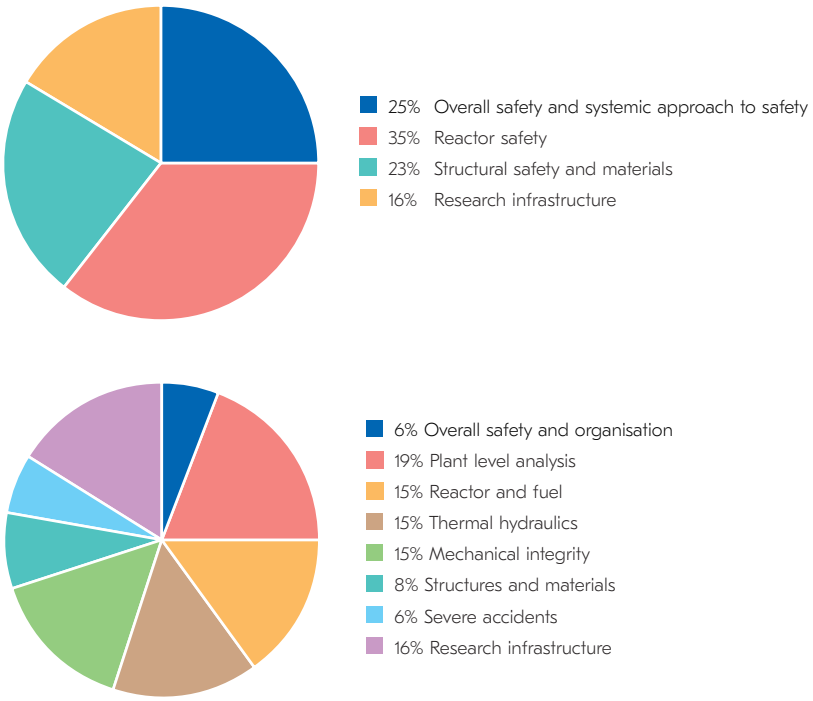

FIGURE 11. Research areas of SAFIR2022 programme and their shares of the total funding in 2020.

the programme. This procedure has been in use from the beginning of the previous SAFIR2018 research programme, and it has proven to be an efficient way to promote the creation of high standard topical research projects. The 2020 small project was aimed at investigating AI applications as support for authority decision-making, machine learning for fault detection, advanced seismic methods and cobalt-free hard coatings.

A new feature in the SAFIR2022 programme is the inclusion of the eight overarching topical areas indicating the focus of the programme. The topics highlight, among other things, the development of the assessment methods of overall safety, the modernisation of safety assessment methods, the long-term use of plants and the requirements set by the changing environment for the safe use of nuclear power plants. The topics relating to overall safety and the life cycle of fuel are shared with the KYT2022 programme, and the aim is to make the cooperation between the programmes even closer.

The four-year KYT2022 research programme was launched in 2018. The research projects planned for 2020 were carried out successfully and the short-term effects of the COVID-19 pandemic on research and international research cooperation were not significant. The research topics consist of the assessment of overall safety, the management of spent nuclear fuel, power plant waste, decommissioning waste and other radioactive waste, the feasibility of nuclear waste management and social research. The topics relating to overall safety and the life cycle of fuel are shared with the SAFIR2022 programme, and the aim is to make the cooperation between the programmes even closer. The programme consisted of research areas which are important for national expertise. It is aimed at extensive coordinated multidisciplinary 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 disposal canisters as well as microbiology. Research infrastructure funding was also continued in the KYT2022 programme.

37 research funding applications were submitted in the first part of the call for projects. The funding applied for had to be reduced by cutting project funding and leaving some projects entirely without funding.

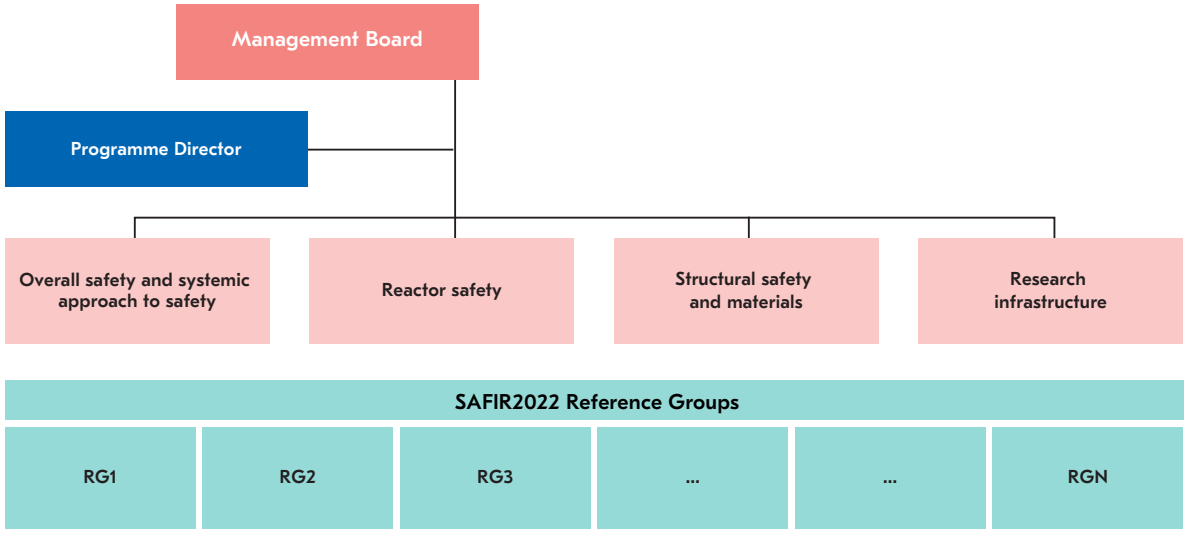

FIGURE 12. The administrative structure of SAFIR2022 research programme.

The research programme's framework programme highlights interdisciplinary research on the interaction of barriers, which has brought to the funding application, for example, a coordinated project investigating the interaction between rock and bentonite. While the framework programme called for research related to overall safety, no funding was applied for research on the topic in this call for projects.

Only one research project related to social science was included in the call for projects. The decision was made to present funding for this project, albeit in cut form. Social science research is important in terms of investigating the acceptability of the disposal of nuclear waste.

The research programme projects are not aimed at nuclear waste management development tasks or licensing required by law of individual licensees, but can be utilised and applied in nuclear waste management in a broader sense.

The KYT2022 management team provided funding recommendations to MEAE using assessments by the support groups based on the applicability and content of the subject matter. In 2020, the funding of the KYT2018 programme from the National Nuclear Waste Management Fund (VYR) was approximately EUR 1.9 million. In 2020, the research programme funded 30 research projects. The six excellence projects selected for 2019 received funding for 2020 as per the application. Additional cuts were made to most projects, but these were mostly minor. The cuts were made so that the projects receiving funding are better able to carry out high-quality research than in the previous KYT programmes.

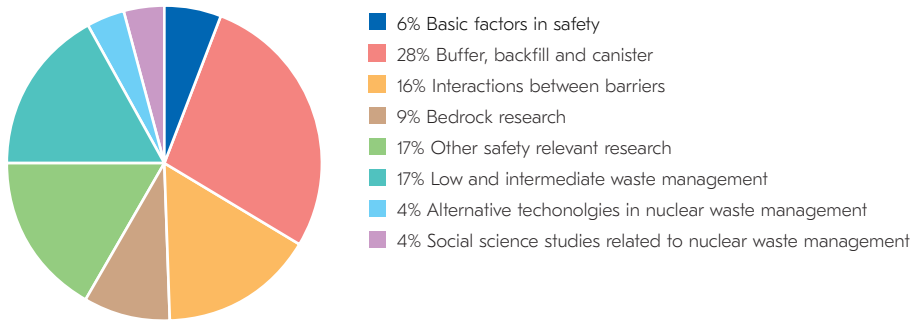

FIGURE 13. Distribution of VYR funding by research area in 2020.

4 Oversight of nuclear facilities in figures

4.1 Processing of matters

A total 3,514 matters were submitted to STUK for processing in 2020. Of these, 1,195 concerned the nuclear power plant under construction and 262 concerned the disposal facility for spent nuclear fuel. The review process of a total of 3,344 matters was completed, including matters submitted in 2020, those submitted earlier and licences granted by STUK by virtue of the Nuclear Energy Act, which are listed in Appendix 7. The average matter review time was 56 days. The number of matters and their average review times in 2016–2020 are illustrated in Figure 14.

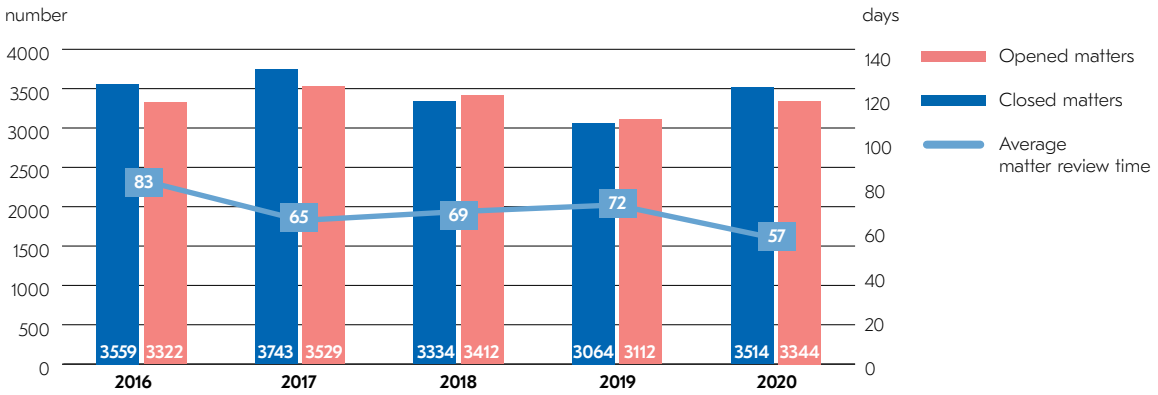

FIGURE 14. Average review time of opened and closed matters.

Figures 15–18 illustrate the review time distribution among matters from the various plant units and matters about Posiva.

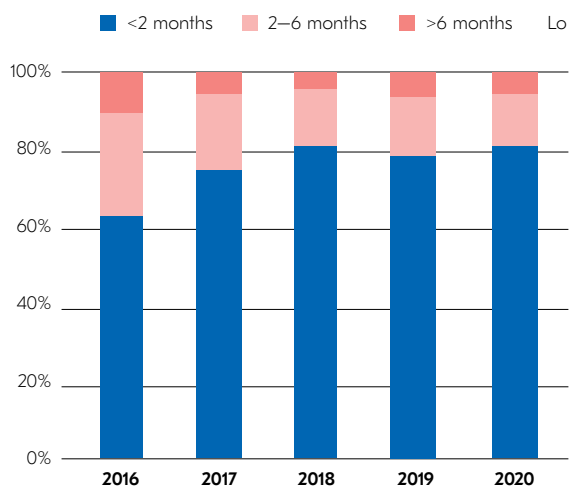

FIGURE 15. Distribution of time spent on preparing decisions on the Loviisa plant.

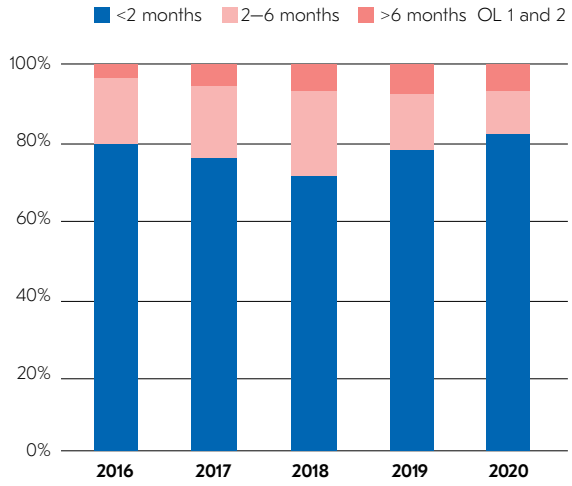

FIGURE 16. Distribution of time spent on preparing decisions on the operating plant units of Olkiluoto.

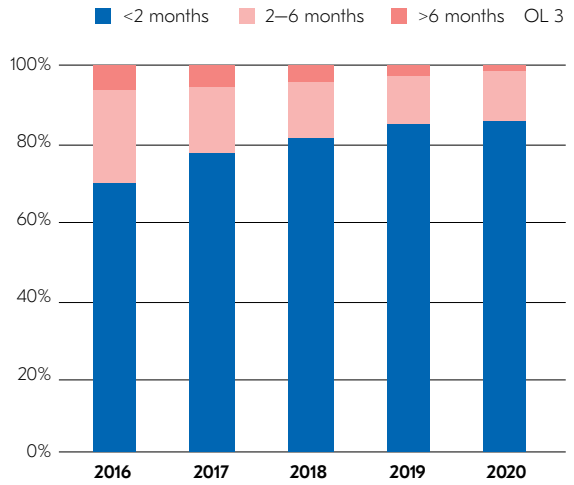

FIGURE 17. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

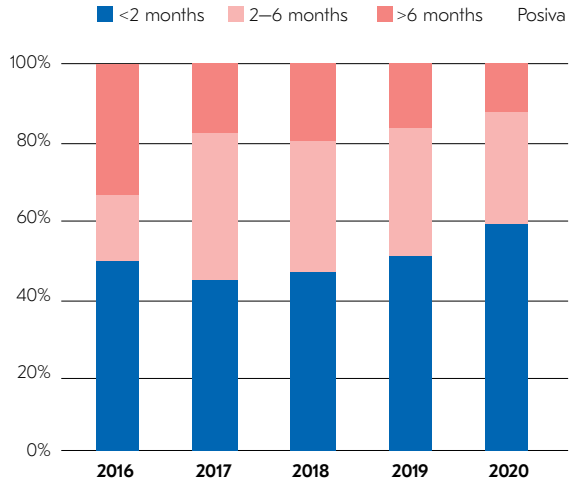

FIGURE 18. Distribution of time spent on preparing decisions on Posiva.

4.2 Inspections at nuclear facility sites and suppliers' premises

Inspection programmes

A total of 16 inspections at the Loviisa plant and 15 inspections at the Olkiluoto plant were carried out under the 2020 periodic inspection programme (Appendix 3). STUK carried out 8 readiness inspections at Olkiluoto 3 and 7 inspections under the periodic inspection programme of Olkiluoto 1 and Olkiluoto 2 that also included Olkiluoto 3 (Appendix 3). There were 8 inspections pertaining to the processing of Fennovoima's construction licence application (Appendix 5). 6 inspections of the encapsulation plant and disposal facility construction inspection programme were carried out in 2020 (Appendix 6). The key findings of the inspections are presented in the appendices and the chapters on regulatory oversight.

Other inspections at plant sites

A total of 2,304 inspection protocols were signed on site or on the suppliers' premises in 2020 (other than the above-mentioned inspection programme inspections and the nuclear safeguards inspections, which are separately described). Of these inspections, 1,263 were part of the oversight of Olkiluoto 3 and 1,031 of the operating plants. The oversight of the construction of Posiva's final disposal facility included 9 inspections. In addition, tunnel inspections of Posiva's encapsulation plant were carried out.

