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Erja Kainulainen (ed.)

Regulatory oversight of nuclear safety in Finland

Annual report 2018

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Introduction

This report constitutes the report on regulatory oversight in the field of nuclear energy which the Radiation and Nuclear Safety Authority (STUK) is required to submit once a year to the Ministry of Economic Affairs and Employment pursuant to section 121 of the Nuclear Energy Decree. The report is also delivered to the Ministry of Social Affairs and Health, the Ministry of the Environment, the Finnish Environment Institute, and the regional environmental authorities of the localities in which nuclear facilities are located.

The report is a compilation of the regulatory oversight of nuclear safety performed by STUK and its results in 2018. The regulatory oversight concerned the engineering, construction and operation of nuclear facilities, planning for their decommissioning, nuclear waste management and nuclear safeguards.

In addition to safety oversight, the report discusses other subjects including the development and implementation of the nuclear energy regulatory framework as well as the main features of safety research programmes regarding nuclear safety and nuclear waste management in Finland.

Significant events at the nuclear facilities as well as summaries of the inspections carried out by STUK have been compiled in the appendices to the report. Furthermore, the report includes the summary of the licenses granted by STUK pursuant to the Nuclear Energy Act in 2018 as required by the Nuclear Energy Decree.

STUK's Financial Statements and Annual Report for 2018 also includes an assessment of the attainment of performance targets set out in the performance agreement between the Ministry of Social Affairs and Health and STUK for the regulatory oversight of nuclear energy.

Contents

1 Development and implementation of legislation and regulations

Amendments to the Nuclear Energy Act and the Nuclear Energy Decree

At the beginning of 2018, the amendment (905/2017) to the Nuclear Energy Act (990/1987) entered into force to implement the supplement of the Nuclear Safety Directive (2014/87/Euratom). It also supplemented the implementation of the Directive of the Safe Management of Spent Fuel and Radioactive Waste (2011/70/Euratom) due to the additional questions by the Commission. The changes caused by the directives concerned the transparency of operations, the licensee's obligation to provide information and responsibility for subcontractors, the involvement of the general public in the decision-making process concerning nuclear facility licensing, and international peer reviews. At the same time, updates were made to the Act's provisions on pressure equipment due to the new Pressure Equipment Act (1144/2016) that entered into force at the beginning of 2017. In addition, the decommissioning licence was added to the act as a new licencing phase for nuclear facilities, and changes were made regarding waste management.

The preparation for the changes to legislation concerning security arrangements started in conjunction with the preparation for the Act amendment that entered into force in the beginning of 2018. Based on the feedback received during the circulation for comments, the Ministry of Economic Affairs and Employment and the Radiation and Nuclear Safety Authority continued preparing the bill separately. The amendment proposal concerns, among other things, the authority of security personnel and the temporal dimension of the use of security personnel. Provisions on health examinations for security and control room personnel and the right to report of the doctor or other medical professional in relation to the health examinations are proposed to be added to the act as completely new items. New items also include rules of jurisdiction concerning defence against drones and unmanned aerial vehicles at nuclear power plant sites. The purpose of the proposals is to improve the safety of the use of nuclear energy. The Ministry of Economic Affairs and Employment submitted the government bill for amending the act for circulation for comments on 15 November 2018 and requested statements by mid-January 2019.

Due to the amendments made to the Nuclear Energy Act provisions specifying the licencing procedure regarding decommissioning and the oversight by the Radiation and Nuclear Safety Authority were added to the Nuclear Energy Decree (161/1988). Provisions regarding the minimum contents of the national nuclear waste management programme were also added to the decree. Due to the entry into force of the new Act on Environmental Impact Assessment Procedure (252/2017) the references to the environmental impact assessment procedure were updated, and the provisions regarding the phases of and documents related to the procedure were amended for compliance with the new act. The amendment (1001/2017) of Nuclear Energy Decree entered into force on 1 January 2018.

Reform of the radiation legislation and its impact on nuclear energy regulations

On 15 December 2018, the new Radiation Act (859/2018), the Government Decree on ionising radiation (1034/2018), the Decree of the Ministry of Social Affairs and Health on ionising radiation (1044/2018) and the Decree of the Ministry of Social Affairs and Health on limiting public exposure to non-ionising

radiation (1045/2018) entered into force. The new radiation legislation implemented the EU radiation safety directive (BSS, 2013/59/Euratom). The requirements of the BSS directive concerning the use of nuclear energy were implemented through the amendment to the Nuclear Energy Act (862/2018), which entered into force on 15 December 2018 as an annexed act to the Radiation Act. The new Section 2a on the application of the Radiation Act to the use of nuclear energy was added to the Nuclear Energy Act. New sections on the exemption of radioactive waste from regulatory control, clearance levels and dilution prohibition of nuclear waste were also added to the act.

When the radiation legislation was reformed, not only contents but also statutory levels were checked to ensure that they are in line with the requirements of the Constitution. In practice, this means that requirements that were previously included in radiation safety instructions (ST Guides) and decisions issued by the Radiation and Nuclear Safety Authority are now presented as binding provisions in acts, decrees and STUK Regulations issued by virtue of the Radiation Act.

The first regulations issued by virtue of the Radiation Act by the end of December 2018 concern work-related radiation exposure, radiation safety deviations, security arrangements for radiation sources and ionising radiation measurements relating to work-related exposure, public exposure and medical exposure. The regulations on radiation safety deviations and security arrangements for radiation sources are not applied to the use of nuclear energy referred to in the Nuclear Energy Act (990/1987).

By virtue of the Radiation Act and the Nuclear Energy Act, STUK also issued on 15 December a new common regulation on the exemption values for radioactive substances and the clearance levels of radioactive materials. However, the clearance values are not applied to the use of nuclear energy.

Update of STUK regulations issued by virtue of the Radiation Act

The Radiation and Nuclear Safety Authority issues more detailed binding regulations to the operators regarding the technical details of the general safety objectives of nuclear facilities prescribed in Chapter 2 a of the Nuclear Energy Act (990/1987) in compliance with Section 7 q of the act. The first five regulations by STUK concerning the safety of nuclear facilities were issued at the beginning of 2016. Until then, these regulations had been issued as government decrees.

As a result of the reform of the radiation legislation and the amendments to the Nuclear Energy Act, STUK updated its Regulations on the Safety of a Nuclear Power Plant, the Emergency Arrangements of a Nuclear Power Plant and the Safety of Disposal of Nuclear Waste, and they entered into force on 15 December 2018. The Regulations on the Security in the Use of Nuclear Energy (STUK Y/3/2016) and the Safety of Mining and Milling Operations Aimed at Producing Uranium or Thorium (STUK Y/5/2016) remain unchanged and are valid as such.

In update of the Regulations on the Safety of a Nuclear Power Plant (STUK Y/1/2018) and the Safety of Disposal of Nuclear Waste (STUK Y/4/2018) the requirements on the monitoring of releases and radiation doses of nuclear facility workers and the public in the vicinity were expanded due to the new Radiation Act requirements originating from BSS directive. Changes to the regulations were also required because the decommissioning of nuclear facilities had been added to the Nuclear Energy Act as a new licence phase. At the same time, the scopes of application of the regulations were specified and some individual requirements were clarified. The additions to the Regulation on the Emergency Arrangements of a Nuclear Power Plant (STUK Y/2/2018) concern emergency workers and helpers in an emergency defined in the Radiation Act and the consideration of the people in these groups in emergency response arrangements and orientation. There are only minor changes caused directly by the directives because they have been considered previously. In connection with the implementation of the supplement of the Nuclear Safety Directive, STUK added to the Regulation on the Emergency Arrangements of a Nuclear Power Plant the obligation of the licensee to prepare for receiving external assistance in an emergency situation.

Update of YVL Guides

The YVL Guides are also updated as part of the update of the nuclear safety regulations. There are currently 44 YVL Guides, most of which were published in 2013. The YVL Guide update work began in 2017, and most of the updated guides will be published in early 2019. The updated Guide YVL D.5 "Disposal of nuclear waste" and the completely new Guide YVL D.7 "Release barriers of spent nuclear fuel disposal facility" were published in spring 2018. Two new YVL Guides are being prepared (YVL D.6 "Producing uranium and thorium in mining and milling operations" and YVL E.13 "Ventilation and air-conditioning equipment of a nuclear facility").

The guide drafts are sent for comments and statements internally within STUK, outside STUK and to the Advisory Commission on Nuclear Safety. In addition, the drafts are published on STUK's website for feedback from the general public. In 2018, a total of 24 YVL Guides were sent for comments and statements, which means that almost all YVL Guides have been circulated for statements. The remaining guides (five updated and two new guides) will be sent for statements in 2019. The changes made to the YVL Guides during the update are mostly clarifications, changes to references to regulations and legislation and minor changes to requirements. The feedback received from licensees during the implementation of YVL Guides was taken into account in the update. A special objective in the YVL Guide update was the reduction of administrative burden. STUK has processed approximately 5,000 proposed changes so far, over 60 per cent of which have been approved for implementation in this revision round.

Last year, more than 100 people at STUK participated in the regulation and YVL Guide update project, using approximately five person-years.

2 Results of regulatory oversight of nuclear facilities in 2018

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 plant's activities were safe to the employees, the population and the environment.

In 2018, a considerable number of different modifications were made at the plant. Most of STUK's regulatory activities concerned these modifications. As regards the safety and continued operation of the plant, the most significant of these were the modernisation of the safety I&C systems and the related modernisation of secondary circuit safety functions, which were successfully completed during the 2018 annual outages.

The descriptions of the annual outages and the most significant events are presented in more detail 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 2018 was 0.27 manSv at Loviisa 1 and 0.97 manSv at Loviisa 2. Most of this accumulated from work completed during the annual outage of the plant (0.24 manSv at Loviisa 1 and 0.95 manSv at Loviisa 2).

Fortum has continued work to reduce the doses at the Loviisa power plant. This involves the further development of work methods and systems and the minimisation of parts containing highly activated substances in accordance with the ALARA principle. During the 2018 annual outages, the silver bursting discs of the cleaning system safety valves in the primary circuit outlet system were replaced with steel discs, which reduces the amount of silver in the primary circuit. This change had been planned for a long time. The improvements of reactor water cleaning circulation were postponed until 2019.

Highly activated elements include nickel, cobalt, silver and antimony, the activation products of which (^{58}Co, ^{60}Co, ^{110m}Ag and ^{124}Sb) may raise radiation levels at the facility. According to the ALARA principle, the use of these elements must be avoided, when possible, in locations where activation may occur or the elements may be released into the reactor coolant circuit. These locations include structural materials, welds and seals of the reactor circuit.

According to the Government Decree on ionising radiation (1034/2018) that entered into force in December 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 individual dose received at the Loviisa power plant was 12.5 mSv, mainly caused by primary circuit heat insulation work during the annual outage.

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 460 samples were collected and analysed from the land and marine environment surrounding the Loviisa power plant in 2018. 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.

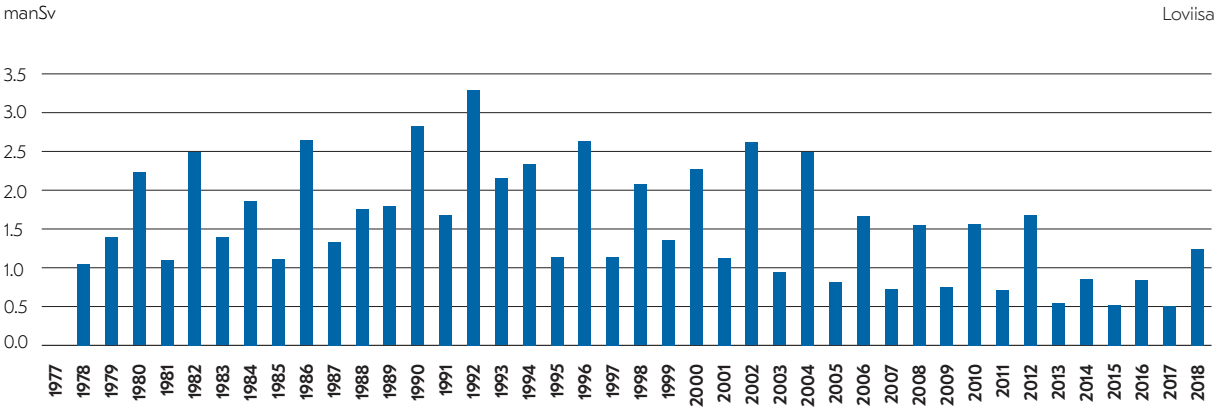

FIGURE 1. Collective occupational doses since the start of operation of the Loviisa nuclear power plant.

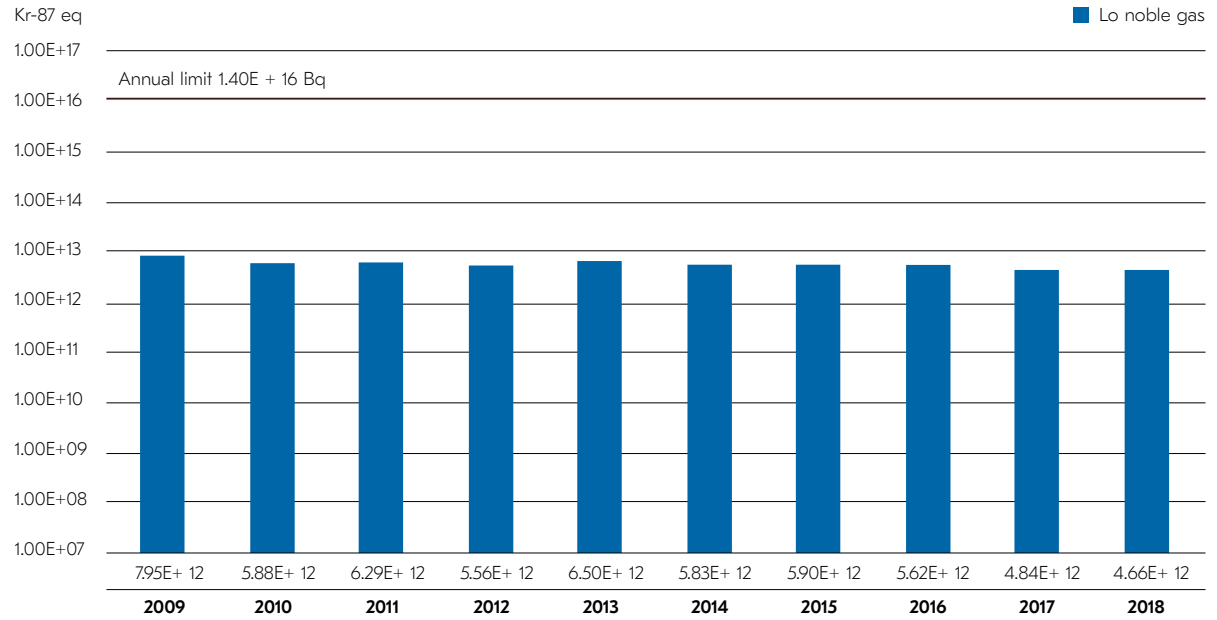

FIGURE 2. Noble gas releases to the atmosphere (Kr-87 eq), Loviisa.

Operational events and operating experience feedback

Fortum reported the results of 18 event analyses and investigations to STUK in 2018. As a conclusion, STUK can state that Fortum identifies events at the Loviisa power plant and initiates event investigations to determine the causes and to improve the plant and the operation. All separate event analyses and investigations concerned individual events. The events revealed areas for improvement in procedures and activities. Fortum decided to further investigate the deviations in the management of preventive maintenance required by the Operational Limits and Conditions as a whole in order to be able to focus actions better. The work will be completed during the first half of 2019.

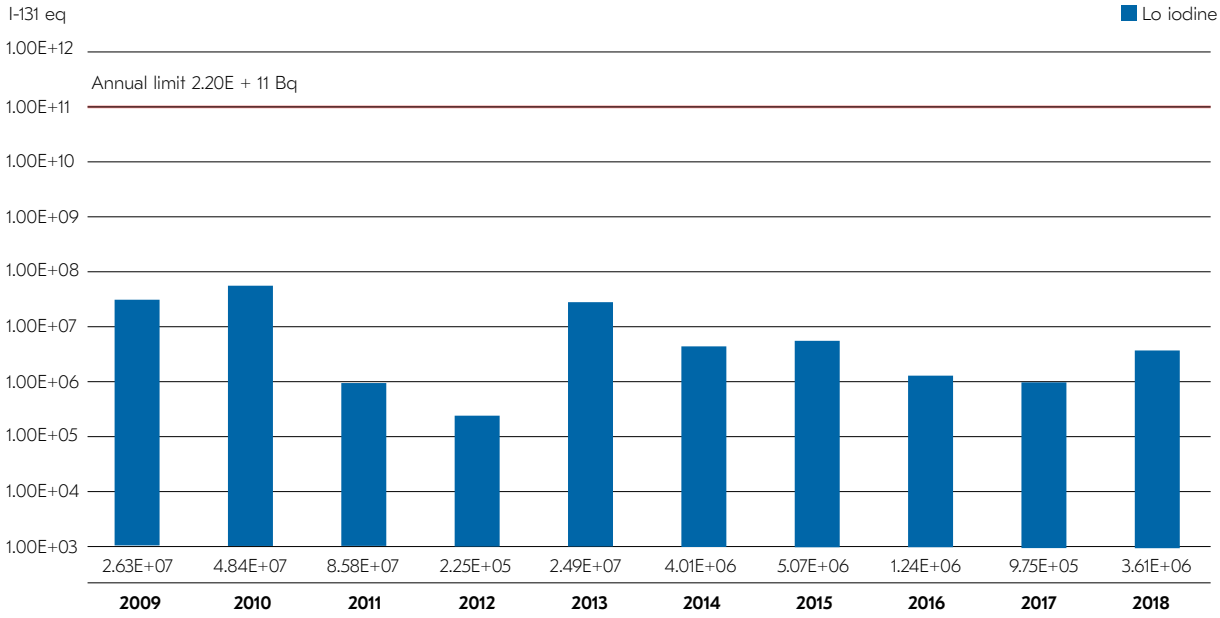

FIGURE 3. Iodine isotope releases to the atmosphere (I-131 eq), Loviisa.

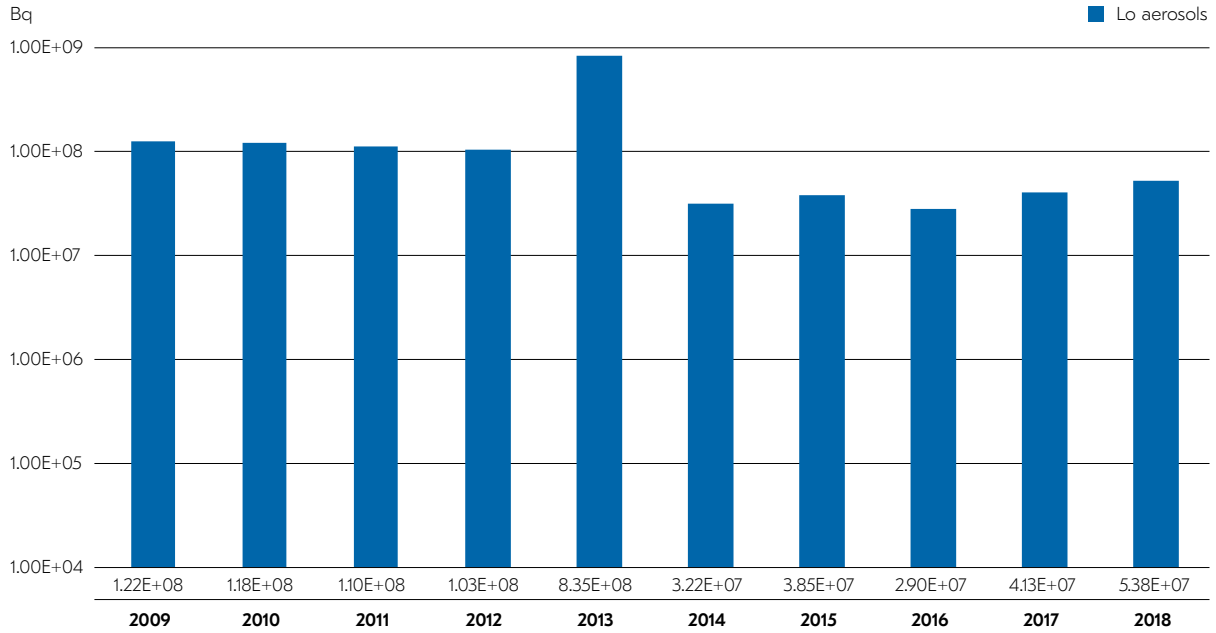

FIGURE 4. Aerosol releases to the atmosphere (Bq), Loviisa.

By reviewing the results of the event analyses and investigations, STUK verified that Fortum had investigated the underlying causes of the events and initiated the necessary actions to correct technical faults and deficiencies in its operations and prevent reoccurrence of the events. STUK considered most of Fortum's event investigations sufficient. In one case, STUK requested Fortum to further investigate the underlying causes of an event and to assess the measures taken.
STUK utilises individual events and event groups in forming an idea of the state of different controlled areas and regulation projects and targeting inspections performed at the plant. When the events were analysed as a whole, it emerged that several events in 2018 were related to topics where deficiencies were found in previous years as well.
STUK inspected the effects of event investigations in 2018 because deviations relating to the same area had recurred. Fortum has not comprehensively analysed the reasons for the recurrence although problems have been clarified and corrected through event investigations. Based on the inspection, STUK required that Fortum improve learning from operating experience. STUK has intensified regulatory oversight with regard to this topic and will continue it in 2019.

Annual outages and maintenance operations

The annual outages of the plant units were implemented as planned in terms of nuclear and radiation safety. In addition to refuelling and modifications, a large number of maintenance measures and inspections are carried out during each annual outage to ensure the safe and reliable operation of the power plant.

The most significant modification carried out during the extensive annual outages in 2018 was the last phase of the I&C reform, which included the key section related to safety I&C. Associated with the I&C reform, the modernisation of secondary circuit safety functions was also completed. The annual outage inspections were carried out on schedule and in the planned scope. Reactor pressure vessel emergency water nozzles were inspected in 2018 at both plant units because an indication was found in 2016 at Loviisa 1 in one of these nozzles (see Annual report 2017, STUK-B 225). No deviating indications were observed in the inspection.

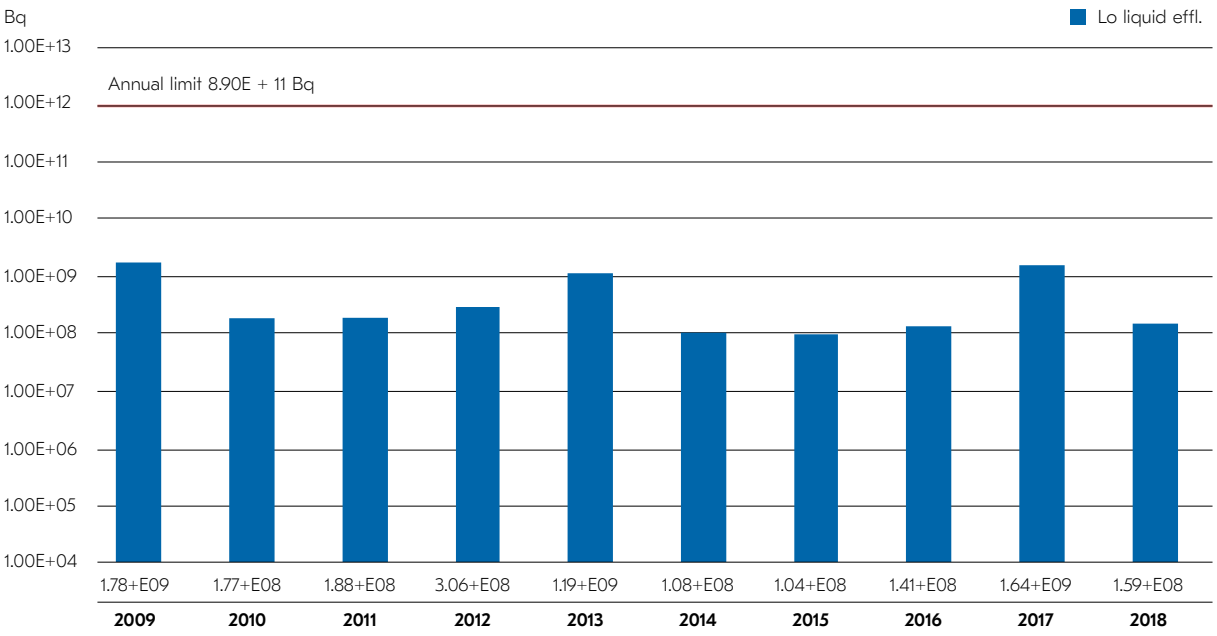

FIGURE 5. Gamma activity of the liquid effluents (Bq), Loviisa.

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. Early in the summer, STUK carried out a periodic inspection concerning the operational waste activities, in which personnel planning, radiation doses to the personnel, the condition of the waste management, storage and disposal facilities and the radiation levels and classifications of premises were reviewed. No major deficiencies were found in the inspection. The inspection summary is provided in Appendix 3.

In 2014, Fortum observed corrosion damage in the outer surface of the concrete trough in the solidified waste storage (KJT) of the final disposal facility for low and intermediate level waste. The renovation project of the concrete trough, including the removal of aluminium nails that pose a corrosion risk from the trough structures and the maintenance of the surrounding rock surfaces, was completed in summer 2018. After this, Fortum has observed other problems in the concrete structures, the investigation of which is still incomplete. Concrete waste packages can be placed in interim storage in accordance with STUK's permission in the maintenance waste space acting as the disposal repository for low level waste (HJT3) until the end of 2021, before which the KJT trough is intended to be taken into use.

Fortum submitted the updated decommissioning plan for the Loviisa nuclear power plant and the safety case for the disposal repository to STUK for assessment at the end of 2018. STUK will inspect the submitted documents during 2019.

Nuclear safeguards

The Radiation and Nuclear Safety Authority granted Fortum two licences concerning nuclear commodities (Appendix 8).

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 2018, a total of 10 nuclear safeguards inspections were conducted at the Loviisa power plant. STUK performed an inspection pertaining to the physical inventory verification of nuclear materials together with the IAEA and the European Commission both before and after the annual outages. Furthermore, STUK inspected the locations of the fuel assemblies in the reactors of Loviisa 1 and Loviisa 2 prior to the closing of the reactor missile shields. The IAEA and the Commission carried out two inspections 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 2018.

Nuclear security

The state of the security arrangements at the Loviisa power plant is good. In 2018, STUK performed one periodic inspection of security arrangements, which concerned both physical security arrangements and information security. No requirements were set in the inspection. The inspection summary is provided in Appendix 3.

The oversight indicated that the level of security arrangements has remained in compliance with the requirements of the YVL Guides and the arrangements have been purposefully developed: for example, the security arrangements of the control rooms of the plant have been improved.

Fire safety

Fire safety at the Loviisa power plant is at a good level. In 2018, 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.

