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

2019 Annual Report on Radiation and Nuclear Safety in the Republic of Slovenia

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2019 Annual Report on Radiation and Nuclear Safety in the Republic of Slovenia

August 2020

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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.

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SUMMARY

In 2019, the Krško Nuclear Power Plant (NPP) operated safely. A regular outage was performed in the fall. During the outage, among other activities, several important security improvements from the Security Upgrade Programme were carried out. The Krško NPP reported three events, which did not affect the population or the environment. The Krško NPP reported two events on the basis of a request from the legislature, while the third event was reported by the Krško NPP at the request of the SNSA.

At the end of May 2019, the deadline for the implementation of the Action Plan for the second periodic safety inspection of the Krško NPP expired. Within the framework of this Action Plan, the Krško NPP carried out more than 95% of the planned works. For the remaining few actions, the Krško NPP requested an extension of the deadline. The SNSA assessed the reasons for the extension as acceptable, as these were tasks that were particularly demanding and related to other projects at the Krško NPP that were being carried out in parallel.

The Krško NPP continued with the implementation of the Safety Upgrade Programme, which is the most extensive project following the modernisation of the Krško NPP in 2000. The implementation of the programme is now in the last phase and is expected to be completed in 2021. The remaining matters concern alternative core cooling systems, auxiliary systems installation, and emergency control room installation.

One of the most important activities of the last phase of the programme is the construction of a dry storage for spent fuel. The Krško NPP intends to start building a new facility at the end of 2020, and its operation is planned for 2022. In 2019, procedures began regarding the placement of the warehouse in space. Thus, the Municipality of Krško started the process of amending the existing NPP regulatory plan, and the Ministry of the Environment and Spatial Planning (MESP) began the process of carrying out a comprehensive environmental impact assessment and cross-border assessment in Austria and Croatia.

At the TRIGA Mark II Research Reactor in Podgorica, all activities from the Action Plan were carried out after the first periodic safety inspection.

In 2019, the revision of the programmes for the decommissioning of the Krško NPP and the disposal of radioactive waste and spent fuel from the Krško NPP was completed. In September, the Interstate Commission for Monitoring the Implementation of the Interstate Agreement on Co-Ownership of the Krško NPP reviewed the prepared programmes and sent them for further consideration to the internal procedures of both countries. The Slovenian Government was informed of the summaries of programmes in December 2019. The Interstate Commission is expected to adopt the latest revision of the programmes in 2020, which will be the basis for determining the contributions that GEN Energija and Hrvatska elektroprivreda, as owners, must each pay into their fund for financing the decommissioning and disposal of radioactive waste and spent fuel.

In addition to monitoring the preparation of new revisions of both programmes, the Coordination Committee, appointed by the International Commission in 2017, also studied the possibilities for the joint disposal of Slovenian and Croatian radioactive waste from the Krško NPP. Based on the report of the Coordination Committee, the Interstate Commission concluded that a joint solution for the disposal of Low- and Intermediate-Level Radioactive Waste (hereinafter: LILW) is not possible, which means that each country must take care of its share of radioactive waste.

The Radioactive Waste Agency (ARAO) continued its activities for the construction of the LILW repository in Vrbina near Krško. Preliminary activities were carried out for the public presentation of the environmental impact report and the cross-border environmental impact assessment of the future disposal site. At the end of the year, a cross-border environmental impact assessment was

launched. A public presentation of the environmental impact report in Slovenia has not yet been carried out. Given the dynamics of the activities and actions of the bodies involved, the challenge remains how the Krško NPP will operate when the storage capacities for such waste in the power plant are filled and there is no disposal site.

At the Boršt hydrometallurgical tailings disposal site of the former uranium mine in Žirovski Vrh, the problems with rock landslides have not been resolved, so the search for solutions as to closing the disposal site continues.

In 2019, there were no major problems for radiation practitioners, and there were few interventions due to the discovery of ionising radiation sources in the field.

In mid May 2019, an amendment to the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1A) entered into force, which newly regulated the safety screening of foreign nationals. The process of transposing the EU BSS directive into Slovenian law has been completed.

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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 2019 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 Management (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 2019 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

2.1.1.1 Operational Safety

In 2019, the Krško NPP produced 5,821,257.0 MWh (5.8 TWh) gross electrical energy from the output of the generator, which corresponds to 5,532,981.2 MWh (5.5 TWh) net electrical energy delivered to the grid.

The most important performance indicators of the Krško NPP are shown in Table 1 and Table 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 2019

Safety and performance indicators	Year 2019	Average (1983–2019)
Availability [%]	99.2	87.59
Capacity factor [%]	94.8	86.26
Forced outage factor [%]	0.0	0.95
Gross production [GWh]	5,821.26	5,200.02
Fast shutdowns – automatic [number of shutdowns]	0	2.05
Fast shutdowns – manual [number of shutdowns]	0	0.14
Unplanned normal shutdowns [number of shutdowns]	0	0.70
Planned normal shutdowns [number of shutdowns]	1	0.81
Event reports [number of reports]	2*	4.0
Duration of the refueling outage [Days]	28.3	48.3
Fuel reliability indicator (FRI) [GBq/m^3]	$3.70 \cdot 10^{-5}$	$5.99 \cdot 10^{-2}$

*Number of events that must be reported in accordance with legislation.

Table 2: Time analysis of the operation of the Krško NPP in 2019

	Hours	Percentage
Number of hours in a year	8,760	100
Duration of plant operation (on grid)	8,081.27	92.25
Duration of shutdowns	678.73	7.75
Duration of the refueling outage	678.73	7.75
Duration of planned shutdowns	0	0.0
Duration of unplanned shutdowns	0	0.0

The operation of the Krško NPP in 2019 is shown in Figure 1. The plant shut down only once, in October, due to a regular outage. In addition, the plant twice reduced its power to about 55% in order to perform tests after maintenance of the main feedwater pump No. 1A. In the summer months, net energy production was lower due to the Sava River flow being lower.

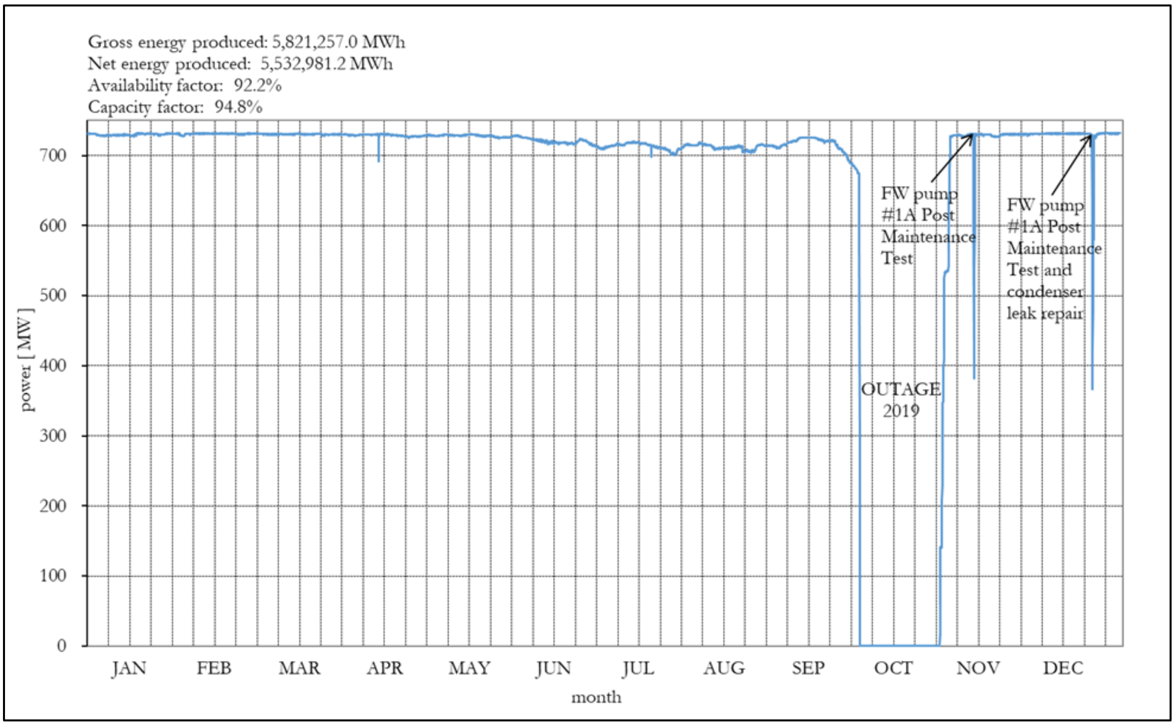

Figure 1: Operating power diagram of Krško NPP in 2019

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

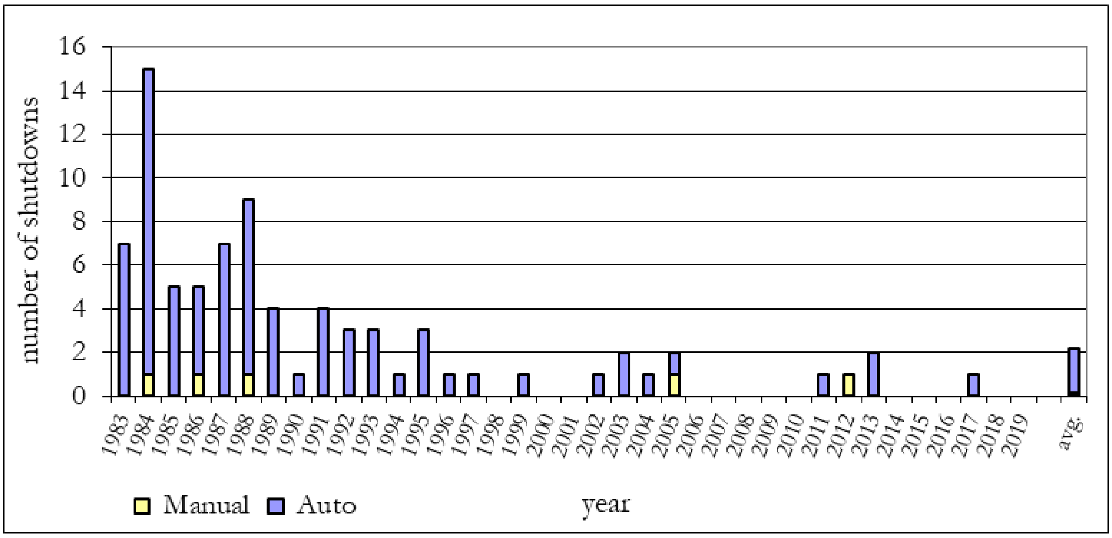

Figure 2: Fast reactor shutdowns – manual and automatic

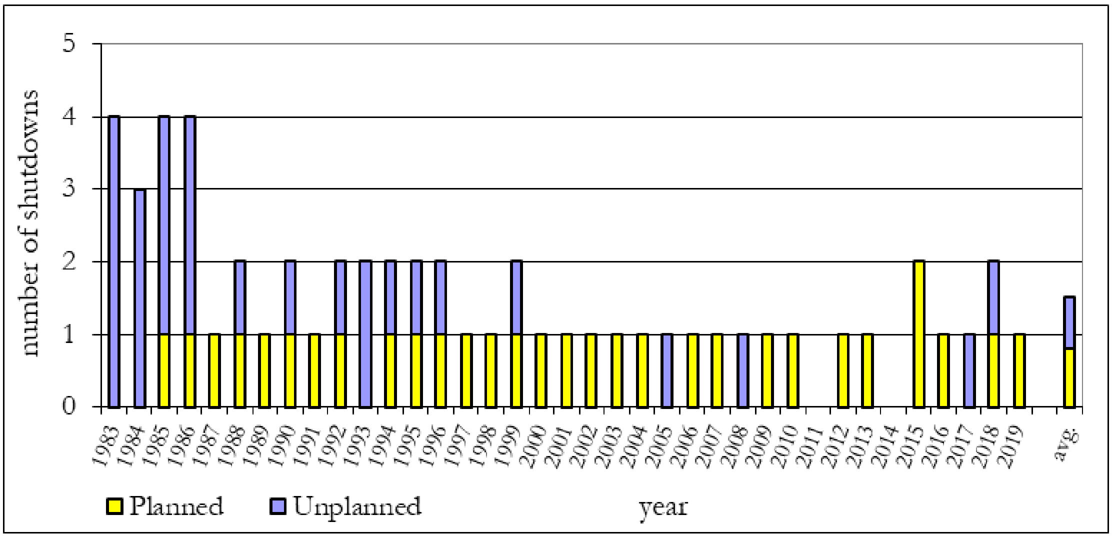

Figure 3: Normal reactor shutdowns – planned and unplanned

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 shutdowns. Normal shutdown due to fuel replacement and regular annual maintenance or outage is a special type of planned shutdown.

The plant has been shut down 205 times during its operation (1981-2019), of which 137 during commercial operation. There have been 138 fast shutdowns. During commercial operation there have been 81 fast shutdowns, of which 76 automatic and 5 manual. There have been 67 normal shutdowns in total. During commercial operation there have been 56 normal shutdowns, of which 27 due to outage, while 26 were planned and 3 unplanned. The number of outages is smaller than the number of years of plant operation because there were no outages in the years 1991, 2005, 2008, 2011, 2014 and 2017. Also, there have been four fast shutdowns due to equipment problems that occurred close to the planned beginning of an outage, which resulted in an earlier start of the outage. A gradual stabilisation of fast shutdowns can be observed (in the last 25 years fewer than 1 per year). In 2019 there were no fast shutdowns.

Figure 4 shows the number of abnormal events. The Krško NPP is obliged to report all events that could reduce the level of nuclear safety to the regulatory body. In 2019 the Krško NPP reported on two abnormal events. In accordance with a request by the SNSA, the Krško NPP reported on another event that was found by the regulatory body to be important and interesting for nuclear safety.

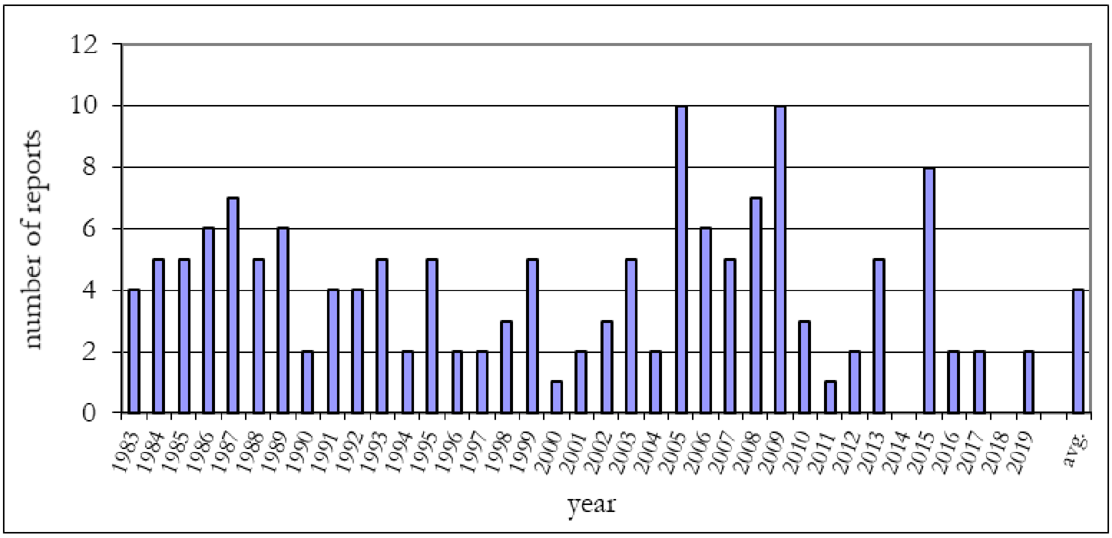

Figure 4: Number of abnormal events per year

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 2019, the production of electrical energy was 14.9 TWh, of which 37% was produced by the Krško NPP.

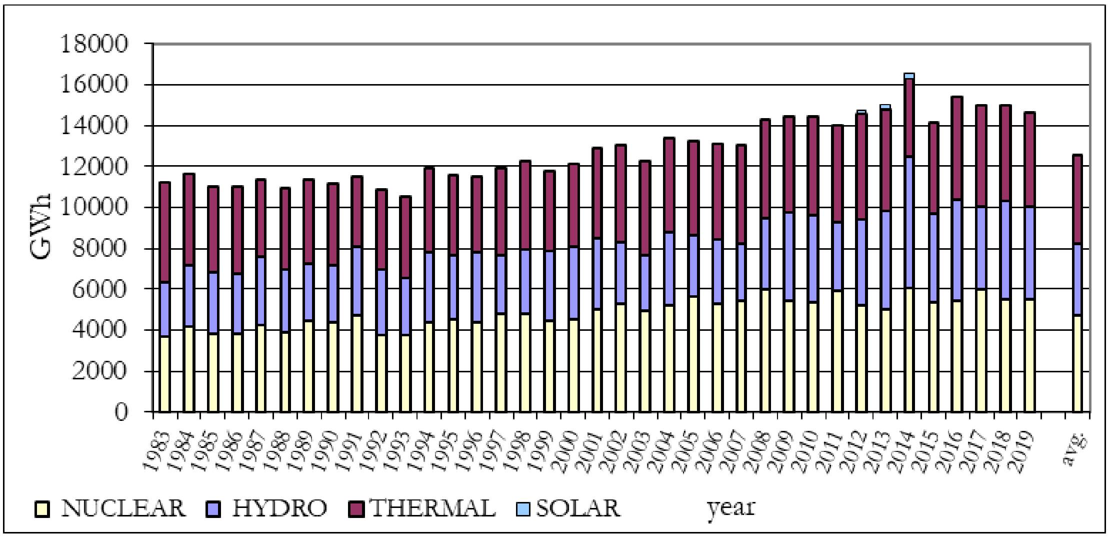

Figure 5: Production of electrical energy in Slovenia

The Slovenian Nuclear Safety Administration'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 (SPIs). In 2019, the SNSA monitored 37 SPIs, examples of which are presented below. One part of the SPIs is the SNSA limits for warnings and alarms. Thereby, the Krško NPP has time to take corrective measures that would improve the SPI values before the SNSA has reached the warning or alarm value, and thus control by the SNSA is increased.

Once a month the SNSA informs the Krško NPP of the state of the SPIs and of possible individual areas that require greater engagement of the Krško 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 December 2018 and September 2019 (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. During the 2019 outage, it was found that there were no leaking or damaged fuel elements in the 30th fuel cycle. In the 31st fuel cycle, the specific activity of xenon ^{133}Xe and iodine radionuclides ^{131}I in ^{134}I was rather constant, which means that at the end of December 2019 there were no leaking or damaged fuel elements.

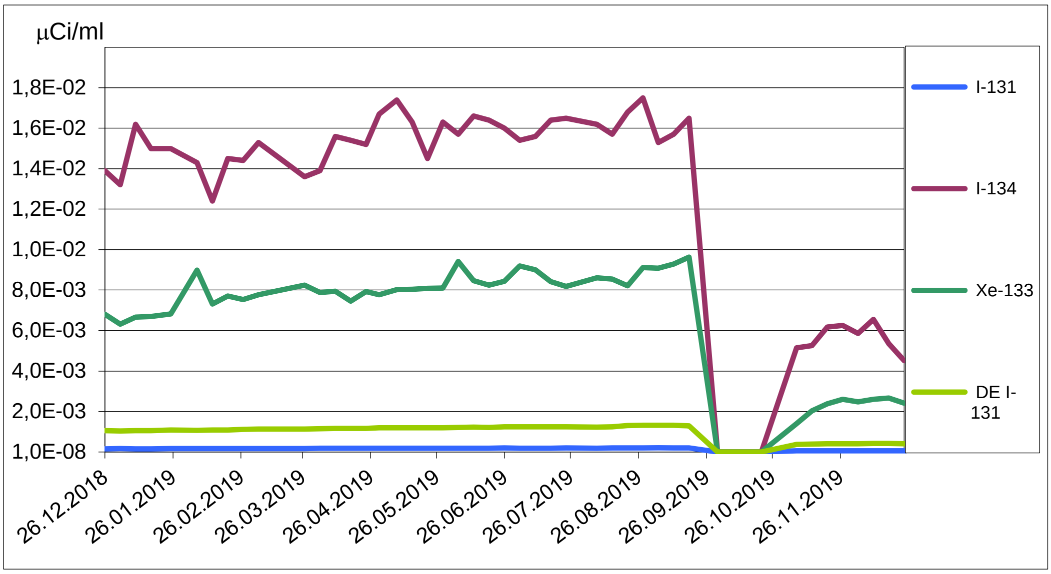

Figure 6: Primary coolant-specific activity – 30th and 31st fuel cycles

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

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

The indicators in Figure 7 and Figure 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.

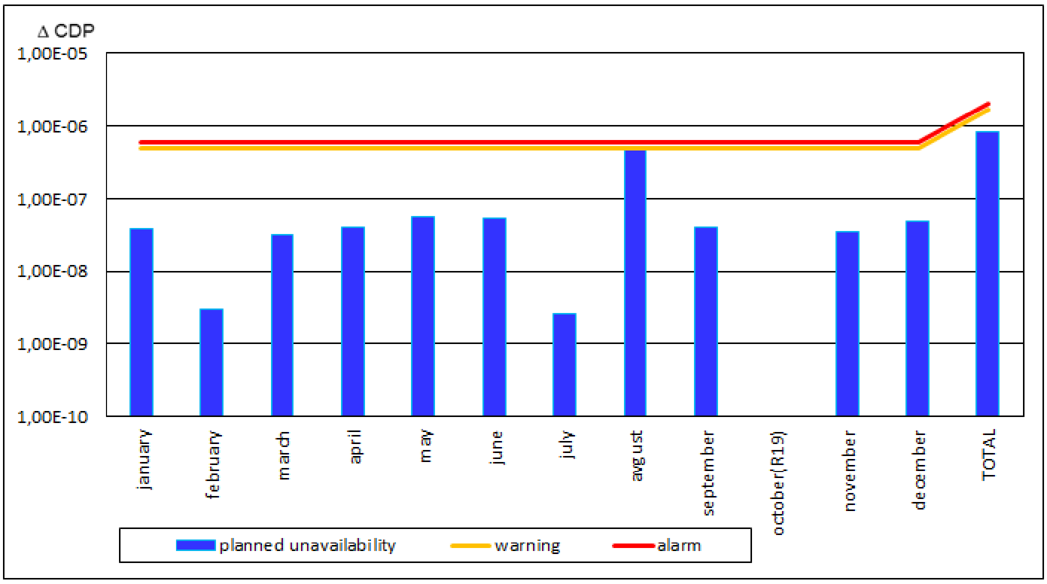

Figure 7: Risk due to the planned unavailability of equipment

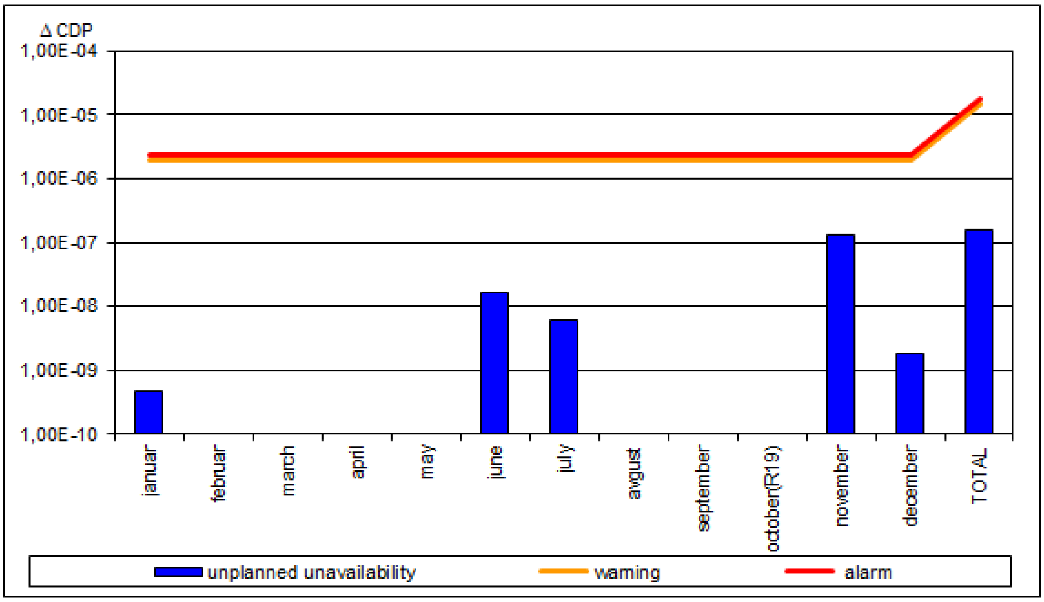

Figure 8: Risk due to the unplanned unavailability of equipment

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 2019, the collective dose was 668 man-mSv (the value of the warning was 720 man-mSv and the alarm value was 860 man-mSv). Years in which there was no outage are shown with asterisks (*).