The numbers of onsite inspection days in 2016–2020 are illustrated in Figure 19.

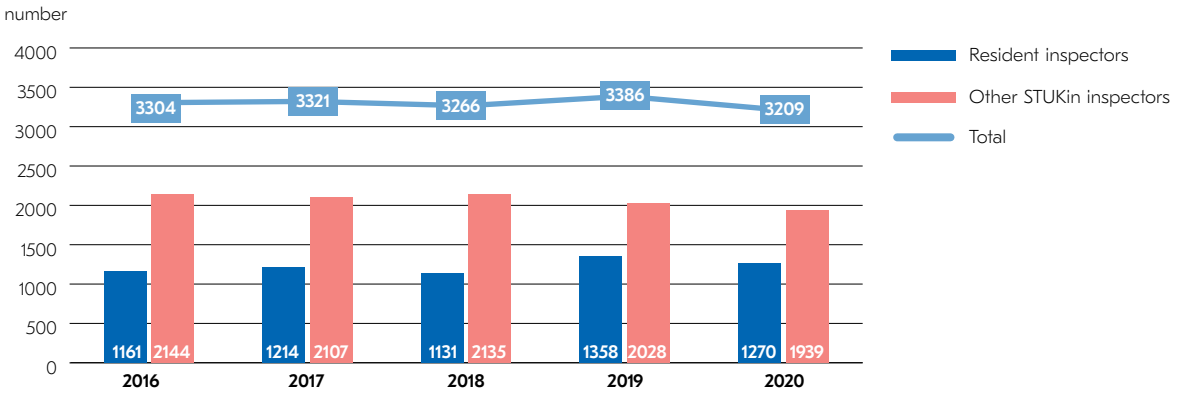

FIGURE 19. Number of inspection days onsite and at component manufacturers' premises.

4.3 Finances and resources

The duty area of regulatory oversight of safety in the use of nuclear energy includes 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, the costs of which are charged to those subject to the oversight. Basic operations free of charge include international and domestic cooperation as well as emergency response operations and communications. Basic operations free of charge are publicly funded. Overheads arising from the preparation of regulations and support functions (e.g. administration, development projects in support of regulatory activities, competence development, reporting, and participation in nuclear safety research) are carried over into the costs of basic operation subject to charge and free of charge and contracted services in relation to the number of working hours spent on each function.

Consequently, the cost correlation of regulatory oversight of nuclear safety was 100%. Attainment of the cost price for the oversight is ensured by adjusting the invoicing with a balancing bill to correspond to actual costs after annual cost accounting. The income and costs of regulatory oversight of nuclear safety subject to a charge were EUR 19.6 million. The figure includes the radiation monitoring in the immediate vicinity of nuclear facilities that was changed from a service operation to regulatory oversight in 2015. The total costs of regulatory oversight of nuclear safety were EUR 21.6 million. This figure includes the costs of regulatory oversight of nuclear safety subject to charge as well as free of charge. The share of activities subject to a charge accounted for 91% of the total costs. Figure 20 shows the annual costs of regulatory oversight of nuclear safety in 2016–2020.

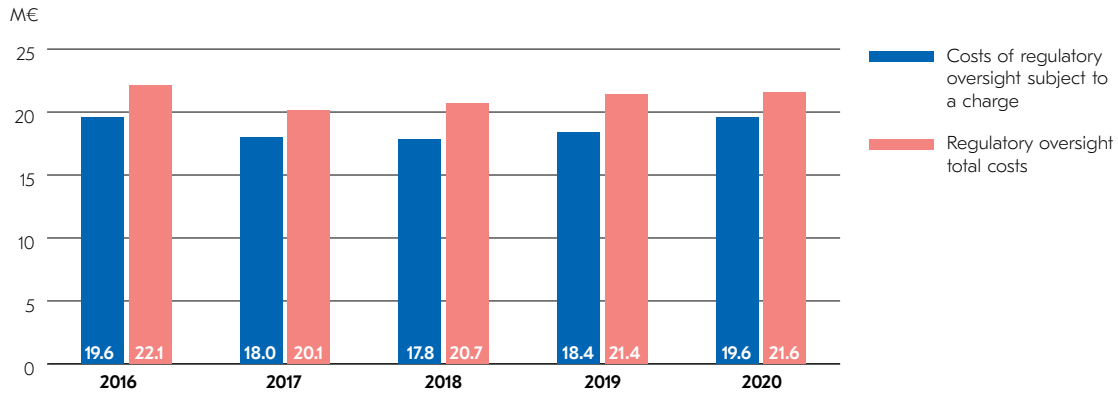

FIGURE 20. Income and costs of nuclear safety regulation.

The time spent on the inspection and review of the Loviisa nuclear power plant was 17.3 man-years or 11.5% of the total working time of the nuclear safety regulatory personnel. The time spent on the inspection and review of the Olkiluoto nuclear power plant's operating units was 16.2 man-years or 10.8% of the total working time. In addition to the monitoring of the operation of the nuclear power plants, these figures include the nuclear safeguards. The time spent on the inspection and review of Olkiluoto 3 was 22.2 man-years or 14.7% of the total working time. Work related to the Fennovoima plant project amounted to 9 man-years or 6% of the total working time. A total of 10.4 man-years or 6.9% of the total working time was spent on the inspection and review of Posiva's operations, and the time spent on the inspection and review of the FiR 1 research reactor was 0.7 man-years. Figure 21 shows the division of working time of the personnel engaged in nuclear safety oversight (in man-years) by subject of oversight during 2013–2020 The time spent on the inspection and review of the Loviisa nuclear power plant was 17.3 man-years or 11.5% of the total working time of the nuclear safety regulatory personnel. The time spent on the inspection and review of the Olkiluoto nuclear power plant's operating units was 16.2 man-years or 10.8% of the total working time. In addition to the monitoring of the operation of the nuclear power plants, these figures include the nuclear safeguards. The time spent on the inspection and review of Olkiluoto 3 was 22.2 man-years or 14.7% of the total working time. Work related to the Fennovoima plant project amounted to 9 man-years or 6% of the total working time. A total of 10.4 man-years or 6.9% of the total working time was spent on the inspection and review of Posiva's operations, and the time spent on the inspection and review of the FiR 1 research reactor was 0.7 man-years. Figure 21 shows the division of working time of the personnel engaged in nuclear safety oversight (in man-years) by subject of oversight during 2013–2020.

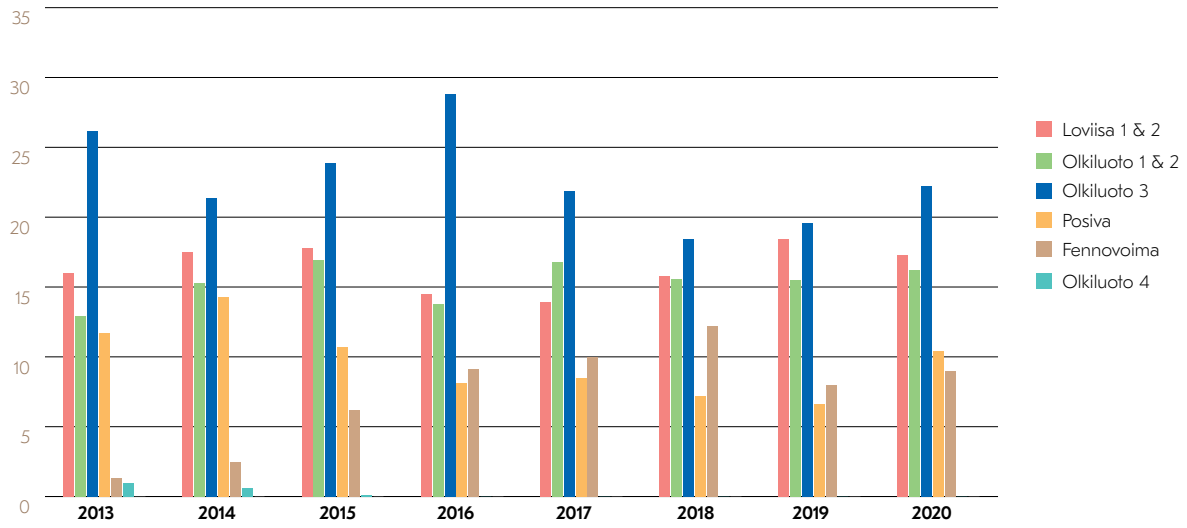

FIGURE 21. Distribution of working time (person-years) of the regulatory personnel by subject of oversight in 2013–2020.

Where necessary, STUK commissions independent assessments and analyses in support of its oversight. Figure 22 illustrates procurement costs in 2016–2020. The procurements in 2020 were mainly associated with the sensitivity analyses of the sites' seismic design bases, Hanhikivi 1 comparison analyses and the plant type's hydrochemistry assessment as well as the safety assessment of Posiva's spent nuclear fuel disposal project.

Distribution of the annual working time of the nuclear safety regulatory personnel to the various duty areas is shown in Table 1. The figures do not include the work for radiation monitoring in the surrounding environment.

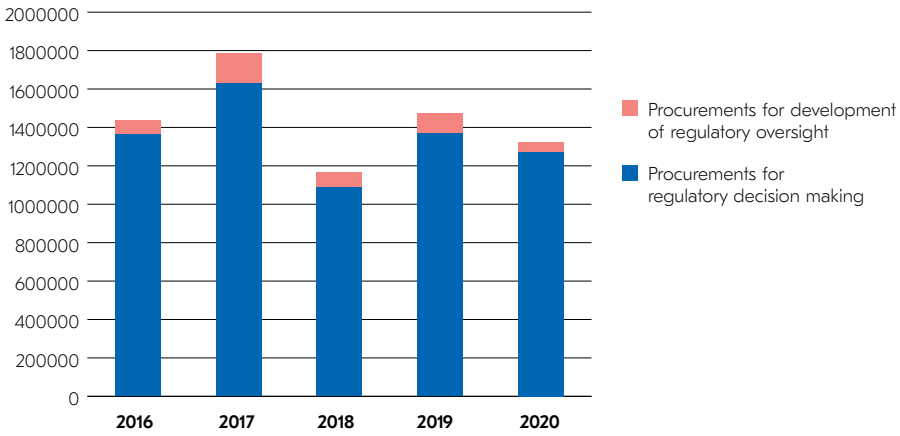

FIGURE 22. The acquisition costs of assessments and analyses.

Duty area	2016	2017	2018	2019	2020
Basic operations subject to a charge	74.9	72.0	71.0	68.7	75.8
Basic operations not subject to a charge	4.0	4.0	4.8	6.3	4.0
Service activities	2.1	4.3	3.7	1.1	0.5
Regulation work and support functions	44.5	42.9	44.1	45.2	44.7
Holidays and absences	26.6	26.9	26.3	26.0	23.3
Total	152.1	150.1	149.9	147.4	148.3

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

5 International cooperation

Impact of the COVID-19 pandemic on international cooperation

International travel seized in spring 2020 due to the COVID-19 pandemic and several international meetings were cancelled or postponed. However, from late spring onwards, new remote meeting procedures were developed to replace travelling. STUK actively participated in international meetings held remotely. Remote meetings functioned reasonably well, although they were not able to fully replace all interactions at face-to-face meetings. Remote meetings can still be utilised in certain situations in the future, even after travelling is possible again.

International conventions

The Convention on Nuclear Safety requires the presentation of a report to be prepared every three years on the fulfilment of its obligations. Starting from 1999, Finland has produced national reports which are compliant with the Convention on Nuclear Safety every three years. The latest report was produced in 2019. 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. In connection with the 2019 report, approximately 130 questions were posed to Finland, and STUK submitted answers to these questions in February 2020. A meeting between the contracting parties was scheduled for March 2020 in Vienna, but was cancelled due to the COVID-19 pandemic. The meeting will take place in 2023.

The previous review meeting for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was held in May 2018. In 2020, STUK coordinated the compilation of a national report required by the Convention, which reported on matters related to nuclear waste management in Finland. Because of the COVID-19 pandemic, the Nuclear Waste Convention's organisation meeting was held remotely in autumn 2020. The new organisation of the Nuclear Waste Convention decided that, due to the circumstances, the 2021 evaluation meeting would be postponed by about a year to summer 2022.

International cooperation groups

The IAEA continued to develop its safety standards on nuclear safety and security. 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) 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 in all main committees of the organisation dealing with radiation and nuclear safety issues. The main committees' fields of activity are the following:

- 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 15 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 design-specific working groups. In addition, the MDEP has an issue-specific working group, Steering Technical Committee and Policy Group. There are five design-specific working groups for the EPR, AP1000, APR1400, VVER and HPR1000 plant types. Of these, STUK has participated in the EPR Working Group and the VVER Working Group, because an EPR plant is under construction in Olkiluoto (the Olkiluoto 3 project) and Fennovoima has submitted a construction licence application for the construction of a VVER plant in Pyhäjoki (the Hanhikivi 1 project). Finland acts as the chair of the VVER Working Group. The only MDEP working group which is independent of plant design deals with plant and equipment supplier inspections.

WENRA's (Western European Regulator's Association) Reactor Harmonisation Working Group (RHWG) convened three times in 2020, but due to the COVID-19 pandemic, the last two meetings were held remotely. During the year, the main tasks of the working group included defining the periodic assessment process of reference levels, including the development of the criteria for updating needs and recording reference levels, as well as preparation for the Topical Peer Review under the Nuclear Safety Directive, where RHWG's task is to prepare a technical content description. STUK actively participated in the work, and was also closely involved in RHWG's subgroups, which processed the need to update the safety objectives set by WENRA for new nuclear power plants, the suitability of the safety objectives for small modular reactors (SMR) and evaluated the measures to improve safety at the operating plants required by the EU Nuclear Safety Directive.

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). The first Topical Peer Review according to the Nuclear Safety Directive updated in 2014 was carried out on ageing management of nuclear power plants in 2017– 2018.

In line with the Nuclear Safety Directive, the peer review will be organised every six years in the future, and planning the next review has started by collecting experiences from the first peer review. In 2020, fire safety was selected as the topic of the second peer review.

The ENSREG nuclear waste management team prepared reviews on the progress indicators of national nuclear waste management and on the reporting of the national waste inventory. Reviews on the initial and final decommissioning status of nuclear power plants and optimisation of the IRRS and ARTEMIS peer reviews were proposed as topics for the 2021–2023 programme. The development of nuclear waste management progress indicators will also be monitored and practices for radioactive waste generated outside the nuclear sector explored.

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 2021. In December 2020, STUK organised a webinar for the group on Guide YVL D.7, "Release barriers of spent nuclear fuel disposal facility", published in 2018. Other countries do not have such detailed guidelines on this issue, as their spent nuclear fuel and high-level waste disposal projects are not yet that advanced, but the topic will sooner or later be relevant to all.

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. During 2020, STUK participated in the working group activities of the VVER forum. The annual meeting of the forum was postponed to 2021 due to the COVID-19 pandemic.

Bilateral cooperation between authorities

Cooperation with the new German Federal Waste Management Authority, Das Bundesamt für die Sicherheit der nucleren Entsorgung (BASE), was launched with two webinars, the first on waste management and related regulatory control in each country and the second on the commissioning and expansion of disposal facilities and acceptance criteria for the waste brought into the disposal facility.