Following the fires in high-rise buildings, e.g. in Great Britain and Dubai, STUK studied the insulation materials and other materials used in the façades, ceilings and roofs of the Loviisa power plant which could potentially spread fire, as well as the way in which the fire safety of façades has been ensured. Fortum provided a clarification of the matter, which did not identify any new fire risk items. In some nuclear power plant buildings, wooden ribs are used in the façades, but it can be considered highly unlikely for them to catch fire. There is always a reinforced concrete wall between wood and process facilities. There are combustible materials in the ceiling structures as well. Ceiling fires have been sufficiently prepared for by means of operative fire-fighting preparedness and hot work instructions, for example.

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 projects is the I&C reform of the Loviisa plant. In its first phase, the control and indication system of preventive safety functions and the I&C status monitoring system were renewed for both plant units in the 2016 annual outage. The second phase covering manual back-up and the extension of monitoring system was installed during the 2017 annual outage. The element concerning safety I&C was installed during the 2018 annual outages. The last work tasks in the modernisation of secondary circuit safety functions, associated with the I&C reform, were completed at the same time, which means that the control of the most important safety functions of the plant has now been completely modernised.

Fortum started the pre-installation work for the new polar cranes of the reactor halls of the Loviisa power plant at the end of 2017 at Loviisa 2. The installation and commissioning at Loviisa 2 were completed in April 2018. Based on the experiences, Fortum decided to delay the installation at Loviisa 1 until after the annual outages in order to ensure the fluent implementation of the work. As a part of the periodic inspection during the annual outage, STUK followed the hoisting and transfer functions at both plant units to ensure the effectiveness of corrective actions performed based on events relating to fuel handling and the use of polar cranes in the changing situation (see Appendix 3). At Loviisa 1, the pre-installation of the polar crane started in December, and Fortum aims to install and commission the crane during spring 2019.

During the annual outages, Fortum replaced three high pressure safety injection pump motors and motor heat exchangers at Loviisa 2. The installations started during the 2016 annual outages, and the last motor is intended to be installed in 2020 at Loviisa 1. The pumps are important to safety, and this action ensures their operability and the availability of spare parts in the future.

The modifications started after the assessments done due to the Fukushima accident were continued in 2018. Flood protection installations and independent power supply connections for the emergency outage cooling system were made during the annual outage and at the end of 2018. The change of procedures will continue until spring 2019. Started in 2017, the installation of an additional system for ensuring the cooling of fuel pools and spent fuel storage pools under highly exceptional conditions was completed with regard to mechanical parts in the 2018 annual outage, but the installation and final commissioning of the system I&C were moved to 2019. The move was due to Fortum's decision to reserve all the resources in question to ensure the completion of the I&C reform at Loviisa. STUK approved the move that ensured the planned completion of the more important modification for overall safety. Although there is no I&C system yet, additional cooling may now be used manually.

From STUK's point of view, the I&C systems that were not included in the I&C reform implemented at the Loviisa power plant will form an important part of ageing management in the future. These will be modernised as separate projects in the coming years. An example of these improvements is the renewal of the I&C system of emergency power diesel generators, the first installations of which are intended to be made during the 2019 annual outages. In addition, STUK specifically follows the progress of the modernisation project of the refuelling machine.

Reports and analyses

In order to further specify the earthquake risk of the Loviisa power plant, Fortum updated the seismic hazard reports and the earthquake response spectrum during 2017. These serve as the basis for the seismic plant walk-around required in connection with the implementation of the YVL Guides. Fortum implemented the plant walk-around in 2018. This was an extensive survey of the plant premises with the intention to determine the earthquake tolerance of the components which are important to safety. STUK participated in the plant walk-arounds as an observer. Fortum will compile the results and submit them to STUK for approval in spring 2019.

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 2018. In spring 2018, STUK approved a new person responsible for emergency response arrangements. The new facilities for the technical support of the emergency response organisation were also taken into use in Keilalahti in the beginning of 2018. In addition, Fortum appointed more people to its emergency response organisation in 2018, and especially in Keilalahti, the emergency response organisation was strengthened.

The annual preparedness exercise was organised at the plant in May, and it went well. This was an unannounced exercise, and when its results were assessed, possible areas for development included the cooperation between authorities and the power plant emergency response organisation and the further development of the management procedure for contamination resulting from any release. Emergency preparedness arrangements at the Loviisa power plant have been systematically developed, and the plant's emergency response arrangements comply with all the key requirements.

2.1.3 Organisational operations and quality management

In 2018, STUK followed Fortum's competence management, migration to a process-based management system, further development of the modification work process, and development activities related to the safety culture. The summaries of periodic inspections regarding the management system, human resources, competence, management and safety culture are included in Appendix 3. In addition, STUK commissioned a survey from VTT in 2018 on the management of human factors at the Loviisa power plant. The research project will end and the final results will be available in early spring 2019. In 2018, STUK continued observing the effects of the organisational changes of the fuel usage handling team, for example, by following the operation and the implementation of the training as part of the annual outage inspection.

Based on the inspections, the migration to a process-based management system has progressed so that the main processes of the management system have been described and indicators have been defined for them. The description of the lower-level processes is still incomplete, but the work is progressing.

Fortum's power plant competence management project has progressed according to plan. STUK still follows the progress of the project, for example, in meetings organised with Fortum.

The resources for assessing and developing the safety culture at the Loviisa plant are still scarce. However, Fortum was able to implement tasks related to the safety culture and develop procedures during the year. Through its regulatory oversight activities, STUK follows the development of the safety culture and the sufficiency of its resources.

As regards project operations and resources, the greatest challenge of 2018 was the implementation of substantial modifications, such as the I&C reform of the Loviisa plant. Planning resources were sometimes scarce, especially in I&C design, due to which smaller projects had to be moved to 2019. However, the moves were under control, and the most important projects were safely completed as planned. What is important for the future is the transfer of the resources of these long-term investment projects and the use of the things learned to support other modifications and operations.

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.

On the basis of this regulatory oversight, STUK can state that as regards radiation exposure, the plant's activities were safe to the employees, the population and the environment. Summaries of inspections included in the periodic inspection programme for 2018 can be found in Appendix 3.

In 2017–2018, the safety of the Olkiluoto 1 and 2 plant units was assessed to a larger extent than usually due to the renewal of the plant's operating licence. STUK inspected the periodic safety review performed by the licensee, including the assessment of the technical condition and operation of the plant in the previous licence period and the development of the plant status and the organisation operating it in the coming operating cycle. According to STUK's assessment, the plant is safe and it is operated well, on the basis of which STUK supported the continuation of the operating licence. The renewal of the operating licence is described in Appendix 2.

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 2018 was 0.84 manSv at Olkiluoto 1 and 0.26 manSv at Olkiluoto 2. Most of this accumulated from work completed during the annual outages (0.74 manSv at Olkiluoto 1 and 0.18 manSv at Olkiluoto 2).

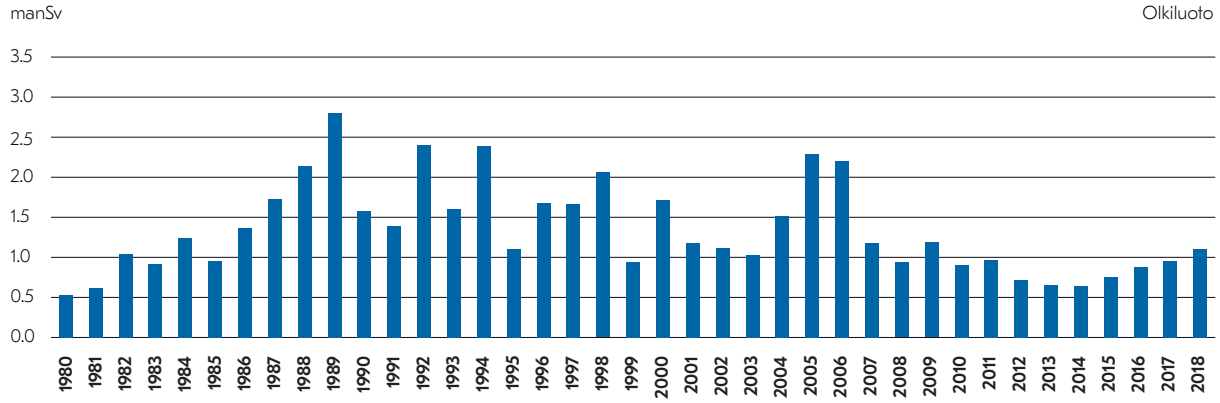

FIGURE 6. Collective occupational doses since the start of operation of the Olkiluoto nuclear power plant

According to the Government Decree on ionising radiation (1034/2018) that entered into force in December 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 9.5 mSv, caused by plant cleaning work.

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).

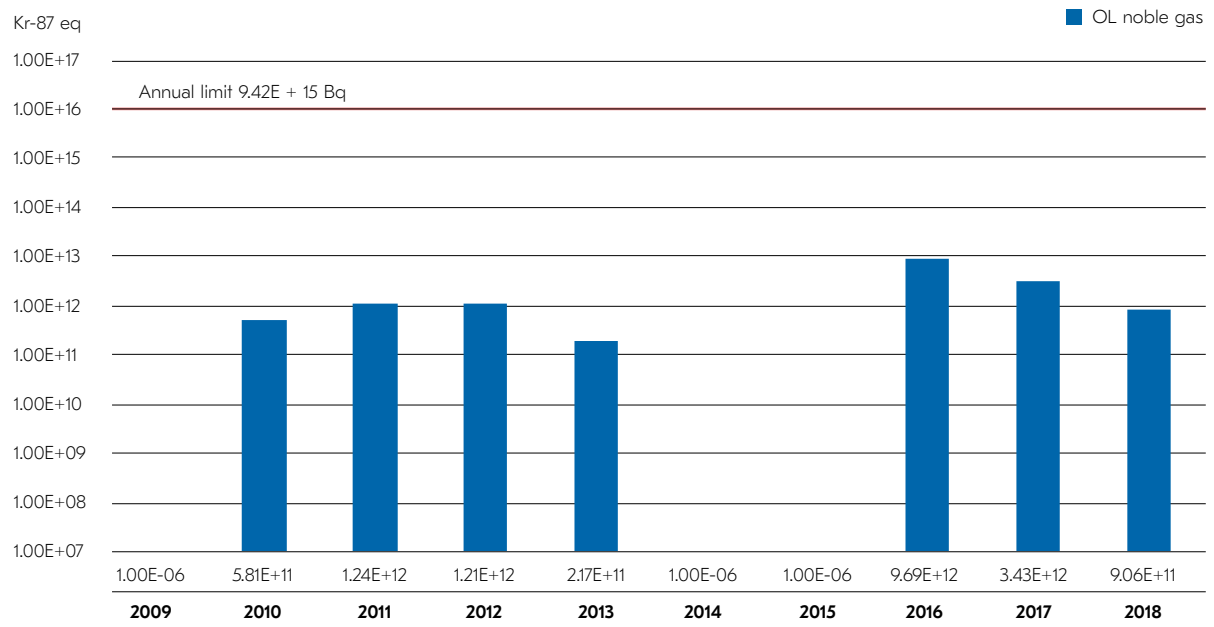

FIGURE 7. Noble gas releases to the atmosphere (Kr-87 eq), Olkiluoto.

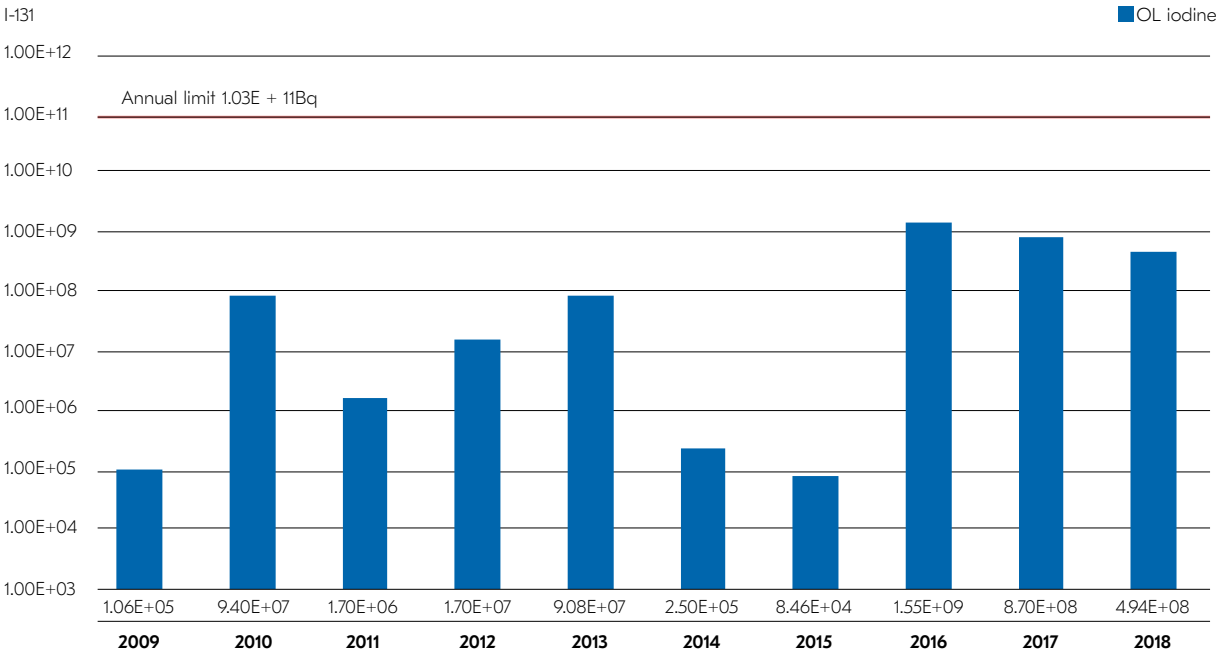

FIGURE 8. Iodine isotope releases to the atmosphere (I-131), Olkiluoto.

A total of approximately 410 samples were collected and analysed from the land and marine environment surrounding the Olkiluoto power plant in 2018. 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.

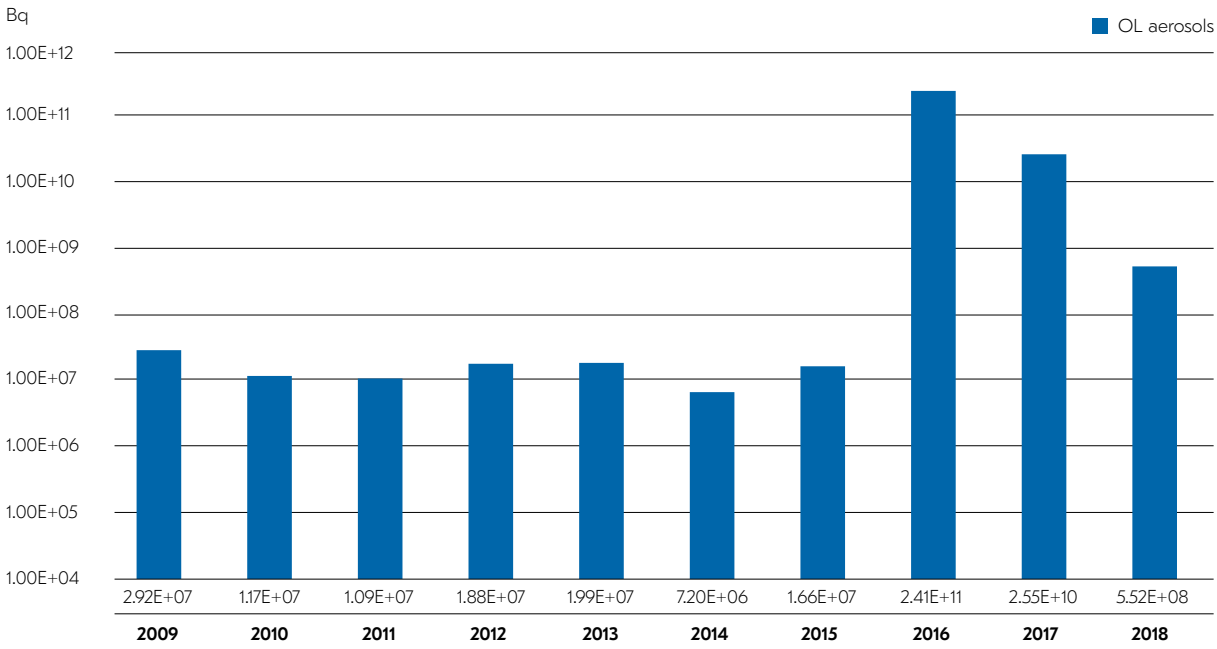

FIGURE 9. Aerosol releases to the atmosphere (Bq), Olkiluoto.

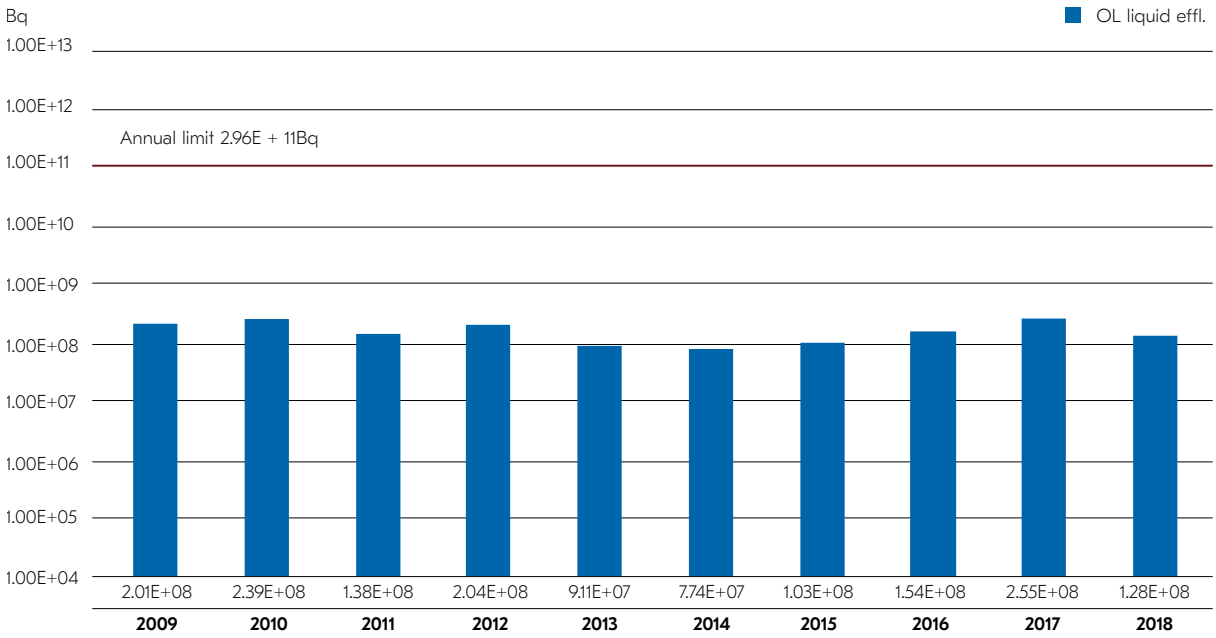

FIGURE 10. Gamma activity of the liquid effluents (Bq), Olkiluoto.

Operational events and operating experience feedback

TVO reported the results of 19 event analyses and investigations to STUK in 2018. As a conclusion, STUK can state that TVO identifies operational events at Olkiluoto 1 and Olkiluoto 2 and initiates event investigations to determine the causes and to improve the plant and the operation. All event investigations concerned individual events. Most of the events revealed areas for improvement in procedures and activities. The most important operational events are described in Appendix 2.

By reviewing the results of the event analyses and investigations, STUK verified that TVO had investigated the underlying causes of the events and initiated the necessary actions to correct technical faults and deficiencies in its operational methods and to prevent the reoccurrence of the events. STUK deemed TVO's event investigations sufficient.

When the events are analysed as a whole, it can be stated that several operational events in 2018 were related to topics where deficiencies were found in previous years as well. The recurrence of events relating to the same area may indicate that there is room for improvement in learning from internal events. TVO is carrying out improvements to learn from internal events. STUK required TVO take measures after observing in the inspection in 2017 that TVO's event investigations do not always have a sufficient impact. The establishment of procedures already created by TVO, the further development of procedures based on accumulated experience and the possible next steps require time. Through its regulatory oversight activities, STUK follows TVO's further measures.

Annual outages and maintenance operations

The annual outages of the plant units were implemented as planned in terms of nuclear and radiation safety. STUK oversaw the annual outages from their design to the start-up of the plant units. A large number of maintenance measures and inspections are also carried out during each 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. STUK carried out an inspection of the annual outages as part of the periodic inspection programme. A summary of the inspection is presented 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. In the holistic development of waste management, the planning has been concentrated on the harmonisation of the waste solidification processes in plant units already in operation and Olkiluoto 3 to be commissioned, and on the underground disposal of very low-level waste. The operating licence concerning the Olkiluoto 1 and 2 plant units, issued by the Government on 20 September 2018, presents as a new condition the permission to treat and store low or medium level waste originating elsewhere or other radioactive waste at the power plant site as part of TVO's activities. This condition enables a safe solution for the treatment and storage of certain other types of radioactive waste generated in Finland.

Nuclear safeguards

STUK granted TVO ten licences concerning the use of nuclear commodities for the Olkiluoto plant units in operation (Appendix 8).

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 updated

version of TVO's nuclear safeguards manual. In the manual, TVO describes how the nuclear safeguards of Olkiluoto nuclear power plant units have been organised.

A total of 17 nuclear safeguards inspections were performed on the material balance areas of TVO's operating plant units and the spent fuel storage facility. 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 pressure vessel lids. 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 at Olkiluoto 2 by the IAEA and the European Commission on short notice in November. No cause for remarks was found in the inspections.

In 2018, STUK performed a periodic inspection of nuclear safeguards. The inspection summary is provided in Appendix 3. The oversight and inspections by STUK indicated that the Olkiluoto plants in operation fulfilled their nuclear safeguard obligations.

Nuclear security

During 2018, STUK reviewed the update of the security plan for the Olkiluoto nuclear power plant. In 2018, STUK required TVO to update the Operational Limits and Conditions as regards control room personnel.

In 2018, STUK carried out one periodic inspection regarding nuclear security. The inspection concerned the demonstration of the effectiveness of security arrangements, addressing the training and practice programme of the safety organisation and the nuclear security observations. Arrangements during the annual outage were addressed by reviewing the results of previous inspections and making a site visit. TVO's human resources planning relating to security arrangements was also reviewed in the inspection. The inspection summary is provided in Appendix 3.

The security arrangements comprise an extensive package of administrative, technical and operational procedures. Although the results of inspections may require rectifications and improvements regarding several areas, the security arrangements as a whole meet the requirements.

Fire safety

Fire safety at the Olkiluoto power plant is at a good level. In 2018, STUK oversaw the fire safety of the power plant by means of inspections and site visits and by reviewing reports submitted by TVO.

Following the fires in high-rise buildings, e.g. in Great Britain and Dubai, STUK studied the insulation materials and other materials used in the facades, ceilings and roofs of the Olkiluoto plant units in operation which could potentially spread fire, as well as the way in which the fire safety of facades has been ensured. TVO provided a clarification of the matter, which did not identify any new fire risk items. Fires in the facades of nuclear power plant buildings are very unlikely. There are some combustible materials in the roof structures, but they have been isolated from the process rooms by a concrete vault and the need to extinguish the roofs has been sufficiently prepared for.

2.2.2 Technical condition of the plant and preparing for exceptional events

Development of the plant and its safety

Several modification projects that will improve plant safety are currently ongoing at the power plant. Based on assessments of the Fukushima accident, several modifications have been carried out at the plant units that improve the provisions for extreme external threats. In 2018, TVO installed a steam turbine-driven make-up water supply system independent of AC power at both plant units. The new system further improved the safety of the plant units in case of loss of power.

Dependence of the auxiliary feedwater system from the seawater cooling was clearly reduced by implementing a modification at Olkiluoto 1 in 2014. Abnormal vibrations and sounds were nevertheless observed during the test run in one new recirculation line. During 2018, TVO continued investigating the problems observed and made modifications to the subsystems of Olkiluoto 1. No abnormal vibrations or sounds have been observed in the subsystems of Olkiluoto 1 after the latest modifications. In 2019, TVO intends to implement more minor piping modifications, and the construction plan concerning these will be submitted to STUK for approval in early 2019. At the same time, TVO will submit the updated schedule plan for implementing the modification of the corresponding recirculating line at Olkiluoto 2.

In 2018, TVO completed a project to replace the reactor coolant pumps and the frequency converters for controlling and supplying power to them. After this, all the main coolant pumps of both plant units have been replaced. STUK continued its review of the documents pertaining to the replacement of the main coolant pumps and the regulatory oversight of their manufacturing. In conjunction with updating the main circulation pumps, a sufficient amount of flywheel mass was added to their shaft. This ensures that the gradual pump speed reduction takes place passively in the event of scram or power loss and the previous electrically connected and separate flywheels will no longer be required to ensure fuel integrity in the context of these transients.

In the emergency diesel generator update project, the plant's eight emergency diesel generators will be replaced and a ninth generator will be built, enabling the replacement of diesel generators during power operation. The commissioning of the first new emergency diesel generator has been delayed, and TVO estimates that it will be commissioned in summer 2019. Thereafter, the eight emergency diesel generators will be installed and commissioned one by one, and the last one will be commissioned in spring 2023. The new diesel generators can be cooled both with seawater and air. The current ones can be cooled with seawater only. STUK oversees the upgrade and in 2018 inspected the related design documents and oversaw the manufacturing.

An alternative float chamber-based reactor trip signal 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. TVO will submit the results of the investigation and a proposal for the continuation of the modification to STUK for approval by the end of August 2019. The assessment of the acceptability of the alternative procedure requires thorough processing by STUK.

Emergency preparedness 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. No events requiring emergency response actions took place at the Olkiluoto power plant in 2018. In September, an exercise regarding the security arrangement situation at several plant units at the same time was organised at the Olkiluoto power plant. When the exercise was assessed, maintenance of a joint view of the situation and the IT and communication systems supporting it were identified as areas for development. These would also support the coordination of communications during the situation. Emergency preparedness arrangements at the Olkiluoto nuclear power plant have been constantly developed, and the power plant's emergency preparedness arrangements comply with all the key requirements.

2.2.3 Organisational operations and quality management

TVO has exhibited significant problems related to work atmosphere in recent years, and the staff turnover has increased from previous years. Staff motivation and competence are essential in maintaining a good safety culture. TVO's work atmosphere issues and the high staff turnover in recent years at the same as the commissioning of the Olkiluoto 3 nuclear power plant unit present a challenge for high-quality and safety-informed work. Due to the challenges with work atmosphere, TVO has initiated extensive measures aiming towards a strong safety culture, good work atmosphere and improved management.

In 2018, STUK continued intensified regulatory oversight on the implementation and efficacy of TVO's measures. Through its oversight, STUK has found that the situation has improved. Staff turnover is now quite low, and TVO has been able to hire new people. The results of TVO's safety culture survey conducted in spring 2018 and personnel study conducted in autumn 2018 also indicated clear improvement from the previous surveys. The implementation of development measures related to management and safety culture as well as staff resourcing and competence need to be continued, and STUK will follow their effectiveness as part of its regulatory oversight efforts.