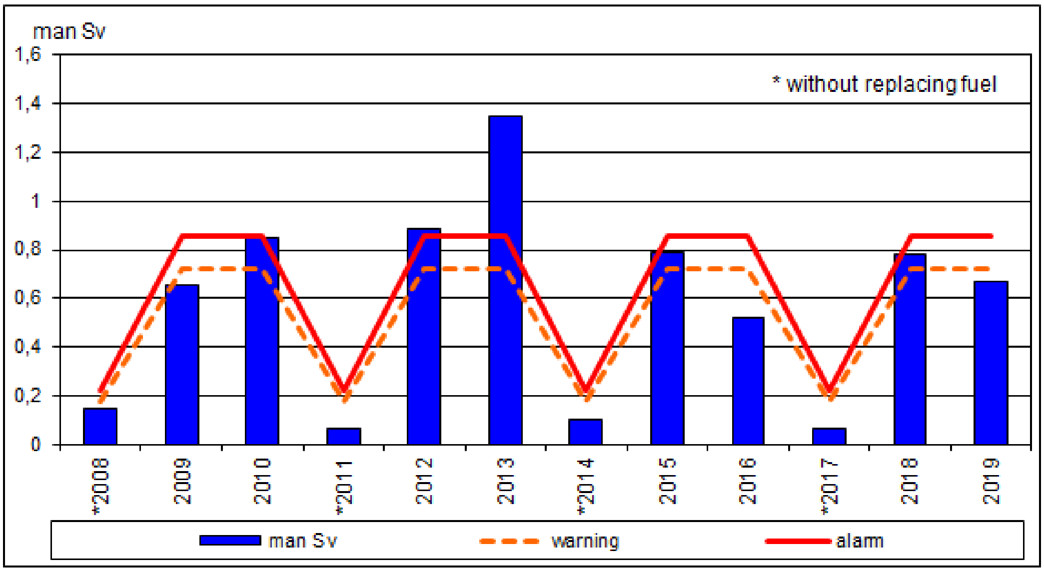

Figure 9: Collective dose

The radiation exposure indicator of the radiation personnel shows the total number of Krško NPP workers and external workers (Figure 10). In 2019, there were a total of 1,581 exposed workers, out of which 411 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.

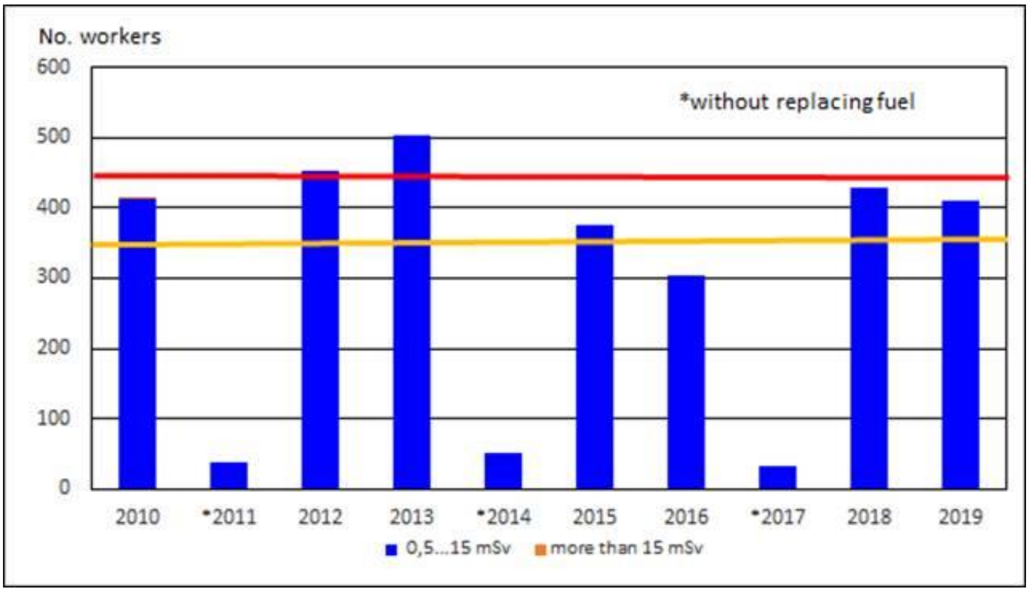

Figure 10: Exposure of radiation personnel

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. Krško NPP must also follow the additional reporting requirements prescribed in its Technical Specifications; Krško NPP reported two events.

At the request of the SNSA, the Krško NPP additionally reported on the event "Failure of more safety and non-safety components due to lightning strikes near Krško NPP". The mentioned event is described because it is an important safety event.

Failure of more safety and non-safety components due to lightning strikes near Krško NPP

On 22 June 2019, there was a storm with lightning strikes in the vicinity of Krško. A large number of lightning strikes were recorded near Krško NPP. The technical report of the Milan Vidmar Electric Power Research Institute (EIMV) on atmospheric discharges shows that there were 47 lightning strikes in a circle 4.5 km from the Krško NPP and three lightning strikes at a distance of 200 m from the Krško NPP. Due to lightning strikes near the Krško NPP, a large number of spurious activations and failures on non-safety and safety components occurred. The following systems were affected by the lightning strikes: the auxiliary feedwater system (overvoltage protection was activated on the PS702 transmitter power supply and PY3046 converter), damaged fire protection systems (the occurrence of multiple alarms on the main fire control panel in the main control room, fire detector, manual fire detector, overvoltage protection of the power supply panel), an essential service water system (an inoperable temperature detector TE2800 (RTD – *Resistance Temperature Detector*), failure of the PT2819EC converter in the emergency control room), electrical systems, seismic instrumentation, communication systems (damaged electronics in the evacuation alarm system), core instrumentation system (failure of ICCMS system indications in the emergency control room), the waste gas treatment system (non-functioning alarms on the GH panel), technical security system (several door controllers were damaged), etc. Due to the mentioned event, the Krško NPP entered into the following Limiting Conditions and Operations (LCO): LCO 3.7.1.2, LCO 3.3.3.8 and LCO 3.3.3.5.

The Krško NPP remedied all irregularities and equipment failures. In the future, the Krško NPP will improve protection against direct impacts from lightning strikes (from 100 kA to 400 kA).

Due to the fact that the event is complex and important from the point of view of nuclear safety, the analysis of the Krško NPP and the SNSA is still being prepared.

Figure 11: Atmospheric discharge (symbolic picture)

Reference: [4]

Loss of the containment penetration closure during the 2019 outage

On 5 October 2019, maintenance work was carried out simultaneously on two valves in series on the fire protection system (for extinguishing reactor coolant pump No. 1), namely on isolation valve 28985 and check valve 28989. Figure 12 shows isolation valve 28985 of the fire protection system. Maintenance work on valve 28989 was completed on 5 October 2019, while maintenance work, an upgrade of the valve actuator, and a local leak test on valve 28985 were completed on 16 October 2019.

The operational limits and conditions of LCO 3.9.4 require closed containment penetrations during refueling. This closure of penetrations is ensured by closed valves, which are determined in the procedure OSP-3.4.602 "*Tedensko preverjanje integritete zadrževalnega hrama v času menjave goriva*" ("*Weekly verification of containment integrity during refueling*"), «), among others also the isolation valve 28985. On 4 October 2019 the closure of the containment penetrations was verified in accordance with the operational limits and conditions of LCO 3.9.4 and procedure OSP-3.4.602. Since 5 October 2019, when the maintenance work on the above-mentioned valve commenced, the containment penetration has not been closed, as required by Krško NPP's operational limits and conditions.

On 7 October 2019, plant workers discovered that the maintenance work had been done on both valves simultaneously. At that time, the maintenance of check valve 28989 was completed, while isolation valve 28985 was still removed due to maintenance. Plant workers responded immediately and additionally closed valves 29051, 29054, and 29057. This met the requirements of LCO 3.9.4, in accordance with which penetration closure is required.

The Krško NPP did not ensure operations in accordance with its operational limits and conditions, because the closure of the containment penetration was not ensured from 5 October 2019 from 17:20 to 7 October 2019 until 14:22, while at the same time the refueling was underway. In addition, when the Krško NPP operators recognised the loss of the containment penetration closure, they performed an alternative isolation, but failed to suspend the movement of irradiated fuel as required by the operational limits and conditions of LCO 3.9.4.

The Krško NPP explained that the operators acted in accordance with procedure ADP-1.3.030 "*Varnost v zaustavitvi*" ("*Safety during shutdown*") to isolate additional valves as soon as possible. The requirements of the operational limits and conditions were checked after the additional isolations had already been approved. At that time, the operators reckoned that the requirements were satisfied and that there was no need to act in accordance with the requirements of the operational limits and conditions of LCO 3.9.4 and stop the fuel movement. Likewise, additional layers of defence in depth were available, e.g. the time after shutdown was longer than 100 hours, the level of the water was higher than 7 m above the reactor vessel flange, etc.

Article 111 of the *Ionising Radiation Protection and Nuclear Safety Act* (ZVISJV-1, Official Gazette RS, No. 76/17 and 26/19) requires that the operator of a radiation or nuclear facility ensure the operation of the facility in accordance with the requirements set in the operational limits and conditions, which are a constituent part of the operating license. The procedures of the Krško NPP should be in line with the operational limits and conditions.

There are several reasons for the event, namely: inadequate processing of work orders (WO), an inadequate system of review and control of WO, non-compliance with the requirements of the operational limits and conditions, inadequate internal procedures, etc.

The Krško NPP and the SNSA examined the event in detail and performed an analysis. The event was classified by the SNSA as a level 1 event according to the INES scale.

Figure 12: Fire insulation valve 28985 (the valve is located on the fire pipe for extinguishing reactor coolant pump No. 1)

References: [5], [6], [7], [8]

Failure of ECR measurement loop T-424EC and entry to LCO 3.3.3.5 and DEC-LCO 3.3.3.5

As part of the 1007-XI-L project "*Construction of the Emergency Control Room (ECR)*", in the 2016 outage, single RTD detectors for the wide temperature range of the hot and cold legs of the Reactor Coolant System (RCS) were replaced with double RTD detectors, which are installed in the same housing. The TE424EC is part of the dual RTD, which also includes the TE424 in the same housing. Since the installation in the 2016 outage, only the connection to the main control room

(TE424) were used for the first operating cycle (18 months). No deviations were observed on this loop during the entire operating cycle.

On 26 February 2019, there was an increase in the indication on the T-424EC loop in the ECR and on the Process Information System (PIS). A search was carried out to identify the reason for the deviation. The measured RTD resistance of the TE424EC detector showed RTD degradation (35 Ohms higher than expected). As a result, the TE424EC temperature measurement was declared invalid. On 26 February 2019 at 13:30:00, entry into the operating conditions and restrictions of LCO 3.3.3.5 and DEC-LCO 3.3.3.5 was announced (DEC – *Design Extension Condition*). Given that the RTD could be replaced only during the outage in October 2019 (or in the event of a forced shutdown of the plant), it was necessary to take action based on the inability to meet the requirements of DEC-LCO 3.3.3.5, which require the return of the channel to operational condition within 60 days in accordance with the requirements of DEC-LCO 3.0.3, namely to report to the SNSA thereon and prepare an analysis within 15 days.

An analysis was initiated to investigate the causes of the failure of the RTDs in connection with similar problems that the Krško NPP already had with RTDs in the narrow measurement range of the same manufacturer. Problems were also on the cold leg of reactor coolant system on the loop No. 2, most likely as a result of increased high frequency vibrations (3–5 kHz) generated on this loop by reactor coolant pump No. 2, which has stronger vibrations than reactor coolant pump No. 1. In the 2019 outage, a faulty RTD was pulled out and replaced with a new RTD of the same type. The faulty RTD was examined by a non-destructive X-ray method. No deviations were observed. The Krško NPP will carry out an analysis of the obvious cause after receiving the conclusions of the manufacturer's analysis. The Krško NPP will complete the analysis in 2020.

References: [9], [10]

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, 220 actions had been completed by 30 May 2019, of which 71 out of 71 actions scheduled for completion in one year, 83 out of 84 actions scheduled for completion in three years, and 66 out of 70 actions scheduled for completion in five years. The implementation plan will be concluded by the end of December 2021. The main reasons for the delays are the complexity of implementation, the occupancy of experts and specialists, and the intertwining of individual activities.

The deadlines for the implementation of the remaining five activities are as follows:

- Action PSR2 2.3-04 – Establishment of a Protected Emergency Control Centre, deadline for implementation: 31 December 2021;
- Action PSR2 4.5-02 – Severe Accident Phenomenological Evaluations Upgrade, deadline for implementation: 31 December 2021;
- Action PSR2 4.5-03 – Plant Specific MAAP4 Model Review/Update, deadline for implementation: 31 December 2020;
- Action PSR2 4.5-15 – Improvement of the Satellite Communications System Availability, deadline for implementation: 31 December 2020; and
- Action PSR2 1.1-45 SSS-PD-02 SSS – Qualification to PIEs and Safe Shutdown Earthquake, deadline for implementation: 1 June 2020.

2.1.1.4 Outage 2019

The 2019 outage at the end of the 30th fuel cycle took place from 1 to 29 October 2019. The power plant operated reliably in the 30th fuel cycle, despite the plant shutdown due to problems with the measurement of the high voltage of the GT2 transformer. There were no major problems related to the equipment that would significantly endanger safety. This is the result of planned and executed outage activities in 2018 as well as activities during plant operation in the 30th fuel cycle.

The 2019 outage ran very smoothly at the beginning, i.e. until the beginning of the start-up of the power plant. At that time, problems with both main feed water pumps occurred. During the outage a loss of closure of the containment, described in detail in Section 2.1.1.2, was noted. In addition, wear and curvature of the in-core instrumentation guides were observed. These deviations did not have an effect on employees, the population, or the environment.

The main activity in the field of the safety upgrading of the power plant was the establishment of an auxiliary control room. This will enable 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. In addition to this upgrade, the Krško NPP introduced nine major modifications, such as alternative cooling of the reactor coolant system, replacement of the T3 transformer, repair of the pipeline between the high-pressure turbine and moisture separator re-heater, replacement of 6.3 kV circuit breakers, and phase 1 of the installation of two additional pumps. All of the above-mentioned activities are the basis for the safe operation of the Krško NPP, including the possibility of operating beyond the facility life expectancy.

A large number of preventive maintenance activities, replacements, and upgrades of equipment were carried out. Minor deviations at work were the result of human error and staff workload, the ageing and wear of equipment, as well as the insufficient preparation of some modifications and some contractors.

During the outage, except for one modification, all planned works related to checking the conditions of the equipment, fuel replacement, and the introduction of modifications were carried out; in particular, the modification related to the drainage of Reactor Coolant Pumps (RCP) was only partially carried out. The result of the repeated calculation related to the expected distance between the new drainage of RCP1 and the RCS loop, namely its isolation, only a few millimetres during the operation of the plant. The Krško NPP did not accept the solution provided by Worley Parsons to remove a part to the mentioned isolation, namely the part that is the closest to the RCP1. The operator decided to launch a new project related to the mentioned drainage of the reactor coolant pumps to ensure a greater distance to the RCS. Therefore, in 2019 only work on the drainage related to RCP2 was carried out. In general, it was carried out as planned except a different time window than planned was used. This change was necessary due to high dose rates while the RCS loops were empty. The implementation of the modification on the drainage pipeline of RCP1 is planned in the 2021 outage.

The SNSA monitored all outage activities. Expert assistance was provided by experts from domestic and foreign authorised nuclear safety experts. In accordance with Slovenian regulations, the power plant was able to resume electricity production only after the authorised nuclear safety experts and the SNSA confirmed that all works had been carried out properly, all tests had been successful, and that nuclear safety had been adequately ensured. These measures will also achieve that the power plant has a minimal impact on the environment. The next outage will take place in 18 months, i.e. in spring 2021.

2.1.1.5 Inspections of fuel assemblies during the 2019 outage

By the In-Mast Sipping (IMS) method, an inspection of cladding integrity was performed for all 121 fuel assemblies of the fuel cycle 30 core. The inspection showed that there were no leaking fuel assemblies (Figure 13).

A 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.

An Underwater Visual Inspection (UWTV) was performed for all four sides of those 96 fuel assemblies from the core of fuel cycle 30 that were planned for the original core design and for the revised core design of fuel cycle 31. Mechanical damage to the first distancer grid was found on fuel assembly AK32 and therefore this fuel assembly cannot be employed for further use in the core. A revised core design for fuel cycle 31 had to be prepared.

Ultrasonic Testing (UT) of fuel assemblies was not performed during the outage because this was not needed since, according to the results of the IMS and Q-UWTV, it was confirmed that there were no leaking fuel assemblies in the core of fuel cycle 30.

Inspection of all 33 control and shutdown assemblies was performed by Eddy Current Testing (ECT) and Ultrasonic Testing (UT) during the 2019 outage. The results showed that control rod assembly R154 is not suitable for further use and it was replaced by control rod assembly R138.

Following the implementation of corrective measures to prevent open defects of fuel assemblies, where the major effect was due to a change to the reactor core bypass flow, "*Reactor Vessel Upflow Conversion*", there have been no leaking fuel rods since fuel cycle 28 (Figure 13).

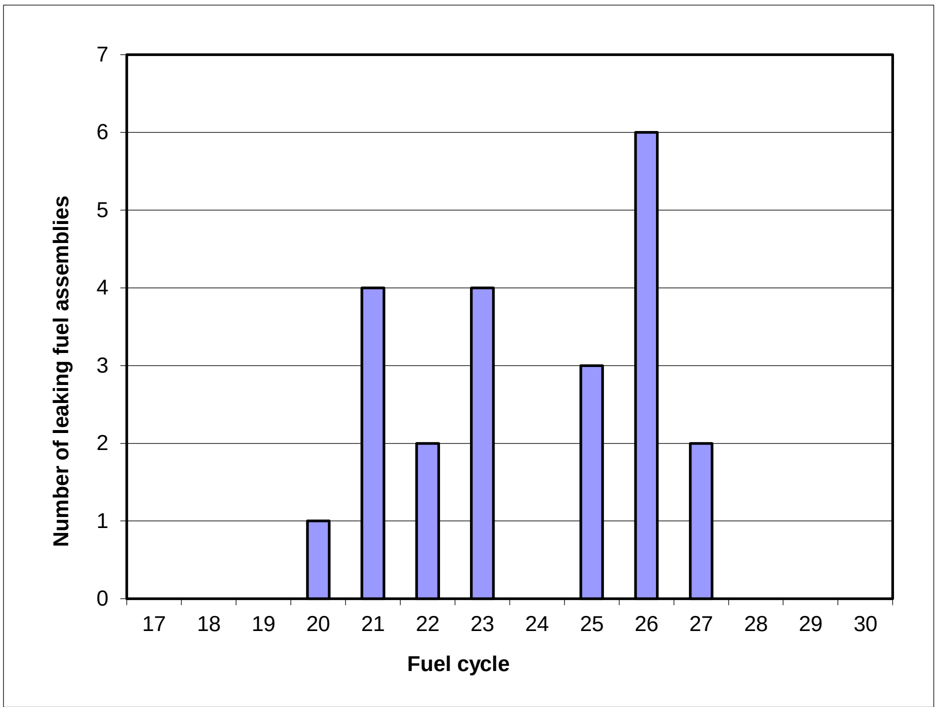

Figure 13: Results of fuel integrity inspections by the IMS method during outages since 2000 (fuel cycle 17)

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). 1,964 fuel assemblies were inspected By UWTV and minor damage was observed in 6 fuel assemblies and debris was found on 109 fuel assemblies, which was subsequently successfully removed from 54 fuel assemblies. By the VCS method, 424 fuel assemblies were inspected and 8 of these were found to be leaking.

The reinforcement was implemented for a selected 271 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 rod guide thimbles are made, to Intergranular Stress Corrosion Cracking (IGSCC). The reinforcement procedure consists of the installation of six 30 cm-long anchors to position the control rod guide thimbles 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.

References: [1], [11]

2.1.1.6 The Krško NPP Safety Upgrade Program

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 lessons learned from the Fukushima Daiichi accident in March 2011. The plant carried out an analysis of needed improvements and based thereon prepared a proposed 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); and
- Installation of a passive containment filtered vent system.

Phase II, which was planned to be implemented by end of 2019 but is still underway, 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 in 2018);
- 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 (delayed, to be implemented by the end of 2020);
- Installation of a fixed spray system on the spent fuel pool with provisions to use mobile equipment (delayed, to be implemented by the end of 2020);
- 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. This improvement was planned to be finished in October 2019, but due to a delay on the part of the supplier of the pump this modification will be completed in April 2021 (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 400 V safety buses and mobile diesel generators, etc.) (implemented in 2018);
- Replacement of the existing remote shutdown panels with the installation of ECR with capabilities to shut down the reactor and maintain the long-term safe shutdown state (implemented in 2018/2019);
- Installation of additional instrumentation dedicated to severe accidents with an independent power supply (implemented in 2018);
- The above-mentioned ECR will include habitability systems for ensuring a safe long-term environment for operators even in the event of severe accidents (delayed, to be implemented by the end of 2020); and
- Upgrade of the operational support centre and technical support centre (emergency centres) to ensure a safe long-term environment for operators even in the event of severe accidents (delayed, to be implemented by the end of 2020).