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. During the cooperation, regulatory practices and requirements of the countries involved have been compared and challenges and problems pertaining to the EPR plants under construction (Olkiluoto 3 and Flamanville 3) have been discussed. In November 2020, STUK held an information exchange meeting with ASN and IRSN remotely due to the COVID-19 pandemic. Topical issues regarding observations on the commissioning testing of the different EPR units, preparation for plant operation and mechanical components were discussed in the meeting.

Cooperation with the Russian nuclear safety authority, Rostechnadzor (RTN), was significantly reduced compared to previous years due to travel restrictions resulting from the COVID-19 pandemic. The 2020 annual programme was settled at the February meeting,

but none of the agreed joint inspections were carried out before the cross-border passenger traffic was closed. The staff of the Russian authority stayed mostly at home until the summer without the opportunity to work remotely. During the autumn, the national restrictions on videoconferencing systems were resolved. STUK also meets twice a year with local inspectors from RTN's Leningrad and Kola nuclear power plants, who report on the events in the nearby plants during the meetings. One such meeting was held in early 2020 before the COVID-19 pandemic broke out. Remote connections could not be established with the local inspectors and, as a result, the second of the planned two meetings had to be cancelled.

The Hungarian radiation and nuclear safety authority (HAEA) started the evaluation of the construction licence application for the AES-2006 nuclear power plant (PAKS-2 project). As the plant type is similar to the one Fennovoima is planning to construct in Hanhikivi, STUK continued its close cooperation with HAEA in 2020. The second meeting scheduled for 2019 was postponed to January 2020 at the request of HAEA, and the 2020 meetings were held remotely due to the COVID-19 pandemic with STUK acting as the meeting organiser. Evaluation and inspection findings on issues such as site surveys, plant design and the submittal of official licence documents were compared during the meetings. HAEA received the PAKS-2 construction licence application at the end of June and started its pre-inspection. Hungarian legislation provides a 1.5-year processing period for construction licence permits.

Cooperation for the prevention of the proliferation of nuclear weapons

The Non-Proliferation Treaty entered into force in 1970. Over 190 countries around the world are members to the treaty. The NPT Review Conference is held every five years. The previous conference was held in 2015, and the next one was scheduled for April–May 2020. Because of the COVID-19 pandemic, the meeting was first postponed by six months and then postponed again to August 2021. The NPT Preparatory Committee holds sessions prior to the Review Conference.

A group of nuclear supplier countries, the Nuclear Suppliers Group (NSG) forms a multinational control system whose members are nuclear supplier countries. The group 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. Finland is represented in the Nuclear Suppliers Group by the Ministry for Foreign Affairs. STUK usually participates in the meetings of the Technical Experts Group (TEG), which are held in April and November. In 2020, both meetings were cancelled. In November, however, an information meeting by the chairs' of the NSG working groups was held as a virtual meeting, attended by a STUK expert.

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 support 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. The Finnish support programme had a review meeting with the IAEA in October 2020. The meeting was held remotely. In 2020, the support programme had 14 ongoing projects.

STUK is a member of ESARDA (European Safeguards Research and Development Association) and it has appointed experts to the association's committees, several working groups and publishing committee. STUK is also a member of ESARDA's Steering Committee and Executive Board. STUK's expert acts as the vice-chair of the Implementation of Safeguards working group. ESARDA held its biennial spring meeting in Luxembourg as a webinar in November 2020. The objective is to continuously monitor and respond to the needs of ESARDA's members.

The Low Level Liaison Committee (LLLC) meeting held in Vienna on 26 September 2012 recommended the establishment of a working group to coordinate the activities of the Encapsulation Plant and Geological Repository (EPGR) project and to be attended by the representatives of the IAEA, European Commission, Sweden and Finland. The LLLC EPGR work group would be a cooperation group and ensure good communications and cooperation between all parties and report regularly to the LLLC. The preparation of the safeguards oversight concepts has started simultaneously with the development of the final disposal concepts and technologies. The observation of safeguards-by-design in plant design is possible through close cooperation of the plant designers, plant operating personnel and authorities. In November 2020, Finland hosted the ninth EPGR meeting remotely. The main topics of last year's meeting included the plans for the safeguards-by-design oversight of Posiva's encapsulation plant and the underground final disposal facility. In addition to the actual EPGR meeting, three tripartite meetings (Finland, EC and IAEA) were held on the oversight of the repository and several technical meetings on the detailed plans for the technical supervision of the encapsulation plant.

APPENDIX 1
Objects of regulation

Loviisa nuclear power plant

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

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

Olkiluoto nuclear power plant

Plant unit	Start-up	National grid	Nominal electric power (gross/net, MW)	Type, supplier
Olkiluoto 1	2 Sep 1978	10 Oct 1979	920/890	Boiling water reactor (BWR), Asea Atom
Olkiluoto 2	18 Feb 1980	1 Jul 1982	920/890	Boiling water reactor (BWR), Asea Atom
Olkiluoto 3	Operating licence granted on 7 Mar 2019		Approx. 1,600 (net)	Boiling water reactor (BWR), Areva NP

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

Hanhikivi 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

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

Olkiluoto encapsulation plant and disposal facility

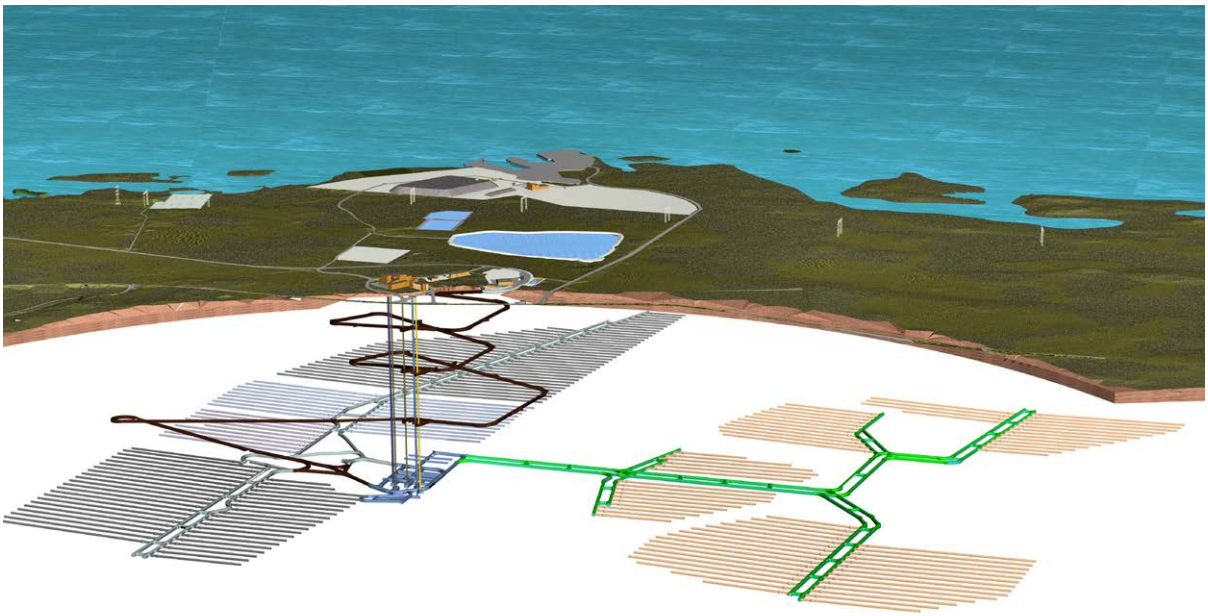

Diagram of the Olkiluoto encapsulation and disposal facility (Posiva Oy).

In November 2015, the Government granted Posiva a construction licence for the Olkiluoto encapsulation plant and disposal facility. The planned facility consists of a surface facility for the encapsulation of spent nuclear fuel, an underground disposal facility, and supporting buildings. Posiva has already built an access tunnel, three shafts and a technical facility and research area at a depth of 420–437 metres as parts of the underground research facility Onkalo. The construction of the disposal facility started at the end of 2016. For the actual disposal facility, the underground facility will be expanded by two additional shafts and the disposal tunnels that will be excavated in stages. The construction of an underground research facility was a prerequisite for granting a construction licence.

The encapsulation plant is an above-ground facility for the encapsulation of spent nuclear fuel that is constructed above the disposal facility. The construction of the encapsulation plant was started in summer 2019. From the encapsulation plant, the capsules will be transferred along an elevator shaft to the disposal facility to be disposed of in the disposal holes in underground tunnels.

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–zirconium hydrid combination: 8% of uranium 91% of zirconium 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.

Other objects of regulatory control

In accordance with Section 2 of the Nuclear Energy Act (990/1987), the regulatory control of the use of nuclear energy covers the nuclear material used, for example, in certain research laboratories and in industry. The control also covers nuclear equipment, systems and information as well as nuclear fuel cycle-related research and development activities and the transport of nuclear materials and nuclear waste. In addition, the regulatory control of the use of nuclear energy covers mining and milling operations aimed at producing uranium or thorium. The planned Terrafame uranium extraction plant is part of this group. The intermediate products of metal industry containing uranium are also included in the regulatory control of the use of nuclear energy when the concentration, as defined by the nuclear material specification, is exceeded in an industrial process or product.

APPENDIX 2
Significant events at nuclear power plants

Loviisa power plant

Loviisa annual outage, 2 August–23 October 2020

Loviisa nuclear power plant's annual outage started with the short refuelling outage of the Loviisa 2 plant unit, which ended on 26 August 2020. After this, on 29 August, the Loviisa plant unit's extensive inspection outage carried out at eight-year intervals was launched, including, for example, emptying the reactor from nuclear fuel for inspection purposes. A large number of modifications were also carried out during the extensive annual outage. The Loviisa 1 annual outages were completed on 23 October 2020.

Despite the COVID-19 pandemic, the annual outages of both units were carried out to the extent originally planned and there was no need to postpone any planned work to future annual outages. Fortum had prepared for the exceptional circumstances with related procedure and implementation well in advance of the annual outages and also during them. STUK monitored the measures and ensured that lessons learned at other plants and countries were taken into account in the activities. STUK had to slightly adapt its inspection and control routines due to the COVID-19 pandemic. STUK only carried out the inspections deemed necessary onsite and supervised the various sites more extensively with the help of remote connections.

One important aspect of the plant's ageing management was the further work carried out on the plant's I&C reform, which was concluded in 2018, to ensure the future functioning of the protection I&C systems, control rods and emergency diesel generators.

Loviisa 1's extensive reactor pressure vessel's inspections verified, among other things, that the 2016 inspection observation (indication) of a reactor pressure vessel water supply unit has remained small and has no impact on the safe operation of the reactor. Also the possible causes of the sound observations reported by the reactor pressure vessel's foreign material control system since the end of 2019 were investigated. For this reason, several additional inspections were carried out for the internal parts of the reactor pressure vessel in addition to the normal inspections. In addition to searching for foreign material, these inspections focused on investigating possible wear and tear of the internal parts of the reactor as well as specific targets that might be linked to the foreign material control system's observations. Despite the extensive inspections, no definitive cause could be established. Fortum will continue to monitor the matter during the 2020–2021 operating cycle and STUK will supervise Fortum's measures. Fortum also carried out pressure tests on the Loviisa 1 primary and secondary

circuits, as well as a leak test of the containment, to ensure that their structures were in condition to continue safe operation.

STUK monitored these tests and reviewed the inspection and test results before authorising the plant to restart.

The 2020 annual outage was supervised by approximately 30 STUK experts. They ensured that Fortum took care of radiation and nuclear safety during the annual outage work. During the annual outages, STUK also carried out an inspection of the annual outages in accordance with the operational inspection programme. No safety deficiencies that would have required immediate intervention by STUK emerged during the inspection. The inspection summary is provided in Appendix 3.

Based on the inspection and regulatory control by STUK, the annual outages were carried out safely, and all planned work important in terms of safety was completed.

Further investigations of the Loviisa 2 emergency diesel cooling piping 2019 event

The cooling piping of Loviisa 2 emergency diesel generators were replaced during the 2018 annual outage. After this, leaks were discovered in the new piping of one of the diesels in summer 2019 before the annual outages. According to Fortum's investigations, the leaks were caused by a fatigue fracture resulting from vibration of the piping. Based on the results of test operations and strength calculations, Fortum estimated that the piping installed in 2018 cannot withstand the strong vibration caused by the diesel engine unit and the forced displacement at different points of the pipes connected to the vibration. During the 2019 annual outage, Fortum added flexible rubber hose elements to two diesel engines to resolve the service life issues caused by the vibration. STUK approved the approach and designs for piping modifications. The matter was reported in the 2019 annual report.

In October 2019, Fortum submitted for STUK's approval an operational event report describing the course of events and analysing the lessons learned and corrective measures taken. As a follow-up measure, Fortum conducted a more extensive root cause analysis of the event, which investigated the various design phases of the replacement of the diesel engine cooling water piping conduced in 2018 and the decision-making during the 2018 annual outage. Fortum submitted this analysis to STUK in spring 2020.

STUK monitored Fortum's investigation and follow-up analysis of the event and also considered conducting its own investigation on the subject, but eventually decided to carry out a brief additional periodic inspection to complement Fortum's extensive investigation. Description of the STUK inspection is presented in Appendix 3. The STUK inspection also included assessment on how YVL Guides and STUK monitoring have supported the licensee's activities during the various stages of the event. STUK considers the observations made as part of the development of its regulatory control and instructions.

One key factor in the event was that the scope of the work and the effects of the modification on the dynamic behaviour of the structure were not identified at the beginning of the piping replacement planning. As the intention was to replace the old piping with a similar new one, Fortum had estimated that the replacement of the piping can be done as repair work instead of modification work. When the new piping was designed, the main focus was on the high quality of the welding joints, which had been found to be problematic

in terms of durability in the old piping. This meant that attention was not paid on the fact that routing changes were made to the new piping already at the design stage, and these changes had an effect on the piping's vibration behaviour. Had the work been carried out as a modification, the problems that emerged later would have most likely been eliminated already at the beginning of the modification project. The scope of STUK's data and construction inspections was also largely based on this same classification, which meant that it did not cover a more extensive perspective on the potential vibration issue. Another important issue is that due to earlier delays in the project, all of the piping replacements at the Loviisa 2 diesel generators were carried out during the same year, and that the underlying cause of the problem was only revealed after several test operations carried out in 2019 and not during the 2018 commissioning tests. In this regard, it is important to pay attention in the future to the fact that long-term modification works are scheduled over several years and that in addition to the modification project, attention is also paid to the extent of test operation phases.

Based on the inspection, STUK required Fortum to take measures to ensure that sufficiently extensive expertise was used to form repair and modification solutions and to evaluate solutions as the work progressed. STUK also required measures to develop the organisational culture in such a way that it supports the challenging of solutions and the search for additional information also in situations that are challenging in terms of scheduling.

Fortum replaced the rubber hose elements installed in 2019 and approved by STUK for one operating cycle with final ones during the 2020 annual outage. Significant leaks have not occurred in 2020 in either plant unit. Fortum is planning a similar modification work at Loviisa 1 based on the operating experience gained from Loviisa 2.