2.2.4 More extensive assessments at the plant

Renewal of the operating licence

On 26 January 2017, TVO submitted an application to the Government for continuing the operating licence of the Olkiluoto 1 and 2 plant units for 20 years. The Ministry of Economic Affairs and Employment (MEAE), which was preparing the matter, requested STUK to issue a statement regarding TVO's application. In early 2018, STUK continued preparing a safety assessment concerning the plant units. STUK delivered its statement on the operating licence application to MEAE on 31 May 2018. According to STUK's assessment, the continued operation of the plant units is safe and meets the statutory requirements. STUK also assessed that the nuclear waste management arrangements used by TVO are adequate and appropriate. Therefore, STUK saw no reason not to issue an operating licence for the plant units for 20 years in accordance with TVO's application.

The Finnish Government issued a new operating licence for the plant units on 20 September 2018. The licence facilitates operation of the plant units until the end of 2038. As a licence condition, it was recorded that a periodic safety review must be conducted and delivered to STUK for approval by the end of 2028. STUK's assessment relating to the renewal of the operating licence is described in more detail in Appendix 2.

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 inspections included in the inspection programme for 2018 are presented in Appendix 4.

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

Before starting operation, TVO needs an operating licence granted by the Government. The operation is deemed to start once nuclear fuel is loaded in the reactor. During the year, STUK continued its review and assessment of the operating licence application documents and finalising the related safety assessment.

The oversight of commissioning constituted a large part of the oversight work carried out by STUK in 2018. The oversight included the inspection of test plans and results as well as the oversight of certain tests.

STUK carried out several inspections of functions related to preparations for plant operation and oversaw, for example, testing of instructions using a plant simulator and the training and approval process of future operators. STUK also oversaw the manufacture of spare parts and the repair, maintenance and modification work performed at the plant.

Based on these oversight, STUK observed that most of TVO's procedures and operations are at a good level. In summary, based on the results of regulatory oversight, STUK can state that the safety goals of the plant can be achieved.

2.3.1 Processing of the operating licence application

STUK continued to review the operating licence application. The operating licence is required before starting the plant operation. TVO submitted an operating licence application to the Government in April 2016. After that, TVO has submitted documentation updates to STUK, including modifications to the systems described in the operating licence documentation based on for example comissioning tests.

When reviewing the operating licence application, STUK will verify that the prerequisites for the safe operation of the plant are met. Detailed safety requirements are included in STUK's regulations and nuclear power plant guidelines (the YVL Guides). STUK assesses compliance with these requirements during the operating licence review process. STUK's safety assessment will not be based solely on a review of the operating licence documentation; instead, STUK will utilise in its assessment all of its oversight operations, such as the general oversight on the plant site, its inspections and the results obtained during the commissioning tests of the plant.

The operating licence application documentation has been processed almost in its entirety. STUK has prepared its operating licence statement and the safety assessment supporting it but is waiting for the solution of the piping vibration problem observed in commissioning before finalising the statement and the safety assessment. Relating to the operating licence documentation, the decisions on the Final Safety Analysis Report and the probabilistic risk assessment are also waiting for the solution of the vibration problem. The vibration issue is discussed in more detail in the chapter on commissioning below.

2.3.2 Review of other licensing documents

I&C suitability analyses, stress analyses of piping and updates to plans for mechanical equipment, in particular, were submitted to STUK for processing in 2018.

STUK followed the progress of the I&C component qualification and reviewed the suitability analyses of the I&C equipment and systems. Documentation work regarding the qualification tests and production of the suitability analyses will continue in 2019. However, the final suitability analyses must be submitted to STUK in good time before loading the fuel. The suitability analyses submitted in 2018 were of good quality, and STUK had no objections regarding them.

Modifications have been made to the plant's systems on the basis of observations made during commissioning. For example, delays and logic relating to I&C functions have been optimised based on the results of commissioning tests. STUK has inspected and approved the modifications related to safety.

During the year, STUK processed a large number of stress analyses of piping and updated construction plans of mechanical equipment. Piping analyses were updated regarding the modifications made during the installation. Construction plans of equipment had to be updated as required by pro-

cess-technical and operational needs for change during the installation and commissioning phases. The stress analyses of the emergency cooling system indicated that the pipe supports are overloaded in a pipe break situation. The plant supplier made several analyses using more realistic initial data and considering more carefully the forces in a pipe break situation. With a more realistic calculation, the loading of the pipe supports was lower and the load-bearing capacity of the supports could be demonstrated as sufficient for most supports. Where the strength could not be demonstrated by calculations, the supports will be strengthened.

2.3.3 Manufacture, installation and construction

STUK continued its oversight of manufacture and installation.

During commissioning in 2017, cracking was observed in the cobalt-free gasket face in certain valves of the reactor plant. Valve inspections were continued in 2018, and it was decided to replace the hard coating in the cracking valve gasket faces. The plant supplier and the valve manufacturer developed procedures relating to the welding of cobalt-free hard coating. STUK inspected new parts manufactured with an improved welding coating method during several inspection visits during summer 2018. The cracked valves will be repaired before fuel loading.

During 2018, the plant supplier also presented several other observations relating to valves, as a result of which the suitability of the valves had to be reassessed. The investigations concerned the suitability of teflon, which is used as a sealing material for valves, in certain usage locations, the necessity of remote drives in hand valves and the corrosion resistance of valve materials. In addition, the suitability of the valves had to be reassessed due to manufacture-related errors. STUK assessed reports and plans submitted by TVO. The investigations will be continued during 2019.

The commissioning of the fuel handling equipment and reactor hall crane started in late 2017 and continued during 2018. The nuclear commissioning tests of the reactor hall crane were delayed by the installation use and several failures of the crane. The exceptionally long installation use of the crane and the durability of the crane rail in long-term nuclear use were discussed during 2018. STUK oversaw the commissioning, assessed reports submitted by TVO and performed inspections of repair and maintenance work.

The 100-hour type testing of the emergency diesel engine was repeated with one diesel engine in the beginning of June. STUK required the type testing to be repeated in connection with the commissioning because damaged engine parts were indicated in the type test performed after manufacturing. After the type test repeated in June 2018, no damaged parts were observed in the dismantled engine. After the type test, the assembled engine was given a commissioning test and found to operate flawlessly. STUK oversaw the type testing and the inspections performed after it.

In summer 2017, one of the emergency diesel engines was damaged. The engine crankshaft and other essential parts had to be replaced. The extensive repair was completed during 2018. STUK inspected the repair plans and oversaw the repair work. TVO submitted to STUK for assessment a report on the possible reasons of the damage and measures to stop similar damage in the future. Key corrective measures included the cleaning of oil piping, the alignment and repair of the coupling and the installation of the temperature measurements of crankshaft bearings. In winter 2018, it was observed that the coolers of the emergency diesel that was being repaired had frozen. As a result of the freezing, the copper piping of the coolers was damaged and extensive repair had to be performed. STUK inspected the plans relating to the repair and oversaw the repair.

2.3.4 Oversight of commissioning

The purpose of commissioning is to verify that the plant's systems, structures and components operate as planned and have been successfully installed. Large-scale commissioning at the Olkiluoto 3 plant unit already began in 2016 when mainly individual components and systems were tested. In 2018, hot functional tests were performed 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.

Based on preliminary assessments, the results of the hot functional tests were mainly acceptable. The result report of the tests was submitted to STUK in December, and its processing was still incomplete at the end of the year. However, the tests indicated that the pressuriser surge line in the reactor coolant circuit vibrates more than allowed. The reason of the vibration is not clear, and it is still being analysed. A possible reason is a hydraulic initiator of the primary circuit causing the pipe to vibrate at the natural frequency of the connecting line. To suppress vibrations, the plant supplier will install two dampers in the line. STUK has approved the plan for principles for the dampers and inspected more detailed plans regarding the design of the dampers. Bitumen is used as damper fluid in the dampers. In a pipe break accident, bitumen will leak out of the damper. Before the final approval of the damper solution, the plant supplier must demonstrate that bitumen cannot block the screens along the flow routes of emergency cooling water and that bitumen cannot enter emergency cooling pumps or the reactor core with the coolant flow. Areva is commissioning tests on the behaviour of bitumen in pipe break situations at the Lappeenranta University of Technology and conducting tests with its own test equipment in Erlangen in Germany. STUK has followed some of the tests. At the end of the year, the tests and the analysis of the test results were still incomplete.

Commissioning of individual systems continued in 2018 as well. All of the plant's systems were not needed in the hot functional tests, and the tests of these systems continued side by side with the hot functional tests. Examples of these systems are standalone systems relating to waste management. Modifications made based on previous tests were also tested.

During the year, STUK reviewed several test programmes and the modifications to them. The test programmes had to be approved before the tests could begin. Among other things, the test programmes describe the methods, goals and acceptance criteria of the tests. 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 mainly been of good quality, and STUK has approved most of them without any requirements. Reports of the commissioning results have also been submitted to STUK. The result reports have been comprehensive, and STUK has not had any objections regarding them. However, STUK has paid attention to the long time it takes to produce the reports.

2.3.5 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, the activities are instructed and there are procedures for managing different types of matters (emergency arrangements, security arrangements, nuclear safeguards, maintenance operations etc.). STUK made several inspections relating to the preparation for operation. STUK inspected, for example, security arrangements, work permit procedures,

emergency response operations, resource planning, the adequacy and competence of personnel, maintenance operations, radiation protection and operating experience feedback. When the operations to be inspected concerned the entire TVO instead of just the OL3 plant unit, the inspection was included in the periodic inspection programme of the plant units in operation.

In the inspections in the beginning of the year, STUK discovered resource deficiencies especially in maintenance, operating personnel and equipment and system owners. During the year, TVO hired a number of new personnel for these areas, and in the inspections at the end of the year, STUK was able to state that the resource situation had improved to an acceptable level.

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.

The suitability of the plant's procedures for abnormal conditions and emergency procedures for their intended application is demonstrated by validation of the procedures using a replica training simulator. STUK oversaw the validation tests performed with a simulator. Conclusions on the validations are still incomplete, but as a result of the assessment so far, the plant supplier and TVO have specified new change requirements regarding the concept and the procedures and identified needs for additional training. Implementing the changes and assessing the need for revalidation of the instructions are still incomplete.

According to the Nuclear Energy Act, 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. Prerequisites for the approval include demonstration of sufficient professional skills in a simulator and a completed and approved oral examination. The demonstrations of professional skills were implemented in October–November 2018. STUK oversaw all demonstrations. The oral examinations were held after the demonstrations of professional skills. The examinations were held by TVO, but STUK oversees all examinations and follows particularly the comprehensiveness of the questions, the sufficient difficulty level and the appropriateness of the assessment. The demonstrations of professional skills indicated that the competence of operators were at a good level, which was also supported by the results of the oral examinations. Towards the end of the year, STUK approved the operators of OL3 in accordance with the application.

TVO has exhibited significant problems related to work atmosphere in recent years, and the staff turnover has increased from previous years. Due to the challenges with work atmosphere, TVO has initiated extensive development programmes aiming towards a strong safety culture, good work atmosphere and improved management. Among other areas, the practical measures of the programmes are aimed at the management's and supervisors' leadership skills and capabilities of managing changes, as well as improving work well-being and the fluency of work. STUK continued intensified regulatory oversight on the implementation and efficacy of TVO's measures. There is some preliminary proof of the positive effects of the measures on TVO's work atmosphere and safety culture, but STUK is still conducting intensified regulatory oversight of their effectiveness.

The Radiation and Nuclear Safety Authority granted TVO two licences concerning the use of nuclear commodities for the Olkiluoto plant unit under construction (Appendix 7). STUK performed on OL3 the first safeguards inspection concerning fuel (determination of initial inventory) on 28 February 2018 together with the IAEA and the European Commission. TVO submitted the nuclear safeguards reports and notifications regarding OL3 it was responsible for in time, and they were consistent with the observations made during inspections. The oversight and inspections by STUK indicated that TVO fulfilled its nuclear safeguards obligations at OL3 in 2018.

As part of the preparation for operation, the IAEA's pre-OSART assessment was conducted at OL3 on 5–22 March 2018. OSART reflects the operations of the power plant against the IAEA's standards and best practices. As a result of the inspection, it was stated that OL3 has good practices, such as the regular assessment of the safety culture, effective procedures for developing the competence and skills of the personnel

and the procedure for analysing secondary circuit samples using a microscope camera. On the other hand, the inspection also indicated many possible development targets, such as communicating the management's expectations, opportunities of the operating organization to manage the plant systems and the following of foreign material procedures. The results of the pre-OSART inspection were submitted in their entirety for the plant's own use and for information to MEAE and STUK. STUK participated in the inspection as an observer and follows the development measures of the plant alongside its other inspection activities.

2.4 Hanhikivi 1

In 2018, STUK did not have at its disposal information on the plant and system design of Fennovoima's Hanhikivi nuclear power plant that would enable the detailed assessment of the plant design and the analyses made and the preparation of the safety assessment.

For the decision in principle, STUK made a preliminary safety assessment in 2014. In autumn 2018, Fennovoima presented measures it will possibly take based on the observations in the preliminary safety assessment. However, only slight concrete progress can be seen in plant and system design. The quality and quantity of the documents submitted to STUK for processing and the observations made in the inspections also indicate that the measures have progressed slowly.

2.4.1 Management systems, quality management and safety culture

The development of Fennovoima into a responsible licensee has been slow. In 2018, several investigations and analyses on the operations of Fennovoima were performed by STUK and Fennovoima itself. These exhibited uncertainties and instability in the operations, organisational structure and responsibilities of Fennovoima. For example, Fennovoima has not taken effective measures based on the safety culture survey conducted by VTT in 2017. Despite the development of the management system, the problems have not been corrected in a significant way, and Fennovoima is designing more extensive development measures to improve the situation. STUK has emphasised that as an organisation, Fennovoima must be able to respond to the requirements and legislation of nuclear safety. Fennovoima must also be able to demonstrate the meeting of the requirements in daily activities and decision-making.

Progress is made in management systems, but the development of certain key organisations is considerably incomplete. STUK has emphasised the importance of long-term planning to Fennovoima. The planning of the project has appeared short-sighted, and there is reason to develop more detailed plans for the progress and phasing of the construction. The deficiencies of the plans complicate, among other things, the competence and resource planning based on project needs and the perception of risks.

Also, the procedures of the plant supplier (RAOS Project Oy) and main contractor (Titan-2) and their practical application are still in significant need of development. STUK paid attention to this, for example, in the inspection concerning site operations.

2.4.2 Plant site and technology

The geological surveys aiming at determining the exact location of the plant and the design basis of the foundations progressed from planning to implementation. STUK assessed the plan for the geological surveys and provided feedback to Fennovoima. To assist in the assessment, STUK used the expertise of the geologists at the University of Turku. Most of the investigations performed at the plant site were completed by the end of the year. The next phases are the approval by Fennovoima of the final reports of the completed investigations and, based on the results in question, the determination of the exact

location and type of foundation of the plant by the main designer and plant supplier. STUK approved the seismic design bases of the plant site.

In the beginning of the year, Fennovoima and the plant supplier presented a strategy of managing severe reactor accidents, which, according to STUK's assessment, did not meet the Finnish safety requirements. The plant supplier presented design changes in the second tertile. The design changes have an effect on the analyses modelling severe reactor accidents that have not yet been submitted to STUK.

In meetings during 2018, the plant supplier and the licence applicant presented to STUK different solution models for the location and layout planning of the plant. In the preliminary safety assessment issued by STUK in the decision in principle phase and in the topical meetings held after this, STUK presented its preliminary view on things requiring further clarification and justifications. The analyses of the protection against internal and external hazards have a key role in the presented location and layout planning solutions. The analyses have not yet been presented to STUK, and neither has any other description of the plant based on which the safety of the plant could be thoroughly assessed.

STUK has performed a general inspection of the preliminary probabilistic safety analysis of Hanhikivi 1 and sent a request for clarification to Fennovoima. STUK has also sent a request for clarification regarding the design values of external events.

Discussions have continued with the licence applicant and the plant supplier on the approval and selection of materials for mechanical equipment. Based on the most recent meetings, the plant supplier has a clear vision on how the approval process in question should be carried out. STUK has participated in supervising the validation of the main coolant pump. In the first tertile of 2019, the manufacturer will continue destructive materials testing, the supervision of which STUK will participate in.

STUK has continued the processing of documents and plans relating to the design bases and procurement of the reactor pressure vessel and other main components. In the document processing for the reactor pressure vessel, the processing of documents relating to manufacture is being prepared for. However, there have been delays in the delivery of documents.

The delivery chain for I&C technology has not yet been defined as regards design and implementation. The I&C licensing documentation to be submitted for regulatory review by authorities in the construction licence phase has not yet been specified in its entirety. Sufficient initial data has not yet been obtained on the plant and process design for designing the I&C system.

STUK continued inspecting the documents concerning the interim storage for spent fuel. By the end of the year, five requests for clarification and two decisions were sent regarding the documents. The documents included a preliminary safety analysis report, a decommissioning plan, a proposal for a classification document and a report on the connections between the interim storage for spent fuel and the power plant. The safety assessment of the interim storage for spent fuel will be performed in two phases: In the first phase, Fennovoima will submit to STUK the concept-level plans regarding the interim storage for spent fuel as part of the construction licence documentation of the nuclear power plant. In the second phase, after the granting of the construction licence, Fennovoima will submit to STUK detailed system-level design documentation to be inspected and approved by STUK before the construction of the storage can be started.

Fennovoima has continued taking and analysing samples in accordance with the baseline study programme. Fennovoima has also progressed in the commissioning of weather monitoring systems at the plant site.

2.4.3 Nuclear safeguards

In 2018, STUK granted Fennovoima the licence to import and possess nuclear information subject to the particular safeguards obligation from Russia and the licence to transfer nuclear information concerning Hanhikivi 1.

Fennovoima applied for approval of a nuclear safeguards manual and a plan under Section 35 of the Nuclear Energy Decree for arranging the necessary safeguards to prevent the proliferation of nuclear weapons. The presented documents were approved, but STUK continuously carries out its regulatory oversight and assesses whether the operations of Fennovoima correspond to the approved plan and manual. STUK will publish its assessment when issuing the statement on the construction licence application at the latest.

Fennovoima applied for approval of the responsible managers for nuclear material safeguards. The processing of the applications was moved to 2019.

Fennovoima submitted the nuclear safeguards reports and notifications it was responsible for in time.

The oversight by STUK indicated that Fennovoima fulfilled its nuclear safeguards obligations in the Hanhikivi 1 project in 2018.

2.5 Research reactor

VTT submitted the operating licence application regarding decommissioning to the Government in June 2017. In 2018, VTT supplemented the licence application in terms of documents submitted to STUK so that the last supplement to the licence application was submitted for inspection in September 2018. STUK carried out its regulatory oversight on the safety of the research reactor by reviewing the licensing materials and using the review results to prepare a safety assessment of the operating licence application. The safety assessment is being finalised and is estimated to be completed by the end of March 2019. Inspections in accordance with the inspection programme of operation have also been continued at the research reactor.

VTT submitted a waste management scheme for the research reactor to the Ministry of Economic Affairs and Employment (MEAE) in June 2018. The waste management scheme includes the details of VTT's provisions for nuclear waste management costs during decommissioning of the research reactor. STUK submitted to the ministry a statement on the waste management scheme, in which it states that there are still significant uncertainty factors related to VTT's cost estimate of decommissioning the research reactor due to negotiations in progress regarding the interim storage and final disposal of nuclear waste and the retrieval of nuclear fuel.

In addition, VTT submitted the nuclear waste management plan to MEAE in September 2018. STUK submitted a statement on the nuclear waste management plan to the ministry in November 2018. In its statement, STUK states that the nuclear waste management plan describes well the implemented measures of nuclear waste management but future plans concerning nuclear waste management are only described on a general level. VTT has worked purposefully to find a storage solution for decommissioning waste, demonstrated by the letter of intent concerning the decommissioning project and nuclear waste management signed with Fortum in September 2018. According to STUK's view, the agreement formed makes it quicker to develop a safe and feasible nuclear waste management solution for VTT's needs. The schedule of the decommissioning project still includes significant uncertainties particularly due to the incompleteness of the plans for the management of spent fuel and decommissioning waste.

Concerning nuclear safeguards, the material balance area of VTT's research reactor includes nuclear materials in the Otakaari 3 building and their related activities. In June 2018, STUK inspected the nuclear material accountancy of the research reactor together with the European Commission. Before that, STUK made its own inspection in May before the export of pile uranium, which was a part of the decommissioning of the reactor and its oversight. VTT's plant site, which is compliant with the Additional Protocol of the Safeguards Agreement, includes the buildings in the material balance areas of both the research reactor and the Centre for Nuclear Safety. The IAEA made a supplementary inspection visit to VTT's plant site on 24 hours' notice in April 2018. The Commission and STUK participated in

the inspection. During the inspection, environmental samples were taken from the laboratory facilities inside the research reactor building. To assess the results of the environmental samples, a report on the operating history of the laboratory has been requested and received from VTT. The processing of the report is incomplete. The oversight and inspections by STUK indicated that VTT fulfilled its nuclear safeguards obligations in 2018.

2.6 Spent nuclear fuel encapsulation and disposal facility

In 2018, Posiva continued the construction of the disposal facility. Auxiliary rooms were excavated for the disposal facility. Preparations were made for the excavation of the central tunnel, which is the first safety-classified room to be excavated.

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 preparation of the the long-term safety case. The oversight also includes the commissioning phase of the nuclear waste facility, during which STUK will oversee Posiva's operations during commissioning, oversee testing, review test plans and test results, and perform commissioning inspections of components, structures and systems.

2.6.1 Construction of the disposal facility

Posiva continued the excavation of the auxiliary rooms included in the scope of the disposal facility covered by the construction licence. The excavated areas include vehicle connections, parking areas and the joint functional testing area. During 2018, Posiva submitted rock engineering design documentation concerning the central tunnel of the disposal area to STUK for review. Based on STUK's inspection, there were such deficiencies in the plans that the review of the documents was suspended and the documents were returned to Posiva for preparation. The central tunnel of the disposal facility is a safety-classified area. In these areas, the approval of the rock engineering plans by STUK is a prerequisite for starting the excavation of the facilities.

In addition to technical planning, it must be ensured when constructing the disposal facility that the areas to be excavated have been positioned in a manner that meets the rock suitability criteria required for ensuring long-term safety. STUK has followed the development work in meetings between STUK and Posiva. Fracture network modelling, bedrock stress measurement data and seismic analyses have been discussed at the meetings. Posiva has further developed its procedures for the assessment of the rock classification of the actual disposal facilities. The procedures must be completed before starting excavation of the first disposal tunnel.

2.6.2 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 observed 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. In 2018, STUK reviewed design documentation regarding rock caverns, canisters, buffers, backfill, radiation measurements and lifting and transfer equipment.

Posiva has projects in operation for the planning and development of long-term safety and engineered barriers. STUK has followed 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 during the construction licence review.

STUK has developed its own analytical capabilities for supporting its oversight and commissioned expert assessments from external experts. The purpose of STUK's own analyses is to produce comparison analyses for the analyses of the safety case produced by Posiva. 2018 saw a continuation of comparison analyses of the thermo-hydro-geochemical (THC) modelling describing the lines of evolution in the near-field of the disposal facility, of the radionuclides released from the canisters migrating above ground and of the scenario analysis estimating possible lines of evolution in final disposal.

2.6.3 Organisational operations and quality management

STUK has overseen the activities of Posiva's organisation in inspections included in the construction inspection programme. The areas assessed in the inspections include the situation of STUK's requirements for the construction of the disposal repositories, competence management, learning from experience during the construction phase, monitoring the effects of underground construction, nuclear safeguards and management of programmes and projects. The inspections and their results, as well as the requirements set by STUK, are described in more detail in Appendix 6.

In 2018, STUK continued oversight and assessment of Posiva's auditing activities by participating in five audits of Posiva's suppliers. The oversight showed that Posiva's supplier audits are compliant with STUK's requirements.

2.6.4 Preparations for the operating licence phase

Posiva has an operating licence project in operation, and a project plan has been submitted to STUK. STUK has commented on the project plan, and regular discussions are taking place with Posiva regarding the operating licence phase.

Posiva submits operating licence application documents to STUK in advance for comments. This is done to streamline the processing of the actual operating licence application documents. During 2018, Posiva submitted to STUK for pre-review a report belonging to the safety case that presents the design bases of the disposal facility from the point of view of long-term safety, as well as a report indicating possible quality deviations affecting the safety functions of barriers. In addition to these, Posiva submitted one chapter of the final safety analysis report for pre-review. STUK has compiled comments on these to Posiva to be taken into account when preparing the actual operating licence documentation.

2.6.5 Nuclear safeguards

STUK implemented nuclear safeguards for the final disposal in compliance with the national regulatory plan. STUK inspected the plant 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. The inspection of Posiva's nuclear safeguards included in the construction inspection programme (RTO) was particularly concerned with how requirements were transferred to Posiva's design documents and

how Posiva ensures the correspondence between the documents submitted for nuclear safeguards and Posiva's other documents. A summary of the inspection is presented in Appendix 6.

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 2018.

STUK continued its close 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. 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. Technical meetings concerning the oversight arrangements of the encapsulation plant were held with Posiva, the European Commission and the IAEA three times in 2018. The monitoring equipment plan for the encapsulation plant was completed by the IAEA and the Commission, and the control equipment in accordance with the plan was taken into account by Posiva in plant design.

STUK's project aimed at developing the methods and equipment for verifying the disposal of spent nuclear fuel progressed during the year within the framework of international cooperation. The new Passive Gamma Emission Tomography (PGET) equipment suitable for verifying spent nuclear fuel was tested in Loviisa in spring 2018. In the test, the equipment was controlled remotely from Luxembourg and Vienna through an existing nuclear safeguards remote connection. The construction of the prototype of the Passive Neutron Albedo Reactivity (PNAR) equipment started. The measurements performed using the PGET and PNAR equipment supplement each other.

2.7 Terrafame

Terrafame Oy applied for a licence from STUK for starting trial uranium extraction operations and for establishing the details of the uranium extraction process, and STUK granted this licence in December 2017. In June 2018, Terrafame applied for an extension for the trial operations until the end of the year, and STUK granted this extension as per the application.

On 31 October 2017, Terrafame submitted an application to the Finnish Government for starting the extraction of uranium in the uranium extraction plant built earlier in the mining area. STUK participated in the hearings organised by MEAE in Sotkamo and Kajaani in winter 2018 and the meeting of the Sotkamo municipal council in which the municipality formed its stand on the project. In May 2018, Terrafame submitted safety documents relating to the licence application to STUK. STUK inspected the documents and submitted a request for further clarification in October 2018. Terrafame submitted the supplementary application documents in November, and STUK's review and assessment and the preparation of the safety assessment and statement will continue in 2019.

2.8 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 2018, STUK approved three new nuclear safeguards manuals prepared by operators and updates to three manuals. In line with the respective applications,

STUK approves the responsible managers or deputies. In 2018, STUK approved the change of deputy of the responsible manager at the University of Helsinki.

