REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

Annual Report 2018 on Radiation and Nuclear Safety in the Republic of Slovenia

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July 2019

Prepared by the **Slovenian Nuclear Safety Administration** in cooperation with:

The Slovenian Radiation Protection Administration;
The Administration of the Republic of Slovenia for Civil Protection and Disaster Relief;
The Ministry of Infrastructure;
The Administration of the Republic of Slovenia for Food Safety, Veterinary and Plant Protection;
The Ministry of the Interior;
The Agency for Radwaste Management;
The Nuclear Insurance and Reinsurance Pool;
The Fund for Financing the Decommissioning of the Krško Nuclear Power Plant;
The Krško Nuclear Power Plant;
Žirovski Vrh Mine d. o. o.;
Jožef Stefan Institute; and
The Institute of Occupational Safety.

The report was approved by the Expert Council for Radiation and Nuclear Safety on 30 May 2019.

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SUMMARY

In year 2018 there were no significant events in the field of nuclear safety and radiation protection. The Krško Nuclear Power Plant (NPP) operated without any major problems. There was only one manual gradual shutdown due to minor problems in the main transformer control system, which was properly resolved. In the spring, a regular outage was carried out, during which some important improvements were made. The construction of bunkered building 2 (BB 2) and the design of a dry storage for spent fuel also continued.

The European Topical Peer Review (under the Nuclear Safety Directive) continued, within which the reports on the monitoring of the aging of nuclear facilities in the European Union were under review. On the basis of the review and the resulting recommendations, the SNSA and the Krško NPP are preparing a plan of measures to further improve the state of the plant as regards aging.

During the year, the preparation of new audits of the decommissioning programmes for the Krško NPP and the management of radioactive waste and spent fuel from the Krško NPP was carried out. The new revisions will be the essential basis for determining the share of the contributions that the Slovenian GEN Energija and the Croatian Hrvatska elektroprivreda, as the owners of the Krško NPP, must each pay into the fund. Until the end of the Krško NPP's operational period, enough funds must be collected to finance the decommissioning of the facility and for the final disposal of radioactive waste and spent fuel, as well as for all compensation to be paid to local communities.

The Coordination Committee, which was appointed in 2017 by the intergovernmental Slovenian-Croatian commission for monitoring the performance of the contract on the ownership of the Krško NPP, monitored the development of the decommissioning programme and the programme for the disposal of radioactive waste and spent fuel, and studied the possibilities for the joint disposal of Slovenian and Croatian radioactive waste from the Krško NPP. For this purpose, Slovenia has proposed Croatia to build a landfill in Vrbina, Slovenia, while Croatia is attempting to build a similar landfill near the border with Bosnia and Herzegovina. As of the end of the year, there was no agreement acceptable to both sides.

The TRIGA Mark II research reactor operated without any major problems in 2018.

The Agency for Radioactive Waste continued its activities regarding the construction of a landfill site for low- and intermediate-level waste in Vrbina near Krško. There were preliminary activities for the public presentation of the report on the environmental impact and cross-border environmental impact assessment of the proposed landfill. Given the dynamic nature of the activities of the authorities involved, the question remains as to how the Krško NPP will operate when the storage capacities for such waste in the plant is filled and a landfill is not available.

At the Boršt hydrometallurgical tailings disposal site of the former uranium mine Žirovski Vrh the problems with rock sliding have not been resolved; therefore, the search for solutions continues.

In 2018 there were no major problems at the organisations and institutions that carry out radiation activities. At the same time, there were only a few interventions due to found sources of ionising radiation in the field.

At the beginning of the year, the new Act on Protection against Ionising Radiation and Nuclear Safety (ZVISJV-1) came into force, with which most of the provisions of the European directive regulating radiation protection were transposed into the Slovenian legal order. Several decrees and regulations were adopted during the year. However, not everything is still ready yet for the implementation of the Act on Liability for Nuclear Damage (ZOJed-1), which was adopted in

2010. State signatories of the Paris Convention are waiting for the entry into force of the Protocol to the Paris Convention, which is expected to happen in 2019.

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1 INTRODUCTION

This report is prepared annually in accordance with the provisions of the Ionising Radiation Protection and Nuclear Safety Act. It summarises all developments related to nuclear and radiation safety. The report is endorsed by the Slovenian Government and is thereafter sent to the National Assembly of Republic of Slovenia. It is also the main method of informing the general public of recent developments in the area of ionising radiation protection and nuclear safety. It has been issued since 1985. This English version is the essential publication for the presentation of these activities in Slovenia to the international public.

The preparation of this report is coordinated by the Slovenian Nuclear Safety Administration (SNSA). The content of the report is contributed by other state bodies that are involved in protection against ionising radiation and nuclear safety, as well other institutions in this field. The most important contributors in 2018 were: the Slovenian Radiation Protection Administration (SRPA), the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPRD), the Ministry of Infrastructure, the Ministry of the Interior, the Administration of the Republic of Slovenia for Food Safety, Veterinary and Plant Protection, the Agency for Radwaste Managment (ARAO), the Nuclear Insurance and Reinsurance Pool, the Krško Nuclear Power Plant (Krško NPP), Žirovski Vrh Mine, d. o. o., Jožef Stefan Institute (IJS), the Institute of Occupational Safety (IOS), the Fund for Financing the Decommissioning of the Krško Nuclear Power Plant and for the Disposal of Radioactive Waste from the Krško NPP, and others.

The year 2018 was quiet and it can be summarised that the fundamental goal of nuclear and radiation safety was achieved:

The protection of people and the environment from unnecessary harmful effects of ionising radiation.

Together with this report, which is aimed at the wider interested public, an extended version in Slovenian has been prepared. The extended report contains all details and data that might be of interest to the narrower group of professionals. It is available on the SNSA website.

2 OPERATIONAL SAFETY

2.1 Operation of Nuclear and Radiation Facilities

2.1.1 Krško Nuclear Power Plant

In 2018, the Krško NPP produced 5,776,439.3 MWh (5.8 TWh) gross electrical energy from the output of the generator, which corresponds to 5,489,907.9 MWh (5.5 TWh) net electrical energy delivered to the grid.

The most important performance indicators of the Krško NPP are shown in Tables 1 and 2, while changes over the years are described in the following parts of this report. The performance indicators confirm that the plant's operation is stable and safe.

Table 1: The most important performance indicators for 2018

Safety and performance indicators	Year 2018	Average (1983–2018)
Availability [%]	91.50	87.46
Capacity factor [%]	94.1	86.35
Forced outage factor [%]	0.08	0.98
Gross production [GWh]	5,776.44	5,182.76
Fast shutdowns – automatic [number of shutdowns]	0	2.11
Fast shutdowns – manual [number of shutdowns]	0	0.14
Unplanned normal shutdowns [number of shutdowns]	1	0.72
Planned normal shutdowns [number of shutdowns]	1	0.81
Event reports [number of reports]	0	4.06
Duration of the refuelling outage [days]	30.9	49.0
Fuel reliability indicator (FRI) [GBq/m^3]	$3.70 \cdot 10^{-5}$	$6.16 \cdot 10^{-2}$

Table 2: Time analysis of the operation of the Krško NPP in 2018

Time analysis of operation	Hours	Percentage (%)
Number of hours in the year	8,760	100
Duration of plant operation (on grid)	8,012	91.46
Duration of shutdowns	748	8.54
Duration of the refuelling outage	741	8.46
Duration of planned shutdowns	0	0.0
Duration of unplanned shutdowns	7	0.08

The operation of the Krško NPP in 2018 is shown in Figure 1. The plant shut down twice, both times manually and gradually. The first shutdown was in April due to the regular outage, while the second shutdown was in July for the removal of the main transformers bushings on-line measuring system. In the summer months, net energy production was lower due to the Sava River flow being lower and the use of cooling towers.

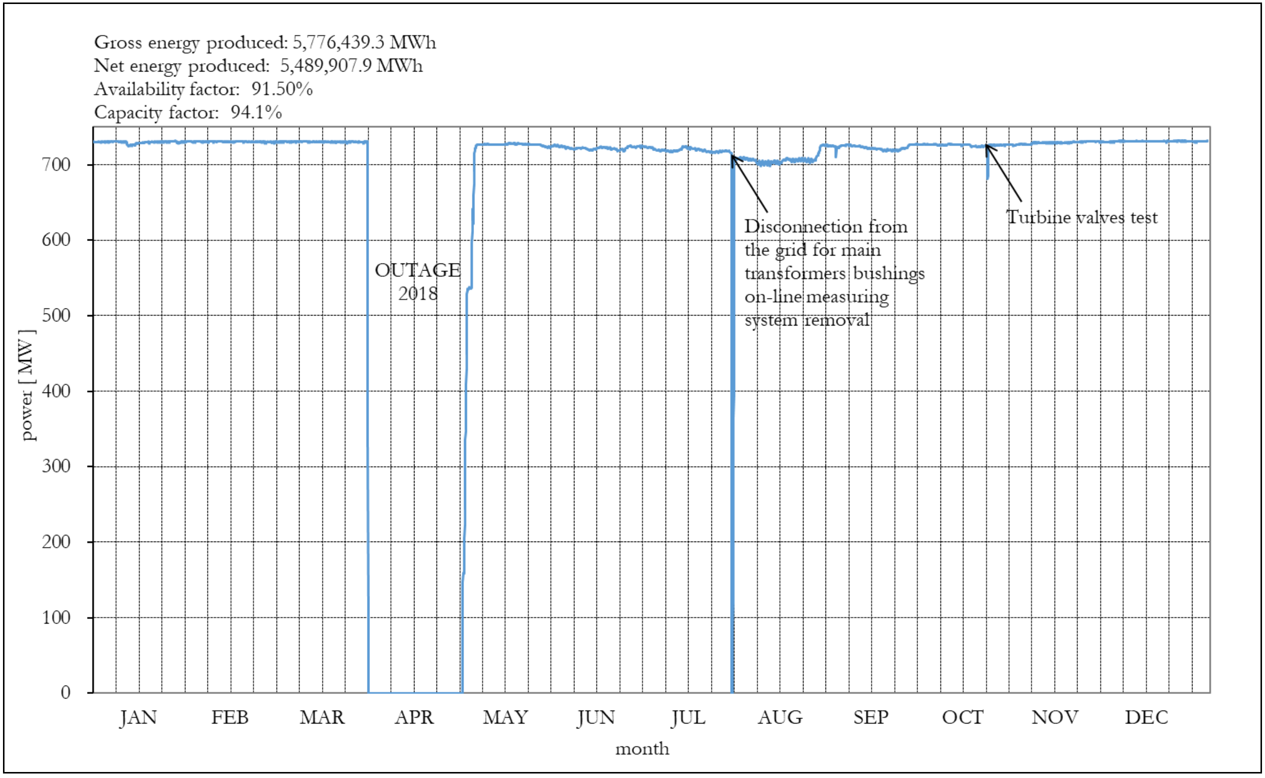


Figure 1: Operating power diagram of the Krško NPP in 2018

Figures 2 and 3 show the number of the plant shutdowns.

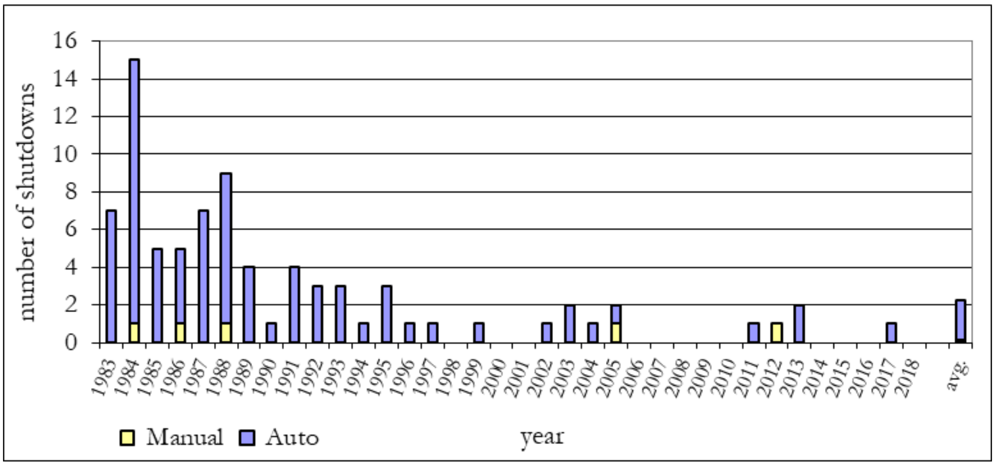


Figure 2: Fast reactor shutdowns – manual and automatic

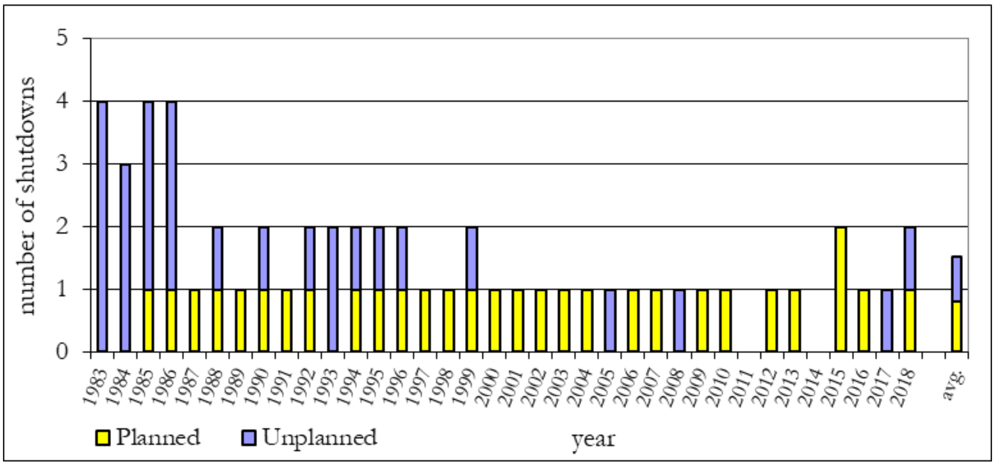


Figure 3: Normal reactor shutdowns – planned and unplanned

Shutdowns are divided into two groups: fast and normal. Fast shutdowns are caused by the operation of a reactor protection system, which is triggered automatically or manually. With normal shutdowns the power of the reactor is gradually reduced. These are further divided into planned and unplanned. Normal shutdown due to fuel replacement and regular annual maintenance or outage is a special type of planned shutdown.

A gradual stabilisation of fast shutdowns can be observed (in the last 25 years less than 1 per year). In 2018 there were no fast shutdowns.

Figure 4 shows the number of abnormal events. In 2018 the Krško NPP did not report any abnormal events. The Krško NPP is obliged to report all events that could reduce the level of nuclear safety to the regulatory body.

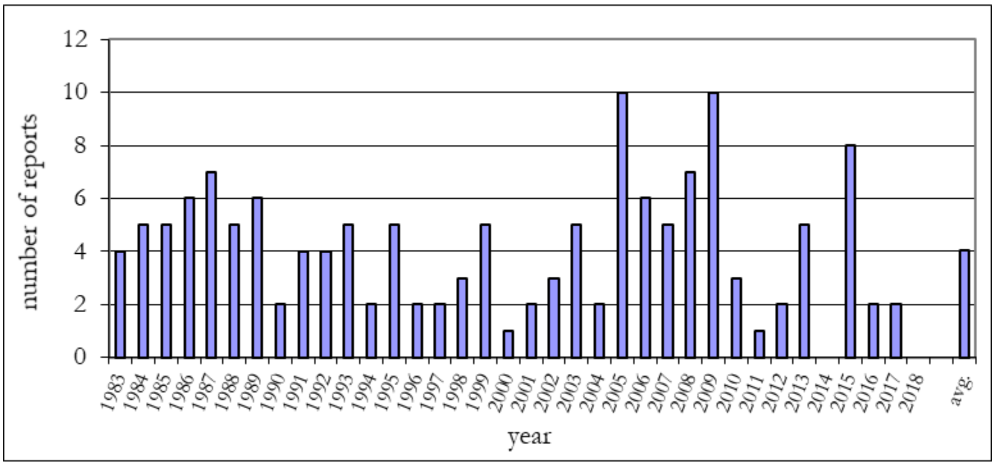


Figure 4: Number of abnormal events

Figure 5 presents data on different means of electrical energy production in Slovenia, specifically electricity production in nuclear, hydro, thermal, and solar power plants. In 2018, the production of electrical energy was 15.3 TWh, of which 36 % was produced by the Krško NPP.

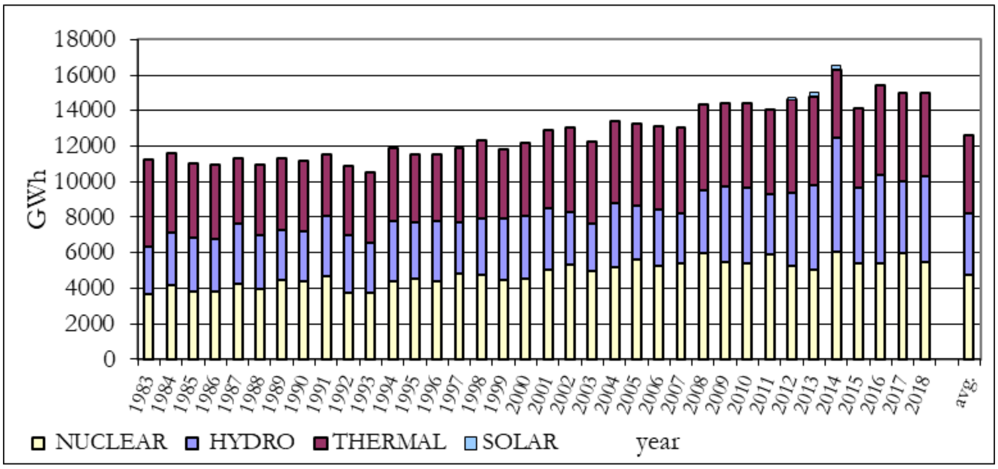


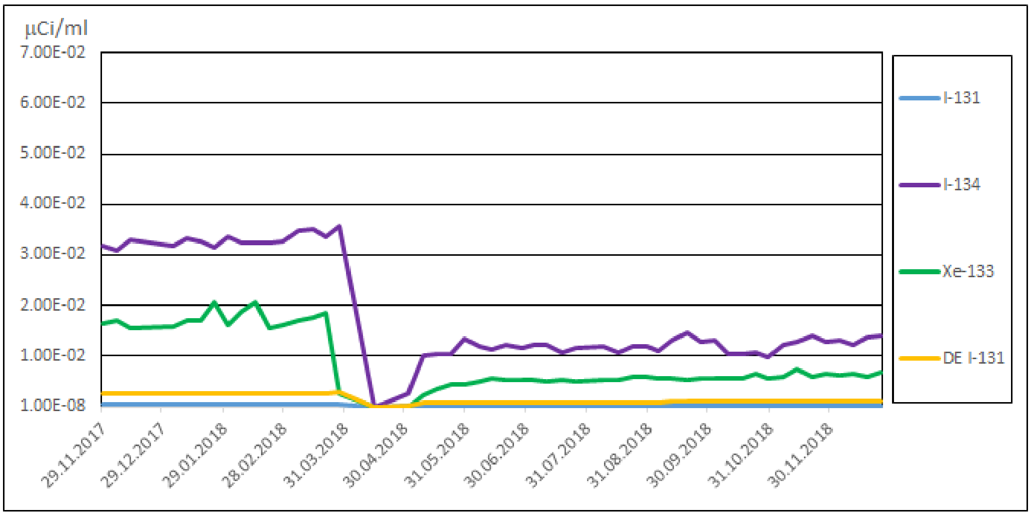
Figure 5: Production of electrical energy in Slovenia

2.1.1.1 The Slovenian Nuclear safety Administation's process of monitoring the Krško NPP by means of safety-performance indicators

At the end of 2007, the SNSA began monitoring the management and operation of the Krško NPP through its set of safety performance indicators (hereinafter: SPIs). In 2018, the SNSA monitored 37 SPIs, examples of which are presented below. One part of SPIs are the SNSA limits for warnings and alarms. The Krško NPP therefore has time to take corrective measures that would improve the SPI values before the SNSA has reached the alert or alarm value, and thus increased the control of the SNSA.

Once a month the SNSA informs the Krško NPP of the state of SPIs and of possible individual areas that would require greater engagement of the Krško NPP or where the SNSA will carry out a more thematic inspection.

From the indicator showing the activity of the primary coolant (Figure 6), it can be seen that during the period between May 2018 and December 2018 (the 30th fuel cycle), the specific activities of xenon ^{133}Xe and iodine radionuclides ^{131}I and ^{134}I were reduced to approximately 1/3 of the value of the 29th fuel cycle (the time period between November 2017 and May 2018). During the 2018 outage, it was found that there were no leaking or damaged fuel elements in the 29th fuel cycle. In the 30th fuel cycle, the specific activity of xenon ^{133}Xe and iodine radionuclides ^{131}I and ^{134}I was rather constant, which means that by the end of December 2018 there were no leaking or damaged fuel elements.



Warning: 100 % increase in the specific activity of ^{131}I, ^{134}I or ^{133}Xe activity compared to the previous week or 0.25 µCi/ml of DE ^{131}I

Alarm: 200 % increase in the specific activity of ^{131}I, ^{134}I or ^{133}Xe compared to the previous week or 0.5 µCi/ml DE ^{131}I

Figure 6: Primary coolant-specific activity - 30th fuel cycle

The indicators in Figures 7 and 8 show the risk of the planned and unplanned unavailability of equipment under the Krško NPP technical specifications. In the event of an increase in unplanned unavailability, the indicators may reflect equipment degradation and a deficient maintenance programme.

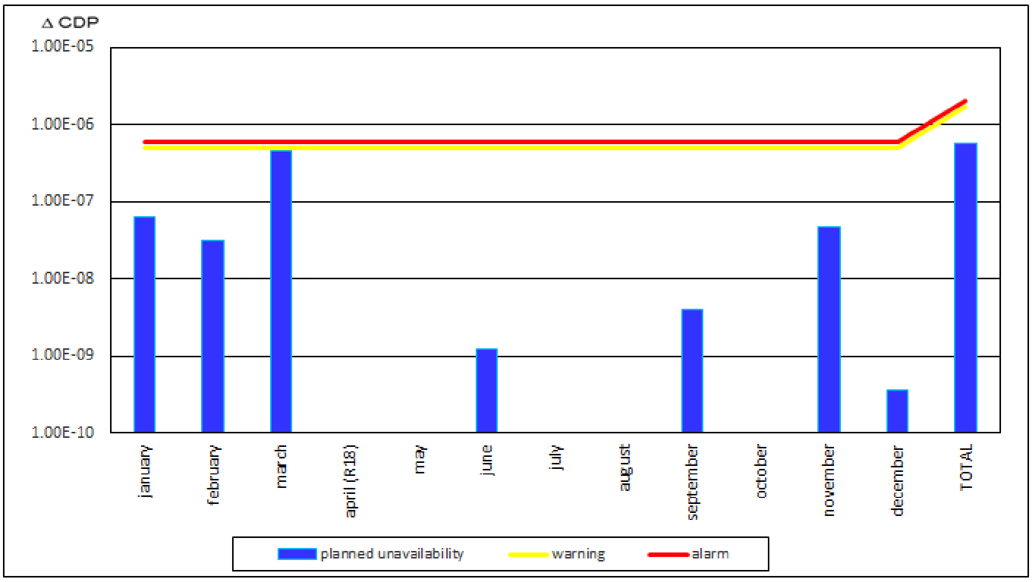


Figure 7: Risk due to the planned unavailability of equipment

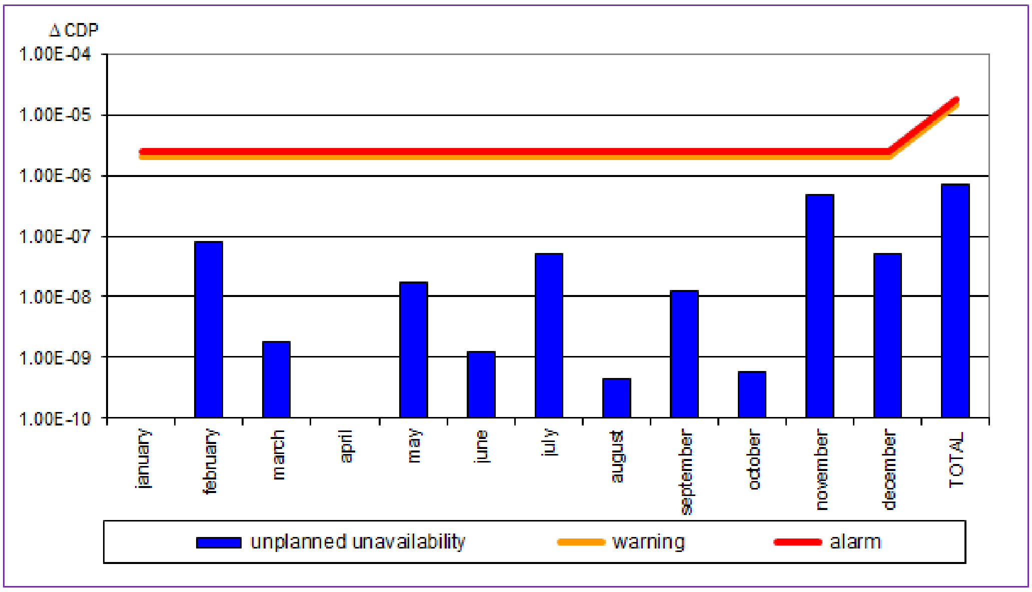


Figure 8: Risk due to the unplanned unavailability of equipment

The collective dose indicator (Figure 9) shows the annual collective effective dose of the whole body, the total for Krško NPP workers, external workers, and visitors. In 2018 the collective dose was 783.01 man-mSv (the value of the warning was 720 man-mSv and the alarm value was 860 man-mSv).

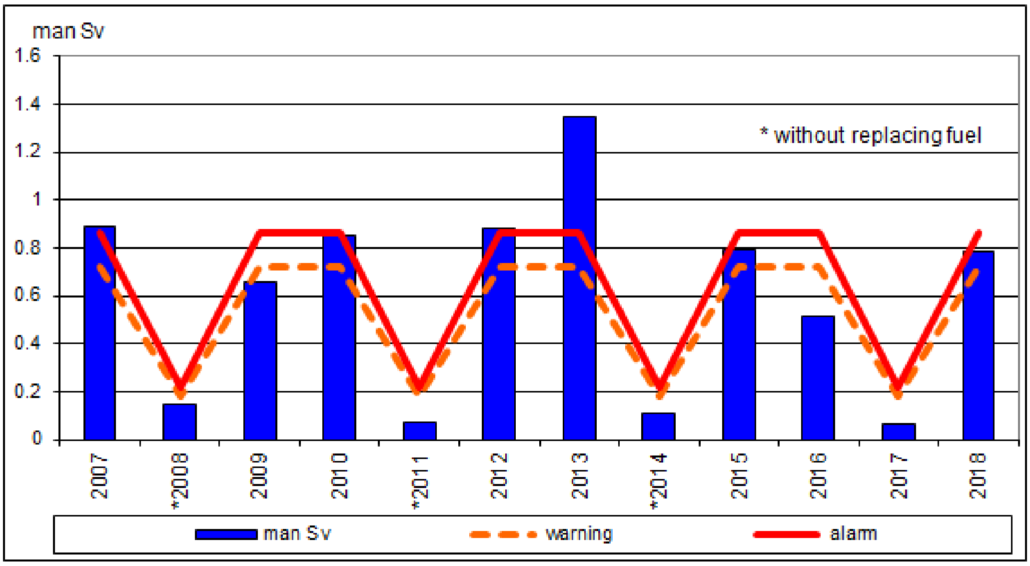


Figure 9: Collective dose

The radiation exposure indicator of the radiation personnel shows the total number of Krško NPP workers and external workers (Figure 10). In 2018 there were a total of 1,508 exposed workers, out of which 430 were exposed to doses ranging from 0.5 to 15 mSv. Figure 10 shows the limit for the warning and alarm. The alarm also represents any contamination above 15 mSv. Years in which there was no outage are shown in Figure 10 with asterisks (*).

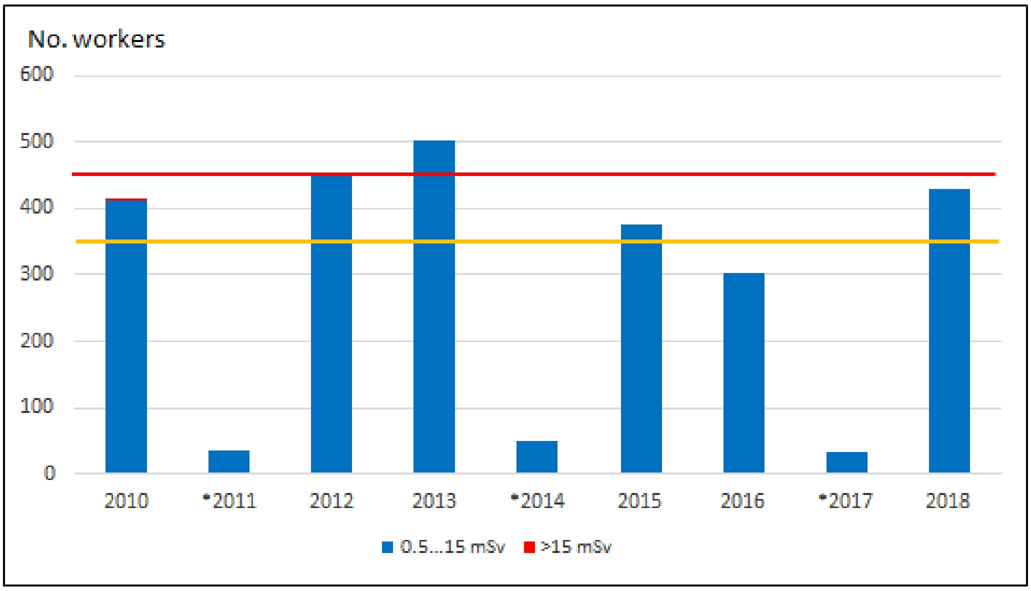


Figure 10: Exposure of radiation personnel

2.1.1.2 Abnormal events and operating experiences in the Krško NPP

The reporting of abnormal events is determined by the Rules on the Operational Safety of Radiation and Nuclear Facilities. These Rules determine the list of events that have to be specially reported by nuclear power plant operators. The Krško NPP must also follow the additional reporting requirements prescribed in its Technical Specifications. In accordance with the Rules and Technical Specifications, the Krško NPP reported two events. The Krško NPP additionally reported one more event (the shutdown of the power plant due to the GT2 transformer having high voltage measuring problems) due to which it was necessary to shut down the power plant. Otherwise, it was not necessary to report this event in accordance with the Rules or Technical Specifications.

Shutdown of the power plant due to the high voltage measuring problems of the GT2 transformer

Following the 2018 outage and since the beginning of May there have been occasional losses of signal on the voltage line of the GT2 main transformer in one of the three phases (in phase C). Long-term operation with an occasional loss of signal on this measuring line or the interruption of the measuring loop represents a risk of overvoltage for the bushings and consequently for the main GT2 transformer. Therefore, a conservative decision was taken and the transformer voltage measuring system was disconnected and thus no longer represents a risk.

In order to avoid such an event, the plant was shut down on 29 July 2018 for a short period. For preventive purposes, six connectors for measuring the high voltage on the bushings of both main transformers (GT1 and GT2) were removed and dedicated plugs to ground the terminals were installed. Operation is possible and safe even without control measurements of the bushings. Final remediation with the replacement of all connections will be carried out during the 2019 outage.

Figure 11 shows the main transformer and measurement of the bushing voltage on the main transformer.

The Krško NPP and the SNSA examined the event in detail and carried out an analysis.

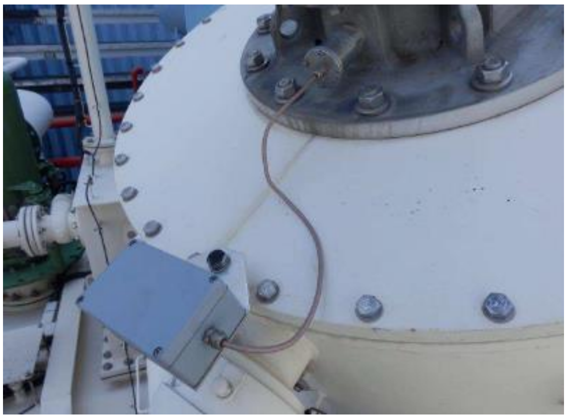


Figure 11: The GT1 main transformer (left) and measurement of the bushing voltage of phase C, on the GT2 main transformer (right)

Failure to install new PT944EC and PT943EC pressure transducers in the containment

As part of the project »Construction of an emergency control room (ECR)«, two new measurements of the pressure in the containment were also installed. The PT943EC and PT944EC measuring transducers were connected to the pressure cell (sensor) PT-943EC-PE, which was installed in the containment. It was installed in the intermediate building (IB) with the capillary lines. The capillary lines had to be vacuumed and filled with silicone oil. During the vacuum process itself, the vacuum pump failed, and the vacuum process was therefore prolonged. After the required pressure was applied (26.7 Pa), the capillary filaments were filled with silicone oil. This operation was not successful because the oil did not reach the sensor. Since the measuring system was only partially filled with oil, the sensor and transducers were disassembled. Operability of the PT943EC and PT944EC transducers is required by the Technical Specifications for the design extension condition (DEC TS) and thus they were declared inoperable and on 28 April 2018, at 00:00, the plant entered DEC LCO 3.3.3.5.

In October 2018, a new revision of the DEC TS was issued, which for the inoperability of pressure transducers required compliance with DEC LCO 3.0.3 (prepare a special analysis with justification for further operation). The purpose of the new transducers is to improve the nuclear safety of the plant, especially for beyond design bases accidents. For the management of project accidents, the plant has additional instrumentation for measuring the pressure in the containment. The Krško NPP prepared an analysis to prove that without the new transducers the power plant would operate with the same configuration as before their installation, and that thus nuclear safety would remain at the same level as before the introduction of this modification. Therefore, the Krško NPP requested that the SNSA approve the exceedance of DEC LCO 3.3.3.5, which the SNSA did on 21 December 2018. The Krško NPP will repair the installation of the new pressure transducers during the 2019 outage.

The Krško NPP and the SNSA examined the event in detail and carried out an analysis.

Uncertain measurement of the level (L-6170EC and L-6171EC) of the coolant in the containment sump at DEC conditions

As part of the project »Construction of an emergency control room (ECR)«, also the installation of two new level meters (L-6170EC and L-6171EC) in the containment sump was carried out. These two measuring channels are intended for use in the event of a severe accident (beyond-design), covering a wide area and qualified for the conditions of severe accidents. Their indication is available in the emergency control room (ECR), while the indication in the main control room is indirect, via the Krško NPP's Process Information System (PIS).