Active impurities discovered in the outdoor area of Loviisa 2

Fortum's radiation protection detected three radioactive particles in the power plant's yard area in April 2020. The particles were found along the material transport route in front of the Loviisa 2 material corridor and staff facilities. Fortum had previously conducted measurements in the yard area in October 2019 following the annual outage, and these impurities were not discovered at the time.

The next time Fortum carried out contamination measurements in the yard area between plant units at the end of the Loviisa 2 annual outage in August 2020. The purpose was to ensure

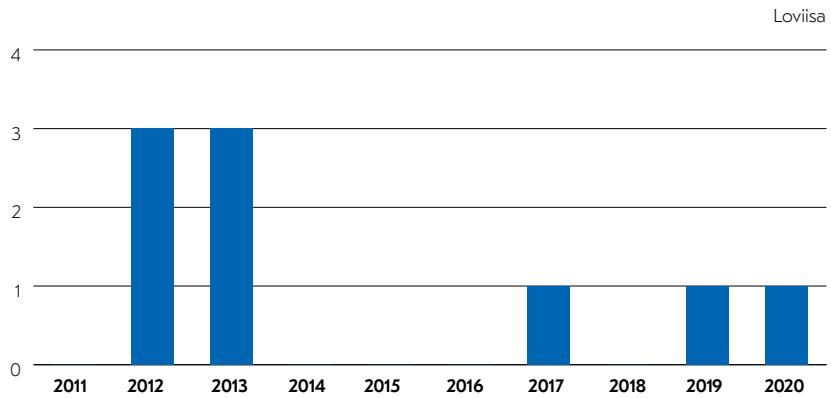

FIGURE A2.1 INES classified events at the Loviisa plant (INES Level 1).

that no radioactivity had entered the yard during the material transports during annual outage or after. However, measurements in the yard area revealed plant-originating radioactivity at seven different locations. Fortum removed the radioactive particles from the yard, and measurements carried out in the power plant's radiochemistry laboratory showed that the nuclide composition of the particles was similar to the observations made in April 2020.

According to Fortum's laboratory analyses, the total activity of the particles found in the yard area was approximately 390 kBq. External exposure caused by the particles in the yard coating is insignificant, even if someone was continuously present in the vicinity of such a particle. If the particles were to enter and remain on bare skin or inside the body, they could cause a clearly abnormal radiation dose.

Fortum launched investigations in order to discover the origin of the radioactive particles and find out why they ended up in the yard. The measures defined based on the investigation are focused on cleaning the spent fuel transfer cask, protection of the casks during transport through the yard area, reducing the contaminants in the cask's storage pools, developing contamination measurements in the yard areas and the possibility to transfer radioactive plant components in made-for-purpose transport shields. The necessary measures are to be introduced during 2021.

Similar observations were made in the plant's yard area in 2010.

The event was rated at level 1 on the International Nuclear and Radiological Event Scale (INES), indicating that it is an anomaly with safety impacts.

Olkiluoto power plant

Incorrectly assembled fuel elements at Olkiluoto 1

On 27 March 2020, TVO informed STUK that Olkiluoto 1 reactor has 20 fuel elements that have been manufactured incorrectly. The total number of fuel elements in the reactor is 500. TVO was informed of the incorrectly assembled fuel elements by the fuel supplier. According to the information received from the fuel supplier, 100 fuel assemblies delivered to TVO in spring 2019 had been incorrectly assembled. The fuel manufacturer had assembled these fuel assemblies with a 180° rotation of the rod chart. While the situation was investigated, TVO reduced the reactor power to 55% of full power. This way the company ensured that the plant remained in a safe state.

After the fuel supplier had notified TVO of the error, TVO lowered the Olkiluoto 1 power level to less than 60% to ensure the sufficiency of margins, after which TVO updated the reactor physical analyses in cooperation with the fuel supplier. STUK reviewed TVO's analyses. The calculations allowed the plant to be operated safely at 94% power until the next scheduled fuel change. This took place during the annual outage, which started in May.

The root cause of the event was the fuel supplier's assembly procedures, which enabled the occurrence of a human error. The fuel supplier used its software with incorrect setting. The error occurred in the orientation selection of the fuel assembly unit's rod chart. As a result, there was a deviation between the physical direction of the fuel assembly and the direction interpreted by the software used in the assembly, and the fuel assemblies were assembled with a 180° rotation of the rod chart. The fuel plant produces two different types of fuel assemblies with a 180 degree difference in the orientation. The orientation selection used for these fuel assemblies were meant for the other type of assemblies, and the fuel manufacturer's inspection procedures failed to notice this.

The fuel supplier corrected the incorrectly assembled fuel elements to correspond to the original design at the end of 2020.

The event had no effect on nuclear or radiation safety. As the event posed a risk of common cause failure, it is rated at level 1 on the International Nuclear and Radiological Event Scale (INES), indicating that it is an anomaly with safety impacts.

Olkiluoto annual outage 10 May–8 June 2020

Due to the COVID-19 pandemic, TVO's Olkiluoto 1 annual outage was shortened from 25 days to 14 days. The originally planned annual outage would have required a large amount of external workforce, and due to the pandemic, TVO did not want as many people simultaneously present at the plant as full annual outage would have required. However, TVO did carry out all work and inspections that are important for safety and operability. The short 8-day refuelling outage at Olkiluoto 2 was carried out as planned. The annual outage also included several special arrangements to prevent the spread of COVID-19.

The Olkiluoto annual outage started on 10 May 2020, when TVO shut down Olkiluoto 2 for a refuelling outage. During the refuelling outage, TVO replaced approximately a fifth of the nuclear fuel to fresh fuel and performed maintenance work included in a normal annual outage. TVO also continued the modification of the auxiliary feedwater system by installing new recirculating lines in two subsystems. The change has now been implemented in all Olkiluoto 1 and Olkiluoto 2 subsystems, which has significantly reduced the plants' dependence on seawater cooling for the auxiliary feedwater systems operation.

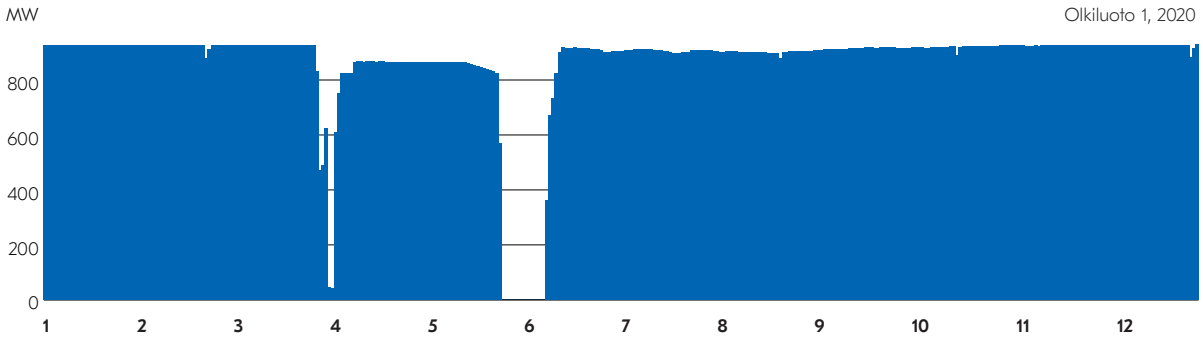

FIGURE A2.5 Daily average gross electrical power of the Loviisa 1 plant unit in 2020.

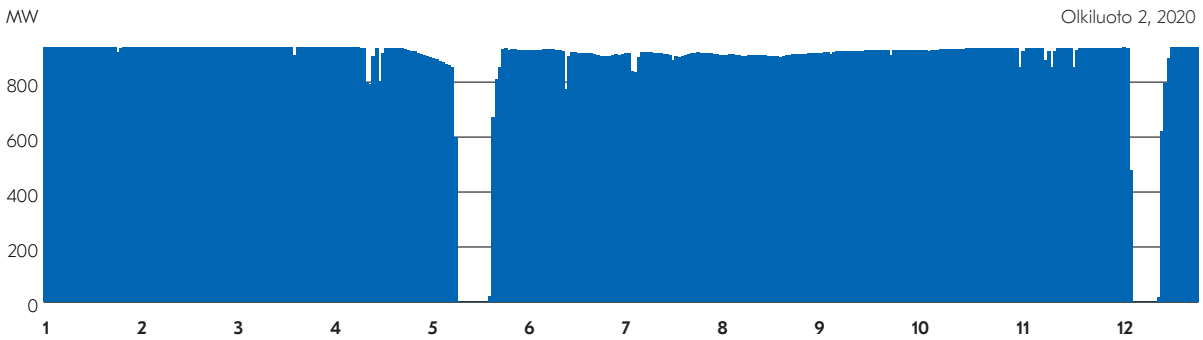

FIGURE A2.6 Daily average gross electrical power of the Loviisa 2 plant unit in 2020.

The Olkiluoto 1 maintenance outage started on 24 May 2020. TVO carried out normal annual outage work and replaced approximately a fifth of the nuclear fuel to fresh fuel. As a result of the COVID-19 pandemic, TVO postponed some of the work planned to be carried out at Olkiluoto 1 to a later date. This way, TVO was able to reduce the number of workers involved in annual outage and thus protect the workers from contracting COVID-19. The maintenance work postponed by TVO included tasks that did not need to be completed immediately. For example, STUK approved the primary circuit pressure test required in connection with the renewal of the operating licence to be carried out during the 2021 annual outage. The decision was supported by the results of the strength analyses of the reactor pressure vessel and good experiences from a similar test performed at Olkiluoto 2 in 2019.

The annual outages ended when, after STUK had issued a start-up permit, unit 1 of the Olkiluoto power plant was reconnected to the national grid on 8 June.

Despite the COVID-19 pandemic, the annual outages were carried out normally in terms of radiation protection. In order to prevent infection, TVO had, among other things, intensified the disinfection of personal monitors and electronic dosimeters, so that exceptional arrangements would not jeopardise the monitoring and control of radiation doses. The radiation doses of the personnel who participated in the annual outage of the Olkiluoto power plant were significantly below the dose limits laid down in the Radiation Decree as well as the dose restrictions set for itself by the power company.

STUK had to slightly adapt its inspection and control routines due to the COVID-19 pandemic. The health of STUK inspectors and annual outage workers was a priority. For example, STUK only carried out inspections deemed necessary onsite and supervised the annual outage with the help of remote connections more than before.

The annual outage was supervised by approximately 30 STUK experts, half onsite and half remotely. Despite the exceptional circumstances, regulatory control was carried out with the same level of accuracy and extent as before. This control ensured that TVO took appropriate care of radiation and nuclear safety during the annual outage work.

During the annual outages, STUK also carried out an inspection of the annual outages in accordance with the operational inspection programme. Inspection topics included updating the operating instructions as a result of modifications, radiation protection, installation of the electrical penetration of the containment, management of foreign material, and the operation of the organisation and decision-making to ensure safety. As a general theme of the inspection, the possible effects of the COVID-19 pandemic and the resulting measures on the safe execution of the annual outage were also observed. The inspection summary is provided in Appendix 3.

Based on the inspection and regulatory control by STUK, the annual outages were carried out safely and all planned work important in terms of safety was completed. According to STUK's observations, the safety measures carried out by TVO due to the COVID-19 pandemic did not hinder the safe execution of the annual outage work. The COVID-19 measures were taken seriously and TVO reviewed their effects throughout the annual outage.

A steam line radiation spike halted Olkiluoto 2 on 10 December 2020

On 10 December 2020 at 12:22 pm, an automatic reactor scram and containment isolation (I isolation) occurred at Olkiluoto 2, which resulted in TVO declaring a plant emergency in accordance with the instructions. The reactor scram was caused by a momentary increase in the radiation intensity in the plant's steam lines. The 3–4 fold increase in the radiation level in comparison to the normal level triggered as an automatic precaution a reactor scram, containment isolation and sprinkling with water. The security systems worked as planned.

The radiation spike was caused by too hot water entering the filters of the reactor's purification system. As a result, material was released from the filters, causing the radiation levels in the steam pipes to rise. There was no damage to the reactor fuel, so there was no risk of harmful radioactive emissions.

In such a case, the containment isolation and sprinkling are activated in case the rise in the radiation level is caused by a sudden fuel damage or pipe damage threatening the safety of the reactor. Neither was involved in this event and there was no actual radiation accident or threat thereof. The event did not pose a risk to workers or the environment.

According to the instructions, the situation also triggered the activities of emergency response organisations at both TVO and STUK. STUK's operations are based on the information available of the event and the implementation of the plant's safety operations, and at the early stage, approximately 80 people at STUK monitored the development of the situation. The situation was managed to the extent required by the original situation information, until at 15:42, TVO lowered the emergency situation classification based on its own verified research results and investigations. However, very early into the situation it was known that there was no risk of emissions to the environment.

Following the reactor scram, TVO brought the plant into a cold shutdown. TVO investigated the root causes of the event and carried out the necessary investigations, inspections and maintenance work to ensure the functioning of all equipment and systems important to safety. STUK supervised the work onsite and reviewed the reports submitted by TVO. According to STUK's assessment, TVO carried out the required investigations and inspections thoroughly, thereby ensuring the safety of the plant. STUK issued a start-up permit to the plant unit on 15 December 2020.

STUK estimates that the event is rated at level 0 on the International Nuclear and Radiological Event Scale (INES). The event was exceptional, but its significance to nuclear and radiation safety was minor and it could not be placed on the actual seven-step scale of the INES evaluation system.

Although there was no real danger or threat of danger, the first indications of the situation communicated the possibility of an accident, so the measures taken by TVO, STUK and other organisations to ensure safety were justified and in accordance with the emergency procedures.

APPENDIX 3
Periodic inspection programme of nuclear power plants 2020

Inspections included in the periodic inspection programme focus on safety management, operational main processes and procedures as well as the technical acceptability of systems. The compliance of safety assessments, operation, maintenance and protection activities with the requirements of nuclear safety regulations are verified with the inspections. No material deficiencies with an effect on the safety of the plant, the personnel or the environment were observed in the 2020 inspections.

In spring 2020, STUK postponed most of the inspections to be carried out in the autumn. Behind this decision was STUK's resolve that only inspections deemed necessary in terms of safety would be physically carried out at nuclear plants during the COVID-19 epidemic. At the end of summer, STUK stated that inspections under the 2020 inspection programmes would be carried out in accordance with the approved programme. These inspections have been carried out both remotely and physically at plant sites. The precondition for remote inspections is that STUK receives all the information it needs from the inspection and can use this information to assess the state of safety and verify compliance with the regulations.

	Inspections in 2020	
Basic programme	**Loviisa 1 and 2**	**Olkiluoto 1, 2 and 3**
I&C technology		x
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		x
Operating experience feedback	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	x
Safety functions		

	Inspections in 2020	
Basic programme	**Loviisa 1 and 2**	**Olkiluoto 1, 2 and 3**
Emergency response arrangements	x	
Power plant waste	x	
Annual outage	x	x
Nuclear safeguards		x
Special subjects		
Management of human factors	x	
Decontamination operations	x	
Leakages of EC cooling water lines	x	

Matters concerning Olkiluoto 3 are also reviewed in the periodic inspection programme of Olkiluoto if the matters to be reviewed are common for the whole of TVO, not merely plant unit-specific. Plant unit-specific (OL1/2 and OL3) inspections are Conduct of operations, Plant maintenance, Safety Functions and Annual outage.