Of the uranium producers, the reports and notifications submitted by the Freeport Cobalt Oy plant in Kokkola and the Norilsk Nickel Harjavalta Oy plant in Harjavalta were inspected by STUK. In addition, STUK received a notification in 2017 concerning the concentration of uranium in the copper slag created in the zinc metal production process and transported to the Harjavalta copper factory and a licence application from Boliden Kokkola Oy for the production and possession of the said uranium. Boliden Kokkola Oy and Boliden Harjavalta Oy also submitted preliminary basic technical characteristics documents to STUK and the Commission. The Commission arrived at a conclusion that this is not considered to be an activity under the safeguards regulation, so it does not need to be reported as a nuclear safeguards issue. As per STUK's recommendation, the operators requested preliminary information from MEAE on the licensing requirement of the activity under Section 8 of the Nuclear Energy Act. MEAE stated that the production of nuclear material in the process is an example of the use of nuclear energy under the Nuclear Energy Act and requires STUK's licence. In December 2018, STUK granted a licence to Boliden Kokkola Oy to produce and possess nuclear material and deliver it to Boliden Harjavalta Oy and a licence to Boliden Harjavalta Oy to possess and process nuclear material. A nuclear safeguards annual report indicating the amount of processed nuclear material must be prepared for the new type of activity. A corresponding licence process is in progress for the production and processing of uranium-bearing refined gold by Dragon Mining based on a notification by the company.

Other operators submitted the nuclear safeguards reports and notifications required from them. Of these operators, STUK inspected the nuclear material inventories of the VTT Centre for Nuclear Safety and the University of Helsinki together with the Commission in 2018. No remarks were made in the inspections. The nuclear safeguards system of the Radiation and Nuclear Safety Authority was also inspected. Three new operators submitted a description of their operations regarding nuclear material (basic technical characteristics) to STUK and the European Commission.

STUK inspected the operators' annual reports on nuclear fuel cycle related research and development activities and produced a report on their basis for the IAEA.

On the basis of the inspections, as well as the reports and notifications submitted, STUK has satisfied itself that other use of nuclear energy in Finland has been implemented in compliance with the nuclear safeguards obligations.

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. The four-year research programmes on nuclear power plant safety (SAFIR2018) and nuclear waste management (KYT2018) continued in 2018, which was the last year of these programmes. An international group of experts appointed by MEAE assessed the SAFIR2018 programme, and the new four-year programmes, SAFIR2022 for nuclear safety and KYT2022 for nuclear waste management, were designed and launched during 2018.

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, 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 Geological Survey of Finland and Lappeenranta University of Technology.

The SAFIR2018 safety research programme consists of 32 projects that were selected in the autumn of 2017 based on a competitive bidding. The available VYR funding for the research was around EUR 4 million. The total funding of the research programme remained at the 2017 level. The research projects are larger than in the previous programme, and the goal has been to create multidisciplinary projects

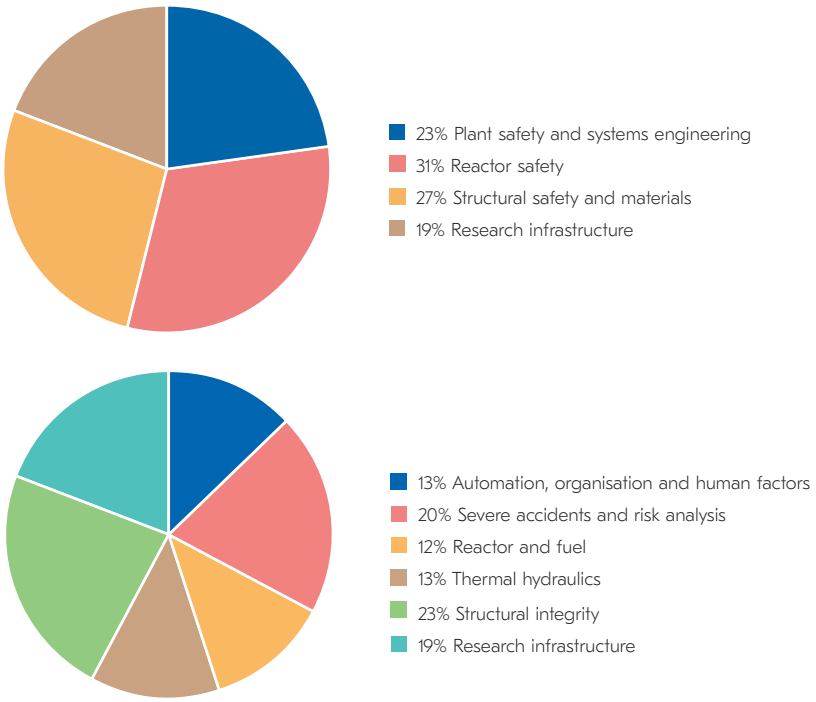

FIGURE 11. Research areas of SAFIR2018 programme and their shares of the total funding in 2018.

to promote multidisciplinary cooperation and achievement of an overall idea of safety. The volume of the SAFIR2018 research programme is EUR 6.8 million, which is divided into three areas as illustrated in image 11 a: 1) overall safety and management of design, 2) reactor safety and 3) structural integrity and materials. The VTT Technical Research Centre of Finland and Lappeenranta University of Technology (LUT) will use around 19% 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. In 2018, the funding was channelled to VTT in the manner required by the Nuclear Energy Act, 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 SAFIR2018 research projects are controlled by six steering groups in addition to the three 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) I&C, organisation and human factors, 2) severe accidents and research of risks, 3) reactors and fuel, 4) thermal hydraulics, 5) structural integrity and 6) 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. An exception to this is the second support group, which includes both projects pertaining to the determination of plant design bases and projects developing safety analysis methods. The infrastructure support group operates in the SAFIR2018 safety research organisation alongside the research areas (Fig. 12).

The projects included in the SAFIR2018 programme for 2018 meet the requirements set for VYR-funded research. The research programme has a special focus on the development of high-quality infrastructure. A project implemented in cooperation with Swedish power companies and research organisations, which deals with investigating the radiation embrittlement of the Barsebäck pressure vessel using samples taken during the decommissioning of the nuclear power plant, was launched in 2018. 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.

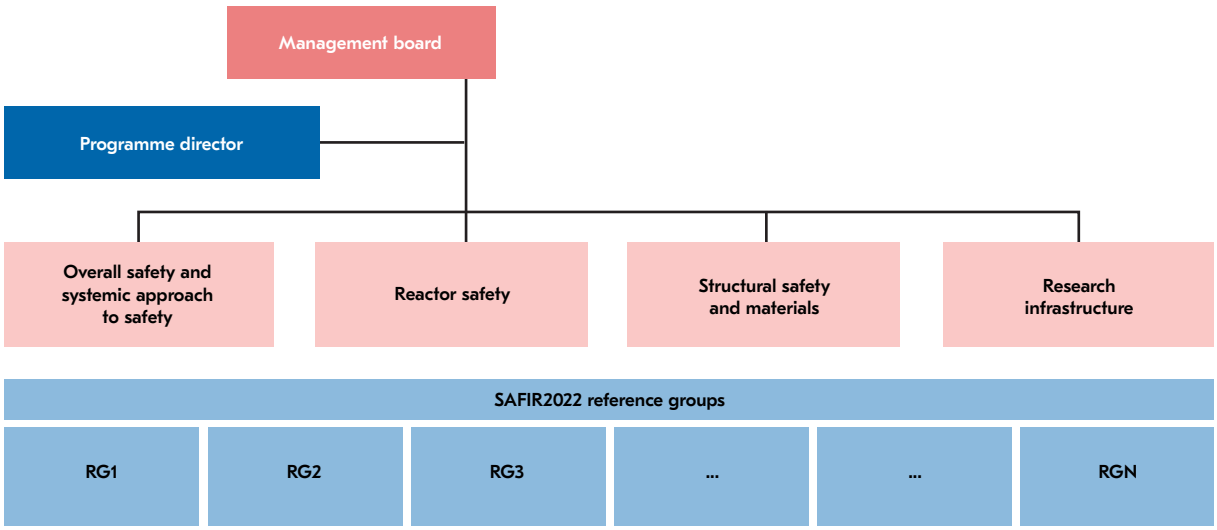

FIGURE 12. The administrative structure of SAFIR2022 research programme.

The SAFIR2018 projects include several projects for developing capabilities, e.g. for avoiding accidents of the type that occurred at the Tepco Fukushima Dai-ichi nuclear power plant or for 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 SAFIR2018 management group may fund small projects aimed at helping the development of research projects with new topics into becoming members of the programme. This procedure has been in use from the beginning, and it has proven to be an efficient way to promote the creation of high standard topical research projects. The objective for the small project in 2018 was to analyse possibilities to utilise 3D printed components in nuclear safety industry.

An international assessment appointed by MEAE was implemented in January 2018, and the assessment group interviewed the key leaders of stakeholder organisations and research projects. The assessment group also visited the research laboratories of VTT and LUT. The group stated that the SAFIR2018 programme was very good and produced more internationally significant research results than it size implied. The group also gave recommendations for further development of the programme. The SAFIR2018 Evaluation Report has been published in the MEAE publication series (MEAE guidelines and other publications, 5/2018).

A framework plan was prepared for SAFIR2022, the new research programme on nuclear power plant safety, and the programme was launched in autumn 2018. 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 reform of the research infrastructure will continue in the coming project term.

The four-year KYT2018 research programme was launched in 2015. The key research topics of the programme are mainly the same as in the KYT2014 research programme. The programme consisted of research areas which are important for national expertise. It aimed at extensive coordinated research projects, particularly regarding the research areas related to the performance of buffer and backfilling materials and the long-term durability of final disposal canisters as well as microbiology. When the Nuclear Energy Act was amended (in 2016), funding of the research infrastructure was added to the KYT2018 programme. In 2018, the last year of the KYT2018 programme, the programme continued with much the same contents as in 2017.

The KYT2018 management team provided funding recommendations to MEAE using assessments by the support groups based on the applicability and content of the subject matter. In 2018, the funding of the KYT2018 programme from the National Nuclear Waste Management Fund (VYR) was approximately EUR 1.9 million. In 2018, the research programme provided funding for 27 research projects representing new and alternative technologies for nuclear waste management (2 projects), safety research concerning nuclear waste management (23 projects), social nuclear waste management research (1 project) and research infrastructure (1 project). The most important coordinated research subjects were buffer and backfilling materials, long-term durability of canisters and microbiology. For 2018, EUR 50,000 had been reserved for small project funding, to be decided on by the management team. This was used to fund two small projects related to safety research.

A framework programme was prepared for KYT2022, and the programme was launched in autumn 2018. The structure of the framework programme was reformed with the aim of increasing the applica-

bility and usability of the research. In the structural reform, research topics were arranged so that they are wider, acknowledge larger entities better and emphasise the integration between projects better. The research topics consist of the assessment of overall safety, the management of spent nuclear fuel, operational 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 reform of the research infrastructure of nuclear waste management will continue in the coming project term.

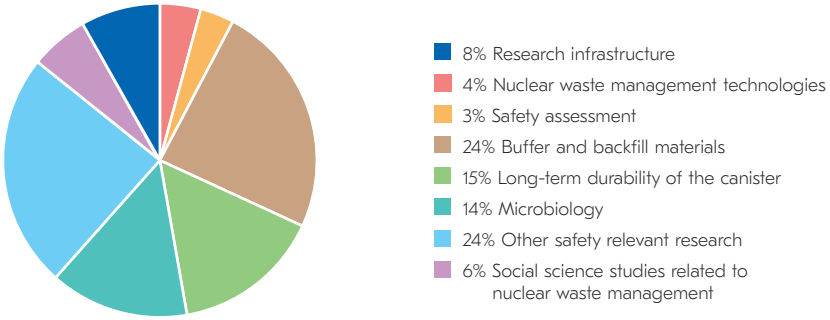

FIGURE 13. Distribution of VYR funding by research area in 2018.

Research area/1000€	2017	2018
Safety assessment	70	58
Buffer and backfill materials	385	401
Long-term durability of the canister	255	255
Microbiology	230.3	238
Other safety relevant research	418	402
Social science studies related to nuclear waste management	100	100
New and alternative technological solutions	62	76
Research infrastructure	143	136
Total	1663.3	1666

TABLE 1. Distribution of VYR funding by research area in 2017–2018. Research area/1000€. Administration project budged is not included in the total funding.

4 Oversight of nuclear facilities in figures

4.1 Processing of matters

A total of 3,334 matters were submitted to STUK for processing in 2018. Of these, 907 concerned the nuclear power plant under construction and 165 concerned the disposal facility for spent nuclear fuel. The review process of a total of 3,412 matters was completed, including matters submitted in 2018, those submitted earlier and licences granted by STUK by virtue of the Nuclear Energy Act, which are listed in Appendix 8. The average matter review time was 69 days. The number of matters and their average review times in 2014–2018 are illustrated in Figure 14.Figures 15–18 illustrate the review time distribution among matters from the various plant units and matters about Posiva.

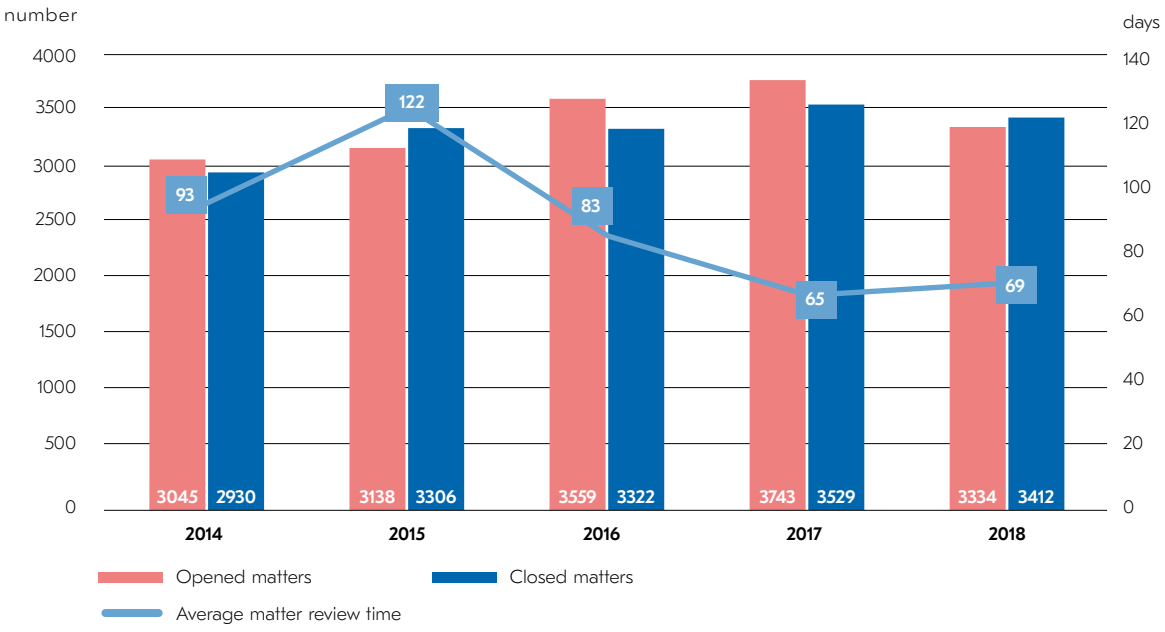

FIGURE 14. Number of opened and closed matters and as well as average matter review time.

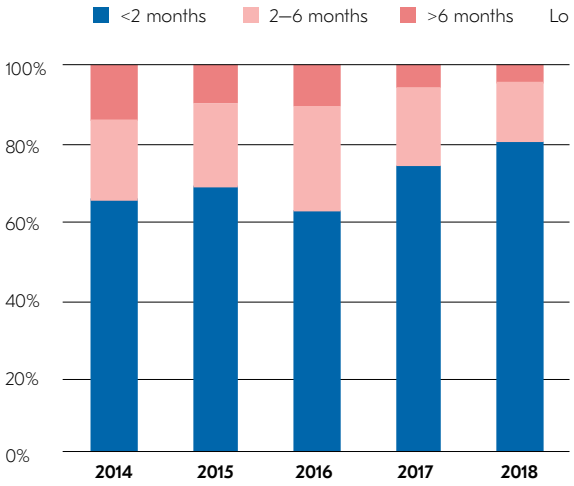

FIGURE 15. Distribution of time spent on preparing decisions on the Loviisa plant.

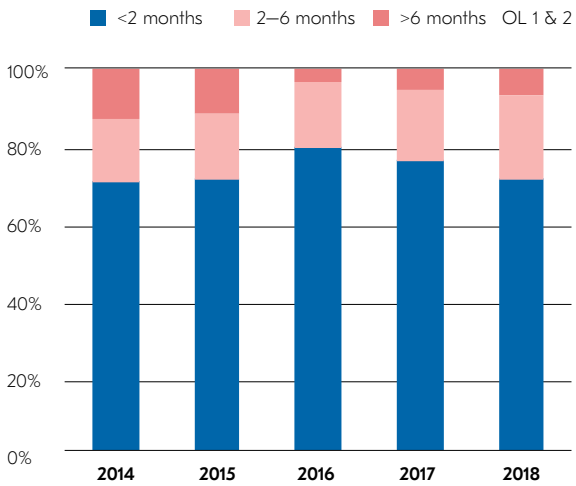

FIGURE 16. Distribution of time spent on preparing decisions on the operating plant units of Olkiluoto.

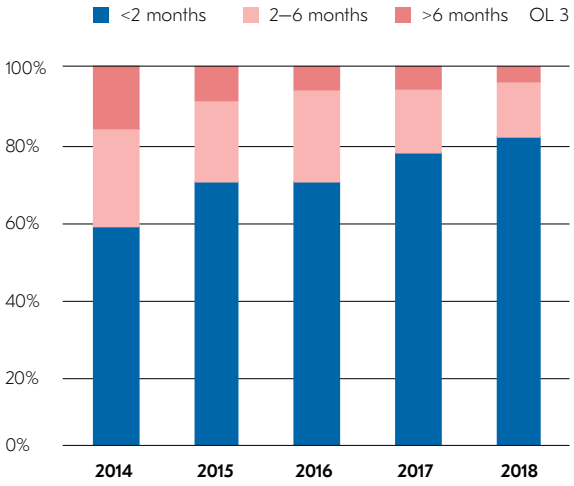

FIGURE 17. Distribution of time spent on preparing decisions on Olkiluoto plant unit 3.

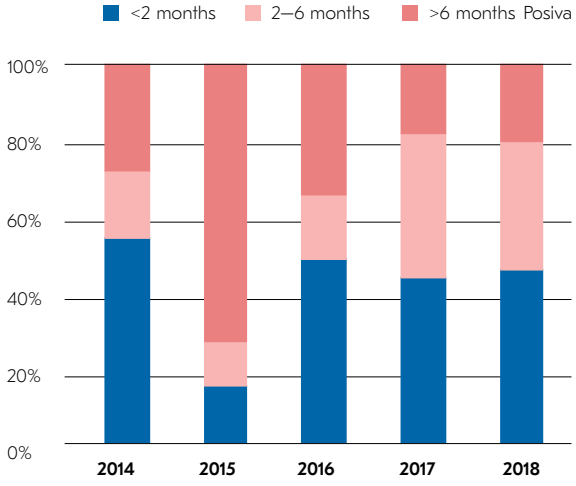

FIGURE 18. Distribution of time spent on preparing decisions on Posiva.

4.2 Inspections at nuclear facility sites and suppliers' premises

Inspection programmes

A total of 16 inspections at the Loviisa plant and 18 inspections at the Olkiluoto plant were carried out under the 2018 periodic inspection programme (Appendix 4). STUK carried out 8 readiness inspections at Olkiluoto 3 and 9 inspections under the periodic inspection programme of Olkiluoto 1 and Olkiluoto 2 that also included Olkiluoto 3 (Appendix 4). 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 2018 (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 2,159 inspections were carried out on site or on the suppliers' premises in 2018 (other than the above-mentioned inspection programme inspections and the nuclear safeguards inspections, which are separately described). An inspection comprises one or more sub-inspections, such as a review of results, an inspection of a component or structure, a pressure or leak test, a functional test or a commissioning inspection. Of the inspections, 835 were related to the regulatory oversight of the plant under construction and 1324 to that of the units in operation.

The number of inspection days on site and on the component manufacturers' premises totalled 3,267. This number includes not only inspections pertaining to the safety of nuclear power plants but also those associated with nuclear waste management and nuclear materials as well as audits and inspections of the underground research facility at Olkiluoto. Five resident inspectors worked at the Olkiluoto power plant and two resident inspectors at the Loviisa power plant. The numbers of onsite inspection days in 2014–2018 are illustrated in Figure 19.

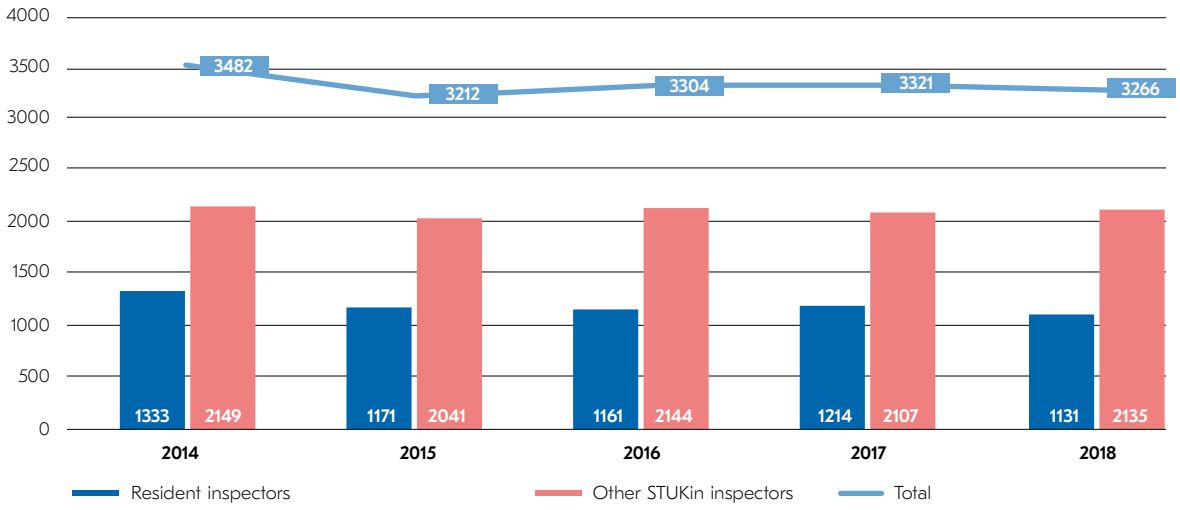

FIGURE 19. Number of inspection days onsite and at component manufacturers' premises.

4.3 Finances and resources

The duty area of nuclear safety regulation included basic operations subject to a charge as well as those not subject to a charge. Basic operations subject to a charge mostly consisted of the regulatory oversight of nuclear facilities, the costs of which were charged to those subject to the oversight. Basic operations not subject to a charge included international and domestic cooperation as well as emergency response operations and communications. Basic operations not subject to a charge are publicly funded. Overheads from the preparation of regulations and support functions (administration, development projects in support of regulatory activities, training, maintenance and development of expertise, reporting, and participation in nuclear safety research) were carried forward into the costs of both types of basic operation and of contracted services in relation to the number of working hours spent on each function.

In 2018, the costs of the regulatory oversight of nuclear safety subject to a charge were EUR 17.8 million. The figure includes the radiation monitoring in the 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 20.7 million. Thus, the share of activities subject to a charge was 86.1%. Figure 20 shows the annual costs of the regulatory oversight of nuclear safety in 2013–2018.

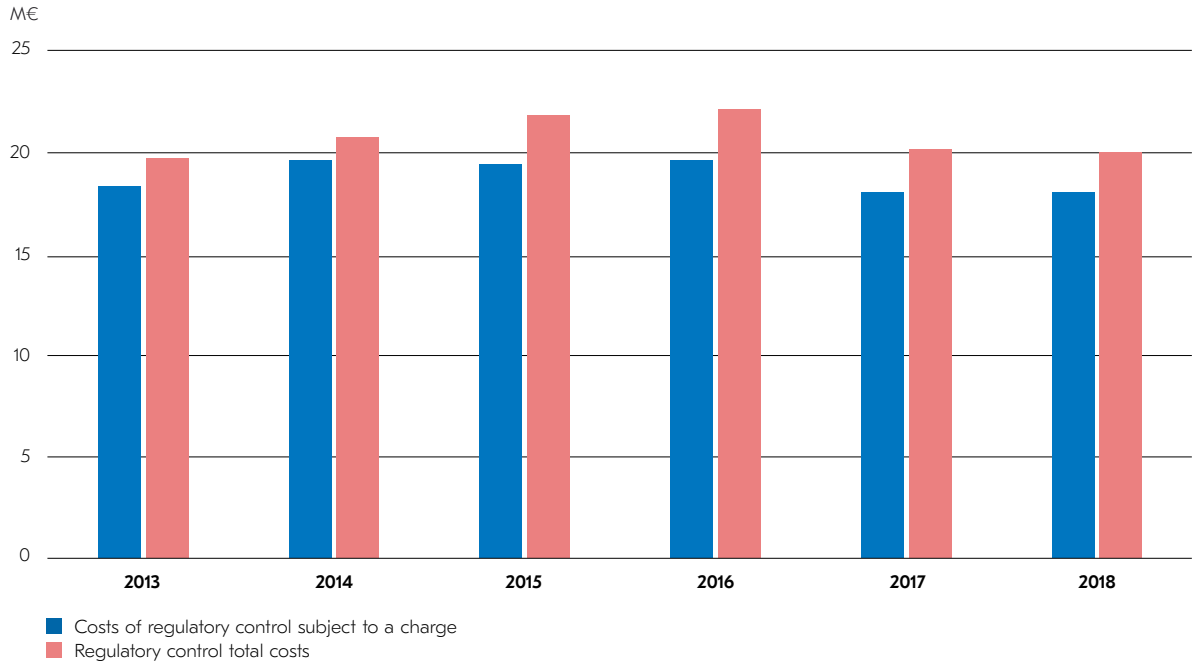

FIGURE 20. Income and costs of nuclear safety regulation.

Attainment of the cost price for the regulatory oversight of nuclear safety is ensured by adjusting the invoicing with a balancing bill to correspond to actual costs after annual cost accounting. Consequently, the cost correlation of the regulatory oversight was 99.0%. The difference between income and costs is due to the charges on small-user waste excluded from the balancing and to radiation monitoring in the vicinity of nuclear facilities, the balancing bills for which are not included in the nuclear facility-specific balancing bills issued at year-end. The income from the regulatory oversight of nuclear safety in 2018 totalled EUR 17.7 million (including radiation monitoring in the vicinity of nuclear facilities).

The time spent on the regulatory oversight of the Loviisa nuclear power plant was 15.8 man-years or 10.5% of the total working time of the nuclear safety regulatory personnel. The time spent on the regulatory oversight of the Olkiluoto nuclear power plant's operating units was 15.6 man-years or 10.4% of the total working time. In addition to the oversight of the operation of the nuclear power plants, these figures include nuclear safeguards. The time spent on the regulatory oversight of Olkiluoto 3 was 18.4 man-years or 12.3% of the total working time. Work related to the Fennovoima plant project amounted to 12.2 man-years or 8.1% of the total working time. A total of 7.2 man-years or 4.8% of the total working time was spent on the regulatory oversight of Posiva's operations, and the time spent on the regulatory oversight of the FiR 1 research reactor was 1.2 man-years. Figure 21 shows the division of working hours of the personnel engaged in nuclear safety oversight (in man-years) by subject of oversight during 2011–2018.