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

- Installation of an additional injection systems for reactor cooling system / containment and steam generators with dedicated reservoirs of cooling water (also borated) capable of replenishing with water from underground wells – the BB2 project (implementation underway); and
- 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 based on the lessons learned from the Fukushima accident. The document was published on the SNSA's website. The Action Plan comprises all activities whose implementation would further reduce the risk due to external and other hazards that could affect the Krško NPP location.

The core of the Action Plan is the implementation of the Safety Upgrade Programme (SUP) described in the previous chapter. Besides the SUP, the SNSA identified additional activities to improve preparedness for severe accident events:

- Legislative changes based on lessons learned from the Fukushima accident and revised WENRA (Western European Nuclear Regulators Association) SRL requirements[1] – implemented in 2016;
- Several measures to improve emergency preparedness:
    - Revision of radiological emergency response plan, which would provide long-term support to the Krško NPP if affected by widespread disasters (e.g. a catastrophic earthquake), such as the provision of 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) –coordination with the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR) regarding the preparation of a new revision of the plan is underway;

[1] WENRA SRL – WENRA Safety Reference Levels are harmonised safety requirements for nuclear power plants that apply to all European power plants.

    - Preparation of additional new internal procedures to be used in the event of nuclear or radiological accidents – implemented;
    - Introduction of regular training for first responders – implemented;
    - Enhanced cooperation with neighbouring countries in the area of emergency preparedness – the Croatian regulatory body was enabled access to on-line communication tool during an emergency, used by state-level governance bodies;
    - Coordination of the emergency preparedness plans of Slovenia and Croatia – implemented;
    - An enhanced exercise plan for Krško NPP – a five-year rolling plan, which also includes longer-lasting exercises with several involved organisations; and
    - A review of radiological monitoring in Slovenia and a comparison with international practice was carried out. Based on these results, several improvements were suggested, which resulted in an upgrade of the monitoring system;

- special post-Fukushima inspections introduced on the topics of mobile equipment, communication during emergency (e.g. long-lasting loss of an electrical power supply), protection against external hazards (floods, earthquakes) – implemented;
- additional analysis performed – a deterministic accident analysis by means of other computer codes, i.e. MELCOR – implemented;
- enhanced communication of the parties involved in the nuclear industry (power plant, technical support organisations, regulatory body) – two conferences implemented;
- education and training of SNSA staff with regard to accident management and the defence in depth concept – implemented;
- the invitation of international peer review missions – three of the planed missions were implemented thus far: an IRRS mission (*Integrated Regulatory Review Service*) for the review of regulatory infrastructure, an EPREV mission (*Emergency Preparedness Review*) for the review of emergency preparedness, and an OSRAT mission (*Operational Safety Review Team*) for the review of the operational safety of the nuclear power plant. There is one more mission planed, i.e. for the review of preparedness for accident management (RAMP – *Review of the Accident Management Program*), which will be implemented once the Krško NPP's SUP is completed;
- upgrade of the system for data transfer between the power plant and the SNSA during an emergency (ERDS – *Emergency Response Data System*) – implemented;
- upgrade of the Krško NPP's probabilistic safety analysis (PSA) for the shutdown states and spent fuel pool – partly implemented. The PSA for the spent fuel pool has been partly implemented. The analysis regarding internal and external hazards (internal flooding, fires, and earthquakes) are to be completed by the end of 2020; and
- review and enhancement of the Krško NPP's safety culture assessment process – implemented. The plan is to also develop a process for assessing the SNSA's safety culture – to be implemented by the end of 2020.

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

References: [12], [13], [14], [15], [16], [17], [18], [19]

2.1.1.7 The Krško NPP Spent Fuel Dry Storage

The construction of a spent fuel dry storage is part of the "*The Krško NPP Safety Upgrade Programme*", Phase 3. The construction of a new dry storage facility for spent fuel is planned at the end of 2020 and its operation is planned in 2022.

In 2019, the main focus of licensing activities was on the spatial planning for a new facility. The process of preparing the Amendments and Supplements of the Krško NPP Spatial Plan (hereinafter referred to as the AS SP NPP Krško) began.

In April 2019, the document "*Pobuda in izhodišča za pripravo sprememb in dopolnitev Ureditvenega načrta Nuklearna elektrarna Krško za prostorsko ureditev skupnega pomena (projekt št.: 19054-00 Krško)*" was prepared ("*Initiative and starting points for the preparation of amendments to the Development Plan of the Krško Nuclear Power Plant for spatial planning of common interest (project No .: 19054-00 Krško)*").

In June 2019, a decision on the "*Priprava Sprememb in dopolnitev ureditvenega načrta NEK za prostorsko ureditev skupnega državnega in lokalnega pomena*" ("*Preparation of Amendments to the NPP zoning plan for spatial planning of common national and local importance*") was adopted by the mayor of the Municipality of Krško. The MESP also gave consent to the decision. The decision was published in the Official Gazette of the Republic of Slovenia.

Following its publication in the Official Gazette, the national institutions responsible for spatial planning were asked for their opinions regarding possible significant impacts on the AS SP NPP Krško. Based on their opinions, MESP issued a decision on the need to carry out a comprehensive environmental impact assessment procedure with cross-border consultation.

In August 2019 the draft of the AS SP NPP Krško was prepared together with the environmental report. The national institutions responsible for spatial planning gave their opinions regarding the environmental report and the AS SP NPP Krško.

In October 2019, an updated draft of the AS SP NPP Krško was prepared. The public hearing of the updated draft of the AS SP NPP Krško together with the environmental report took place on 16 October and 18 November 2019 on the premises of the municipality of Krško and also on the website of the municipality Krško. In line with the legal requirements, a public hearing was held on 4 November 2019 on the premises of the Krško Cultural Centre. At the same time, a cross-border consultation was held. In the context of public participation, the public submitted opinions and comments regarding the plan and the environmental report. Following the receipt of all the opinions and comments, the observations were announced to the public.

In December 2019, the final proposal of the AS SP NPP Krško was prepared, following the public announcement. The municipality of Krško has asked all participants in the process to give second opinions on the proposal.

In the year 2019, MESP carried out some of the comprehensive environmental impact assessment phases in cooperation with the Republic of Austria and the Republic of Croatia, such as notifications, technical consultations, and public hearings.

2.1.1.8 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 2019, the SNSA approved 11 modifications and agreed to 24 modifications. During the safety evaluation screening, the Krško NPP did not identify any open safety issues for 283 modifications. Therefore, the Krško NPP only informed the SNSA of those 283 modifications. As of 31 December 2019, there were 32 active temporary modifications.

In 2019, the Krško NPP issued the 26th revision of the "*Updated Safety Analysis Report*", which considered the changes approved up to 1 November 2019.

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

2.1.1.9 Safety culture

The SNSA regularly assesses the safety culture in the Krško NPP over the whole year. The observations include the period from the beginning of the implementation of a modification (the administrative procedure, documentation overview, communication with Krško NPP) to the realisation of the modification. In addition, the SNSA collects the observations from the inspections and outage activities.

Safety culture observations are categorised into five safety culture characteristics defined in the IAEA document GS-G-3.1 "Application of the Management System for Facilities and Activities". Positive and negative observations are observed for other safety culture characteristics (safety is clearly a recognised value, safety is integrated into all activities, and safety is integrated into all activities). One could jump to the conclusion that some individuals or some smaller groups of individuals are more aware of the importance of safety in comparison to others, whose attitude may deviate from the safety culture of the whole organisation.

The SNSA identified cases of positive and negative safety culture at the Krško NPP and informed the Krško NPP of the findings, which provided additional explanations. The SNSA and the Krško NPP will discuss all findings in order to harmonise a common understanding and upgrade the safety culture.

2.1.1.10 Topical peer review of the aging management programme (TPR - AMP)

The SNSA participated in all activities under the scope of the first Topical Peer Review (TPR) in accordance with the Euratom Directive on aging management in nuclear installations. 19 EU countries and some neighbouring countries have been participating in the peer review. The SNSA prepared the technical report in cooperation with the Krško NPP, which was published on the European Nuclear Safety Regulators Group (ENSREG) website together with the reports of other participating countries and made available for public consultation; all stakeholders were able to comment and raise questions. After that, a review meeting of all countries took place, and the ENSREG then prepared a report on the meeting with conclusions, and a public presentation of the results of the peer review was organised.

The completion of the peer review and the development of generic and country-specific findings were followed by the preparation of the national Action Plans of the participating countries. The SNSA submitted its national Action Plan to the ENSREG in September 2019.

The Action Plan defines the scope and timing of the necessary improvements and actions to be implemented identified during the TPR process. All TPR findings related to the technical areas described in the already-mentioned TPR technical report were taken into account, namely the overall aging management programme of the Krško NPP, electrical cables, concealed piping, the reactor pressure vessel, and concrete containment structure. In the Action Plan, in addition to other findings, also all generic challenges for all areas that were not otherwise required by the ENSREG were addressed, and finally nine actions were defined. Most of the actions include the implementation of thematic inspections, mainly in the areas of electrical cable testing, foreign operating experience, and research in the field of the non-destructive testing of reactor pressure vessel material and safety-related concrete structures, including the containment. In addition, the compliance of the scope of systems, structures, and components included in the NPP aging management programme with the IAEA documents within the PSR3 and the legislation in the event of possible longer shutdowns will be reviewed. The Krško NPP will also report on the findings of the inspection of concrete piping penetrations during the outage in 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. At the end of the first TPR process, the ENSREG WG1 working group also prepared a questionnaire on the response of the participating countries and other stakeholders to the derived process. In cooperation with the Krško NPP, the SNSA submitted a completed questionnaire with comments to the ENSREG, where the importance of improving the process was emphasised, especially in the phase of formulating specific and generic findings for individual countries after the peer review and review meeting.

2.1.1.11 Inspection Review

In 2019, altogether 59 planned inspections, including three unannounced inspections, were performed at the Krško NPP. There were no reactive inspections.

During the planned inspections, among other inspection topics, the SNSA inspection service verified how the operator addressed and solved important deviations identified during normal operation. Regarding the mentioned deviations, the inspection service verified the causes, the actions immediately performed, the analyses results, long-term actions, as well as the implementation and effectiveness thereof.

The inspection service supervised the implementation of outage activities, focusing on those that are important for ensuring a high level of nuclear safety. The expert basis for the assessment of important outage activities were prepared by the authorised radiation and nuclear safety expert organisations, which did not identify significant issues regarding the quality of the works performed. Nevertheless, they provided recommendations for further improvement of the quality of work. These recommendations were addressed by the inspection service within special inspections.

Based on inspection supervision, it was found that most outage activities were performed to the full extent and with high quality, taking into account regulations and good engineering practices. As a rule, the deviations were corrected regularly in a professional manner. They did not affect nuclear safety. Nevertheless, during the outage the inspection unit also dealt with a violation of operating limitations and conditions. In addition, the unit also monitored how the operator addressed some unexpected deviations after the outage.

The violation of operating limitations and conditions identified was related to a violation of the requirement regarding the closure of all containment building penetrations during the outage phase, when the closure of penetrations is required due to fuel movement. Namely, one of the penetrations was not closed. The violation occurred due to deficiencies in planning as well as deficiencies in the preparation of work orders. As a result, the implementation of maintenance activities on the isolation valve of the mentioned penetration were carried out at the wrong time. The SNSA prepared a special analysis of the event (for details, see Section 2.1.1.2). A special inspection review was also performed.

On the basis of the inspections during normal operation and the outage, the SNSA inspection unit concluded that the Krško NPP operated safely in 2109, i.e. without causing harm to people and the environment. The implementation of the activities during the outage ensures the safe and reliable operation of the Krško NPP during the next 18 months.

The radiation protection of exposed workers at the Krško NPP is supervised by the Slovenian Radiation Protection Administration (SRPA). In 2019 no inspections of the Krško NPP were performed by the SRPA.

The SRPA monitors the radiation protection of workers in the NPP. In 2019 no such inspections were performed.

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 staff of the Reactor Infrastructure Centre (RIC).

2.1.2.1 Operation

In 2019, the reactor operated for 137 days, during which it released 112.6 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 – 90 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 835 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 2019 there were five automatic reactor shutdowns. Three of those were due to operator error, one occurred during the calibration of a safety channel and one due to the error of a trainee. Such errors of operators or trainees 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. Automatic shutdown always occurred at low reactor power.

There were no violations of the operational limits and conditions from the Safety Analysis Report in 2019. There were also no events in 2019 that would require 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 2019 was 1.31 man-mSv for operating staff and 2.87 man-mSv for personnel carrying out work at the reactor.

2.1.2.2 Nuclear Fuel

In 2019, a total of 84 fuel elements were located on the reactor site. There were no spent fuel elements. All fuel elements were standard fuel 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 2019, inspections of 17 fuel elements were performed and for the first time the length of the fuel elements was measured at a precision of 0.1 mm. The JSI reported on the fuel balance monthly to the EURATOM and to the SNSA by a special form. In October 2019, 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

In December 2019 an evacuation exercise was carried out that included all the employees at the Reactor Infrastructure Centre.

In April 2019 the operators of the TRIGA Mark II reactor went on an expert excursion to Chernobyl.

Regular training of staff was performed in line with the annual programme for the expert training of TRIGA Mark II Research Reactor operators for the year 2019.

2.1.2.4 Modifications and Inspections of the Systems, Structures, and Components of the Nuclear Facility

The reactor operated in stationary mode and pulse mode. The pulsing was performed for exercise purposes for trainees and for the purpose of testing the response of different neutron detectors. The pulsing was approved in advance by the reactor safety committee and the SNSA was notified of the pulsing.

In 2019, six 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 2019, design modifications of the facility included renovation of the paging system, the refurbishment of the pneumatic post of the carousel, and the installation of an irradiation device into tangential channel five for the purpose of large detector testing. Refurbishment of the positioning system for control rods and renovation of the control for the dry cell were carried out.

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 Mark II 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 2019, the implementation of the Action Plan, with a total of 85 modifications and improvements, was completed. By means of semi-annual reports, the JSI reported on the implementation status. All actions were implemented by the end of 2019. Some of these actions also require changes to the Safety Analysis Report and this will be approved separately in the modification assessment process.

2.1.2.6 Inspection Reviews

In 2019, the inspection service for radiation and nuclear safety carried one inspection review of the TRIGA Mark II Research Reactor.

The inspection dealt with the actual regulatory state of the operational monitoring of the TRIGA Mark II reactor and with a review of the performance of operational monitoring of the TRIGA Mark II reactor in 2019.

In June 2019, the SNSA authorised the JSI to perform radioactivity monitoring for the next five years.

The inspection found that the scope of monitoring as defined in the Safety Analysis Report is more extensive than the requirements of the Basic programme for the operational monitoring of the radioactivity of the research reactor from the *Rules on monitoring radioactivity*, which can be commended as a good practice of the JSI radiation protection service.

Because the independence of measurements needs to be ensured, the inspection service required that the IJS provide at least one independent measurement of emissions and imissions in 2020. If possible, the samples should be selected in a manner that will enable the JSI to cover all of the different types of measurements in a few years.

During the inspection no deficiencies were found that would affect the assurance of radiation and nuclear safety.

With regard to the radiation protection of exposed workers, the Reactor Centre of the JSI is also supervised by the SRPA. The SRPA did not inspect the Research Reactor Centre in 2019.

References: [20], [21]

2.1.3 The Central Storage for Radioactive Waste in Brinje

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

The operating licence of the CSRW facility was extended in 2018 for a further ten years. Modifications and improvements resulting from the Action Plan of the first Periodic Safety Review are being implemented and regularly reported to the SNSA. Preventive periodic maintenance, inspections and tests of the assemblies of structures, systems, and components were carried out as planned.

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 2019 and the inventory of the waste stored as of the end of 2018 are described in more detail in Chapter 6.4.

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 hydro-metallurgical tailings disposal 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. The area covering the landfill body of the site became a national infrastructure object, 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 2019 was the ninth year (the fourth 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 6.5.

References: [23], [24]

2.2 RADIATION PRACTICES AND THE USE OF RADIATION SOURCES

Use of radiation sources is regulated by the ZVISJV-1 and secondary legislation adopted on the basis thereof. The SNSA is responsible for reviewing radiation assessment elaborations in the area of industry, research, and education, while the SRPA is responsible for the area of medicine and veterinary care.

2.2.1 Use of Ionising Sources in Industry, Research, and Education

In 2019, 74 licenses to carry out radiation practices, 30 licenses for the use of a radiation source, 11 print-outs from the register of radiation practices, 86 print-outs from the register of radiation sources, 13 approvals for external operators of radiation practices, 4 decisions on the termination of the validity of a license to carry out radiation practices, 5 decisions on sealing an X-ray device, and 1 decision on unsealing an X-ray device were issued by the SNSA.

In 2019, the SNSA continued to inform radiation practitioners regarding the expiry of licenses to carry out radiation practices and licenses for the use of a radiation source. Notifications, which are automatically generated by the InfoURSJV intranet portal, were sent a few weeks before the licenses expired. Thus, the parties still had sufficient time to prepare applications for their renewal. Despite the above-mentioned notifications, parties are still late in submitting applications for the renewal of licenses and providing information on radiation protection officers. They are also late in ordering periodic reviews of radiation sources, which have to be carried out by technical support organisations. In some cases, radiation sources are not reviewed until customers are alerted by the SNSA. 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. As of the end of 2019, 51 editions of the leaflet had been issued, four of them in 2019.

Ionisation smoke detectors, utilising isotope ^{241}Am, form a special group of radiation sources. According to the registry of radiation sources, there were 20,157 ionisation smoke detectors being used at 257 organisations at the end of 2019. In addition, 304 ionisation smoke detectors were stored on users' premises. Among them, 194 were stored on the premises of companies dealing with the maintenance, mounting and dismounting of ionisation smoke detectors. Recently, the number of detectors transferred to the Central Storage facility for radioactive waste increased.

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.

In 2019, the SNSA twice issued a change in a license to carry out a radiation practice. The changes refer to the maintenance, calibration, and other similar work carried out on radiation sources – linear accelerators and changes regarding Klystrons, as well for increasing the power of both accelerators from 40 kW to 60 kW. The license to carry out a radiation practice, the license to use radiation sources, and the decision on the status of the facility were modified due to the increase in power.

2.2.2 Inspections of Sources in Industry, Research, and Education

In 2019, the SNSA inspection service conducted 79 inspections related to industry, research institutions, ministries, educational institutions, scrap dealers, and transport companies. Interventions are included in this number. As a part of the regular inspection activities, the inspection service also conducted minor offence proceeding related to the implementation of long-term supervision and maintenance of the Jazbec mine tailings disposal site. The supervision and maintenance are conducted by the ARAO (details are given in Chapter 3.3.3).

In line with a graded approach, annual inspections related to the use of high-activity radioactive sources were performed. In 2019, special attention was devoted to industrial radiography. As a rule, annual inspections of industrial radiography practices are carried out not only due to the high-activity radioactive sources involved, but also due to the use of x-ray machines. This practice carries risks that require special attention from the inspection service. Special attention was devoted to training on emergency preparedness, i.e. to user preparedness for accidents in industrial radiography. Systematic inspections of the security of radioactive sources in industrial radiography were conducted as new requirements related to security were established. The inspection service noted that special attention must still be devoted to enclosures where industrial radiography takes place. The inspection service noted that big changes are foreseen in industrial radiography. Namely, the sources used in this practice come from abroad and old projector devices are becoming obsolete. They are widely being replaced by new projector devices abroad.

Since 2010, sources from past activities, except for smoke detectors with a radioactive source, are rarely found. Namely, in that year the systematic intensive search for orphan sources in companies and institutions ended. In 2019, such sources, actually forgotten radioactive waste, were found at only one site. The inspection service also continued with monitoring the implementation of numerous requirements related to inspections from previous years.

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 had already taken place. In addition, attention was devoted to communicating with bankruptcy managers. Such mangers might reluctantly and without any knowledge manage radioactive sources or radioactive waste during the bankruptcy.

One of the particularly challenging areas of the inspection service is inspection of the management of smoke detectors with radioactive sources. This issue has been regularly addressed by inspectors from 2010, i.e. the total number of inspectors since that year is higher than 90, showing that the management of such smoke detectors either as sources or as radioactive waste is a substantial burden on the inspection service.

In 2019, the inspection service also conducted inspection control of a transport of waste that included natural radionuclides from the company Cinkarna Celje d.d.

In 2019, the total number of inspection interventions was 16, i.e. somewhat more than in 2018, when only 11 interventions were carried out. The majority of interventions, i.e. altogether 10, were related to suspicion that orphan sources were present in scrap metal being transported. The regulatory activities are based on the preparedness of the SNSA, 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. Three types of interventions are identified:

- Interventions related to sources from past activities or present practices in Slovenia, which are the most demanding interventions;
- Interventions related to orphan sources in scrap metal; and

- Other interventions, namely in 2019 only three such interventions were carried out and all were related to the suspicion that safety measures were not in place, but subsequently this was not confirmed.

Three interventions of the first type required inspection actions as safety measures related to ionising radiation sources were not in place. The ARAO was informed that a large number of abandoned smoke detectors with radioactive sources were found in a building shelter in Ljubljana. This was followed by the inspection of a building manager, i.e. the company SPL d.o.o. The ARAO carried out an inspection control of radioactive waste, i.e. 128 smoke detectors. The second intervention was related to handling a TROXLER gauge 3440. A worker at the Slovenian national construction and civil engineering institute unwittingly pulled the handle of the ^{137}Cs source together with the source out of the gauge because the gauge had a defective safety screw. The radiation protection officer informed the SNSA. An analysis of the event followed as well as servicing of the gauge and an examination conducted by a qualified expert for radiation protection. Figure 14 shows the gauge.

Figure 14: TROXLER 3440 gauge with defective movement mechanism (Photo: IOS)

The third intervention of the first type was initiated by an occupational safety officer at the National Institute of Biology. Namely, workers of at the Institute found a box with laboratory equipment labelled ^{14}C in the basement of the Institute's premises in Ljubljana. A qualified expert for radiation protection, i.e. the JSI, carried out the analysis. In 2020 the SNSA carried out an inspection and finally the radioactive waste with ^{14}C was taken over by the ARAO. Figure 15 shows the box found and a part of the found radioactive waste.

Figure 15: Measurements at the National Institute of Biology and part of the items found (Photo: JSI)

In 2019, ten SNSA interventions were related to the identification of enhanced dose rates when performing measurements during the control of transport. Cargo was returned to the country of origin in seven interventions; Croatia, Hungary, Germany, and Bosnia and Herzegovina were the countries of origin. One intervention was related to transport by the company Gorenje Surovina d.o.o. Namely, on its premises in Ravne enhanced radiation was identified in cargo containing scrap metal. A qualified expert for radiation protection, i.e. the Institute of Occupational Safety (IOS), conducted an analysis of the cargo as well as decontamination. The radiation source was a gyroscope dial containing ^{226}Ra radio fluorescent paint. A conservative assessment of the activity was 500 kBq. Figure 16 shows the gyroscope dial.