During operation after the 2018 outage, a slow creep and oscillation of the indication on both measuring loops were observed. Due to exceeding the criterion referred to in the Krško NPP procedure, on 23 October 2018 entry into DEC-LCO 3.3.3.5 was declared. The level meters were declared inoperable. Since these meters cannot be put into reliable, calibrated operation until the next outage and cannot be declared operable, the Krško NPP complied with DEC LCO 3.0.3, and requested that the SNSA approve the exceeding of DEC LCO 3.3.3.5. The purpose of the new level meters is to improve the nuclear safety of the plant, especially for accidents that exceed the design bases. For the management of project accidents the plant has additional instrumentation for measuring the level in the containment. Because the power plant without the new transducers will operate with the same configuration as before they were installed, nuclear safety remains at the same level as before the introduction of this modification, therefore the SNSA approved this exceedance on 21 December 2018. The Krško NPP will again calibrate the new transducers during the 2019 outage according to the revised procedure.

The Krško NPP and the SNSA examined the event in detail and carried out an analysis.

2.1.1.3 Second Periodic Safety Review

On 30 May 2014, the SNSA approved the second Periodic Safety Review (PSR2) and the resulting implementation plan. The Krško NPP reports every six months to the SNSA in accordance with the SNSA decision on progress regarding the changes and improvements implementation plan of the PSR2, which includes 225 improvements. In total, by 31 December 2018, 204 actions had been completed, of which 71 out of 71 actions scheduled for completion in one year, 82 out of 84 actions scheduled for completion in three years, and 51 out of 70 actions scheduled for completion in five years. The Krško NPP must complete the implementation plan by 30 May 2019.

2.1.1.4 2018 outage

The 2018 outage at the end of the 29^{th} fuel cycle took place from 1 April to 1 May. In the 29^{th} fuel cycle the Krško NPP operated reliably, despite an automatic shutdown due to the inadvertent closing of the main supply valve, the reduction of the water level in steam generator number one in February 2017 and automatic shutdown due to the opening of a relief valve on one of two steam boilers and a water drop separator on the secondary - the classic site of the power plant in April 2017.

This year's outage ran very smoothly initially and in accordance with the outage plan, until the beginning of the operation of transferring used fuel from the reactor core, when problems with the equipment dedicated to the transfer of nuclear fuel from the containment building to the spent fuel pool occurred. Problems also occurred while lifting an engine of one of the circulating reactor pumps with an auxiliary polar elevator. Corrective measures applied to this equipment extended the outage for two days. The deviations did not have a radical impact on employees, the population, or the environment.

Besides the partial replacement of the fuel, extensive maintenance work was carried out and some technological improvements and upgrades were made, which will continue to provide a high level of nuclear and radiation safety during an outage.

The main activity in the field of a safety upgrade of the NPP was the establishment of an auxiliary control room, which will enable the safe shutdown of the power plant and its long-term cooling from a dislocated location in the area of the Krško NPP in the event the main control room is not available due to a severe accident scenario. In addition, eight more important changes were introduced, such as the installation of additional valves for charging and discharging water in the pressuriser, alternative cooling of the reactor cooling system, replacement of the generator excitation system, replacement of some circuit breakers, and updating the turbine sealing system. All these updates and upgrades form the basis for the safe operation of the NPP even in the event of potential operation beyond the projected life expectancy.

The results of the examinations and tests did not show unexpected defects on the equipment, except in some cases. Fuel element AJ39 with a damaged 9th grille, which was intended for the formation of a new core, was not suitable for further use. In the examination of valves, circumferential cracks 44 mm in length were found on the sealing ring with liquid penetrants. Problems also appeared upon testing the autocatalytic plates of the system. Also two pressure indicators designed to measure the pressure in the containment and qualified for severe accidents were inoperable.

The main unforeseen events of this year's outage were:

- leaking of the shut-off valve on the fuel transport channel from the containment to the spent fuel building;
- problems with lifting the engine of the circulating reactor pump;
- problems with a trolley designed for transferring nuclear fuel; and
- problems with the replacement of fissile cell guides.

During this year's outage, all planned works were carried out in connection with checking the condition of the equipment, the replacement of nuclear fuel, and the introduction of changes, with the exception of the arrangement of the inlet facility of the cooling water system, which was canceled before the beginning of the outage.

There is a long-term practice of independent authorised professional organisations providing assistance in supervising outage activities, which report their observations and comments to the SNSA and the NPP at weekly meetings.

The SNSA's preparation for monitoring outage activities was systematic and similar to previous outages. After the outage the SNSA prepared an outage analysis. Implementation of the tasks from the outage analysis action plan will continue to solve the identified discrepancies and outstanding issues from the 2018 outage.

Also the SNSA reviewed the report of the authorised organisations and the recommendations that were made. Thematic inspections were carried out where NPP staff provided answers to the implementation of the recommendations of the authorised organisations and pledged to implement all of them in order of relevance.

2.1.1.5 Inspections of fuel assemblies during the 2018 outage

By the In-Mast Sipping (IMS) method, an inspection of cladding integrity was performed for all 121 fuel assemblies of the fuel cycle 29 core. The inspection showed that there were no leaking fuel assemblies (Figure 12).

Quick Underwater Visual Inspection (Q-UWTV) was performed during core unload for the top part of the fuel assemblies between grids 7 and 8 and the top nozzle. Mechanical damage was found on grids 7 and 8 of fuel assemblies AG31 and AJ39.

Underwater Visual Inspection (UWTV) was performed for all four sides of 122 fuel assemblies, including all from the core of fuel cycle 29 and one fuel assembly, AC04, which was planned for the new core of fuel cycle 30. Mechanical damage to distancer grids were found on three fuel assemblies AJ39, AG31 and AH02. These fuel assemblies cannot be employed for further use in the core.

A search for and retrieval of debris on fuel assemblies was performed by means of the FOSAR method. Debris was found on fuel assemblies AJ54, AH22, and AH50. Removal of debris from fuel assembly AJ54 was successfully performed and this fuel assembly was then suitable for future use in the core, while the other two fuel assemblies are not.

Ultrasound Testing (UT) was not performed because this was not needed since according to the results of the IMS and Q-UWTV it was confirmed that there were no damaged fuel assemblies in the core of fuel cycle 29.

Inspection of control and shutdown assemblies was not performed during the 2018 outage.

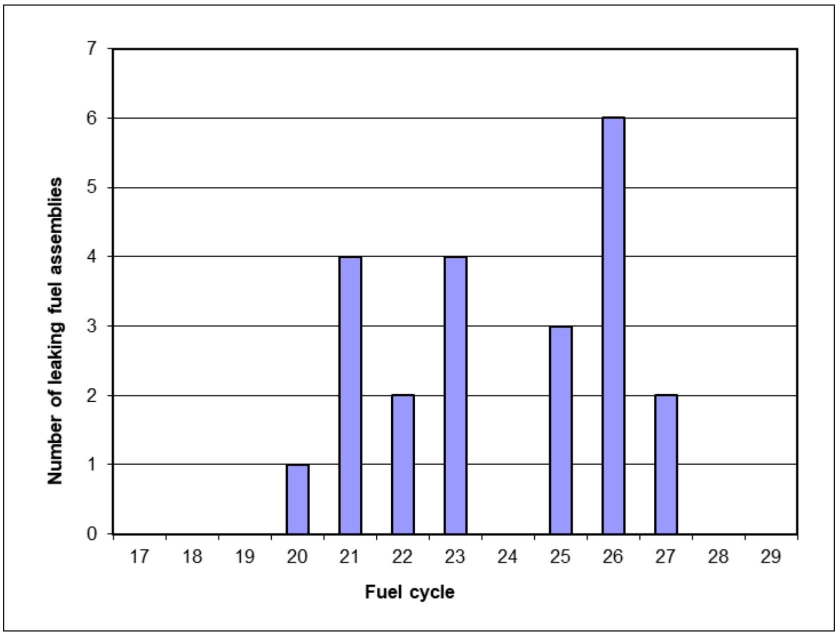


Figure 12: Results of the fuel integrity inspections by the IMS method during outages since year 2000 (fuel cycle 17)

Following the implementation of corrective measures to prevent open defects of fuel assemblies, where the major effect was due to the change of the reactor core bypass flow »Reactor Vessel Upflow Conversion«, there have been no leaking fuel rods since fuel cycle 28.

Fuel inspections and reinforcement of fuel assemblies for the implementation of the dry storage project

Within the scope of the project of the construction reinforcement of selected spent fuel assemblies which will be transferred to the dry storage for spent fuel (Project FANCHOR), fuel assembly inspections and the implementation of reinforcement were performed from October 2018 to February 2019. The inspections of fuel assemblies consisted of verification of the fuel assemblies' cladding integrity by the Vacuum Can Sipping (VCS) method and Underwater Visual Inspection (UWTV).

The reinforcement was implemented for selected spent fuel assemblies that were susceptible to the separation of the top nozzle from the rest of the fuel assembly due to the load upon the lifting or movement of the fuel assemblies. The cause was the sensitivity of the material, from which control rods guides are made, to intergranular stress corrosion cracking. The reinforcement procedure consists of the installation of six 30 cm long anchors to position of control rods guides in the fuel assembly top nozzle. The installed anchors provide an additional mechanical joint between the top nozzle and the fuel assembly. The process of fuel construction reinforcement is performed in such a way that the anchor or tool cannot in any case or at any time come into contact with the fuel rods and therefore the possibility of fuel rod damage is minimal. A total of 271 fuel assemblies were planned for reinforcement.

2.1.1.6 The Krško NPP Safety Upgrade Programme

In September 2011, the SNSA issued a decision regarding the Krško NPP in which it set requirements for the implementation of the Krško NPP Safety Upgrade Programme (SUP). The requirements are based on Slovenian legislation and the lessons learned from the Fukushima Daiichi accident in March 2011. The plant performed an analysis of the improvements needed, and based thereon prepared a proposal for the SUP, which was reviewed by the SNSA and approved in February 2012.

The Krško NPP's SUP, which is due to be finished by the end of 2021, is divided into three phases.

Phase I, which was implemented in 2013:

- installation of passive autocatalytic recombiners (PARs);
- installation of a passive containment filtered vent system.

Phase II, which is underway and is to be implemented by the end of 2019, includes:

- additional flood protection of the nuclear island and all the new systems, structures and components (implemented in 2015/2016);
- installation of pressuriser bypass relief valves, qualified for severe accidents (implemented during the 2018 outage);
- acquisition of a mobile heat exchanger, which will be located outside the nuclear island and with provisions for quick connections to the spent fuel pool (implementation underway);
- installation of a fixed spray system on the spent fuel pool with provisions to use mobile equipment (implementation underway);
- installation of an additional heat removal pump with a dedicated heat exchanger (which will be cooled by Sava River water through mobile equipment) capable of removing heat from the primary system and the containment (implementation underway);
- upgrade of the bunkered building 1 (BB1) electrical power supply (provisions to connect an additional mobile 2 MW diesel generator, seismic requalification of the 3rd emergency bus, upgrade of the connection between the 400 V safety buses and mobile diesel generators, etc.) (implemented during the 2018 outage);
- replacement of the existing remote shutdown panels with the installation of an emergency control room (ECR) with capabilities to shut down the reactor and maintain the long-term safe shutdown state (the greater part of the upgrade was implemented during the 2018 outage, while the completion thereof is planned for the 2019 outage).
- installation of additional instrumentation dedicated to severe accidents with an independent power supply (implemented during the 2018 outage);
- the above-mentioned ECR will include habitability systems for ensuring a safe long-term environment for operators even in the event of severe accidents (implementation underway); and
- upgrade of the operational support center and technical support center (emergency centers) to ensure a safe long-term environment for operators even in the event of severe accidents (implementation underway);

Phase III, which will be implemented by the end of 2021:

- installation of additional injection systems for the reactor cooling system / containment and steam generators with dedicated reservoirs of cooling water (also borated) capable of being replenished with water from underground wells - the bunkered building 2 (BB2) project (implementation underway);
- construction of a dry spent fuel storage facility (implementation underway).

The SNSA's post-Fukushima Action Plan

In December 2012 the SNSA prepared a comprehensive action plan on the basis of the lessons learned from the Fukushima accident. The document was published on the SNSA's website. The Action Plan comprises all activities by whose implementation the risk due to external and other hazards that could affect the Krško NPP location would be further reduced.

The core of the Action Plan is the implementation of the Safety Upgrade Programme described in the previous chapter. Besides the SUP, the SNSA identified 11 additional activities to improve preparedness for severe accident events. Among them are legislative changes, additional international review missions, additional studies and inspections, enhancements in the area of emergency preparedness, and improvement of the safety culture of both the licensee and the regulatory body.

The implementation of most of the actions from the Action Plan started already in 2013. In 2018 the following actions were being implemented:

- the IAEA's OSART (Operational Safety Review Team) Follow-up mission was implemented, which reviewed how the Krško NPP implemented improvements on the basis of the OSART mission performed in May 2017 (for more information, see Chapter 2.1.1.8);
- in the area of emergency preparedness, coordination with the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR) was undertaken with regard to the revision of the radiological emergency response plan, which is to ensure long-term support to the Krško NPP in the event it is hit by a major disaster (e.g. a catastrophic earthquake), such as providing fuel for diesel generators (after the plant's onsite supplies are depleted), as well as additional equipment for supporting major safety systems (e.g. mobile diesel generators and pumps);
- preparations for the construction of the dry spent fuel storage on the Krško NPP site.

The updated Action Plan (December 2018) is published on the SNSA's website.

2.1.1.7 Technical improvements and modifications

In addition to day-to-day monitoring of the operation of the nuclear power plant, the SNSA devotes particular attention to the inspection and validation of modifications and improvements in the power plant on the basis of global practice, operational experience, and the latest developments in the nuclear field.

Modifications of the design conditions and the design bases of the nuclear power plant or the conditions for the exploitation of nuclear power plants are some of the most important activities that can affect the safety of the nuclear power plant; therefore, modifications must be strictly controlled and properly documented.

In 2018 the SNSA approved 9 modifications and agreed to 18 modifications. During the safety evaluation screening the Krško NPP did not identify any open safety issues for 313 modifications. Therefore, the Krško NPP only informed the SNSA of those 313 modifications. As of 31 December 2018, there were 39 active temporary modifications. 65 temporary modifications were opened, and 63 were closed in 2018. Of the active temporary modifications, 1 is from 2010, 2 temporary modifications were approved in 2013 and 3 in 2014, 3 from 2016, and 5 from 2017. These modifications are scheduled to be closed by the end of 2019, 3 in 2020, 5 in 2021, and 1 in 2022.

In 2017 the Krško NPP issued the 25th revision of the "Updated Safety Analysis Report", which considered the changes approved up to 1 November 2018.

A list of modifications since 2000 approved by the SNSA or those of which the SNSA was informed can be found on the SNSA website.

2.1.1.8 OSART Follow-up Mission

The Krško NPP hosted an OSART Follow-up mission between 15 and 19 October 2018, which performed a review of the implemented operational improvements on the basis of the recommendations and suggestions of the original OSART mission performed in May 2017.

The Krško NPP reported to the OSART Follow-up mission the improvements implemented, such as:

- the revision and amendment of procedures and programms:
    - the planning of succession and the development of leading personnel;
    - the operational indicators programme;
    - performance indicators;
    - the use and consideration of procedural guidance;
    - the preparation of matrices of necessary training for workplaces;
    - the control of temporary modifications;
    - trends monitoring;
    - the installation of the Krško NPP's flood protection system;
- the preparation of new procedures for:
    - analysis of the needed systematic training of employees;
    - control of the containers in the decontamination building yard;
    - control of microbiologically induced corrosion;
    - the definition of probabilistic safety analysis modeling steps;
    - review of the probabilistic safety analysis;
- indoctrination and training regarding process improvements;
- the development of an application for the aggregation of performance indicators;
- the development of new indicators for different organisational units' needs;
- the development of new indicators for the control of temporary modifications;
- changes and amendments to human performance indicators;
- changes in the process of activating Krško NPP's response organisation in a case of an emergency;
- the introduction of additional markings at entrances and doors indicating entry into a radiologically controlled area;
- the preparation of new fire protection plans for certain parts of the plant;
- adding smoke detectors and fire extinguishers to certain pieces of mobile equipment (mobile diesels and transformers);

- improvements in the corrective action programme.

At the time of the follow-up mission, 70 % of the planned actions had been fully implemented and the rest were in the process of being implemented. All actions should be completed by the end of June 2019. The mission concluded that the implemented actions and actions in the process of being implemented fully meet the recommendations and suggestions of the original OSART mission.

2.1.1.9 Topical Peer Review (TPR)

Since finishing the report on aging management, which was prepared in cooperation with the Krško NPP and forwarded to the European Commission, the SNSA has continued its activities under the scope of the Topical Peer Review (TPR) in accordance with the Euratom Directive.

19 EU countries and some neighboring countries are participating in the peer review. The reports prepared by the participating countries were published on the ENSREG website in January 2018. Reports were made available for public consultation in January and February and all stakeholders were able to comment and raise questions. In addition, a peer review of the reports of the participating countries took place, in which the SNSA also participated. In the framework of this review, the SNSA reviewed the reports of other countries, asked them questions and answered all open questions regarding SNSA report and forwarded the answers to the European Commission.

After that, a review meeting of all countries in Luxembourg took place from 14 to 18 May 2018, where representatives from the SNSA and the Krško NPP represented Slovenia. At this meeting each country presented its aging management approach for nuclear facilities. Slovenia presented its legislative framework and aging management system in the Krško NPP. An important part of the meeting was the discussion of common important topics, which were identified during a peer review process and presentations. Examples of good practices that all countries will try to follow and the challenges that need to be solved in order to ensure adequate and effective ageing management were also provided. The ENSREG then prepared a report on the meeting with conclusions, and a public presentation of the results of the conducted peer review was also organised.

This was followed by the preparation of country-specific action plans. The SNSA has already submitted a draft action plan to the Krško NPP, which was prepared on the basis of the findings in the TPR final report. The deadline for submitting the action plan to the ENSREG is September 2019. In the year 2021, the status of the implementation of the actions from the TPR action plan will have to be reported for the first time, and then every two years until the end of the implementation of all actions.

2.1.1.10 Inspection Review

In 2018 altogether 68 planned inspections, including one unannounced inspection, were performed at the Krško NPP.

Reactive inspections, i.e. inspections related to abnormal events, were not conducted. However, during planned inspections the SNSA inspection service also analysed operator's consideration of solutions related to some important deviations identified during the normal operation of the Krško NPP. Regarding the mentioned deviations, the inspection service checked the root causes, realised immediate actions, and checked the outcomes of the analyses as well as the long-term plan of actions.

A serious challenge for the Krško NPP staff was the management of difficulties related to enhanced vibrations of the feedwater centrifugal pump of the system for the control of the chemistry and volume of reactor cooling water. These vibrations were a consequence of the fact that a part of the balancing disk of the pump broke down. The broken materials could end up in the reactor as foreign material, thus causing damage to the nuclear fuel. The operator coordinated the activities related to this situation very well. The expert activities were harmonised and carried out within the time limit required by the Technical Specifications. The SNSA inspection service analysed the operator's activities continuously. In addition, a specific inspection was dedicated to these activities.

On the basis of the inspections during normal operation and the outage, the SNSA inspection service concluded that the Krško NPP operated safely in 2108, i.e. without causing harm to people and the environment. The outage conducted in 2018 was managed professionally. The identified problems were analysed regularly. They were corrected within the framework of the implementation of the corrective programme as appropriate. The SNSA inspection service assessed the activities of most of the organisational units of the Krško NPP as good. The inspections identified the high level of the safety culture of the majority of Krško NPP experts. This level is reflected in the high quality of the activities carried out, where safety is always considered to be the priority. This level was also demonstrated in the identification of possible problems based on the operators' as well as foreign experiences and in the operators striving to implement appropriate corrective actions.

The SRPA monitors the radiation protection of workers in the NPP. In 2018 one coordinated inspection by the SRPA and the SNSA was conducted during the outage.

2.1.2 The TRIGA Mark II Research Reactor in Brinje

The operator of the TRIGA Mark II Research Reactor is the Jožef Stefan Institute (JSI) and it is operated by the personnel of the Reactor Infrastructure Centre (RIC).

2.1.2.1 Operation

In 2018 the reactor operated for 143 days, during which it released 116.0 MWh of heat. Operation was carried out according to a programme that is approved for each week by the head of the RIC and the JSI radiation protection service. The reactor operated in stationary mode and in pulse mode – 27 pulses were performed. The reactor was mostly used as a neutron source for neutron activation analysis, for the irradiation of electronic components or other materials, and for educational purposes. The reactor in shutdown mode was used as a source of gamma radiation to test electronic components. A total of 1,019 samples were irradiated in the carousel and the irradiation channels.

In the Hot Cell Facility (HCF), which is a part of the research reactor, the Department of Environmental Sciences, the JSI radiation protection service, and the ARAO regularly carried out radioactive waste treatment and preparations for the purpose of radioactive waste storage in the Central Storage of Low- and Intermediate-level Radioactive Waste at Brinje

In 2018 there were three automatic reactor shutdowns due to operator error. Such errors occur during reactor start-up or upon a power change while switching the meter for the linear channel of nuclear instrumentation. The nominal power of the reactor was not exceeded. The automatic shutdown always occurred at a low power of the reactor.

There were no violations of the operational limits and conditions under the Safety Analysis Report in 2018. There were also no events in 2018 that required reporting to the SNSA according to the criteria of Article 30 of regulation JV9 and there were no events connected to fire safety or physical security.

The performance indicators regarding the doses acquired by the operating staff and researchers showed values far below the regulatory limits. The collective dose in 2018 was 1.08 man mSv for operating staff and 2.13 man mSv for personnel carrying out work at the reactor.

2.1.2.2 Nuclear Fuel

In 2018 a total of 84 fuel elements were located on the reactor site. There were no spent fuel elements. All fuel elements were standard elements with 12 % uranium content and 20 % enrichment. Control measurements of radioactivity in the reactor building and in the reactor coolant showed that no fuel elements were damaged. In 2018, 15 inspections of the fuel elements were performed. The JSI reported on the fuel balance monthly to the EURATOM and to the SNSA by a special form. In September 2018, the EURATOM performed an inspection of the status of the nuclear material and the inspection findings showed no anomalies.

2.1.2.3 Staff Training

At the beginning of 2018 the RIC employed a new operator, who was then trained throughout the year in line with the programme for obtaining the license for reactor operation. On 5 July 2018 an internal training course was organised for the operators and the JSI radiation protection service regarding protection of the body and respiratory system in case of contamination. Regular training of staff was performed in line with the annual programme of expert training of the TRIGA Research Reactor operators for the year 2018.

2.1.2.4 Modifications and Inspections of the Systems, Structures, and Components of the Nuclear Facility, Fire Safety and Physical Protection

The reactor operated in stationary mode and pulse mode. The pulsing was performed in March and April as an exercise for course participants and for a M.Sc. thesis. The pulsing was approved in advance by the reactor safety committee and the SNSA was notified of the pulsing.

In 2018 ten reactor core modifications were made for the experimental purposes of the Nuclear Physics Department and the French Commission for Atomic Energy and Alternative Energies (CEA, Commissariat à l'énergie atomique et aux énergies alternatives).

In 2018 a design modification for the replacement and upgrading of relay R-G/1 was carried out, which also includes the installation of an uninterruptible power supply. In the HCF the experimental transmutation of elements and fusion energy generation were performed. The lights were replaced in the cellar of the reactor hall and in room B of the HCF.

The RIC personnel, the JSI technical services, the JSI radiation protection service, and authorised external organisations conducted periodic inspections and supervision of the safety related structures, systems, and components (SSC). The inspections did not find any deficiencies.

2.1.2.5 Periodic Safety Review

The Periodic Safety Review of the nuclear facility that comprises the TRIGA Research Reactor and the hot cell facility was completed in December 2014 with the SNSA approving the Periodic Safety Review report with an action plan for the implementation of modifications and improvements. In 2018 the implementation of the action plan, with a total of 85 modifications and improvements, was carried out. By means of semi-annual reports, the JSI reported on implementation status. Altogether, 76 actions had been implemented by the end of 2018, while the implementation of 7 actions continues and should be completed in 2019. In the same manner, in 2019 two actions are scheduled for implementation. The implementation of the action plan for modifications and improvements should be completed by December 2019. By the end of 2018, altogether 90 % of all planned actions had been implemented.

2.1.2.6 Inspection Reviews

In 2018 the inspection service for radiation and nuclear safety carried one inspection review of the TRIGA Research Reactor. The inspection dealt with the actual regulatory state of the operational monitoring of the TRIGA reactor and with a review of the performance of operational monitoring of the TRIGA reactor in 2018. The inspection ordered the JSI to provide at least one independent measurement of emissions and imissions in 2019. If possible, the samples should be selected in a manner that will enable the JSI to cover all sorts of measurements in a few years. During the inspection no deficiencies were found that would affect the assurance of radiation and nuclear safety.

The SRPA did not inspect the Research Reactor Centre in 2018.

2.1.3 The Central Storage for Radioactive Waste in Brinje

The Central Storage for Radioactive Waste (CSRW) in Brinje is managed by the Agency for Radwaste Management (ARAO).

Preventive periodic maintenance, inspections and tests of assemblies of structures, systems, components, work and measuring equipment were carried out as planned. Upon completion of the first periodic safety review of the CSRW and the final report prepared last year, the SNSA issued a decision approving the report on the periodic safety review. In doing so, it ordered the operator of the facility to implement the implementation plan for the next three years. The decision to confirm the Periodic Safety Review report was also the basis for the prolongation of the operating license in April 2018. The operating license of the CSRW facility was prolonged for another ten years.

Records are kept of radioactive waste (RW) and nuclear materials, of preventive and corrective maintenance of SSCs, modifications, operational events, and experiences. Foreign and own operating experiences were monitored, as well as the development of technology in the field of nuclear and radiation facilities and novelties in the management of radioactive waste. The amendments were addressed in accordance with the legislation and duly reported.

The acceptance of radioactive waste in the CSRW in 2018 and the inventory of the waste stored as of the end of 2018 are described in more detail in Chapter 5.4.

2.1.4 The Former Žirovski Vrh Uranium Mine

The excavation of uranium ore took place in the area around Žirovski Vrh between 1982 and 1990 and uranium concentrate was processed therefrom. Mill tailings were disposed of in the Jazbec mine tailings disposal site and hydrometallurgical tailings were disposed of at the Boršt site. In 1990, after the exploitation of uranium ore was temporarily halted and the subsequent decision on permanent cessation was made, the process of the remediation of this mining process and its consequences began.

The Jazbec disposal site was closed in 2015. An area covering the landfill body of the site became an object of the national infrastructure, and since the end of 2015 it has been managed by the ARAO under the State's authority. The P-10 plateau at the foot of the body of the disposal site is also included in the area of the national infrastructure facility referred to as the Jazbec disposal site due to the rupture of mining waste. The area together with the facilities that stand on the plateau has been rehabilitated and is managed by several legal entities.

For the disposal site, the year 2018 was the eighth year (the third additional year) when regular maintenance work was carried out. More information on the remediation activities regarding the former mining activities at Žirovski Vrh can be found in Chapter 5.6.

2.2 Radiation Practices and the Use of Radiation Sources

One part of the requirements of Council Directive 2013/59/Euratom of 5 December 2013 was transposed with the adoption of the new Ionising Radiation Protection and Nuclear Safety Act in the middle of December 2017. In 2018, secondary legislation was prepared on the basis of the new law, in fact seven implementing regulations were adopted.

2.2.1 Use of Ionising Sources in Industry, Research and Education

In 2018, 64 licences to carry out radiation practices, 28 licences for the use of a radiation source, 1 print-out from the register of radiation practices, 71 print-outs from the register of radiation sources, 18 approvals for external operators of radiation practices, 1 decision on the termination of the validity of a licence to carry out radiation practices, 3 decisions on sealing an X-ray device and 3 decisions on unsealing an X-ray device were issued by the SNSA.

At the end of 2018, 175 organisations in industry, research and the state administration in the Republic of Slovenia were using 343 X-ray devices, and 707 sealed sources were being used in 76 organisations. As many as 29 radioactive sources were stored at 16 organisations, which are intended to be handed over to the ARAO in the future.

Since 2004 the SNSA has periodically issued the leaflet Radiation News, with the aim of disseminating useful information in the field of regulatory control and the use of radiation sources to entities carrying out radiation practices. By the end of 2018, 47 editions of the leaflet had been issued, 2 of them in 2018.

Ionisation smoke detectors, utilising isotope ^{241}Am, form a special group of radiation sources. According to the registry of radiation sources, there were 20,258 ionisation smoke detectors being used at 263 organisations at the end of 2018. In addition, 305 ionisation smoke detectors were stored on the users' premises. Among them, 195 were stored on the premises of companies dealing with the maintenance, mounting and dismounting of ionisation smoke detectors.

The STERIS manufacturing and storage facility for the sterilisation of medical equipment

In 2017, the STERIS manufacturing and storage facility was built in the area of the Komenda business zone. The sterilisation of medical equipment is implemented in the facility. The facility, in which there are two linear accelerators, is classified as a less important radiation facility. The user of the facility is the STERIS manufacturing and storage facility, but its owner is the international cooperative Synergy Health Holdings Limited from the United Kingdom.

In 2018, the SNSA issued a licence to carry out a radiation practice and a licence to use radiation sources.

2.2.2 Inspections of Sources in Industry, Research and Education

In 2018 the SNSA inspection service conducted 75 inspections related to industry, research institutions, ministries, educational institutions, scrap dealers and transport companies. Altogether eight interventions are included in this number.

Annual inspections related to the use of high-activity radioactive sources were performed as a part of regular inspection activities already carried out in the past. Namely, industrial radiography as a practice related to specific risks was generally a subject of special attention of SNSA inspectors conducting annual inspections. The risks are associated not only with the use of high-activity radioactive sources but also with the use of x-ray machines. The inspectors noted that ensuring a culture of safety is still a big challenge for companies carrying out this practice. Therefore, the inspectors concluded that the frequency of inspections of this practice should be maintained. In particular, the inspectors devoted special attention to the enclosures within which industrial radiography takes place.

In 2010 the SNSA inspectors concluded a few-year long project involving a systematic search for all sources in companies and institutions where inspections were carried out for the first time. As a result, since that year radiation sources from abandoned past practices have been identified very rarely. Namely, except for smoke detectors using ionising radiation sources, no other radiation sources abandoned by users were identified in 2018. The smoke detectors mentioned do not cause a risk to users during the normal use of such detectors. However, when handling smoke detectors, i.e. during installation, service and dismantling, a source can be damaged, and contamination can occur. Therefore, a permit for handling such sources is needed. In addition, when such smoke detectors become disused sources they should be stored in a radioactive waste storage. The SNSA devotes special attention to disused smoke detectors using an ionising radiation source as there is a risk that they will not be dismantled and disposed of as required. In 2018 the inspection service continued to monitor the implementation of the required corrective actions on the basis of inspections from previous years, e.g. at the Ministry of Defence.

In 2018 the SNSA inspection service conducted two inspections at a company involved in the sterilisation of medical materials using two linear particle accelerators.

As in previous years, the SNSA inspection service devoted special attention to companies expected to enter into bankruptcy as well as to those where bankruptcy has already taken place. In addition, attention was devoted to bankruptcy managers in order to ensure that the managers are informed of any radioactive sources and radioactive waste that might be a subject of bankruptcy processes.

As already mentioned, the SNSA inspectors also conducted eight interventions. This number is somewhat lower than number of interventions in previous years, i.e. 17 interventions in 2017 and 18 interventions in 2016.

The majority of interventions were related to the suspicion that orphan sources were present in metal scrap materials in cargo from abroad. Altogether seven interventions were related to such cases. The regulatory activities are based on preparedness of the SNSA on-duty officer, the collaboration of the SNSA with the Agency for Radwaste Management, qualified experts for radiation protection and other institutions in or outside the country dedicated to the management of radiation sources and radioactive waste.

As a general rule, an orphan source is detected by measurement equipment. The source or radioactive waste, as appropriate, is subsequently returned under special conditions to the polluter. In 2018 such cargo was returned to the country of origin three times, i.e. two times from Italy, namely to Croatia and Hungary, and once from SIJ Acroni d. o. o. to Germany. In certain cases radioactive waste is put in the Central Storage for Radioactive Waste. In 2018 enhanced doses detected on a wagon required detailed analysis in four cases. In all cases measurements were performed by SIJ Acroni d. o. o. Qualified experts, namely IOS, provided measurements and as well as an opinion on how to ensure appropriate handling of the items causing an enhanced dose field. In one case the suspicion that an orphan source existed was not confirmed, while in three cases radiation sources were identified. In the first case, identified contamination with ^{60}Co led to the controlled melting of the material in a few batches at SIJ Acroni d. o. o. The melting process was supervised by IOS. In one case IOS identified a dial containing ^{226}Ra, causing a contact dose rate of 2 μSv/h. This dial was placed in secondary scrap metal materials by a company collecting such material, i.e. Dinos d. d. The same company placed in secondary scrap metal materials slag containing enhanced values of artificial radionuclide ^{241}Am and natural occurring radionuclides, i.e. ^{226}Ra and ^{210}Pb. With regard to the available data, this is the very first case of the identification of ^{241}Am in Slovenia in secondary material originating from a foundry. Upon contact, the dose fields were up to 0.7 μSv/h. The measurements were performed by IOS at the location of a company in Ljubljana. The sum of the ratios between the measured specific activities and clearance levels was 1.4, i.e. above 1, so the material was managed as radioactive waste by the Agency for Agency for Radwaste Management.

2.2.3 Use of Radiation Sources in Medicine and Veterinary Medicine

The Slovenian Radiation Protection Administration (SRPA) is responsible for the administration and inspection of practices involving radiation in medicine and veterinary medicine.

X-ray Devices in Medicine and Veterinary Medicine

According to the records of the SRPA, 1,108 X-ray devices for medicine and veterinary medicine were installed as of the end of 2018; 129 of them were not in use (6 required servicing, 94 were on reserve, and 29 were proposed for decommissioning). The categorisation of X-ray devices based on their purpose is given in Table 3.

Table 3: The number of X-ray devices in medicine and veterinary medicine by purpose

Purpose	Status 2017	New	Written-off	Status 2018
Dental	558	40	15	583
Diagnostic	311	14	13	312
Therapeutic	12	1	1	12
Simulator	4	0	0	4
Mammography	34	2	1	35
Computed Tomography CT	31	2	0	33
Densitometers	45	0	0	45
Veterinary	71	14	1	84
TOTAL	**1,066**	**73**	**31**	**1,108**

In the field of the use of X-ray devices in medicine and veterinary medicine in 2018, the SRPA granted 74 licences to carry out a radiation practice and 195 licences to use X-ray devices.