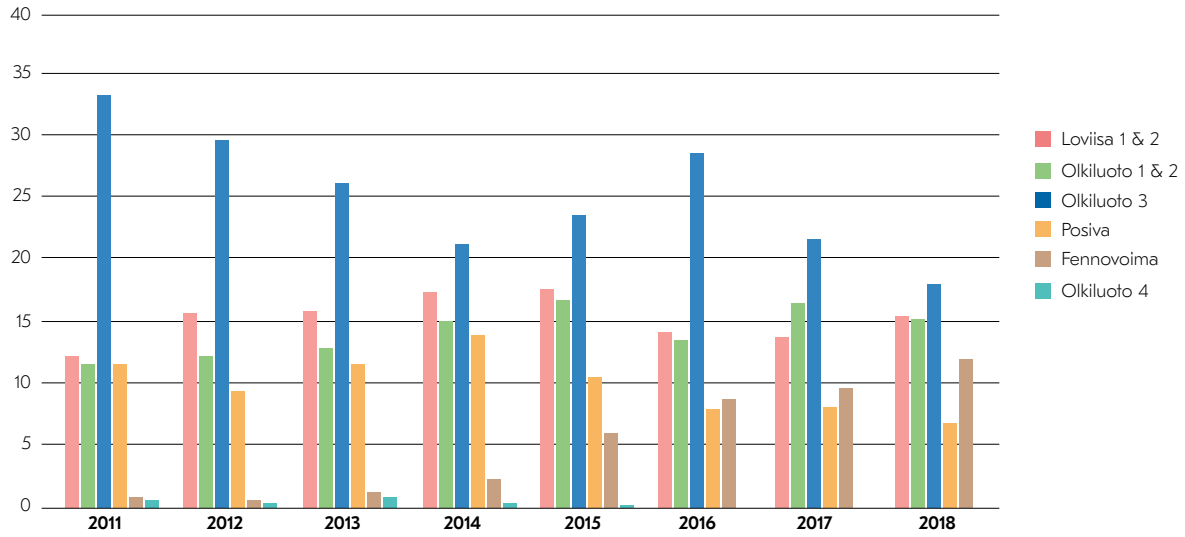

FIGURE 21. Distribution of working hours (person-years) of the regulatory personnel by subject of oversight in 2011–2018.

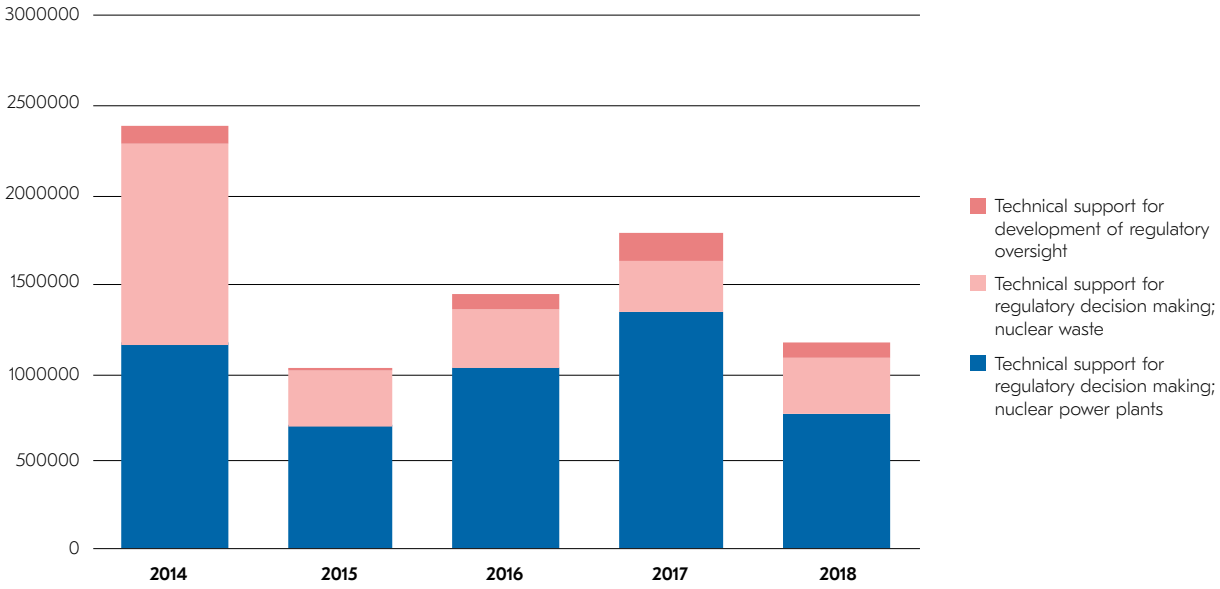

FIGURE 22. The costs of research and commissioned work.

Where necessary, STUK commissions independent assessments and analyses in support of its oversight. Figure 22 illustrates the costs of such assignments in 2014–2018.The expenses in 2018 were mainly associated with the comparison analyses of Hanhikivi 1 and Olkiluoto 3, independent assessments and reports and the assessment of the safety of the spent fuel disposal project.

Distribution of the annual working time of the nuclear safety regulatory personnel to the various duty areas is shown in Table 2. The figures do not include the work for radiation monitoring in the vicinity of nuclear facilities.

Duty area	2014	2015	2016	2017	2018
Basic operations subject to a charge	72.0	76.6	74.9	72.0	71.0
Basic operations not subject to a charge	3.5	2.6	4.0	4.0	4.8
Contracted services	2.9	2.8	2.1	4.3	3.7
Rule-making and support functions	41.8	42.2	44.5	42.9	44.1
Holidays and absences	25.3	26.4	26.6	26.9	26.3
Total	145.5	150.5	152.1	150.1	149.9

TABLE 2. Distribution of working hours (person-years) of the regulatory personnel in each duty area.

5 International cooperation

International conventions

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 2016. STUK participated in the organisation meeting held in October 2018 in preparation of next year's review meeting. The arrangements and officials for the review meeting were decided on in this meeting.

The review meeting for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was held in May 2018. Finland submitted the report for the review meeting in autumn 2017 and participated in the assessment process during 2018 by preparing questions for the other participants and responding to the questions posed to Finland, of which there were 94 in total. STUK published the questions posed to Finland and the answers to them on its website.

The progress of the disposal of spent fuel in Finland was identified by the review meeting as a Good Practice. The start of the operation of the solidification plant in Loviisa, the acknowledgement of waste management already at the beginning of nuclear facility projects, the safety improvements of KPA interim storages and the effective implementation of IRRS recommendations were identified as Areas of Good Performance. However, the Joint Convention took notice of the recommendation that was still open concerning STUK's position in state administration. The improvement of the national management and licensing system for radioactive waste for all types of waste flow, the development of the management and competence relating to decommissioning, and the improvement of the communication of safety matters to citizens so that they understand the safety principles of final disposal were listed as challenges for Finland.

The development of the waste convention in the review meeting did not succeed because a consensus was not reached on the proposed improvements. It was agreed in the meeting that in conjunction with the next organisation meeting in 2020, an extraordinary meeting will be held with the aim of carrying the development forward.

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. An expert from STUK was appointed to the Advisory Committee on Nuclear Security to the Director General of the IAEA (AdSec) for the term 2016–2018.

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)
- nuclear waste management (RWMC, Radioactive Waste Management Committee).

The Multinational Design Evaluation Programme (MDEP) was established on the initiative of the United States nuclear safety authority (Nuclear Regulatory Commission, NRC). It involves 16 countries with the objective of improving cooperation in the field of the assessment of new nuclear power plants and developing convergent regulatory practices. In addition to the United States of America, the following countries participate in the programme: Argentina, Canada, China, Finland, France, Hungary, India, Japan, Korea, Russia, South Africa, Sweden, Turkey, the United Arab Emirates and United Kingdom. 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 and issue-specific working groups. In addition, the MDEP has a Policy Group and a Steering Technical Committee. 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).

The only MDEP working group which is independent of plant design deals with plant and equipment vendor inspections. The other issue-specific group, which dealt with pressure equipment standards, was transferred in 2018 to be part of the cooperation performed under the framework of the CNRA. STUK participated in the activities of both issue-specific working groups.

STUK actively participated in the work of WENRA's (Western European Nuclear Regulators Association) Reactor Harmonisation Working Group (RHWG) in 2018. The most important tasks in 2018 included the update of reference levels relating to external threats. STUK was also involved in RHWG's subgroups that developed the reference level update plan for WENRA, prepared a report on the principles of practical elimination, developed a procedure to assess and compare the fulfilment of the reference levels at plants and started an assessment on the need for updating the safety objectives.

STUK actively participated in the work of **WENRA's Working Group on Waste And Decommissioning (WGWD)** in 2018. The working group convened twice. Self-assessments and peer reviews of reference levels associated with disposal were completed during the year, and a reference level report on nuclear waste processing facilities was finalised. The peer review of reference levels concerning the treatment of nuclear waste was started in 2018.

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). ENSREG decided that the theme of the first Topical Peer Review, which will be arranged every six years from now on according to the Nuclear Safety Directive that was updated in 2014, is management of the ageing of nuclear power plants. In cooperation with Finnish power companies, STUK produced a national report on the peer review and published it on its website at the end of December 2017. Finland participated in the peer review of EU countries in the spring of 2018 by assessing the national reports of other countries and answering questions regarding the national report of Finland. The workshop on the peer review was organised in Luxembourg in May 2018. As regards Finland, the most significant development areas relate to ageing management in prolonged construction projects. At equipment level, update needs were identified in the in-service inspection programme of the base material in the core area of the reactor

pressure vessel. Good practices that came up included Finland's active participation in international peer reviews, for example, SALTO and OSART coordinated by the International Atomic Energy Agency (IAEA). As regards identified development areas, a national action plan will be prepared by September 2019.

STUK prepared a report required by the EU Waste Framework Directive on the management of radioactive waste and spent nuclear fuel. The report was prepared in accordance with the updated instructions of ENSREG. Otherwise, as regards nuclear waste management, STUK participated in the operation of ENSREG, the main focus of which was on compiling the peer review programme and examining the fulfilment of certain areas of the directive (inventories of radioactive material, preparation for costs).

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 2018 was postponed until January 2019. In addition to the actual substance, the development of the working methods of the group will also be discussed.

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. The annual meeting of the VVER Forum was organised in June in Belarus, and STUK participated in the meeting. STUK also took part in activities of the Forum's working groups during 2018.

Bilateral cooperation between authorities

STUK continued its regular meetings with the **Swedish nuclear safety authority SSM**, focusing on topical issues concerning nuclear power plants. The issues included topical oversight matters concerning plants, regulatory oversight tools, the management system of nuclear safety regulation, competence and resource issues of the authorities, STUK's new strategy and the related projects, overall safety assessments and inspector exchange between authorities.

STUK started regular cooperation with the **French nuclear safety authority Autorité de sûreté nucléaire (ASN)** and its support organisation **Institut de radioprotection et de sûreté nucléaire (IRSN)** when the Olkiluoto 3 project was launched in the early 2000s. 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 2018, STUK met with ASN and IRSN in Helsinki in September. Topical issues regarding commissioning, the preparation for operation and mechanical components were discussed in the meeting. The Olkiluoto 3 site was visited after the meeting.

Cooperation with the **Russian nuclear safety authority Rostechnadzor (RTN)** was expanded to also cover issues pertaining to the safety assessments of AES2006-type VVER plants. Four AES-2006 plants are currently under construction in Russia. Of them, the Leningrad 2 plant in Sosnovyi Bor is the reference plant for Fennovoima's Hanhikivi 1 project. The situation of the plant projects was discussed in the annual meeting, which agreed on future cooperation relating to, for example, experiences from the commissioning of the first unit of the Leningrad 2 power plant.

An AES-2006 plant is also under construction in Astravets, in Belarus. In 2018, STUK had no bilateral meetings with the **nuclear safety authority of Belarus, Gosatomnadzor (GAN)**, but STUK participated in the international safety assessment of the Astravets plant conducted on the initiative of the European Nuclear Safety Regulators Group (ENSREG).

The Hungarian radiation and nuclear safety authority HAEA has also started preparation for a safety assessment of an AES-2006 nuclear power plant (PAKS-2 project). In 2018, STUK and HAEA held two collaboration meetings concerning plant design issues.

Cooperation for the prevention of the proliferation of nuclear weapons

The IAEA organised the "Symposium on International Safeguards: Building Future Safeguards Capabilities" in November in Vienna. The symposium is held every four years, and it attracted 900 participants from more than a hundred different countries. STUK and Finnish operators gave several presentations at the event.

STUK's representatives have participated in the work of the Executive Board and Steering Committee of the **ESARDA (European Safeguards Research and Development Association)** as well as the association's strategy work group (Reflection Group). ESARDA held its annual meeting in Luxembourg in May, and the **INMM (Institute of Nuclear Material Management)** held its annual meeting in Baltimore, USA in July. The presentations by STUK's representatives at the meetings were mainly concerned with the control of new nuclear facilities during design and the safeguards control of final disposal.

A group of nuclear supplier countries, the **Nuclear Suppliers Group (NSG)** is a multilateral export control system that seeks to contribute to the non-proliferation of nuclear weapons by controlling the export of materials, equipment and technology that can be used to manufacture nuclear weapons. There are 48 Participating Governments of the NSG. Finland is represented in the NSG by the Ministry for Foreign Affairs. An expert from STUK participated in the meetings of NSG's Technical Expert Group held in April and November.

Nuclear security is often multi-authority operation. It is related to a strong international dimension. Established in 2006, the **Global Initiative to Combat Nuclear Terrorism (GICNT)** is one of the key international nuclear security forums. Its participants currently consist of 88 countries and six international organisations. The GICNT develops the nuclear security readiness and cooperation of the partner nations, for example, through practical exercise. Finland (the Ministry for Foreign Affairs) will act as the coordinator of the GICNT until summer 2019. STUK acts as the technical advisor of the Ministry for Foreign Affairs.

The International Partnership for Nuclear Disarmament Verification (IPNDV) develops techniques and procedures to ensure the dismantling and destruction of nuclear weapons. The second phase of the IPNDV started in the beginning of 2018 and will end at the end of 2019. In the second phase, the IPNDV has been expanded to also cover other stages of nuclear disarmament besides the dismantling of the weapons. In addition, work in the second phase has become partly more concrete through various technology demonstrations and exercises. Invited by the United States, both nuclear and non-nuclear weapon states participate in the IPNDV. Finland has participated in the initiative since its launch. The tasks of STUK in the IPNDV have always been related to the development of technological verification methods.

The Non-Proliferation Treaty (NPT) entered into force in 1970. The parties of the Non-Proliferation Treaty include approximately 190 countries. The **NPT Review Conference** is held every five years. The previous conference was held in 2015, and the next will be held in 2020. The NPT Preparatory Committee holds sessions prior to the Review Conference. An expert from STUK, together with the Ministry for Foreign Affairs, the Ministry of Economic Affairs and Employment, the Ministry of Defence and other organisations, attended the session held in May in Geneva.

The Stimson Center is an independent research centre conducting safeguards research, among other things. In cooperation with experts from INMM, the Stimson Center organised a visit to Finland in October with the aim of exploring the safeguards control of final disposal. STUK hosted the visit in cooperation with Posiva, and its implementation also involved the Ministry for Foreign Affairs, the Ministry of Economic Affairs and Employment and the municipality of Eurajoki.

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	Construction license granted 17 Feb 2005		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 construction.

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

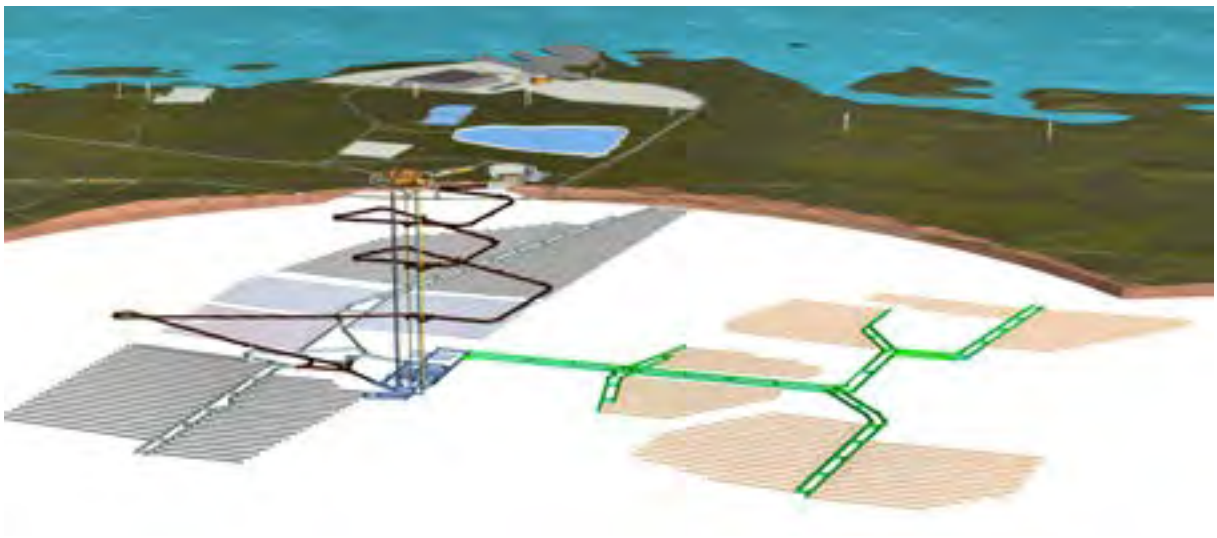

Diagram of the encapsulation and disposal facility in Olkiluoto (Posiva Oy).

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. 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. Onkalo provided an opportunity for more detailed study of the rock volumes best suited for the disposal of spent nuclear fuel and allowed for the testing of disposal facility construction methods and installation of the disposal system components.

FiR 1 research reactor

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

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

Other objects of regulation

In accordance with Section 2 of the Nuclear Energy Act, the regulatory control of the use of nuclear energy covers the nuclear material in 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 oversight 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. As nuclear material, the intermediate products of metal industry containing uranium were also included in the regulatory oversight of the use of nuclear energy in 2018.

APPENDIX 2
Significant events at nuclear power plants

Loviisa power plant

Annual outages at Loviisa, 5 August – 18 October 2018

The annual outages of the Loviisa nuclear power plant started on 5 August at the Loviisa 2 unit. The outage of Loviisa 2 was the extensive outage implemented every eighth year, which involved carrying out extensive primary circuit inspections with pressure tests. The annual outages of Loviisa 2 were completed on 21 September 2018. The annual outage of Loviisa 1, which started after that on 22 September 2018, was a short fuel replacement outage. Significant plant improvements were also carried out at both plant units, and Fortum acted in accordance with good nuclear and radiation safety during the outages.

The maintenance work was supervised by approximately 30 STUK experts who supervised that Fortum acted in accordance with radiation and nuclear safety and carried out the maintenance work in a safe manner. At both plant units, the key section related to safety automation was replaced and the associated modernisation of secondary circuit safety functions was completed. During the outages, STUK supervised particularly this alteration work as a part of its inspection targeted at annual outages in accordance with the periodic inspection programme. Other subjects of the annual outage inspection included fire prevention and management of foreign material as well as familiarising the staff with duties that are important for annual outages. Based on the inspection, the annual outages went safely and the aforementioned extensive alteration work was completed as planned. The inspection summary is provided in Appendix 3.

The radiation doses of the workers who participated in the annual outages were clearly below the dose limits laid down in the Radiation Decree. The combined radiation dose for the annual outage of Loviisa 2 was 947 manmSv, which is somewhat higher than Fortum's preliminary estimate. For Loviisa 1,

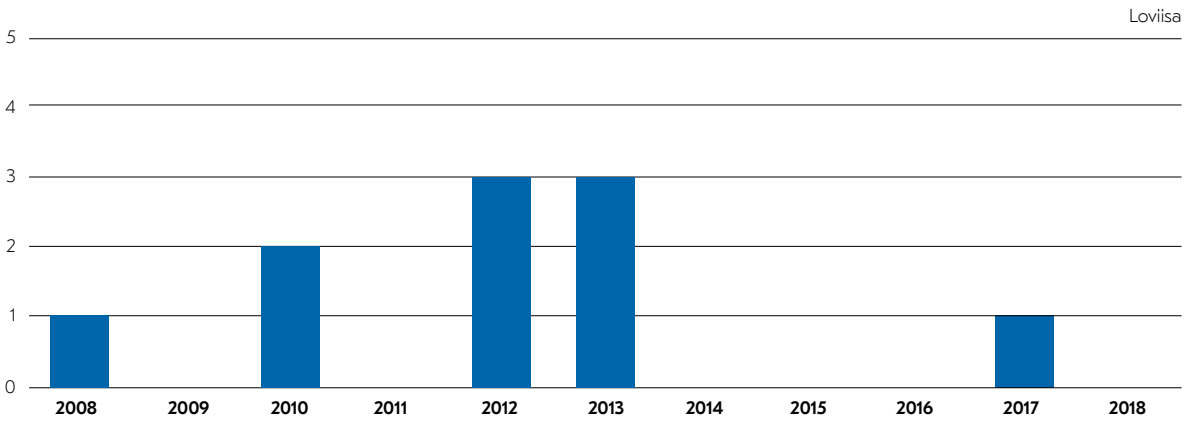

FIGURE A2.1 INES classified events at the Loviisa plant (INES Level 1).

the result of 244 manmSv was significantly under the preliminary estimate. The combined radiation dose of the two units was the lowest in operating history compared to similar annual outages.

During the outage, STUK performed measurements of workers' internal contamination in its measurement vehicle. Among the 93 persons measured, the recording threshold of 0.1 mSv was exceeded slightly for two persons, the measured values being 0.11 mSv and 0.13 mSv. The results are very low and do not cause a health hazard.

The environmental radioactivity measurements or environmental samples taken during the outage were not found to contain radioactive substances that would cause a hazard to people or the environment.

The most significant plant events at Loviisa took place during the outages

During the annual outages, three events took place that violated the operational limits and conditions (OLC). Two of them occurred during the annual outage of Loviisa 2 and were associated with the functioning of the fuel pool cooling system. The first involved a minor administrative error in which a system connected to residual heat removal was isolated even though the surface level of the fuel pool was below the level required for such a situation. The level had been reduced in order to facilitate inspection of the bottom ring in the other pool. The second involved a control I&C failure due to which the cooling of the fuel pool was lost momentarily (30 min) after all fuel had been transferred into the pool. The temperature of the pool and fuel remained stable during both events, and therefore they did not cause a hazard. As corrective actions for the first event, Fortum will improve the review of work planning and recognition of OLC requirements during the work coordination phase, and regarding the second event, Fortum will make the power supply of the control I&C of fuel pool cooling redundant.

In the third event that violated the OLC, it was noticed at Loviisa 1 that a sheet of plywood had been accidentally left in front of a ventilation air intake opening important to safety, covering and blocking it. The sheet of plywood was removed and other similar air intake ducts at the plant were inspected. During the investigation of the event, Fortum was unable to determine when and why the sheet of plywood, which had apparently been on the duct for years, had been installed in the air intake opening. In spite of the event, the ventilation was sufficient for safety, which reduced the possibility of detecting the erroneous installation afterwards. The event emphasises the importance of meticulously finishing all work completed at the plant to ensure that systems are left in the proper state after the work.

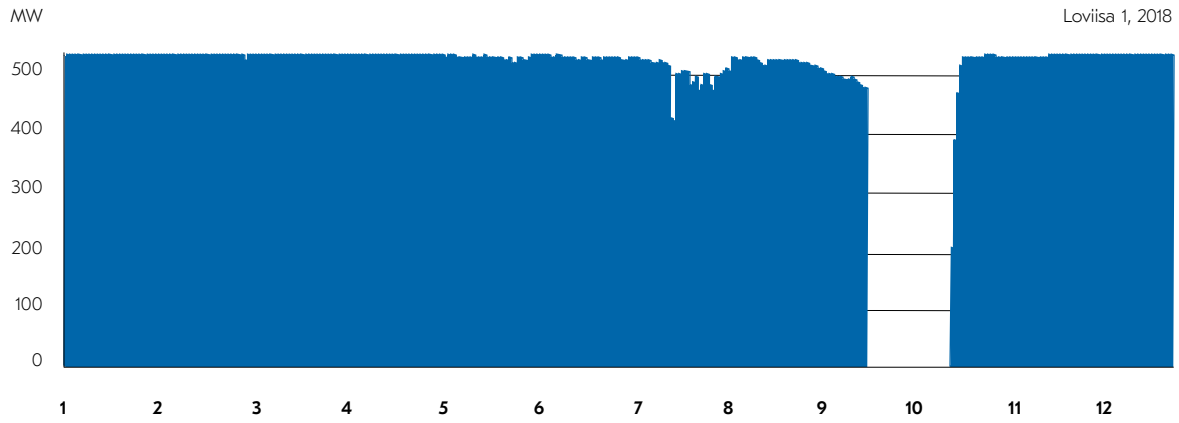

FIGURE A2.2 Daily average gross electrical power of the Loviisa 1 plant unit in 2018.

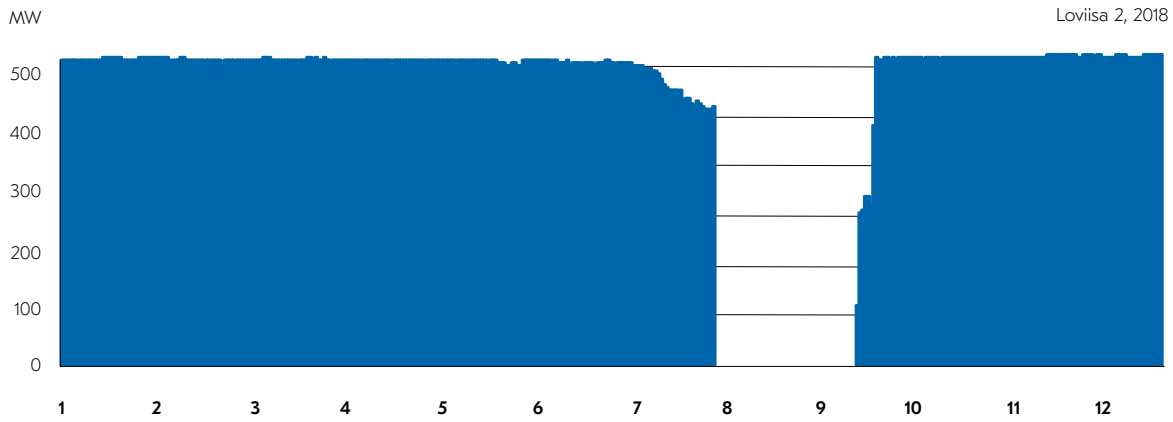

FIGURE A2.3 Daily average gross electrical power of the Loviisa 2 plant unit in 2018.