Figure 16: Gyroscope dial containing ^{226}Ra radio fluorescent paint found in a scrap yard causing soil contamination (Photo: IOS)

Two times a company informed the SNSA that Italian experts measured enhanced radiation in cargo from Slovenia. Such cargo was returned to Slovenia and a qualified expert for radiation protection identified the origin of the enhanced radiation. In one case, dust was contaminated with ^{226}Ra and ^{232}Th, while in the other case the cargo was contaminated with ^{238}U, ^{226}Ra, and ^{210}Pb. The expert's advice to dilute the contaminated material at a 1:10 ratio before placing the material in a landfill was accepted by the SNSA as an acceptable solution.

2.2.3 Use of radiation sources in Medicine and Veterinary Medicine

The 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, 1,181 X-ray devices for medicine and veterinary medicine were installed as of the end of 2019; 153 of them were not in use (7 required servicing, 111 were in reserve, and 35 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 2019
Dental	583	57	17	623
Diagnostic	312	25	27	310
Therapeutic	12	1	1	12
Simulator	4	0	1	3
Mammography	35	3	1	37
Computed Tomography CT	33	9	4	38
Densitometers	45	3	0	48
Veterinary	84	31	5	110
TOTAL	**1,108**	**129**	**56**	**1,181**

In the field of using X-ray devices in medicine and veterinary medicine in 2019, the SRPA granted 110 licenses to carry out a radiation practice and 296 licenses to use X-ray devices.

In medicine (not including veterinary medicine), 476 X-ray devices were used in public hospitals and institutions and 595 in private dispensaries. The average age of the X-ray devices in the public sector was 9.8 years (10.1 years in 2018, 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 10.3 years (10.2 years in 2018, 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 91 in the private sector. The average age of the X-ray devices was 15.0 years (14.9 years in 2018, 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, and 13.8 years in 2012) in the public sector, and 7.3 years (8.8 years in 2018, 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 (80%)	9.5	117 (19%)	10.8	12 (100%)	7.2	17 (16%)	15.0	493 (42%)	9.9
Private	89 (20%)	12.4	506 (81%)	10.0	0	0	93 (84%)	7.3	688 (58%)	9.9
TOTAL	**436**	**10.1**	**623**	**10.2**	**12**	**7.2**	**110**	**8.5**	**1,181**	**9.9**

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 17, which shows that more than 95% of devices were classified as "fully functional".

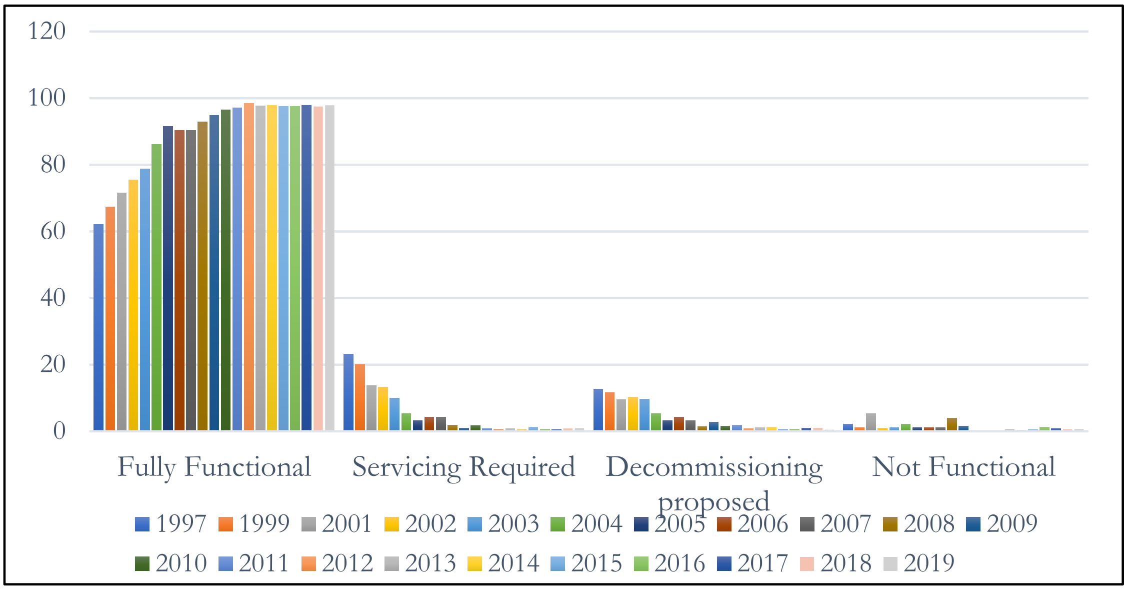

Figure 17: Percentage of diagnostic X-ray devices according to quality in the period 1997– 2019

In 2019, 13 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. Ten in-depth inspections in X-ray diagnostics were performed, six of them in dental radiology and one in veterinary medicine. In five cases, based on the findings of the inspection, the SRPA inspection service issued a decision requiring compliance with the valid regulations. During the inspections, four X-ray devices in reserve were sealed.

Based on a review of the inspection reports regarding X-ray devices for medical use sent to the SRPA by approved technical support organisations, nine inspections were conducted, during which the SRPA requested that the user provide evidence that the noted shortcomings had been eliminated. There were 37 cases in which the user was asked to present evidence relating to cessation of the use of an X-ray device and 123 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 5,803.4 GBq of isotope ^{99}Mo, 4,653.3 GBq of isotope ^{18}F, 986.7 GBq of isotope ^{131}I, and minor activities involving the isotopes ^{123}I, ^{177}Lu, ^{201}Tl, ^{111}In, ^{123}I, ^{90}Y, ^{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, 0.6 GBq of that isotope were imported in 2019 (a bit less than in 2018, when 1.4 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, seven licences to carry out a radiation practice, 16 licences to use a radiation source, one export licence (return of a used source to the manufacturer), and 27 statements on the shipment of radioactive materials from European Union Member States were issued in 2019.

In 2019, one inspection was conducted at the Oncology Institute, during which only minor irregularities were found.

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 2019.

Neither unsealed nor sealed radioactive sources were used in veterinary medicine in 2019.

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* (Official Gazette RS, Nos. 33/06-UPB1, 41/09, 97/10, and 56/15). 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 2019, the SNSA and the SRPA did not issue any licenses for the transport of radioactive materials according to the Act on the Transport of Dangerous Goods.

In 2019, 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 2019, the SRPA issued one permit for the shipment of radioactive sources from non-EU countries (the return of a spent source to the manufacturer) and approved 27 applications of consignees of radioactive material for 50 isotopes. Each isotope from an individual producer intended for the same end user is counted separately.

In 2019, the SNSA approved 18 applications of consignees of radioactive material from other EU Member States. The SNSA also issued six permits for the import of radioactive material, two permits for the import of nuclear material, i.e. fresh fuel for the Krško NPP and the chemicals uranil acetate dihydrate, which contains depleted uranium, two permits for the shipment of radioactive material into Slovenia, i.e. fission chambers, and three permits for the export of radioactive material.

In September 2019, about 30 tons of waste material contaminated with natural radionuclides originating from Cinkarna Celje were sent to the United States. As early as August 2018, the SNSA issued approval for these exports on the basis of a European directive, after obtaining all the consents of the transit countries (Austria, Germany, and Belgium) and the USA as the country of destination. The waste material was finally disposed of at the US Ecology facility in Idaho in November 2019. In early September 2019, the SNSA notified the European Commission of the scheduled shipment. This was done in accordance with Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.

Figure 18 shows the ISO containers in which the drums of radioactive waste are loaded.

Figure 18: Manipulations of the ISO container with a crane at Cinkarna Celje, d.d. (left); markings on the ISO container and seal (right) (Photo: SNSA inspection service)

In 2019, the SNSA also issued one permit for the transit of radioactive material with important activity.

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 to ensure 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 based on 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 (both located at Brinje near Ljubljana) is monitored. Doses for the population are assessed in the vicinity of these facilities on the basis of measured or modelled 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 2019.

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 is an automatic measuring system that instantly detects increased radiation in the environment in the event of an emergency.

All radioactivity data is collected in a dedicated application called Radioactivity in the Environment (RVO, "**R**adioaktivnost **V** **O**kolju" in Slovenian). Access to the RVO public portal is made possible on this website (Figure 19). The public portal displays real-time data on radiation measurements in the environment, basic information on radioactivity, historical data on the radiation exposure of the population in Slovenia, and studies on radiation problems in Slovenia. In addition to archiving, displaying, and informing the SNSA's experts in the event of elevated radiation values, the portal also enables real-time displays of data from field measurements obtained by mobile units or SNSA employees. It also offers other more in-depth analysis. The content set "*Exercises and Emergencies*" has an important functionality as it enables the use of the results of models to predict the spread of radioactive contamination for educational purposes, as well as to compare the calculated and real measured values. The collected data are automatically entered into the system and are simultaneously available to the public on the RVO web portal. At the same time, they are exchanged abroad on the basis of international agreements (data is transferred to the European Joint Research Center in Ispra, Italy) and bilateral agreements with Austria, Croatia, and Hungary. The RVO system enables the preparation of real-time reports on the radiological situation, which are sent every 30 minutes.

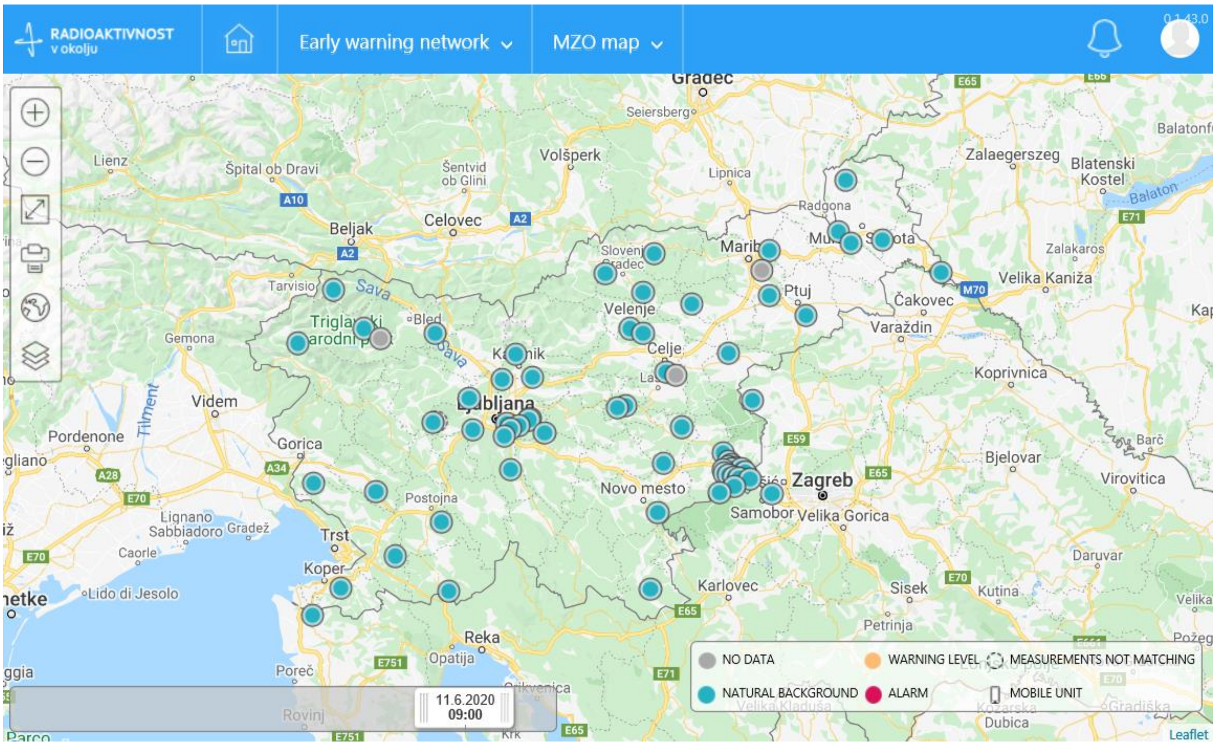

Figure 19: Basic overview of the of the status of the early warning network in Slovenia

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 2019 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.

^{137}Cs has been present in air samples for years as a result of global contamination due to nuclear tests and the Chernobyl accident. The sensitivity of air pump measurements makes it possible to monitor very small changes in radionuclide concentrations, which cannot be detected in other environmental media. The long-term trend of the specific activity of ^{137}Cs measured in Ljubljana is shown in Figure 20. A declining trend can be observed after the highest concentrations in 1986. Minor increases after the Chernobyl accident were seen in 1998, at the time of the accident at the Acerinox steel works in Spain, where a ^{137}Cs radioactive source was melted, resulting in 10 times higher values. Minor increases were also noted in the first few months after the Fukushima nuclear accident in Japan in March 2011 and in July 2016, when there was a forest fire in the Chernobyl exclusion zone, but there were no significant impacts on Europe and Slovenia.

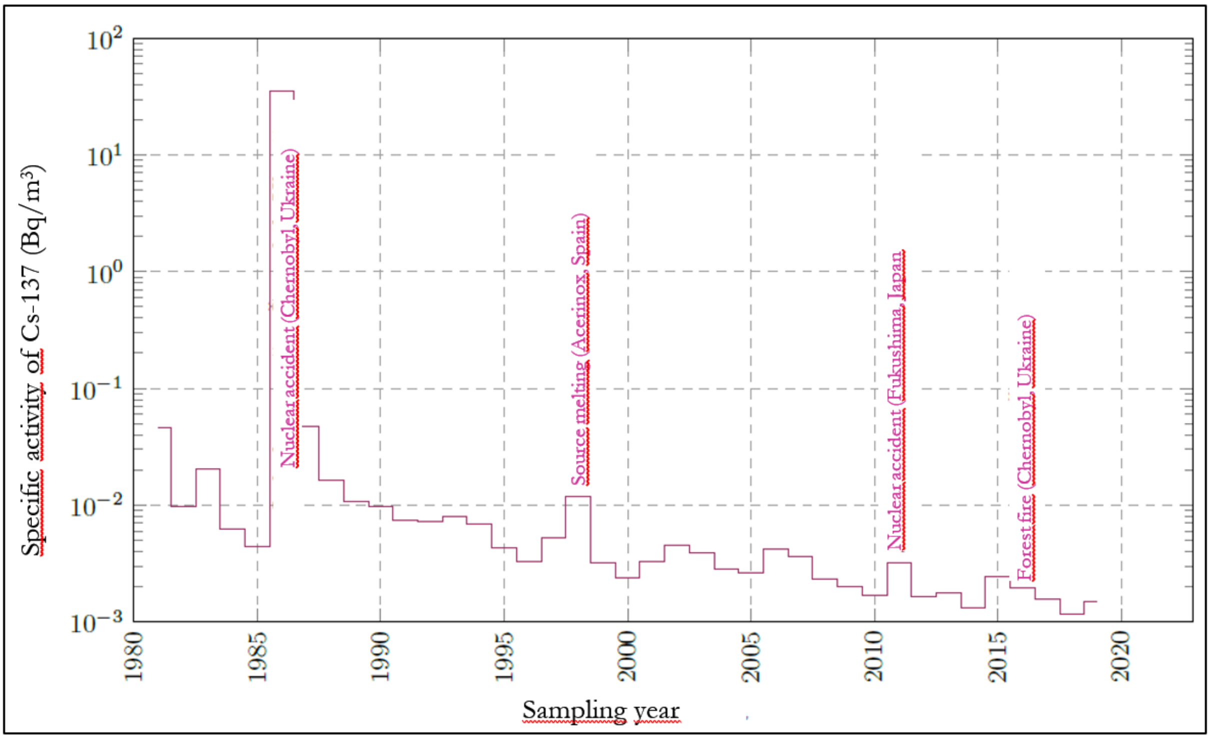

Figure 20: Average annual specific activities of ^{137}Cs in the air in Ljubljana since 1981

Measurements of specific activity in the air also enable a more detailed analysis of seasonal variations of ^{137}Cs activity in the air, which are assumed to be a result of increased use of firewood and wood fuels in the winter months. Based on data on the total consumption of wood fuels in previous years, it can be estimated that a total of 5.6 GBq of ^{137}Cs was released into the air in 2019, which is, for comparison, much more than is released every year by the Krško Nuclear Power Plant.

Measurements of all environmental media were, within static variations, comparable to values from previous years.

The largest contribution to the radiation exposure of the population due to contamination of the environment with artificial radionuclides comes from external radiation and food. The received dose due to the inhalation of air particles with fission radionuclides is negligible. ^{90}Sr contributes the largest part of the dose in food, while ^{137}Cs contributes the most to external radiation. The effective dose of external radiation due to ^{137}Cs (mostly from the Chernobyl accident) was estimated at 5.6 ± 0.2 μSv in 2019, which is 0.21% of the dose received by the average resident of Slovenia from external radiation due to the natural background.

In 2019, nutrition data were updated, where differences are noticeable, especially with smaller amounts of certain types of consumed food. Therefore, in 2019, within the statistical deviations of food selection and sampling, the estimated dose due to ingestion (the ingestion of food and beverages) is expected to be lower than in 2018 and is estimated at 0.8 ± 0.4 μSv. However, if individual types of food are analysed, the largest part of the effective dose for adults is contributed by the ingestion of radionuclides through the consumption of vegetables and meat, and for infants by the ingestion of milk and vegetables. Due to the low concentrations of ^{137}Cs and ^{90}Sr in the air, the estimated annual contribution of both long-lived fission radionuclides to the inhalation dose is negligible compared to radiation exposures from other transmission pathways and is about 0.1 nSv for both radionuclides together, which is similar to that in previous years.

The dose from drinking water due to the artificial radionuclides it contains is also assessed each year. Calculations show that it averages approximately 0.02 μSv per year. The annual limit value of

0.1 mSv due to natural and artificial radionuclides in drinking water from local water supplies was not exceeded in any of the examined cases.

In 2019, 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 6.4 µSv, as shown in Table 5. This value represents less than 1% of the annual limit dose for the long-term exposure to ionising radiation of an individual in the population. 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 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 2019

Transfer pathway	Effective dose [µSv per year]
Inhalation	0.0001
Ingestion (of food and beverage):	
drinking water	0.02
food	0.8
External radiation	5.6*
Total (rounded)	**6.4****

* 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.

Figure 21 shows the estimated total effective dose (ingestion, inhalation, and external radiation) due to environmental contamination with long-lived artificial radionuclides for adults since the year 2000. The calculation methodology changed after 2000. The grey area represents the highest expected value of the dose exposure and represents the error in the calculations.

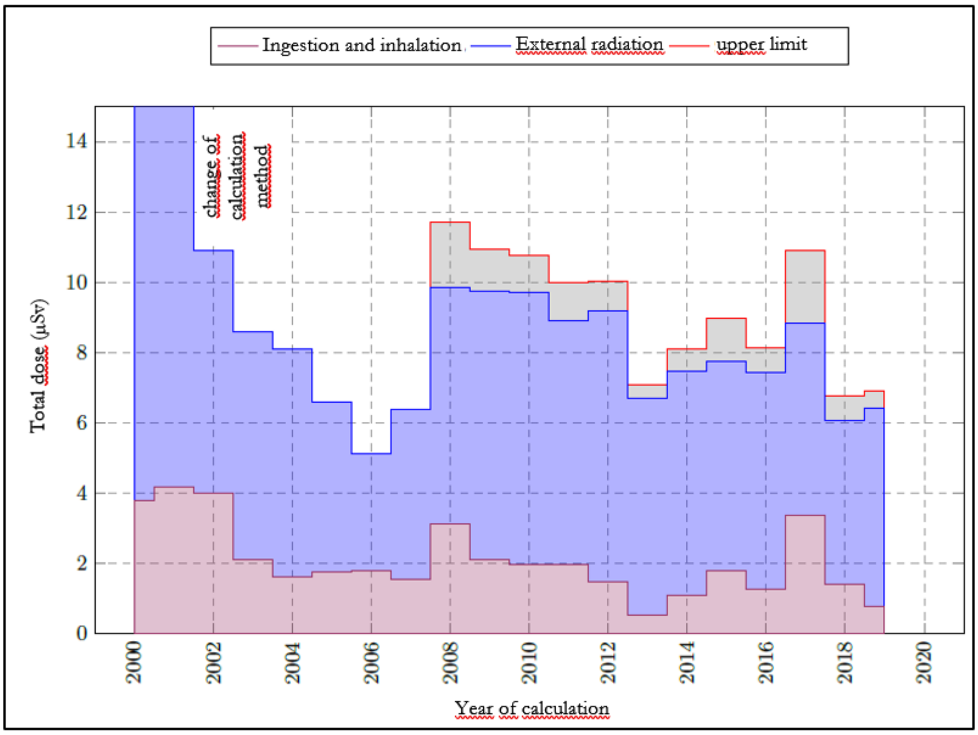

Figure 21: Estimated effective dose due to environmental contamination with long-lived artificial radionuclides for adults (Slovenian average) since 2000

Reference: [25]

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 based only on 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 2019, 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

As in 2018, an outage also took place in 2019, so radioactive releases were slightly increased compared to those in the year 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 0.843 TBq in 2019, resulting in a dose exposure that represents 0.2% of the total limit. In 2019, radioactive iodine radionuclides released 1.6 MBq (calculated to the equivalent of ^{131}I), which is 0.01% of the annual limit (one order of magnitude smaller than in 2015). The discharged activity of radioactive particulates was negligible in 2019 and amounted to 1.63 kBq, which is approximately one thousand times less than in 2016 and 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 gaseous discharges has been observed from year to year. This increase was mainly due to improvement of the sampling and analysis methods 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 2019 was expected to be higher due to the outage of the NPP, and amounted to 13.6 TBq, which is 30.2% 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 also slightly higher than in the previous year due to the refuelling outage and amounted to 25.1 MBq or 0.025% 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 2019, the total activity of released ^{14}C was 0.088 GBq, which is comparable to recent years and less than suggested in the literature and international practice, i.e. 0.07 Ci/GW(e)/year or 1.8 GBq/year.

Figure 22 shows the activity of the released ^{3}H in liquid discharges from 1983 to 2019.