Inspections in accordance with the periodic inspection programme at the Loviisa plant

Additional inspection: Leakages of EC cooling water lines 27 February–8 May 2020

The cooling piping of Loviisa 2 emergency diesel generators were replaced in the 2018 annual outage. After this, several leaks were detected in the piping in 2019 and due to the gravity of the issue, the decision was made to carry out an additional inspection on the matter. The inspection focused on the events following the cooling piping replacement and focused mainly on the events and activities following the 1-diesel cooling pipe leak observed at Loviisa 2 in summer 2019. The inspection was carried out at four separate times, during which several power plant employees were interviewed and the documents drafted during the cooling piping replacement project and the reports prepared on the 2019 incident were reviewed. The inspection and the interviews were for the most part carried out remotely.

The inspection focused particularly on:

- the organisation's decision-making in a problematic situation
- the interaction and communication between Fortum and STUK at various stages
- justification and clarifications of technical solutions during the annual outage
- Fortum's views on diesel generator's cooling piping solutions based on their experience at Loviisa 2.

During the inspection, it was observed that during annual outage, schedule pressures have a strong impact on the operations at the plant. The resulting urgency affects the extent to which Fortum utilises its expertise to evaluate and challenge various solutions. When being rushed, Fortum's operational decision-making process supports and guides the organisation towards conservative decision-making, but the procedure is not able to fully control the effects of urgency, which does not always lead to the optimal result.

Based on the inspection, the fact that Fortum originally decided to carry out the replacement of emergency diesel cooling pipes as internal line organisation repair work resulted in insufficient use of expertise regarding, for example, vibrations. Furthermore, at

the very beginning, Fortum excluded all solution alternatives that, according to the power company's interpretation, would have required a deviation application from the YVL Guides.

Based on the inspection, STUK required that Fortum must reassess its current modification procedures, which have been developed since 2016. The procedures must consider appropriately extensive expertise at the beginning of the design phase as well as independent review that sufficiently challenges the design at various stages of the modification or repair work. Furthermore, STUK required Fortum to develop its organisational culture towards encouraging the challenging of solutions and searching for additional information in accordance with the conservative decision-making culture outside its own organisation also in challenging and urgent situations.

In the case of emergency diesel cooling piping, the modification and its safety have been covered separately through STUK's usual control methods, and STUK has approved the measures taken in the 2019 annual outage and will review the plans to improve the piping.

Decontamination operations, 29 April 2020

The licensee's procedures relating to the implementation, maintenance and development of decontamination operations (cleaning radioactive substances from the plant's process systems) were reviewed during the inspection. Particular attention was paid on investigating the impact of decontamination operations as a factor reducing radiation doses. In addition, the 2020 inspection addressed the management of deviations related to decontamination operations. Decontamination of individuals had been excluded from the inspection of decontamination operations. The inspection was carried out remotely. In addition, STUK monitored the operations as part of the supervision of the 2020 annual outages.

Based on the inspection, Fortum has clearly assumed overall responsibility for decontamination operations.

However, STUK's inspection observations show that there is still room for improvement in the instructions on radiation protection principles and practices related to decontamination work. STUK required Fortum to reassess the comprehensiveness and consistency of the decontamination instructions with regard to matters related to radiation protection and to update the instructions where necessary.

Based on STUK's inspection observations, it also remained unclear what Fortum's instructions on the aims of decontamination operations and special cleaning are, as well as the monitoring and reporting on these aims. For this reason, STUK required Fortum to investigate how its decontamination operations implement the monitoring of decontamination efficiency and to evaluate the planning and monitoring procedures related to its decontamination operations.

Radiation protection, 14–15 May 2020

The inspection concerning radiation protection focused on radiation protection, radiation measurements and release and environmental monitoring at the nuclear power plant. The inspection focused on administrative radiation protection. A particular target was the Loviisa nuclear power plant's ALARA (As Low As Reasonably Achievable) operation, of which Fortum

had prepared a self-assessment. In addition, the joint theme of this year's periodic inspections is deviation management. The inspection was carried out remotely.

STUK had requested Fortum to draft a report on the implementation of the ALARA principles and the timeliness of the procedures at the power plant. During the inspection, it was established that the report was well prepared and that it included extensive development targets, and that good progress had already been made on reaching these targets.

Radiation protection procedures in deviation management were covered during the inspection. Fortum had made comprehensive observations on events related to radiation protection, had taken the necessary corrective measures and forwarded the observations within the organisation. Particular focus was paid on the discovery of radioactive particles in the yard area of the Loviisa power plant and their research results. The particles were discovered and recovered on 9 April 2020 during verifying contamination measurements of the yard areas performed by Fortum.

STUK presented one requirement during the inspection, requesting that a suitability assessment of an electronic dosimeter measuring neutron dose be submitted to STUK.

Human resources and competence, 27–28 May 2020

The topics of the inspection included a development project on competence management, ensuring system managers' resources and competence, as well as supervisory work at the Loviisa power plant. The inspection was carried out remotely. Fortum had responded to STUK's preliminary questions.

During the inspection, Fortum presented the progress of the power plant's competence management development project. The project is lagging behind its original schedule. The data system is currently being piloted.

The inspection covered the Loviisa power plant's procedures for ensuring system managers' resources and competence management. Fortum has redefined and partly redistributed the system responsibilities in its LOLTO (Loviisa Long Term Operation) project and has also established that all plant systems must have a system manager. A large number of the system managers attend to this task in addition to their main duties. There are no appointed deputies for system managers, and when a person leaves the organisation, the task is transferred to the supervisor until a successor has been appointed. Ageing monitoring reports have not been finalised on time, which may communicate the lack of resources available for work and prioritisation of work tasks. System managers play a key role in managing the ageing of a plant and therefore, in accordance with requirement 308 of Guide YVL A.4, persons performing these tasks must have deputies. STUK presented a requirement that deputies must be appointed to all system managers of systems that are essential to the safety of the nuclear power plant.

The third object of the inspection was supervisory work at the Loviisa power plant. The management of the power plant, Fortum Group, the power plant HR section and training group are among the parties in charge of the induction, training and operating conditions of supervisors. The expectations and practices related to the supervisory and managerial duties at the Loviisa power plant have not been defined in a way that would systematically take into account the above-mentioned parties as a whole and the requirements of the nuclear sector. Instructions related to managerial work are available in various locations, e.g. on Fortum's

intranet, and have not been compiled into procedures. STUK issued a requirement that Fortum must assess its management's expectations regarding managerial work and leadership at the Loviisa power plant and also evaluate the induction, training and assessment practices as an entity and ensure that they cover the nuclear sector's requirements on managerial work and leadership.

Power plant waste, 4 June 2020

STUK focused its nuclear waste management inspection on the Loviisa power plant's waste management resources and instructions as well as the current measures of nuclear waste management. The inspection covered the observations of the previous inspection, the up-to-dateness of the instructions and the current waste management measures, such as the commissioning of an intermediate level waste disposal repository, the situation regarding the treatment of damaged waste packages and the main ongoing measures concerning solid waste management. In addition, the functionality of Fortum's deviation management procedure was reviewed with the help of an example case. The inspection was carried out remotely.

Fortum has launched a development project on the resources of the group responsible for radioactive waste in 2019. In STUK's view, Fortum has carried out a very thorough study and analysis of the waste organisation's current competence and resources in connection of launching the development project. Based on the study, Fortum has taken measures to ensure a sufficient level of competence and resources for the coming years. The guidelines on waste management are up-to-date, with the exception of the guidelines on shipments of radioactive waste abroad, and during the inspection, STUK issued a requirement to update these guidelines.

STUK stated that Fortum had made progress in its waste management measures. The intermediate level waste disposal repository has been commissioned. Progress has been made in the treatment of damaged waste barrels, and next, they will be packed in concrete waste packaging. The investigation into the causes of the damage had been launched. In addition, the emptying of the power plant's old waste storage and the repackaging of waste for final disposal have continued.

Fortum has continued to solidify liquid waste into concrete at the solidification plant. As regards premises, Fortum had made an investment decision on building a new hall for the control of metal waste for exemption measurements and storage of waste packaging. Once completed, the new hall will improve working conditions significantly. The handling of the deviation related to waste records was handled in accordance with Fortum's deviation procedure. The reasons leading up to the incident had been thoroughly investigated and the necessary corrective measures had been taken.

Annual outages 2 August–23 October 2020

The annual outage inspection covered and verified the power plant's annual outage actions used to maintain safety as well as the actions used to manage and control operations during an annual outage. STUK inspectors from various fields of technology participated in the inspection. They each had their own predetermined inspection areas. Furthermore, STUK carried out general supervision in the plant area, for example, by carrying out plant tours

and monitoring the progress of work and the related radiation protection procedures. STUK inspectors also paid particular attention to the management of foreign material when moving around the plant. STUK also monitored the prioritisation of safety in Fortum's decision-making process. Despite the COVID-19 epidemic, Fortum was able to arrange its work so that the annual outages of both plant units were carried out in accordance with the original plans. The COVID-19 epidemic was also taken into account in the STUK inspection – all inspection areas for which monitoring at the plant site was not necessary were carried out remotely.

During the annual outage inspection, particular focus was paid on the replacement of the reactor pressure vessel cover's bushings at Loviisa 2 and on the additional inspections of the Loviisa 1 reactor pressure vessel due to suspected foreign material. Other inspection targets included the I&C replacement of emergency diesel generators at Loviisa 1, lifting in the reactor hall, radiation protection procedures for work tasks and contamination control in sampling, decontamination operations and the effects of the additional circuit of the primary circuit cleaning system implemented in 2019.

In the regulatory control targeting the management of foreign material, STUK verified the procedures implemented by Fortum during the annual outage both in the controlled areas of the plant units and in the turbine halls. Although no development measures related to training had been implemented at the Loviisa power plant due to COVID-19 epidemic, the annual outage inspection showed improvement in the use of foreign material protection and improved practises of storing items compared to recent years. Based on STUK's observations, foreign material management has improved. However, STUK considers it important that any observations made in foreign material management are treated with due seriousness and that operations are systematically developed also in future.

STUK carried out its regulatory control targeting the radiation protection activities by carrying out plant tour and by having discussing with the representatives of Fortum and contractors. Based on STUK's observations, most of the work areas established to prevent the spread of contamination were separated and marked clearly, and there were sufficient protective equipment available at the work areas. The level of cleanliness at the controlled area remained for the most part good during the annual outage and major contamination spreads were avoided. During the annual outages, there were several abnormal incidents related to radiation protection, and Fortum has prepared operational event reports on them. For example, radioactive contaminants were discovered during measurements carried out in the plant's yard area during the annual outage. STUK considered it important that Fortum thoroughly investigates the root causes of the contaminant's migration the yard areas and takes all necessary corrective measures.

STUK also supervised the replacement of the Loviisa 2 reactor pressure vessel cover's bushings. Fortum developed, where necessary, inspection procedures during the repair process. From the radiation protection point of view, the replacement of the cover bushings went smoothly.

During the operating cycle 2019–2020, the Loviisa 1 reactor pressure tank's foreign material monitoring system detected additional noises, causing Fortum to carry out additional inspections. In STUK's view, these inspections were comprehensive and STUK did not have any remarks on the way that the inspections were carried out. However, based on the inspection, no

clear reason for the observations was discovered. Fortum will continue to monitor the situation during the 2020–2021 operating cycle, and STUK will supervise Fortum's measures.

STUK supervised the I&C replacement of Loviisa 1's emergency diesels by participating in the project's daily monitoring meetings, reviewing the interim stage review protocols, and monitoring hot tests and diesel start-up sequence tests. Fortum adopted an active role in observing any deficiencies in activities and correcting them Overall, the installation and commissioning went ahead as planned. In terms of the modifications, no factors were found that would have had a significant effect on the planned tests or installations in terms of safety.

Several individual incidents took place during the annual outage of Loviisa 2 that showed deficiencies in lifting operations. For this reason, STUK established lifting operations as one of the additional topics of the annual outage inspection at Loviisa 1, where STUK interviewed employees responsible for lifting operations and also observed lifting activities in the reactor hall on one day. Fortum had clearly addressed the deficiencies discovered and no similar deficiencies were observed in the lifting operations at Loviisa 1. STUK will continue to monitor lifting operations and their management also in the future.

No deviations that would have required immediate intervention by STUK were observed in the operations of Fortum during the annual outage. According to STUK's findings, the annual outages were performed safely.

Security arrangements – physical protection, 21–25 September 2020

The inspection focused on the plant's security arrangements, which are considered to include structural, technical, operational and organisational arrangements to detect, delay and prevent illegal or unauthorised activities. With regard to security arrangements, both the topic areas related to physical security arrangements and the interfaces and the interface issues related to information security were examined.

Deviation management was a particular focus, and for its part, it was stated that the handling of deviations, deficiencies and observations and the documentation of the information resulting from them seemed appropriate and sufficient in the security arrangements. No requirements were issued in the inspection.

Security arrangements – information security, 21–25 September 2020

The information security inspection was carried out at the same time with another security arrangement inspection: the physical protection inspection. The security inspection reviewed the structure of data networks and their security controls.

The inspection focused on activities related to the management of deviations, for the part of which, the measures related to the handling of events, deviations, deficiencies and observations were reviewed. Based on the inspection, these matters appeared to be appropriate and sufficient. No requirements were issued in the inspection.

Management system, 6–8 October 2020

The inspection covered the procedures by which Fortum manages deviations and the risks associated with its operations. The licensee's organisation and the development of Loviisa's

operations from the point of view of the independent assessment of nuclear safety were also covered.

The inspection addressed the grounds on which Fortum defines which parts of Fortum's organisation fall under the licensee's organisation. Based on the inspection, STUK required Fortum to clarify the definition. Based on the inspection, Loviisa has transferred the independent assessment of its operations to the plant's nuclear safety unit, which has initiated new reporting procedures related to this matter. STUK will monitor the further development of operations under its further monitoring.

The inspection also addressed the plant's deviation management procedures and verified their situation. There have been delays in the performance of the related corrective measures initiated by Fortum, and STUK required Loviisa to settle the situation.

As regards risk management, the licensee has started to develop its operations based on self-assessment. New procedures were discussed during the inspection and risk management was verified. The procurement process description required by the previous management system inspection was found to be appropriate.

Operating experience feedback, 20 October 2020

The inspection focused on external operating experience feedback, for which procedures and their functionality were verified with the help of example cases; the processing of operating experiences and events of other plants, utilisation of experiences and reporting outside the plant. Also deviation management related to operating experience feedback was inspected.

Fortum updated the operating experience feedback process of the Loviisa plant during 2018, at which time the internal and external operating experience procedures were merged into the same process. In this context, instructions were also updated to ensure that the procedure corresponds to the process and the work instructions describe the activities more accurately on a practical level. The development measures that have continued since then are still partly unfinished: efforts have been made to improve efficiency, indicators and monitoring have been added, and some development targets have also been identified in self-assessments. Based on the verification of example cases, the processing of external events has become faster and the processing is available in the plant's data systems. In STUK's view, Fortum has made effort to improve its operations to correct the observed deficiencies and development findings. The adequacy of resources or operations and the effectiveness of the corrective measures cannot yet be fully assessed, as the development measures are still in progress.