All of the events were preliminarily rated on the international scale as belonging in the INES 0 category, and they did not cause a radiation hazard to people or the environment. The power company investigated the events and their causes, submitting the results of the investigation to STUK for assessment.

In addition to these, investigative actions were required due to the collision of a biological shield with a fuelling machine railing during the lifting of the new polar crane's heavy support cage before the start-up of Loviisa 2. The event as such had no impact on plant safety, but because heavy lifting is one of the most significant risk factors in an annual outage, special care must be taken during lifts. Fortum suspended the lifting work and investigated matters related to the event and the corrective actions. During the investigation, it was noted that there was room for improvement, for example, in procedures and the operation monitoring technology of the new crane, which were improved based on the observations. Lifts important to safety were not continued until after STUK issued an oral permission to continue once the corrective actions had been completed. As a consequence of the event, STUK supervised the lifts closely during the annual outages of Loviisa 1 as well.

Lack of separation in non-safety-classified I&C

The Loviisa plant has planned to update its process computer system, which is non-safety classified system. During the review relating to the planning of this modification in spring 2018, STUK observed that the separation of I&C signals connected to the process computer system is deficient. Non-classified and safety classified signals of both parallel subsystems of the plant had been connected to I&C cabinets in the same room instead of separating the signals into different rooms. In situations such as a fire or flood, a lack of separation like this can cause error signals that spread throughout the I&C systems controlling the plant and disturb the operation of systems important for both normal use and safety. The room in question, along with its equipment and signal routings, is part of the original design of the plant. As immediate actions, Fortum further improved the fire protection arrangements of the room.

STUK required Fortum to immediately determine what kinds of error signals and malfunctions a fire situation in the room in question would cause. The investigation involved going through the design and separation of approximately 6,300 signals and assessing the effects of these malfunctions for the safe shutdown of the reactor. In addition, Fortum investigated the effects using probabilistic risk assessment (PRA). STUK inspected and approved Fortum's report.

The main result of the analysis was that the lack of separation had no effect on the key safety functions such as reactor protection, plant protection or the management of severe accidents or bringing the plant to a safe state. However, the lack of separation may hamper bringing the reactor to a final safe shutdown state, for example, by causing incorrect interlockings for some of the plant's locations dur-

ing a fire in the room under analysis, and prevent control room steering of these locations. Despite the examined faults, all this equipment can be controlled either locally (for example, with a hand wheel) or from the main distribution. According to the PRA results, the significance of the event is low because an extensive fire in a room with a lack of separation is very unlikely.

Based on the report, Fortum prepared preliminary plans on safety modifications to repair the lack of separation and determined the necessary modifications to the instructions on redundant manual actions in a fire situation. The necessary modifications to the instructions regarding safe shutdown were made during 2018. According to Fortum's plan, the most significant safety modifications to the separation will be included in the update of the process computer system in 2019 and the rest will be implemented as individual jobs in 2020–2021. STUK considered the assessments sufficient and approved the repair plan presented by Fortum.

Olkiluoto power plant

Operating licence renewal for the Olkiluoto 1 and 2 plant units

For a statement for the Ministry of Economic Affairs and Employment (MEAE), STUK prepared a safety assessment of the Olkiluoto 1 and 2 plant units, which was based on STUK's review of matters and documents related to the operating licence application, the review of TVO's own periodic safety review and the results of STUK's continuous regulatory oversight. STUK asked the Ministry of the Interior for a statement on the security arrangements and physical protection, and the Advisory Commission on Nuclear Safety for an opinion on STUK's draft statement.

Review of the documents started at STUK in early 2017, once TVO had submitted to STUK clarifications connected to the periodic safety review in accordance with Guide YVL A.1. In spring 2017, STUK made a request for clarification regarding the documents. Based on the requirements in the request for clarification, TVO supplemented the documents and provided updated clarifications in summer 2017. Key areas of STUK's review included ageing management, revised safety assessments, the organisation and the personnel as well as matters related to operation of the plant and its safety culture.

STUK delivered its statement on the operating licence application to MEAE on 31 May 2018. In its statement, STUK supported the application to continue the operation of the operating plant units in Olkiluoto. According to STUK's assessment, the continued operation of the plant units is safe and meets

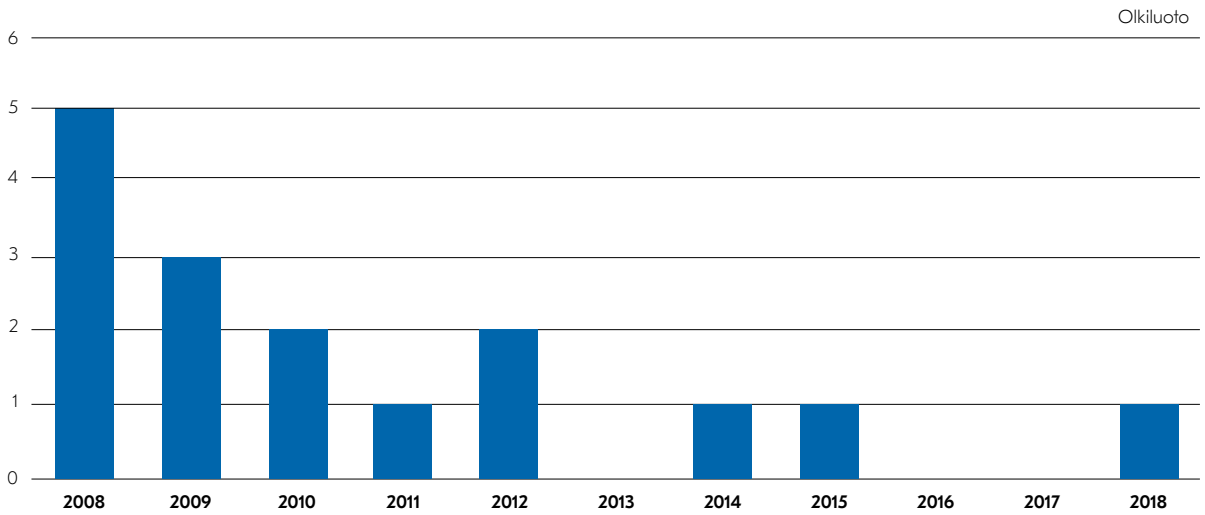

FIGURE A2.4 INES classified events at the Olkiluoto plant (INES Level 1).

the statutory requirements. STUK also assessed that the nuclear waste management arrangements used by TVO are adequate and appropriate. Therefore, STUK saw no reason not to issue an operating licence for the plant units for 20 years in accordance with TVO's application. In its statement, STUK stated that if the operating licence is issued for the time period specified in the application, TVO must carry out a periodic safety review of the plant units and submit it to STUK for approval by the end of 2028.

The design basis concerning the systems, structures and components (SSCs) of the Olkiluoto 1 and 2 nuclear power plant units was primarily issued in the 1970s. The goal for the operating period of the plant has been to ensure the continuous improvement of plant safety. TVO has retrofitted the Olkiluoto 1 and 2 plant units to a significant degree and, during the facility's operating history, carried out extensive modifications on the plants' systems, structures and components in order to improve safety. In its statement, STUK emphasised that, in the coming operating licence period, it is important to continue the implementation of the safety-improving measures. Based on the documentation submitted to STUK, TVO is committed to continuing the efforts to improve plant safety also during the coming operating licence period.

Over the course of the current operating licence period, TVO has significantly reduced the risk of core damage and large release at the Olkiluoto 1 and 2 units. However, among the risk reduction opportunities, the share of a common cause failure in the protection I&C system's terminal, which is currently about 8% of the total core damage frequency, remains to be examined. Based on its own periodic safety

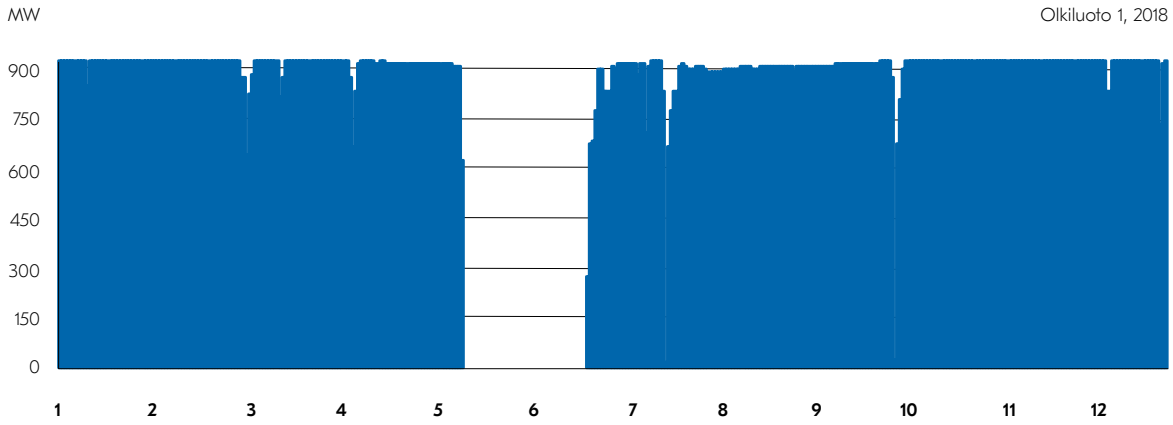

FIGURE A2.5. Daily average gross power of the Olkiluoto 1 plant unit 2018.

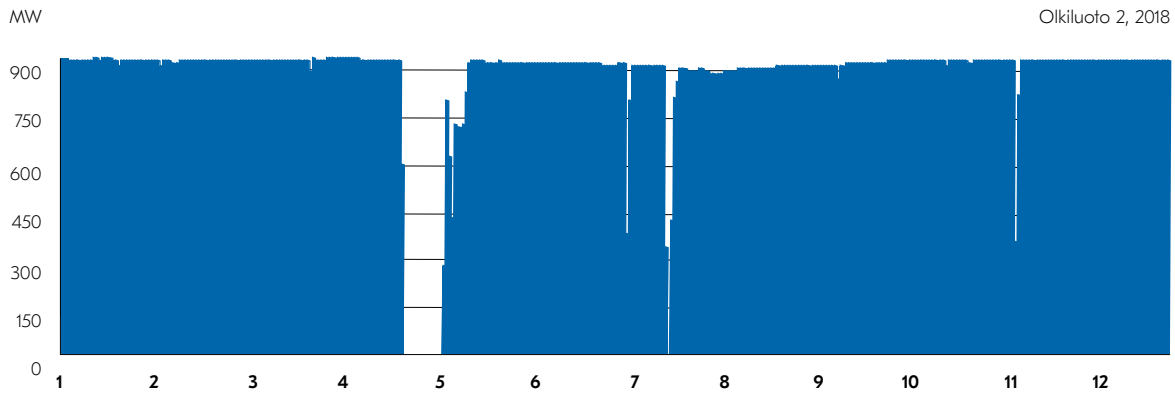

FIGURE A2.6. Daily average gross power of the Olkiluoto 2 plant unit 2018.

review, STUK required TVO to investigate in more detail how this risk could be reduced. TVO must analyse the significance of common cause failures in the reactor protection system's terminal relays from the perspective of the reliability of the safety functions and the core damage frequency and use these analyses to determine the necessary measures to reduce the core damage risk caused by the aforementioned common cause failures.

TVO's application for the continuation of the operating licence in such a way that the original design-basis service life of 40 years will be exceeded by 20 years is largely based on ageing management. TVO's goal is to keep the SSCs of the Olkiluoto 1 and 2 nuclear power plant units continuously up-to-date and in good condition in terms of safety and production capacity. TVO has an ageing management programme which entails the functions, tasks and responsibilities to ensure the operability of the SSCs related to safety for the entire duration of their service life. Early identification of the relevant SSCs and the related ageing phenomena makes possible far-reaching predictions and plans on the requisite fundamental improvements and maintenance tasks. According to STUK's assessment, ageing management at the Olkiluoto 1 and 2 units has been organised in an appropriate manner.

TVO has updated the strength analyses of the primary circuit to correspond to a service life of 60 years. The analyses cover the Safety Class 1 pipes, the reactor pressure vessel and the reactor pressure vessel internals. The strength analyses cover dimensioning against pressure and other mechanical design loads as well as tension and fatigue analyses for critical points. The design loads account for the various operating and accident situations of the primary circuit as well as the effects of the environmental conditions. Based on the analyses, the safety margins remain sufficient for the entire planned 60-year service life of the plant unit.

At the Olkiluoto 1 and 2 units, the primary circuit's periodic pressure test has not been performed since the commissioning of the plant units. By STUK decisions, periodic pressure tests have been replaced with tightness tests (1.02 × operating pressure) conducted at 8-year intervals, which is permitted by the ASME XI standard for reactor plants planned and inspected in accordance with ASME requirements. When the pressure test was originally replaced with a tightness test compliant with ASME XI, it was not known that the service life of the plant units would be longer than the 40 years presumed in the ASME version effective at the time. For this reason, STUK required, based on its own periodic safety review, that the periodic primary circuit tightness test prescribed by the current procedure must be replaced with a periodic pressure test conducted every eight years at the maximum allowable operating pressure. The purpose of the pressure test is to demonstrate through tests that the known or any possible latent ageing mechanisms have not weakened the integrity of the primary circuit once the plant units have reached their original design life span. The first pressure tests on Olkiluoto 2 must be conducted in 2019 and on Olkiluoto 1 in 2020.

In its review, STUK took particular notice of the development of the work atmosphere and staff turnover in TVO's organisation. In order to improve the safety culture, work atmosphere and management, TVO has launched extensive programmes to improve the safety culture, work atmosphere and management. In 2017 and 2018, STUK carried out intensified regulatory oversight on the implementation and efficacy of TVO's measures. Based on the oversight, STUK stated that the work done at TVO is systematic and that the safety culture in the company is currently at an acceptable level. However, TVO must continue its development work because the improvement of matters requires long-term efforts. Based on its own periodic safety review, STUK required TVO to provide periodic reporting on the development of the safety culture and work atmosphere. The annual report must be submitted to STUK for information regularly until STUK deems that the positive development of the work atmosphere and safety culture at TVO has been established as the norm and that the human resource situation has stabilised.

The Finnish Government issued a new operating licence for the plant units on 20 September 2018. The licence facilitates operation of the plant units until the end of 2038.

Olkiluoto annual outages on 22 April–23 June 2018

The Olkiluoto annual outages started on 22 April 2018, when TVO shut down Olkiluoto 2 for a fuel replacement outage. During the maintenance of unit 2, which ended on 6 May, TVO carried out the work associated with a normal annual outage, such as replacing approximately one-fifth of its nuclear fuel with fresh fuel. The maintenance outage of Olkiluoto 1 started on 13 May 2017. During the maintenance outage, TVO for example replaced parts of the primary circuit, which carries radioactive water and steam, such as the cleaning system's heat exchangers, sea water condenser and five of the six main coolant pumps – one was replaced earlier, in 2016. The annual outages ended when, after STUK had issued the start-up permit, unit 1 of the Olkiluoto power plant was reconnected to the national grid on Saturday, 23 June.

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 monitors the radioactivity of the environment near the Olkiluoto power plant and regularly takes samples of the air, soil and marine environment. During the annual outage, extremely small amounts of radioactive iodine were observed in the air at sampling stations near the power plant. This was to be expected because fuel rods that had broken during the operating cycle were removed from the reactor during the annual outage. The observed amounts of iodine were so small that they could barely be detected by the highly accurate measuring instruments. They did not affect the safety of the environment or people.

The regulatory oversight of the annual outage was carried out by approximately 30 STUK experts. They ensured that TVO 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. During this year's outages, STUK oversaw in particular the installation and commissioning of a new electricity-independent steam-driven make-up water system at both plant units. The new system further improved the safety of the plant units in case of loss of power. Other subjects of the regulatory oversight during the annual outage included fire prevention and management of foreign objects as well as familiarising the staff with duties that are important for annual outages. Based on the inspection, the annual outages went safely and almost all the work planned for them was completed. No safety deficiencies that would have required immediate intervention by STUK emerged during the inspection. The inspection summary is provided in Appendix 3.

Olkiluoto 2 reactor scram, 8 May 2018

On 8 May 2018, Olkiluoto 2 was undergoing power increase to full power after the 2018 annual outage. At power level 98%, a reactor scram occurred due to condition SS15 (high power relative to the main coolant flow) when five of the six main coolant pumps stopped simultaneously. The reason for the main coolant pumps stopping was a transient in the off-site grid. Due to the transient, the protections of the main coolant pump frequency converters stopped the frequency converters (the contactors opened), which caused the main coolant pumps to stop. The grid transient was caused by a deviation in the changeover switching of the Fenno-Skan connection managed by Fingrid.

As a consequence of the tripping of the scram, all control rods were inserted into the reactor in scram mode and the cooling of the condensation pool started. All of the safety functions for scrams functioned as planned.

For the frequency converters, it was a common cause failure in regard to the protection parameter settings. A protection function based on a parameter value that was too low caused five frequency converters to stop during a transient where the protection function in question was not necessary. In the situation, the impact mainly focused on the Olkiluoto 2 unit, where the replacement of main coolant pump frequency converters had been fully completed. As a result of the event, the protection settings

where changed, due to which the immunity to interference of the frequency converters of both plant units is better in regard to similar transients.

The event did not affect the plant's nuclear or radiation safety, but due to the common cause failure of the frequency converters, the event has been rated at level 1 on the International Nuclear and Radiological Event Scale (INES).

Switchyard fire, 18 July 2018

On 18 July 2018, there was a fire at the 400 kV switchyard of the substation of transmission system operator Fingrid in the Olkiluoto area. The fire started when a current transformer failed at the switchyard. The fire also spread to the cable culvert, which caused the greatest consequences for Olkiluoto 2 and later Olkiluoto 1.

As a result of the switchyard fire, Olkiluoto 2 had a reactor trip at 08:57 due to scram condition SS15. The tripping of scram condition SS15 (see above) was caused by the stopping of all main coolant pumps, which caused the reactor operation point (reactor power relative to main coolant flow) to exceed the trip limit.

The reason for the stopping of the main coolant pumps and the reactor scram was the pumps' loss of power due to the loss of the 400 kV connection.

All of the plant's safety functions functioned as planned during the event and the reactor scram. During the event, the voltage of the plant's internal consumption grid decreased, which caused the emergency diesel generators to start as planned, the plant's loads to transfer to the 110 kV supply and the condensation pool cooling to start. The off-site grid (110 kV) and feedwater remained available. Reactor water had time to stratify before any main coolant pumps could be restarted, due to which the reactor had to be cooled by blowing steam into the condensation pool. However, this did not affect nuclear safety. Olkiluoto 2 ended up in a hot shutdown state.

The event was rated at 0 on the International Nuclear and Radiological Event Scale (INES), meaning that it has no significance for nuclear or radiation safety. The event did not affect the safety of the plant, personnel or the environment.

At 21:39 on the same day, when restoring the electrical protections during the repairs of the 400 kV switchyard, the Olkiluoto 1 plant unit lost contact with the 400 kV grid, which resulted in a partial reactor scram. The reactor power of Olkiluoto 1 fell to approximately 30%, and the plant unit was left on house load operation. The plant and its safety systems functioned as planned during the operational occurrence.

TVO investigated the events in cooperation with Fingrid and determined corrective actions aimed at improving the plant units' failure tolerance of off-site grid transients as well as TVO's own actions during operational occurrences.

APPENDIX 3
Periodic inspection programme of nuclear power plants 2018

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 2018 inspections.

	Inspections in 2018	
Basic programme	**Loviisa 1 and 2**	**Olkiluoto 1 and 2**
Human resources and competence	x	x
Management and safety culture	x	x
Management system	x	x
Disposal facilities		x
Chemistry		
Operating experience feedback	x	
Operation	x	
Plant maintenance	x	x
Fire protection	x	x
Utilisation of the PRA		x
Structures and buildings		x
Radiation Protection	x	x
Nuclear security	x	x
Safety design	x	x
Safety functions	x	x
Emergency preparedness arrangements	x	x
Power plant waste	x	
Annual outage	x	x
Nuclear safeguards		x
Special subjects		
Management and safety culture (additional)		x
Management of modifications (additional)		x
Establishing the reason for operational events and impact of the actions	x	
KPA storage lifting and transfer equipment (additional)	x	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.

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

Human resources and competence, 7–8 May 2018

The inspection concerned the procedures with which Fortum specifies, plans and ensures the competence and human resources needed for the use of nuclear energy. Procedures relating to staff orientation were also inspected. STUK verified that Fortum has specified group-specific competence requirements by job title.

Fortum does not have documented procedures for assessing and verifying competence, but the assessment practices are supposed to be standardised using the requirement specifications prepared in connection with the ongoing competence management project. Fortum will prepare the staff establishment plans by unit in connection with annual planning. For the most important tasks, follow-up plans have been prepared to be updated annually. From reports of internal audits and results of self-assessments, it was verifiable that Fortum has identified deficiencies in resource management and work prioritisation, which has caused delays in the implementation of agreed actions and modifications and the update of the instructions.

Based on the inspection and related interviews, STUK issued the requirement that Fortum must ensure that the personal initial training plan is prepared in a sufficiently early phase and the progress of its implementation is monitored regularly.

Management and safety culture, 11–12 June 2018

With the inspection, STUK aimed to determine how the plant management identifies, prioritises, resources, monitors and supports development actions relating to the operation of the organisation so that they would be implemented at the right time and effectively. This also included the assessment of the state of the safety culture and its development actions. The competence management project and the development of fuel handling functions were examined as examples. The organisation and resourcing of the assessment and development of the safety culture were also discussed in the inspection.

In the inspection, it was found that the management has developed the monitoring tool for the actions included in the strategy plan during the last two years but the organisation does not yet use the monitoring procedure actively. A clear procedure could not be verified for how the delays in the progress or the prioritisation needs between actions are addressed. Projected matters are monitored in more detail than other development actions, but there are only two ongoing development projects approved by the plant management. The development of fuel handling functions has not been adopted as a particular issue to be monitored at the plant management group level although the solution of the function's problems has previously remained half-finished. The management's presentation of the background of the problems of the unit in question created a somewhat different picture from that of the operational event reports. The organisational change of the function in question has not been systematically monitored, for which a requirement was set.

The plant management is aware that in different assessments, the communication and verification of the management's expectations and the prioritisation of matters have become development targets. They find that this can be helped by emphasising the teachings of the *Ydinvoima-alan ammattilainen* (Nuclear professional) leaflet and emphasising prioritisation to the rest of the organisation.

The human resources of safety culture assessment and development are scarce, but basic actions were taken during the year. The matter will be followed up. The management has not started new actions based on the recommendations presented in the annual assessment of the safety culture or the survey

conducted one year ago. This may be impacted by the light presentation method of the results of these assessments. According to the management's view, the nuclear professional concept launched a few years ago answers to all development needs of the safety culture. A requirement was issued for the handling and utilisation of safety culture assessments in the specifications of development actions. Similarly, a requirement was issued for the implementation of safety culture assessments.

Management system, 7–8 November 2018

The inspection concerned the methods with which Fortum measures and monitors the functionality and compliance of the management system processes.

The development and operational status of the management, support and core processes of the Loviisa power plant are discussed in the management review once a year. Based on the inspection, STUK stated that Fortum has a systematic procedure and expert support to describe the processes, but the work is still under way. The process managers are committed to the task, and the work also has the support of the management.

The other targets for inspection were the procedures and competence relating to the quality management of projects carried out at the Loviisa power plant. Based on the inspection, STUK stated that Fortum does not have instructions for preparing quality plans for projects and that the practices vary between different fields of technology. STUK issued the requirement that Fortum must assess the quality planning relating to the planning stage of projects and specify the role of the quality plan and the related instructions.

When the recently ongoing investment projects ended, the activities relating to Fortum's projects and their management were going through major changes and several development actions were being taken. STUK will follow up the situation by performing an additional supervision visit in spring 2019.

Operating experience feedback, 14 and 16 May 2018

This was a follow-up inspection, i.e. the aim was to find out the situation of the requirements issued in the previous inspections.

Based on the inspection, STUK closed most of the requirements. STUK deemed that the improvement work required by two requirements had not progressed sufficiently. According to STUK's view, Fortum has still room for improvement in learning from its own events at those of other plants. STUK closed both requirements and set a new requirement on one of the issues. To investigate the other issue, STUK will use another procedure.

Establishing the reason for operational events and effectiveness of the actions, 23 May and 4–7 June 2018

The inspection focused on determining the interfaces and cooperation between the organisation responsible for operating experience feedback and other organisational units. The aim is that organisational units identify and solve deficiencies arising in their area of responsibility with different procedures such as supervisory duties and self-assessment. In addition to this, the Loviisa power plant has operating experience feedback experts who, when necessary, assist the line organisation in solving deficiencies in the operation and in the plant, for example, with event investigations.

STUK observed that the Loviisa power plant has scope for improvement in learning from its own operating experience. There are different views on the responsibilities and tasks of the operating experience feedback of the line organisation. This manifests as variation in the operation. All organisational units do not utilise the lessons available in events and near misses. In this case, the results of event investigations, for example, remain unconnected to the plant's operation. This impairs the correction of deficiencies and may show as repeating events.

STUK issued the requirement that Fortum develop learning from its own operating experience by strengthening the line organisation's responsibility in learning from experience.

Conduct of operations, 18 April 2018

Because of the deficiencies observed in the control of periodic tests, STUK focused the inspection on the use of the work management system and other tools. In 2017, Fortum observed three cases where periodic tests required by the operational limits and conditions (OLC) were not performed. The violations were caused by various problems in the use of the work management system.

In the inspection, STUK investigated the use of the work management system in the management of periodic tests and the way the competence in using the system is taken care of. The aim of the inspection was to give an idea of the current situation and to ensure that Fortum has identified the deficiencies and is improving the operations appropriately.

In light of the inspection, the OLC violations of 2017 appear to have originated from factors relating to the complexity of the use of the work management system. The system is extensive, and its use, particularly in work planning, requires the users to use check lists and tools. This indicates deficiencies in the user-friendliness of the system. However, Fortum continuously and purposefully seeks to develop the system and its procedures. On the basis of the inspection, STUK issued no requirements.

Plant maintenance, 11–12 December 2018

The objective of the inspection was to verify that the licence holder takes care of the operability of the structures and equipment in the short and long term. This time, the selected inspection targets included the decision-making process when changing periodic maintenance, inspections and tests, internal audits and competence mappings of maintenance and the management of the service life of the main components (pressure and temperature transients, radiation embrittlement of the reactor pressure vessel).

The data was obtained in the inspection that in connection with the next periodic safety assessment, the load estimates and fatigue analyses concerning the pressure and temperature transients will be updated in their entirety. In addition, special subjects in maintenance included the verification of the operability requirements of equipment with periodic tests, the update and qualification of I&C equipment needed in accident circumstances, I&C spare parts and the condition monitoring of valve extension stems. The grounds for defining the condition of systems, structure and components in the ageing monitoring and for reporting the matter to the power plant management group were also reviewed in the inspection. In these respects, no major deficiencies were found in the inspection.