In medicine (not including veterinary medicine), 470 X-ray devices were used in public hospitals and institutions and 554 in private dispensaries. The average age of the X-ray devices in the public sector was 10.1 years (9.8 years in 2017, 9.6 years in 2016, 9.4 years in 2015, 9.6 years in 2014, 9.5 years in 2013, and 9.1 years in 2012), and in the private sector 10.2 years (10.0 years in 2017, 10.2 years in 2016, 10.1 years in 2015, 9.9 years in 2014, 9.8 years in 2013, and 9.2 years in 2012).

In veterinary medicine, 17 X-ray devices were in use in public institutions and 67 in the private sector. The average age of X-ray devices was 14.9 years (15.4 years in 2017, 15.5 years in 2016, 15.5 years in 2015, 14.5 years in 2014, 13.5 years in 2013, 13.8 years in 2012) in the public sector, and 8.8 years (8.8 years in 2017, 8.7 years in 2016, 10.1 years in 2015, 9.4 years in 2014, 9.6 years in 2013, and 8.0 years in 2012) in the private sector.

A detailed classification of X-ray devices in medicine and veterinary medicine according to their ownership is given in Table 4.

Table 4: Number of X-ray devices in medicine and veterinary medicine by ownership

Ownership	Diagnostic		Dental		Therapeutic		Veterinary		Total	
	No. (%)	Age (years)	No. (%)	Age (years)	No. (%)	Age (years)	No. (%)	Age (years)	No. (%)	Age (years)
Public	347 (81 %)	9.9	110 (19 %)	10.8	13 (100 %)	7.2	17 (20 %)	14.9	487 (44 %)	10.2
Private	81 (19 %)	11.9	473 (81 %)	9.9	0	0	67 (80 %)	8.8	621 (56 %)	10.0
TOTAL	**428**	**10.3**	**583**	**10.1**	**13**	**7.2**	**84**	**10.0**	**1,108**	**10.1**

All X-ray devices are examined by approved radiation protection experts at least once a year. The devices are classified with regard to their quality into the following groups: fully functional, servicing required, decommissioning proposed, and not functional. The analysis of the data for X-ray devices is presented in Figure 13, which shows that more than 95 % of devices were classified as »fully functional«.

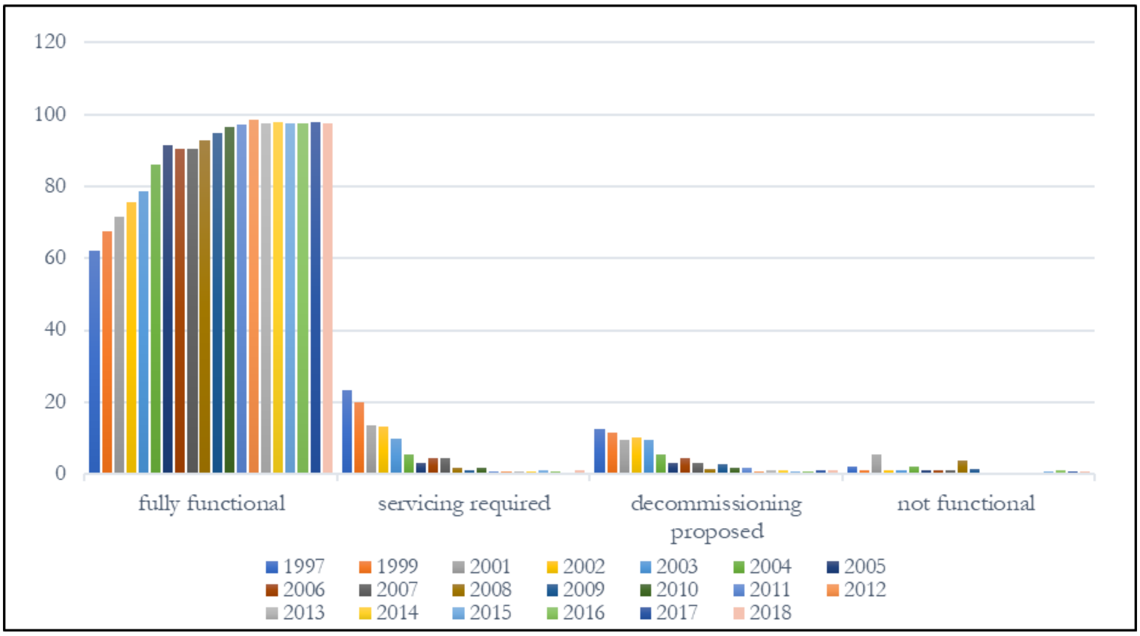


Figure 13: Percentage of diagnostic X-ray devices according to quality in the period 1997– 2018

In 2018, 12 in-depth inspections of the use of X-ray machines and linear accelerators for radiotherapy in medicine and veterinary medicine were carried out. Three of them were dedicated to radiotherapy; two to the introduction of radiotherapy (the use of linear accelerators) at the University Medical Centre in Maribor, and one to regular surveillance of radiotherapy at the Institute of Oncology (OI) in Ljubljana. 9 in-depth inspections in X-ray diagnostics were performed, 4 of them in dental radiology. In 6 cases, based on the findings of the inspection, the inspection service issued a decision requiring harmonisation with the valid regulations. In one case a decree forbidding the use of the CT device was issued due to essential noncompliance with the requirements.

Based on a review of the inspection reports on X-ray devices for medical use sent to the SRPA by approved technical support organisations, 9 inspections were conducted during which the SRPA requested that the user provide evidence that the noted shortcomings had been eliminated. There were 38 cases in which the user was asked to present evidence relating to the termination of the use of an X-ray device and 96 cases involving the requirement to comply with the applicable legislation.

Unsealed and Sealed Radiation Sources in Medicine and Veterinary Medicine

Seven hospitals or clinics in Slovenia, namely the Clinic for Nuclear Medicine of the University Medical Centre in Ljubljana, the Institute of Oncology, the University Medical Centre in Maribor, and general hospitals in Celje, Izola, Slovenj Gradec, and Šempeter pri Novi Gorici use unsealed sources (radiopharmaceuticals) for diagnostics and therapy in their nuclear medicine departments.

In these nuclear medicine departments, altogether 6439.6 GBq of isotope ^{99}Mo, 4578.5 GBq of isotope ^{18}F, 1027.4 GBq of isotope ^{131}I, and minor activities involving the isotopes ^{123}I, ^{177}Lu, ^{201}Tl, ^{111}In, ^{68}Ge, ^{223}Ra and some other isotopes are used for diagnostics and therapy. Isotope ^{99}Mo is used as a generator of the isotope technetium ^{99m}Tc, which is used for diagnostics by nuclear medicine departments. From the initial activity of ^{99}Mo, a few-times higher activity of ^{99m}Tc can be eluted in one week. At the end of 2014, the Institute of Oncology started to use ^{223}Ra, which emits alpha particles. Cumulatively, 1.4 GBq of that isotope were imported in 2017 (a bit more than in 2017, when 1.26 GBq of that isotope were imported).

Sealed sources for therapy are used at the Institute of Oncology and the Ophthalmology Clinic, and for the irradiation of blood components at the Blood Transfusion Centre of Slovenia. At the Institute of Oncology, two ^{192}Ir sources with initial activity of 440 GBq and 44 GBq, and three ^{90}Sr sources with initial activities of up to 740 MBq are in use. The Ophthalmology Clinic uses three sources of ^{106}Ru, with initial activities of up to 37 MBq, to treat eye tumours. At the Blood Transfusion Centre of Slovenia a device is used for the irradiation of blood components with a ^{137}Cs source with an initial activity of 49.2 TBq.

Sealed sources of minor activities are used for the operational testing of various devices and measurement equipment at some nuclear medicine departments.

With reference to the use of unsealed and sealed sources in medicine, 6 licences to carry out a radiation practice, 6 licences to use a radiation source, 4 import licences and 32 statements on the shipment of radioactive materials were issued in 2018.

Five in-depth inspections were performed; 3 at the Ophthalmology Clinic, one at Celje General Hospital and one at the Clinic for Nuclear Medicine. The Ophthalmology Clinic uses radioactive eye applicators with isotope Ru-106 to treat eye tumours. Applicators are surgically sewed on an appropriate spot and removed afterwards. In addition to the patient, who receives a therapeutic dose, workers performing the procedure are also exposed. Ru-106 is mainly a betta emitter, so special attention to finger and eye exposure is necessary. Several inconsistencies were observed at the Ophthalmology Clinic: the health certificates were not valid because they were not signed by an approved medical doctor. The IOS stated in its reports that the medical certificates are valid. The training certificates stated the training programmes that deviated from the required ones (what are required are programmes in the use of brachytherapy sources instead of the use of X-ray devices as stated in the reports). The IOS reported that workers have valid training certificates. Not all the medical doctors were listed in the programme of radiological procedures. Personal dosimetry was not monthly, as stated in the technical checks reported by IOS. Finger dosimetry was performed only from December 2005 until April 2006 and then omitted without the consent of the regulatory authority.

The Ophthalmology Clinic and the approved IOS institution have corrected the shortcomings identified in the inspection procedures. The Ophthalmology Clinic presented health certificates for its workers, signed by the approved medical doctor. The IOS gave a training course for workers of the Ophthalmology Clinic in line with the required training programme. The Ophthalmology Clinic, in cooperation with the IOS, reviewed the programme for radiological procedures and the evaluation of radiation protection. The programme for radiological procedures was amended with a list of responsible medical doctors. The evaluation of radiation protection was amended with a description of personal dosimetry including finger dosimetry. The

SRPA issued a licence to carry out a radiation practice and licence to use a radiation source to Ophthalmology Clinic.

An additional inspection at the Ophthalmology Clinic was performed in November 2018 due to an incident with the handling of an ^{106}Ru source. The personal dosimeter of one of the workers was exposed to a radiation dose exceeding the annual dose limit of 20 mSv. At the request of the inspector, an approved IOS dosimetry service assessed the equivalent doses to fingers and eye lenses and the effective dose due to the event. The IOS reported that the high reading of the dosimeter was not in line with the statement of the worker as to her handling of the source and the dosimeter as well as with the measured dose rates in the vicinity of the source. The working procedures were amended.

Due to one of the workers at the Institute of Oncology exceeding the dose constraint of 1.6 mSv, an explanation and documentation were required from this institution. The worker stated that while he was helping an immobile disabled person the dosimeter was detached and remained unobserved in the diagnostic room.

Medical departments with unsealed and sealed radiation sources were surveyed (once or twice annually, depending on the source type) by approved experts in radiation protection and medical physics at the Institute of Occupational Safety (IOS). No major deficiencies were found in 2018.

Neither unsealed nor sealed radioactive sources were used in veterinary medicine in 2018.

2.2.4 The Transport of Radioactive and Nuclear Materials

The transport of radioactive and nuclear materials is regulated by the Act on the Transport of Dangerous Goods. All road transport of such materials has to be carried out in accordance with the provisions of the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR).

In 2018 the SNSA and the SRPA did not issue any licenses for the transport of radioactive materials according to Act on the Transport of Dangerous Goods.

In 2018 the SNSA approved a package for the transport of nuclear material such as fresh non-irradiated nuclear fuel.

2.2.5 The import/shipment into Slovenia, transit, and export/shipment out of Slovenia of radioactive and nuclear material

The SNSA and the SRPA issue permits for the import into and export of radioactive and nuclear materials outside the EU and approve prescribed forms (declarations of shipment) for the shipment of radioactive material between EU Member States.

In 2018 the SRPA issued four permits for the import of radioactive sources from non-EU countries and approved 32 applications of consignees of radioactive material for 47 isotopes. Each isotope from an individual producer intended for the same end user is counted separately.

In 2018 the SNSA approved 14 applications of consignees of radioactive material from other EU Member States. The SNSA also issued five permits for the import of radioactive material, one permit for multiple imports and exports of radioactive material, two permits for the import of nuclear material, i.e. three detectors of neutron flux, and one permit for the export and one for the multiple export of radioactive material.

In 2018 the SNSA issued one approval for multiple shipments of radioactive waste from the Krško NPP to Sweden for treatment and one approval for the multiple export of waste material contaminated with natural radionuclides from Cinkarna Celje d.d. for final disposal in the United States of America. The export of the pertinent material was not yet implemented in 2018.

In 2018 the SNSA issued also two permits for the transit of radioactive material with important activity.

2.3 Achieving the Goals of the Resolution on Nuclear and Radiation Safety

The Resolution on Nuclear and Radiation Safety in the Republic of Slovenia for the Period 2013-2023 defined, *inter alia*, one of the most pressing and complex goals regarding nuclear and radiation activities:

Goal 1

Nuclear and radiation facilities and radiation operators fulfill the legal requirements, they are responsible for the continuous improvement of nuclear and radiation safety and closely follow the developments in the international area.

Realisation of the goal in 2018

The realisation of this goal is multifaceted. By monitoring and actively participating in international, especially European forums such as WENRA, ENSREG, EC, MAAE, etc., we are updating Slovenian legislation in nuclear safety and are enriching our domestic knowledge. In carrying out our basic mission, that is, safety oversight in nuclear facilities, we apply the established requirements and experience gained from abroad to ensure constant checking of the state of nuclear safety.

The fulfillment of legal requirements, and the constant verification and improvement of the level of nuclear safety in all nuclear and radiation facilities and activities in Slovenia was the main priority pursued in Slovenia also this year. The previous chapters in this report show that achieving the goal was successful.

3 RADIOACTIVITY IN THE ENVIRONMENT

The purpose of monitoring radioactivity in the environment is mainly to monitor the levels of general radioactive contamination, trends regarding the concentrations of radionuclides in the environment and timely warning in the event of a possible sudden increase in radiation on the territory of Slovenia.

Radiation protection of the population is ensured through continuous control of external radiation levels in the environment, the monitoring of radioactivity in the environment and regular control of the radioactive contamination of drinking water, food and feed on the basis of laboratory measurements.

Radioactivity released into the environment by the Krško NPP, the former uranium mine at Žirovski Vrh, the TRIGA Mark II Research Reactor, and the Central Storage for Radioactive Waste is monitored. Doses for the population are assessed in the vicinity of these facilities on the basis of measured or modeled data. The doses of the population must be lower than the dose limits determined by the competent administrative authority.

This chapter contains a summary of the reports on the state of environmental radioactivity on the territory of Slovenia in 2018.

The monitoring of exposure to natural sources of radiation is carried out under the governmental programme for the systematic inspection of working and living environments and raising the awareness of the population regarding measures to reduce exposure due to the presence of natural radiation sources. This programme was amended in 2016 and includes industrial activities that deal with materials containing naturally occurring radioactive material.

3.1 The Early Warning System for Radiation in the Environment

A nuclear or radiological accident occurring in Slovenia or abroad would also have consequences throughout the country. One of the key tasks in such an event is to provide immediate data on radioactivity in the environment. The successful implementation of protective measures for the population depends on this data. During such an emergency, the population would be exposed to external radiation and inhale radioactive particles from the air and consume contaminated water and food. The Slovenian early warning system regarding environmental radioactivity is an automatic system that instantly detects increased radiation in the environment in the event of an emergency.

The renewed and advanced software of the Early Warning System, referred to as the RVO, was put into test operation at the end of 2017. The RVO represents a new system for collecting, archiving and displaying data on radiation in the environment. In addition, it will also display data from laboratory measurements of environmental samples (the ROKO database) and real-time individual measurements made by mobile units or by SNSA co-workers. The important novelties include the modules Exercise and Emergency Events (exercises and simulations) and Mobile Units (operators can request field measurements and display real-time data from mobile units). The new system will also allow the public insight into the state of the environment, on the same websites as was the case for the previous system (www.radioaktivnost.si).

3.2 Monitoring Environmental Radioactivity

Monitoring of global radioactive contamination due to atmospheric nuclear bomb tests (1951–1980) and the Chernobyl accident (1986) has been carried out in Slovenia for almost five decades.

Primarily, two long-lived radionuclides cesium (^{137}Cs) and strontium (^{90}Sr), have been monitored in the atmosphere, water, soil, drinking water, foodstuffs and feedstuffs. Other natural gamma emitters are also measured in all samples, while in drinking water and precipitation the levels of tritium (^{3}H) are additionally measured.

The results of the measurements for 2018 showed that the concentrations of both long-lived radionuclide products in samples of air, precipitation, soil, milk, foodstuffs of vegetable and animal origin, and feedstuffs continued to slowly decrease.

Due to trends of seasonal deviations of the ^{137}Cs concentrations in the air, the SNSA in 2018 conducted a study on the concentration of radionuclides in heating pellets of Slovenian origin as well as from imports from countries that were affected by the Chernobyl accident (Ukraine and Belarus). The ^{137}Cs content was determined in the samples. The average specific activity of ^{137}Cs in all collected pellets was 9.2 ± 0.2 Bq/kg with a maximum value of 60 ± 2 Bq/kg in a sample from Ukraine taken in Dekani (Primorska region). The average specific activity of ^{137}Cs in imported pellets was 18 ± 8 Bq/kg, while in samples of Slovenian origin for all locations it was 3 ± 1 Bq/kg. The highest specific activity of ^{137}Cs in pellets of Slovenian origin was found in the Nazarje sample (14 ± 1 Bq/kg). Comparison of average specific ^{137}Cs activities in pellets taken in areas where air is sampled under various radioactivity monitoring programmes and concentrations of ^{137}Cs activity in the air does not show a statistical correlation. On the basis of the performed measurements, it was found that the storage and burning of pellets in households does not pose a potential risk due to additional exposure to ionising radiation, since such doses to the population are negligible compared to the inevitable natural background.

In addition to ^{137}Cs and ^{90}Sr, which have been present in global contamination for years due to nuclear tests and the Chernobyl disaster, ruthenium (^{106}Ru) was also measured in the autumn samples in 2017. The concentration of ^{106}Ru activity in the air in Ljubljana dropped below the detection limit in the first week of October. At the Jareninski Vrh site, concentrations of ^{106}Ru activity in the air were detected until November 2017 and at Predmeja until January 2018. Later, the ^{106}Ru was no longer detectable in the air. In February 2018 ^{106}Ru was detected in precipitation patterns at all sampling points. The reason for this is probably the re-suspension of particles from the ground. Despite the efforts of the international community within the framework of the IAEA, the precise source of radionuclide ^{106}Ru is still unknown.

The biggest contribution to the radiation exposure of the public due to environmental contamination by artificial radionuclides comes from external radiation and food ingestion. The inhalation dose from aerosols with fission radionuclides is negligible. ^{90}Sr is the biggest contributor to the food ingestion dose and ^{137}Cs is the biggest contributor to the external radiation dose. In 2018 the effective dose from external radiation from ^{137}Cs (mainly from the Chernobyl accident) was estimated at approximately 4.7 µSv, which is 0.18 % of the dose received by an average adult in Slovenia from the natural background radiation. The annual dose from the ingestion pathway (the consumption of food and drinking water) was 1.4 ± 0.7 µSv, which is comparable with previous years. The contribution of inhalation (the inhalation of radioactive particles) to the total dose is 0.0001 µSv for an adult due to low concentrations of ^{137}Cs and ^{90}Sr in the air and is similar to that of previous years.

The total effective dose received by the population from drinking water due to artificial radionuclides was also estimated. Calculations showed that it was on average about 0.02 µSv per year. The annual limit value of 0.1 mSv per year due to natural and artificial radionuclides in drinking water from local water supplies was not exceeded in any sample.

In 2018 the total effective dose of an adult in the central part of Slovenia, arising from global contamination of the environment with artificial radionuclides (external radiation) was estimated at 6.1 µSv, as shown in Table 5. This is approximately 0.25 % of the dose compared to the annual exposure of an adult in Slovenia received from natural radiation in the environment (2,500–

2,800 μSv). In the regions with lower radioactive contamination of the soil, such as Prekmurje and the Coastal-Karst region, the corresponding dose is lower, while it is higher in the Slovenian Alpine region.

Considering all the estimated doses specified in this chapter, it should be kept in mind that these values are extremely low and cannot be measured directly. The final results are calculated by using mathematical models and are based on measurable quantities of radionuclides, most of which are also low. The measurement uncertainties are therefore considerable and in some cases the results differ considerably from year to year. Most importantly, these values are far below the limit values.

Table 5: The radiation exposure of the adult population in Slovenia due to global contamination of the environment with artificial radionuclides in 2018

Transfer pathway	Effective dose [μSv per year]
Inhalation	0.0001
Ingestion:	
- drinking water	0.02
- food	1.40
External radiation	4.7*
Total (rounded)	**6.1****

* This applies to central Slovenia; the value is slightly lower for the urban population and higher for the rural population.
** Radiation exposure from natural radiation is 2,500–2,800 μSv per year.

3.3 Operational Monitoring in Nuclear and Radiation Facilities

Each installation or facility that may discharge radioactive substances into the environment is required to be subjected to regulatory control. Radioactivity measurements in the surroundings of the installations are performed in the pre-operational period, during operation, and for a certain period after the installation ceases to operate. The goal of operational monitoring is to establish whether the discharged activities are within the authorised limits, whether the radioactivity concentrations in the environment are within the prescribed limits, and whether the radiation doses received by the population are lower than the prescribed dose limits.

3.3.1 The Krško Nuclear Power Plant

The radiological situation in the surroundings of the Nuclear Power Plant is monitored by the continuous measurement of gaseous and liquid radioactive discharges and by carrying out radioactivity measurements of environmental samples. The measured values of the analysed radionuclides in environmental samples (in air, soil, surface and underground water, precipitation, drinking water, food and feedstuffs) during the normal operation of the plant are low, usually considerably lower than the detection limits of analytical procedures. The impacts of the NPP on the environment are therefore evaluated only on the basis of data on gaseous and liquid discharges. These discharge data are used as an input for modelling the dispersion of radionuclides in the environment. The low results of the measurements in the environment of the NPP during normal operation confirm that radioactive discharges into the atmosphere and in aquifers were low. In the event of an emergency, the established monitoring network allows the immediate sampling and analysis of contaminated samples.

In 2018 independent monitoring confirmed that the measurements of discharges performed by the Krško NPP were fully consistent with the results of measurements carried out by the laboratories of the authorised performers of radioactivity monitoring, i.e. the Jožef Stefan Institute (JSI) and the Institute of Occupational Safety (IOS).

3.3.1.1 Radioactive discharges

In 2018 a refueling outage was carried out, which caused slightly increased radioactive releases in comparison with 2017. The values were within the average value in the years when an outage was carried out. Noble gases predominate in the gaseous discharges. The emissions of noble gases into the atmosphere amounted to 0.974 TBq in 2018, representing 0.08 % of the total limit. In 2018, radioactive iodine radionuclides released 27.2 MBq (calculated to the equivalent of ^{131}I), which is 0.01 % of the annual limit. The discharged activity of radioactive particulates was negligible in 2018 and amounted to 5.49 kBq, which is approximately one millionth of a percent of the annual limit. Regarding ^{3}H discharges into the atmosphere, a slight increase in the activity of ^{3}H in gas discharges has been observed from year to year. This increase was mainly due to improvement of the sampling and analysis method in the laboratory. As expected, the levels of these releases slowly stabilised. The activity of ^{14}C corresponds to the typical values.

^{3}H, bound to water molecules, predominates in liquid discharges from the plant into the Sava River. Total ^{3}H activity released in 2018 was expected to be higher due to the outage of the NPP, and amounted to 10.5 TBq, which is 23.4 % of the annual administrative limit (45 TBq). Due to its low radiotoxicity, despite its higher activity, tritium is radiologically less important in comparison to other radioactive contaminants. The activity of other radioisotopes in liquid discharges was slightly higher than in the previous year due to the refueling outage and amounted to 16.9 MBq or 0.017 % of the annual limit (100 GBq). After an unexplained increase in the total activity of the released ^{14}C in 2016, values decreased for the second consecutive year. In 2018, the total activity of released ^{14}C decreased to 0.041 GBq, which is in accordance with data from the literature and international practice, i.e. 0.07 Ci/GW(e)/year or 1.8 GBq/year, and was even lower than in 2015.

Figure 14 shows the activity of the released ^{3}H in liquid discharges from 1983 to 2018.

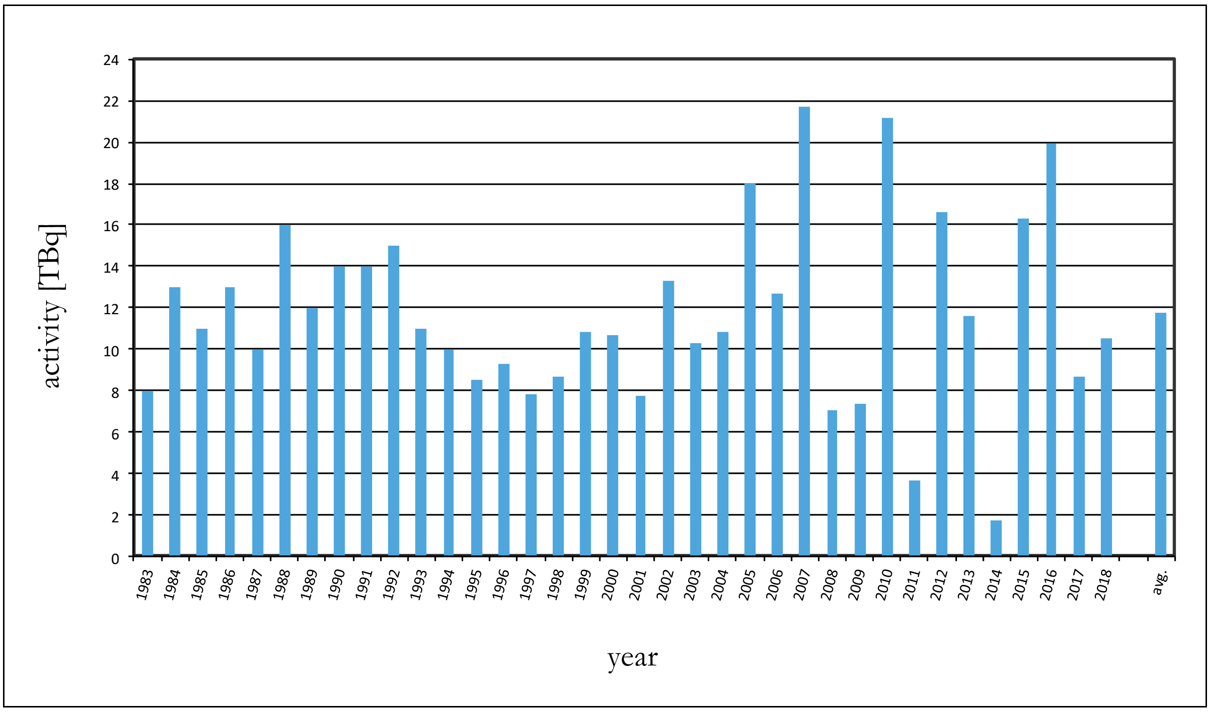


Figure 14: Activity of released 3H in liquid discharges in the Krško NPP

3.3.1.2 Exposure of the Public

The programme for monitoring environmental radioactivity from the above-mentioned discharges comprises the following measurements of the concentrations or contents of radionuclides in environmental samples in:

- air (aerosol and iodine filters);
- dry and wet deposition (dry and wet precipitation);
- the Sava River water, sediments, and water biota (fish);
- tap water (Krško and Brežice), wells and underground water;
- food of vegetable and animal origin (including milk);
- soil on cultivated and uncultivated areas; and
- measurements of ambient dose equivalents at several locations.

Dose assessment of the public was based on model calculations made by contractors. The calculated dispersion factors for atmospheric discharges, on the basis of realistic meteorological data, showed that the most important pathways for food exposure were the ingestion of food due to ^{14}C and the inhalation of airborne particles of ^{3}H and ^{14}C.

The highest annual dose received by adult individuals was due to the intake of ^{14}C from vegetable food (0.15 µSv), while a lower dose (0.03 µSv) was also received due to the inhalation of ^{3}H and ^{14}C. The liquid discharges in 2018 did not significantly contribute to the additional exposure of individuals from the population. On the basis of the calculation, it is estimated that ^{14}C still contributes the most to the total dose compared with other radionuclides resulting from the operation of the Krško NPP. It is important to emphasise that all types of exposure of the population were negligible compared to natural radiation and were far below the dose limits and the authorised limits.

Table 6 shows that the estimated total annual effective dose of an individual who lives in the surroundings of the Krško NPP is less than 0.14 µSv. This value represents 0.38 % of the authorised limit value (the dose constraint is 50 µSv per year), or 0.007 % of the effective dose received by an average Slovenian from natural background radiation (2,500–2,800 µSv per year).

Table 6: Assessment of the partial exposure of an adult member of the reference public group due to atmospheric and liquid radioactive discharges from the Krško NPP in 2018

Type of exposure	Transfer pathway	The most important radionuclides	Effective dose [µSv per year]
External radiation	Cloud immersion	Noble gases: (^{41}Ar, ^{133}Xe, ^{131m}Xe)	$9.4 \cdot 10^{-4}$
	Deposition	particulates: (^{58}Co, ^{60}Co, ^{137}Cs…)	$2.1 \cdot 10^{-9}$
Inhalation	Cloud	^{3}H, ^{14}C, ^{131}I, ^{133}I	$3.0 \cdot 10^{-2}$
Ingestion (atmospheric discharges)	Vegetable food	^{14}C	0.15
Ingestion (liquid discharges)	Ingestion of fish (from the Sava River)	^{3}H, ^{137}Cs, ^{89}Sr, ^{90}Sr, ^{131}I, ^{14}C	0.008
Total Krško NPP in 2018			**< 0.19***

*The total amount is conservative since all contributions cannot simply be summed up due to different reference groups of the population.

3.3.2 The TRIGA Mark II Research Reactor and the Central Storage for Radioactive Waste at Brinje

The TRIGA Mark II Research Reactor and the Central Storage for Radioactive Waste are both located in Brinje near Ljubljana. The samples irradiated in the reactor are analysed in the laboratories of the Department of Environmental Science of the Jožef Stefan Institute, which are located near the reactor building. Therefore, the radioactive discharges at this location arise from the reactor operation, the Central Storage for Radioactive Waste, and from laboratory activities. Since the operation of the facilities was stable and there were no incidents that resulted in radioactive material being released into the environment, the results of the operational monitoring for 2018 are essentially the same as for the previous year.

3.3.2.1 The TRIGA Mark II Research Reactor

Environmental monitoring of the TRIGA Mark II Research Reactor comprises measurements of atmospheric and liquid discharges and measurements of radioactivity levels in the environment. The latter are carried out to determine the environmental impact of the installation and include measurements of radioactivity in the air and underground water, as well as measurements of external radiation, radioactive contamination of the soil, and the radioactivity of Sava River sediments.

Measurements of radioactive aerosol discharges into the atmosphere showed results below the detection limit. Discharges of the noble gas ^{41}Ar into the atmosphere, calculated on the basis of the reactor operation time, were estimated at 1.3 TBq in 2018, which is slightly more than in the previous years (2017: 1.2 TBq; 2016: 1.0 TBq; 2015: 0.9 TBq; 2014: 0.7 TBq; 2013: 0.8 TBq; 2012 and 2011: 0.9 TBq).

The programme of specific activities in the environment showed no radioactive contamination from the operation of the reactor. The external dose due to radiation from the cloud on an individual who mows grass or ploughs snow 65 hours annually at a distance 100 m from the reactor and only stays 10 % of the time in the cloud, was estimated at 0.03 µSv per year due to

^{41}Ar discharges, which is similar to previous years. Despite the conservative assumption that inhabitants drink the water from the Sava River where liquid discharges emerge, it was estimated that there is no impact on the population due to this transmission path. The total annual dose received by an individual from the population in 2018 was approximately 1 % of the authorised dose limit, which is 50 μSv/year, or several thousand times less than the effective dose of the natural background in Slovenia (2,500-2,800 μSv per year).

3.3.2.2 Central Storage for Radioactive Waste at Brinje

The programme for monitoring the environmental radioactivity of the Central Storage for Radioactive Waste at Brinje mainly comprised control measurements of radioactive atmospheric discharges (radon and its short-lived progeny from the storage facility, dug into the ground, coming from the stored ^{226}Ra sources), radioactive wastewater from the drainage collector and direct external radiation on the outside parts of the storage area. Environmental concentrations of radionuclides were measured in the same way as in previous years, namely in the underground water from two wells, as external radiation at several different distances from the storage area, and as dry deposition on soil near the storage area.

The estimated average radon discharge rate in 2018 was 9 Bq/s, which is, considering the measurement uncertainty, similar to the discharge rates in previous years. The increase in radon ^{222}Rn concentrations in the vicinity of the storage is not measurable and was therefore estimated by a model for average weather conditions to be around 0.5 Bq/m^3 at the fence of the reactor site. In the wastewater from the underground reservoir, the only artificial radionuclide measured was again ^{137}Cs, which is a consequence of global contamination and not of storage operation. Even the ground soil in the storage vicinity does not indicate the presence of other radionuclides, except the Chernobyl contaminant ^{137}Cs and the natural radionuclides ^{7}Be, ^{40}K, as well as radionuclides of the uranium-radium and thorium decay series.

For dose assessment of the most exposed members of the public, the inhalation of radon decay products and direct external radiation from the storage facility were considered. The most exposed members of the reference group are the employees of the reactor center, who could potentially be affected by radon releases from the storage area. In 2018 they received an estimated effective dose of 1.28 μSv, according to the model calculation. A security officer of the Reactor center received 0.61 μSv per year from his or her regular rounds, while the annual dose received by a farmer adjacent to the controlled reactor area was estimated to be only approximately 0.03 μSv. These values are comparable with those in 2017 and are much lower than the authorised dose limit for individuals from the reference group of the population (100 μSv per year). The annual dose collected by an individual from the natural background is 2,500–2,800 μSv.

3.3.3 The Former Uranium Mine Žirovski Vrh

The monitoring of environmental radioactivity consists of measuring radon releases, liquid radioactive discharges, and concentrations of radionuclides in the environment. An integrated programme of measurements has been implemented, including the radionuclide-specific activities of the uranium-radium decay chain in environmental samples, including the concentrations of radon and its decay products in the air, as well as external radiation. Measurement locations are set mainly in the settled areas in the valley, up to 3 km from the existing mine radiation sources, from Todraž to Gorenja Vas. For evaluation of the impact of uranium mining and milling, the relevant measurements of radionuclides of natural origin are carried out at reference points outside the influence of mine and disposal site discharges (as an approximation of natural radiation background).