STUK will monitor the progress of Fortum's work and development measures in connection with other supervision and processing of reports (such as the annual report). On the basis of the inspection, STUK presented no requirements.

Management of human factors , 3–5 November 2020

STUK reviewed Fortum's management of human factors related to safety. Management of human factors was selected as an inspection topic in order to verify that it meets the standards that have become more exact as a result of changes to the regulation. The inspection covered three different areas of human factors:

- The role of human factors and organisational issues in event investigation

- Human Factors Engineering (HFE)
- Further development of human factors management

Event investigations, current development measures and modification projects at the plant were used as examples in the inspection.

For the part of the event investigations, STUK observed that Fortum has recently utilised less human and organisational factors specialists in its investigation. Fortum's instructions do not include exact criteria for the kinds of events requiring thorough investigation of human and organisational factors with the help of special expertise. However, Fortum does have access to experts who could participate in the investigation of events from this perspective. STUK requires Fortum to strengthen the utilisation of expertise in the investigation of human and organisational factors and to specify its instructions in such a way that the scope of human and organisational factors processing and the expertise used in it are planned consistently and transparently in all investigations.

During the inspection, STUK also examined how the process computer used to control the plant had been further developed based on events and other usage needs. The process computer is developed in three different lines, and the development is mainly based on the direct development needs identified in use. In addition, Fortum is currently examining the development of the emergency function. According to information received by STUK, the development of the process computer does not fully correspond to the level of quality management required by its significance in the control of the plant. STUK requires Fortum to review the observations made by STUK and, if necessary, to develop its process computer development procedures.

During the inspection, STUK examined Fortum's human factors engineering (HFE) procedures, e.g. in modifications. Fortum has some procedures in place, but the systematic employment of the HFE program is not currently part of Fortum's practice. During the inspection, STUK found that the HFE procedure competence in the Loviisa power plant organisation is currently not at the level required to systematically integrate HFE in the design procedures. Based on the inspection, STUK required Fortum to develop its procedures to take human factors into account in design and to examine the development needs of its own instructions in this regard.

Plant maintenance, 10–11 November 2020

The sufficiency of the resources, functions and tasks relating to the condition monitoring and maintenance of the Loviisa 1 and Loviisa 2 plant units to ensure safe operation in design basis conditions was assessed in the inspection. The inspection focused particularly on the human resources of maintenance and the extent and procedures of the plant units' ageing management programme. The selected inspection targets included load monitoring procedures, qualification requirements for system managers and their deputies, monitoring of maintenance tasks and data on ageing management monitoring reports, such as the validity of I&C equipment's time-limited qualifications. The inspection did not reveal any significant deficiencies in the maintenance of the Loviisa plant units. Based on the inspection, STUK required Fortum to submit a plan for the modernisation of the continuous temperature and

elongation measurement system originally installed at Loviisa 1, as well as a supplemented strength analysis register already submitted to STUK based on the previous inspection.

Mechanical technology, 30 November 2020

The power company's activities related to ensuring the integrity and reliable function of mechanical equipment and structures were assessed during the inspection. The inspection focused on the scope and sufficiency of the verification of the operability of the containment's sprinkler system equipment, testing procedures for the pumps of three different systems in safety classes 2 and 3, and the way Fortum applies the piping condition monitoring programme in practice. In addition, the inspection procedures of hoisting accessories and fuel handling equipment at the plant were reviewed during the inspection.

Based on the inspection, the preventative maintenance activities and operability monitoring of the containment's sprinkler system are comprehensive and sufficient. The testing procedures of the examined pumps were found to be sufficient and the results corresponded to the design standards set for the pumps. The current piping condition monitoring programme is mainly used as a databank and as an additional tool, and inspection targets are selected based on experience and inspection history. STUK did not have any remarks regarding the inspection of hoisting accessories and fuel handling equipment. STUK did not issue any requirements based on the inspection.

Fire protection, 1–2 December 2020

The inspection focused on the structural and active fire protection arrangements at the nuclear power plant and on operative fire-fighting. The inspection targets included the organisation, the training and equipment of the plant fire brigade, inspections and maintenance of active fire protection systems, modifications and repairs, inspections carried out by the licensee and other organisations, and operating experience feedback. As part of the inspection, four persons were interviewed on the management of deviations. In addition, Fortum and STUK discussed the handling of fire compartment structures as a part of the inspection.

Based on the inspection, the fire safety of the Loviisa nuclear power plants is at the level required by the applicable regulations. Resources have been strengthened during 2020. The Loviisa fire load management procedures have been further developed and fire safety has been improved, for example, a new hot work building was commissioned during the 2020 annual outage.

No requirements were issued in the inspection. STUK stated as an observation that it would be a good idea for the plant fire brigade to practice the activities brought along by the changes made to improve the cooling of the fuel tanks.

Safety design, 2–3 December 2020

The inspection focused on the design activities of the Loviisa power plant. The inspection covered the organisations involved in the process and I&C design, the procedures used and their development needs, as well as the available resources.

The inspection focused particularly on the flow of information and document commentary between the technical fields and Fortum's organisational units, the ongoing development

projects of the design process and instructions, and the use of subcontractors. The extensive and long-term renovation of the chemical station, the design work of which was mainly ordered from outside Fortum, the primary water purification cycle during annual outage and the renewal of plant protection were examined as examples of recent plant modifications. No requirements were presented based on the inspection.

Emergency response arrangements, 14–15 December 2020

The inspection regarding the emergency response arrangements covers the emergency response arrangements, procedures, facilities and training of the nuclear power plant. It covers the lessons learnt over the past year on emergency response operations, experiences and feedback on emergency response exercises and the development projects of emergency response operations. The inspection area also includes the automatic radiation monitoring of the environment, meteorological measurements and forecasting of dispersion. The 2020 inspection also addressed the management of deviations related to emergency response arrangements.

Based on the inspection, STUK required Fortum to submit the entire emergency plan for approval, as many of the previous changes only covered parts of the plan and had been submitted for information. In addition, STUK required Fortum to provide STUK with a report on improving the operational prerequisites for the vacancies of the Radiation Protection Director and the Radiation Protection Measurement Manager. According to STUK's view, the resources allocated to Fortum's emergency response organisation's radiation protection vacancies are small, especially from the point of view of the long-term situation, for example, in the event of an illness or a business trip.

Fortum's emergency response arrangements are at a good level and its organisation develops the emergency response arrangements in accordance with the regulations and procedures.

Inspections in accordance with the periodic inspection programme at the Olkiluoto plant

I&C technology, 25–26 November 2020

The inspection focused on the I&C technology systems, organisation and instructions at the OL1, OL2 and OL3 plant units. The inspection covered, for example, configuration and version management, the renewal programme of the electrical and I&C equipment inside the containment, as well as the maintenance organisation and resources.

No requirements were made based on the inspection, but some observations were made regarding the configuration management at the OL1 and OL2 plant units. The inspection verified, among other things, that the current practice e.g. in parameter management is fragmented due to different systems, among other things. During the inspection, it remained unclear how the parameter layout and storage of a software-based device or system are instructed to be inspected during the commissioning inspections. In addition, it was found that there is no description or image of the plant level I&C architecture and configuration. Such an image could be helpful in gaining a better understanding of e.g. system interfaces

and the dependencies between them and in verifying and ensuring their management. STUK monitors the issues above in its control.

Management system, management and safety culture, 10–11 November 2020

In its 2020 programme, STUK decided to merge the "Management system" and "Management and safety culture" inspections. In this inspection, STUK paid particular attention on the changed requirements related to the update of Guide YVL A.3 "Leadership and management for safety" and their implementation at TVO. Assessments made by TVO and related interpretations and measures were also examined. The inspection also included advance familiarisation with assessments made on TVO's operations.

STUK had an open requirement regarding TVO's ability to ensure that its suppliers have a healthy safety culture. TVO has carried out development work on being better able to assess the safety culture of suppliers in procurement, manufacturing and reception activities and disseminating information throughout the organisation. In STUK's view, this development work seemed to be focused on procurement, while quality management has developed its own practices, and the two have remained separate from each other. Based on the inspection, STUK issued a requirement that TVO must at the beginning of 2021 present the development measures that remained unfinished at the time of the inspection in order to ensure uniform data collection and dissemination within the organisation.

The inspection covered various TVO assessments, such as international peer reviews (WANO, IAEA), technology department self-assessment, personnel surveys and the final evaluation practice of projects. In STUK's view, TVO's organisational assessment activities are versatile, comprehensive, self-critical and inclusive. The overall picture of organisational matters that are important to safety presented to the management seems clear.

Examples of other changes to the requirements of Guide YVL A.3, including stakeholder work, staff's ability to communicate on work-related matters, the content of the quality plan and the employment of the Graded Approach principle were also covered in the inspection. As a result of the inspection, STUK concluded that TVO's instructions and operations meet the requirements necessary for implementation.

Disposal facilities, 30 September–1 October 2020

The inspection was focused on the concrete and rock structures of the Olkiluoto power plant's waste disposal repository (VLJ repository), and the related TVO organisation, processes and operations, operating instructions, TVO's own inspections, the status of ongoing investigations and maintenance procedures were reviewed during the inspection. During the inspection, STUK paid particular emphasis on the adequacy of resources and competence related to the use of the VLJ repository.

Based on the inspection, STUK presented three requirements. TVO must, for example, submit to STUK a report on the deputy arrangements that will ensure the continuity of the VLJ repository's monitoring, examinations and long-term testing. TVO must also submit to STUK a report on how the traceability and transparency of the monitoring material of all the VLJ repository research areas and the clarity of reporting can be improved.

Chemistry, 3–4 November 2020

The inspection assessed the procedures used to maintain and control the chemical conditions of systems important to safety and to control the radionuclide concentrations of the reactor coolant. Procedures related to the radionuclide-specific determination of the activity accumulated on the interior surface of heat exchangers and pipes were examined in particular. The inspection also addressed the management of deviations related to chemistry operations. The inspection covered all three Olkiluoto plant units, and STUK issued four requirements based on it.

During the inspection it was established that TVO uses an external service for nuclide-specific measurements of the primary circuit's surface activity. TVO's Chemistry team is responsible for organising and planning the measurements. The inspection covered the situation of the measuring equipment as well as the measurement procedures and reporting on the results at the OL1 and OL2 plant units. At OL3, the measurement point planning is still underway. STUK required that the quality control of the measurements must be traceable in the measurement reports submitted to TVO and that procedures must be established for the laboratory's subcontracted activities in accordance with TVO's pre- and post-job briefing practice.

The inspection covered the management of deviations in chemistry operations. The chemistry laboratory has introduced a new laboratory data system. In connection with the introduction of the new data system, the values and action levels of the Technical Specifications (TechSpecs) related to hydrochemistry management were entered into the data system, as were the quality assurance sample action/alarm limits. When entering sample data analysis results into the system, the data system automatically compares the entered result to the TechSpec value/action level and, in case of a quality assurance sample, compares the result to the action/alert limit. The data system provides the person entering the sample data with an immediate respond as to whether or not the result is within the permitted limits. During the inspection, it was also established that in addition to Chemistry, sampling is also carried out by other organisations. STUK issued a requirement that a verifiable procedure must be established to ensure the sampling competence of persons from outside the chemical organisation. STUK also required that the verification of laboratory analysis qualifications must be clearly described in the Chemistry operating instructions.

Mechanical technology, 13–14 October 2020

The licensee's activities related to ensuring the integrity and reliable function of mechanical equipment and structures are assessed during the mechanical technology inspection. For the part of plant units OL1 and OL2, the inspection focused on the auxiliary feedwater system's recirculating line modifications and nuclear hoisting equipment. Based on the inspection, STUK presented two requirements.

Due to the upcoming fuel loading, the following issues deemed essential were reviewed at OL3: the serviceability of safety class 2 pumps following the long standstill and various maintenance and modification tasks, nuclear hoisting equipment, the procedure applied in the pipeline condition monitoring and periodic inspections of pressure equipment, and the adequacy of the staff's competence and mechanical training.

The inspection did not provide full certainly of the operability of OL3's safety class 2 pumps in the above-mentioned situations. According to TVO, the pumps normal periodic tests will be started already before fuel loading, and will continue throughout the nuclear test operation and also after the launch of commercial operation. TVO must present justifications on how these periodic tests or, if necessary, additional inspections and tests can ensure the serviceability of the pumps under all design basis conditions before the start of commercial operation. The justifications must be submitted to STUK for information before fuel loading.

The test runs related to the OL1/2's auxiliary feedwater system's recirculating line modifications revealed inoperability of measuring equipment, in relation to which STUK required TVO to submit to STUK for information a plan and schedule for repairing the measuring equipment.

Interim storage of spent nuclear fuel 28–29 October 2020

The inspection focused on the operation of the interim storage of spent fuel (KPA storage), the modification of systems and the ageing management of systems and structures. The inspection assessed the current state of use and modifications of the KPA storage as well as future modification work. The inspection also covered the responsibilities and authorities of various TVO organisations involved in the use of the KPA storage.

Based on the inspection, the operating activities related to the KPA storage appear to be clear and the responsibilities of the various organisations are described in the administrative rules of the Olkiluoto nuclear power plant. Responsibilities have been defined for several different organisational levels and tasks.

The inspection also covered the ageing of KPA storage systems and structures, system managers and their role in the assessment of ageing, ageing management monitoring and reporting and the spare parts situation. During on the inspection, TVO assessed the KPA storage systems' spare parts situation to be good. TVO uses a spare parts process, on the basis of which spare parts are purchased. During the inspection, it was established that a comprehensive survey of the KPA storage systems' spare parts situation is underway, including the spare parts for the VLJ repository systems and the plant waste systems. No requirements were presented based on the inspection.

Plant maintenance, 2–3 December 2020

The sufficiency of the resources, functions and tasks relating to the condition monitoring and maintenance of the OL1 and OL2 plant units to ensure safe operation was assessed in the inspection. As the commissioning of OL3 is approaching, the status of OL3's maintenance organisation and instructions was also addressed. The inspection focused particularly on the human resources of maintenance and the extent and procedures of the plant units' ageing management programme.

In recent years, TVO has reviewed the vocational induction of new maintenance recruits and the inspection established that the situation has improved clearly. The sufficiency of the maintenance resources and competence will also be monitored in STUK's future inspections. TVO has invested in incorporating the requirements of Guide YVL A.8 into its ageing management programme. Progress has been made in the development work, but the provision

of information on plant parts remains partly unfinished. No significant deficiencies were identified in the inspection. However, some issues remain to be clarified by TVO.

STUK presented two requirements based on the inspection. TVO must examine from recent periodic test result the compliance of the measured performance of all safety class 2 pumps with the design basis performance presented in the final safety analysis report (FSAR). The compliance must be unambiguously demonstrated to the pump's operating point defined in the FSAR (lifting height vs. flow). Any potential deviations from FSAR must be justified. The second requirement was related to bringing TVO organisation's documentation on strength technical competence and resources in line with the current situation and expected future needs.