Further actions were required for minor deficiencies and issues that could not directly be verified in the inspection situation. Of the seven requirements issued, three concerned the further development of ageing follow-up reports and one concerned submitting the status summary of the radiation research programme regarding reactor pressure vessels to STUK. The rest concerned the verification that STUK will inspect in the next inspection of plant maintenance at the latest.

Fire protection, 25–26 April 2018

The inspection concerned the structural and active fire protection arrangements of the nuclear power plant. The licence holder's procedures and operations related to fire protection and the condition monitoring and maintenance of the related systems, structures and equipment were assessed in the inspection.

The situation of the requirements of the implementing decision of Guide YVL B.8 was reviewed in the inspection. Based on the report on the fire doors' conformity to requirements, the power plant is planning an extensive replacement of fire doors. Other subjects inspected included human resources, competence mapping, fire brigade training, fire protection system inspections, fire inspections performed by other organisations and instructions relating to fire safety.

The most significant modifications affecting fire safety after the previous inspection have been the replacement of the oil-driven hydraulics stations to water-driven stations, the expansion and decrease of operating temperature of the sprinkler system at the feedwater tank level and the replacement of one fire water pump.

Based on the inspection, it can be stated that fire protection arrangements at the plant are at an acceptable level.

STUK required Fortum to submit a report on the extent of condition surveys of the main piping of the fire water system to STUK for information. In addition to this, three other observations were made in the inspection regarding the ageing management of fire doors, the role of the system owner in the monitoring of maintenance work and the processing of international operational event reports, as well as two positive observations regarding the annual outage training of the fire brigade and the tightening of roof hot work procedures.

Radiation protection, 27–28 November 2018

The inspection concerning radiation protection focused on radiation protection, radiation measurements and release and environmental monitoring at the nuclear power plant. Among other things, the report prepared by the Loviisa nuclear power plant on conducting alpha radiation measurements at the plant was reviewed in this year's inspection. In addition, human resources planning in terms of radiation protection was a general theme of the inspection.

In its report on alpha radiation measurements, the power plant has identified development targets the plant intends to implement in training and the monitoring and specification of alpha activity. In the inspection, however, STUK issued three requirements relating to the report concerning the inspection of the alpha contamination of employees, instructions on the measurement of alpha radiation and collecting samples from the plant for alpha specification and mapping.

The list of position-specific competence requirements for the power plant radiation safety group prepared in the year of the inspection was detailed and extensive. Competence requirements are utilised in the preparation of development plans for the personnel.

In addition to the requirements, STUK presented three observations relating to the inspection topics and identified two good practices. The good practices were associated with the increase of resources and the development of dose recording practices.

Nuclear security, 9–13 April 2018

The inspection was implemented in two parts: one for conventional (physical) security arrangements and the other for information security. In both parts, the inspection was carried out extensively, covering

structural, technical, operative and organisational security arrangements in the nuclear power plant. The arrangements and procedures of the Loviisa nuclear power plant and the requirements Fortum sets for security arrangements and the related procedures and organisations at the Loviisa power plant were reviewed in the inspection. The resources and expertise related to the security arrangements at the Loviisa nuclear power plant were also assessed. No requirements were issued in the inspection. The actions due to the requirements issued in earlier inspections (2 requirements) had been appropriately carried out.

Safety design, 24–25 January 2019

The inspection focused on requirement and configuration management at Fortum's Loviisa plant. The inspection concerned the procedures in use and their development plans and needs.

In the inspection, it was stated that Fortum's configuration management is mainly based on maintained documentation also including requirement management. This is supplemented by the plant database and the database of electrical and I&C equipment. As regards managing requirements, Fortum has developed procedures while a requirement-driven modification process has been developed at the Loviisa power plant. Fortum has developed a database tool for managing requirements with the aim of also functioning as a part of the requirement specification of modification records and the monitoring of compliance with the requirements. With regard to the requirements relevant for requirement and configuration management under Guide YVL B.1, STUK stated based on the inspection that the agreed actions to comply with the requirements have been taken.

Safety functions, 5–6 November 2018

The ageing management follow-up reports of systems relating to the containment function and hydrogen management, which served as a basis for discussion on the status of the systems, were reviewed in the inspection. In accordance with the general theme of organisational control in 2018, human resources planning for the systems selected for the inspection were also reviewed by verifying the competence requirements of the ageing management group.

The status of the systems inspected was mainly quite good. No requirements were issued in the inspection. 22 individual minor observations were presented, for example, on corrosion on the roof at the entrance to the emergency access opening, the replacement of anchor dowels of the containment, the management of spare parts (particularly sealing materials) and the division of system responsibilities. The situation of the most significant observations will be reviewed in the next inspection.

According to the review of the situation of the observations presented in the previous inspection, Fortum has updated its instructions, and the flood protection project related to the changes made because of the Fukushima accident is about to end.

Emergency preparedness arrangements, 20–21 November 2018

The inspection of emergency preparedness arrangements was held in Loviisa and on Fortum's premises in Keilalahti. The inspection concerned, among other things, emergency equipment, emergency facilities, the emergency response organisation, emergency exercises, alarm arrangements, the environmental radiation system, meteorological measurements and human resources planning.

The technical support of the emergency response organisation of the Loviisa power plant is located in Keilalahti, to where the emergency facilities moved from Keilaniemi in the beginning of 2018. In the inspection, the share of the emergency preparedness arrangements of the technical support in Keilalahti

was weighted for all applicable inspection targets, in addition to which the emergency equipment and the new facilities were inspected.

Development projects relating to Fortum's emergency preparedness arrangements have been supplemented based on the observations from the Loviisa 18 emergency exercise. In the inspection period, development projects have been advanced in a systematic manner.

The human resources situation of the emergence preparedness arrangements is also good. In spring 2018, STUK approved a new person responsible for emergency response arrangements, and Fortum has appointed two deputies for this person. In addition, Fortum has appointed more people to its emergency response organisation, and especially in Keilalahti, the emergency response organisation has been strengthened.

On the basis of the inspection, STUK issued no requirements. STUK made several observations in the inspection, four of which were positive. The positive observations concerned Fortum's development actions in the emergency facilities of Loviisa and Keilalahti and in the organisation.

Operational waste, 15—16 May 2018

The inspection concerned the observations from the previous inspection, the development and notable events after the previous inspection, human resources planning and the radiation doses to the personnel. The condition of facilities in which waste is processed, stored and disposed of, radiation levels in these facilities, their classification and their markings were inspected during the site visit.

No major deficiencies were found in the inspection, but one requirement relating to the specification of difficult-to-measure radionuclides using nuclide relationships was set based on the inspection. The reliability of these nuclide relationships used in waste records is ensured from time to time, and Fortum must therefore collect more measurement results in connection with the solidification of liquid waste. As a positive observation, it was stated in the inspection that Fortum is prepared for exceptional situations occurring in lifting waste packages.

Annual outage, 5 August—18 October 2018

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. Inspectors from several fields of technology from STUK's nuclear reactor regulation department participated in the inspection. They had their own predetermined inspection areas. STUK also performed general oversight of the plant site by means of regular site walk-arounds and overseeing the progress of planned work, for example. Furthermore, STUK oversaw the way in which safety is prioritised in the licensee's decision-making process.

The subjects of this year's inspection included the Loviisa I&C reform project and the related improvement of secondary circuit safety functions, the management of foreign material, fire safety and radiation protection. The aforementioned projects were completed as planned. No deviations that would have required immediate intervention by STUK were observed in the operation of the power plant.

In the inspection relating to the management of foreign material and fire protection, STUK verified procedures at work areas using several inspectors. STUK made several observations on risks related to foreign material, the good and bad management of foreign material at work areas and the correct and incorrect use of protection. There was visible development from previous years. At some work areas, the storage and protection of items were exemplary. There are still challenges regarding items stored at work areas, the correct use of protection and some area protections. The attitude regarding the management of foreign material has improved, awareness has increased and the reporting threshold has lowered. The

total number of observations made concerning fire protection was so low that it is difficult to form an overall picture of the status of fire protection arrangements. The observations mainly created a picture of a relatively clean plant where no major deficiencies were observed. Observations indicating deficiencies included uninspected fire hydrants and fire doors locked open.

With regard to radiation protection, STUK considers that the annual outages went mainly as usual. As expected, the extensive annual outage at Loviisa 2 and the large-scale repair and modification work caused higher radiation doses than shorter annual outages. According to the observations, activities in work areas and at shoe boundaries were mainly appropriate. Radiation doses were lower than in any similar annual outage in history.

Based on the inspection, it can be stated that Fortum's annual outage operations met the requirements and were performed well, safely and according to pre-determined plans. No requirements were issued based on the annual outage inspection.

KPA storage lifting and transfer equipment, 16 November 2018

The inspection of the spent nuclear fuel storage (KPA storage) was conducted at the Loviisa NPP for the first time as part of the periodic inspection programme. Inspections have previously been conducted separately outside this inspection programme. The inspection concerned the KPA storage lifting and transfer equipment, focusing on their operation, operating experiences and operability. In addition, the inspection focused on Fortum's instructions relating to the operation of the lifting and transfer equipment, the related organisation, training and qualification and the spare part situation and planned modifications of the lifting and transfer equipment.

During 2018, Fortum has made changes to its organisation in order to clarify tasks and operations relating to fuel handling. The organisation has been strengthened with new resources, and new tasks have been set up. In addition, Fortum presented its new training programme concerning loading and transfer machines and its qualification procedure in the inspection. Training and qualification are going through a transitional phase. Both new and old fuel handlers are trained according to the new training programme.

Two requirements were issued in the inspection. The first one was related to the correction of the deficiencies observed in the instructions concerning Fortum's KPA storage lifting and transfer equipment. The second requirement concerned the lifting capacity markings of the transfer machine in the KPA storage, the hook blocks of cranes and the lifting accessories.

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

Human resources and competence, 12–13 September 2018

The inspection confirmed the preparedness of the personnel of the OL3 plant unit for the use of the plant. The inspection included an interview part conducted by the Technical Research Centre of Finland (VTT), concerning the operating personnel of the OL3 plant unit and the simulator training of the plant vendor.

In the inspection, TVO presented justifiably that the resources needed for the use of OL3 had been hired but the training for the personnel was still partly unfinished. According to TVO, personnel have been recruited particularly for maintenance duties in accordance with the maintenance strategy prepared in 2017. The system owner table was reviewed in the inspection because it was observed in the Management and safety culture inspection carried out in the beginning of the year that responsible persons had not yet been appointed for many different systems at the plant. Based on the inspection, it can be stated that responsible persons and their deputies have now been designated for different systems. The duties

of the responsible person include being in charge of technical solutions, operability and development work. There are currently 24 field operators at OL3, 9 of whom were hired in July 2018. The training of new personnel has been completed in accordance with the training programme, and the on-the-job learning phase is under way. The analysis of the number of field operators will be separately addressed by STUK.

Two requirements were issued based on the inspection. Before starting operation, TVO must ensure that the shifts have sufficient practical competence in the management of severe accidents. In addition, TVO must ensure that the observations presented in the instruction and HFE validations have been specified as training content and the training provided has been sufficient and effective.

Management and safety culture (additional), 9–11 January 2018

In the additional Management and safety culture inspection, the management, work atmosphere and safety culture of TVO were investigated. The inspection concerned the verification of the improvements required from TVO. In May 2017, STUK required that in order to solve the challenges related to the work atmosphere and safety culture, TVO's management must outline, communicate and implement actions to improve the leadership skills of the management, to improve the consideration of safety matters in decision-making and communication, to solve the problems relating to the organisational reform and the change of methods and to ensure the necessary resources for safe operation in a systematic way. Interviews conducted by STUK in December 2017 and during the inspection were also utilised in the inspection. In addition, STUK used the inspection to verify the organisation and resourcing of the operating experience feedback and event investigations. STUK's regulatory oversight does not actually cover the work atmosphere of TVO but ensures that TVO has identified its possible effects on the safety culture and started the necessary actions to improve the situation.

In 2017, TVO implemented a number of improvement actions, some of which concerned the development areas identified by STUK (the atmosphere and safety culture). The inspection did not clearly indicate the practical effectiveness of the actions. The understanding of TVO's management was that the trend was positive. In the personnel interviews conducted by STUK in December 2017, however, the majority of the interviewees did not yet see any clear development in the interaction between the management and the personnel or the work atmosphere of TVO. The management and communication of safety matters and the uncertainties caused by the organisational reform were areas where the effectiveness of development actions was verifiable based on the personnel's feeling of an improved situation. With regard to operating experience feedback, STUK was also able to verify the improvement concerning management (organisation, resourcing, taking care of competence development).

On the basis of the inspection, STUK issued five requirements. STUK stated that the resource situation, especially in maintenance, required immediate actions. TVO had to present an updated maintenance strategy plan and the resource situation regarding those responsible for OL3's equipment, system and technology to STUK in the OL3 spare parts and maintenance operations inspection in March. TVO also had to assess the effectiveness of the actions aimed at the development of management and systematise the documentation of decisions affecting safety, their justifications and their risks. STUK continued intensified regulatory oversight of the organisational matters in 2018.

Management and safety culture, 2–4 October 2018

The inspection concerned the conception of TVO's management of safety culture as a phenomenon and its status at the Olkiluoto NPP. The inspection also concerned the state of the safety culture at the OL3 plant unit, particularly as regards control room operations, and TVO's actions to correct safety culture challenges identified in control room operations at OL3.

In the inspection, STUK observed that the preparedness of TVO's management to talk about culture-related matters was good but there were still matters that might make it more difficult to identify and communicate the state or development needs of the safety culture – also to the authorities. The observations were discussed with TVO's management in the inspection.

The inspection concerned the results of the latest safety culture mapping at the OL3 plant unit and the lessons from operational events, for example, relating to control room and work permit operations. The results of the safety culture survey indicated the schedule pressure and its perceived effect on the possibility of those working in the OL3 organisation to perform their work with high quality. The survey also revealed that there were uncertainties about responsibilities. According to STUK's view, these observations were significant in this stage of commissioning and required actions from TVO's management to ensure better organisation and support of the next stages. The draft of the OL3 safety culture development plan presented in the inspection and other planned development actions included things that seem appropriate. STUK could not verify that the planning of actions and the analysis of the background of observed problems is systematic. Also, the inspection did not result in a clear picture of TVO's actions to better manage schedule pressure and support operators in taking responsibility.

The inspection also focused on the realisation of the familiarisation requirements issued in the approval decisions of the persons selected in 2017 as the responsible manager for operation and their deputies. The familiarisation requirements issued in the approval decisions of the responsible manager for operation and their deputies had been addressed well, and most of the required additional familiarisations had already been completed.

Based on the inspection, STUK issued two requirements relating to the control room operations at OL3. TVO must submit to STUK for information an overall plan of the key actions with justifications and schedules to solve the responsibility challenges of OL3 control room operations and the problems of high-quality work. In addition, TVO's operating organisation and the plant construction project must co-ordinate their activities so that control room operators at OL3 have the prerequisites to bear their responsibility. The responsibilities in control room operations must be clear, and it must be possible to perform the work with high quality. TVO must demonstrate that things have been brought to a good level before fuel loading.

Management system, 14–15 November 2018

The inspection concerned TVO's project activities and the management of the delivery chain. For the inspection, ten people from different units were interviewed, the topics were discussed on a general level and the material on the licensee's systems and documentation were verified.

Based on the inspection, TVO's project activities are documented, personnel are trained for project activities and the activities are in accordance with the instructions. TVO also seeks to adopt proven practices more widely and to harmonise its practices. It could also be verified in the inspection that TVO has developed the consideration of safety-significant matters in the planning stage of modifications and projects and in the planning of taking them to the plant. The development of project activities is still under way.

As regards the management of the supply chain, the control of the supply chain and its scope are determined in the agreement stage, and the supply chain includes audits and quality assurance visits. Normally, TVO audits the main supplier and the main supplier audits the subcontractors, if necessary. TVO has stated the need to pay more attention to the control of the supply chain, and the matter has also been included in the management review. TVO's supply control and inspections and the opportunities to stop deliveries were well considered when preparing the agreements. TVO has written procedures for communication in the supply chain, and according to TVO, this works well in practice.

In the inspection, no observations were made regarding project activities or the management of the supply chain based on which requirement should have been issued.

Disposal facilities, 2–3 October 2018

The inspection concerned the concrete and rock structures of the disposal facility of power plant waste at Olkiluoto (VLJ repository). The related TVO organisation, processes, functions, operating instructions, situation of ongoing research and maintenance procedures were reviewed in the inspection. The inspection also included a walkdown in the VLJ repository.

One requirement was issued based on the inspection. The change of nearly all key personnel and the simultaneous preparation of the new research and monitoring programme had the effect that the update or preparation of the instruction needed for implementing the programmes in different areas of monitoring was still incomplete during the inspection. TVO must update or prepare the instructions relating to in-service monitoring to align with the new research and monitoring programme 2018–2027.

A positive observation was that TVO has defined and justified parameter-specific action and alarm limits for the new research and monitoring programme of the VLJ repository, which brings objectivity to the management of observations in monitoring. For the monitoring of the VLJ repository, TVO receives expert resources from Posiva.

Plant maintenance (OL1/2), 27–28 March 2018

The sufficiency of the resources, functions and tasks relating to the condition monitoring and maintenance of the Olkiluoto 1 and 2 plant units to ensure safe operation was assessed in the inspection. The inspection was especially concerned with the human resources planning of maintenance and the coverage and procedures of the ageing management of plant units. As regards maintenance, TVO has started major recruitments, which were still under way during the inspection. The sufficiency of the maintenance resources will be verified in STUK's later inspections. The ageing management procedures under Guide YVL A.8 were also still partly incomplete.

On the basis of the inspection, STUK issued six requirements. TVO must provide instructions for the actions enabling the identification of counterfeit products in factory and acceptance tests of equipment, spare parts and materials. TVO must inspect the fuel transfer piping of emergency diesel generators to the extent that the inspections give reliable information on the condition of the entire length of the piping from the storage tanks to the supply tanks. TVO must inspect the small-diameter pipes important to safety that are located in rooms not accessible during operation and that have not been inspected in 2016 or later. TVO must prepare an instruction on the assessment of the operability of spare parts past their recommended life in case it is absolutely necessary to use these parts. TVO must finalise the monitoring and reporting procedures of critical spare parts and present them in the next Plant maintenance inspection. In addition, TVO must specify requirements for its own structural competence and present actions to ensure meeting the requirements even in the long term.

Fire protection, 17–18 October 2018

The inspection concerned the fire protection arrangements at the nuclear power plant. The inspection focused on the impact of the forthcoming commissioning of the OL3 plant unit on the instructions of the operating plants and the operation of the plant fire brigade. In addition, the efficiency of the fire pro-

tection arrangements at the nuclear power plant and the operation of the power company were assessed and the modification plans concerning the fire protection arrangements were reviewed in the inspection.

The inspection targets were TVO's organisation and human resources, instructions relating to fire protection and the training and equipment of the plant fire brigade. To gain a better view of the situation, four members of the fire brigade were also interviewed in the inspection. The commissioning of OL3 has been prepared for by hiring two new persons to the day staff of the plant fire brigade. The fire brigade has received plenty of training in OL3 fire protection systems and operations at the plant. The process of integrating the instructions to the instructions of the operating plants is still under way. STUK considered the development process of the OL3 instructions generally good.

Based on the inspection, it can be stated that fire protection arrangements at the plants are at an acceptable level.

No requirements were issued based on the inspection, but STUK made observations for which the development of the situation will be followed up. The observations concerned, among other things, the sufficiency of the resources of the fire brigade during the operation of OL3, the practices regarding the temporary closing of penetrations and the number of joint exercises arranged with the rescue department.

Utilisation of the PRA, 26–27 September 2018

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 the Olkiluoto 1, 2 and 3 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.

No requirements were issued based on the inspection. In the inspection, STUK verified 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. Despite the personnel changes, TVO has kept the resources related to the use of the PRA at the earlier level and there are no comments on the resource situation.

Structures and buildings, 7–8 November 2018

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 the power company's inspections and the completed modifications. The effect of the commissioning of the OL3 plant unit on the technical services and maintenance organisations, the plant instructions and their update needs were addressed in the inspection.

Based on the inspection, it was stated that property maintenance performs its preventive maintenance activities expertly and no observations relating to the operability of structures have been made in recent years.

The need for personnel caused by OL3 has been identified, the OL3 system owners involved in the inspection area have been appointed, and the necessary orientation has been started. TVO has recruitments under way to eliminate the personnel deficit. TVO has mapped the plant instructions that must be updated to also cover the OL3 plant unit. Responsible persons and time limits have been set for these updates.

Two requirements were issued based on the inspection. TVO must submit the human resources planning procedures of construction technology and property maintenance to STUK for information.

In addition, based on the observations made in the walkdown, TVO must present justifications for the sufficiency of the temporary fire seals in the compartmenting walls.

Radiation protection, 16—18 October 2018

The matters reviewed in the inspection included the situation of release reporting based on last year's inspection findings and a separate request for clarification. A special item in the inspection was a clarification of the implementation of alpha radiation measurements. The inspection was the first inspection in accordance with the periodic inspection programme that involved the OL3 plant unit. The inspection concerned how radiation protection is taken into account at all three plant units, for example, in terms of instructions and the organisation.

In the inspection, it was stated that in terms of radiation protection, the power company had prepared for the need of extra resources created by the new power plant unit. New employees have been hired for radiation protection tasks. In addition, approximately 15 contract workers will be hired for the commissioning of OL3.

The reporting of releases has been developed, although the procedures for reporting releases should be developed to be more illustrative than they currently are. The utilisation of activity trends should be further developed with regard to release reporting to make periodic comparison of release amounts easier.

Six requirements were issued based on the inspection. The requirements were related, among other things, to the development of radiation protection instructions and measurement practices. In addition, the monitoring and specification of alpha activity must be further improved to get a more accurate overall picture of the activity concentrations occurring at the plant units and their systems.

Nuclear security, 15—18 May 2018

The inspection concerned the demonstration of the effectiveness of security arrangements, addressing the training and practice programme of the safety organisation and the nuclear security observations. Arrangements during the annual outage were addressed by reviewing the results of previous inspections and making a site visit. TVO's human resources planning relating to security arrangements was also reviewed in the inspection.

The implementation of the current processes of TVO's human resources planning has proceeded well from the security arrangements point of view. During the site visit, good practices were recorded in the activities of both the safety organisation and the control room personnel. Based on the inspection, STUK issued a total of five requirements, all of which concerned the further development of existing procedures. One of the requirements was related to the update of the risk management tool to correspond to the current practice, and four were connected to the procedures of identifying unauthorised intentional activity.

Safety design, 15—16 August 2018

The inspection concerned the configuration and requirement management procedures of TVO's currently operating Olkiluoto 1 and 2 plant units. The inspection indicated that configuration management is mainly based on documentation concerning the plants maintained from the very beginning as well as different databases. TVO's objective is that after modifications to the plants, the maintained documentation be updated within six months of the completion of the work. It was found in the inspection that TVO's management system does not clearly indicate how configuration management is carried out.

Based on the inspection, a requirement was issued in order to improve this matter. As regards requirement management, it was found in the inspection that TVO does not have at its disposal procedures for the systematic management of requirements. TVO has started to develop these procedures, and its intention is to provide training on them and start piloting them by the end of 2018.

It was also stated in the inspection that TVO's management system does not require configuration or requirement management procedures from subcontractors. Based on the inspection, the requirement was issued that while developing its own procedures, TVO must also develop requirements concerning procedures demanded of subcontractors.

Safety functions (OL 1/2), 17–18 October 2018

The inspection of safety functions assesses the licensee's procedures used to ensure that the systems implementing safety functions are in a state required for safety and that their basis is correct. The subject of the 2018 inspection was "Containment and severe accident management". The system responsibility analyses of the systems relating to the aforementioned subject were reviewed in the inspection, and the status of the systems was discussed with TVO based on the analyses.

The status of the systems inspected was mainly good. Different observations were made, for example, on the monitoring of the condition of the containment liners, manhole seals, research activities and operating experience feedback with Energiefors, preparation schedules for system responsibility analyses and the preparation for ageing phenomena.

In the inspection, one requirement was issued concerning the exceeding of the attention criteria in the partial leak tests. If a leak of the lower personnel lock exceeds the attention criterion in the next periodic leak test of OL2, corrective measures must be taken. In conjunction with any corrective measures, a report must be submitted to STUK for information, presenting an assessment of the reasons for the consecutive exceeding of the attention criteria and the measures taken.

Emergency preparedness arrangements, 17–18 April 2018

The emergency preparedness arrangements inspection comprehensively covers the nuclear power plant's emergency preparedness arrangements. Issues that are regularly inspected include emergency preparedness guidelines, facilities and equipment, the emergency response organisation and related training. In addition, the 2018 inspection was particularly concerned with the situation of the development measures specified on the basis of the 2017 preparedness exercise concerning the Olkiluoto power plant.

One of the purposes of the inspection was to verify the degree of preparedness of the emergency arrangements at TVO's Olkiluoto 3 plant unit (OL3). TVO has stated to repair most of the deficiencies observed based on the 2017 preparedness exercise. However, TVO has not been able to start equipping the emergency response premises, for example, because the plant supplier has not yet handed over the OL3 emergency response premises for TVO's permanent use. Because the efficiency of TVO's preparedness arrangements, as regards the OL3 emergency response premises, could not be verified in the documents, STUK will make a separate inspection concerning the emergency response premises in early autumn 2018.

On the basis of the inspection, STUK issued three requirements. Among other things, TVO must supplement its preparedness plan so that in an emergency situation concerning fuel pools, the preparedness plan will provide sufficient support for making an assessment on the released radioactive substances. Alarms within the plant must also be possible during annual outages, so TVO must investigate the functioning of alarm systems in rooms with poor audibility.

Annual outage (OL 1/2), 22 April–23 June 2018

The inspection concerning annual outages 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. Furthermore, STUK oversaw the way in which safety is prioritised in the licensee's decision-making process during the annual outage.

Inspectors from several fields of technology participated in the inspection. They followed the activities, conducted site walk-arounds, interviewed employees and oversaw the progress of planned work.

The particular subjects of this year's inspection were the installation and commissioning of a new electricity-independent steam-actuated make-up water system at both plant units. Other subjects of the inspection included waste management, radiation protection of workers, management of foreign material and fire safety as well as familiarising the staff with duties that are important for annual outages. Based on the inspection, the annual outages went safely and in accordance with pre-determined plans. No safety deficiencies that would have required immediate intervention by STUK emerged during the inspection.

In the inspection relating to the management of foreign material and fire protection, STUK verified procedures at work areas using several inspectors. Relating to the management of foreign material, STUK made many positive observations, according to which foreign material protection was used appropriately. However, there is scope for improvement in the tidiness levels of work areas and especially the storage of small items such as screws and nuts. TVO's extensive training investments in the management of foreign material had resulted in improved identification of the significance of foreign material compared to previous years. Based on the observations on fire safety, hot work arrangements and fire protection are in proper condition. No major fire loads were observed. According to STUK's observations, there is still scope for improvement in the closing of fire doors and the following of storage area limits.