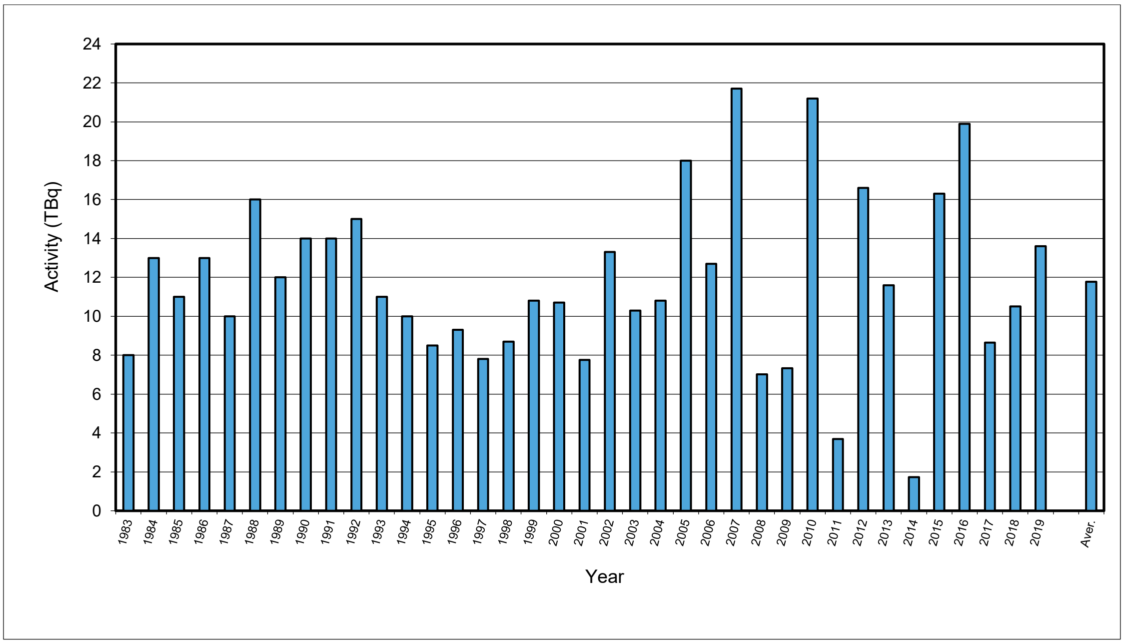

Figure 22: Activity of released ^{3}H in liquid discharges in the Krško NPP

3.3.1.2 Exposure of the Public

The programme for monitoring environmental radioactivity that may be attributed to 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);
- Sava River water, sediments, and water biota (fish);
- drinking 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 carried out by contractors and was based on discharge measurements and model calculations because the influence of the Krško NPP on the concentrations of radionuclides in environmental samples is mostly not measurable. The model is based on the calculation of dilution factors for air discharges, on the basis of real meteorological data and methods of mixing liquid discharges into the Sava River. The calculated dispersion factors for atmospheric discharges, based on realistic meteorological data, showed that the most important pathways for food exposure were the ingestion of ^{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 (0.08 µSv), while a lower dose (0.016 µSv) was also received due to the inhalation of ^{3}H and ^{14}C. The liquid discharges in 2019 did not significantly contribute to the additional exposure of individuals from the population – of which ^{3}H makes the largest contribution. 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, 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 0.11 µSv. This value represents 0.2% of the authorised limit value (the dose constraint is 50 µSv per year), or 0.005% of the effective dose received by an average Slovenian from natural background radiation (2,500 – 2,800 µSv per year).

Table 6: Assessments 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 2019

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)	$1.2 \cdot 10^{-3}$
	Deposition	Particulates: (^{58}Co, ^{60}Co, ^{137}Cs …)	$2.7 \cdot 10^{-9}$
Inhalation	Cloud	^{3}H, ^{14}C, ^{131}I, ^{133}I	0.016
Ingestion (atmospheric discharges)	Vegetable food	^{14}C	0.08
Ingestion (liquid discharges)	Ingestion of fish (from the Sava River)	^{3}H, ^{137}Cs, ^{89}Sr, ^{90}Sr, ^{131}I, ^{14}C	0.012
Total Krško NPP in 2019		**< 0.11***	

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

Reference: [26]

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 2019 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 the 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, based only on reactor operation time, were estimated at 1.2 TBq in 2019, which is comparable to previous years. As in the past, low concentrations of radioactive substances were occasionally present in liquids from the containment tank of the O-2 section. In 2019, ^{197}Hg and ^{54}Mn were detected.

The programme of specific activity measurements in the environment showed no radioactive contamination from the operation of the reactor. The external dose from the cloud shine due to ^{41}Ar discharges 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 his time in the cloud, was estimated at 0.03 µSv per year, which is similar to previous years. A resident of Pšata, a settlement at a distance of 500 m, receives 0.63 µSv per year for a year-round stay. Taking into the account the conservative assumption that inhabitants drink the water from the Sava River where liquid discharges emerge, the annual received dose was estimated at 0.07 µSv. The total annual dose received by an individual from the population in 2019 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 environmental radioactivity monitoring programme of the Central Storage for Radioactive Waste (CSRAO) 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 underground 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 underground water and in the air. In addition, external radiation was measured at different distances from the storage area. As part of the measurements for maintaining preparedness, measurements of soil contamination and the concentration of radionuclides in the dry deposition from the air near the storage area were also performed.

The estimated average radon discharge rate in 2019 was 11 Bq/s, which is, considering the measurement uncertainty, similar to the discharge rates in previous years (Figure 23). The higher values in 2004 and 2005 are due to the situation before the reconstruction of the storage facility. An increase in the radon ^{222}Rn concentration near the storage was not measurable in 2019 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 and ^{40}K, as well as radionuclides of the uranium-radium and thorium decay series.

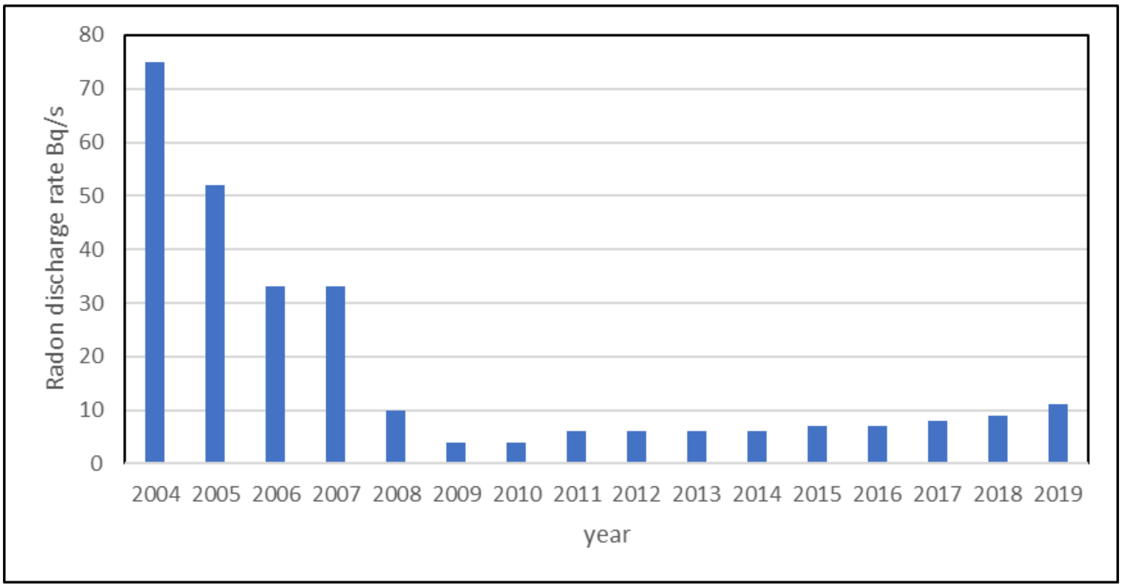

Figure 23: ^{222}Rn emissions from the Central Radioactive Waste Storage Facility in Brinje

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 Centre, who could potentially be affected by radon releases from the storage area. According to the model calculation, they received an estimated effective dose of 1.54 µSv in 2019, which amounts to 1.5% of the authorised dose limit for individuals from the reference group of the population (100 µSv per year). A security officer of the Reactor Centre received 0.73 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. The values are comparable to the year 2018 and are much lower than in 2008 due to lower radon emissions; at the same time, they are negligible compared to the annual dose received by each individual due to natural radiation, which is 2,500 – 2,800 µSv.

Reference: [27]

3.3.3 The Former Uranium Mine Žirovski Vrh

The monitoring of the environmental radioactivity of the former uranium mine 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 the natural radiation background).

In 2015, ARAO assumed the management and long-term monitoring of the Jazbec disposal site, while the Boršt hydro-metallurgical tailings disposal site is managed by Rudnik Žirovski Vrh d.o.o. (RŽV). Currently, both disposal sites operators are responsible for implementing the environmental monitoring programme. The SNSA issued a license for the implementation of long-term supervision and maintenance of the Jazbec disposal site to the ARAO. Until the confirmation of the change in the Safety Report for the Jazbec disposal site, the ARAO has been 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 fifth (last) year of the transitional period.

On 24 September 2019, the SNSA approved a change to the Safety Report of the Jazbec disposal site. Thereby, the radioactivity control programme of the Jazbec disposal site was changed and the scope was decreased according to the analysis of the implementation of monitoring in the past and the condition of the closed disposal site.

The year 2019 was already the ninth year of the envisaged transitional five-year period at the Boršt disposal site. The monitoring programme for the Boršt disposal site was carried out under the same programme as in the fifth (last) year and will remain active in the future until the closure of the disposal site.

Throughout 2019, the ARAO implemented a radioactivity monitoring programme at the Jazbec disposal site according to the new, reduced programme for long-term surveillance, although it was approved in September 2019.

3.3.3.1 Radioactive Releases

In 2019, it was not possible to estimate the total value of all releases from the Jazbec disposal site because all necessary measurements were not performed. It was not possible to assess the compliance of the emission values with the authorised limit values. Measurements of liquid discharges showed that they were within the authorised limit values for the Boršt disposal site. For Jazbec and for mine water, only one-time measurements were performed, which is not sufficient for a relevant assessment of discharges, but it provides indicative information on the current state of the disposal site. Concerning gas discharges, the situation was slightly better because, despite the incomplete data, it was possible to estimate radon discharge from the surfaces of both disposal sites. Values for both disposal sites 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 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 disposal site 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 2019, the most important part of the programme was the measurement of radon concentrations, which additionally contribute to the population dose 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 the Brebovščica Stream, where all the liquid emissions from the mine and from both disposal sites are discharged, only the concentration of uranium has noticeably increased compared to the natural background values.

For 2019, it is estimated that the contribution of ^{222}Rn from the remaining mining sources to the natural concentrations in the environment was approximately 3.2 Bq/m^3 (in 2018: 3.3 Bq/m^3).

The following pathways were considered in assessing the effective dose of the population: the inhalation of long-lived radionuclides of the uranium decay chain, radon and its short-lived progeny, ingestion without the contribution of water (the provision of residents with public water supply), and external gamma radiation. In 2019, the radiation exposure of an adult individual in the reference group of the population was estimated at 0.071 mSv, for a 10-year-old child 0.067 mSv, and for a 1-year-old child 0.075 mSv. The values are similar to those from 2018 and are in accordance with averages from recent years. 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 0.068 mSv of additional exposure in this area (Table 7). The dose due to drinking water from contaminated watercourses was estimated but not considered in the total. The inhabitants do not use this water for drinking, watering, irrigating, or watering cattle.

Table 7: The effective doses received by an adult member of the public living in the surroundings of the former Žirovski Vrh Uranium Mine in 2019

Transfer pathway	Important radionuclides	Effective dose [mSv]
Inhalation	– aerosols with long-lived radionuclides (U, ^{226}Ra, ^{210}Pb)	(pathway no longer exists)
	– only ^{222}Rn	0.0017
	– Rn – short-lived progeny	0.068
Ingestion	– drinking water (U, ^{226}Ra, ^{210}Pb, ^{230}Th)	(0.015)*
	– fish (^{226}Ra and ^{210}Pb)	not estimated (0.002)**
	– agricultural products (^{226}Ra and ^{210}Pb)	not estimated (0.007)**
External radiation	– immersion and deposition (radiation from the cloud and deposition)	0.0011
	– deposition of long-lived radionuclides (deposition)	-
	– direct gamma radiation from disposal sites	-
Total effective dose		**0.071 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, the watering of animals, or irrigation.

** Values in brackets are calculated on the basis of the last measurements of fish and food from 2015.

Radioactivity measurements and dose assessments in recent years have shown that the cessation of mining, together with the closure work carried out thus far, has significantly reduced the impact on the environment and the population. The estimated exposure is less than one fifth of the authorised limit value of 0.3 mSv per year, which is determined for all facilities after the remediation (the mine and the Boršt hydro-metallurgical tailings disposal site and Jazbec mine tailings disposal site) (Figure 24).

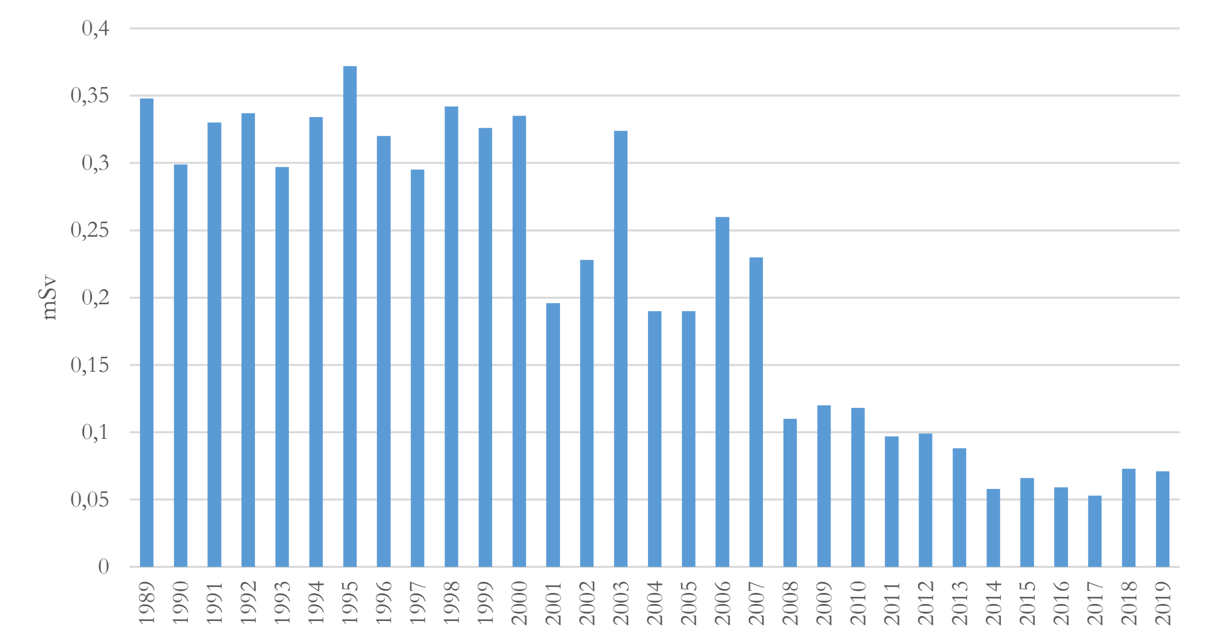

Figure 24: Annual contributions to the effective dose received by an adult member of the public due to the former Žirovski Vrh Uranium Mine in the period 1989-2019

3.3.3.3 Inspections of the former Žirovski Vrh Uranium Mine

The Inspectorate reviewed the reports of performed measurements for the needs of monitoring the Jazbec disposal site for 2017 and 2018. The Inspectorate found that the ARAO documents or reports show that the ARAO did not perform all planned measurements under the monitoring programme and long-term control plan in accordance with the amendment of the safety report, for the fifth (last) year of the transitional period in either 2017 or 2018, which entails a violation. The inspectorate therefore issued a minor offence decision.

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 are presented in Chapter 4 (due to artificial and natural sources), while medical exposures are presented in Chapter 5.

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. Based on 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 in Slovenia 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 be ensured in areas where there is an increased exposure of workers or the environment 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 2019, measurements of external gamma radiation in working environments and in production were performed, as well as measurements of specific activities of natural radionuclides in the air, samples of raw materials, and disposed waste products resulting from industrial processes. The following companies were included: Heating Plants in Ljubljana and Celje, Central Wastewater Treatment Plants in Ljubljana and Celje and Thermal Power Plants in Trbovlje and Šoštanj.

Measurements showed that in some places the level of radiation was determined to be above the natural background due to ^{40}K and radionuclides of the uranium and thorium decay chain. The highest detected value at the boiler at Heating Plant Ljubljana was 135 nSv/h. At the ash landfill between Škalsko and Velenje Lake a maximum of 210 nSv/h was measured.

Based on measurements of radiation and radionuclide concentrations, the authorised radiation protection expert of the JSI estimated that the additional exposure of workers is not significantly higher than exposure due to the natural background, as there are no permanent jobs in places with elevated values and workers do not stay there more than 10 to 20% of their working time.

3.4.3 Programme of systematic surveillance and measurements of radon

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* (Official Gazette RS, Nos. 18/18 and 86/18) was adopted in 2018. Together with the *Ionising Radiation Protection and Nuclear Safety Act* (Official Gazette RS, Nos. 76/17 and 26/19), the Decree establishes the legislative framework for the 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 and measurements in dwellings continued. The 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 2019, the SRPA issued one approval to perform radon measurements to the Swedish company Radonova.

From January to November 2019, the IOS carried out measurements in various buildings for education, cultural, and healthcare activities. Different methods were used: 325 basic radon measurements using nuclear track detectors for determining average radon concentrations, 52 additional continuous measurements for weekly monitoring of the timing of radon progeny and radon, and 8 measurements of potential radon sources originating from soil, shafts, or openings into rooms. A total of 144 buildings were measured. The average radon concentrations exceeded the reference level (300 Bq/m^3) in 76 buildings (53%) and in 151 rooms (46%). A value of 900 Bq/m^3 was exceeded in 43 rooms (28%). 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 81 estimated annual doses, 6 exceeded the threshold of 6 mSv for members of the public. The highest estimated dose was around 15 mSv due to an average radon concentration of 3,000 Bq/m^3 in the office of the Zelena jama Ljubljana kindergarten. In 33 cases, the estimated annual doses were between 2 and 6 mSv, in 30 cases between 1 and 2 mSv, and in 12 cases less than 1 mSv. Protection measures continue to be performed in most of the rooms with high radon concentrations.

In 2019, the SRPA conducted 8 in-depth inspections of legal entities that operate facilities with increased levels of radon. (Naklo Primary School, Tržič Kindergarten, including the Lom subsidiary, Tržič Primary School, including the Lom subsidiary, Škocjan Caves Park, the Primary School Matije Valjavca Preddvor, including the Kokra subsidiary, Predoslje Primary School, Sostro Primary School, including the Janče subsidiary, and Radovljica Music School). The highest radon concentration (about 4,200 Bq/m^3) was measured in a classroom of the Janče subsidiary during the winter season. Seven warnings with requests to reduce radon concentrations (ventilation, time limitation, remediation) were issued as a part of an inspection process. Also four inspection orders were issued (Komen Primary School, Kranj Kindergartens, Preddvor Primary School, and Sostro Primary School). Additional and control measurements are continuing in most buildings.

In 2019, 52 letters with information on measurement results and recommendations regarding appropriate measures (if needed) were sent to institutions where the IOS performed measurements according to the programme for the systematic examination and measurement of radon.

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 520 basic measurements using nuclear track detectors for assessing average monthly or bi-monthly radon concentrations in 48 municipalities (Bloke, Bohinj, Borovnica, Brezovica, Cerknica, Črnomelj, Divača, Dobrepolje, Dolenjske Toplice, Gorenja vas-Poljane, Gorje, Grosuplje, Hrpelje-Kozina, Idrija, Ig, Ilirska Bistrica, Ivančna Gorica, Jesenice, Kanal, Kočevje, Komen, Kostanjevica na Krki, Kostel, Ljubljana, Logatec, Loška dolina, Loški, Potok, Metlika, Miren-Kostanjevica, Mirna Peč, Mozirje, Nova Gorica, Novo mesto, Pivka, Postojna, Radovljica, Ribnica, Semič, Sežana, Sodražica, Straža, Škofja Loka, Trebnje, Tržič, Velike Lašče, Vrhnika, Žirovnica, Žužemberk). The majority of the measurements were performed from February to April 2019 and fewer from September to November 2019. The measurements were done mostly in older buildings at the ground floor level or basements in rooms such as living rooms or bedrooms. The measurements were performed mainly in the radon-prone areas defined by the *Decree on the national radon programme* (Official Gazette RS, Nos. 18/18 and 86/18) and also in the areas where additional measurements should be carried out. The average radon concentration exceeded the reference value of 300 Bq/m^3 in 270 cases (52%). The value of 900 Bq/m^3 was exceeded in 126 cases (24%). The highest average radon concentrations were between 4,000 Bq/m^3 and 4,500 Bq/m^3. The highest radon concentration was measured in a pantry in the Municipality of Ribnica, in Idrija, Kočevje, and in Postojna two living rooms and one bedroom exceeded 4,000 Bq/m^3. In 50 cases radon concentrations were between

200 and 300 Bq/m^3, in 112 cases between 100 and 200 Bq/m^3, and in 88 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 be taken.

Cooperation with school principals, teachers, journalists, and members of the public is increasing. The SRPA is providing them with relevant information and lending radon detectors for preliminary radon concentration measurements in working or living environment. The SRPA purchased 56 such detectors between 2015–2018. Interested individuals, companies, or institutions can borrow radon detectors free of charge for a period of two months. Such measurements are not official but serve for a preliminary assessment of the average radon concentration on the premises and in the facilities. In 2019, radon detectors were borrowed 117 times (24 in 2018, 17 in 2017, 8 in 2016, and 3 in 2015).

In 2019, the development of the Register of Radon Measurements continued. All measurement performers will report all measured results to the Register, which in the future will contribute to the comprehensive evaluation of radon exposure in Slovenia.

Measurements of gross alpha and gross beta activities in drinking water

In 2019, 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 85 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 0.17 Bq/kg, with an average value of 0.031 Bq/kg. The values for gross beta concentrations were up to 0.48 Bq/kg, with an average value of 0.16 Bq/kg. The parametric value of the beta concentration (1 Bq/kg) was not exceeded. Gross alpha and gross beta concentrations were similar to the values in 2018.

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 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 maximally exposed adults from the reference groups for all objects in consideration. For comparison, the average annual dose received by individuals originating from global radioactive contamination of the environment (nuclear tests and the Chernobyl accident) is also shown. The highest exposures for individuals are recorded in the surroundings of the former uranium mine in Žirovski Vrh and are estimated at a few percent of the natural exposure in Slovenia. The radiation exposure of individuals from the public does not exceed the regulatory limits.

The population is also exposed to radiation due to other activities. These exposures come mainly from irradiation from deposited substances with increased natural radioactivity which originate from past activities and are mostly related to the mining and processing of raw minerals containing uranium or thorium admixtures.

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	0.071	**0.300
Chernobyl and nuclear tests	0.006–0.015	/
Krško NPP	<*0.00011	***0.050
TRIGA Mark II Research Reactor	0.00063	0.050
The Central Storage for Radioactive Waste	0.00003	0.100
Natural radiation sources (average)	2.5–2.8	

* Estimated value for different population groups, radioactivity monitoring in the vicinity of the Krško NPP.

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

*** Due to radioactive discharges.

Reference: [25]

4 RADIATION PROTECTION OF WORKERS

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.

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 2019 were the IOS, JSI, and Krško NPP. The IOS was approved for the assessment of radon exposure in mines and Karst caves. Currently, 18,096 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 431 plant personnel and 953 external workers, who received an average dose[2] of 0.61 mSv of ionising radiation. As for other work sectors, workers in nuclear medicine received the highest average annual effective dose of 0.52 mSv from external radiation, while employees in medicine and veterinary medicine received an average of 0.19 mSv. Workers in industry received an average annual effective dose of 0.32 mSv, of which the maximum recieved effective dose for workers performing industrial radiography was 0.50 mSv.

In 2019, the highest collective dose from external radiation was received by workers at the Krško NPP (668 man-mSv), followed by workers in the medical and veterinary sector (257 man-mSv), workers in other industries (38 man-mSv), and workers in other activities (35 man-mSv).