Utilisation of the PRA, 21 October 2020

The inspection concerned the preparation of the probabilistic risk assessment (PRA) of the nuclear power plant and the procedures relating to its application and the utilisation of PRA in the management of safety at the nuclear power plant. In the inspection, the situation regarding the PRA models and applications of all Olkiluoto plant units and the KPA storage, the extensions and updates under preparation and their schedules were reviewed. In addition, the instructions and the operation of the organisation relating to the preparation and application of the PRA were assessed in the inspection. Despite staff changes, PRA resources have been maintained at the same level as before. Currently, there are no comments on the resource situation.

Based on the inspection, it can be stated that the instructions concerning the PRA are up to date and the PRA is used in accordance with the plans and in a versatile manner as a support for safety management. One requirement was presented based on the inspection. TVO must assess the need for updating the risk-informed TechSpec and, if necessary, draw up an updating schedule and submit the results of the assessment to STUK for information.

Structures and buildings, 4–5 November 2020

The inspection concerned the use, condition monitoring, maintenance and ageing control of structures, buildings and sea water ducts and tunnels. The inspection included an assessment of the licensee's procedures and operations and a review of the results of construction inspections and the completed modifications. In this year's inspection, STUK emphasised the management of deviations as part of the organisation's operations and construction practices.

Based on the inspection, STUK did not issue any requirements, but made some observations, the development of which will be monitored in the future. The observations were related to the procedures of the receiving inspections, ensuring that the modification work material at the construction site is up-to-date, monitoring the validity of approved suppliers' certificates, recording the results of maintenance inspections and managing the repair priority, developing the condition monitoring and assessment of inaccessible and restricted structures, recording the justifications for closing the handling of operating experience reports, and positive operating experience cooperation with Swedish sister plants.

The periodic inspections and renovations of TVO's power plant buildings' rooms as well as structural modifications have been carried out as planned. Based on the inspection, the use,

condition monitoring, maintenance and ageing management of structures and buildings are at an adequate level.

Electrical technology, 25–26 November 2020

The electrical technology inspection assessed the licensee's procedures to ensure the reliable operation of the nuclear plant's electrical systems and equipment. The inspection topics included the condition monitoring and periodic inspections of safety classified electrical equipment carried out by the licensee, the installation inspections and procedures related to electrical equipment and cables carried out by the licensee, as well as drafting requirement specification and verifying the requirements. The inspection also dealt with open electrical issues at OL3, which must be resolved before fuel loading.

During the inspection, TVO presented condition monitoring reporting from its preventative maintenance system and also the procedures related to the installation inspections and the electrical technology installation inspection organisation. During the inspection, TVO was told to pay closer attention to familiarising new installation inspectors with the inspection targets and procedures. The inspection also reviewed and verified TVO's procedures related to the preparation of requirement specifications for electrical systems and equipment and to communicating and verifying the requirements.

Based on the inspection, STUK presented three requirements. TVO must include in its instructions the procedures for applying the verification table for the compliance of electrical systems and equipment with the requirements. TVO must also submit to STUK a plan of measures on how to bring the drafting of requirement specifications for electrical systems and equipment in line with the instructions. Regarding OL3, TVO was required to report on the frequency converter failures during their commissioning and their repairs. The report must be submitted to STUK for information before OL3's fuel loading.

Radiation protection, 6–7 October 2020

The inspection concerning radiation protection focuses on radiation protection, radiation measurements and release and environmental monitoring at the nuclear power plant. The 2020 inspection focused on administrative radiation protection. Particular focus was paid on the Olkiluoto nuclear power plant's ALARA (As Low As Reasonably Achievable) activities. The inspection covered all Olkiluoto plant units.

STUK had requested TVO to prepare a self-assessment on the implementation of the ALARA principles and the currency of the procedures at the power plant. STUK concluded that TVO's report on the matter was carefully prepared and that it identified development targets. In the future, the OL3 plant unit and waste management will be more included more extensively in the assessment of ALARA activities. Radiation protection procedures in deviation management were reviewed during the inspection. The inspection was carried out with separate interviews. In STUK's view, deviations are handled systematically in the area of radiation protection, staff is familiar with the instructions for handling plant level deviations and observes them.

STUK presented three requirements based on the inspection. These concerned the updating of the radiation protection instructions and the radiation source accounting.

Security arrangements, 1–4 September 2020

The inspection focused on the security arrangements of the Olkiluoto plant units. Inspection targets included risk and deviation management, both in terms of physical security arrangements and information security. External and internal assessment of information security and the implementation of their results were also discussed. Monitoring of person traffic, the items brought to the plant site and transport were inspected at the plant gates. Information security procedures and ongoing development measures were reviewed at the maintenance unit.

Based on the inspection, STUK presented two new requirements and a new deadline was set for one requirement issued at an earlier inspection. In order to maintain and improve both physical security arrangements and information security procedures, several development projects are ongoing and underway at Olkiluoto. STUK considers these to be good and necessary.

Safety design, 16–17 September 2020

The inspection focused on TVO's design activities at the Olkiluoto power plant. The inspection covered the organisations involved in the process and I&C design, the procedures used and their development needs, as well as the available resources.

The inspection focused in particular on the flow of information between various technical fields, the harmonisation of OL3 design practices with those of the OL1 and OL2 plant units, and the use of subcontractors. As examples of recent plant modifications, changing the water supply of the reactor core's injection and boron system from above the core to the annulus, the project on increasing the heat transfer capacity of the KPA storage and the project on renewing the I&C system components to ensure its lifecycle were reviewed.

No requirements were presented based on the inspection. TVO has recently developed its design process towards a direction in which model templates are widely used in the compilation of the data, which, in STUK's view, has improved the quality and consistency of the data. The flow of information between various technology sectors has improved lately and the interaction, particularly in the pre-design stage, has increased from what it was.

Nuclear material safeguards, 7–8 December 2020

The inspection covered TVO's nuclear safeguards with regard to the following entities: Nuclear material licensing and accountancy and reporting system, enabling regulatory control and oversight by international organisations (IAEA, Euratom), TVO's nuclear material safeguards system and organisation. The inspection topics were reviewed through interviews and TVO's example cases.

No requirements were presented based on the inspection. In STUK's view, TVO's activities with regard to nuclear material safeguards are appropriate. For example, STUK considered it a good practice that TVO's personnel responsible for nuclear material safeguards regularly provide training on nuclear material safeguards issues to all those who operate within the power plant area.

Annual outage, 10 May–8 June 2020

The inspection verified and assessed the safe implementation of the annual outages of TVO's OL1 and OL2 plant units. Several inspectors from various fields of technology took part in the inspection. Due to the COVID-19 epidemic, various sites were monitored via remote connections more than usually.

Inspection topics included updating the operating instructions as a result of modifications, radiation protection, installation of the electrical penetration of the containment, management of foreign material, and the operation of the organisation and decision-making to ensure safety. As a general theme of the inspection, the possible effects of the COVID-19 epidemic and the resulting measures on the safe execution of the annual outage were also observed.

STUK carried out on-site radiation protection annual outage monitoring at both plant units. Based on the monitoring visits, radiation protection measures had been appropriately implemented and no comments were made.

STUK verified TVO's procedures related to the management of foreign material during the annual outage on a spot-check basis at the controlled areas of OL1 and OL2 and also by monitoring TVO's reporting on foreign material observations. The observations made by STUK at the plant site were mostly positive. TVO's investment on the development of foreign material management is reflected at work areas and the operations of the plant.

No requirements were presented based on the inspection. According to STUK's observations, TVO's COVID-19 safety measures did not hinder the safe execution of the annual outage work. The COVID-19 measures were taken seriously and TVO reviewed the effects of the measures throughout the annual outage. However, TVO postponed some of the work planned for the annual outage to the future to ensure the availability of competent workforce and necessary parts for the annual outage. All work necessary in terms of safety was carried out in accordance with the original plan. STUK considers it important that TVO continues to plan the implementation of the postponed work in such a way that the matter will be compensated quickly.

APPENDIX 4
The operational readiness inspections of Olkiluoto 3 in 2020

The Olkiluoto 3 plant unit was dealt with both in the operational readiness inspections and inspections specified in the periodic inspection programme because many functions inspected are shared by all plant units of Olkiluoto. The periodic inspection programme inspections are described in further detail in Appendix 3 and this appendix contains only the inspections related to the verification of operational readiness.

The inspections concerning solely the Olkiluoto 3 plant unit were made in accordance with the operational readiness inspection plan. The objective of the construction inspection programme (RTO) is to verify that the functions required by the construction of the facility ensure its high-quality implementation in accordance with approved plans, while following the official regulations and without jeopardizing the operating plant units at the plant site during the different stages of the construction project. The inspection programme of Olkiluoto 3 was launched in 2005 when construction of the unit started, and the last RTO inspection was performed in November 2017. Because the RTO programme ends in an operating licence and it was to be expected that OL3 plant unit gets the licence during spring 2018, no semiannual RTO plan was prepared for spring 2018. Instead, a operational readiness inspection plan was prepared. Due to delays in the project, the granting of the operating licence was transferred to the beginning of 2019. After the operating licence, fuel loading has been transferred several times, so STUK has updated and completed the inspection programme based on the project schedule and other inspection findings.

Readiness inspection plans are part of the verification of safe use required by Section 20 of the Nuclear Energy Act:

Operation of the nuclear facility shall not be started on the basis of a licence granted:
(1) until the Radiation and Nuclear Safety Authority (STUK) has ascertained that the nuclear facility meets the safety requirements set, that the physical protection and emergency planning are sufficient, that the necessary control to prevent the proliferation of nuclear weapons has been arranged appropriately, and that the licensee of the nuclear facility has, as provided, arranged indemnification regarding liability in case of nuclear damage.

During the year, operational readiness inspections were performed as follows:

Inspection	Date
Security arrangement	18–21 August 2020 17–18 November 2020 7–10 December 2020
Operating Manual for the plant and procedures related to severe accident management	27–28 April 2020
Review of emergency response arrangements	3 June 2020
Spare parts situation review	13–14 July 2020
Management system	22–23 September 2020
Control room readiness	1–3 December 2020

The security arrangement inspections assessed the operational readiness of the Olkiluoto 3 plant unit from the point of view of the implementation of the security arrangements. The inspections focused, among other things, on the state of information security, management of keys and alarm centre operations. Based on the inspection, STUK concluded that in terms of security arrangements, the plant is not yet ready for fuel loading. Based on the inspection, previous requirements were closed, for example, based on evidence gained from exercise activities. Regarding security arrangements, further inspections will be carried out to verify the plant's fuel loading readiness in 2021.

While inspecting the plant's Operating Manual, STUK assessed TVO's methods through which TVO has formed its opinion on the readiness and suitability of the plant's Operating Manual and severe accident management procedure. In addition, TVO's methods and resources for maintaining and developing the plant's operating instructions as well as the administrative guidelines on plant disturbances prepared by TVO were assessed during the inspection. Based on the inspection, STUK concluded that the plant's key Operating Manual have been shown to be suitable for their intended purpose. However, the instructions are not yet in all respects ready for nuclear fuel loading. TVO has surveyed and scheduled all unfinished work to be completed before fuel loading. In its inspection protocol, STUK issued requirements regarding the completion of unfinished work before fuel loading. STUK also presented requirements for ensuring the functioning of the severe accident management procedure and managing I&C disturbances.

The review of the emergency arrangements verified that TVO's OL3 plant unit's emergency arrangements have been brought into readiness for operation in accordance with the emergency plan. STUK concluded that the emergency arrangements of TVO's OL3 plant unit are in accordance with the emergency plan.

The spare parts situation required by the YVL Guides was reviewed. Based on this review, the situation has improved since the previous spare parts inspection. STUK will carry out another review regarding the spare parts before fuel loading to verify the plant's readiness for fuel loading.

The completion of instructions and the training situation were among matters reviewed during the management system inspection. Based on the inspection, in terms of management system, the plant is not yet ready for fuel loading, but progress had been made. STUK will conduct a review on open issues before fuel loading to verify the plant's readiness for fuel loading.

STUK inspected OL3 control rooms' and control room activities' readiness for the launch of operations of the nuclear power plant. The scope of the inspection included the OL3 unit's entire control room entity, including the monitoring and control user interfaces in the control room, the instructions applied by the control room operators and the procedures and practices applied in the control room. As a positive finding, STUK observed that TVO has clearly assumed the lead in operating the OL3 nuclear plant. TVO's shift supervisor manages control room operations while the line management has ownership of the plant's operations. The plant supplier's and TVO's responsibilities for the running of the plant are clearly defined and the division of responsibilities is observed. Progress was detected in the control room's preparedness to achieve fuel loading readiness, but matters had not yet progressed to such level to allow fuel loading readiness to be established. STUK will verify open issues and the plant's fuel loading readiness before fuel loading.

APPENDIX 5

Inspections pertaining to the processing of Fennovoima's construction licence application 2020

STUK inspects and assesses the management systems of Fennovoima and the other organisations participating in the project. Furthermore, STUK performs inspections of the organisations to ensure that their actual operations comply with what is specified in the management systems and that they meet the necessary requirements. STUK launched the inspections included in the regulatory inspection programme (RKT) in September 2015. The inspections are planned every six months, and in 2020, STUK carried out eight inspections according to its inspection programme.

There was no need to postpone or cancel the processing of matters due to the COVID-19 pandemic, as all 2020 inspections were carried out remotely. With regard to the transition to remote inspections and based on the experiences from the first remote inspections, STUK made some changes to the detailed implementation and running of the inspections. The results of the inspections will be used by STUK when preparing a safety assessment and statement on the construction licence.

Summaries of the inspections performed in 2020 are presented below.

Fennovoima, I&C technology

The I&C technology inspection in April was the first RKT inspection carried out by STUK as a remote inspection.

During the inspection, STUK stated that Fennovoima's I&C technology operates in accordance with the instructions and procedures of Fennovoima's management system and the current I&C specific instructions and checklists are sufficient, taking into account the current stage of the I&C design. Fennovoima must complete the work it has started to draw up instructions and lists, inspect the actual I&C data and monitor the I&C lifecycle.

RAOS Project Oy, inspection procedures and safety assessment

STUK carried out its first international remote inspection to RAOS Project Oy. Plant supplier's and main designer's experts from Helsinki, St. Petersburg and Moscow participated in the inspection remotely. STUK observed some positive developments in the plant supplier's internal information portal, in the management of interfaces between different areas and in document management. Three old requirements were closed during the inspection and two new requirements opened.

One of the new requirements is a specification to a previous requirement on configuration management that was closed in the same inspection. STUK requires that construction licence application materials submitted for construction licence application material inspection and safety assessment must be based on the same frozen baseline configuration.

The other new requirement relates to the organisation of the plant supplier. RAOS Project Oy must assess the maturity of RAOS organisation, management system and project management to ensure that the roles and interactions of project organisations are defined and clearly communicated both in RAOS organisation and in Hanhikivi 1 project. Furthermore, RAOS has to assess its process and organisational structures, the roles of various organisations and its human resources and competence needs for future project phases. The assessments must take into account the project's long-term plans and the experiences gained thus far. STUK stressed that RAOS should actively develop its long-term project plans, taking into account all coming project phases. Based on these assessments, RAOS must develop a plan for possible corrective measures. Fennovoima must assess the assessment made by RAOS and the plan for corrective measures.