In 2015, the Agency for Radwaste Management (ARAO) assumed the management and long-term monitoring of the Jazbec disposal site, while the Boršt disposal site is managed by Rudnik Žirovski Vrh d. o. o. (RŽV). The Jazbec disposal site is no longer a radiation facility. At present, both landfill operators are responsible for the implementation of the environmental monitoring programme. The SNSA issued a license for the implementation of long-term supervision and maintenance of the Jazbec disposal site. Until the confirmation of the change in the safety report for the Jazbec landfill, the ARAO was instructed to perform long-term supervision and maintenance under the monitoring programme and the long-term control plan, which is an integral part of the Update of the Safety Report for the last (fifth) year of the transitional period. Environmental monitoring in the closed area of the Jazbec disposal site was not fully implemented in accordance with the license requirement. The procedure for changing the safety report with the renewed long-term facility monitoring programme after the closure is still in progress. In addition to failing to comply with the programme for the fifth year of the transitional period, no measurements were made that would be sufficient to compare with the authorised values. Therefore, the Radiation and Nuclear Safety Inspectorate carried out an inspection and issued a reminder. The year 2018 was the eighth year of the envisaged transitional five-year period at the Boršt disposal site. The monitoring programme for the Boršt landfill was carried out under the same programme as in the fifth year of the transitional period. The monitoring programme in the environment of the former uranium mine Žirovski Vrh contains measurements that are common for the monitoring of both the Jazbec and Boršt landfills. In 2018 these measurements were fully implemented in accordance with the fifth year of the monitoring programme.

3.3.3.1 Radioactive Releases

In 2018 it was not possible to estimate the total value of all releases because no adequate measurements were made. Measurements of liquid discharges showed that they were within the authorised limit values for the Boršt disposal site, while measurements were not fully carried out for Jazbec and the relevant mine water. Concerning gas discharges, the situation was slightly better because, despite incomplete data, it was possible to estimate the radon discharge from the surfaces of both landfills. Both values were below the authorised limits.

3.3.3.2 Exposure of the Population

During operation, it was possible to evaluate the contribution of the mine by a comparison with the reference locations outside the influence area of the mine. Following the remediation of the mine, its impact is difficult to separate from the natural background; therefore, a model estimate has to be made. The contribution of mining radon in Gorenja Dobrava in the current year is calculated from the ratio of radon concentrations at the Jazbec landfill from the period after the closure of the mine when the closing or regulatory activities (1991-1995) had not started, and the average contribution of mining radon in Gorenja Dobrava in this period.

In 2018 the most important part of the programme was the measurement of radon concentrations that additionally contribute to the population dose rate from the Žirovski Vrh mine. The contribution of short-term progeny can also be evaluated from these results.

In recent years, the radioactivity in surface waters has been slowly but steadily decreasing. In Brebovščica, where all the liquid emissions from the mine and from both landfills are discharged, only the concentration of uranium has noticeably increased in recent years.

For the 2018, it is estimated that the contribution of ^{222}Rn from the remaining mining sources to the natural concentrations in the environment was approximately 3.3 Bq/m^3.

The following pathways were considered in assessing the effective dose of the population; only the realistic pathways were taken into account, such as the inhalation of radon and its short-lived progeny and external gamma radiation. In 2018 the reference exposure of an adult individual in the reference group of the population was estimated at 0.073 mSv, which is slightly more than in 2017 due to the higher estimated contribution of the former RŽV facilities to the concentration of radon's short-lived progeny, but still within the uncertainty of the assessment method. The low exposure is the result of the completion of the arrangement of the Jazbec and Boršt disposal sites and represents approximately one third of the effective dose value estimated in the 1990s. However, the most important source of radioactive contamination from the mine environment is ^{222}Rn with its short-lived progeny, which contributed 0.070 mSv of additional exposure in this area (Table 7).

Table 7: The effective dose received by an adult member of the public living in the surroundings of the former Žirovski Vrh Uranium Mine in 2018

Transfer pathway	Important radionuclides	Effective dose [mSv]
Inhalation	– aerosols with long-lived radionuclides (U, ^{226}Ra, ^{210}Pb) – only ^{222}Rn – Rn – short-lived progeny	(pathway no longer exists) 0.0017 0.070
Ingestion	– drinking water (U, ^{226}Ra, ^{210}Pb, ^{230}Th) – fish (^{226}Ra in ^{210}Pb) – agricultural products (^{226}Ra and ^{210}Pb)	(0.0057)* not estimated (0.002)** not estimated (0.007)**
External	– immersion and deposition (radiation from the cloud and deposition) – deposition of long-lived radionuclides (deposition) – direct gamma radiation from disposal sites	0.0011 – –
Total effective dose rate (rounded):		**0.073 mSv**

* The dose contribution due to the ingestion of water from the Brebovščica stream is not included in the dose assessment because the water is not used for drinking, watering of animals, or irrigation.
** Values in brackets are calculated on the basis of the last measurement of fish and food from 2015.

The total effective dose for an adult from the reference group amounted to less than one tenth of the general limit value for the population, which is 1 mSv per year. The estimated annual dose received by a 10-year-old child was 0.098 mSv and 0.153 mSv for a 1-year-old child. Measurements of the radioactivity and dose estimations for the last several years have shown that the cessation of uranium mining together with the remediation works that have already been carried out have significantly reduced the environmental impact and exposure of the population. The estimated dose exposure is less than one fifth of the authorised dose limit value of 0.3 mSv per year, which is set for all objects after remediation (the Boršt and Jazbec disposal sites and the mine).

These values represent a few percent of the average radiation exposure due to natural radiation in this environment, according to the Jožef Stefan Institute's 1990 estimation about 5.5 mSv per year. Annual changes in the effective dose due to the contribution of the mine are shown in Figure 15.

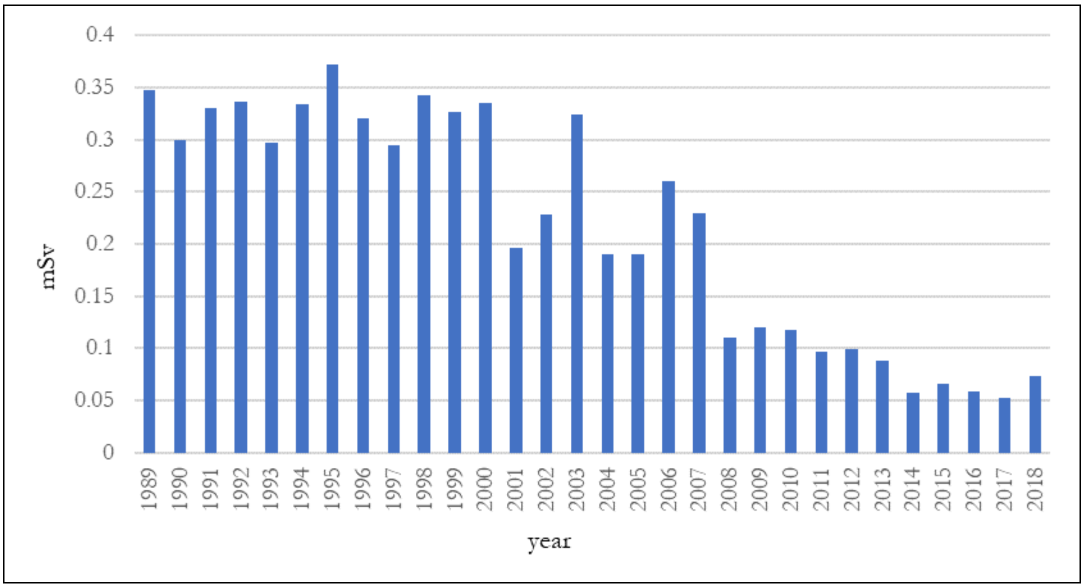


Figure 15: Annual contributions to the effective dose received by an adult member of the public due to the former Žirovski Vrh Uranium Mine in the period 1989–2018

3.4 Radiation Exposure of the Population in Slovenia

Every person on Earth is exposed to natural and artificial radioactivity in the environment. A great part of the population receives radiation doses from radiological examinations in medicine, while only a small part of the population is exposed occupationally due to their work in radiation fields or with radiation sources. The term "external radiation" means that the source of radiation is located outside the body. Internal radiation occurs when radioactive material enters the body by inhalation, the ingestion of food and water, or through the skin. The data on population exposure are presented below, while occupational exposures (due to artificial and natural sources), as well as medical exposures, are presented in Chapter 4.

3.4.1 Exposure to Natural Radiation

The average annual effective dose from natural sources received by a single individual on Earth is 2.4 mSv, varying from only 1 mSv and even exceeding 10 mSv at some locations. The average annual dose from natural radiation sources received by an average member of the public in Slovenia is approximately 2.5 to 2.8 mSv. Higher values are found in areas with higher concentrations of radon in living and working environments. On the basis of the existing data on external radiation and radon concentrations in dwellings and outdoors, it can be estimated that most of the radiation, approximately 50 %, comes from inhaling indoor radon and its progeny (1.2–1.5 mSv per year) in residential buildings. The annual dose from the intake of radioactivity with food and water is approximately 0.4 mSv. The annual effective dose due to external radiation from the radioactivity of soil, building materials in dwellings, and cosmic radiation together is estimated to be from 0.8 to 1.1 mSv in Slovenia.

3.4.2 Programme for the Systematic Inspection of Industrial Activities

Systematic inspection of the working environment must mainly be ensured in areas where the increased exposure of workers or the environment may be expected due to activities involving materials or waste with an increased content of naturally occurring radioactive materials (hereinafter: NORM) or where there is an increased presence of naturally occurring radioactive substances due to technological processing.

In 2018 the measurements of external gamma radiation, specific activities of natural radionuclides in samples of raw materials, and measurements of radon concentrations were performed in the working environments of the following production facilities: Helios kemična tovarna Domžale d. o. o., JUB kemična industrija d. o. o., TALUM d. d., and Loški museum Škofja Loka.

Measurements showed that in some places the level of radiation was determined above the natural background due to ^{40}K and radionuclides of the uranium and thorium decay chain. In some samples of raw materials and samples from the environment an elevated concentration of radionuclides was also measured. All measured values of concentrations were lower than those set in the Decree on Limit Values, Reference Levels and Radioactive Contamination (UV2; Official Gazette of Republic of Slovenia, No. 18/18). Radon concentrations did not exceed the limits set in the Decree on the National Radon Programme (UV4, Official Gazette of Republic of Slovenia, No. 18/18), namely 300 Bq/m^3. The additional exposure of workers is not significantly higher than the exposure due to the natural background, as there are no permanent jobs at the measurement sites. The roughly estimated doses do not actually exceed a few µSv. Due to the locally elevated natural background, an additional contribution to the dose of employees at Loški museum is roughly estimated to be around a few 10 µSv.

3.4.3 Measurement of Radon in Living and Working Environments

Radon is a natural radioactive gas. In most cases it is a dominant source of natural radiation in the living environment. On average, it contributes more than half of the effective dose due to natural ionising sources. It penetrates into buildings mainly from soil through various openings e.g. shafts, drains, crevices and cracks. Radon induces approximately 10 % of all lung cancers. This is the reason EU Directive EURATOM 2013/59 defines stricter rules for radon programmes, which are expected to reduce this share.

In line with EU Directive EURATOM 2013/59 the National Radon Programme Regulation (Offical Gazette RS, No. 18/18) was adopted in 2018. Together with the Ionising Radiation Protection and Nuclear Safety Act (Offical Gazette RS, No. 76/17), the Decree sets the legislative framework for systematic examination and measurement of radon. In comparison to previous years, more financial resources were dedicated to radon concentration measurements. The programme for taking measurements in schools and kindergartens was expanded. For the first time measurements in dwellings were financed. Legislation anticipates a new type of approval for companies performing radon measurements. In order to obtain approval, accreditation is required in addition to permanently employed specialists in radon. In 2018 the SRPA issued one approval to perform radon measurements to the Institute of Occupational Safety (IOS). Due to the high interest of the wider public, the SRPA bought 30 measurement devices for preliminary radon measurement. All together, the SRPA has 56 such radon measurement devices. In 2018 the development of the Register of Radon Measurements was begun. Companies performing radon measurements should report all measured results to the Register, which will help to assess radon exposure in Slovenia in the future.

From January to November 2018, the IOS carried out measurements in various buildings for education, culture and health care activities. Different methods were used: 354 basic radon measurements using nuclear track detectors for determining average radon concentrations, 45 additional continuous measurements for weekly monitoring of the timing of radon progeny and radon, and 15 measurements of potential radon sources originating from the soil, shafts, or openings into rooms. A total of 179 buildings were measured. The average radon concentrations exceeded the reference level (300 Bq/m^3) in 76 buildings (42 %) and in 179 rooms out of 354 (51 %). A value of 900 Bq/m^3 was exceeded in 49 rooms (14 %). The effective doses received for staff and children were estimated on the basis of the measurement results and the occupancy time in these buildings. Out of a total of 122 estimated annual doses, 5 exceeded the threshold of 6 mSv for members of the public. The highest estimated dose was around 21 mSv due to an average radon concentration of 5000 Bq/m^3 in the kindergarten room of Tone Tomšič Primary School in Knežak. In 38 cases, the estimated annual doses were between 2 and 6 mSv, in 39 cases between 1 and 2 mSv, and in 40 cases less than 1 mSv. Protection measures continue to be performed in most of the rooms with high radon concentrations.

In 2018 the SRPA conducted 17 in-depth inspections of legal entities that operate facilities with increased levels of radon. (Tone Tomšič Primary School Knežak, Franjo Golob Primary School Prevalje, Muta Primary School, Belokranjski odred Primary School Semič including the Štrekljevec subsidiary, Sežana Hospital, Sanolabor d. d. – twice: a store in Ribnica and the management building in the Ljubljana Municipality health care centre dr. Janez Oražem Ribnica with the Health Station Loški Potok, Cvetko Golar Primary School Škofja Loka, Škofja Loka kindergarten, Ivan Grohar Primary School Podlubnik including the Bukovščica subsidiary, Stražišče Primary School, including the Podblica subsidiary, Kranj kindergartens, the private kindergarten Dobra teta Kranj and Postojna cave d. d. – twice, and IOS in relation to Postojna cave d. d.). 15 warning were issued as a part of an inspection process. Additional and control measurement are continuing in most buildings.

In 2018, 22 letters with information on measurement results and recommendation regarding appropriate measures (if needed) were sent to institutions where the IOS performed measurements according the programme for the systematic examination and measurement of radon. Cooperation with school principals, teachers and members of the public is increasing. The SRPA is lending measurement devices for preliminary radon concentration measurement to these individuals. In 2018, such devices were borrowed 24 times (17 in 2017, 8 in 2016, and 3 in 2015).

The SRPA has financed the programme for the systematic examination and measurement of radon in dwellings in radon prone areas. In the scope of the programme, the IOS performed 480 basic measurements using nuclear track detectors for assessing average monthly or bi-monthly radon concentration in 23 municipalities (Bloke, Cerknica, Črnomelj, Divača, Dobrepolje, Dolenjske Toplice, Hrpelje-Kozina, Idrija, Ivančna Gorica, Kočevje, Komen, Logatec, Loška Dolina, Loški Potok, Miren-Kostanjevica, Pivka, Postojna, Ribnica, Semič, Sežana, Sodražica, Vrhnika and Žužemberk). The average radon concentration exceeded the reference value of 300 Bq/m^3 in 147 cases (31 %). The value of 900 Bq/m^3 was exceeded in 51 cases (11 %). The highest radon concentrations, between 5300 and 5400 Bq/m^3, were found in two living rooms and one bedroom in the municipalities of Idrija, Kočevje and Loški Potok. In 55 cases radon concentrations were between 200 and 299 Bq/m^3, in 102 cases between 200 and 299 Bq/m^3, and in 176 cases lower than 100 Bq/m^3. The IOS informed all members of the public in writing of the measurement results and in the event of high measurement results recommended that further measures to be taken.

Measurements of gross alpha and gross beta activities in drinking water

In 2018 the SRPA continued to finance the measurement of gross alpha and gross beta activities in the drinking water of Slovenia. The measurements were performed by the Jožef Stefan Institute. Altogether, 130 samples were analysed from 94 water supply systems. The sampling covered the entire area of Slovenia, taking into account the number of inhabitants near the water supply point and the hydrogeological characteristics of the water. The gross alpha concentration values were up to 0.15 Bq/kg, with an average value of 0.037 Bq/kg. The values for gross beta concentrations were up to 0.46 Bq/kg, with an average value of 0.19 Bq/kg. The parametric value of the beta concentration (1 Bq/kg) was not exceeded. Additionaly, 5 analyses were performed in those water supply systems where measurement results exceeded 80 % of total parametric value for gross alpha and gross beta activities. The indicative dose of 0.1 mSv/year was not exceeded.

3.4.4 Radiation Exposure of the Population Due to Human Activities

Higher radiation doses due to the normal operation of nuclear and radiation facilities are usually only received by the local population. The exposures of particular groups of the population that are a consequence of radioactive discharges from these facilities are described in Chapter 3.3. In Table 8, the annual individual doses are given for the maximally exposed adults from the reference groups for all objects in consideration. For comparison, the average annual dose received by individuals originating from the global radioactive contamination of the environment (nuclear tests and the Chernobyl accident) is also shown. The highest exposures of the population are recorded for individuals living in the surroundings of the former uranium mine in Žirovski Vrh. The exposures were estimated as amounting to a maximum of a few percent of the exposure from natural sources in this area. The radiation exposure of the individuals from the public does not exceed the dose levels determined by the regulatory limits.

The population is exposed to radiation also due to other human activities. These exposures come mainly from deposited materials with enhanced natural radioactivity and originate from past industrial or mining activities and are related mostly to the mining and processing of raw materials containing uranium or thorium admixtures, as described in Chapter 3.3.2.

Table 8: Exposures of adult individuals from the reference population group

Source of radiation	Annual dose [mSv]	Regulatory dose limit [mSv]
Žirovski Vrh Uranium Mine	0.073	*0.300
Chernobyl and nuclear weapon tests	0.03	/
Krško NPP	< 0.00012	**0.050
TRIGA Mark II Research Reactor	0.00065	0.050
The Central Storage for Radioactive Waste	0.00003	0.100
Exposure to natural background	2.4	-

* Limitation due to the consequences of the mining in the Žirovski Vrh Uranium Mine (mine pit and disposal sites at both Jazbec and Boršt).

** Due to radioactive discharges.

4 RADIATION PROTECTION OF WORKERS AND MEDICAL EXPOSURES

Due to occupational exposure, individuals can receive substantial doses of ionising radiation. Therefore, organisations that carry out radiation practices should optimise work activities to decrease the dose of ionising radiation to a level as low as reasonably achievable (ALARA). Exposed workers must take part in regular medical surveillance programmes and receive adequate training. Persons carrying out a radiation practice have to ensure that the received dose of ionising radiation is assessed for every worker performing specific activities.

The Slovenian Radiation Protection Administration (SRPA) manages the Central Records of Personal Doses (CRPD). All approved dosimetry services report monthly to the CRPD on the external exposure of all exposed workers and annually or semi-annually for internal exposures to radon.

The approved dosimetry services for 2018 were the Institute of Occupational Safety (IOS), the Jožef Stefan Institute (JSI), and the Krško Nuclear Power Plant (Krško NPP). The IOS was approved for the assessment of radon exposure in mines and Karst caves. Currently, 16,892 persons have a record in the central registry, including those who have ceased to work with sources of ionising radiation workers. The Krško NPP performed individual dosimetry for 426 plant personnel and 910 external workers, who received an average dose of 0.82 mSv of ionising radiation. As for other work sectors, workers in industrial radiography received the highest average annual effective dose of 0.66 mSv from external radiation, while employees in medicine received an average of 0.18 mSv. The highest average value among these, 0.50 mSv, was recorded for workers in nuclear medicine. In this calculation a dosimeter reading of 35.2 mSv for a worker at the Ophthalmology Clinic is not taken into account. If this result is taken into account, the average annual dose in the medical sector is 0.52 mSv and 5.05 mSv for brachytherapy (without the high reading, the average annual dose for the brachytherapy sector is 0.02 mSv).

In 2018 the highest collective dose from external radiation was received by workers at the Krško NPP (783 man mSv), followed by workers in the medical sector (265 man mSv,) workers in other industries (39 man mSv), and workers in other activities (29 man mSv).

Since 2010, the data on doses received by radiation workers who took part in NPP outages abroad and data on the doses of Adria Airways flight personnel who are exposed to cosmic radiation have been included in the CRPD. In 2018 the collective dose for 12 workers in foreign NPPs was 5.5 man mSv (an average dose of 0.92 mSv). During flights, 399 workers were exposed to cosmic radiation, receiving an average dose of 0.95 mSv and a collective dose of 379 man mSv.

The highest doses are received by workers exposed to radon and its progeny. In 2018, out of 188 tourist workers, 4 workers received a dose between 15 and 20 mSv, 35 workers received a dose between 10 and 15 mSv, 56 workers received a dose between 5 and 10 mSv, 70 workers received a dose between 1 and 5 mSv, and 23 workers received a dose of less than 1 mSv. The highest individual dose was 18.28 mSv. The collective dose was 1,092 man mSv, with an average dose of 5.81 mSv. Tourist workers in Karst caves are the category of workers most exposed to ionising radiation in Slovenia.

The findings of a study on the exposure of individuals in Karst caves, financed by the SRPA, show that the doses of tourist workers in Karst caves due to radon exposure, assessed according to the ICRP (International Commission for Radiation Protection) 65 model, are underestimated. Due to the high unattached fraction of radon progeny in the atmosphere of the Karst caves, the ICRP 32 model should be used and an approximately two-times higher dose factor should be taken into account. Therefore, the received doses from radon and its progeny are assessed according to the ICRP 32 model in this report. The doses calculated in such a manner are thus twice as high as those calculated according to the ICRP 65 model.

At the Žirovski Vrh Uranium Mine, 8 workers received a collective dose of 0.98 man mSv, whereas the average individual dose was 0.12 mSv.

The distribution of workers in different work sectors by received dose interval (mSv) is shown in Table 9.

Table 9: The number of workers in different work sectors by dose interval (mSv)

Sector	0–MDL	MDL ≤E<1	1≤E< 5	5≤E<10	10≤E<15	15≤E<20	20≤E<30	E≥30	Total
Krško NPP	386	698	239	13	0	0	0	0	1,336
Industry	556	75	18	0	0	0	0	0	649
Medicine and veterinary medicine	3,115	1,250	26	0	0	0	0	1	4,392
Flights	0	187	212	0	0	0	0	0	399
Other	690	276	3	0	0	0	0	0	969
Radon	0	31	70	56	35	4	0	0	196
Abroad	6	4	2	0	0	0	0	0	12
Total	**4,753**	**2,521**	**570**	**69**	**35**	**4**	**0**	**1**	**7,953**

MDL – minimum detection level

E – effective dose in mSv received by an exposed worker

Table 9 does not include the high reading of a dosimeter for a worker at the Ophthalmology Clinic (35.2 mSv).

The training of exposed workers using sources of radiation

The education level of workers using sources of radiation is in accordance with regulations. Minor deficiencies were found regarding the timely updating of knowledge and skills in the field of ionising radiation protection and regarding unsuitable training certificates. Training, refresher courses, and tests were carried out by the approved technical support organisations, namely IOS, d. o. o., and the JSI. In 2018 a total of 1,983 participants attended courses on ionising radiation protection.

Irregularities regarding training courses were established at the training provider JSI. This institution carried out two training courses without suitable approval. The SRPA did not acknowledge such training, thus the trainees had to attend the training course again with an approved training provider.

Targeted medical surveillance

Medical surveillance of radiation workers was performed by the physicians of five approved institutions:

- The Clinical Institute of Occupational, Traffic and Sports Medicine, Ljubljana;
- The IOS, Ljubljana;
- Aristotel, d. o. o., Krško;
- The Krško Health Centre; and
- The Škofja Loka Health Centre.

Altogether, 2,550 medical examinations were carried out. Of the examined workers, 2,145 fully fulfilled the requirements for working with sources of ionising radiation, whereas 343 fulfilled the requirements with limitations. 21 candidates temporarily did not fulfil the requirements, and 8 did not fulfil the requirements. 5 workers did not fulfil the requirements and other work was proposed for them. In 28 cases an evaluation was not possible.

4.1 Exposure of the Population due to Medical Use of Radiation Sources

The use of ionising radiation in medicine is the main contributor to population exposure due to the use of artificial sources of ionising radiation. Slovenia assessed the contribution to the total dose received by patients in diagnostic procedures in medicine in 2010 and 2011 within the framework of the project "*Dose DataMed2*", which was carried out under the guidance of the European Commission. The results of the study show that the average inhabitant of Slovenia receives approximately 0.7 mSv per year from medical procedures. The most important contribution comes from computed tomography (CT), which contributes approximately 60 % of the total dose. Classic X-ray diagnostics contributes approximately 20 %, while interventional procedures and examinations in nuclear medicine contribute approximately 10 %. The results show that the exposure of the population in Slovenia is slightly below the European average, which is 1 mSv per year per capita.

Due to the increasing role of X-ray diagnostics in modern medicine and on the basis of trends in other developed countries, a further increase in population exposure is expected due to medical use of ionising radiation. Therefore, the SRPA carries out activities to improve the application of the principles of justification and optimisation, with particular attention devoted to examinations with computed tomography and interventional procedures. The key activities for the optimisation of radiological procedures are described in Chapter 4.2, on patient exposure.

Another key principle of the use of ionising radiation in medicine is the principle of justification. Numerous international studies have shown that 30 % or more of diagnostic radiological procedures may be unjustified or inappropriate. This leads to the unnecessary exposure of patients and at the same time represents an additional economic burden on the health care system. The implementation of this principle has therefore increasingly been taken into account in recent years. The most appropriate solution seems to be the use of the referral criteria, especially in conjunction with an electronic ordering system and digital systems for clinical support when directing patients. Unfortunately, the referral criteria and the mentioned support systems are not yet established in Slovenia. In order to assess the implementation level of this principle in practice, in November 2016 the SRPA carried out systematic monitoring at five Slovenian health care institutions within the framework of a coordinated action by the competent administrative authorities of many European countries. The findings show that at least in the case of procedures resulting in the largest doses (computerised tomography imaging and intervention procedures), all referrals are examined by doctors qualified to bear clinical responsibility for the radiological procedure. This provides a good basis for ensuring the justification for referral, but unfortunately the inadequate clinical information provided by the referring doctors is often a serious obstacle to better implementation. These deficiencies should be eliminated with more complete fulfilment of referrals and/or a unified health information system, such as is already used by several European regions and countries.

Therefore, the SRPA has been actively included in an initiative for establishing guidelines for referral to radiological procedures based on the referral criteria of the European Radiology Association. Further, the SRPA is participating in introducing an electronic system for general practitioners supporting the choice of the most appropriate radiological diagnostic procedures.

4.2 Exposure of Patients during Radiological Procedures

X-ray examinations implemented in accordance with good radiological practice provide a radiogram that contains all the information necessary for a correct diagnosis at the lowest exposure to patients. In 1996 the International Commission on Radiological Protection introduced the concept of the Dose Response Rate (DRR) in order to promote the optimisation of radiological procedures. The level of patients' exposure during an individual examination in each radiology department or when using a single X-ray device can be assessed by comparing the average exposure in such department or due to an X-ray device to a DRR value obtained on the basis of the relevant regional or local data.

The use of a DRR is more efficient when national DRR values are applied. Thus, following a five-year data collection project on the exposure of patients undergoing X-ray examinations in Slovenia, the DRR values for fifteen X-ray examinations were presented in 2006. Due to changes in technology and professional guidance, it is necessary to regularly review the DRR. Updates provide information on the exposure of patients. Institutions preforming radiological procedures must evaluate these data at least every five years. At the same time, these data provide a good overview of the state of the optimisation of radiological procedures in Slovenia. Concurrently, Slovenia continues to participate in International Atomic Energy Agency projects (RER-9-147 and RER-6-038) regarding the radiation protection of patients in radiological procedures and quality improvement in such procedures.

The use of the DRR enables the identification of X-ray devices, where the average exposure of patients considerably exceeds the expected values. Focusing on the optimisation of the procedures carried out using these X-ray devices leads to the improvement of radiological practice and reduces patient exposures. The level of exposure for a single X-ray device or a group thereof are compared to the DRR in the process of issuing a licence to carry out a radiation practice or the use of a radiation source in medical care. If the average patient exposure for a specific examination exceeds the DRR, the optimisation of procedure protocols is required by the regulatory authority. This process is important for all radiological procedures; nevertheless, special attention is devoted to procedures involving high patient exposures, foremost interventional procedures and computer tomography. These two types of radiological procedures contribute about 70 % of the gross exposure due to medical use of ionising radiation. The SRPA thus started activities for the extensive systematic and automatic data collection for all patients. Such data will enable better and more detailed optimisation and assessment of the exposure of the population with respect to sex and age.

In 2018 the SRPA financed a study on the exposure of a patient during radiological procedures with the aim of establishing a method of regular patient doses data collection and the format of reporting.The database will be used to optimise radiological procedures and for dose assessment for the population as a whole or for individual groups of population. The data are anonymised, but include age and sex. Data on 18 devices and for more than 350,000 radiological procedures were collected within the study. This type of data collection is not aimed at assessing individual doses due to radiological procedures for a single patient. Each patient can be informed of the dose received due to the radiological procedure by the doctor responsible for this particular procedure.

In nuclear medicine, rather than the DRR, the recommended activities of the administered radioisotope are used. Due to the small number of departments of nuclear medicine in Slovenia, developing national values is not sensible, so international recommendations, mainly the recommendations of the ENMA, the European Association of Nuclear Medicine, are applied instead, taking into account the technical characteristics of each imaging device. The SRPA checks typical amounts of administered activity when approving programmes for radiological procedures. In addition, in 2011 systematic reviews of the typical values of the administered activity for all major examinations in all seven nuclear medicine departments were also conducted within the framework of the "*Dose DataMed2*" project.

5 MANAGEMENT OF RADIOACTIVE WASTE AND IRRADIATED FUEL

5.1 Irradiated Fuel and Radioactive Waste at the Krško NPP

In Slovenia, the greatest amount of low- and intermediate-level radioactive waste (over 95 %) is generated from the operations of the Krško NPP. The rest is produced in medicine, industry, and research activities. The only high-level radioactive waste (HLW) is the spent nuclear fuel (SNF) from the Krško NPP and the TRIGA Research Reactor. A special category of waste is spent sealed radioactive sources produced by small holders, which are stored in the Central Storage for Radioactive Waste in Brinje.

5.1.1 Management of Low- and Intermediate-Level Waste

The total volume of waste accumulated by the end of 2018 amounted to 2,271 m^3, with the total gamma and alpha activity of the stored waste amounting to 15.9 TBq and 24.7 GBq, respectively. In 2018 the equivalent of 29 standard drums containing solid waste was stored with a total beta-gamma and alpha activity 19.1 GBq and 12.4 MBq, respectively.

Figure 16 shows the accumulation of low- and intermediate-level radioactive waste in the Krško NPP storage. Periodic volume reductions, which are a consequence of compression, super-compaction, incineration, and melting, are shown. After 1995, the accumulation of waste volume was reduced as a result of a new in-drum drying system (IDDS) for evaporator concentrate and spent ion exchange resins.

In 2013, the Krško NPP started planning a facility for manipulating equipment and shipments of radioactive cargo (WMB - Waste Manipulation Building), as in 2012 the occupancy of the radioactive waste storage facility reached 95 % of the available storage capacities. The new building will ease the problems caused by delays in the construction of a low and intermediate level of radioactive waste disposal (LILW).

In 2018, the construction of the building was completed. The new structure enabled the removal of the measuring equipment and the super-compactor from the temporary storage. This measure will provide additional storage space in the storage. The reorganisation of the storage according to the Krško NPP will provide sufficient space for the storage of radioactive waste only until 2022. For the normal operation of the Krško NPP after 2022, it is therefore necessary that the activities for the construction of the LILW repository in Vrbina are accelerated and that the takeover of LILW waste begins during the year 2023.

In 2006, a super-compactor was installed in the storage facility at the Krško NPP, which thus began the continuous super-compaction of its radioactive waste. From 2015 to 2018 there was no super-compacted newly-generated radioactive waste due to the ongoing project of moving equipment to the new WMB facility.

Radiactive waste for incineration and melting is being temporarily transferred to the Decontamination Building due to a lack of space in the storage facility near the super-compactor. In the second half of 2018, 350 packages of compressible waste were shipped to Sweden. In the new WMB building, 52 packages of dried ion exchange resin from the secondary circle were stored at the end of the year, and await further shipment to Sweden for incineration.

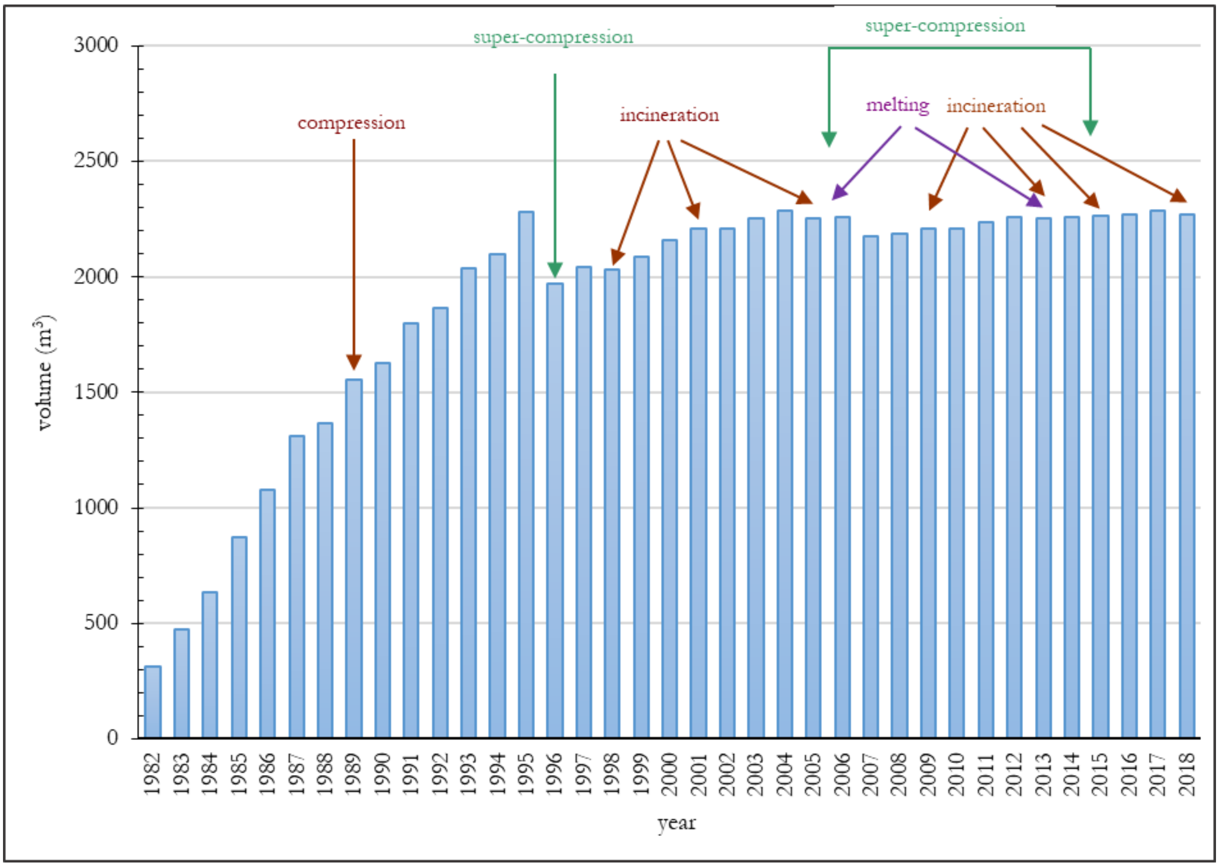


Figure 16: The accumulation of low- and intermediate-level radioactive waste in the Krško NPP storage

5.1.2 Management of Spent Fuel

All spent fuel in the Krško NPP is stored in the spent fuel pool with 1,694 cells. At the end of 2018, the total number of spent fuel assemblies in the spent fuel pool amounted to 1,266 – including two special canisters with damaged fuel rods.