Since 2010, the CRPD has included personal doses received by employees of Slovenian companies when performing radiation activities abroad. In 2019, 16 workers abroad received a total dose of 7.0 man-mSv or an average of 0.70 mSv. High individual doses due to external radiation are received by workers who perform outage works at nuclear power plants abroad, participate in work at the Krško NPP, and perform industrial radiography. It is important that their annual individual dose takes into account the contribution from all activities. The most exposed individual in this group received an annual individual dose of 5.8 mSv.

Between 2010–2018 data on the doses of Adria Airways flight personnel who were exposed to cosmic radiation were included in the CRPD. Due to the company's bankruptcy, it was not possible to obtain this data for the year 2019.

The highest doses are received by workers exposed to radon and its progeny. In 2019, out of 170 tourist workers, 12 workers received a dose between 15 and 20 mSv, 38 workers received a dose between 10 and 15 mSv, 32 workers received a dose between 5 and 10 mSv, 79 workers received a dose between 1 and 5 mSv, and 9 workers received a dose of less than 1 mSv. The highest individual dose was 17.5 mSv. The collective dose was 1,135 man-mSv, with an average dose of 6.7 mSv. Tourist workers in Karst caves are the most exposed category of workers in Slovenia.

The findings of a study (Institute of Occupational Safety, No. LMSAR-100/2005-PJ, 2005) 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 Karst caves, the ICRP 32 model should be used and an

[2] All average doses in this section are converted into the number of workers who received doses above the detection level.

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 0.51 man-mSv, whereas the average individual dose was 0.06 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	291	864	228	1	0	0	0	0	1,384
Industry	542	107	10	0	0	0	0	0	659
Medicine and veterinary medicine	3,235	1,346	40	0	0	0	0	0	4,621
Other	1,213	326	3	0	0	0	0	0	1,542
Radon	0	17	79	32	38	12	0	0	178
Abroad	6	7	3	0	0	0	0	0	16
Total	**5,287**	**2,667**	**363**	**33**	**38**	**12**	**0**	**0**	**8,400**

MDL – minimum detection level

E – effective dose in mSv received by an exposed worker

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 the IOS, d.o.o., and the JSI. In 2019, a total of 1,883 participants attended courses on ionising radiation protection.

Targeted medical surveillance

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

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

Altogether, 4,444 medical examinations were carried out. Of the examined workers, 3,717 fully fulfilled the requirements for working with sources of ionising radiation, whereas 630 fulfilled the requirements with limitations. 34 candidates temporarily did not fulfil the requirements, and 5 did not fulfil the requirements. 8 workers did not fulfil the requirements and other work was proposed for them. In 50 cases an evaluation was not possible.

5 EXPOSURE DUE TO MEDICAL USE OF IONISING RADIATION

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 0.7mSv 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 1mSv 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 5.1, 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 healthcare 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 healthcare 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. In 2019, the SRPA, along with other administrative authorities in radiation protection, joined an awareness campaign for referring physicians, which will be carried out in Slovenia in 2020 within the HERCA network.

5.1 DIAGNOSTIC REFERENCE LEVELS

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, based on the data collected on the exposure of patients undergoing X-ray examinations, in 2019 in Slovenia the official DRR values for 29 X-ray examinations were presented. 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 performing 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. Updated DRRs are published on the SRPA website. Users can compare these reference values with the typical exposures of their patients. In addition, 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 regarding a single X-ray device or a group thereof are compared to the DRR in the process of issuing a license 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 total exposure due to medical use of ionising radiation. The SRPA thus started activities for 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 2019, the SRPA received data on patient exposure for a limited set of X-ray machines, which, in addition to determining the average dose for standard examinations, also enables monitoring of other parameters such as distribution width, distribution by sex or age, etc. At the same time, such data also enables an analysis of individual types of examination by number and thus lays the foundation for an easier and more reliable assessment of the radiation exposure of the population due to radiological procedures.

In 2019, the SRPA financed the continuation of a study on the exposure of patients during radiological procedures with the aim of establishing a method of regular patient dose data collection and the format of reporting. During the study, data was automatically collected on X-ray devices for diagnostic radiology. In 2019, the number of X-ray machines on which data are collected and patients' radiation is monitored increased. In addition, mammography procedures from the DORA programme were included in the study. Based on experiences from the 2018 study, three clinical assessments based on automatically collected data were prepared. The database will be used to optimise radiological procedures and for dose assessment of the population as a whole or for individual groups of the population. The data are anonymised, but include age, sex, and all the necessary parameters for dose assessment. By the end of 2019 a system for automatic data collection had been established for data on the exposures of patients in CT procedures. The next step will include image-guided interventional procedures. 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 the 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 the 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.

6 MANAGEMENT OF RADIOACTIVE WASTE AND IRRADIATED FUEL

6.1 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. High-Level Radioactive Waste (HLW) will be produced from the decommissioning of the Spent Nuclear Fuel (SNF) from the Krško NPP, and in case of possible reprocessing of spent fuel from the Krško NPP and the TRIGA Mark II Research Reactor. A special category of waste is sealed radioactive sources, which are out of use and had been used by small holders; they have been stored in the Central Storage for Radioactive Waste in Brinje.

6.1.1 Management of Low- and Intermediate-Level Waste

The total volume of waste accumulated by the end of 2019 amounted to 2,274 m^3, with the total gamma and alpha activity of the stored waste amounting to 15.3 TBq and 23.7 GBq, respectively. In 2019, the equivalent of 285 standard drums containing solid waste was stored, with a total beta-gamma and alpha activity of 3.21 GBq and 1.35 MBq, respectively.

Figure 25 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 accumulated 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.

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 2023. For the normal operation of the Krško NPP after 2023 it is therefore necessary that the activities for the construction of the LILW repository in Vrbina be accelerated and that the takeover of LILW waste begin during the year 2023. Waste packages for storage or incineration are being prepared in the new building.

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 2019 there was no super-compacted newly-generated radioactive waste due to the ongoing project of moving equipment to the new WMB facility.

Radioactive 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, radioactive waste was sent from the building to Sweden for incineration, the ash of which had not yet been returned to the Krško NPP in 2019. At the end of the year, 50 packages of compressible waste were stored in the new WMB building, awaiting further incineration in Sweden. Also, 53 packages of dried secondary spent resins (BR) and 229 packages of compressible waste awaiting further treatment were temporarily stored in the decontamination building.

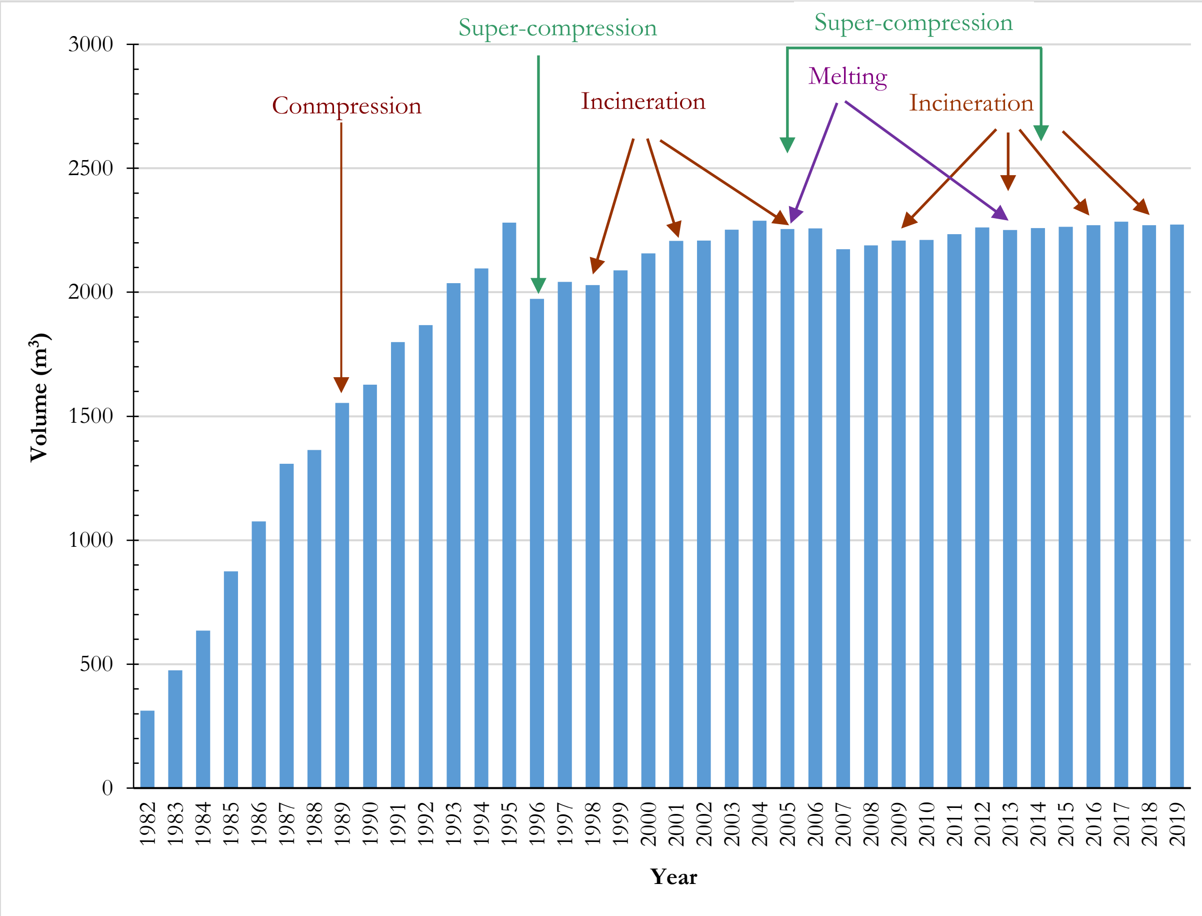

Figure 25: The accumulation of low- and intermediate-level radioactive waste in the Krško NPP storage

6.1.2 Management of Spent Fuel

All spent fuel in the Krško NPP is stored in the spent fuel pool with 1,694 cells. In 2019, a regular outage took place, with the shipment of 56 elements of fresh fuel to the Krško NPP in June 2019. At the end of 2019, a total of 1,323 fuel elements were stored in the spent fuel pool, including two special containers with fuel rods and a fission cell from 2017.

The number of annually spent fuel assemblies and the total number of such elements in the pool are shown in Figure 26.

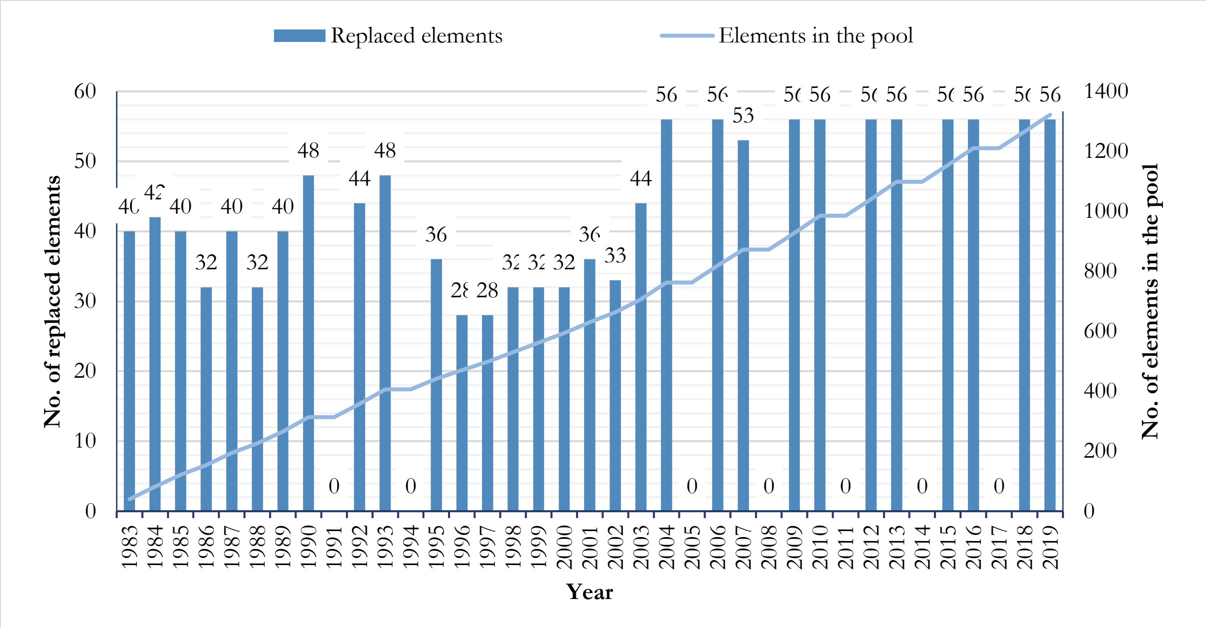

Figure 26: The number of annually spent fuel assemblies and the total number of such elements in the pool of the Krško NPP

6.2 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 2019, the JSI did not hand over to the Central Storage Facility in Brinje any packages of radioactive waste.

There are seven 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.

6.3 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.

6.4 THE COMMERCIAL PUBLIC SERVICE OF RADIOACTIVE WASTE MANAGEMENT

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

The 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 2019 the ARAO ensured the regular and uninterrupted 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. The 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 2019, the ARAO accepted 136 packages of radioactive waste from 82 producers, namely 5 packages of solid waste, 12 packages of sealed radiation sources, and 119 packages of ionisation smoke detectors. The total volume of the stored radioactive waste was 2.6 m^3. As of the end of 2019, there were 805 packages stored, as follows:

- 414 packages of radioactive waste (solid waste, sorted according to compressibility, combustibility, shape, and size);
- 179 packages of sealed radiation sources; and
- 212 packages of ionisation smoke detectors.

The total activity of the 90 m^3 of stored radioactive waste as of the end of 2019 was estimated to be 3.2 TBq, with a total weight of 50 tonnes.

The ARAO carries out the treatment and preparation of 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.

Utilisation of storage space in the CSRW is about 80%. One of the effective methods for reducing the volume of RW 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 the 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 wherein the devices can no longer be safely dismantled. The RW treatments are expected to have a positive effect due to the better properties of the RW, thus enabling safer storage, and at the same time the RW takes up less volume in the CSRW. Thus, despite the new acceptance of RW into storage, the amount of stored RW is growing more slowly than it would have if the treatments had not been carried out.

At the end of 2019, the ARAO inspected the packages in two compartments. Eleven packages from the rehabilitation of the facility in Zavratec, packed in drums without previous characterisation, were all taken to the hot cell facility for measurements of high-resolution gamma spectrometry. The outer packaging and labels of the selected packages were also visually inspected, and the packages were weighed and dose rate measurements of the external gamma radiation were performed. As a result, some of the packages could be released from regulatory control. In 2020, the further option of the release of radioactive material will be explored and implemented.

6.4.2 The management, long-term control, and maintenance of the Jazbec mine tailings disposal site

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

In 2019, the ARAO ensured the monitoring of the Jazbec mine tailings disposal site, which included safety fences and warning signs, access routes, drainage ditches for the drainage of surface water, the condition of the cover, and the technical monitoring facilities (piezometers, geodetic points, inclinometers). The condition of the culvert under the Jazbec disposal site and the drainage shaft at the disposal site were also monitored. The situation is appropriate. Maintenance work in 2019 consisted of mowing the grass on the entire surface within the protective fence of the Jazbec disposal site, and the removal of the undergrowth on the outside and inside of the fence. Repairs to the disposal site fence and the cleaning of drainage ditches and a channel for the drainage of surface water from the banks of the disposal site were also carried out. No other maintenance work was required.

The Safety Report for the Jazbec mine tailings disposal site provides for long-term monitoring and maintenance after a five-year transitional period. Monitoring during the long-term control period is carried out in order to detect any changes in the repository. This includes radiological, physical-chemical, and geodetic measurements. In September 2019 the SNSA issued a decision amending the Safety Report of the Jazbec mine tailings disposal site in the part relating to long-term post-closure control, which is discussed in more detail in Chapter 3.3.3.

6.4.3 Disposal of Radioactive Waste

In 2019, work on activities related to the preparation of documentation necessary to obtain approvals and permissions for the repository for LILW were carried out in all areas. Work on the project documentation continued, while the revision of the project for obtaining a building permit is in the final stage 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 being carried out. Also work on other project documentation was carried out regarding other documents, such as the environmental impact assessment report, the draft safety report, and safety report for obtaining the approval of the body responsible for nuclear safety in the procurement process of the building permit, the project basis, and the draft prior consensus on nuclear and radiation security issued by the URSJV, was also obtained. The intensity of work in the area of LILW planning in 2019 was also dictated by funding. The Financing Agreement was signed by the ARAO with the Ministry of Infrastructure in mid May 2019. An annex to the ARAO Financing Agreement on the smooth operation of works after the old work programme in 2019 was concluded with the Krško NPP Fund.

In the year 2019, in relation to ensuring land availability for the purpose of building a repository, the rights were acquired regarding most of the land. The land, whose ownership was transferred to the Slovenian Water Agency (The Lower Sava River area division), is still in the process of being regulated. Co-financing of the renovation and expansion of the existing optical network in the Municipality of Krško and the payment of compensation for the use and wear of roads during the period of construction in 2019 was not realised because the consent of the competent body and determination of the source of financing are still needed.

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, in 2018 the ARAO prepared a tender and the selection of the contractor for these works was carried out, but the appeal of an unselected bidder submitted to the national review commission for the revision of procedures for awarding public contracts halted the procedure and postponed the scheduled start of the work until 2019. In July 2019, the contractors began works at the LILW repository site. Five shallow boreholes (up to 15 m in depth) and two deep boreholes (50 and 60 m) were drilled in accordance with the project task and technological plan. In 2019, the regular collection of groundwater monitoring data, maintenance of the probes in the piezometers, and the upgrading of the hydro-geological study of the wider area of the LILW repository were also carried out.

In 2019, activities related to the production of project and other documentation and consultancy services in the field of design and construction continued.

The review has not yet been completed, especially regarding verification of the control calculations for the underground facilities. The project leader is continuing with the corrections and supplements of the project documentation for the building permit and the project documentation for the construction preparation for the LILW's infrastructure facilities and partly for the repository facilities. For the project documentation for the construction performance of the infrastructure facilities, a review of the project documentation, which is in the final stage of production, was conducted. 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. The comments and guidelines for amendments were taken into account in the new revision of the programme (revision E, March 2019), which was submitted to the Ministry of Infrastructure in March 2019 for review and approval. In November 2019, the Ministry of Infrastructure submitted a report on the review and assessment of the investment documentation. The report shows that the investment documentation needs to be amended due to the amendment of the *Decree on the Criteria for Determining the Compensation Rate Due to the Restricted Use of Areas and Intervention Measures in Nuclear Facility Areas* and the decisions of the Interstate Commission and special audits of investments in the LILW repository. The next revision of the investment documentation will be prepared in 2020.

Work on the project for preparing the safety analyses and acceptance criteria continued in 2019. 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. Work on the safety analyses continued for the phase of the acquisition of the building permit and the preparation of the Safety Report. In the years 2018 and 2019, the acquisition of the draft of the prior consent of the URSJV on radiation and nuclear safety was held in April 2019. For the transboundary impact assessment, led by the MESP, a Summary of Transboundary Environmental Impact was prepared in 2018 and translated into English and Croatian. In 2019, the English and Croatian translation of the Environmental Impact Assessment Report, the draft of the Safety Report, the Project Bases, and the German and Italian translations of the Summary of Transboundary Environmental Impact were produced. A public hearing was carried out in Austria and Croatia.

The preparatory work for the LILW repository was completed in 2017. In 2019, the ARAO performed occasional status control at the LILW site. There were no complaints regarding the implementation of the preparatory work in 2019; the bench slopes are stable and well-compacted.

Permissions for the LILW repository

Already in 2017, the ARAO applied to the Environmental Agency of the Republic of Slovenia (hereinafter: ARSO) for the issuance of an environmental consent. 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 on the basis of Article 65.b of the then valid ZVISJV. 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 first in July 2018. The ARAO prepared responses to the SNSA's comments and revisions of documents where necessary several times, the last time in March 2019. The SNSA issued the above-mentioned consent in early April 2019.

This was a prerequisite to initiating a public hearing and cross-border environmental impact assessments. The latter began in September 2019, when the Ministry of the Environment, the Sector for Comprehensive Environmental Impact Assessment, called on all neighbouring countries to declare if they wished to engage in the cross-border environmental impact assessment process. Austria and Croatia were engaged in the process, which was not yet complete by the end of the year. The public hearing on the report on the environmental impact in Slovenia had not yet begun as of the end of the year.

In June 2019, the SNSA issued a new decision on the division of content to prove fulfilment of the criteria for issuing a consent to construction, as the delivery of the documentation by the deadlines under the previous decision, issued in 2017, had not been realised. Towards the end of July, the ARAO submitted an application for a building permit by submitting documentation for the first thematic sections. Towards the end of the year, the ARAO also provided documentation for some other thematic sections. The SNSA also appointed an expert in the field of the use of concrete to carry out an additional expert examination. A documentation review is in progress.

6.5 REMEDIATION OF THE ŽIROVSKI VRH URANIUM MINE

Hydro-metallurgical tailings at the Boršt site

The remediation of the Žirovski Vrh Uranium Mine (RŽV) has been in progress since 1992, involving both the uranium processing plant and the mine, together with the various accompanying objects.

Rehabilitation works at the Boršt disposal site have been completed, and the possibility of global instability in the wider area of the landfill prevents the disposal site from being closed. For the Boršt disposal site, 2019 was the ninth year (the fourth additional year) of the transitional period of long-term management.

In 2019, the RŽV carried out maintenance work: the cleaning of drainage channels for the drainage of backwaters and meteoric waters at the Boršt disposal site and next to it, the cleaning and maintenance of devices and facilities for technical monitoring and monitoring to control the impact of the RŽV facilities on the environment, including the consequences of landslides at the Boršt disposal site, cleaning of the undergrowth near the disposal site and near infrastructure facilities, mowing the grass at and near the disposal site, and monitoring the condition of the finally arranged mining facilities. An assessment of the overall state of the remediated mine facilities was intensified 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.

In 2016, the MESP decided to implement emergency drainage measures and in 2019 the mining project "*Construction of 11 additional piezometers in the wider area of the HMJ Boršt disposal site*". Its decision was based on the results of a study on the extent of the possible landslide of a part of the Boršt disposal site with the spread of hydrometallurgical tailings into the Todraščica and Brebovščica valley, a study on the radiation exposure of residents in the impact area of such an event and on the basis of suggestions by the Expert Project Council from the Final Report. The construction of 11 piezometers was planned, but two piezometers were not built due to the proximity of the drainage tunnel, at the suggestion of experts supervising the implementation of the piezometers, taking into account the established hydrological condition. Piezometers will enable better control of the stability of the HMJ Boršt disposal site and observation of groundwater levels in the area of the sliding zone and in the rock base in the wider area of the disposal site.