Two requirements were issued based on the inspection, both of which concerned the new make-up water system. In the inspection concerning the implementation of the steam-actuated make-up water system, STUK verified that the operating personnel had been trained in using the system and the instructions on the use of the system were appropriate. However, the new system had not yet been installed on the training simulator, and the operating personnel had therefore not been able to practice using the system in a simulator environment. For the same reason, it has not been possible to validate the new instructions on the simulator. STUK issued the requirement that the training simulator should be updated to correspond to the plant in this respect and the operating personnel should receive training in situations in accordance with the updated emergency situation instructions by the end of 2018. In addition, the commissioning of the system involved renewal of the trial operation and adjustment of the pump's operation, as a result of which STUK required TVO to provide a report on the demonstration of operability in the low pressure point of the system.

Nuclear safeguards, 16–18 October 2018

The inspection concerned the nuclear safeguards system of TVO's Olkiluoto power plants and how TVO takes care of its nuclear safeguards obligations.

The inspection focused on the operation of the nuclear safeguards system of the power plant at a general level, the permits for nuclear commodities, the accounting and reporting system, information security in sending nuclear safeguards reports, the actions in accordance with the safeguards agreement and its additional protocol and the practices relating to the implementation of safeguards and inspections by STUK, the IAEA and Euratom.

Based on the inspection, the nuclear safeguards instructions of TVO's power plants are at a good level and the operation is in line with them. Based on the inspection findings, two requirements were issued, which relate to the development of the instructions and procedures.

Management of modifications, 11–12 September 2018

The inspection concerned TVO's procedures for the management of modifications. The inspection focused on TVO's procedures for planning and prioritising implementation schedules and ensuring resources required by the modifications.

As a summary of the observations, it can be stated that TVO has procedures for planning the implementation of plant modifications but some of them are still in the introduction phase. STUK will continue the follow up of the development of procedures in future inspections.

No requirements were issued based on the inspection.

KPA storage lifting and transfer equipment, 4 December 2018

The inspection of the spent nuclear fuel storage (KPA storage) was conducted at the Olkiluoto NPP for the first time as part of the periodic inspection programme. Inspections have previously been conducted separately outside this inspection programme. The inspection concerned the KPA storage lifting and transfer equipment, focusing on their operation, operating experiences and operability. In addition, the inspection focused on TVO's instructions relating to the operation of the lifting and transfer equipment, the related organisation, training and qualification and the spare part situation and planned modifications of the lifting and transfer equipment.

Several TVO teams participate in the handling of spent nuclear fuel. The inspection indicated that the responsibilities of the TVO teams are defined in TVO's instructions, and no deficiencies have been observed in the operation. TVO has training and qualification procedures for the use of KPA storage lifting and transfer equipment, as well as operating instructions taking into account operations in exceptional situations. It was observed in the inspection that TVO has not had internal audits concerning the operation of the KPA storage lifting and transfer equipment. However, it emerged in the inspection that the operation of the KPA storage had been addressed in TVO's internal audit and WANO had addressed the operation of lifting and transfer equipment at the plant in general terms in its peer review.

Two requirements were issued in the inspection. Some deficiencies were detected in TVO's instructions on the KPA storage lifting and transfer equipment, and one requirement was issued related to the system inspection instructions. Another requirement regarded the lifting capacity markings of the KPA storage transfer machine, which must be made to conform with legislation.

APPENDIX 4
Construction inspection programme of Olkiluoto 3 in 2018

The OL3 plant unit was mostly dealt with in the inspections specified in the periodic inspection programme because most functions inspected are shared by all plant units of Olkiluoto. The inspections specified in the periodic inspection programme are described in more detail in Appendix 3. This appendix includes a short summary for OL3.

The inspections concerning solely the Olkiluoto 3 plant unit were made in accordance with the 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 gets the licence during spring 2018, no semiannual RTO plan was prepared for spring 2018. Instead, inspection plan of readiness for plant operation was prepared. After that, the granting of the operating licence has moved forward because of delays in the project, and STUK has updated and supplemented the inspection programme as appropriate.

Readiness for plant operation 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, readiness inspections were performed as follows:

Inspection	Date
Security arrangements	9–11 January 22–23 August 4–5 October 30–31 October 3–4 December
Performance of hot functional tests	during hot tests (1 January–29 May)
Spare parts and maintenance activities	20–21 March
Work permit procedures	22–23 May

Several inspections were focused on security arrangements and information security. Matters reviewed and verified in the inspections included the general situation of the installation of security arrangements, information security issues, alarm centre work, key management, the demonstration

and verification of the sufficiency of security arrangements, the documentation and processing of commissioning results relating to security arrangements at TVO and the access control of I&C and main distribution rooms.

Resources and action plans of maintenance, transfer of responsibility from the plant supplier to TVO and methods relating to the procurement of spare parts were addressed in the inspection concerning maintenance activities and spare parts. In addition, STUK reviewed the spare parts situation at storages. Of the inspection, STUK presented no requirements – TVO had extensive plans for maintenance activities, but the implementation was still incomplete (for example, the orientation of the maintenance personnel and the procurement of spare parts).

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. On the basis of the inspection, STUK presented two requirements concerning control room procedures. One of the requirements necessitated that common operating methods and compliance with new instructions be ensured when the responsibilities of TVO and the plant supplier change as the commissioning progresses. STUK also required the qualification of the instruction on moving to the emergency control room and the training of the persons who need the instruction on the content of the instruction.

The inspection of work permit procedures concerned, among other things, instructions relating to work permit procedures, the division of responsibilities between the licensee and the plant supplier, the work permit IT systems currently used and those to be commissioned later. Based on the inspection, STUK presented several requirements relating to the clarification of the procedures, the compliance with the instructions, the sufficient number of field operators, the correction of the deficiencies of the work permit system and the responsibilities of different organisations. STUK will verify the meeting of the requirements using reports submitted to it and future inspections.

During the year, matters concerning the OL3 plant unit were addressed, for example, in the below periodic inspections. The inspections are described in more detail in Appendix 3. Below is a brief presentation of the most essential things with regard to the OL3 plant unit.

Periodic inspections that also covered the OL3 plant unit:

Inspection	Date
Management and safety culture	9–11 January
Emergency preparedness arrangements	17–18 April
Safety design	15–16 August
PRA	26–27 September
Management and safety culture	2–4 October
Radiation Protection	16–18 October
Fire protection	17–18 October
Human resources and competence	1–2 November
Structures and buildings	7–8 November

Management and safety culture, 9–11 January

It was found in the inspection that there are challenges relating to maintenance resources, and TVO was required to present an updated maintenance strategy and the resource situation in the spare parts and maintenance activities inspection in March 2018.

Emergency preparedness arrangements, 17–18 April

One of the purposes of the inspection was to verify the degree of preparedness of the emergency arrangements at the Olkiluoto 3 plant unit. The inspection concerned, among other things, the situation of the development measures specified on the basis of the preparedness exercise held in 2017.

The state of the emergency response arrangements was also verified in the operational oversight inspection on 9–10 October. The inspection concerned the situation of open measures in TVO's own system relating to emergency response arrangements, the situation of the instructions, the operational readiness of OL3 emergency equipment and facilities, and the personnel and personnel training required to handle OL3 emergency situations. In the inspection, three requirements were presented concerning the preparation of the facilities and equipment before fuel loading.

Safety design, 15–16 August

The safety design inspection concerned configuration and requirement management. For OL3, the situation and the progress compared to previous RTO inspections was noted. Changes to operational processes and information systems were also addressed so that the systems of the operating plants can also be used to handle OL3 modifications. No requirements concerning the OL3 project were presented in the inspection.

PRA, 26–27 September

The inspection concerned the preparation of the 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. No requirements were presented based on the inspection.

Management and safety culture, 2–4 October

The inspection concerned the state of the safety culture at the Olkiluoto 3 plant unit, particularly the worrying results of the surveys on the operating organisation and control room operations. The state of the safety culture at the OL3 construction site is assessed twice a year. The results of the latest assessment, carried out in May, showed, among other things, schedule pressure, its effect on high-quality operations and uncertainties regarding responsibilities in control room work. STUK required TVO take measures and prepare an overall plan to correct the situation.

Radiation protection, 16–18 October

The inspection was the first inspection in accordance with the periodic inspection programme that involved the OL3 plant unit. The inspection concerned how radiation protection is taken into account at all three plant units, for example, in terms of instructions and the organisation. In the part of the inspection concerning Olkiluoto 3 focused on the current practices of radiation protection after nuclear fuel has been brought to the plant. Commissioning inspections of rooms located in the controlled area, the situation of the commissioning of radiation measurement, contamination management and decontamination systems, and radiation protection instructions were also addressed. The readiness of these is a prerequisite for transferring fuel to the reactor.

Fire protection, 17–18 October

The inspection focused on the impact of the forthcoming commissioning of the OL3 plant unit on the instructions of TVO and the operation of the plant fire brigade.

The inspection targets were TVO's organisation and human resources, instructions relating to fire protection and the training and equipment of the plant fire brigade. Based on the inspection, the operation phase of OL3 has been well prepared for in terms of fire protection, although all the planned operations have not been completed. No requirements were issued based on the inspection.

Human resources and competence, 1–2 November

The resources of the maintenance and operating personnel of the OL3 plant unit were reviewed in the inspection. In 2018, TVO continued recruiting more people to maintenance and operating organisation tasks and provided orientation and training. Based on the inspection, STUK stated that the situation is at an acceptable level, but STUK still monitors the personnel's experiences of work management. With regard to training, STUK required that it must be ensured that the shifts have sufficient practical competence in the management of severe accident situations before starting the operation of the plant. In addition, TVO must ensure that the necessary additional training identified based on the instruction validations has been provided, the training has been adequate and it has corrected the observed competence deficiencies.

Structures and buildings, 7–8 November

The inspection concerned the impact of the commissioning of the OL3 plant on the technical service and maintenance organisations, the extent to which the current plant instructions are suitable for covering the OL3 plant and the update need of the instructions. No OL3-specific requirements were made in the inspection.

APPENDIX 5
Inspections pertaining to the processing of Fennovoima's construction licence application 2018

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 six months in advance. In 2018, STUK carried out eight inspections in line with its inspection programme. The first one, concerning nuclear waste, was an inspection postponed from 2017 to January 2018. The results of RKT inspections will be used by STUK when preparing a safety assessment and statement on the construction licence. Summaries of the inspections performed in 2018 are presented below:

Fennovoima, nuclear waste, Salmisaari

The inspection concerned the planning and implementation of the management of low and intermediate level waste in Fennovoima's Hanhikivi 1 plant project and the planning of the interim storage for spent fuel and the decommissioning of the nuclear power plant. The inspection also included an assessment of the organisations participating in the planning and implementation of waste management and their human resources.

Based on the inspection, STUK required that Fennovoima must develop a systematic procedure covering the whole organisation to reserve and allocate resources for projects and tasks significant for safety. The procedure must take into account the safety significance of the operation. Fennovoima must also assess the preparation regarding quality plans in the project. The assessment must take into account the right timing of quality planning and whether the planning of quality is adequately specified with regard to the production of construction licence documents. The necessary corrective and preventive measures must be taken based on the assessment. Fennovoima must ensure that the attitude of quality planning towards the progress of the project has been adequately documented to ensure transparency and a common understanding.

Fennovoima must also develop its procedures so that it can ensure that the plant supplier has allocated the requirements for procurement appropriately and in a relevant phase for the procurement. For this reason, the procedures of the project must be developed as necessary.

Fennovoima, emergency power machinery, Salmisaari

The inspection concerned the current situation of emergency power machinery and the sub-project started at Fennovoima to manage them as well as the monitoring of the planning and procurement of emergency power machinery performed by Fennovoima. The current situation of the construction licence documentation was also reviewed.

Based on the inspection, STUK required that Fennovoima must estimate what emergency power-specific plans of its own it needs and when they are needed. In addition, Fennovoima must assess how the sub-project in question complies with the instructions of Fennovoima's management system. For example, a steering committee required by Fennovoima's instructions has not been appointed for the sub-project.

Fennovoima must continue planning its own supply control. In the planning, it must be assessed how the quality plans of different deliveries and the requirements presented in them are taken into account and what kinds of instructions and tools the planning and implementation of supply control require. Fennovoima must also determine whether the project plans of different sub-projects must be updated, for example, due to quality or qualification plans of systems or new organisation interfaces.

Main designer JSC Atomproekt, Saint Petersburg

The inspection concerned the management and operation of JSC Atomproekt (AP), and it focused on the actions and procedures of the company for identifying, monitoring and processing safety issues and assessing and managing suppliers. In the inspection, the efficiency of the aforementioned processes was verified with selected examples. During the inspection, STUK verified procedures and documents relating to the Hanhikivi 1 project in AP's information systems or in paper form. This was a two-day follow-up inspection focusing on the inspection of the situation of corrective actions in accordance with old requirements.

Based on the inspection, things progress and develop slowly at AP. Some of the requirements of the first RKT inspection performed in December 2015 were still unresolved. Also, five requirements were still open from the 2016 inspection. These include requirements essential for system design and the production of construction licence documentation, which are expected to be in order during design and the preparation of documentation, not just afterwards.

STUK also presented new requirements in the inspection. STUK required that system design must be described in the relevant system descriptions of the preliminary safety analysis report. STUK also stated that AP must plan resources for the construction phase as well, including commissioning. In addition, STUK required the key design values to be presented directly in the safety analysis report instead of plant agreement references. Fennovoima was reminded in the inspection to ensure that the preliminary safety assessment of STUK's decision-in-principle stage is also acknowledged in the development of the 3D model and in the relevant instructions in the construction licence phase.

Management and the handling of safety matters

The inspection concerned the management of Fennovoima, the work of the organisation and the procedures in the handling of safety matters. The inspection addressed the actions of Fennovoima's management and organisation in the identification, monitoring and handling of safety matters and the situation of the open issues of previous inspections. The inspection focused on the key processes of the management system: the handling on safety matters, the management of competence and resources, HR functions and configuration and requirement management including the management of changes.

Based on the inspection, certain requirements of previous inspections were closed and new requirements were issued.

It was found in the inspection that in the project, Fennovoima makes decisions that are only justified afterwards. The management of Fennovoima has not taken into account some important matters concerning the project, such as the issues relating to the 60-year service life, when making decisions. Based on the handling of the examples, STUK required that Fennovoima must use investigation procedures to clarify whether the handling and coordination of the management strategy of severe reactor accidents have been performed in proper organisational units and at proper organisational levels, taking into account the safety significance of the matter. Fennovoima must plan the further processing of the matter and submit the inspection report to STUK for information.

The inspection concerned the actions planned based on the observations of VTT's safety culture investigation concerning Fennovoima, RAOS and Titan-2. The plans and actions are still incomplete in the organisations.

STUK required Fennovoima to have an external assessment made on the benefits and weaknesses relating to the matrix organisation of quality control (QC) operations. STUK also required Fennovoima to partition the work in the delivery portions under its own responsibility and the division of responsibilities in project plans.

STUK has observed that the launching of Fennovoima's operating experience feedback has been difficult and practical results of the work cannot be seen. In the inspection, STUK set a requirement that Fennovoima must organise, instruct and implement the procedures relating to the utilisation of construction and operating experience. The systematic collection and utilisation of experiences and observations, taking into account the plant site, must be ensured.

Regarding the use of human resources, Fennovoima must identify the positions and functions important to safety and define the applicable competence and qualification requirements in accordance with Guide YVL A.4. Fennovoima must have procedures in place for monitoring the competences, qualifications and training records of the individuals involved in functions important to safety. Fennovoima must ensure that the training programmes concerning the organisation's tasks significant for safety are completed appropriately.

Similarly, Fennovoima must assess its procedures and their adequacy in suppliers' resource control and competence assessment. Based on the assessment, the operations must be developed so that the regularity and extent of the procedures in terms of the supply chain is ensured.

Fennovoima is planning to gradually move operations to the plant site in Pyhäjoki, which is an effective and significant change for the whole organisation. Finland has experience of relocation processes of nuclear organisations and other safety-critical organisations and the related difficulties. Fennovoima must assess the safety effects of the change, and STUK requires an independent assessment to be made of the change. As a part of the assessment of safety effects relating to the relocation of operations, Fennovoima must perform an analysis of previous experiences and lessons learnt from similar relocations of operations. The suitability of the experiences and lessons learnt must be assessed, and they must be utilised in the implementation and monitoring of the change.

Safety and plant design

The inspection of the operations and procedures of safety and plant design concerned Fennovoima's operations in identifying, monitoring and handling safety matters. The processing of the design bases of the containment, the assessment and control of plant design and the utilisation of the construction information model (3D) in the safety assessment of the plant and its systems were verified in the inspection.

Based on the inspection, STUK required that Fennovoima must identify the Finnish requirements and organise orientation in the requirements. According to STUK's view, the processing and closing of

open matters must also be developed. Similarly, Fennovoima must ensure that the preliminary safety analysis report refers to the instructions and standards used in the design work. In addition, Fennovoima must ensure through its own monitoring that the design organisations use the agreed instructions and standards in the design, which is particularly important in systems of safety classes 1 and 2.

Site management and safety culture

Based on the RKT inspection of the site organisations of Fennovoima, RAOS and Titan-2, STUK required that Fennovoima and its supply chain develop the long-term planning of the project. According to STUK's view, the role of plant supplier RAOS in site management must also be clarified and the monitoring methods of its supply chain must be developed. The main contractor, Titan-2, must promote the development of practical safety culture.

Kurchatov institute

The follow-up inspection concerned the institute performing deterministic disturbance and accident analyses and fuel modelling. In the inspection, two requirements from the 2016 inspection were closed, one of which was rephrased. Three requirements remained open as they were. Four new requirements were also presented in the inspection. These concerned requirement management, the traceability of the initial data of analyses, the archiving of analysis results, the definition of any differences at the Hanhikivi 1 plant and their presentation in documents and analyses.

Management and safety culture

In the inspection, Fennovoima presented a development programme to improve its operations. The development programme perceives the operation as four entities: safe plant design, readiness for construction, implementation quality and readiness for operation. The development programme concerns Fennovoima's all operations, and the other development projects related to them were discontinued towards the end of the year because of the larger change.

Some old requirements were closed in the inspection, but all requirements relating to VTT's safety culture research remained open. It was found in the inspection that Fennovoima has little interest in processing construction and operating experience at this stage of the project. It was also verified in the inspection that there is no comprehensive quality plan for soil investigations. Unawareness of the recommendations of previous investigations, the suppliers and the suppliers' quality plans, among other things, was found in the inspection.

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

In 2018, the encapsulation plant and disposal facility oversight project at STUK systematically continued the inspections included in the construction inspection programme. 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 2018 inspections only focused on the licensee's operations.

The 2018 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 since that time, and for this reason STUK decided to focus its 2018 inspections on areas that had not been inspected yet. These inspections included the inspection of learning from experience. 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.

Status of STUK's requirements concerning the construction of safety-classified disposal facilities

The inspection assessed how the requirements concerning rock caverns in safety class SC3 have been responded to and whether the preconditions for starting the construction of these facilities are about to be met. Before starting the excavation of facilities in safety class SC3, the requirements concerning this phase must be met. Requirements have been presented in decisions made during the review of the construction licence documents and in decisions on system documents made after that.

The inspection also concerned the status of system documents of underground systems in safety class SC3. In this connection, it emerged that the need to close the test holes had not been described. In addition, the delivery schedules of design documents, arrangements and procedures to be followed at the construction site, further characterisation and ensuring the functionality of a natural barrier in safety class SC3 and the schedules of the annual reporting of monitoring were assessed in the inspection.

Based on the inspection, STUK set requirements requiring that a strategy must be created to close the test holes, the connection of the official review concerning the design documents to the design and construction phases of rock construction must be specified, the documents on the disturbance category and excavation vibration of the construction must be submitted to STUK, the effect of specifying the

tension of the bedrock on the layout design of the facilities must be justified and the suitability classification plan of the rock must be specified.

Competence management

In the inspection, Posiva's competence management procedures were assessed as part of the operation of TVO Group. The inspection concerned the responsibilities and resources of competence management and the development of competence. In addition, one topic of the inspection was the assessment and maintenance of competence. In the inspection, the verification of operations was targeted at the competence requirements of those in safety-significant tasks at Posiva.

The main observations in the inspection focused on the development of competence verification methods and the periodical competence assessment of persons in positions important to safety for whom separate approval by Posiva is required. TVO's competence management process covers Posiva's operations. The commissioning of some practical tools for competence management is still somewhat behind TVO.

Learning from experiences during the construction phase

The inspection concerning the utilisation of construction and operating experiences assessed Posiva's procedures with which it ensures learning from its own experiences and those of other facilities. Posiva's procedures are inspected as part of the operation of TVO Group. This CIP inspection was the first inspection focused on learning from Posiva's own operating experiences and those of other actors. The objective of the inspection was to establish an understanding of the whole and ensure that the foundation of the operation is in order.

Tasks and responsibilities relating to learning from events, the development of the competence of those handling the matter, objectives, the communication of the expectations of the operations, procedures, results of event investigations and measures specified based on them were assessed in the inspection.

Based on the inspection, Posiva has a reasonable foundation for learning from its own operating experiences and those of others. In the inspection, several development areas were found and requirements were presented concerning the setting of objectives for learning from operating experiences and the monitoring of their realisation as well as the execution of measures specified based on event investigation and the monitoring of the progress of their implementation.

Monitoring the impacts of underground construction

Underground monitoring is concerned with the impacts of construction on the bedrock.

The main objective of the monitoring inspection was to verify how Posiva's organisation implements Posiva's currently valid monitoring programme of Olkiluoto (OMO) and its updated action limits. The inspection concerned the organisation implementing the monitoring, the justifications for OMO updates after the equivalent inspection of 2015, the instructions on different areas of monitoring, the

procedures for the assessment of the impacts of underground construction on the safety features of the nearby bedrock, the changes of action limits defined by Posiva and their justifications after the equivalent inspection of 2015, the exceeding of action limits and the organisation's procedure of handling it, the quality assurance of monitoring results and reporting and the reporting and its realisation. The inspection also concerned the functionality of the interfaces between Posiva's OMO programme and the design and construction of the disposal facility.

Based on the inspection, the traceability of monitoring documentation must be improved, new personnel implementing monitoring must be systematically inducted and the principles of acknowledging the safety significance must be clarified in the monitoring instructions.

Nuclear safeguards

Posiva's nuclear safeguards system and the way Posiva takes care of its nuclear safeguards obligations were assessed in the inspection. Posiva's procedures to comply with the requirements set in legislation, the YVL Guides and EU regulations were assessed in the inspection. The inspection was also concerned with how requirements were transferred to Posiva's design documents and how Posiva ensures the correspondence between the documents submitted for nuclear safeguards and Posiva's other documents.

It was found in the inspection that the current practices are good and adequate but they are largely based on the good position of the person in charge of nuclear materials in the organisation, this person having a good view on the operations and a possibility to influence them.

The main observations of the inspection concerned the successor plan and the design requirements of nuclear safeguards. The successor plan ensures that the person in charge of nuclear safeguards and their deputy are able to take care of their tasks also in case of personnel changes. The design requirements of nuclear safeguards must be included in Posiva's requirement management system in more detail and more clearly than previously.

Programme and project management

The inspection concerned Posiva's ongoing programmes and projects and the reorganisation of the programmes and projects in early 2019. The objective of the planned modification is to rationalise and clarify the decision-making for programmes and projects and transfer more responsibility for resource and schedule management to programmes and projects. The inspection also focused on the procedures and tools of project management.

The inspection assessed how Posiva had estimated the safety impact of the reorganisation of programmes and projects. Based on the inspection, the justifications for the planned organisational change not having an impact on safety could not be verified.

It was also stated based on the inspection that Posiva has not had sufficient resource and schedule management tools with respect to the project stage, and it was required that the resource management procedures of projects be developed. It was found in the inspection that no deputies had been appointed for persons in significant roles in projects. Appointing deputies ensures the continuity of projects in unexpected situations.

APPENDIX 7
Licences STUK has granted in accordance with the Nuclear Energy Act in 2018

Teollisuuden Voima Oy

- 1/C42214/2018, 15/02/2018: Licence for import and possession of a sample fuel element. Last date of validity for import 31/12/2018 and for possession 31/12/2030.
- 2/C42214/2018, 22/02/2018: Import licence for a dummy fuel element. Last date of validity 31/12/2018.
- 3/G42214/2018, 09/04/2018: OL3 – Import licence for fuel documentation. Last date of validity 31/12/2025.
- 8/G42214/2018, 24/08/2018: OL3 – Import licence for a control rod actuator. Last date of validity 31/12/2019.
- 5/C42214/2018, 12/10/2018: Import of nuclear fuel with Euratom obligation code "S" from Sweden (OL1 e 41). Last date of validity 31/12/2019.
- 1/D42214/2018, 12/10/2018: Import of nuclear fuel with Euratom obligation code "P" from Sweden (OL2 e 39). Last date of validity 31/12/2019.
- 2/D42214/2018, 12/10/2018: Import of nuclear fuel with Euratom obligation code "S" from Sweden (OL2 e 39). Last date of validity 31/12/2019.
- 3/D42214/2018, 12/10/2018: Import of nuclear fuel with Euratom obligation code "P" from Sweden (OL2 TRITON11 test). Last date of validity 31/12/2019.
- 6/C42214/2018, 12/10/2018: OL1 – Import licence for replacement nuclear rods. Last date of validity 31/12/2018.
- 9/C42214/2018, 12/10/2018: Export licence for components removed from use.
- 7/C42214/2018, 12/11/2018: OL1/OL2 – Import licence for main coolant pumps. Last date of validity 31/12/2019.
- 11/C42214/2018, 13/12/2018: FH1 – Licence for possession and transfer of fuel documentation.
- 13/C42214/2018, 13/12/2018: OL1, OL2 – Licence for possession of sample fuel rods. Last date of validity 31/12/2023.

Fortum Power and Heat Oy

- 1/A42214/2018, 17/01/2018: Import licence, import of neutron flux sensors from France (ELSA). Last date of validity 30/06/2018.
- 5/A42214/2018, 17/04/2018: LO1 and LO2, Import of intermediate shafts for control rods from the Czech Republic. Last date of validity 31/12/2018.
- 7/A42214/2018, 05/10/2018: Import of Incore neutron flux sensors from Canada. Last date of validity 31/12/2019.

Fennovoima Ltd

- 2/J42214/2018, 11/04/2018: Licence for the import of nuclear information subject to the particular safeguards obligation from Sweden and the possession of the information. Last date of validity 31/12/2028.
- 3/J42214/2018, 13/12/2018: FH1 – Licence for the transfer of nuclear information subject to the particular safeguards obligation. Last date of validity 31/12/2023.

Others

- 9/42214/2018, 06/08/2018: Hospital District of Helsinki and Uusimaa / Licence for the import, possession, use and storage of fission chambers of accelerator dose monitors. Last date of validity for import 28/02/2019 and for possession, use and storage 31/12/2028.
- 23/Y42214/2017, 20/12/2018: Boliden Kokkola Oy / Licence for operations for the possession and handling of material with uranium content. Last date of validity 31/12/2028.
- 13/Y42214/2018, 20/12/2018: Boliden Harjavalta Oy / Licence for operations for the possession and handling of material with uranium content. Last date of validity 31/12/2028.