Fennovoima: Leadership, personnel and competence, and handling of safety matters

The inspection focused on the management of Fennovoima (FV) and the organisation of its operations as well as the procedures in the handling of safety matters. The inspection covered the consequences of the extensive organisational change carried out at Fennovoima in 2019, as well as management and organisational measures for identifying, monitoring and processing safety matters. The status of open matters in selected previous inspections was verified during the inspection. The inspection was carried out using remote connections.

In connection with the above-mentioned organisational change and the subsequent development of various processes (including control and core processes), STUK estimates that Fennovoima has assumed more leadership in safety-related matters of the project. At the same time, it was discovered that FV's process development is still under way. STUK stated that the processes are part of perceiving the overall picture of the organisation's activities, and the operational status can be assessed and developed from the starting points formed by the existing processes. FV stated that process development is one way of perceiving FV's internal dialogue and communication. STUK will monitor Fennovoima's process development during autumn 2020 RKT inspections.

The role of FV's new Oversight function was also discussed during the inspection. In order to monitor the development of the Oversight function, thematic monitoring meetings have been arranged with FV in autumn 2020.

No new requirements were presented based on the inspection. One previous requirement concerning the assessment of the plant supplier's preliminary safety analysis report preparation project (PLP) was closed during the inspection. Fennovoima had carried out the required assessment and stated it was useful in the inspection. The previous requirement concerning the plant's uniform identification system was handled during the inspection, but remained open. During the inspection, it was observed that some progress had been made in the procedures for the identification system. The unambiguous identification system must be

in use and its instructions must be provided to STUK so that they are available in connection with the processing of system descriptions.

Fennovoima, Nuclear material, Safeguards

The inspection focused on Fennovoima's nuclear safeguards system and Fennovoima's plans for arranging the necessary safeguards to prevent the proliferation of nuclear weapons. Fennovoima's plans and procedures to comply with the requirements set in legislation, the YVL Guides and EU regulations were assessed during the inspection.

The audit focused on the nuclear safeguards system and the processes related to the application for nuclear material licences and licensing conditions. Requirements related to the updating and reporting of the safeguards manual and the approval of the deputy for the responsible manager for nuclear material safeguards were issued during the inspection. During the inspection, a requirement was also issued stating that Fennovoima must draw up procedure for organising access rights to international inspectors.

Fennovoima, Electrical technology

The inspection focused on the safety issues of Fennovoima's electrical and emergency power systems. The inspection focused on the control and monitoring carried out by Fennovoima regarding chapter PSAR 8 of the preliminary safety evaluation. The general situation of Fennovoima's electrical technology and Fennovoima's control and monitoring of the design and construction licence application material were reviewed during the inspection. The inspection also focused on the control and monitoring activities of Fennovoima's emergency power supply equipment's design and construction licence application.

Based on the inspection, STUK issued two new requirements, one focused on Fennovoima's quality plans and the other on the evaluation of the conformity of the construction licence application and design material. The previous requirement concerning the emergency power supply equipment's RKT inspection was closed.

Titan-2

During the inspection, main contractor Titan-2's management and operations in St. Petersburg, Pyhäjoki and Helsinki were evaluated. This was a follow-up inspection, reviewing the status of requirements selected during the previous inspection and verifying with examples the operation of various project and design management processes. The inspection and the related preliminary tasks and interviews were carried out remotely. With the exception of the requirement to utilise previous construction related operating experiences, all of the previous requirements could be closed based on the inspection. New requirements were opened on submitting clarifications and interpretations of the requirements of the nuclear safety regulations to Titan-2 and incorporating experiences gained from the construction of other nuclear power plants into the training programme.

Fennovoima, Inspection procedures

The inspection focused on Fennovoima's inspection procedures. The inspection included human factors engineering (HFE), deterministic safety analyses, probabilistic risk analysis

(PRA) and compliance and technical configuration management. The status of open matters in selected previous inspections was reviewed during the inspection.

Based on the open requirements for the management of the requirements and technical configuration reviewed during the inspection and the discussions, one of the main conclusions was that the main designer's plant design process does not create continuous trust from the perspective of quality production. This is reflected, among other things, in the small number of phase reviews related to design. The first phase review is carried out in stage 1 of submitting the preliminary safety analysis report, once all of the construction licence application material has been produced. As this is only one stage, it carries a very high workload and no quality management component evaluations are carried out during this stage via review procedure. In practice, quality is verified from the finished design documentation and through audits.

STUK's inspection team reminded that according to requirement 311 of YVL Guide B.1, a nuclear power plant and the systems important to safety shall be designed by using design processes and methods appropriate for the required level of quality, and by applying the relevant safety regulations, guidelines and standards. The standards applied as well as the suitability and coverage of the components shall be substantiated.

One aspect of the inspection was Fennovoima's inspection procedures to ensure human factors engineering. STUK's inspection concluded that the human factors engineering (HFE) carried out by the plant supplier in the plant design does not meet the Finnish standard. Based on the inspection, Fennovoima's own design review procedure is also not adequate to provide sufficient assurance on human factors engineering during the construction licence application phase and to compensate for the shortcomings observed in the plant supplier's HFE operations. However, STUK did not present any new requirements in this regard during the inspection, as there are open requirements related to HFE operations in other contexts (such as the review of the draft safety report), which also cover the deficiencies identified during the inspection.

Fennovoima: Leadership and management system

The inspection covered Fennovoima's management system, as well as its evaluation and development, for example, from the point of view of the comprehensive implementation of safety functions and taking into account the safety significance of the functions. The inspection covered the management of deviations from both Fennovoima's operation and project implementation perspectives. In addition, Fennovoima's rewarding principles and reviews related to plant design were reviewed.

STUK observed that Fennovoima's management system is starting to form a logical entity. The way Fennovoima assesses its construction readiness and, as a part of this, the conformity of its management system, has not yet been clearly understood, and a requirement was issued on this matter during the inspection. Based on the inspection, two other requirements were also issued concerning the slow progress of Fennovoima's own monitoring, i.e. the slow progress of the definition of the Oversight function, and the lack of a uniform view on the deviation management procedure.

APPENDIX 6
Construction inspection programme for the encapsulation plant and the disposal facility 2020

In 2020, licensing and construction oversight project PORA regarding Posiva's spent fuel disposal project systematically continued the inspections included in the construction inspection programme (CIP). The aim of these inspections was to assess the functionality of Posiva's management system as well as the sufficiency and appropriateness of the procedures for implementing and controlling the plant construction work and for taking the safety requirements into account in the project. Inspections included in the programme may also be targeted at Posiva's suppliers that are important to safety. The 2020 inspections only focused on the licensee's operations.

The 2020 programme included six inspections on current activities important to the safety of the construction phase. The number of inspections remained at the level of the previous year. No significant changes have taken place in Posiva's operations, and for this reason, STUK decided to focus its 2020 inspections on the assessment of Posiva's basic operations. Based on the results of STUK's inspection, it was noted that Posiva's operations and management system procedures in the assessed areas of operation are sufficiently compliant with STUK's requirements.

Brief descriptions of the inspections as well as the key observations made, based on which STUK has required Posiva to carry out improvements and development actions, are presented below. The inspections assessed Posiva's nuclear facilities' commissioning and preparing for production, monitoring programme, safety arrangements, design activities, procurement and product control, as well as nuclear material safeguards.

Commissioning and preparing for production

The commissioning and preparing for production inspection covered Posiva's plans and measures related to preparing for production and commissioning. The inspection paid particular attention to schedules, guidelines, organisational matters, resources and training. The inspection also covered ageing management plans for the operating phase as well as radiation protection arrangements. Posiva has started the planning of activities related to preparing for production and commissioning, and these are sufficient in relation to the project stage. On the basis of the inspection, STUK presented no requirements. The development of matters covered during the inspection will be monitored during coming inspections.

Olkiluoto monitoring programme

The inspection of the Olkiluoto monitoring programme covered the updating of the monitoring programme for 2020–2021, the design of the monitoring of technical barriers and the management and control of the safety-classified materials used by Posiva. In these respects, the inspection concluded that the development of limits and requirements is ongoing and that the work aims at defining unambiguous limits for the operating phase.

In the monitoring of technical barriers, the inspection focused on the monitoring strategy and human resources. Based on the inspection, it was concluded that the requirement of Section 33 of Regulation STUK Y/4/2018 for the operating phase research and monitoring programme to ensure the functional capacity of barriers is met, but the operating phase activities must be further developed.

For the part of the safety-classified materials, the review covered the use of alternative safety-classified materials as well as guidelines on approval procedures and criteria. As regards the use of alternative materials, Posiva was required to update the guidelines so that alternative, less harmful materials must be sought regularly in connection with construction activities. Posiva was also required to update the guideline on the approval procedures and criteria of materials.

Security arrangements and information security of Posiva's nuclear facilities

The construction inspection programme (CIP) inspection focused on Posiva's physical protection and information security, especially for the part of the encapsulation plant. The fencing arrangements of the disposal facility were also inspected. Two requirements were presented in the inspection and three observations were made. In accordance with the Framework Contract, Posiva relies heavily on TVO's arrangements on the administrative, technical and physical implementation of security arrangements, and the procedures are largely the same. This yields clear synergy benefits, but also poses certain challenges. From the perspective of security arrangements, Posiva's situation is at an acceptable level in terms of the licence and construction phase.

Design activities

The CIP inspection focusing on design activities covered the integration of the HFE programme into design, the integration of failure tolerance analyses and other analyses into design processes, as well as the adequacy of Posiva's available human resources and resource planning with regard to design activities.

Based on the inspection, STUK presented two requirements related to the HFE programme. These requirements were related to the fact that Posiva started planning and implementing the HFE programme at a late stage, so it cannot be considered to be carried out in a timely manner. In addition, Posiva has yet to plan at a sufficient level of detail how the effectiveness of the HFE programme can be ensured now that all other design activities are well advanced and only the first stages of HFE planning (design and analysis) are underway.

In the part of the inspection concerning analyses, it was discovered that Posiva has not described the procedure for ensuring that the results of analyses are taken into account in the design. STUK presented one requirement related to this issue.

During the inspection, it was established that Posiva's resource planning is sufficiently planned and systematic. Resource planning procedures and effectiveness have improved from what they were a few years ago.

Management system: Procurement and product control

The CIP inspection on procurement and product control investigated how Posiva's procurement and product control procedures comply with the requirements of the YVL Guides and verified how Posiva has observed the procedures in its operations. In the cases reviewed during the inspection, deficiencies were found in the assignment's definition of duties, design work guidance and product control. It was verified that in the procurement of the handling cell liners, the requirements of the YVL Guides were sufficiently fulfilled in view of procurement and product control. Posiva had initiated corrective measures to improve activities for the part of deficiencies discovered, so no requirements were presented during the inspection.

Safeguards arrangements at Posiva's nuclear facilities

The nuclear safeguards inspection focused on Posiva's nuclear material accounting and database software developed for accounting purposes. The inspection covered activities related to the production and processing of accounting records required for nuclear safeguards in view of the current situation and future development. Based on the inspection, Posiva's activities do not currently differ from the Nuclear Safety Code. The presented requirements concern future activities. One good practice was also recorded during the inspection.

APPENDIX 7
Licences STUK has granted in accordance with the Nuclear Energy Act in 2020

Teollisuuden Voima Oy

- 1/C42214/2020, 20 March 2020: Import of a dummy fuel element from the USA. Last date of validity 31 December 2021.
- 2/C42214/2020, 26 March 2020: OL1/OL2 – Import of rotors from Germany. Last date of validity 31 December 2022.
- 3/C42214/2020, 30 March 2020: OL1/OL2 – Import of SIRM protective tubes from Germany and Sweden. Last date of validity 31 December 2038.
- 1/G42214/2020, 29 September 2020: OL3 – Transfer of country of origin restricted (Russia) data set on fuel. Last date of validity 31/12/2025.
- 1/D42214/2020, 29 September 2020: OL2 e 39 "S" Import of fuel assemblies 31287 and 31288 that had been repaired Last date of validity 31 December 2021.
- 2/D42214/2020, 1 October 2020: Import of fresh nuclear fuel with Euratom obligation code "C" from Sweden (OL2 e 41 "C"). Last date of validity 31 December 2021.
- 3/D42214/2020, 14 September 2020: Import of fresh nuclear fuel with Euratom obligation code "P" from Sweden (OL2 e 41 "P"). Last date of validity 31 December 2021.
- 5/C42214/2020, 29 September 2020: Import of fresh nuclear fuel with Euratom obligation code "T" from Spain (batch OL1 e 43 "T"). Last date of validity 31 December 2021.
- 2/G42214/2020, 2 October 2020: Import of fresh nuclear fuel with Euratom obligation code "P" from Germany (batch OL3 e 02 "P"). Last date of validity 31 December 2021.
- 6/C42214/2020, 4 November 2020: OL1/OL2 – Import of fuel channels from Sweden or the United States. Last date of validity 31 December 2030.
- 7/C42214/2020, 30 October 2020: Import of a dummy fuel element from Spain (amendment to import licence 1/C42214/2020). Last date of validity 31 December 2021.
- 3/G42214/2020, 5 November 2020: Import of fresh nuclear fuel with Euratom obligation code "P" from Germany (batch OL3 e 02 "P"). Replaces import licence 2/G42214/2020. Last date of validity 31 December 2021.

Fortum Power and Heat Oy

- 2/A42214/2020, 15 May 2020: Import of in-core neutron flux sensors from Canada. Last date of validity 30 June 2021.
- 5/A42214/2020, 20 October 2020: Export of nuclear waste samples to Denmark. Last date of validity 31 December 2022.
- 7/Y42214/2020, 2 October 2020: Possession and transfer of country of origin restricted (Russia) data sets regarding OL3 fuel. Last date of validity 31 December 2025.

Posiva Oy

- 1/H42214/2020, 12 February 2020: Import of fuel element models and fuel channels from Sweden. Last date of validity 31 December 2020

Fennovoima Ltd

- 1/J42214/2020, 4 September 2020: Transfer of country of origin restricted (Russia) data sets. Last date of validity 31 December 2023.
- 2/J42214/2020, 4 September 2020: Amendment to an import and possession licence 2/J42214/2018 on country of origin restricted (Russia) data sets. Last date of validity 31/12/2028.

VTT

- 1/F42214/2020, 16 December 2020: Export of the spent nuclear fuel from the FiR 1 research reactor. Last date of validity 30 June 2022.
- 2/F46201/2020, 19 May 2020: Transport of spent nuclear fuel. Last date of validity 30 April 2025.

Others

- 1/Y42214/2020, 6 February 2020: Joint Stock Company Concern Titan-2 import, possession and transfer of country of origin restricted (Russia) data set. Last date of validity 31 December 2028.
- 1/Y46201/2020, 18 March 2020: Studsvik Nuclear AB, transport of fresh nuclear fuel through Finnish territory from Russia to Sweden. Last date of validity 31 December 2024
- 6/Y42214/2020, 22 October 2020: RAOS Oy, import, possession and transfer of country of origin restricted (Russia) data sets, extension to licence 6/Y42214/2019. Last date of validity 31 December 2023.

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