Only a part of the vertical drainage wells in the transverse leg of the drainage tunnel are operational 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, which work especially during rainfall. With the implementation of intervention drainage wells in the drainage tunnel, the requirements from the decision of the mining inspectorate, issued in 2012, 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 the 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. In 2018, the appropriate periodic geodetic monitoring was increased to twice a year due to a suggestion from the Expert Project Council. The same extent of monitoring took place in 2019.

As there was only one point on the surface of the deposited hydrometallurgical tailings in the Plaz network until 2018, 47 control points at Vrtine-2 were included in the proposal of the Expert Project Council. The results of the measurements show that all points of the network, with the exception of three points of the second iteration and two points of the third iteration in the eastern part of the disposal, which is outside the landslide, moved significantly. The directions and magnitudes of the movements are expected and comparable to the values that are also identified by measurements in the Plaz network, calculated over a 12-month period.

The movements of the Boršt disposal site are continuously monitored by a GPS system. The measured horizontal movement for the period from March to September 2019 is 6.6 mm (II-GPS). As part of technical monitoring, "*Precise geodetic measurements of the stability of Boršt 2019*" were carried out in March and October in the Plaz geodetic network, which connects the Boršt disposal site with the wider surroundings, and Vrtine-2, which connects checkpoints along piezometric and inclinometric wells at the Boršt disposal site. together with six points of the Plaz network, ten new geodetic points and seven new piezometers. The results show that the movements are comparable to the previous measurements and that the movements maintain approximately the same direction.

The damage from 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, and since 2018 also on the breaking edge on the upper plateau of the 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 MESP. Details of this monitoring project can be found in Chapter 3.3.3.

The RŽV has a prepared revision of the Safety Analysis Report in accordance with the requirements of the MESP in connection with the activities related to the closure of the disposal site. This document is the basic document for the closure of the disposal and the transition to long-term control and maintenance, which will be carried out by the ARAO as part of the mandatory state public utility service for radioactive waste management.

6.6 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. The operating costs are covered from the financial revenue 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. 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 and the disposal of LILW and high-level waste (hereinafter: the Decommissioning 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 Decommissioning Programme should have been carried out by the end of 2009 and 2014 (every five years), but had not been approved by the end of 2019. The third revision of the Programme for Decommissioning and the Programme for the disposal of LILW and high-level waste were prepared by the ARAO and the Fund in co-operation with the Krško NPP. The Programme was presented to the Intergovernmental Commission and the Intergovernmental Commission decided to send both programmes for further admission procedures in the Republic of Slovenia and the Republic of Croatia. The Government of the Republic of Slovenia was informed of the summary of the third revision of the NPP Decommissioning Programme and the Programme for the disposal of LILW and high-level waste at its session in December 2019, the Government of the Republic of Croatia was informed in January 2020. The Croatian Parliament was informed of the documents of the third revision in February 2020. Final consideration and adoption by the Intergovernmental Commission is expected in the current year.

As of 31 December 2019, the book value of the Fund's financial portfolio amounted to EUR 206.4 million. This amount does not include unallocated funds in the bank account, accrued interest, interest purchased, and claims to dividends in the amount of EUR 1.6 million. Considering this, the Fund's portfolio as of 31 December 2019 amounted to EUR 207.9 million. The Fund's financial assets (together with property and equipment and debts) as of 31 December 2019 amounted to EUR 211.2 million.

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

In 2019, the company GEN energija, d.o.o., paid a total of EUR 8.3 million for its decommissioning contributions into the Fund, thereby fully settling all its liabilities to the Fund deriving from decommissioning contributions and within the agreed deadlines. From 1995 to 2019 the Fund received a total of EUR 202.9 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 (in previous years, the Fund was obliged to pay compensation also to the Municipality of Brežice, the Municipality of Kostanjevica na Krki, the Municipality of Sevnica, and the Municipality of Kozje) for the limited use of land. In 2019, the Fund paid a total of EUR 1.8 million to the ARAO. From 1998 until the end of 2019, the Fund paid a total of EUR 44.8 million to the ARAO for 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 the 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 55.5 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 100.4 million (the amounts paid to co-finance the activities of the ARAO and to municipalities as compensation for limited use of land are not valorised). Payments made to the ARAO and municipalities account for 48.64% of the Fund's financial portfolio as of 31 December 2019, which amounted to EUR 206.4 million (book value). Figure 27 shows the book value of the financial portfolio of the Fund as of 31 December 2019.

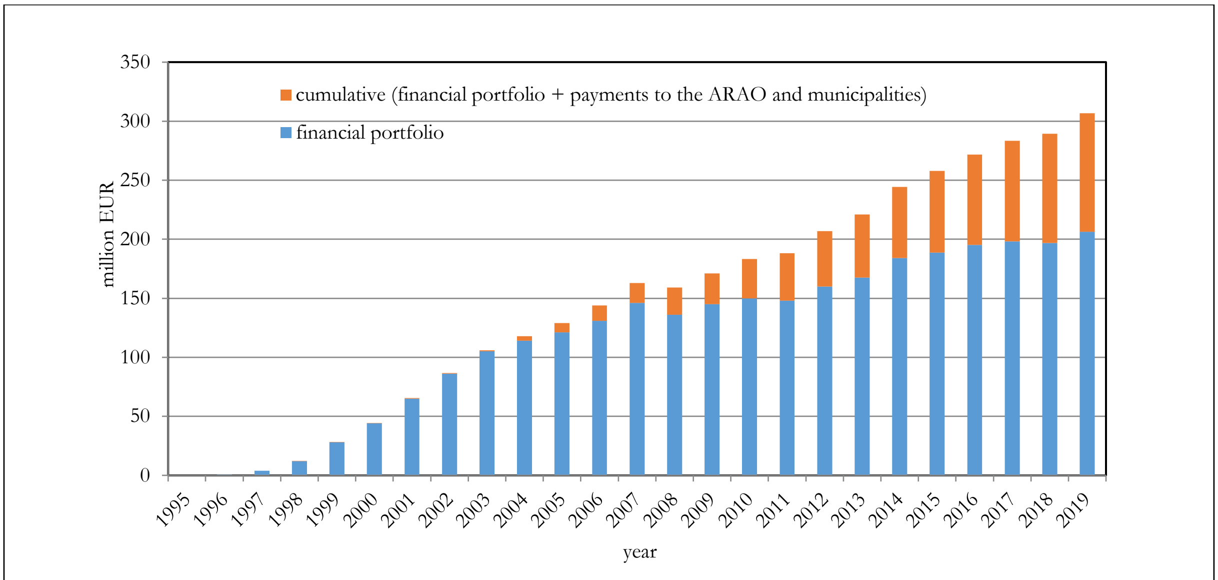

Figure 27: Presentation of the Fund's assets as of 31 December 2019 in millions of euros

6.6.2 Investments and business operations in 2019

As of 31 December 2019, 85.19% of the portfolio was invested in debt securities and 14.81% in equity securities, which is practically unchanged in comparison to the end of 2018. The main asset class are government securities, which accounted for 42.62% of the portfolio as of 31 December 2019. Over the previous years, the share of this asset class gradually decreased, principally due to the purchase of bonds with a negative yield to maturity and long-term bonds, which have reduced the portfolio's interest rate risk. The proportion of corporate bonds stood at 26.35% 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 2019, the segment of the 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. The share of funds in the financial portfolio was 16.22% as of 31 December 2019.

Investment activities in 2019 were carried out according to the Fund's investment policy for 2019 and within the investment goals set by the Fund's investment policy.

In 2019, the Fund continued to maintain a low level of market risk. As of 31 December 2019, the one-day 95% VaR (Value-at-Risk) was EUR 318,192, or 0.15% of the portfolio's value, and as of the end of 2018, the one-day 95% VaR was EUR 318,794, or 0.16% of the portfolio's value. The low value of the VaR is achieved with a short portfolio duration, which limits the interest rate risk of bond investments. The value of the portfolio and monthly data for the VaR are shown in Figure 28.

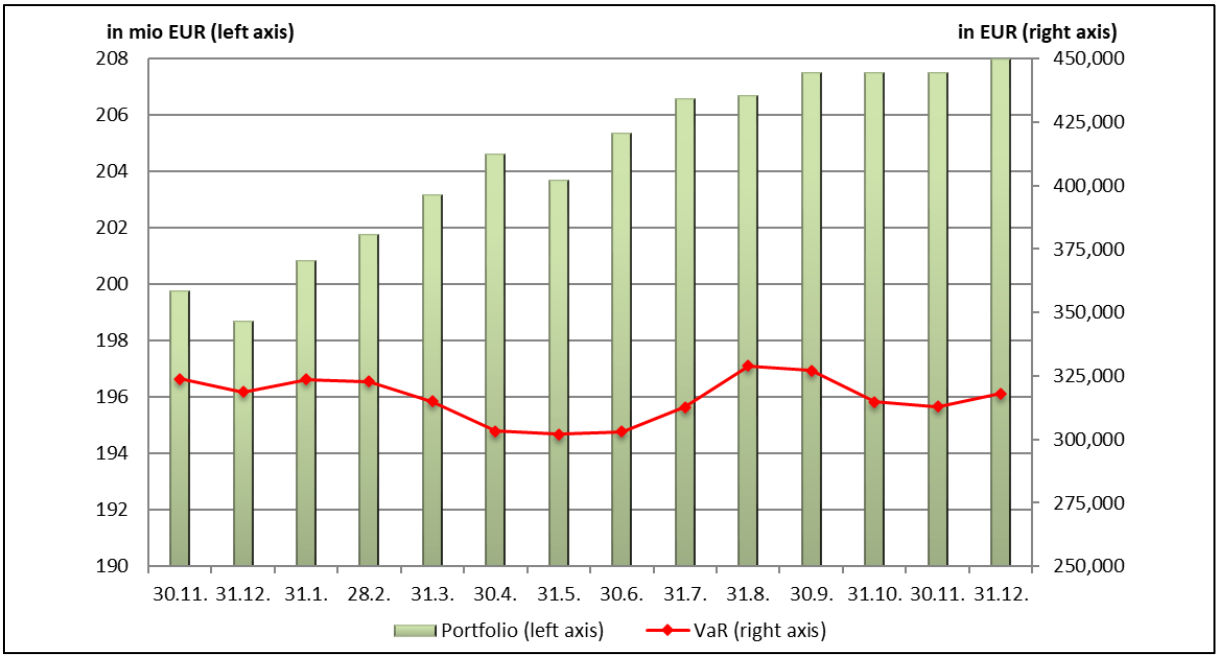

Figure 28: Monthly data for VaR (one-day, confidence interval 95%)

The interest rate risk of the portfolio is evaluated by means of simulations and measures the impact of a change in interest rates on the portfolio. Currently, we are in a period of low interest rates, regarding which an increase is in sight. Credit risk management is conducted on the basis of the credit ratings of the leading global credit rating agencies (Moody's, Standard & Poor's, and Fitch), whereas in accordance with the Fund's investments policy, the Fund invests only in investment-grade bonds.

In 2019, the Fund generated income of EUR 12.4 million, which is at the level of 2018. In 2019, the Fund generated EUR 4.1 million of financial revenue, while the corresponding value for 2018 was EUR 4.3 million. Financial revenue include paid interest, dividends, and other payments, while accrued interest is excluded.

In 2019, the costs of the Fund reached EUR 8.5 million, which was 10.85% higher than in 2018.

The Fund had a surplus of revenue over expenses in the amount of EUR 3.9 million. The realisation of the surplus for 2019 was 19.31% lower than in 2018 due to the smaller amount of realised revenue and higher expenses in 2019.

As of the end of 2019, the proportion of operating expenses in comparison to the financial portfolio amounted to 0.24%, 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 2019, the Fund received EUR 61 million from due investments and assets. The new purchases amounted to EUR 65 million, which is EUR 4 million more than the due investments and assets sold.

In 2019, the return of the portfolio, calculated on the basis of the internal rate of return (IRR), was 4.74%. The annual yield of the financial portfolio of the Fund from 2004 to 2019 is shown in Figure 29.

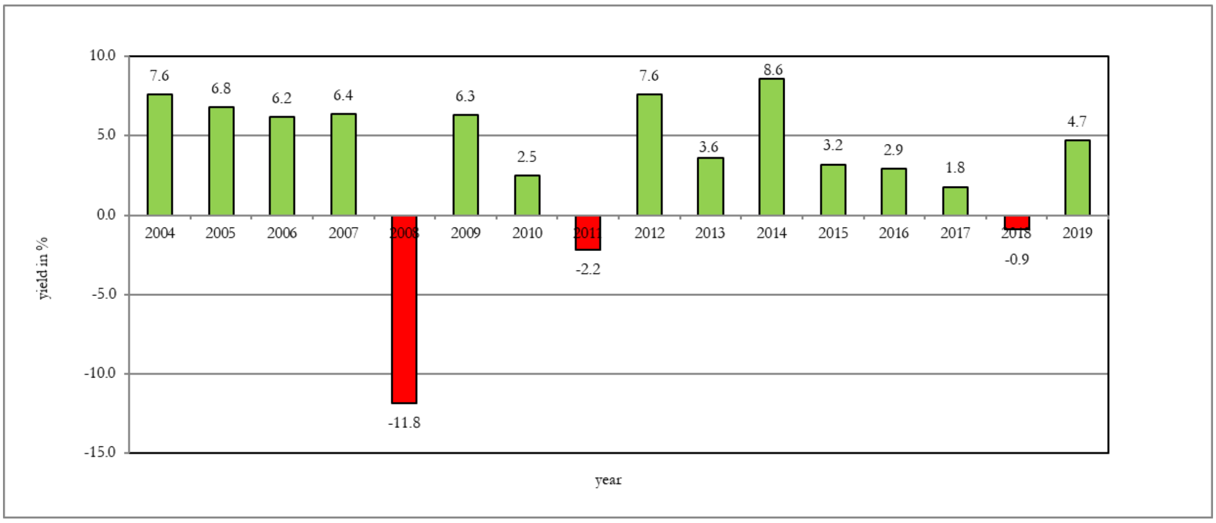

Figure 29: The annual yield of the financial portfolio of the Fund from 2004 to 2019 in %[3]

In 2019, the return of the portfolio reached or exceeded all criteria of comparability, with the exception of the benchmark. It lagged behind the benchmark due to a lower risk of the portfolio's structure in comparison to the benchmark. The Fund outperformed the target yield in the amount of 4.29% defined in the Decommissioning Programme. The Decommissioning Programme defines the basis for the determination of an interest rate factor that amounts to 1.0429 and targeted portfolio yield accruing therefrom that amounts 4.29%. The defined basis is the value of the long-term interest rate of state securities in the euro area on 10 December 2003.

The next criterion that has to be followed up is the yield on 10-year German security bonds, which are set up as a euro-area benchmark. On 30 December 2019, this amounted to -0.19%, which is less than four percentage points under the portfolio yield from 2003, which was set up as a criterion determined in the Decommissioning Programme. The third criterion of comparability, i.e. a guaranteed yield rate, defined by the minister responsible for finance, was 0.42% for the year 2019.

In 2019, higher yields were shown by all investment segments, with the exception of the money market segment, where bank interest rates continued to fall. In 2019, as a result of general growth

[3] 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.

in the stock markets, equity investments increased. There were better results also in bond investments in all investment classes. The growth in both segments is mainly due to the extremely loose policies of the central banks, which in 2019 again began to intervene more actively with cheap money in the capital markets, as well as the extremely good economic indicators at the same time.

Also in 2019, the Fund followed the adopted investment policy in its operations, and managed a conservative investment policy in the management of assets, taking into account the principles of safety, diversification, profitability, and liquidity. This year the Fund marked the 25th anniversary of its existence, and, if we may say so, we proudly proclaim a quarter of a century of the successful business operations of the Fund.

The Fund is aware of the importance of the tasks it performs. In the future, special attention will be devoted by the Fund to following and managing the various types of risks to which the Fund is exposed in portfolio management and the Fund's operations. From a managerial point of view, a conservative investment policy and defined investment principles will be pursued.

Reference: [28]

7 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 SNSA provides advice and makes recommendations.

7.1 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 2019, the SNSA conducted 215 individual and group training courses, exercises, and tests totalling 442 hours. The SNSA also participated in two regular annual emergency exercises of the Krško NPP, at the national table-top exercise (more about this exercise can be found in Chapter 7.2), at the radiological exercises carried out within the ENRAS (ENsuring RAdiation Safety) project, at several international IAEA exercises, "ConvEx", and at the table-top exercise "Harmonisation of the implementation of protective actions in the event of a nuclear or radiological emergency with transboundary or transnational consequences". The aim of such exercises was to identify discrepancies in the implementation of protective measures in the event of a nuclear accident at the Krško Nuclear Power Plant with cross-border impacts. Representatives of the SNSA, IAEA, Austria, Croatia, and the Slovenian National Civil Commander participated in the exercise. The exercise was an example of good practices in regional cooperation. Adequate regular communication between countries was identified as a key element in the coordination of protective actions. The exercise showed that in an early stage of emergency all countries have clear procedures for alerting and informing organisations in their countries, as well as neighbouring countries and the international community. An example of good practices in 2019 was the organisation of the first exercise in the field of cyber security in the nuclear sector in Slovenia, i.e. KIVA 2019 (more about this exercise can be found in Chapter 9.6).

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.

7.2 ADMINISTRATION OF THE RS FOR CIVIL PROTECTION AND DISASTER RELIEF

In 2019, 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 accordance with its statutory powers.

The ACPDR has prepared a new Decree amending the *Decree on the content and elaboration of protection and rescue plans which relate to the additional content of protection and rescue plans in the event of a nuclear and* *radiological accident* transposed from Council Directive 2013/59/EURATOM laying down basic safety standards for protection protection against the dangers arising from exposure to ionising radiation– the EU BSS Directive. The Decree was adopted by the Government of the Republic of Slovenia in March 2019.

The national table-top exercise "Accident at the Krško NPP 2019" was organised by the ACPDR in cooperation with the SNSA and the Krško NPP. The purpose of the exercise was to test the response to a nuclear emergency at the Krško NPP in accordance with protection and rescue plans and activity plans. The exercise took place on November 29 at the Training Centre for Civil Protection and Disaster Relief in Ig. The exercise was attended by the municipalities of Krško and Brežice, the Brežice regional office of the ACPDR and its key Civil Protection commanders, ministries, the Government Communication Office, the Slovenian National Civil Protection Commander, operational structures of the Civil Protection Headquarters, and the Krško NPP. The participants were divided into various levels: on-site, local, regional, and national, as well as the operational structure of the Civil Protection Headquarters.

During the exercise, the participants highlighted a number of challenges that they would face in event of an emergency at the Krško NPP. Along with the challenges, also some potential solutions were identified. The exercise was also a good opportunity to meet people and establish personal contacts with individuals from other response organisations.

In 2019, the ACPDR also carried out tasks from the Action Plan after the EPREV mission (more on this can be found in Chapter 7.4).

The Inter-ministerial Commission for coordinating the implementation of the national plan continued its work and monitored the implementation of tasks from the Action Plan after the EPREV mission.

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

Reference: [29]

7.3 THE KRŠKO NPP

In 2019, the activities of the Krško NPP in the area of preparedness for emergencies included the following:

- Training , drills, and exercises;
- maintenance of support centres, 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 (18 persons passed the initial training for emergency team members).

In 2019, the Krško NPP conducted a set of training courses, tests, and exercises with a total of 454 participants from the Krško NPP and 116 participants from supporting organisations. The Krško NPP conducted two annual emergency exercises with 284 participants from the Krško NPP. In total, emergency staff consist of 588 persons, including NPP personnel and external contractors.

Furthermore, in 2019 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.

7.4 EPREV ACTION PLAN

In 2017, an EPREV mission visited Slovenia and reviewed the activities of all organisations involved in the response to a possible nuclear or radiological accident according to the National Emergency Response Plan for Nuclear and Radiological Accidents. The mission concluded that Slovenia is successful in implementing the safety standards in the nuclear and radiological field. The report of the mission includes 19 recommendations and 12 suggestions for improvements based on the IAEA Safety Standards. These are useful guidelines for further improvements in this area.

Based on these findings, an Action Plan with 31 actions was prepared and adopted by the Government of Slovenia in April 2018. By the end of 2019, more than half (54%) of the tasks had been completed, while other tasks (46%) are ongoing or partially implemented.

Among the key tasks in progress are the revision of the National Emergency Response Plan for Nuclear and Radiological Accidents, which, in addition to the new Decree, is related to the development of the protection strategy. The ACPDR and the SNSA also actively participated in the analysis entitled "Evacuation Time Estimate" (ETE) commissioned by the Krško NPP. The task was successfully completed and presented to the key evacuation stakeholders in Posavje.

The implementation of the Action Plan will improve emergency preparedness for nuclear and radiological accidents in Slovenia, and concurrently the conditions for the so-called EPREV follow-up mission, which will review progress in this area in a few years' time.

8 SUPERVISION OF RADIATION AND NUCLEAR SAFETY

8.1 ACHIEVING THE GOALS UNDER THE RESOLUTION ON NUCLEAR AND RADIATION SAFETY

Objectives of nuclear and radiation activities

Goal 1

Nuclear and radiation facilities and providers of radiation practices comply with legal requirements, provide for continuous improvement of nuclear and radiation safety, and closely follow the development in the international arena.

Measures to achieve the goal

Maintaining a high level of radiation and nuclear safety is achieved by facility operators and contractors by constantly checking the condition of equipment, the adequacy of processes (programmes and procedures), the attitude of staff, and the level of the security culture. In the previous period, the emphasis continued to be on the implementation of safety upgrade projects based on the Fukushima experience, checking the condition of equipment, focusing on aging programmes, completion of the 2nd Periodic Safety Inspection, and preparations for the start of the 3rd Periodic Safety Inspection which is crucial for extending the operation of the Krško NPP after 40 years of expecting life. As with every year, attention is devoted to operational data that reveal potential deficiencies and vulnerabilities that need to be addressed. For this purpose, the system of safety indicators and reports on operational experiences in the Krško NPP as well as in other foreign power plants is used.

The SNSA monitors and controls these activities through inspections, through the review of reports on safety analyses, analyses of events and deviations, and similar. If deficiencies are identified, the administrative authorities mainly issue recommendations or requests to remedy these activities.

The SNSA strives to use technological and technical knowledge and research results, which are a product of the work of authorised organisations or the facilities themselves in the control of operations and the preparation of bases for the issuance of permits. In accordance with its financial possibilities, the SNSA commissioned three development and scientific tasks in 2019.

Goal implementation in 2019

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

Fulfilment of the legal requirements and continuous 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 in 2019. The previous chapters in this report show that this goal was achieved.

Objectives of international cooperation

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 2019

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.

Cooperation in the framework of multilateral agreements was also conducted as planned. Slovenia has fulfilled all of its obligations and prepared a report on the implementation of the Convention on Nuclear Safety.

Goal 3

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

Goal implementation in 2019

The Republic of Slovenia was active in the Working Party on Atomic Questions of the Council of the EU and in the groups 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 financed by the European Commission; in 2019 the SNSA began to participate in two projects for providing support to the nuclear regulatory authorities of Ghana and Bosnia and Herzegovina. The second report on the implementation of the radioactive waste management directive was also prepared.