The number of annually spent fuel assemblies and the total number of such elements in the pool are shown in Figure 17.

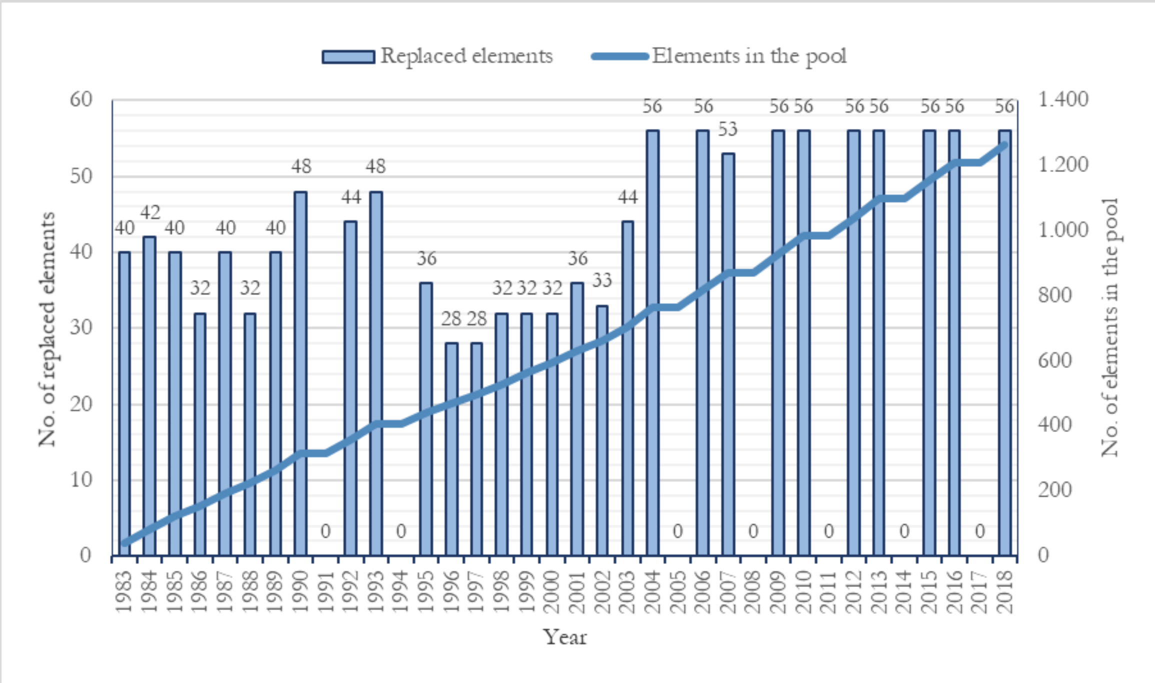


Figure 17: The number of annually spent fuel assemblies and the total number of such elements in the pool of the NPP

5.2 Radioactive Waste at the Jožef Stefan Institute

Approximately 40 litres of spent ion exchange resins, 200 litres of activated or contaminated experimental and protective equipment, and 100 litres of aluminium irradiation containers are produced annually during the operation of the reactor, as well as from the work in the hot cell and controlled areas of the Department of Environmental Sciences. The Radiation Protection Unit of the Institute collects spent radioactive material in the temporary storage in the hot cell facility. After repacking, treatment (compression), and detailed characterisation, the material is declared radioactive waste. The Jožef Stefan Institute annually produces approximately 2 drums (< 0.5 m^3) of solid radioactive waste.

In 2018 the JSI did not hand over to the Central Storage Facility at Brinje any packages of radioactive waste.

There are 7 drums of metal and wood contaminated with naturally occurring radioactive material (NORM) temporarily stored at the location of the Reactor Centre in Brinje. The waste material was produced during the decontamination and decommissioning of buildings used for the processing of uranium ore, which took place from 2005 until 2007.

5.3 Radioactive Waste in Medicine

The Institute of Oncology in Ljubljana has appropriate holding tanks to decrease the activity of waste liquids through decay. The tanks are emptied every four months after approved radiation protection experts carry out preliminary measurements of specific activities. Adequate temporary storage of radioactive waste has also been arranged in the new building of the Institute of Oncology. The Clinic for Nuclear Medicine at the University Medical Centre in Ljubljana has not built a system for holding liquid waste, but, according to IAEA doctrine, such systems are not considered to be justified due to the minimal influence the liquid waste has on the health of the population and the environment. In other hospitals in Slovenia only daily treatments are applied and thus systems for holding liquid waste are not necessary.

Disused sealed radioactive sources are returned to the producer or transferred to the Agency for Radwaste Management. Radioactive waste with short-lived radionuclides are stored in a special storage facility until clearance levels are reached and then disposed of as normal waste.

5.4 The Commercial Public Service of Radioactive Waste Management

5.4.1 Radioactive waste that is not waste from nuclear facilities for energy production (e.g. small producers)

The Agency for Radwaste Management (ARAO) is responsible for providing the public service of radioactive waste management.

Within the public service of the management of radioactive waste from small producers, in 2018 the ARAO ensured the regular and smooth collection of radioactive waste at its place of origin, its transport, treatment, and preparation for storage and disposal, and management of the Central Storage Facility, as described in Chapter 2.1.3. ARAO is also the operator of the national infrastructure facility CSRW.

For processing radioactive waste, the ARAO can independently use the premises of the hot cell facility that is part of the TRIGA Mark II Research Reactor at the Jožef Stefan Institute.

In 2018 the ARAO accepted 108 packages of radioactive waste from 72 producers, namely 3 packages of solid waste, 13 packages of sealed radiation sources, and 92 packages of ionisation smoke detectors. The total volume of the stored radioactive waste was 2.02 m^3. As of the end of 2018, there were 754 packages stored as follows:

- 409 packages of radioactive waste (solid waste, sorted according to compressibility, combustibility, shape and size);

- 167 packages of sealed radiation sources; and

- 178 packages of ionisation smoke detectors.

The total activity of 90.8 m^3 of stored radioactive waste as of the end of 2018 was estimated to be 3.3 TBq, with a total weight of 50.2 tonnes.

ARAO carries out the treatment and preparation of radioactive waste (RW) in a form suitable for storage in the CSRW. The purpose of the treatment is to achieve the criteria for safe storage as well as a reduction in the volume that the waste occupies in the CSRW.

One of the effective methods is to disassemble devices that contain closed radiation sources. By disassembling these devices, radioactive sources of radiation are separated from other parts of devices that are normally non-radioactive. The encapsulation of the closed radiation sources following dismantling reduces the risk of potential contamination that may occur due to leakage of radiation sources. It also avoids the damage, corrosion, and degradation of devices, which after a certain storage period can lead to a situation when the devices can no longer be safely dismantled. At the beginning of 2018, the dismantling of devices containing closed radiation sources of categories 3 - 5 was carried out. Workers disassembled 10 devices with radionuclide ^{90}Sr.

In order to reduce the volume of RW in the CSRW and to provide storage space, 972 ionisation fire detectors were transported for recycling abroad. Also, 100 kg of depleted uranium was removed for recycling abroad (9 shielding containers for industrial radiography). The transports were carried out in accordance with the regulations for the transport of dangerous goods. Two containers of depleted uranium were handed over to the CSRW for reuse. In doing so, the

ARAO began to apply the 3R principle (Reduce, Reuse, Recycle) and the provision of paragraph 8 of Article 121 of the ZVISJV-1.

5.4.2 The management, long-term control and maintenance of the Jazbec mine waste disposal site

In 2018 the ARAO ensured the regular control of the Jazbec mine waste disposal site which included visual inspection of the surface of the disposal site, safety fences and warning signs, access routes, drainage ditches for the drainage of surface water and the entry part below the disposal, technical monitoring facilities (piezometers, geodetic points, inclinometers). The situation is appropriate. Maintenance work in 2018 consisted of grass mowing on the entire surface within the protective fence of the Jazbec disposal site, removal of the undergrowth on the outside and inside of the fence. No other maintenance work was required.

The Safety Report for the Jazbec mine waste disposal site provides long-term monitoring and maintenance after a five year transitional period. Post operational monitoring is carried out in order to detect any changes in the repository. This includes radiological, physico-chemical and geodetic measurements.

Changes in the body of the Jazbec mine waste disposal site are followed by two inclinometers. These measurements have been carried out since 2009. Measurements in 2018 showed that the movements remain within the limits that were characteristic of previous measurements. The disposal has a somewhat vertical subsidence and is moving towards the valley. The movements are comparable to the previous measurements.

5.4.3 Disposal of Radioactive Waste

In 2018 work on activities related to the preparation of documents necessary to obtain approvals and permissions for the repository for low- and intermediate-level radioactive waste (LILW) were carried out in all areas. Work on the project documentation continued, where the revision of the project for obtaining a building permit and the preparation of the project for implementation, together with the technical work required for the tender for the construction contractor for the LILW repository, is in the final stage. The project documentation is expected to be completed in 2019. In parallel with the work on the project documentation, work was carried out on other documents, such as the environmental impact assessment report, the draft safety report and the project basis. In 2018, three revisions of the mentioned documents were prepared in order to obtain an environmental consent. A positive opinion of the approved expert on nuclear and radiation safety was also obtained for these documents. An annex to the ARAO Financing Agreement for the smooth running of works in 2018 was concluded with the Krško NPP Fund.

On the basis of the national spatial plan for the LILW repository, it was necessary to provide the land for the purpose of building a repository. The acquisition of rights to build infrastructure facilities based on the designed project documentation began in 2017 and continued in 2018. Co-financing of the renewal and expansion of the existing optical network in the Municipality of Krško and payment of compensation for the use and wear of roads during the time of construction in 2018 was not realised. Such co-financing is based on the signed protocol between the ARAO and the Municipality of Krško.

Most of the required field research for the LILW repository has already been carried out in recent years. In order to monitor the environment in the area of the LILW repository, a project task for the implementation of new wells in the area of the repository was prepared in 2018. The tender and the selection of the contractor for these works were carried out, but the appeal of an unselected bidder to the national review commission for the revision of the procedures for awarding public contracts halted the procedure and postponed the scheduled start of the work until 2019. In 2018, regular collection of groundwater monitoring data was also carried out, and the completion of the hydro-geological study of the broader area of the LILW repository was completed. For its implementation, in addition to hydrogeological data, data were also obtained from the company Hydroelectric Power Plants on the lower Sava River and the Krško NPP. For the purposes of geochemical research of groundwater after the construction of HPP Brežice, the sampling of groundwater was carried out in Vrbina.

In 2018, activities related to the production of project and other documentation and consultancy services in the area of design and construction continued. A review of the project documentation required to obtain a building permit was carried out. The review has not yet been completed, especially in the field of the verification of the control calculations. Slovenian technical approval and evidence of compliance with the requirements for the transport of dangerous goods in road transport were obtained for the certification of the concrete container for packaging waste. At the beginning of 2018 a new revision (D) of the investment programme was carried out and submitted for review and approval to the Ministry of Infrastructure.

Work on the project for preparing the safety analyses and acceptance criteria continued in 2018. Within the framework of the multi-phase project "Safety Analysis (SA) and Waste Acceptance Criteria (WAC) for the Preparation of a Low- and Intermediate-Level Waste Repository in Slovenia", work on complementing the existing acceptance criteria was continued in light of the development of the LILW repository project. A new revision report on the inventory of radioactive waste in Slovenia and an assessment report providing for the possibility of the repositioning of the planned inventory were prepared. Work on safety analyses and the development of acceptance criteria for the phase of acquiring a construction permit and the preparation of the Safety Report continued.

In 2018, periodic control of the situation at the location of the repository was carried out, after preparatory works were completed in 2017. A complaint was submitted to the performer, who remediated the partial removal of material on the slope. In the area of the repository site, mowing and control of invasive plants on the dyke was carried out.

5.4.3.1 Permissions for the LILW repository

Already in 2017, the ARAO applied for the issuance of an environmental consent to the Environmental Agency of the Republic of Slovenia (hereinafter: ARSO). In the framework of this process, in May 2018 the ARSO submitted to the SNSA an application for the issuance of a preliminary consent to nuclear and radiation safety. The SNSA reviewed the documentation covering the environmental impact assessment report, the draft safety report, the concept design, the project basis, the expert opinion of an approved expert on nuclear and radiation safety and the reference documentation and commented thereon in July 2018. The ARAO prepared responses to the SNSA's comments and revisions of documents where necessary. The ARSO submitted a supplement to the application for a preliminary consent for nuclear and radiation safety to the SNSA in November 2018. Most of the requests were duly completed or clarified by the ARAO; however, some open issues remained, and the SNSA was not able to issue the above-mentioned consent by the end of the year. After completing all open questions, the SNSA will issue a draft preliminary consent to nuclear and radiation safety, on the basis of which the environmental impact assessment report will be publicly announced, and at the same time a cross-border environmental impact assessment will be conducted.

5.5 Remediation of the Žirovski Vrh Uranium Mine

Hydro-metallurgical tailings at the Boršt site

The remediation of the Žirovski Vrh Uranium Mine has been in progress since 1992. Both the uranium processing plant and the mine, together with the various accompanying objects, as well as the Jazbec mine tailings disposal site have been successfully decommissioned.

The majority of remediation work on the Boršt hydrometallurgical tailings was successfully concluded, but a non-stable landslide beneath the Boršt disposal site has prevented its final closure. The year 2018 was the 8th year (the third additional year) of the envisaged five-year transitional period for the Boršt disposal site. Sampling, measurements, control of the overall state, maintenance, collecting and storing information, record keeping, the preparation of reports for the relevant authorities, etc., were carried out. An assessment of the overall state of the remediated mine facilities was performed and even intensified at the request of the mining inspectorate because the rock base of the Boršt disposal site is still moving. The velocity of the movement of the control point on the Boršt disposal site is approximately 2 cm per year.

Only a part of the vertical drainage wells in the transverse leg of the drainage tunnel are in function throughout the year. Three out of six drainage wells, which were drilled in 2010/2011, operate continuously. In order to further reduce the groundwater level at the Boršt disposal site and thereby reduce the velocity of the landslide, interventional drainage measures (additional drainage wells in the drainage hole) were carried out in 2016 and 2017. Therefore, the requirements of the mining inspectorate were fulfilled, so the inspection procedure stopped.

In 2018, an inspection of the concrete lining of the passageway of the tunnel, the shotcrete lining of the entrance of the tunnel, and the landslide beneath the Boršt disposal site was carried out. In addition, the functioning of the drainage wells was assessed and the movement of the landslide was measured by a special extensometer placed in a tunnel.

Monitoring the stability of the Boršt disposal site is an important task of the transitional five-year period and long-term period. After the final settlement of the Boršt disposal site and the end of remediation activities, the conditions for appropriate periodic geodetic monitoring as well as continuous online monitoring by means of the GPS system at the Boršt disposal site will be achieved.

There was only one geodetic point on the surface of the deposited hydrometallurgical tailings in the Plaz network. In 2018, the measurements of the new Vrtine-2 network were carried out for the purpose of detailed monitoring of the disposal movements. In April 2018, initial measurement of the network was carried out and in November 2018 the first measurements were repeated. The Vrtine-2 network consists of six observation points and 40 control points. The network was supplemented with ten additional control points before the first repetition of the measurements. That was the recommendation of the Expert Project Council. This has densified the network on the expected contact between stable and unstable terrain on the eastern part of the disposal. The Vrtine-2 network replaced the measurements of the settlement plate that were carried out after the end of the final disposal arrangement. The results will be evaluated in the coming years due to the shorter period of the measurement.

The movements of the Boršt disposal site were continuously monitored by a GPS system. The measured movement in the direction of the movement vector at the control point located on the disposal site was slightly less than 2 cm (17 and 18 mm) in 2018. Precise geodetic measurements of the stability were performed on the Boršt geodetic networks (Plaz and Navezava, which connect the Boršt disposal with the surroundings). Measurements of the new Vrtine-2 network were also carried out to determine the stability of the landfill.

The damage of the landslide on the surface has been visible in individual drainage channels since 2013 on the western rockfill toe on the SW edge of the disposal and on the northern rockfill toe.

In 2018, the Expert Project Council for monitoring the remediation work on the hydro-metallurgical tailings prepared a final report. The effects of the maintenance, monitoring and intervention measures to reduce the groundwater impact on the stability of the Boršt hydrometallurgical tailings performed between 2010 and 2018 were assessed, as well as the current state of the Boršt disposal site.

Financing the activities of the RŽV uranium mine from the budget was covered by a contract for the financing of the company's operations with the Ministry of the Environment and Spatial Planning (MOP). Details of this monitoring project can be found in Chapter 3.3.3.

5.6 The Fund for Financing the Decommissioning of the Krško NPP and the Disposal of Radioactive Waste from the Krško NPP

The Fund for Financing the Decommissioning of the Krško NPP and the Disposal of Radioactive Waste from the Krško NPP (hereinafter: the Fund) was established pursuant to the Act on the Fund for Financing the Decommissioning of the Krško NPP and the Disposal of Radioactive Waste from the Krško NPP.

The Fund is an indirect budget user that is not financed from the national budget. Operating costs are covered from the financial revenues generated by the Fund's operations. GEN energija, d. o. o., is liable to pay contributions for the decommissioning of the Krško NPP and the disposal of radioactive waste from the Krško NPP to the Fund in the amount of EUR 0.003 per kWh electrical energy produced in the NPP and sold in the Republic of Slovenia. The contribution is determined on the basis of levying half of the electrical energy produced by the Krško NPP.

The amount of the contribution is based on calculations determined in the Programme for the Decommissioning of the Krško NPP (hereinafter: the Programme) adopted in 2004. According to Article 10 (3) of the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on regulating the status and other legal relations regarding investment in and the exploitation and decommissioning of the Krško Nuclear Power Plant governing the co-ownership of the Nuclear Power Plant, the revision of the Programme should have been carried out by the end of 2009 and 2014 (every five years), but had not been approved and finalised by the end of 2018. The revision should be carried out as soon as possible, because the fundamental assumptions and parameters have substantially changed since 2004. The delays in the preparation of the Programme were also noted by the Court of Audit. Additional information regarding the preparation of the Programme is given in Chapter 9.5.

As of 31 December 2018, the book value of the Fund's financial portfolio amounted to EUR 196.9 million. This does not include unallocated funds in the bank account, accrued interest, interest purchased and claims to dividends in the amount of EUR 1.7 million. Considering this, the Fund's financial assets as of 31 December 2018 amounted to EUR 198.7 million.

5.6.1 Fulfilment of legislative and contractual obligations and proceeds from the contributions for decommissioning

In 2018, the company GEN energija, d. o. o., paid a total of EUR 8.2 million for the decommissioning contribution into the Fund, thereby fully settling all its liabilities to the Fund deriving from decommissioning contributions and within the agreed deadlines. From 1995 to

2018 the Fund received a total amount of EUR 194.6 million from the Krško NPP and GEN energija, d. o. o.

The Fund is obliged to finance the ARAO's activities and compensation to be paid to the Municipality of Krško for the limited use of land. In 2018, the Fund paid a total of EUR 1.2 million to the ARAO. From 1998 until the end of 2018 the Fund paid a total of EUR 43.0 million to the ARAO for the activities implemented by the ARAO. This amount includes compensation paid by the ARAO to the local Municipality of Krško totalling EUR 14.9 million.

In 2015 the Decree on the Criteria for Determining the Compensation Rate Due to the Restricted Use of Areas and Intervention Measures in Nuclear Facility Areas entered into force, succeeding the Decree of 2008. The Fund is obliged to pay compensation for the limited use of land just to the Municipality of Krško, where the LILW repository will be located. Since 2004, municipalities have received EUR 49.5 million as compensation for the limited use of land.

Since 1995, the total amount of transfers to municipalities and the ARAO have amounted to EUR 92.5 million (the amounts paid to co-finance the activities of the ARAO and to municipalities as compensation for the limited use of land are not valorised). Payments made to the ARAO and municipalities account for 46.98 % of the Fund's financial portfolio as of 31 December 2018, which amounted to EUR 196.9 million (book value). Figure 18 shows the book value of the financial portfolio of the Fund as of 31 December 2018.

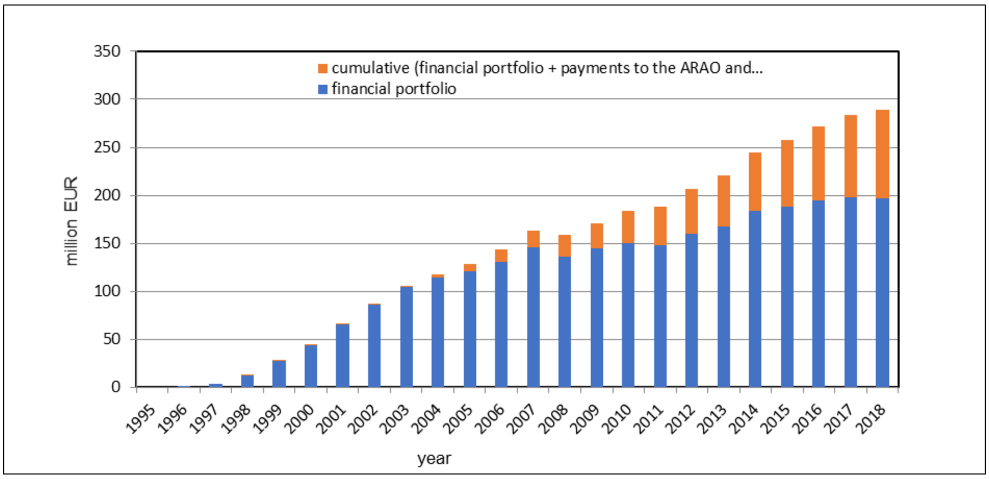


Figure 18: Total financial portfolio of the Fund, in euro millions, as of 31 December 2018, for the period 1995–2018

5.6.2 Investments and business operations in 2018

As of 31 December 2018, 87.43 % of the portfolio was invested in debt securities and 12.57 % in equity securities, which is practically unchanged in comparison to the end of 2017. The main asset class are government bonds, which accounted for 43.0 % of the portfolio. Over the previous years, the share of this asset class gradually decreased, principally due to the purchase of bonds with negative yield to maturity and long-term bonds that have reduced the portfolio's interest rate risk. The proportion of corporate bonds stood at 25.83 % of the portfolio. This asset class maintains exposure to developing countries, whose government bonds exhibit negative yields to maturity also very deep into the intermediate term. In 2018, the segment of bonds of financial institutions increased in particular, principally with euro-denominated bonds of US financial institutions. The segment of equities consists mainly of investments in mutual funds and ETFs issued by leading asset management companies, which brings low risk and higher liquidity through investment diversification.

Investment activities in 2018 were carried out according to the Fund's investment policy and within the goals set by the Fund's investment policy.

In 2018, the Fund continued to decrease the portfolio risk, aiming to limit market risks. The most important risks are market risk, interest rate risk, and credit risks, while in 2017 the Fund began to closely monitor the spread risk. The market risk of the portfolio is evaluated by the so-called Value-at-Risk (VaR) method. As of 31 December 2017, the one-day 95 % VaR was EUR 331,800, or 0.17 % of the portfolio's value, and as of the end of 2018 the one-day 95 % VaR was EUR 318,800 or 0.16 % of the portfolio's value (Figure 19).

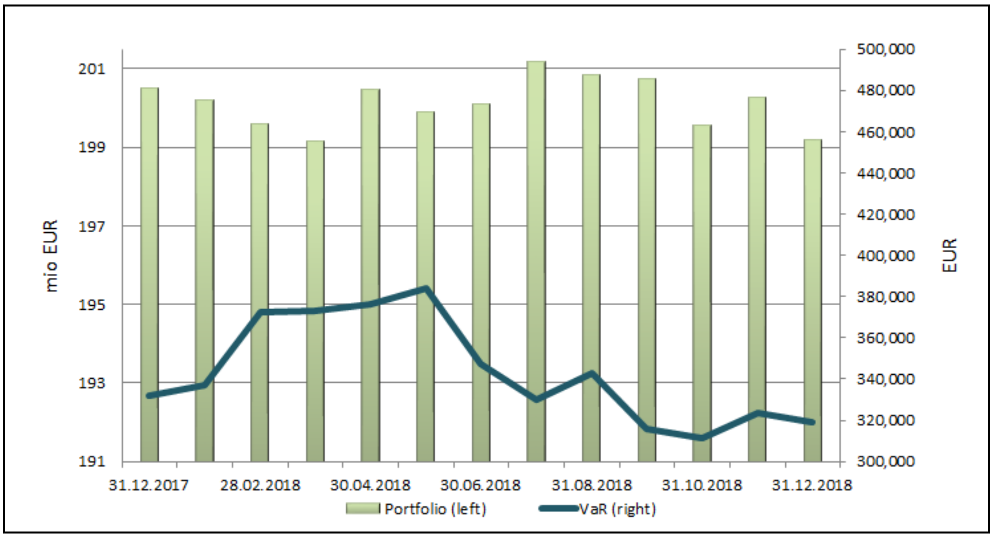


Figure 19: Monthly data for VaR (one-day, confidence interval 95 %)

The interest rate risk of the portfolio addresses the impact of a change in interest rates on the portfolio. The interest rate risk is evaluated and managed over the duration of the bonds. Currently, we are in a period of low and also negative interest rates, for which an increase is in sight. In 2018 an increase in the volatility of the market was noted. Credit risk management is conducted on the basis of the credit ratings of the leading global credit rating agencies (Moody's and Standard & Poor's), whereas the Fund invests only in the investment-grade bonds.

In 2018 the Fund generated income of EUR 12.5 million, which is at the level of the previous year. In 2018 the Fund generated EUR 4.3 million of financial revenues, while the corresponding value for 2017 was EUR 3.7 million. Financial revenues include paid interest, dividends, and other payments, while accrued interest is excluded.

In 2018 the costs of the Fund reached EUR 7.6 million, which was 17.85 % lower than in 2017. The Fund had a surplus of revenues over expenses in the amount of EUR 4.9 million. The realisation of the surplus for 2018 was 45.95 % higher than in 2017 due to the smaller amount of realised expenses in 2018.

As of the end of 2018, the proportion of operating expenses to the financial portfolio amounted to 0.22 %, while in 2001 the corresponding share was 0.44 %. Notwithstanding the performance of the portfolio management, the operational costs of the Fund have remained at these levels for the last several years.

In 2018 the Fund received EUR 70.9 million from due investments and assets. The new purchases amounted to EUR 75.8 million, which is EUR 4.9 million more than due investments and assets sold.

By the end of the first half of the year there was an indication that the portfolio return would be positive, yet the market situation changed significantly in the second half of the year. In December, the equities lost 8.6 %, 12.4 % in the last quarter alone. This affected the return of the portfolio, which ended the year at -0.94 %. The debt securities of the portfolio returned a total return of 0.1 %, while equities decreased by -7.94 %. The negative return was mainly generated by the riskier securities and asset classes (bond funds, equity funds, corporate bonds), yet the proportion of these investments was kept low in 2018. Within this segment of equities the highest negative return was generated in the segment of equity funds, namely 9.08 %. The annual return of the financial portfolio of the Fund (in %) from 2004 to 2018 is shown in Figure 20.

In the first three months of 2019 there was an increase in the returns on the markets, which was reflected in the portfolio's positive return. As of 31 March 2019, the book value of the Fund's portfolio was EUR 203.2 million, and the yield was 2.23 %. It should be noted that we are dealing with yields that in some countries reach into negative territory even for a period of 10 years, which is substantially different from the market situation in the past, when yields surpassed the 4 % margin.

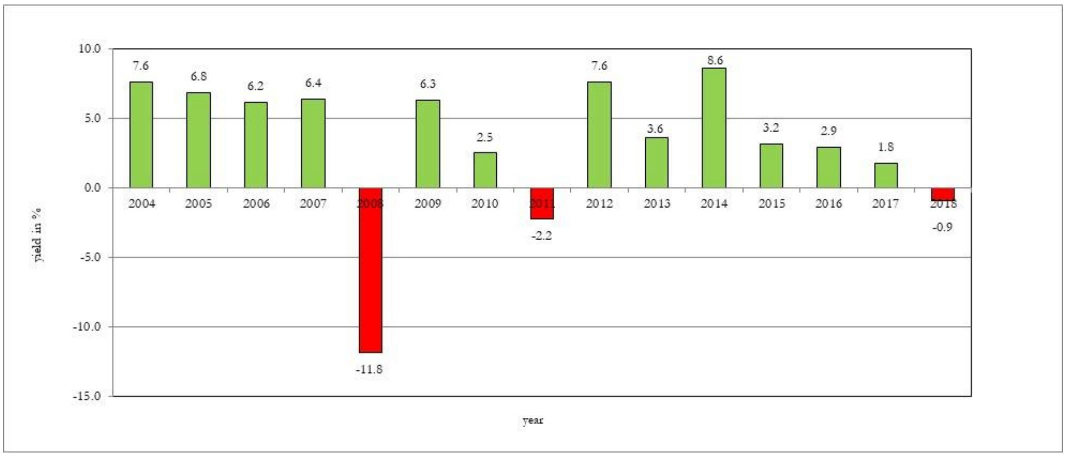


Figure 20: The annual yield of the financial portfolio of the Fund from 2004 to 2018 in %

The annual yield of the financial portfolio of the Fund from 2004 to 2018 in %[1]

The average annualised return of the portfolio over the medium term surpasses 3.0 % and follows the developments of the euro bond index. The average annual return of the portfolio over the last five years was 3.07 %, which is comparable with the average return of the index (3.20 %). In the period of the last fifteen years the rate of return was 3.11 %, which is less than the index (4.07 %). The average return of the Fund (1.24 %) is also comparable to the average return of the index (1.42 %) in the period of the last three years. The average annual return of the Fund's portfolio in different periods is shown in Figure 21.

[1] In 2008, all equity securities, investments, and mutual funds that are listed on the stock exchange or whose market price is publicly available were valorised to fair value in accordance with the Accounting Act. This valorisation was in accordance with the amendments to the Rules on Breaking Down and Measuring the Revenues and Expenses of Legal Entities under Public Law (Official Gazette RS, No. 120/2007). In 2010, debt securities were valorised for the first time, which was also in accordance with the above-mentioned Rules.

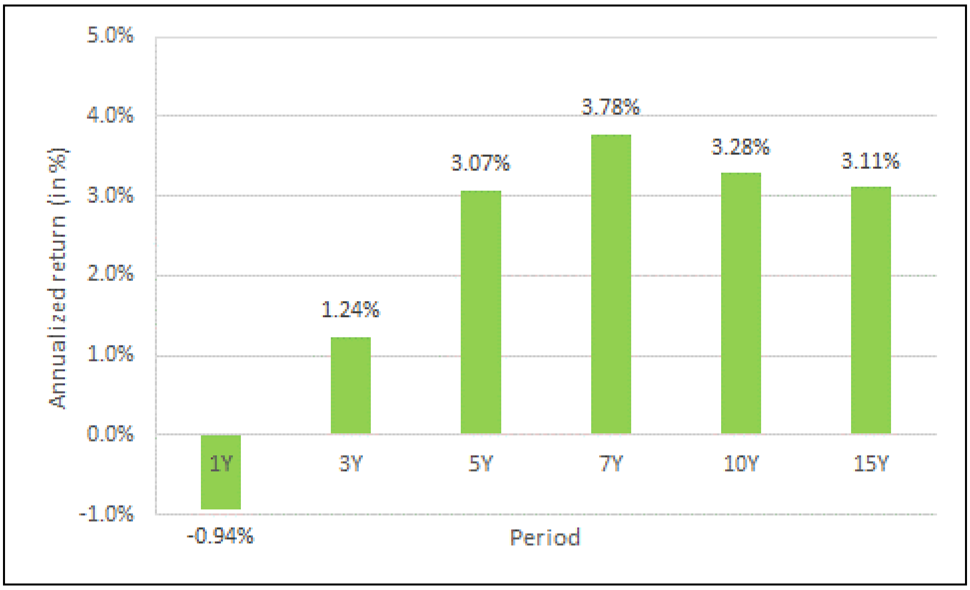


Figure 21: The average annual return of the Fund's portfolio in different periods in %

In the period from 2012 to 2018, the average annual return of the Fund's portfolio exceeded the average annual returns of pension funds with guaranteed returns. In 2018, the return of the Fund's portfolio was slightly below the benchmark, which also realised a negative return(-0.67%).

The year 2018 demonstrated once again that under the current market conditions, which are marked by low and negative interest rates, an average annual return of 4.29 % as defined in the Decommissioning Programme is an unattainable goal that does not reflect the real situation on the capital markets. It should not be neglected that the average yield of the 10-year German government bond over the year, which the Decommissioning Programme considers to be the criteria for the average annual yield of the portfolio, has been at 0.46 %, ending the year at 0.24 % and reaching -0.07 % on 31 March 2019.

The value of the Fund depends on the contributions paid by GEN energija d. o. o., transfer payments, operational costs and the generated return. From 1995 to 2018 the Fund received a total of EUR 194.6 million, and in the same period it paid to ARAO and the municipalities a total of EUR 92.5 million in transfers. The difference between the income and payments (net income) amounts to EUR 102.1 million. As of 31 December 2018 the book value of the financial portfolio of the Fund was EUR 196.9 million, which means that the increase in the portfolio was due to the management of "free" assets of EUR 94.9 million. Given the market value of the portfolio, amounting to EUR 198.7 million, the increased amount from portfolio management was EUR 96.6 million. Over the last couple of years the increase in the portfolio is mainly due to portfolio management, since the contributions paid to the Fund barely correspond to the total amount of the Fund's liabilities.

5.7 Achieving the Goals under the Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management

Below follows a summary of the implementation of the individual strategies under the Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management for the 2016–2025 Period (ReNPRRO16–25).

Strategy 1: The prime responsibility for radioactive waste management in nuclear and radiation facilities rests with the holders of operating licensees. Radioactive waste is to be managed in accordance with the approved safety analysis reports for the operation of individual nuclear facilities. Storage is to be implemented for the purpose of *efficient and secure phased disposal at the LILW repository. In the field of radioactive waste management, the strategy promotes the concept of the clearance of radioactive materials from regulatory control in accordance with the prescribed criteria in order to avoid unnecessary generation of radioactive waste.*

Achieving the goal: The radioactive waste at the Krško NPP, the TRIGA Research Reactor, and the CSF is managed in accordance with the operating licenses and requirements of the safety analysis reports. The concept of the clearance of radioactive materials from regulatory control is applied. In 2018, construction, installation and craft works were completed. A technical review was carried out in accordance with the construction legislation and the issued permit for use of the facility. Non-technical equipment and part of the foreseen technical equipment were installed on the premises.

Strategy 2: After radioactive material is no longer in use, its users are to hand it over to the SGEI provider of radioactive waste management, return it to the supplier/manufacturer, or hand it over to another contractor carrying out a radiation practice. The radioactive material can be reprocessed or reused even if it is already stored in the CSF. The use of alternative methods in activities, where this is possible, is encouraged.

Strategy 3: The users of sealed radiation sources will, as a rule, return the used devices containing sealed radiation sources to the supplier/manufacturer. Failing that, sealed radiation sources are to be delivered to the SGEI provider of radioactive waste management and stored in the CSF. The clearance of radioactive material from regulatory control is recommended in accordance with the prescribed criteria in order to avoid the generation of excessive amounts of radioactive waste. Transitional liquid radioactive waste is to be managed according to the "dilute and disperse" principle: the waste is diluted with water and dispersed into the sewerage system in accordance with the prescribed limit values for release into the environment.

Strategy 11: The discharge of radioactive waste into the environment is to be carried out in accordance with the prescribed limits for individual nuclear or radiation facilities and radiation practices, whereby the holder of the radioactive waste must ensure that the release of liquid and gaseous radioactive waste into the environment is controlled and minimised within the prescribed limits. An increase in the prescribed limits is not envisaged.

Achieving the goal: Performers of radiation activities transfer the sources after they stop using them to the CSF operated by the ARAO or return them to the foreign supplier. The ARAO performs the national public service of radioactive waste management. In February 2018, the SNSA issued a decision approving the report on the periodic safety review, thus imposing on the operator the implementation of the implementation plan for the next three years. The decision to approve the report on the periodic safety review was also the basis for the extension of the operating license in April 2018. Releases of radioactivity into the environment were within the permitted limits. The concept of clearance is applied.

Strategy 4: This strategy concerns the construction of the LILW repository, the disposal of the current LILW inventory in the repository as soon as possible, and the temporary closure of the repository. After the Krško NPP has ceased to operate, the repository is to be re-opened and, after all LILW has been disposed of, again closed. The conditioning of all LILW for disposal is to be carried out in the Krško NPP.

Achieving the goal: These activities are performed but unfortunately some delays are accumulating, and the start of operations has been shifted into the future. Details are available in Chapter 5.5.

Strategy 5: Spent fuel from the Krško NPP is to be stored in the spent fuel pool and the spent fuel dry storage facility at the location of the power plant. The holder of the spent fuel is to examine the possibility of spent fuel processing. The SGEI provider of radioactive waste management is to monitor and actively participate in international and especially European developments in the field of the treatment, reprocessing, and final disposal of spent fuel or HLW generated from spent fuel reprocessing, and implement activities for the construction of its own spent fuel and HLW repository.

Achieving the goal: The spent fuel is stored in the spent fuel pool in Krško. Within the framework of the Krško NPP safety upgrade programme, intensive preparations are underway to build a new dry storage for spent fuel at the Krško NPP site. The start of operation is foreseen in 2021. ARAO, as a contractor of the public service for the management of radioactive waste, monitors and participates in international developments in this field.

Strategy 6: The Programme for the Decommissioning of the Krško NPP and the Programme for the Disposal of LILW and Spent Nuclear Fuel are to be periodically revised in accordance with the Bilateral Slovenian-Croatian Agreement on the Krško NPP (BHRNEK). In addition to the strategy of immediate dismantling, preparations for the revision of the decommissioning programme should also include an analysis of the possibility of a deferred dismantling strategy after the standby period following the shut-down of the Krško NPP.

In 2018, the activities for the preparation of the Decommissioning Programme of Krško NPP and the Programme for the Disposal of LILW and SF continued on the basis of the decision of the Interstate Commission of November 2017, which charged ARAO and the Fund for Financing the Decommissioning of the Krško NPP and for the Disposal of Radioactive Waste from the NPP from Croatia (the Fund), in cooperation with the Krško NPP, with the preparation of a new revision of the Programmes. In May 2018 ARAO and the Fund carried out a public procurement procedure for the preparation of support studies for the preparation of the third revision of the Programme for the disposal of LILW and SF and signed contracts with the selected contractors at the beginning of June, i.e. IBE Ltd. (for the disposal study of HLW and SF) and Enconet Zagreb together with Ekonerg Zagreb (for the study of the division and acquisition of LILW). Both programmes had not yet been created by the end of the year. The Decommissioning Programme of Krško NPP and the Programme for the disposal LILW and SF from the Krško NPP is monitored by the Coordination Committee appointed by the Interstate Commission. It is envisaged that the third joint review of the Decommissioning Programme of the Krško NPP and the Programme for the Disposal of LILW and SF will be made in the first quarter of 2019. Until this deadline, all costs of decommissioning the Krško NPP and the costs of disposing of radioactive waste and spent fuel from the Krško NPP must be optimised and decided at the appropriate discount rate. In this regard, all starting points should be checked at least every five years, and the level of the discount rate even more frequently. Details are available in Chapter 9.5.

Strategy 7: All LILW resulting from the decommissioning of the TRIGA Research Reactor will be disposed of in the LILW repository in Vrbina, Krško. The spent fuel generated by the TRIGA Research Reactor is to be either repatriated to the state of origin or managed together with the spent fuel generated by the Krško NPP.

Achieving the goal: This goal will be met after the decommissioning of the TRIGA Mark II Research Reactor.

Strategy 8: Slovenia is to maintain the operation of the CSF for radioactive waste that is not generated from the production of electricity in Slovenia for as long as such waste is generated and there is a need for its safe storage. After the disposal of radioactive waste from the CSF in the LILW repository, the need for the continuation of the operation of the CSF is to be re-examined. After the final clearance and elimination of the need for storage, the facility is to be decontaminated and handed over for other purposes.

Achieving the goal: The CSF operated without any complications. In February 2018, the SNSA issued a decision approving the report on the periodic safety review, thus imposing on the operator the obligation to carry out the implementation plan for the next three years. The decision to approve the report on the periodic safety review was also the basis for the extension of the operating license in April 2018 for the next ten years.

Strategy 9: The Jazbec mine tailings disposal site and the Boršt hydrometallurgical tailings disposal site are to be closed. After their closure, the two disposal sites are to be subject to long-term monitoring and maintenance by the Agency for Radwaste Management (ARAO) as the SGEI provider of radioactive waste management.

Achieving the goal: The Jazbec disposal site is closed; the ARAO assumed long-term surveillance and monitoring. At the Boršt hydrometallurgical tailings disposal site, remediation works are mostly finished. The assessment of the effectiveness of intervention measures carried out in 2017 (additional drainage wells) will be assessed by continuous monitoring of the flow and observing the stability of the disposal site in the following years. An amendment to the Safety Report is being prepared. It will evaluate all the risks arising from the possibility of a landslide in the wider area of the disposal site and a detailed plan of long-term supervision and maintenance is given with the criteria on the basis of which, based on the results of monitoring the radioactivity of the closed disposal site, it will decide on the maintenance work on the closed disposal site.

Strategy 10: Materials that are usually not regarded as radioactive but which contain naturally occurring radionuclides are to be regularly monitored in terms of their impact on the population and the environment. If the permissible impacts are exceeded, measures are to be taken to rectify the situation. Radioactive waste containing naturally occurring radionuclides is to be managed in accordance with the established level of radioactivity and other waste properties.

Achieving the goal: Activities are ongoing and described in Chapters 3.4.2 and 3.4.3.

Strategy 12: The State is to maintain and update the legislative and institutional framework, ensure the research and development required for the implementation of the national programme and provide information to the public on progress in the implementation of this programme.

Achieving the goal: The strategy is ongoing; the details can be found in Chapters 7.1 and 7.2.

6 EMERGENCY PREPAREDNESS

Emergency preparedness is an essential part of the comprehensive system for ensuring a high level of nuclear and radiation safety. During a nuclear or radiological emergency, all competent organisations in Slovenia must take appropriate actions according to their emergency plans.

The response to a radiation emergency in Slovenia is determined by the National Emergency Response Plan for Nuclear and Radiological Accidents. The Administration for Civil Protection and Disaster Relief (ACPDR) has a leading role in dealing with emergencies, whereas the Slovenian Nuclear Safety Administration (SNSA) provides advice and makes recommendations.

6.1 The Slovenian Nuclear Safety Administration

At the SNSA, the responsibility for emergency preparedness and response falls under the Emergency Preparedness Division.

In an emergency the SNSA emergency team is activated, which is led by the emergency team director. Since tasks during an emergency mostly differ from regular work, the training of the emergency team members is very important. Therefore, in 2018, the SNSA conducted 75 individual and group training courses, exercises, and tests totaling 216 hours. The SNSA also participated in two regular annual emergency exercises of the Krško NPP, and in several international exercises, including the ConvEx exercises, and in the annual emergency exercise of EU Member States in this area (“ECUREX”).

An example of good practice was the ConvEx-2b exercise, which was carried out in October 2018. On the basis of the analysis of the exercise and cooperation between the SNSA and the ACPDR, procedures for requesting and providing assistance in the event of nuclear emergencies were amended.

In March 2018, the new Rules on monitoring radioactivity entered into force, in line with the proposal of the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1), which ensures the transposition of the provisions of the new Basic Safety Standards Directive into Slovenian legislation.

The provisions of the new Directive, which also concern the implementation of environmental monitoring programmes, are supplemented with the lessons learned from its ten-year implementation. The new rules supplement the guidelines for the development of emergency monitoring programmes in the event of an emergency, as well as the programmes for ensuring preparedness for an emergency. In the field of technical measurements, the quality standards are defined in a new way, by defining the smallest quantities of radioactive substances that the measurement providers must be able to measure.

In the area of emergency preparedness, the SNSA regularly cooperates with other organisations in the country and abroad. In this manner, i.e. the transfer of lessons learned and good practices, its preparedness constantly improves.

6.2 Administration of the RS for Civil Protection and Disaster Relief

In 2018, the ACPDR maintained and ensured preparedness and developed procedures for the effective response of the system for protection against natural and other disasters to nuclear and radiological emergencies in 2018, in accordance with its statutory powers.

In 2018, activities related to the pre-distribution of potassium iodide tablets in a radius of 10 km around the Krško Nuclear Power Plant (Krško NPP), in the event of a nuclear accident at the

NPP, continued. The ACPDR distributed potassium iodide tablets to schools, kindergartens, municipal personnel of the civil protection service, the municipalities of Krško and Brežice for random visitors, and others in accordance with the Plan for the Distribution of Potassium Iodide Tablets. The pre-distribution of potassium iodide tablets to the inhabitants of Posavje with a health insurance card was not implemented. This has now been resolved by the Ministry of Health.

The ACPDR continues to maintain the website www.kalijevjodid.si, where visitors can obtain more information on such tablets, the iodine thyroid blocking protective action, and pre-distribution.

The revision of the National Emergency Response Plan for Nuclear and Radiological Accidents was coordinated by the ACPDR. The ACPDR also implemented its actions from the Action Plan on the basis of the findings of the EPREV mission. In 2018, and in cooperation with the SNSA, the ACPDR participated in the international exercise ConvEx-2b. During this exercise the international procedures for assistance in the event of a nuclear or radiological emergency through the RANET system were tested (see also Chapter 6.1).

6.3 The Krško NPP

In 2018 the activities of the Krško NPP in the area of preparedness for emergencies included the following:

- Training, drills, and exercises;
- maintenance of support centers, equipment, and communications;
- updating of the document "Krško NPP Protection and Rescue Plan", procedures, and other documentation; and
- the replacement of staff and the appointment of new members to the emergency organisation (three persons passed the initial training course for emergency team members).

In 2018 the Krško NPP conducted a set of training, tests, and exercises with a total of 485 participants from the Krško NPP and 133 participants from supporting organisations. The Krško NPP conducted two annual emergency exercises with 329 participants from the Krško NPP. In total, the emergency staff consist of 433 persons, including security and operating personnel.

Furthermore, in 2018 the staff of the Krško NPP actively cooperated with the planners and providers of protection and rescue services at the local and national levels, as well as with the administrative authorities, namely the SNSA and the ACPDR.

6.4 Action Plan after the EPREV Mission

The EPREV mission was conducted in November 2017. The mission team noted some areas where improvements could be made. The report of the mission therefore includes 19 recommendations and 12 suggestions for improvements based on the IAEA Safety Standards. On the basis of these findings, an action plan with 31 actions was drafted for adoption by the Government of Slovenia. Each action includes the mission's observations and findings, the action to be taken, the leading and participating organisations, and deadlines for its implementation. The Slovenian Government adopted an Action Plan based on the findings of the mission in April 2018. The Action Plan represents a basis for the implementation of the recommendations and suggestions in the report and to improve the Slovenian EPR system.

According to the Government's decision, the SNSA's role is to monitor the progress of the EPREV action plan so that it is realised by the set deadlines. Additionally, the SNSA is also responsible for the implementation of a number of actions. Some of these actions were completed in 2018 and at the beginning of 2019: amendment of the hazard assessment for nuclear and radiological emergencies, analysis of the notification and activation system of the SNSA emergency response team, production of a poster for emergency workers, including for the purposes of providing non-designated emergency workers with just-in-time training, production of a poster with information for the general public on the health hazards and health effects in the event of a radiological emergency, also addressing the most vulnerable members of the public, amending procedures for requesting and receiving international assistance, conducting an exercise wherein the SNSA's duty officer provides advice during the initial response to a radiological emergency, etc. Most actions are still ongoing, including the revision of the national emergency plan, the protection strategy, procedures, guidelines and analyses. They need to be completed by the end of the 2019. The SNSA is obliged to report to the Government on the implementation of the Action Plan by 31 January 2020 at the latest.

6.5 Achieving the Goals of the Resolution on Nuclear and Radiation Safety

Goal 10

In the use of nuclear energy and radiation activities in the Republic of Slovenia, emergency preparedness and response are appropriately ensured so that in the event of such the impact on people and the environment is minimal.

Realisation in 2018

From the above, it can be concluded that with regard to the use of nuclear energy and radiation-implementing activities in the Republic of Slovenia, the SNSA appropriately addressed the issue of emergency preparedness and response. The Inter-ministerial Commission for coordinating the implementation of the national plan meets regularly and is responsible for directing and coordinating preparedness at the national level.

7 SUPERVISION OF RADIATION AND NUCLEAR SAFETY

7.1 Education, Research, Development

Once again in 2018, the field of education, research and development regarding nuclear and radiation safety was stable.

7.1.1 Achieving the Goals of the Resolution on Nuclear and Radiation Safety

The objectives to be achieved in the field of education, research and development in the period 2013–2023, as envisaged by the Resolution, are as follows:

Goal 9

The system of authorised experts enables optimum professional support in the decision-making of the regulatory bodies on nuclear and radiation safety, while ensuring that the producer or the applicant covers the costs of preparing an expert opinion.

Realisation in 2018

The Slovenian system of authorised experts provides optimum professional support in the decision-making of the regulatory bodies on nuclear and radiation safety. In 2017 the amended Act on Protection Against Ionising Radiation and Nuclear Safety (ZVISJV-1) maintained the same solution as applied in the past: the party that initiated an administrative procedure in which the expert opinion of an authorised expert for radiation and nuclear safety is necessary bears the cost of preparing such expert opinion. At the end of 2018, 11 experts from the Republic of Slovenia were authorised to cover all areas of nuclear and radiation safety. Furthermore, the Act also allows the authorisation of foreign professional organisations (in 2018 there was one from Austria and five from Croatia), which ensures greater coverage of professional areas. The Act furthermore contains provisions on ensuring the independence of authorised experts from nuclear or radiation facility operators or persons carrying out a radiation practice.

Apart from the direct financing of the preparation of expert opinions, authorised experts are also financed through research and development projects, as described below in the achievement of Goal 12.

Goal 11

Slovenian educational institutions offer study programmes whose graduates, after gaining appropriate additional training, can secure important positions in organisations where they can ensure nuclear safety.

Realisation in 2018

There were no major changes in this area in 2018.

At the Faculty of Mathematics and Physics of the University of Ljubljana, within the framework of the Department of Physics, the two-stage master's degree programme "Nuclear Engineering" is being carried out. In the school year 2018/19, five students enrolled in the programme, who, together with two repeating students and two students in the second year, are attending four modules of the Nuclear Engineering Programme, while approximately half of the additional credits are received through courses from other study programmes. Some students were enrolled for an additional year. For reason of financial savings, lectures are only held for eight courses and even for those only in a cyclical mode, i.e. they are carried out every second year. In the year 2018, one graduate finished his master's degree in Nuclear Engineering. The study programme was carried out by teachers who are members of the Jožef Stefan Institute, the Faculty of Electrical Engineering, and the Faculty of Mechanical Engineering. They are all involved in the programme through additional employment or contracts with the Faculty of Mathematics and Physics. No permanent position for a nuclear engineering professor was available at the University of Ljubljana.

At the moment, there are 15 students in the "Mathematics and Physics" Doctoral Programme within the module Nuclear Engineering; in 2018 one student enrolled in the first year. Most of them are employed at the Jožef Stefan Institute. In 2018, three students finished PhD studies.

We estimate that in the current circumstances in Slovenia the scope of studies and the number of students approximately correspond to the needs of the profession. It should be noted that in the field of nuclear engineering, there are also some engineers from other technical and natural science faculties who acquire nuclear knowledge outside faculties by means of post-employment training.

Goal 12

In the Republic of Slovenia, stable conditions for the financing and implementation of research and educational activities in the field of nuclear and radiation safety are established by which a "critical mass" of experts that can competently cover all key aspects of the safe use of nuclear energy and ionising radiation sources is ensured.

Realisation in 2018

The SNSA regularly gathers data from major funders (leaving aside the main nuclear facilities and state authorities) on how the funds are disbursed to Slovenian organisations and authorised experts in the field of nuclear and radiation safety. The total amount for applied projects and research studies in 2014 was nearly EUR 5 million, while in the years 2015 and 2016 the total funds increased to more than EUR 7 million primarily due to work on the project regarding the repository for radioactive waste in Vrbina. In 2017 the total amount dropped to approximately EUR 6.2 million. In 2018 the figure more than doubled, to EUR 13 million. Investments in the Krško NPP as a part of the programme for upgrading safety contributed the most, as well as the costs of the Vrbina repository project. In 2018, also direct funding for research and development significantly increased, i.e. from EUR 1.8 million to EUR 2.25 million.

Since the average cost of one expert, 1 FTE (FTE - Full Time Equivalent), is approximately EUR 65,000 per year, the figures above indicate that the nuclear profession outside nuclear facilities and state authorities receives enough funds to finance around 200 professionals (compared to approximately 100 in the preceding year), of which approximately 34.5 (in the preceding year approximately 28.3) directly for research activities. This level of funding contributes to the maintenance of professional competences in the country and provides assistance in making important decisions in the field of nuclear safety.

7.2 Legislation

The most important piece of legislation in the field of nuclear and radiation safety in the Republic of Slovenia is the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1). The Act was adopted in 20017, published in Official Gazette of the Republic of Slovenia No. 76, and entered into force on 6 January 2018. ZVISJV-1 substituted the act with the same name from 2002, which had been amended four times by the year 2015.

In this manner, the requirements of Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from ionising radiation (which is better known to the professional public as the EU BSS Directive) have been transposed into the Slovenian legal order; furthermore, also some minor changes in the field of nuclear safety arising from the provisions of Council Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations (the so-called revised Nuclear Safety Directive) were introduced. With this, the process of adapting Slovenian legislation to the latest international knowledge in the field of regulating radiation protection and nuclear safety continues.

In the year 2018, very intensive work on the preparation of executive regulations in the field of nuclear and radiation safety continued since the ZVISJV-1 envisages in its transitional and final provisions a nine-month period starting from its entry into force for the adoption of several executive regulations. The executive regulations, which were prepared by the Slovenian Nuclear Safety Administration and the of Slovenian Radiation Protection Administration in parallel with the preparation of the ZVISJV-1 in 2017, were also adopted and published in the Official Gazette of the Republic of Slovenia in 2018. These include the following decrees adopted by the Government :

- Decree on limit doses, reference levels and radioactive contamination (UV2; Official Gazette RS, No. 18/18),
- Decree on the national radon programme (UV4; Official Gazette RS, Nos. 18/18 and 86/18),
- Decree on radiation activities (UV1; Official Gazette RS, No. 19/18),
- Decree on the reduction of exposure due to natural radionuclides and existing exposure situations (UV5; Official Gazette RS, No. 38/18).

The Minister of the Environment and Spatial Planning together with the Minister of Health and the Minister of Agriculture, Forestry and Food adopted the Rules on monitoring radioactivity (JV10; Official Gazette RS, No. 27/18), while the Rules on the use of radiation sources and radiation activities (JV2 / SV2; Official Gazette RS, No. 27/18) were adopted together with the Minister of Health.

In 2018, the Minister of Health adopted the following regulations in the field of radiation protection (the last three of which were adopted in agreement with the Minister of the Environment and Spatial Planning):

- Rules on the criteria of using ionising radiation sources for medical purposes and practices involving non-medical imaging exposure (SV3; Official Gazette RS, No. 33/18);
- Rules on authorising ionising radiation practitioners (SV7; Official Gazette RS, No. 39/18);
- Rules on special radiation protection requirements and the method of dose assessment (SV5; Official Gazette RS, No. 47/18);
- Rules on authorising radiation protection experts (SV7A; Official Gazette RS, No. 47/18);
- Rules on the obligations of persons carrying out a radiation practice and person possessing an ionising radiation source (SV8; Official Gazette RS, No. 43/18);
- Rules on radiation protection measures in controlled and monitored areas (SV8A; Official Gazette RS, No. 47/18).

Thus, in 2018 all implementing regulations were adopted whose adoption was imposed by the ZVISJV-1 and by which primarily the EU BSS Directive was transposed into the Slovenian legal order. Due to the transposition, each draft of the mentioned regulation had to be sent to the European Commission for review in accordance with Article 33 of the Euratom Treaty. Due to this, and to the slightly delayed adoption of the ZVISJV-1, as originally planned, the complete transposition of the Directive was not carried out by the deadline (6 February 2018); nevertheless, Slovenia was among the more successful and faster Member States with respect to the transposition of the EU BSS Directive.

It is true, however, that the transposition is not yet complete since the following regulations were not adopted in 2018:

- Decree on the verification of the radioactivity of consignments that could contain sources of radiation of unknown origin (UV11) and
- Decree amending the Decree on the content and elaboration of protection and rescue plans (UVINZR).

While the first mentioned regulation (UV11) was in the final stage of adoption at the end of 2018, as the inter-ministerial coordination had been successfully concluded and only coordination with the Government Office for Legislation had not finished, the adoption of amendments to the UVINZR was still in the initial phase.

A more detailed overview of the already adopted implementing regulations and those in preparation is provided on the website of the SNSA.

After less than half a year since the entry into force of the new ZVISJV-1, the Slovenian Nuclear Safety Administration started preparations for amending the act. The reason for this was a letter from the Government Office for the Protection of Classified Information (UVTP) informing the SNSA, the Ministry of the Interior (MNZ), and the Krško Nuclear Power Plant (Krško NPP) of problems in the implementation of the provisions of the ZVISJV-1 regarding the security checks (vetting) of foreign nationals who perform or will perform work in a controlled facility or area, a physically controlled facility or area, or a vital object or area of a nuclear facility, in the handling of radioactive materials and the transport of nuclear materials.

Even though the Ministry of the Environment and Spatial Planning and the SNSA are formally responsible for the preparation of the amendments to the ZVISJV-1, the amendments to the Act in the field of the security checks/vetting of foreign nationals were taken over and managed by the Ministry of the Interior, which coordinated the proposed solutions with other stakeholders. At the end of 2018, the SNSA provided for the publication of the proposal for amendments to the ZVISJV-1 on the e-Democracy portal and on its website (with the conclusion of the public debate on 4 January 2019), and the proposal of the ZVISJV-1A was sent to the inter-ministerial coordination (which was concluded on 8 January 2019). Beside the amendments to those articles related to the security checks/vetting of foreign nationals, the proposed amendments also relate to some of the other articles, which mainly consist of editorial corrections and terminological alignment of the text of the Act.

Issues related to the entry into force of the Protocol to the Convention on Third Party Liability in the Field of Nuclear Energy (the so-called Paris Convention) and the Protocol to the Convention of 31 January 1963 supplementing the Paris Convention (the so-called Brussels Supplementary Convention) and the beginning of the full application of the Act on Liability for Nuclear Damage (ZOJed-1) have already been reported in annual report for the year 2017. After two meetings organised on the initiative of the SNSA (3 July 2017 and 19 December 2017), substantive progress in resolving outstanding issues (the guarantee of the Republic of Slovenia for so-called "refused" insurance coverage and the related issue of possible unauthorised state aid; the preparation of a methodology for calculating the premium for such a guarantee; determining the elements of the contract which, pursuant to Article 23 of the ZOJed-1, is to be concluded between the Ministry of Finance and the Krško NPP for the regulation of relations under the guarantee of the Republic of Slovenia for insurance coverage) has not been achieved.

Therefore, in June 2018 the SNSA asked the Ministry of Finance for information on the possible resolution of the outstanding issues in accordance with the agreed workplan from December 2017, and also informed the Ministry that at the meeting of the Contracting Parties to the Paris Convention in March 2018 it was clarified that Italy, as the last of the Contracting Parties by the end of 2018, would most likely implement all internal legal procedures for the adoption of its legislation in the area of nuclear liability. This would enable the simultaneous deposit of the ratification documents with the depositary of the Paris Convention and the Brussels Supplementary Convention, which would, for the Slovenian situation, mean that with the entry into force of both Protocols to these conventions, a six-month deadline would begin to run (in accordance with the first paragraph of Article 31 of the ZOJed-1), by the end of which the articles that have not been in force since the entry into force of the Act (including the provisions from Articles 22 to 24 relating to the guarantee of the Republic of Slovenia on refused insurance coverage) shall also apply.

At the beginning of September 2018, the SNSA also provided information to the Ministry of Finance regarding the fact that the European Commission's Directorate-General for Competition had reviewed a Belgian methodology for determining a guarantee premium that is provided by the state for risks for which commercial coverage cannot be found and considering that the Belgian state guarantee does not constitute state aid. Since the Ministry of Finance did not respond to those efforts to speed up the resolution of the problem relating to »refused« insurance coverage, in mid-October the Minister of the Environment and Spatial Planning sent to the Ministry of Finance a request for clarification of what had been done in this field in 2018 and once more drew attention to the consequences of such an unsettled situation and suggested that the Ministry of Finance convene a meeting to assess the progress and to exchange information on compliance with the agreed workplan in December 2017. In its reply at the end of November, the Ministry of Finance explained that it had been in working contacts with the Insurance Supervision Agency and the Nuclear Pool, however, the Ministry of Finance has no intention to conclude the contract for so called »refused insurance coverage« with the Nuclear Power Plant Krško in advance (including charging a commission for the aforementioned guarantee), since, according to the Nuclear Pool, there is a high probability that until the entry into force of the Protocol to the Paris Convention (presumably at the beginning of 2020) this head of damage will be covered by insurance companies themselves. Moreover, the contract will be prepared by the Ministry of Finance on the annual basis and will be linked to correspodant annual contract on liability insurance for nuclear damage between the Nuclear Pool and the Krško NPP.

7.2.1 Achieving the Goals of the Resolution on Nuclear and Radiation Safety

With regard to the legislative and institutional framework, the resolution sets two goals.

Goal 7

The Republic of Slovenia maintains its legislation in the field of nuclear safety and radiation protection in accordance with international best practices. The legislation provides for the priority of nuclear and radiation safety while enabling the main purpose of the use of nuclear energy and ionising radiation sources.

Realisation in 2018

As described above, the SNSA is striving to the greatest extent possible to transpose into the legal system of the Republic of Slovenia the EU acquis (directives), to harmonise domestic regulations with accepted WENRA standards, and to fulfil all other commitments undertaken with respect to relevant international treaties to which Slovenia is a party.

The work done in this field in the year 2018 was also largely determined by the efforts to harmonise domestic legislation with international developments and best practices, and above all with already established international commitments and standards. Chapter 7.2 describes in detail the achieved objectives that are linked to international commitments and the European legal system. At the end of 2017, it was clear that, despite the timely adoption of the ZVISJV-1, the new EU BSS Directive would not be fully transposed into the Slovenian legal system, since all the implementing regulations (the decrees and rules issued on the basis of the Act) would not be adopted by 6 February 2018, by which the transposition should have taken place.

Goal 8

The Republic of Slovenia shall maintain the appropriate separation and independence of the regulatory authorities responsible for the supervision of nuclear and radiation safety from those entities whose primary mission is to promote the use of nuclear energy or ionising radiation sources. The supervisory authorities shall have adequate financial resources and appropriate personnel to perform their duties.

Realisation in 2018

The organisation of administrative bodies/regulatory authorities in the field of nuclear and radiation safety in the Republic of Slovenia is adequate and in 2018 there was no need for any substantive changes.

7.3 The Expert Council for Radiation and Nuclear Safety

The Expert Council for Radiation and Nuclear Safety provides expert advice to the Ministry of the Environment and Spatial Planning and to the Slovenian Nuclear Safety Administration in the field of radiation and nuclear safety, the physical protection of nuclear materials and facilities, safeguards, radioactivity in the environment, radiation protection of the environment, intervention measures and mitigation of the consequences of emergencies and the use of radiation sources other than those used in health and veterinary care.

The Expert Council for Radiation and Nuclear Safety convened a regular session and two correspondence sessions in 2018. In addition to the regular reporting of the SNSA Director to the Council on the status of nuclear and radiation safety, the Council discussed the situation in Slovenia in the field of authorised experts in radiation protection and nuclear safety, and the situation in the field of legislation, especially regarding the amendment of the Ionising Radiation Protection and Nuclear Safety Act. The Council further considered the following second level legislation: the Decree on the reduction of exposure due to natural radionuclides and existing exposure situations (UV5), the Decree on checking the radioactivity of consignments that could contain orphan sources (UV11), the Decree on the Establishment of a Public Company for Radioactive Waste Management, and practical guideline PS 1.02 Consideration of Changes in Radiation and Nuclear Facilities. The Council also considered and approved the 2017 Annual Report on Radiation and Nuclear Safety in the Republic of Slovenia. In a correspondence session the Expert Council also considered and approved a report on EC Directive 2011/70/Euratom on the responsible and safe management of spent fuel and radioactive waste.

7.4 The Slovenian Nuclear Safety Administration

The Slovenian Nuclear Safety Administration (SNSA) performs administrative and developmental tasks in the field of nuclear and radiation safety, radiation practices, and the use of radiation sources (with the exception of medicine and veterinary medicine), environmental protection against ionising radiation, the physical protection of nuclear materials and facilities, the non-proliferation and security of nuclear materials, radiation monitoring, and liability for nuclear damage; it also carries out inspection duties in the above areas and cooperates in radiological and nuclear emergency events with the State Civil Protection Headquarters to determine protective measures for the population and informs the public regarding such matters.

At the beginning of 2018, the SNSA employed 44 civil servants. Four new employees were hired during the year, while one civil servant left the SNSA. Thus, the total number of employees at the SNSA as of the end of 2018 amounted to 47. The number of employees covers all civil servants who are employed for a fixed and indefinite period, regardless of the source of funding. This means that the number of employees also includes those whose salaries are financed from other sources. As of 31 December 2018, four civil servants were employed for project work; they are not financed from budgetary integral funds, and they are not counted in the Staffing Plan, which set a quota of 41 employees. The number of employees was complemented by one trainee civil servant and one civil servant employed on the basis of a temporarily increased workload.

Special attention is devoted to training in nuclear safety and radiation protection. Many workers (especially all inspectors) have passed a special course and exam in the framework of the US NRC training and re-training programmes, as well as exams on the appropriate simulator (a replica of the Krško NPP control room).

Training and education abroad are also very intensive, which enables the SNSA to professionally cover this constantly developing area. The SNSA staff attends, among other things, various forms of training organised by the IAEA, the OECD / NEA and the EU. In order to acquire specific knowledge and additional training in narrower areas of work, the SNSA organised and implemented so-called internal education. These forms are particularly suitable in areas where the provider adjusts the programme to the requirements and needs of the client (the SNSA), and is usually implemented at the SNSA's headquarters, which also enables the participation of a larger number of participants.

In 2018, almost 40 different major training courses were carried out, mostly foreign, and some in Slovenia, accounting for over 180 working days. Over 20 civil servants were involved in this training and education, although, of course, this does not include participation in a wide range of working groups, committees and associations; more information can be found below in this report (Chapter 9). It is worth mentioning that the costs of training and education abroad are minimal, since nearly always training forms are selected whose costs are fully covered by the organiser.

The most significant thereof are internal training courses in the field of emergency preparedness, the number of which was even greater than in previous years and which are included in the above statistics. Practically all employees of the SNSA, who according to the internal plan of measures are foreseen to participate in an emergency response, were also intensively involved in the training process in 2018. Over 100 training sessions were organised in this field and attended by all SNSA employees, who spent nearly 1,200 man hours on such.

Furthermore, the above statistics do not include the training of three SNSA employees at the Milan Čopič Nuclear Technology Education Centre of »Jožef Stefan Institute«, who participated in the first and second part of the two-month course »Fundamentals of Nuclear Power Plant Technologies« (OTJE) and two other employees who only attended the second part of the same course.

The SNSA constantly strives to enable the public to become acquainted with issues in its field of work. The SNSA thus informs the public primarily throught the publication of information on its websites, which is constantly updated, with content made transparent and readable. The »News« section, regarding which the SNSA tries to be fresh and informative, is intended for current events related to the work of the SNSA. In the year 2018, 52 such news items were published, on average slightly more than four per month.

In 2018, the SNSA continued with the practice of publishing »Radiation News«, which started about fifteen years ago. Two editions (46 and 47) were prepared, which are also published on the SNSA website. Edition 46 of the News is thematic, since it is almost entirely dedicated to cases of "interventions" by the SNSA inspection service in 2017, while a smaller part of the edition of Radiation News deals with the safety culture among practitioners of radiation activities. Edition 47 is also thematic, but it is devoted entirely to the presentation of important novelties in the new implementing regulations in the field of radiation safety adopted in 2018 on the basis of ZVISJV-1.

For the public abroad, especially for foreign administrative bodies in the field of nuclear and radiation safety, the SNSA prepares News from Nuclear Slovenia with a standardised content concept, which is updated twice a year. Both publications, Radiation News and News from Nuclear Slovenia, are also published on the SNSA website.

The Annual Report on the Protection of Ionising Radiation and Nuclear Safety in the Republic of Slovenia, which is prepared on the basis of the provisions of the ZVISJV-1, undoubtedly represents part of the public information package. The report for 2017 was discussed and adopted by the Government of the Republic of Slovenia at the 252nd Session on 27 June 2018 and forwarded to the National Assembly of the Republic of Slovenia. The Commission of the National Council of the Republic of Slovenia for Local Self-Government and Regional Development discussed the report at its 14th session on 24 September 2018, and the Committee of the National Assembly for Infrastructure, Environment and Spatial Planning, as the parent body, took note of the report at its 2nd meeting on 16 October 2018.

At the same time, the report represents the basic manner of informing the general public of the state of nuclear safety and radiation protection in the country, for which it also is primarily intended.

The Fulfilment of Other Requirements in Respect of Workers Performing Duties and Tasks in Nuclear and Radiation Facilities

In 2018 the Expert Commission for the Verification of Professional Competences and Fulfilment of Other Requirements in Respect of Workers Performing Duties and Tasks in Nuclear and Radiation Facilities (hereinafter: the Commission) carried out exams for Senior Reactor Operators, Reactor Operators, and Shift Engineers of the Krško NPP. Three candidates acquired a Reactor Operator license for the Krško NPP for the first time. The Commission organised exams for the extension of a license six times. Extensions of licenses were granted to five Reactor Operators, seven Senior Reactor Operators and eight Shift Engineers. Altogether, two candidates also acquired a Senior Reactor Operator license for the first time and three candidates qualified as a Reactor Shift Engineer for the first time. No exams at the TRIGA Research Reactor for an Operator license or a Storage Facility Manager license at the Central Radioactive Waste Storage Facility were held in 2018.

The SNSA granted the appropriate licenses to all candidates who were successful at the exams.

7.5 The Slovenian Radiation Protection Administration

The Slovenian Radiation Protection Administration (SRPA), a regulatory body within the Ministry of Health, performs specialised technical, administrative, and developmental tasks, as well as inspection tasks related to carrying out activities involving radiation and the use of radiation sources in medicine and veterinary medicine; the protection of public health against the harmful effects of ionising radiation; systematic surveying of exposure at workplaces and in the living environment due to the exposure of humans to natural ionising radiation sources; monitoring of the radioactive contamination of foodstuffs and drinking water; the control, reduction and prevention of health problems resulting from non-ionising radiation; and the auditing and approval of experts in the field of radiation protection.

As a special operational unit within the SRPA, the Inspectorate for Radiation Protection is responsible for monitoring sources of ionising radiation used in medicine and veterinary medicine and for the implementation of legislation on the protection of people against ionising radiation. In 2018 the SRPA had one temporary and five permanent employees.

The activities of the Administration were focused on performing duties in the field of radiation protection and on strengthening the system for health safety against the harmful impacts of radiation in the Republic of Slovenia. Within this framework, the activities of the SRPA comprised issuing permits and certificates as prescribed by the Act (ZVISJV-1); issuing approval to radiation protection experts; performing inspections; providing information and increasing public awareness of procedures regarding health protection against the harmful effects of radiation; and cooperating with international institutions involved in radiation protection.

The SRPA supervised radiation practices in medicine and veterinary medicine and the use of radiation sources in these activities, the protection of exposed workers in nuclear and radiation facilities, and radon exposure. Altogether, 80 permits to carry out a radiation practice, 201 permits to use radiation sources, 82 certificates of received individual doses and 32 statements of consignees of radioactive materials were confirmed. In 2018 the SRPA issued 11 approvals to natural or legal persons performing professional tasks in radiation protection.

In 2018 the Inspectorate carried out 180 inspections. Of these, 17 were in-depth inspections of exposure to radon; the SRPA issued 15 warnings regarding the required reduction in exposure. In medicine and veterinary medicine, 17 in-depth inspections were performed. A total of 6 decisions requiring harmonisation with the valid regulations and one decree forbidding the use of a CT device were issued. Nine requests to submit evidence regarding corrected authorised deficiencies, 38 requests to submit evidence regarding the termination of the use of an X-ray device, and 96 requests regarding harmonisation with the existing legislation were issued. The SRPA took action in 2 cases when the operational monthly personal dose of 1.6 mSv was exceeded. Comprehensive control was ensured through cooperation with professional institutions that regularly monitor the situation in this field.

The SRPA continued the programme for the systematic examination and measurement of radon, which expanded in comparison to previous years. The number of measurements in schools and kindergartens increased and in 2018 for the first time the programme was extended to dwellings.

The SRPA continued to finance the radiation monitoring of food and drinking water and the measurement of gross alpha and gross beta activities in the drinking water of Slovenia.

In 2018 the SRPA financed analysis of gross alpha and gross beta activities in the drinking water of Slovenia, which will be the basis for the monitoring strategy in the coming years. In the field of radon exposure, the SRPA financed the publication of a cartoon, printed on high school accessories. In the field of patient exposure, the SRPA financed a study on patient exposure due to radiological procedures.

In 2018 the SRPA was intensively involved in the preparation of legislation and the transposition of Council Directive 2013/59/Euratom, as described in Chapter 7.2.

Thus far, the SRPA has operated with a small number of employees and modest financial resources. Despite this, a high level of radiation protection has been ensured in its areas of competence. This is achieved by effectively optimising work processes and the optimal use of available resources. The understaffing of the SRPA was noted by the EPREV mission in 2017, which pointed out that in the event of an emergency the SRPA could not respond to the event and perform its regular duties at the same time. Furthermore, the ZVISJV-1 burdens the SRPA with additional tasks in relation to protecting the population against the harmful effects of radon exposure and in the field of the health protection of patients. Accordingly, additional financial resources have been granted to the SRPA to carry out radiation protection measures in the field of the radiation protection of patients and radon exposure. The need for additional staffing was also described in the commentary on the ZVISJV-1, which was discussed in the National Assembly of Slovenia in the process of adopting the law. The SRPA does not have any staff reserves to fulfil the additional tasks assigned to it. Additional staffing in the near future is thus a pressing requirement in order for it to fulfil its legal obligations and maintain an adequate level of radiation protection.

7.6 Approved experts

Approved Experts in Radiation and Nuclear Safety

Operators of radiation or nuclear facilities must obtain an expert opinion provided by an approved expert in relation to specific interventions in facilities. In 2018 there were no major changes in the operations of the experts in comparison to previous years. Their staff maintained the level of competence and the equipment used was well maintained and updated. The organisations established quality management programmes. The majority of them had certified programmes in compliance with the ISO 9001:2008 standard. Approved experts also provided independent opinions for the Krško NPP. Special focus was devoted to the independence of opinions on plant modifications.

Research and development activities are an important part of the work of approved experts. It can be noted that some organisations successfully participated in international research projects.

In 2018 the SNSA considered five submitted applications for the extension of approvals. The SNSA extended all five approvals regarding one or more of the expert fields on the basis of Article 89 of the ZVISJV-1. No new approvals were issued.

In 2018 altogether 19 legal entities were approved by the SNSA to perform the tasks of an approved expert in radiation and nuclear safety.

The SNSA website provides information on approved experts in various fields of radiation and nuclear safety.

Approved Radiation Protection Experts

Approved Radiation Protection Experts (RPEs) are advisory persons who carry out a radiation practice involving all issues important for radiation protection. They give expert opinions on these issues and in cooperation with persons carrying out a radiation practice prepare radiation protection evaluations and reports on reviews of radiation protection evaluations and provide expert opinions. Within the prescribed time limits, they examine working and radiation conditions in controlled and supervised areas, and conduct examinations of radiation sources and personal protective equipment. RPEs provide training in radiation protection.

Approval can be granted to natural persons (to provide expert opinions, prepare and review radiation protection evaluations, and give lectures as part of radiation protection training courses) or to legal persons (to provide expert opinions, prepare and review radiation protection evaluations, examine working and radiation conditions in controlled and supervised areas, examine radiation sources and personal protective equipment, and carry out training courses in radiation protection).

In 2018 the SRPA issued 3 radiation protection expert approvals to natural persons and 1 approval to a legal person, i.e. the JSI to carry out training courses in radiation protection. The approval was issued on the basis of an application from 2017. The application was partially refused in the part referring to training in radiation protection for persons involved in carrying out a radiation practice and persons carrying out radiological procedures in medicine and veterinary care using ionising radiation as a consequence of particle acceleration (dental care, densitometry and diagnostic radiology), radiation protection of patients undergoing radiological procedures, and exposure to natural sources.

The application for approval was refused in the fields described because the JSI did not have confirmed training programmes. In the field of exposure to natural sources, the training materials were not provided, so the programme was not confirmed. In the fields of medicine and veterinary care using ionising radiation as a consequence of particle acceleration and the radiation protection of patients undergoing radiological procedures, the training materials were insufficient, and foremost the JSI had not provided evidence of collaboration with an approved medical physics expert, as required by legislation.

The first approval was issued on 6 October 2017, but due to the partial refusal of the application the JSI appealed against the administrative procedure. The second instance authority annulled the approval and returned the application to the SRPA for a renewed procedure. The SRPA corrected the irregularities in the administrative procedure and decided the same as in the first procedure. The JSI carried out two training courses for workers in industrial radiography and dentists, although it did not hold the appropriate approval. The SRPA did not recognise such training course, thus the trainees had to attend the training course and pass the examination again with an approved training provider. At the end of 2017 two inspections were performed at the JSI – Milan Čopič Training Centre in relation to carrying out training courses without the appropriate approval. The aim of the inspections was to establish which training courses were carried out without approval. The SRPA instructed the trainees to attend a training course and pass the exam again with an approved training provider.

Approved Dosimetry Services

Approved dosimetry services perform tasks related to the monitoring of individual exposures to ionising radiation. An approval can only be granted to legal entities that employ appropriate experts and have at their disposal appropriate measuring methods that meet the SIST EN ISO/IEC 17025 standard.

In 2018 no approvals for dosimetry services were issued.

Approved Medical Physics Experts

Approved medical physics experts provide advice on the optimisation, measurement, and evaluation of the irradiation of patients, the development, planning, and use of radiological procedures and equipment, and ensuring and verifying the quality of radiological procedures in medicine. Only natural persons can become approved medical physics experts.

In 2018 the SRPA authorised four medical physics experts. The granting of such approval was based on the opinion of a special commission that assessed whether the candidates fulfilled the requirements.

Approved Medical Practitioners

Approved medical practitioners carry out the medical monitoring of exposed workers. An approval is issued by the Minister of Health on the recommendation of the SRPA and the Expanded Professional Collegium of Occupational Medicine.

In 2018 the SRPA prepared two opinions with regard to fulfilment of the requirements for carrying out the medical monitoring of exposed workers.

Approved radon measurement institutions

The IRPNSA-1 and the Decree on the National Radon Programme Regulation (Offical Gazette RS, No. 18/18) define a special approval for institutions carrying out the governmental Programme of Systematic Examination and Measurement of Radon. The requirements for obtaining an approval are defined in more detail in the Rules on approving experts performing professional tasks in the field of ionising radiation (Offical Gazette RS, No. 39/18). In 2018 the SRPA issued one approval to institutions performing radon measurements.

7.7 The Nuclear Insurance and Reinsurance Pool

The Nuclear Insurance and Reinsurance Pool (hereinafter: the Nuclear Pool GIZ) insures and reinsures against nuclear threats. It has been operating since 1994, when eight members (insurance and reinsurance companies based in the Republic of Slovenia) signed a treaty establishing the Nuclear Pool GIZ.

In 2018 the following members had the largest shares: the Insurance Company Triglav, d. d.; the Reinsurance Company Sava, d. d.; and the Reinsurance Company Triglav Re, d. d.

The Nuclear Pool GIZ insures domestic nuclear facilities and reinsures foreign nuclear installations within the capacity and shares provided by the Pool's members for each year.

The liability of the operator of a nuclear facility is insured in accordance with the applicable Liability for Nuclear Damage Act, which entered into force on 4 April 2011. According to this policy, the Nuclear Pool GIZ insures damages as prescribed in the Act and thereby ensures the payment of victims in the event of a nuclear accident; the costs, interest, and expenses that the policyholder is obliged to compensate the plaintiff in respect of a nuclear incident are also covered. The insurance covers the legal liability arising from the operator's activities and its possession of the property if the damage is caused by an accident at the NPP during the period of insurance. In 2017 the Protocol to the Paris Convention (on Third Party Liability in the Field of Nuclear Energy), to which the Republic of Slovenia is a signatory, had still not entered into force. This Protocol will bring significantly higher liability limits and a greater range of damages for which the operator of a nuclear installation is liable, and which must be covered by insurance.

The Nuclear Insurance and Reinsurance Pool participates in third-party liability insurance risk up to its capacity level, while the rest of the risk is reinsured by foreign pools.

8 NON-PROLIFERATION AND NUCLEAR SECURITY

8.1 The Treaty on the Non-Proliferation of Nuclear Weapons

The Treaty on the Non-Proliferation of Nuclear Weapons (hereinafter: NPT) was signed in 1968 and entered into force two years later in 1970. The NPT has three well recognised pillars, namely nuclear disarmament, non-proliferation, and the peaceful use of nuclear energy. The goals of the NPT are to curb the further proliferation of nuclear weapons, to provide security to those countries that have decided not to pursue nuclear weapon capabilities, to ensure conditions for the peaceful use of nuclear energy, as well as to encourage further negotiations that would pave the way for the elimination of nuclear weapons in the future.

The international community has devoted attention to upholding nuclear non-proliferation. The Slovenian stance on the subject is aligned with the EU position, and all three "pillars" of the NPT are considered; furthermore, the Middle East as a Weapons of Mass Destruction Free Zone is important, together with the early entry into force of the CTBT, and the universality of the NPT. The next important conference will undoubtedly be the 10th RevCon – NPT Review Conference in 2020, together with three standard-format meetings in 2017, 2018, and 2019 – i.e. NPT PrepCom - Preparatory Committees). A half of century has passed since the signing of the NPT. The second NPT PrepCom meeting took place from 23 April to 4 May 2018 (in Vienna). The European Union prepared several cluster-based statements which presented the common views of its Member States – also those of Slovenia. At the same time, Slovenian representatives – during the second session of the NPT PrepCom meeting – underscored, *inter alia*, the importance of nuclear non-proliferation and disarmament, both international treaties (NPT, CTBT), and the important role of the IAEA; furthermore, the area of nuclear security was addressed, together with the noteworthy United Nations Security Council Resolution 1540 (2004) and endeavours aiming to achieve a successful NPT RevCon in 2020. The Ministry of Foreign Affairs in particular, as well as SNSA to certain extent, will be following NPT-related themes.

8.2 The Comprehensive Nuclear Test Ban Treaty

The Comprehensive Nuclear Test-Ban Treaty (CTBT) forbids all nuclear weapons-related tests. The CTBT Organisation (CTBTO) has been setting up a global supervisory system, based upon numerous monitoring stations, which transmits (via communication satellites) the data thereof into a special data centre. Slovenia signed the treaty in 1996 and ratified it in 1999. Currently, there are 184 states that have signed the treaty, 167 of which have also ratified it. In addition to the detection of nuclear tests, monitoring stations can also be used for other civil purposes, e.g. in order to detect tsunamis. The pivotal challenge of the CTBTO and its long-standing Executive Secretary, Lassina Zerbo, is that the CTBT has yet to enter into force. This will change only after it is ratified by the remaining 8 out of 44 countries listed in Annex II of the Treaty (i.e. Egypt, India, Iran, Israel, China, Pakistan, North Korea, and the USA). Despite its non-universality, the CTBT has positively contributed to a decrease in the number of nuclear tests.

Slovenia has co-operated bilaterally and, in the framework of international meetings, actively promoted the importance of the CTBT and its entry into force, and called upon the remaining countries to do so as soon as possible. It is only by this path that the CTBT's objective will be reached, i.e. a total ban on nuclear tests. Mr Lassina Zerbo has visited Slovenia several times in the past (the last time in 2017) and participated in meetings, e.g. in the Bled Strategic Forum (BSF).

In 2018, fortunately, no "unusual seismic events" or nuclear tests (assessed as having a human cause or due to an explosion) took place in the world.

8.3 Nuclear Safeguards in Slovenia

At the international level, nuclear safeguards are regulated by the Treaty on the Non-Proliferation of Nuclear Weapons and the Treaty Establishing the European Atomic Energy Community. Slovenia's legal framework had to be adapted in the process of accession to the EU. Slovenia completely fulfils its obligations regarding nuclear safeguards.

In Slovenia, all nuclear material, namely the fresh and spent fuel at the Krško NPP, at the TRIGA Research Reactor, at the Central Storage for Radioactive Waste in Brinje, and at the other holders of small quantities of nuclear material, is subject to international inspection.

All holders of nuclear material are obliged to report directly to the European Commission (EURATOM) regarding the quantities and status of their nuclear materials. Copies of reports are sent to the SNSA, which maintains a registry of nuclear material.

There were eight IAEA/EURATOM inspections in Slovenia in 2018 (three out of them were conducted independently by EURATOM). The SNSA's staff participated in the majority of these international inspections, which took place at three nuclear facilities. There were no international inspections in 2018 held on the premises of any of the domestic small holders of nuclear material., In 2018, one international inspection at the Krško NPP was conducted based upon the requirements under the Additional Protocol.

8.4 Export Control of Dual-use Goods

The SNSA, together with the Ministry of Foreign Affairs, monitors the activities of the Nuclear Suppliers Group (NSG) and the Zangger Committee. The mission of both associations is to prevent the export of dual-use goods, i.e. goods that might be used to manufacture nuclear weapons, to those countries that wish to acquire such weapons. The annual Plenary Week of the NSG was held in Jūrmala (Latvia) in June 2018.

On the basis of the Act on Export Controls of Dual-Use Goods, a special Commission for the Export Control of Dual-Use Goods ("KNIBDR") has been functioning at the Ministry of Economic Development and Technology. Dual-use goods are goods that can be used not only for civil but also for military purposes (including nuclear weapons and other weapons of mass destruction). An exporter of dual-use goods must obtain a permit from the Ministry of Economic Development and Technology, which is issued on the basis of the Commission's opinion. In 2016 the Commission had nine regular and 13 correspondence sessions. The role of the SNSA in the Commission is primarily related to the export of goods that might be used in the production of nuclear weapons or nuclear dual-use items. In 2018, the Slovenian Government endorsed the Annual Report (covering 2017) of the above-mentioned Commission.

At the beginning of September 2018, an outreach event took place in Ljubljana and Koper – and the counterparts were the Montenegrin officers responsible for dealing with the export control of sensitive goods. Slovenian activities were co-ordinated by the Ministry of Foreign Affairs, and this activity was spread under the patronage of the US »EXBS program« (»Export Control and Related Border Security Program«).

8.5 Physical Protection of Nuclear Material and Facilities

The operators of nuclear facilities and carriers of nuclear material implemented physical protection measures in accordance with their plans regarding physical protection approved by the Ministry of the Interior.

The role of the Commission on the Physical Protection of Nuclear Facilities and Nuclear and Radioactive Material (hereinafter: the Commission) is to monitor and harmonise different tasks in the sphere of physical protection. The Commission provides its opinions on the threat assessment of nuclear facilities and nuclear and radioactive material, monitors and coordinates the implementation of measures for the physical protection of nuclear facilities and nuclear and radioactive material, makes suggestions to improve these measures, and makes proposals in the drafting of legislation in the area of physical protection.

In 2018, two regular sessions of the Commission were held. The Commission considered proposals regarding the threat assessment for Slovenian nuclear facilities, and the future disposal of low- and intermediate-level radioactive waste (Vrbina) – all considered for 2017.

The Ministry of the Interior issued two decisions (approvals) regarding physical protection plans, namely for the Central Storage of Low- and Intermediate-level Radioactive Waste at Brinje ("CSRW") and for the Krško NPP.

The Inspectorate of the Ministry of the Interior did not plan or carry out any inspections/supervisions of domestic nuclear facilities in 2018.

In the scope of the General Police Directorate, a threat assessment of the transport of nuclear fuel (intended for 2019, from the Port of Koper to the Krško NPP) was completed. At the beginning of 2018, the Police escorted a transport of nuclear fuel (from the Port of Koper to the Krško NPP).

During 2018, no cases of a real threat to any domestic nuclear facilities were considered by the Police; there were no such events connected directly to the security of the nuclear facilities. No information was collected regarding criminal groups or individuals threatening the security of nuclear facilities or persons who might attempt to access radioactive material in an unauthorised manner.

In December 2018, a representative from the Ministry of the Interior participated in a meeting of the points of contacts of the convention (CPPNM/A). The Slovenian point of contact was also subsequently nominated.

The Ministry of the Interior was also involved in the process of collecting and preparing some changes to Article 155 of the "Nuclear Act" (involving "background checks" or "security vetting").

8.6 Illicit trafficking in nuclear and radioactive materials

A new Radioactivity Monitoring Regulation (JV 10) was adopted in March 2018. It also sets out the conditions for obtaining a license for providers of radioactivity measurements of shipments of secondary raw metal materials. Under these new rules, the validity of authorisation was extended from the previous two to a maximum of five years. In 2018, there were a total of 22 authorised providers of radioactivity measurements of shipments of secondary raw metal materials.

In 2018, the SNSA issued 11 approvals for providers of radioactivity measurements of shipments of secondary raw metal materials. Out of a total of 22 measurement providers, 21 submitted an annual report. These reports show that in Slovenia 75,965 measurements of shipments of scrap metal were made in the year 2018. Increased radiation was detected by two measurement providers in a total of five shipments.

In order to provide assistance and consulting to other authorities, as well as to collectors and processors of scrap raw metal materials, permanent preparedness has been established at the SNSA. In 2018, the SNSA dealt with a total of 8 interventions. In most cases, an elevated dose was detected during the transport of waste raw metal materials over the territory of Slovenia. For more information on interventions, see Chapter 2.2.2.

The SNSA regularly receives and to a certain extent analyses information on incidents and trafficking cases in foreign countries. The SNSA disseminates this information appropriately to other Slovenian stakeholders whose scope of responsibilities also includes (combating) illicit trafficking in nuclear and other radioactive material. In 2018, Slovenia (the SNSA) did not report to the IAEA "Incident and Trafficking Database" (ITDB). Already in December 2015, the SNSA began its e-reporting to the IAEA ITDB, using the NUSEC platform (this reporting method was also modernised in 2017). The SNSA's representative (i.e. point of contact) took part in the triennial meeting regarding the ITDB Programme, which was held in Vienna in May 2018. The IAEA has put substantial efforts into promoting the ITDB and membership has risen to 136 participating states. The periodic (plenary type) meeting resulted in a string of valuable national presentations and the exchange of good practices – which will be considered and applied by those states that are not so mature in this respect. The IAEA thoughtfully collates and analyses the reports from the Member States and issues periodic analyses.

In October 2018, representatives from the SNSA, the Customs Administration, the Market Inspectorate, the Ministry of the Interior, as well as mail/airport organisations (i.e. Pošta Slovenije, d. o. o., and Aerodrom Ljubljana, d.d.) met and reviewed the current situation in the area of illicit trafficking in nuclear and other radioactive material. The core issues of discussion were foreign good practices and the improvement of current detection capabilities at the major Slovenian nodal points.

8.7 Achieving the Goals under the Resolution on Nuclear and Radiation Safety

Goal 6

As Slovenia does not have any intention to pursue non-peaceful use of nuclear energy, it is firmly bound by the NPT and fully respects its obligations; Slovenia is entirely open to international inspection control of the nuclear material on its territory ("safeguards").

Slovenia has been co-operating with international organisations in the sphere of nuclear non-proliferation and dual-use items; Slovenia in particular tries to fulfil its obligations with regard to reporting, export control of dual-use items, and – based upon its financial capabilities – contributes to global efforts to prevent the proliferation of nuclear weapons.

Realisation in 2018

Slovenia is committed to its obligations regarding safeguards, follows international inspections in this regard, fulfils the requirements regarding reporting events to international databases and associations, and follows discussions in the area of dual-use goods, nuclear security, and nuclear terrorism. Based upon its human and financial resources as well as its priorities, Slovenia contributes to the global endeavours towards nuclear non-proliferation and nuclear security. As can be seen from the previous chapters, Slovenia has achieved the set goal.

Goal 4:

With regard to the part related to the international advisory missions in the area of nuclear security, the Republic of Slovenia will encourage the future involvement of its experts in expert engagements abroad. The Ministry of the Interior has invited, within a time frame of ten years, the international advisory mission "IPPAS" (International Physical Protection Advisory Service) to review domestic measures in the area of the physical protection of nuclear facilities and activities.

Realisation in 2018

The Slovenian experts (more as an exception) did not participate in any foreign IAEA IPPAS missions in 2018. The IAEA has also established a mechanism for future "IPPAS peer reviewers".

No special activities took place in 2018 – within the 10-year goal and cycle of such missions in Slovenia. This matter is to be pursued more actively in the next few years.

9 INTERNATIONAL COOPERATION

9.1 Cooperation with the European Union

Working Party on Atomic Questions (WPAQ)

In the first half of 2018, the WPAQ was presided over by Bulgaria. During this period the WPAQ discussed legislative proposals of two regulations regarding financial assistance for decommissioning nuclear facilities in Bulgaria, Slovakia, and Lithuania and the management of radioactive waste. The preparations for the sixth review meeting under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management were discussed and the Working Party also became acquainted with current issues such as the operation of the Instrument for Nuclear Safety Cooperation (INSC), the investigation of causes of the increased atmospheric levels of Ruthenium-106 in the autumn of 2017, as well as information regarding the meetings of the ENSREG group and of the IAEA Board of Governors. Austria assumed the presidency of the WPAQ in the second half of 2018. The delegates continued their discussions on legislative proposals regarding the financing of decommissioning and also dealt with the ENSREG Topical Peer Review results, the stress tests in Belarus, the preparation of joint positions for the organisational meeting under the Convention on Nuclear Safety and preparations for the first review meeting under the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities.

The High-level Group on Nuclear Safety and Waste Management (ENSREG)

The High-level Group on Nuclear Safety and Waste Management (ENSREG) is an independent expert body established in 2007 by a decision of the European Commission. It consists of prominent representatives of the regulatory bodies responsible for nuclear safety, radiation protection, and the safety of radioactive waste from all 28 Member States of the European Union. Representatives of the European Commission collaborate in the group on an equal basis. The role of ENSREG is to help establish conditions for continuous improvement and to reach a common understanding in the areas of nuclear safety and radioactive waste management.

In 2018 the topical peer review (TPR) on the ageing management of nuclear power plants and research reactors was performed under auspices of ENSREG and a joint report on this review was published in October. ENSREG also dealt with the Belarus stress tests report and adopted its own work programme for the following two years with an emphasis on the performance and conclusion of national action plans and on the promotion of transparency. The Slovenian representatives also participated in ENSREG's working groups, namely in Working Group 1 on Nuclear Safety and Working Group 2 on Waste Management and Decommissioning.

Consultative Committees under the Euratom treaty

Within the framework of the Treaty on European Union, which is a part of the Community acquis, at present several technical and consultative committees are active. The SNSA complies with its obligations in three committees: the Committee under Article 31 of the Treaty, the Committee under Article 35, and the Committee under Article 37.

The Committee under Article 31 makes recommendations to the European Commission related to radiation protection and public health. Slovenia also participated in the Working Party on Natural Sources on Ionising Radiation and in the Working Party on Research Implications on Health and Safety Standards. In 2018 the majority of the Committee's work was focused on the implementation of the provisions of the Euratom Basic Safety Standards (BSS) Directive; for that purpose, the Working Party on Natural Sources on Ionising Radiation prepared a document regarding the presence of radon in workplaces. The Committee also discussed the need for higher coordination of national emergency preparedness measures and became acquainted with the SAMIRA Project (*Strategic Agenda for Medical, Industrial and Research Applications of Nuclear and Radiation Technology*), which studies the use of radioisotopes in medicine, industry and research.

The work of the Committee under Article 35 relates to the provisions of the Euratom Treaty that require EU Member States to set up a system in their territory for measuring radioactivity in the environment (Article 35) and to report the results thereof regularly to the European Commission. The Commission has the right to verify whether such a system is established and whether it complies with the established requirements (Article 36). There was one committee meeting in 2018, in which the Slovenian representatives did not take part.

The Consultative Committee under Article 37 has correspondence meetings, as needed, wherein the European Commission provides its opinion on major reconstruction or the construction of new nuclear installations.

Reports under the radioactive waste management directive

In 2018 all EU Member States were required to submit reports to the European Commission regarding the implementation of Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. The second Slovenian national report was prepared; it describes the means of implementing each article of the Directive by license holders and the regulatory authority. The report was delivered to the European Commission in August 2018.

9.1.1 Cooperation in EU Projects

In the project "*Enhancing the Capacity and Effectiveness of the Thai Regulatory Body and Developing a National Waste Management Strategy*", the SNSA cooperates in a consortium consisting of the company Enconet from Austria and two Belgian companies, BEL-V and IRE-Elit. Most of the tasks and responsibilities in relation to the beneficiary were concluded in 2017. The remaining activities in 2018 were related to the preparation of mandatory reports in order to fulfil the obligations towards the contracting authority, i.e. the European Commission.

In the project "*Training and Tutoring for Nuclear Safety Regulatory Bodies' Experts and their Technical Support Organisations and Technical Competences*", the SNSA cooperates with a consortium led by the Italian company ITER. The SNSA provides mentoring and takes part in implementing training courses for the personnel of nuclear and radiation safety regulatory bodies from partner countries. In October 2018 the SNSA's experts participated in a course on the evaluation of safety, licensing and regulatory oversight of research reactors. After the course, two participants received practical training at the SNSA in the fields of the regulator's role in the licensing and oversight of research reactors. The project will be concluded in 2019.

The SNSA and the SRPA are jointly participating in the three-year project "*Further Enhancement of the Technical Capacity of the Nuclear Regulatory Bodies of the West Balkans*" within the Instrument for Pre-Accession. The purpose of the project is to stimulate the transposition of the EU acquis into the national legislation of the beneficiary countries and to bring the capabilities of their regulatory authorities to a level comparable to related institutions in the EU. The SNSA and the SRPA participated mainly in activities relating to the transposition of the EU acquis. The SNSA also participated in the following activities: the elaboration of the operating procedures for the regulatory authority, staff education, and the elaboration of the strategy and management system. The SRPA participated in the development of the quality assurance and verification system for the use of ionising sources in medicine. All activities in the beneficiary countries were concluded by June 2018. The remaining activities included the preparation of task reports, the coordination of report contents with the beneficiaries and within the consortium, and the preparation of the final report.

Since 2017 the SNSA has also been participating in the European Commission's project for "*Enhancing the Capabilities of the Iranian Nuclear Regulatory Authority and supporting the implementation of the stress tests at the Busher Nuclear Power Plant*", performed within the INSC – Instrument for Nuclear Safety Cooperation. The objective of this project is to assist the Iranian nuclear and radiation safety regulatory body in improving the knowledge and expertise of its staff, modernising its administrative infrastructure, which is to become aligned with international standards as much as possible, and in transfering the Western nuclear regulatory methodology, to the extent possible, to the Iranian regulatory authority. The SNSA participates in a consortium consisting of nuclear safety regulatory bodies from the Czech Republic, Slovakia, and Hungary, while the Austrian company ENCO is the consortium leader. In 2018 the SNSA finished its draft feasibility study on the future Iranian nuclear safety centre, which will provide technical support to the regulatory authority. The final project meeting is planned for 2020.

In 2018 the consortium participating in the so-called first Iranian project described above was also selected to work on the second Iranian project, i.e. "*Support to the Iranian Nuclear Regulatory Authority – INRA*". For this project, the consortium has been reinforced by the German company TÜV Nord. The assignments of the SNSA include the further development of the management system for the Iranian regulatory authority, which should soon be supported by the nuclear safety centre drafted by the SNSA within the first Iranian assistance project. The SNSA will also organise visits to Slovenia for the practical training of Iranian nuclear regulatory authority staff. The kick-off project meeting took place in November 2018. The project will be carried out for 42 months; therefore, the majority of its tasks will be performed between 2019 and 2021. The final meeting is planned in autumn 2021.

Since 2014 the SRPA has been participating in the *ENATRAP III* project, which is aimed at harmonising radiation protection training and the mutual recognition of the qualifications of skilled workers and experts at the EU level. Slovenia joined the project as a test country in the field of the mutual recognition of the qualifications of skilled radiation safety workers and experts. In 2018 the project was successfully finished. Slovenia already transposed the articles of Directive 2013/59/Euratom regarding the recognition of skilled radiation safety workers and experts, which sets the foundations for mutual recognition among other Member States. The SRPA representative also participated in the final project meeting.

9.2 The International Atomic Energy Agency

Slovenia successfully continued its cooperation with the International Atomic Energy Agency (IAEA). During the 60th Session of the General Conference of the IAEA, Slovenia became a member of the Board of Governors for the period 2016 – 2018. In September 2018, its membership on the Board of Governors expired. As it does every year, in September the Slovenian delegation attended the regular annual session of the General Conference. In 2018 the Republic of Slovenia settled all of its financial obligations towards the IAEA.

Slovenia closely cooperated with the IAEA in these areas:

In 2018, Slovenia received 38 requests for the individual training of foreign experts. 28 of these training requests were implemented, along with five such requests received in 2017.

The Jožef Stefan Institute, the Institute of Oncology Ljubljana, the Department of Neurology, the Institute of Biomedical Informatics of the University of Ljubljana, and the Institute of Civil Engineering actively participated in coordinated research projects. They were involved in seven research projects, which had already been launched in 2015 or earlier. Two coordinated research projects were successfully completed in 2018.

In 2018, two new national projects began: the joint national project of the Institute of Oncology Ljubljana and the Department of Nuclear Medicine SLO/6/006 »*Improving the Safety and Quality of Radiology Services through the Development of the Medical Physics Department and Enhancing the Theranostic Nuclear Medicine Approach*« and the joint national project of the SNSA and ARAO SLO/9/019 »*Supporting the Regulatory Authority and the Implementing Organisation in the Enhancement of Nuclear Safety and the Implementing Organisation*«.

The national project of the Biotechnical Faculty entitled SLO/5/004 »*Improving Water Quality in Vulnerable and Shallow Aquifers under Two Intensive Fruit and Vegetable Production Zones*« was launched in the second half of 2018. Originally the project was approved as a so-called footnote, i.e. a project seeking finances from sources other than the IAEA. However, during the year the financial situation of the IAEA changed, consequently the status of the project changed and it turned into a project financed from the regular Technical Cooperation Fund.

In 2018, the activities pending within the framework of the national project of the ARAO SLO/9/017 »*Supporting Radioactive Waste Management Activities for the Implementing Organisation*« and the national project of the SNSA SLO/9/018 »*Enhancing the Regulatory Oversight of the Slovenian Nuclear Safety Administration*« were completed, even though the projects had already been closed in 2017.

In 2018 Slovenia organised one national and two regional workshops and an international meeting of the IAEA.

The participation of Slovenian specialists and their involvement as experts in various IAEA committees, missions and workshops abroad are important as well.

The SRPA collaborates in the Radiation Safety Standards Committee (RASSC). The RASSC is one of the four committees responsible for issuing IAEA international standards. Standards are developed by the IAEA Secretariat with the assistance of the Member States. The RASSC convenes twice a year and considers standards in various stages of preparation. In 2018, a representative of the SRPA attended the autumn meeting.

In 2018, the IAEA launched two projects related to the use of ionising radiation in health, in which the SRPA also collaborates. The first project »*Applying Best Practices for Quality and Safety in Diagnostic Radiology*« aims to improve the level of quality and safety in diagnostic radiology. The project focuses primarily on technical aspects of quality assurance and quality control, as well as the training of key practitioners, i.e. medical physicists, radiological engineers and radiologists. Within this project a radiologist (MD) attended a training course on the application of referral criteria entitled »*Training Course for Radiologists on Applying Justification and Referral Guidelines for Imaging*«. The second project »*Enhancing Member States' Capabilities for Ensuring Radiation Protection of Individuals Undergoing Medical Exposure*« is aimed at improving the radiation protection system in the medical use of ionising radiation, with an emphasis on strengthening the cooperation among competent administrative bodies and professional associations and the application of international safety standards on radiation protection.

The project is divided into several thematic areas, with Slovenia focusing primarily on the following fields:

- optimisation with an emphasis on the development of diagnostic reference levels for CT examinations of paediatrics patients;
- the development and implementation of referral guidelines for radiological examinations;
- the improvement of emergency reporting systems in radiotherapy and the introduction of an emergency reporting system in radiological procedures with the exposure of patients to high doses.

Under this project, two training courses were held in 2018 in Slovenia. Participation in these projects enables not only the involvement of selected radiologists, physicians, medical physicists and employees of the competent regulatory body in professional training courses and workshops organised and financed by the IAEA, but also access to expertise, guidelines and the relevant IAEA documents enabling faster and more efficient implementation of set tasks.

In 2018, the IAEA regional project providing assistance to the countries of Eastern Europe and the countries of the former Soviet Union in the implementation of national radon programmes, as well as surveillance and raising awareness of the risks of radon in the living and working environment continued. The SRPA is responsible for coordinating participation in workshops, training courses and other meetings in this field.

9.3 The Nuclear Energy Agency (NEA) of the OECD

The NEA is a specialised agency within the Organisation for Economic Co-operation and Development, which celebrated its 60th anniversary in 2018. The purpose of the agency is to assist its member states in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for safe, environmentally sound and economical use of nuclear energy for peaceful purposes. Slovenia has been a full member of the NEA since 2011.

In 2018 the Slovenian representatives participated in six standing committees as well as in several working groups within the committees. The Steering Committee, which is the governing body of the NEA and oversees the work of the standing committees, held two regular meetings. During the Radioactive Waste Management Committee meeting the Regulators' Forum was also organised. The Committee on the Safety of Nuclear Installations held two regular meetings; Slovenian representatives also participated in the Working Group on the Analysis and Management of Accidents and in the Working Group on Electrical Power Systems. Slovenian delegates also participated in the meetings of the Committee on Nuclear Regulatory Activities and its Working Group on Inspection Practices and the Working Group on Operating Experiences. The Slovenian representatives actively participated in the work of the NEA Steering Committee and the standing committees, particularly in the fields of regulatory authority activities, the safety of nuclear installations, radiation protection, radioactive waste and spent fuel management, nuclear law and research. In 2018 two meetings of the Nuclear Law Committee were held, during which the meetings of the Contracting Parties to the Paris Convention were also organised by the NEA Secretariat regarding enforcement of the Convention; for more information, see Chapter 7.2. The Slovenian participant in the Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle participated in one meeting, while the representatives of the Committee on Radiological Protection and Public Health, the Nuclear Science Committee, and the newly established Committee on the Decommissioning of Nuclear Installations and Legacy Management did not attend the meetings.

Slovenia is also participating in the management committee of the NEA Data Bank, which provides access to a great deal of information and scientific data, and in the *International System on Occupational Exposure (ISOE)*. The NEA is carrying on with the development of the *Nuclear Education, Skills and Technology Framework (NEST)*, which is focused on attracting young, highly-educated professionals to work in nuclear science and industry. Knowledge preservation and management of the aging workforce are among the priorities of the Agency's future strategic development.

The ISOE, in which Slovenia also participates, is an information system on occupational exposure to ionising radiation in nuclear power plants and is supported by the OECD/NEA and the IAEA. The information system is maintained by technical centres with the support of the above-mentioned international organisations and with the cooperation of nuclear power plants and national regulatory authorities. The representative from the SRPA participated in the regular ISOE committee meeting in 2018 and presented reports on the regular outage of the Krško NPP and on the transposition of Directive 2013/59/Euratom regulations into Slovenian legislation.

9.4 Cooperation with Other Associations

The Western European Nuclear Regulators Association (WENRA)

The Western European Nuclear Regulators Association (WENRA) is an informal association consisting of representatives of nuclear regulatory authorities from European countries with nuclear power plants. The main objective of WENRA is to develop a common approach to nuclear safety, the provision of independent reviews of nuclear safety in the candidate countries for accession to the EU, and the exchange of experiences in the field of nuclear safety. The Association consists of eighteen member states and thirteen observers, also including non-European states.

The 2018 plenary meetings were hosted by Gent, Belgium and Schaffhausen, Switzerland. The participants discussed the future strategic plans, the possible membership of South Korea, Brazil an Iran as observer states, as well as relevant nuclear safety events. Slovenia suggested a new working topic, namely the elaboration of reference cyber security frameworks. The Slovenian representatives also actively participated in WENRA working groups, namely the Reactor Harmonisation Working Group and the Working Group on Waste and Decommissioning.

The International Nuclear Law Association (INLA)

The International Nuclear Law Association (INLA) is an international association of legal and other experts in the field of the peaceful use of nuclear energy whose main objectives are to support and promote the knowledge and development of legal issues and research related to this field, the exchange of information among its members, and cooperation with similar associations and institutions. The INLA has approximately 600 members from more than 60 countries and international organisations.

The INLA operates in seven working groups: Security and Regulations; Liability for Nuclear Damage and Insurance; International Nuclear Trading/New Constructions; Radiation Safety; Waste Management; Nuclear Security; and Transport.

The INLA generally organises a congress every two years; the first one was organised in 1973 in Germany, the last one in 2018 in Abu Dhabi, amounting to 45 years of operation of this association. Exactly when and where the next congress will be held, in 2020, is not yet known. In 2005 the INLA congress was organised in Portorož, Slovenia.

ENSRA

The European Nuclear Security Regulators Association (ENSRA) is an association consisting of representatives of nuclear regulatory authorities that cover nuclear security. It was established in 2004. Slovenia joined the ENSRA in 2008. The main objectives of the ENSRA are to exchange information on nuclear security, current security issues and events regarding the development of a comprehensive understanding of the fundamental principles of physical protection, and to promote common security principles in Europe.

In October 2018, Sweden hosted the ENSRA plenary meeting. The main topics were the exchange of information on current security challenges, the exchange of information on legislation and the approaches of the members, cooperation with the IAEA and others, as well as the future activities of ENSRA working groups. In 2019, the ENSRA will be led by Finland and the next plenary meeting will be hosted by STUK.

NSCG – Nuclear Security Contact Group

The NSCG – the Nuclear Security Contact Group – is an association that was established after the 4th Nuclear Security Summit, held in 2016. The NSCG has also attracted a few countries that were not invited to the previous summits. Slovenia joined the NSCG in March 2017; this was a step forward in the framework of Slovenian activities in the nuclear security domain. The NSCG's members from Slovenia comprise representatives from the Ministry of Foreign Affairs and the SNSA. One of the most important topics within the NSCG are future activities in pursuing the amended Convention on Physical Protection of Nuclear Material (A-CPPNM).

A number of thematic areas have resulted from past summits and different groups of states have been set up to promote these endeavours. In September 2018, Slovenia (through the Ministry of Foreign Affairs) officially sent a letter (*note verbale*), stating that it would join two specific initiatives, i.e. INFCIRC/910 (the security of high activity radioactive sources) and INFCIRC/918 (countering nuclear smuggling).

EACA – the European Association of Competent Authorities

The EACA (the European Association of Competent Authorities) is an association that was established in 2008. It consists of regulatory authorities that are responsible for the safe transport of radioactive material. The prime goal of this group is to formulate a common approach to, as well as understanding of, the pertinent legislation in force in Europe. This has been tackled in various ways – particularly by developing a network of competent authorities for the safe transport of radioactive material, sharing knowledge and good practices amongst members, as well as through dedicated working groups and developing a common understanding and efficient co-operation among authorities as regards their working level. Since 2015, when Slovenia was an observer, and fully since 2017, Slovenia has taken part in the work of the EACA. In 2018, the annual meeting took place in Paris, France; the next meeting is to be held in Athens, Greece (in spring 2019). In the last couple of years the EACA has published several useful documents, which can be found on its public website.

Association of the Heads of the European Radiological Protection Competent Authorities (HERCA)

A representative of the SRPA is a member of the Association of the Heads of the European Radiological Protection Competent Authorities (HERCA) and participated in two regular meetings in 2018.

The SRPA also participates in the working group on medical applications. Apart from exchanging important information on the implementation of Directive 2013/59/Euratom, the other important working group activities in 2018 included the organisation of a workshop for nuclear medicine department inspectors, cooperation with radiological equipment manufacturers regarding the implementation of Article 78 of Directive 2013/59/Euratom, the harmonisation of dosimetry data output and preparations for the European action week on raising awareness among physicians regarding justification for ordering the performance of radiological procedures.

CAMP (NRC)

On the basis of an agreement with the US NRC (Nuclear Regulatory Commission of the United States), the SNSA cooperates in the CAMP (*Code Application and Maintenance Program*). CAMP enables cooperation in the maintenance and use of software in the field of the prevention and management of accidents and abnormal events at nuclear power plants.

The CAMP agreement provides access to computer programs that are developed under the programme. The latest versions of software tools are currently available to users.

For 2018, the Jozef Stefan Institute prepared an contribution entitled "*Semiscale S-NC-02 and S-NC-03 natural circulation tests performed by RELAP5 / MOD3.3 Patch 5*", which was peer reviewed and is awaiting publication.

Representatives of Slovenian organisations in CAMP met in June 2018 at a working meeting where the national coordinator of the programme detailed the latest developments in the CAMP research programme and its work and JSI activities in this area.

CSARP (NRC)

In 2015 Slovenia renewed cooperation in the US NRC severe accident research programme CSARP (*Cooperative Severe Accident Research Program*). The Slovenian CSARP members are the Slovenian Nuclear Safety Administration, the Krško NPP, and Jožef Stefan Institute as the Slovenian National Coordinator. Membership in the CSARP programme enables usage of the computer code MELCOR for the simulation of severe accidents in nuclear power plants.

The representatives of the Slovenian CSARP members had a business meeting in November 2018. The National Coordinator presented the status of CSARP research in Slovenia, current activities, attendance at the EMUG meeting, attendance at the MELCOR workshop and the CSARP/MCAP meeting, the research project "*Analysis of the influence of the Krško NPP safety upgrade on SAMG using the MELCOR 2.2 computer code*", as well as the realisation of plans. All planned activities were realised, as well as one research project.

The European ALARA Network

As one of 20 European countries, Slovenia participates in the European ALARA Network (EAN). The EAN is dedicated to optimising radiation protection and sharing good ALARA practices in industry, research, and medicine. In the framework of the EAN, international workshops on specific fields are organised. In addition, the EAN issues a newsletter on practical implementation of the ALARA principle, examples of good practices, and other news on radiation protection. The EAN plays an active role in studies conducted by the European Commission and other international organisations in the field of radiation protection. The network is also involved in other aspects of implementing the ALARA principle in practice. There are several sub-networks within the framework of the EAN. The SRPA is active in the ERPAN (the European Radiation Protection Authorities Network), which is dedicated to the exchange of operational information on surveillance and measures in radiation protection.

The European Study of Occupational Radiation Exposure (ESOREX)

Slovenia participates in the project »The European Study of Occupational Radiation Exposure« (ESOREX), which is aimed at collecting, processing and comparing on the international level data on ionising radiation doses received by exposed workers. Within this project, the participating states are also able to exchange experiences in the field of personal dosimetry organisation and the management of national dosimetry registers. The project used to be financed by the European Commission, but henceforth it is to be maintained solely by the participating states. In 2018 the SRPA representative attended a meeting organised by the French IRSN institute on the exchange of experiences and on the future prospects of the project.

9.5 Agreement on the co-ownership of the Krško Nuclear Power Plant

In 2002, Slovenia and Croatia mutually agreed on the ownership and operation of the Krško Nuclear Power Plant and concluded the Treaty between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on the regulation of the status and other legal relations regarding investment in and the exploitation and decommissioning of the

Krško Nuclear Plant (Official Gazette RS, No. 5/03 - International Treaties, hereinafter: Intergovernmental Treaty), which entered into force in March 2003. Under the Treaty, the responsibility for handling radioactive waste and spent fuel from the Krško Nuclear Power Plant is the task of both countries, as the parties agreed to ensure an effective joint solution for the decommissioning of the Krško Nuclear Power Plant and for the disposal of radioactive waste and spent fuel from the Krško Nuclear Power Plant. The Intergovernmental Treaty also stipulates that the Parties will seek solutions by agreement and jointly fund the same solutions in equal proportion. If the parties fail to reach a joint solution, each will, at its own expense, assume the obligation to provide for the final disposal of its part of the radioactive waste and spent fuel from the Krško Nuclear Power Plant produced by the operation and decommissioning thereof, either in its respective territory or in a third country.

Slovenia is aware of its responsibility regarding the management of radioactive waste and spent fuel from the Krško Nuclear Power Plant and, in accordance with the Intergovernmental Treaty, is seeking to ensure an effective mutual solution. Due to the small quantities of waste and small nuclear programme, a mutual solution would have many safety, economic and social benefits for both countries.

In order to monitor implementation of the Intergovernmental Treaty, the Parties established an Interstate Commission in accordance with Article 18 thereof. Each of the Parties has a president and four members on the Commission.

In 2018, the Government of the Republic of Slovenia re-appointed three members of the Slovenian delegation (Government Decision No. 36011-3/2018/3 of 15 November 2018) on the Interstate Commission.

Beside monitoring the implementation of the Intergovernmental Treaty, the Interstate Commission is responsible for confirming the Programme for Disposal of Low- and Intermediate-Level Radioactive Waste and Spent Fuel from the Krško Nuclear Power Plant (hereinafter: Programme for Disposal of LILW and SF) and the Programme for the Decommissioning of the Krško Nuclear Power Plant (hereinafter: Programme for the Decommissioning) and deals with outstanding issues related to mutual relations related to the Intergovernmental Treaty and is the key body for regulating relations between the Contracting Parties.

In accordance with the provisions of the Intergovernmental Treaty, in 2004 the first revision of the Programme for the Decommissioning and the Program for Disposal of LILW and SF was prepared and confirmed at the 7th Interstate Commission meeting in 2005. The Government of the Republic of Slovenia was acquainted with the decommissioning programme and adopted the relevant Decision No. 311-01 / 2001-21, and the same holds true regarding the Parliament of the Republic of Croatia (Official Gazette No. 175/04), which gave its prior consent to adoption.

Preparation of the second revision of the Programme for the Decommissioning and the Programme for Disposal of LILW and SF began after the 8th Interstate Commission meeting in 2008, which granted a mandate for the preparation of the documents to the Agency for Radioactive Waste from Slovenia and the Agency for Special Waste from Croatia. The first version of the documents was produced in June 2010 and the second version in February 2011. These documents were not considered or confirmed by the Interstate Commission. The Interstate Commission met again in July 2015 and took note of the status of the second revision of the Programme for the Decommissioning and the Programme for Disposal of LILW and SF. At this meeting the Interstate Commission decided to stop all activities for the preparation of these documents, on one hand, and to immediately begin activities for the preparation of the third revision of the Programme for the Decommissioning and the Programme for Disposal of LILW and SF, on the other.

The Interstate Commission instructed the expert organisations referred to in Article 10 of the Intergovernmental Treaty to prepare, together with the Krško Nuclear Power Plant, a project proposal for the preparation of a new revision of the Programme for Disposal of LILW and SF as well as for a new revision of the Programme for the Decommissioning within three months.

Pursuant to the decision of the Interstate Commission, the Parties have authorised each of their professional organisations (the Agency for Radioactive Waste of the Republic of Slovenia and the Fund for Financing the Decommissioning of the NPP of the Republic of Croatia) to prepare both programmes in accordance with the Intergovernmental Treaty.

Due to the fact that almost 15 years have passed since the approval of the Programme for the Decommissioning and the Programme for Disposal of LILW and SF and more than 10 years since the preparation of the second revision of both programmes, the 2004 documents no longer reflect the actual and current status of the plans for the future management of radioactive waste and spent fuel and the decommissioning of the Krško Nuclear Power Plant. Furthermore, due to several new and changed facts related to the operation of the Krško Nuclear Power Plant, the construction of facilities for the storage and disposal of radioactive waste and spent nuclear fuel, as well as changes in other boundary conditions, the new revision of both programmes should be carried out as soon as possible; preparation thereof began in 2018.

On 17 November 2017, the Interstate Commission set up a Coordinating Committee to monitor the implementation of the third revision of the Programme for the Decommissioning and the Programme for Disposal LILW and SF. In the year 2018 the Coordinating Committee met fourteen times and discussed the preparation of the third joint revision of both Programmes and the proposal for the solution of the joint disposal of low and intermediate level radioactive waste. At the end of 2018, the Coordinating Committee reported that the third joint audit of the two Programmes would be completed in the first quarter of 2019. Until this deadline, all costs of decommissioning the Krško Nuclear Power Plant and the costs of disposing of radioactive waste and spent fuel from the Krško Nuclear Power Plant should be optimised and the appropriate discount rate should be decided on. In this regard, all starting inputs should be checked at least every five years, and the level of the discount rate even more frequently.

The work of the representatives of the Republic of Slovenia in the Coordination Committee follows the implementation of the policy of radioactive waste management and the achievement of the objectives and principles established by the Resolution on the National Programme for the Management of Radioactive Waste and Spent Fuel for the Period 2016-2025.

In 2018, intensive preparations for the 12th session of the Interstate Commission, which was convened in January 2019 by the President of the Croatian delegation, were carried out.

9.6 Cooperation within the Framework of International Agreements

In May the regular annual meeting of the nuclear regulatory bodies of the Czech Republic, Hungary, Slovakia, and Slovenia, which all have bilateral agreements with each other, i.e. the so-called Quadrilateral Meeting, was hosted by the Hungarian regulatory authority. The main objective of such meetings is to inform each other of important developments in the field of nuclear safety. The participants presented and discussed new developments in the legislative and regulatory field, important issues regarding the surveillance of nuclear power plant operation, security, relevant operational events and international cooperation. The participants also received information regarding the status of the common project which all four regulatory authorities are participating in, i.e. providing assistance to the Iranian regulatory authority within the INSC – the Instrument for Nuclear Safety Cooperation.

The annual meeting between the representatives of Austria and Slovenia in accordance with the agreement on early notification and issues of common interest in the field of nuclear and radiological safety was hosted by Austria. The purpose of the meeting was to inform each other of major developments since the last meeting. The subjects of discussion were new developments regarding legislation, radiation monitoring, emergency preparedness, nuclear waste management, and important changes or events in the field of nuclear programmes. Slovenia reported on the adoption of the new nuclear safety law, on the conducted EPREV mission, the upgrade of the radiation monitoring equipment, the operation of and developments regarding the Krško NPP lifetime extension including the demands of non-governmental organisations for an elaboration of the environmental impact assessment. Austria reported on the development of its new framework radiation protection legislation, on the emergency event sampling plans, the reorganisation of its federal notification centre, and the construction of a new waste management facility.

In October the SNSA hosted the second bilateral meeting with the Italian regulatory authority in accordance with the agreement on the early exchange of information during a radiation emergency and cooperation in the field of nuclear safety. On the first day of the meeting the delegations presented new developments since the last meeting. The topics included new developments regarding legislation, news from the fields of nuclear safety and nuclear waste management, activities regarding emergency preparedness, as well as operational arrangements under the bilateral agreement. The Slovenian delegates reported on the safety upgrade programme in the Krško NPP and on the developments regarding the construction of the new spent fuel dry storage and the new storage facility for low- and intermediate-level waste. In Italy activities for the decommissioning of the existing nuclear facilities are in progress as well as preparations to carry out the construction of a new waste management facility. On the second day of the meeting the Italian delegation visited the Krško NPP, where the staff presented the plant operation, safety mechanisms, and planned extensions and improvements.

On 5 November a regular meeting in accordance with the bilateral agreement on the early exchange of information during a radiological emergency event was held in Zagreb. The topics of the meeting included new developments in the field of the jurisdiction of both regulatory authorities, the exchange of notifications and information during an emergency event, the application of the Euratom BSS directive in the areas of the registration and transport of radiation sources, the exchange of information on radiological monitoring and data from the early notification system, as well as cooperation in the field of public communication. Croatia announced the reorganisation of its regulatory authority; discussions were also held regarding the status of both national rescue and protection plans and progress on the harmonisation of the mutual agreement in the field of emergency preparedness and response to a nuclear or radiological emergency.

In November a Memorandum of Understanding between the SNSA and the Ministry of Emergency Situations of the Republic of Belarus on the exchange of information on nuclear and radiation safety matters was signed. The memorandum provides for cooperation and the exchange of information and experiences in the fields of nuclear and radiation safety, including surveillance of radioactive materials, environmental radiation monitoring, control of naturally occurring radioactive materials, radioactive waste treatment, the safety of nuclear facilities, emergency preparedness and response, the transport of radioactive materials and waste, education, information and legislation.

9.6.1 The Convention on Nuclear Safety (CNS)

The organisational meeting regarding preparations for the eighth review meeting of the contracting parties to the Convention on Nuclear Safety (hereinafter: the Convention) was held on 17 October 2018 in Vienna. During the meeting the review meeting groups were formed by lot. Slovenia will be working in Group 2 together with the following nuclear countries: France, Spain, the Czech Republic, the Netherlands, and Belarus (not yet a nuclear country, however it has two facilities under construction) and the following non-nuclear countries: Libya, Niger, Portugal, Syria, Australia and Cuba.

The officials for the eighth review meeting were also selected. Ms Dana Drabova, the chairwoman of the Czech regulatory authority, was unanimously elected to chair the meeting. The vice chairs will be Mr Carl-Magnus Larsson from Australia and Mr Manwoong Kim from South Korea.

The vice chair of the previous meeting, Mr Georg Schwartz from the Swiss regulatory authority, presented the report on the experience of the CNS officials. Mr Greg Rzentkowski, from the IAEA, presented an overview of the IAEA documents contributing to the implementation of the CNS, and introduced various documents related to the basic safety standards in order to formulate conditions, including the Design Extension Conditions and sequence eliminations leading to large early emissions.

Two topics for the topical session were also suggested and adopted, namely NPP aging management and safety culture.

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

In Slovenia, the Joint Convention applies to the safety of spent fuel management in the Krško NPP and at the IJS Reactor Infrastructure Centre, as well as to the safety of the operational waste at the Krško NPP, the safety of the waste from the decommissioning of the Žirovski Vrh Uranium Mine and the safety of the waste from small producers stored at the CSRW in Brinje. The Review Meetings of the contracting parties take place every three years in Vienna. At the end of 2018, the Joint Convention was in effect in 80 countries, including Slovenia.

The Sixth Review Meeting took place from 21 May to 1 June 2018. A total of 69 delegations of contracting parties to the Joint Convention attended. The review process was organised in the form of plenary sessions and country group sessions. During the first week, the majority of the contracting parties also participated in the open-ended country group sessions that took place after the country group sessions. Slovenia participated in country group 4 together with the United Kingdom, Belgium, Italy, Senegal, Austria, Denmark, Ireland, Serbia and Malta.

The National Report was prepared in 2017 by the Slovenian Nuclear Safety Administration, with contributions from the Slovenian Radiation Protection Administration, the Krško NPP, the Jožef Stefan Institute, the Agency for Radwaste Management, the Žirovski Vrh Mine d. o. o., the Institute of Oncology, and the Clinic for Nuclear Medicine at the Ljubljana University Medical Centre. The report and the presentation were well accepted.

Slovenia was asked to report at the Seventh Review Meeting, scheduled for May 2021, on the licensing, construction, and operation of the LILW repository and the spent nuclear fuel dry storage, the long-term management of the Boršt former uranium mine site, including the achievement of an acceptable licence for closure, and on the resolution with Croatia regarding the decommissioning of the NPP, the disposal of radioactive waste, and the management of spent fuel.

9.7 Achieving the Goals of the Resolution on Nuclear and Radiation Safety

Slovenia successfully and rationally strives to achieve the goals set out in the Resolution.

Goal 2

In principle, the Republic of Slovenia joins international conventions, agreements, contracts, or other modes of cooperation enabling the fast and equitable exchange of information and mutual assistance in ensuring nuclear and radiation safety and reducing risks to humans and the environment both in the territory of the Republic of Slovenia as well as elsewhere.

Goal Implementation in 2018

The Slovenian authorities and other organisations in the field of nuclear and radiation safety and physical protection were actively involved in international associations in line with the needs and benefits of membership in organisations such as the WENRA, ENSRA, HERCA, and CAMP, as well as in their working groups. Cooperation in the framework of bilateral agreements was conducted as planned. Slovenia has fulfilled all its obligations. Besides the activities of state institutions described in this chapter, entities such as operators of nuclear installations and other expert and research organisations actively take part in international cooperation.

Goal 3

The Republic of Slovenia will continue to actively participate in all activities within the EU where its presence is mandatory and where Slovenia can meet its specific long-term interests.

Goal Implementation in 2018

The Republic of Slovenia was active in the Working Party on Atomic Questions of the Council of the EU in the group established by Articles 31, 35 and 36 of the Euratom Treaty, and followed the work of the group established by Article 37 of the Euratom Treaty. The Slovenian representatives attended and actively participated in ENSREG meetings. They also cooperated in the implementation of assistance to third countries, which is supported by the European Commission; in 2017 and 2018 the SNSA began to participate in two projects for providing support to the Iranian Nuclear Regulatory Authority. Slovenia participated in the consultative committee of the research programme Euratom-Fission and monitored the work of the *Instrument for Nuclear Safety Cooperation* committee.

Goal 4

The Republic of Slovenia is and remains an active member of the IAEA. As a member of this Agency, it contributes the mandatory membership fee. In accordance with its capabilities, it also provides human and financial resources, in particular in the areas where its direct or indirect interests can be served.

Goal Implementation in 2018

As described in Chapter 9.2, Slovenia has continued its intensive and active cooperation with the IAEA.

Goal 5

The Republic of Slovenia remains an active member of the OECD Nuclear Energy Agency (NEA). For its collaboration, Slovenia contributes the agreed amount of the membership fee. In line with its human and financial resources, Slovenia participates in the work of NEA committees, the NEA Data Bank, and those subcommittees and working groups that are important for ensuring a high level of nuclear and radiation safety.

Goal Implementation in 2018

The Slovenian representatives are actively involved in the work of the directing committee, standing comittees and working groups of the NEA, in particular in the committees and working groups dealing with regulatory activities, the safety of nuclear installations, radiation protection, radioactive waste and spent fuel management, and nuclear law, as well as regarding research projects.

10 USE OF NUCLEAR ENERGY IN THE WORLD

As of the end of 2018, there were 453 nuclear reactors for electricity production operating in 30 countries. There are 55 nuclear reactors under construction; construction thereof began in 2018 in Turkey, Great Britan, Russia, Bangladesh and the Republic of Korea. There were nine new grid connections, seven in China and two in Russia. Six reactors were permanently shut down, three in Japan and one each in Russia, the United States of America and Taiwan. In Europe, there are nuclear power plants under construction in Finland, Slovakia, Belarus, France, Russia, Turkey, Ukraine and Great Britan.

Detailed data on the number of reactors by country and their installed power is presented in Table 10 (data source: PRIS database, IAEA).

Table 10: The number of reactors by country and their installed power

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
Belarus			2	2,220
Belgium	7	5,918		
Bulgaria	2	1,926		
The Czech Republic	6	3,930		
Finland	4	2,779	1	1,600
France	58	63,130	1	1,630
Hungary	4	1,889		
Germany	7	9,515		
The Netherlands	1	482		
Romania	2	1,300		
Russia	36	27,339	6	4,573
Slovakia	4	1,814	2	880
Slovenia	1	688		
Spain	7	7,121		
Sweden	8	8,612		
Switzerland	5	3,333		
Turkey			1	1,114
Ukraine	15	13,107	2	2,070
The United Kingdom	15	8,918	1	1,630
Europe total	**182**	**161,801**	**16**	**15,717**
Argentina	3	1,633	1	25
Brazil	2	1,884	1	1,340
Canada	19	13,554		
Mexico	2	1,552		
USA	98	99,333	2	2,234
Americas total	**124**	**117,956**	**4**	**3,599**

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
Armenia	1	375		
Bangladesh			2	2,160
India	22	6,255	7	4,824
Iran	1	915		
Japan	42	39,752	2	2,653
China	46	42,800	11	1,982
Korea, The Republic of	24	22,494	5	6,700
Pakistan	5	1,318	2	2,028
Taiwan	4	3,844	2	2,600
The United Arab Emirates			4	5,380
Asia and Middle East total:	**145**	**117,753**	**35**	**37,327**
South Africa	2	1,860		
World total	**453**	**399,370**	**55**	**56,643**

11 RADIATION PROTECTION AND NUCLEAR SAFETY WORLDWIDE

The International Nuclear and Radiological Event Scale (INES) is used worldwide as a tool for ensuring consistent reporting to the public on the safety significance of nuclear and radiological events. International reporting on events is performed for more significant events rated at level 2 or higher and for events that have attracted the interest of the international public. The INES reports are published on the web-based communication system NEWS and the INES reports of events in Slovenia are published on the SNSA website.

INES events in the year 2018

In 2018, 12 event reports were published via the NEWS system. The reports were divided into the following groups: one event in a NPP, one event during the transport of radioactive material, three events involving the theft of radioactive sources, three events with orphan sources, one event involving the exposure of personnel in a veterinary clinic and three events involving the exposure of workers during the performance of radiography. In 2018 there was one event rated level 3, five events rated level 2 and six events rated level 1.

A level 3 event occurred in Iran during the performance of radiography. Two workers of a private company found that the holder of an ^{192}Ir source with activity of 2.2 TBq was not returned to the projector. By means of handling tongs and other tools the workers moved the source back into the projector. The workers did not wear any dosimeters. Sometime later, signs of local deterministic effects from irradiation were observed. On the basis of the results of cytogenetic analysis, the whole body dose to the first worker was estimated to be about 400 mSv and the local dose to the hands was less than 50 Gy and 40 Gy. The estimates for the second worker are a whole body dose of about 280 Gy and a local dose to the right hand of less than 15 Gy. The workers received appropriate medical treatment.

An event at a British nuclear power plant was rated as level 2 according to the INES scale. The inspection of safety systems found extensive corrosion of pipework, storage vessels and seismic restraints. Both reactors at the plant were shut down for the time needed to perform corrections to the corroded components. The event did not cause any consequences to the public or the environment.

Two ^{241}Am/Be sources were transiting through an international airport, where they were rejected for onward travel and delivered to a company that was not authorised to hold radioactive material and had no radiation safety procedures in place. The event did not cause any consequences to the public or the environment. The INES rating of the event is level 2 because these were category 2 sources that were delivered to a company that does not have any procedures for the safe handling of radiation sources.

Three events rated as INES level 1 related to the theft of radiation sources. In the first event a ^{99m}Tc source was missing after its delivery to a nuclear medicine institute. The source was not found because the thief discarded it in a container for the collection of used glass, which was later sent abroad for recycling. A month later the thief was found and arrested but in the meantime the source decayed and there were no consequences to the public. The second event was the theft of a radiography device with an ^{192}Ir source that was placed near a vehicle. A search action was launched and after 10 days the source was recovered in safe condition. The investigation of the theft continued. The third event was the theft of a moisture/density gauge with two category 4 sources of ^{241}Am/Be and ^{137}Cs. The meter was stolen from the back of a pickup truck. The next day the gauge with two sources was retrieved in a city street. The gauge with the source was intact and there was no risk to the public.

Three events rated as INES level 1 were related to orphan sources that were mixed in with scrap metal. The ^{241}Am sources were melted together with scrap metal in steel factories (all three in the same country) and americium radionuclide was captured by filtration together with other dust particle sources. There was no contamination of the environment and the steel was not contaminated. The origin of the sources in all three events is unknown.

An event rated as INES level 2 occurred in a veterinary clinic. An animal keeper was contaminated with radionuclide ^{131}I, which is used for the treatment of feline hyperthyroidism. The veterinarian injected the radionuclide under the skin of the animal and some drops were spilled onto the cat's fur. The animal keeper was then contaminated on her neck, which was detected two days later. Activity of 360 kBq was detected on 4 cm^2 of skin and the dose was estimated at 2 Sv, which exceeds the annual dose limit. The activity of the iodine radionuclide in the thyroid was measured and an estimate of the activity at the time of contamination was determined to be 18 kBq, with an estimated dose of 1.4 mSv. No deterministic effects of irradiation were observed.

Two level 2 events were reported where workers were overexposed during the performance of radiography because an ^{192}Ir source was not appropriately withdrawn into the radiographic camera. In both events the performers of radiography received doses that exceeded the annual dose limit for workers, while no deterministic effects of the irradiation were observed. The cause of the first event was a noisy working environment and an error by the worker, while for the second event the cause was the inappropriate action of workers, and they were later removed from radiography work positions and subsequently changed jobs.

In Slovenia there were no events in the year 2018 that required reporting according to the INES criteria. The SNSA dealt with three findings or events at the Krško NPP, which were all rated as level 0 on the INES scale. These events are described in Chapter 2.1.1.2.

Other Internationally Interesting Events in 2018

The IAEA website reported three other events in 2018 that were not included in reporting through the NEWS system for INES event reporting. There events were not rated according to the INES criteria.

The first event was the notification of preparations in US nuclear power plants on the Atlantic coast for the approaching hurricane Florence. Two reactors of one plant were preventively shut down and other plants implemented measures for protection against the hurricane. The consequences after the passing of the hurricane were not reported.

The second event was a fire at the department of nuclear medicine at a hospital in an Asian country. The fire spread to the ceiling and the electric circuit of a small operation room and was then extinguished in a few hours. There were no casualties or radiological risk during the event.

The third event was the discovery of radioactive material of unknown origin in the streets of a South American metropolis. The package contained two metal bars of depleted Uranium used as collimators. The package was delivered to a centralised facility for the management of radioactive waste. There was no contamination of the public. An investigation of the found collimator was initiated but the results were not reported.

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