Goal 4

The Republic of Slovenia is and remains an active member of the IAEA. As a member of this agency, it pays a mandatory membership fee in accordance with its capabilities. It also contributes additional personnel and financial contributions especially in the areas where the country's interests can directly or indirectly be realised.

In the field of technical cooperation, Slovenia supports projects that have great development potential especially in countries that are geographically close, in countries with similar programmes or technology, and in particular in the areas where Slovenian experts are able to provide assistance.

The Republic of Slovenia will receive technical assistance, especially in the areas where it lacks skills domestically, in order to achieve certain objectives in nuclear and radiation safety.

The Republic of Slovenia would like to change its status from a country receiving technical assistance to a donor country.

The Republic of Slovenia will keep promoting experts for professional work in third countries within the framework of the IAEA and invite international expert advisory teams for periodic reviews of its facilities and institutions to independently verify its capabilities. Above all, it will invite the teams that Slovenia is committed to invite.

Goal implementation in 2019

As described in Chapter 10.2, Slovenia has continued its intensive and active cooperation with the IAEA and fulfilled its obligations in full and on time. It has also supported the implementation of national technical cooperation projects by facilitating training activities, particularly in the fields of medical applications and environmental sciences in Albania, Bosnia and Herzegovina and Northern Macedonia. Slovenia has also been active in the majority of the regional technical cooperation projects. Two national projects have been concluded and one new national project has been approved for the 2020-2021 cycle. Slovenia has requested that IRRS and ARTEMIS missions be carried out in the first half of 2022.

Slovenian experts participated in many IRRS missions in 2019, namely in Latvia, the United Kingdom, and Norway, as well as in the IRRS Follow-up mission in Estonia and Croatia. There was no participation in IPPAS missions. In 2019, there were no preliminary activities within the 10-year objective and cycle of the IPPAS missions in Slovenia. This should be addressed more actively in the future.

Goal 5

The Republic of Slovenia remains an active member of the Nuclear Energy Agency (NEA) of the OECD. It contributes the calculated amount of the membership fee. In accordance with its human and financial resources, it participates in the work of NEA's committees, the NEA Data Bank and subcommittees important for ensuring a high level of nuclear and radiation safety.

Goal implementation in 2019

The financial obligations towards the NEA were fulfilled. The Slovenian representatives are actively involved in the work of the steering committee, standing committees, 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.

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, the 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 2019

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. More details in Chapter 9.

Legislative objectives

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 2019

As described above, in the field of nuclear and radiation safety, the SNSA strives to transpose the EU acquis (directives) into the legal system of the Republic of Slovenia on an ongoing basis, to harmonise domestic regulations with WENRA standards, and to fulfil commitments under all relevant international treaties it is party to.

The work done in this field in 2019 was 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 8.4 describes in detail the achieved objectives related to international commitments, especially the European legal system. Regarding the transposition of the EU BSS Directive, the transposition was completed with the adoption of the Decree amending the Decree on the content and preparation of protection and rescue plans, as the latest regulation in this field.

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 2019

The organisation of administrative bodies in the field of nuclear and radiation safety in the Republic of Slovenia is adequate and did not change in 2019, as there was no need therefor.

Objectives in the field of emergency preparedness

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 an emergency the impact on people and the environment is minimal.

Realisation in 2019

From the above, it can be concluded that with regard to the use of nuclear energy and radiation-related activities in the Republic of Slovenia, the SNSA appropriately addressed the issue of emergency preparedness and response. As a member of the Inter-ministerial Commission for coordinating the implementation of the national plan, the SNSA regularly monitors the progress of the EPREV Action Plan.

Objectives in the field of education, research and development

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 2019

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 initiates 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 2019, 10 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 2019 there were two 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 and 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 2019

There were no major changes in this area in 2019.

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 2019/20, three 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 2019, two graduates finished their 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 2019 four students enrolled in the first year. Most of them are employed at the Jožef Stefan Institute. In 2019, four students finished PhD studies.

At the Faculty of Energy Technology of the University of Maribor, the study programme Nuclear Energy includes compulsory subjects in the field of nuclear technology and energy at all three Bologna levels.

In 2016, Slovenia (the Jožef Stefan Institute) assumed the presidency of the ENEN (European Nuclear Education Network) association, which brings together most European universities and institutes dealing with higher education in the field of nuclear engineering and promotes the exchange of students and teachers between European institutions.

In 2018, the University of Ljubljana and a consortium of three other European universities successfully applied for EU funding for the Erasmus Mundus tender for the international master's degree study programme in nuclear engineering. The name of the programme is SARENA (SAfe and REliable Nuclear Applications). The first nine students enrolled in the programme in 2019/20. In the coming school year, four of them will continue their studies in the second year of the master's degree programme Nuclear Engineering in Ljubljana.

We assess that in the current circumstances in Slovenia the scope of studies and the number of students is at the lower limit of adequacy and does not provide a sufficiently large staff base for the permanent 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 2019

The SNSA regularly gathers data from major funders (in addition to the main nuclear facilities and state authorities) on how funds are disbursed to Slovenian organisations and authorised experts in the field of nuclear and radiation safety. The total amount for applied projects, research studies, and the legal obligations under the ZVISJV-1 in 2014 was nearly EUR 5 million gross, while in the years 2015 and 2016 the total funds increased to more than EUR 7 million gross primarily due to work on the project involving the repository for radioactive waste in Vrbina. In 2017, the total amount dropped to approximately EUR 6.2 million gross. In 2018, the figure more than doubled, to EUR 13.7 million gross, because the Krško NPP spent just over EUR 9 million gross in total for domestic institutions. The total amount for applied projects, research studies, and the legal obligations under the ZVISJV-1 in 2019 was EUR 15.7 million gross, while the Krško NPP spent slightly less than EUR 7 million gross in total for domestic institutions (of which slightly less than EUR 2.5 million gross for authorised organisations). In 2019, also direct funding for research and development significantly increased, i.e. from EUR 1.5 million gross to EUR 2.8 million gross.

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, of which approximately 40 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.

8.2 IMPLEMENTATION OF 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 Mark II 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 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. In 2019, most of the technological equipment was installed and partially in use. Due to extensive maintenance work, the supercompactor has not yet been moved to the new facility.

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 goals

Performers of radiation activities transfer 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 extending the operating license in April 2018. Releases of radioactivity into the environment were within the permitted limits. The concept of clearance is applied. In 2019, in order to reduce the volume of RW in the CSF and create storage space in two transports of dangerous goods, the ARAO sent 2,289 ionisation fire detectors for recycling abroad, where they will also remain.

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 being carried out, but unfortunately some delays are accumulating, and the start of operations has been postponed. In 2019, there was no agreement between the owners of the Krško NPP that the processing would be carried out in the Krško NPP. Other options for preparing waste for disposal are being sought. Details are available in Chapter 6.5.

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 procedures for the preparation and approval of the document "Amendments to the Development Plan (DP) of the Krško NPP" and the acquisition of an integrated building permit are underway. The ARAO, as a contractor of the public service for the management of radioactive waste, monitors and participates in international developments in this field. As part of the preparation of the third revision of the RW and SF Disposal Programme from the Krško NPP, a revision of the study on the geological disposal of SF and HLW in solid/hard rocks was prepared.

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.

Achieving the goal

In 2019, 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 the 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 April 2019, a draft of the third revision of the Programme for the Disposal of RAW and SF from the Krško NPP was prepared, which was submitted by the ARAO and the Fund to the IAEA for expert review and later for adoption by the Interstate Commission.

At its 13th session in September 2019, the Interstate Commission agreed with both prepared programmes and decided to forward them for further adoption procedures to the Republic of Slovenia and the Republic of Croatia. The third review of the Programme for the Disposal of LILW and SF from the Krško NPP was signed by the drafters in September 2019 and, together with the summaries, according to the agreements of the Interstate Commission, was submitted to the Slovenian Ministry of Infrastructure and the Croatian Ministry of Environmental Protection and Energy for further procedures of seeking consents from the governments of the Republic of Slovenia and the Republic of Croatia and from the legislature of the Republic of Croatia. The Government of the Republic of Slovenia was informed of the summary of the third revision of the Krško NPP Decommissioning Programme and the third revision of the RAW and spent fuel disposal programme for the Krško NPP at its 202nd session in December 2019. More details about the Krško NPP Decommissioning Programme are available in Chapter 10.5.

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 renewal 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. In September 2019, the new long-term control of discharges from the Jazbec disposal site was approved. At the Boršt hydrometallurgical tailings disposal site, remediation works are mostly finished. The effectiveness of the intervention measures carried out in 2017 (additional drainage wells) will be assessed by continuous monitoring of the flow and stability of the disposal site in the following years. An amendment to the Safety Report is being prepared, which is one of the key documents for the closure of the Boršt disposal site. It will evaluate all the risks arising from the possibility of a landslide in the wider area of the disposal site; it also provides a detailed plan of long-term supervision and maintenance 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. Closing the Boršt disposal site has been delayed and it is now expected to be closed in 2020.

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 Chapter 3.4.2 and Chapter 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 Chapter 8.4.

8.3 EDUCATION, RESEARCH, DEVELOPMENT

Once again in 2019, the field of education, research and development regarding nuclear and radiation safety was stable.

8.4 LEGISLATION IN THE FIELD OF NUCLEAR AND RADIATION SAFETY

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*. The Act was adopted in 2002 (ZVISJV, Official Gazette of the Republic of Slovenia, No. 67/02), first amended in 2003 (ZVISJV-A, Official Gazette of the Republic of Slovenia, No. 24/03), a second time in 2004 (ZVISJV-B, Official Gazette of the Republic of Slovenia, No. 46/04), a third time in 2011 (ZVISJV-C, Official Gazette of the Republic of Slovenia, No. 60/11), and a fourth time in 2015 (ZVISJV-D, Official Gazette of the Republic of Slovenia, No. 74/15).

After several amendments of the above-mentioned Act from 2002, it was time to renew the regulation of this field. *The Ionising Radiation Protection and Nuclear Safety Act* (ZVISJV-1) was published in the Official Gazette of the Republic of Slovenia, No. 75 on 22 December 2017, and entered into force on 6 January 2018. In this manner, the process of adapting Slovenian legislation to the latest international knowledge in the field of regulating radiation protection and nuclear safety continues.

Less than half year after the entry into force of the new ZVISJV-1, the SNSA started preparations for amending the act due to perceived problems in implementing the provisions on the security clearance of foreign nationals who perform or will perform work in a controlled facility or area, a physically controlled facility or area, or a vital facility or area of a nuclear facility involving the handling of radioactive materials and the transport of nuclear materials.

The draft amendments were prepared by the SNSA in close collaboration with the Ministry of the Interior, while other interested parties were also involved in their preparation. At the end of 2018, the SNSA arranged the publication of the draft amendments to the ZVISJV-1 on the e-Democracy portal and on its website; the public debate ended on 4 January 2019. After the intersectoral coordination, the Government of the Republic of Slovenia, at its 19th regular session on 14 February 2019, confirmed the draft Act Amending the Ionising Radiation Protection and Nuclear Safety Act, and sent it to the National Assembly for consideration and adoption, and proposed an abbreviated procedure since the amendments were not that demanding. The Act Amending the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1A) was adopted by the National Assembly on 16 April 2019 and published in the Official Gazette of the Republic of Slovenia, No. 26/19 on 26 April 2019; it entered into force on 11 May 2019. The adopted amendment regulates the security clearance procedure for foreign nationals in a similar manner as determined for citizens of the Republic of Slovenia. Due to the amended Article 155, it was necessary to amend or supplement some other articles of the Act related to security clearance; the amendment also introduced some minor changes in other areas, mainly nomotechnically changes regarding some provisions, the elimination of deficient references, and terminological alignment of the text of the Act.

Considering the fact that 2018 saw the adoption of four governmental decrees and eight regulations entailing implementing (executive) regulations in the field of nuclear and radiation safety which the new ZVISJV-1 required the adoption of in its transitional and final provisions, almost all implementing regulations transposing the EU BSS Directive into the Slovenian legal order (Council Directive 2013/59/Euratom of 5 December 2013) were adopted in 2018. The process of transposing this Directive into the Slovenian legal order was completed in 2019 with the adoption of:

- *Decree on checking the radioactivity of consignments that could contain orphan sources* (UV11, Official Gazette of the Republic of Slovenia, No. 10/19) and
- *Decree amending the Decree on the content and elaboration of protection and rescue plans* (Official Gazette of the Republic of Slovenia, No. 26/19).

A more detailed overview of the already adopted legislation and legislation that is being prepared can be found on the SNSA's website.

8.5 THE EXPERT COUNCIL FOR RADIATION AND NUCLEAR SAFETY

The Expert Council for Radiation and Nuclear Safety provides expert advice to MESP and to the Slovenian Nuclear Safety Administration in the fields 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.

In 2019, the Expert Council for Radiation and Nuclear Safety convened one regular session and one correspondence session. In addition to the regular reporting of the SNSA Director to the Council on the status of nuclear and radiation safety, the Council considered the amendment to Article 155 of the Ionising Radiation Protection and Nuclear Safety Act regarding the security screening of foreign nationals intending to work with radioactive sources or to transport nuclear material in protected areas of nuclear installations, as well as the amendment to the Decree on checking the radioactivity of consignments that could contain orphan Sources (UV11). The Council members also discussed the status of the low and intermediate level waste repository in Vrbina in the Municipality of Krško and approved the 2018 Annual Report on Radiation and Nuclear Safety in the Republic of Slovenia as well as the Eighth National Report as referred to in Article 5 of the Convention on Nuclear Safety (CNS). Three Council members were granted an extension of their term of office for the next six years.

8.6 THE SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

The Decree on bodies within the ministries (Official Gazette of the Republic of Slovenia, Nos. 35/15, 62/15, 84/16, 41/17, 53/17, 52/18, 84/18, 10/19, and 64/19) determines that 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.

The legal basis for administrative and professional tasks in the field of nuclear and radiation protection and for inspections in this field is provided by the ZVIJSV-1 and the implementing regulations adopted on the basis thereof, the *Nuclear Damage Liability Act* (Official Gazette of the SFRY, Nos. 22/78 and 34/79), and the *Nuclear Damage Liability Insurance Act* (Official Gazette of the SRS, No. 12/80), both of which will remain valid until the full entry into force of the new *Nuclear damage Liability Act* (ZOJed-1, Official Gazette of the SRS, No. 77/10), the *Transport of Dangerous Goods Act* (Official Gazette of the Republic of Slovenia, Nos. 33/06 – UPB1, 41/09, 97/10, and 56/15), and the regulations in the wider field of nuclear and radiation safety and ratified and published international contracts in the field of nuclear energy and nuclear and radiation safety. A more detailed overview of the current legislation, including the relevant acquis in this area, can be found on the SNSA's website.

The SNSA has implemented a management system in accordance with the ISO 9001 standard and concurrently with the IAEA standard GSR Part 2 *Leadership and Management for Safety*. The management system of the SNSA is described in the Rules of Procedure of the SNSA and related procedures.

8.6.1 Organisational chart of the SNSA

The Staffing Plan of MESP for 2019 determines a quota of 41 employees for the SNSA. This number in the Staffing Plan has been steadily declining over the last fifteen years. The Unified Personnel Plan for 2004 and 2005 allowed the SNSA a total of 48 employees as of the last day of the year. In 2006, the total number of employees was reduced to 47 and remained so until 2007. With the amendments of the Unified Personnel Plan, the number of employees was further reduced to 46 in 2008. This quota lasted for two years and then began to steadily decline. For 2010 it initially determined 45 employees and at the end of the year 44. In 2013 this quota was drastically reduced to 41 employees and has remained so until the present. The SNSA manages its staffing deficit with short-term project employment.

At the beginning of 2019, the SNSA employed 47 civil servants. During the year, 2 new civil servants were hired and 5 ended their employment; thus, as of the end of 2019, the SNSA had 44 civil servants. The number of employees includes all employees who are employed for a definite or indefinite period of time, regardless the source of funding. As of 31 December 2019, 2 civil servants were employed on project work and 1 for a period of replacement, which are not included in the

Staffing Plan. Thus, of the 44 employees, 3 are not included in the Staffing Plan; as of the end of 2019, the SNSA consistently met the specified employment quota.

The composition of 44 employees as of the last day of 2019 was as follows:

- 42 officials and 2 technical staff;
- Number of fixed-term employees: 3;
- Gender: number of women: 20 or 45%, men: 24 or 55%;
- Age: average age of employees: 49.6 years, ranging from 23 to 66 years.

The level of professional qualifications of the 44 SNSA employees is shown in the Table 10.

Table 10: Level of professional qualifications of SNSA employees

Level of professional qualification	Number of employees	Percentage (%)
High School Education	1	2%
Higher Education	4	9%
University Degree	18	40%
Master's Degree	10	24%
Doctorate	11	24%

Despite the reduction in the number of employees and financial resources, the SNSA ensured a high level of nuclear and radiation safety in the country through effective optimisation. The SNSA points out that its internal reserves are practically exhausted, and the SNSA is being given an increasing number of tasks. Thus, the new European Directive on basic safety standards for radiation protection assigned the SNSA quite a few new tasks, and the need for staff reinforcement was also defined in the ZVISJV-1, which transposed this Directive into the Slovenian legal order. Both the Government of the Republic of Slovenia and the National Assembly of the Republic of Slovenia have been informed of these needs, but additional employment has not yet been realised. Appropriately staffing the SNSA is necessary to ensure a high level of nuclear safety in the country. If in the future it is decided to strengthen the nuclear energy option, it will become even more urgent, as sufficient training of new experts requires more than five years of training and experience in this field.

On 1 May 2019, the SNSA received new leadership. On the last day of April 2019, the long-term director, who had headed the SNSA since September 2002, retired and was succeeded by a long-term SNSA employee who had been the head of the Emergency Preparedness Department prior to his appointment as director.

8.6.2 Training

In 2019, the SNSA, as in all previous years, devoted a great deal of attention to training and education, with the aim of monitoring and developing the careers of civil servants and creating conditions for improving the professional skills of all employees.

Over 40 different types of important training were conducted, mostly abroad, and some also in Slovenia, amounting to nearly 350 working days. Almost 120 employees were involved in these training and education programmes, taking into account, of course, the fact that individual employees were involved in several different forms of training and advanced training. Naturally, participation in various working groups, committees, and associations is not included in these statistics, which is reported in more detail later in this report (Chapters 10.2 to 10.5). It is worth mentioning that the costs of training and education abroad are minimal, while the costs of courses which are selected, are mostly fully covered by the organiser.

Furthermore, the most common are internal training courses in the field of emergency preparedness, which are reported in more detail in Chapter 7.1 of this report and are not included in the above statistics.

On the basis of appropriate education or additional training, the SNSA has the following:

- A person responsible for radiation protection, who is responsible for the implementation and planning of measures for protection against ionising radiation in accordance with Article 52 of the ZVISJV-1;
- A workers' trustee for safety and health at work in accordance with the Occupational Safety and Health Act (Official Gazette of the Republic of Slovenia, No. 43/11);
- A data protection officer in accordance with Article 37 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of individuals with regard to the processing of personal data and on the free movement of such data and repealing Directive 95/46/ES;
- A commissioner for the referral of SNSA staff to periodic preventive medical examinations;
- An adviser for assistance and information regarding measures available in connection with protection against sexual and other harassment or torture in accordance with the Decree on measures to protect the dignity of employees in state administration bodies (Official Gazette of the Republic of Slovenia, Nos. 36/09 and 21/13 - ZDR-1).

8.6.3 Informing the public

The internal acts of the SNSA, especially the *Act on the Internal Organisation and Systematisation of Working Places in the SNSA* and the *Rules of Procedure of the SNSA*, determine that the public nature of work required by the SNSA, in addition to general legislation and the ZVISJV-1 (in point 11 of Article 4 – The public nature principle, and Article 8 – The public nature of data), is ensured by the director, mainly by issuing official messages and in other ways that enable the public to be informed of the work of the SNSA and by resolving issues in its field of work.

The SNSA informs the public mainly by publishing information on its website. In 2019, due to the development project P11: Renovation and optimisation of the websites of the entire state administration, which was approved by the Government in July 2016, the transfer of content from the archive page to the new central GOV.SI website was still ongoing.

The web content is constantly updated, with individual content given in multiple places. Important topics and news can also be highlighted, allowing users to access them more quickly.

In 2019, the SNSA continued the practice of publishing "Radiation News", which started more than fifteen years ago. Four editions (from 48 to 51) were prepared and published on the SNSA website. Edition 48 of Radiation News, published in January 2019, was dedicated to the transport of radioactive materials and the obligations of nuclear material holders, while edition 49, published in April 2019, was thematic and focused on the novelties of the *Decree on checking the radioactivity of consignments that could contain orphan sources* published in February. Edition 50, published in June, contained innovations in the field of the protection of radioactive and certain nuclear materials, as contained in the Rules on the Use of Radiation Sources and Radiation Activities and applicable from mid-2019; this edition also provided general information on the subject of administrative fees. The last edition issued in 2019, issue 51 published in November, briefly reported eight intervention inspection cases this year and events abroad reported by countries via the NEWS online information system.

Since 2010, for the public abroad, especially for foreign administrative bodies in the field of nuclear and radiation safety, the SNSA has also been preparing "News from Nuclear Slovenia" with a standardised content concept, which is updated twice a year. Edition 20 was published in April 2019 and edition 21 in October. Both publications, "Radiation News" and "News from Nuclear Slovenia", are also available on the SNSA website.

The annual preparation of the Report on Ionising Radiation Protection and Nuclear Safety in the Republic of Slovenia, which is prepared based on the ZVISJV-1, undoubtedly represents part of the public information package. The report for 2018 was discussed and adopted by the Government of the Republic of Slovenia at its 39th regular session on 11 July 2019 and submitted 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 was informed of the report at its 34th session on 2 September 2019, and the Committee of the National Assembly for Infrastructure, Environment, and Spatial Planning, as the parent body, took note of the report at its 12th session on 10 September 2019. The report represents the basic manner of informing the general public of nuclear safety and radiation protection in the country, for which it is primarily intended.

8.6.4 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

In 2019, 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) held eight meetings. In 2019, there were no candidates for obtaining their first Reactor Operator license at the Krško NPP. Extensions of licenses were granted to four Reactor Operators, eight Senior Reactor Operators, and one Shift Engineer. Altogether, three candidates also acquired a Senior Reactor Operator license for the first time.

One candidate successfully passed the exam and obtained his first license for the TRIGA Mark II Research Reactor Operator. A candidate for Storage Facility Manager of the Central Radioactive Waste Storage Facility was also successful and passed the license renewal exam.

The SNSA issued the appropriate licenses to the mentioned candidates.

8.7 THE SLOVENIAN RADIATION PROTECTION ADMINISTRATION

The 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 2019, the SRPA had five permanent employees. At the end of 2019, another permanent position was filled, which is the first new permanent employment since the SRPA was established in 2003.

The activities of the Administration were focused on performing duties in the field of radiation protection and on strengthening the system of 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, 117 permits to carry out a radiation practice, 312 permits to use radiation sources, 47 certificates of received individual doses, one permit for the export of radioactive substances, and 27 statements of consignees of radioactive materials were confirmed. In 2019, the SRPA issued 10 approvals to natural or legal persons performing professional tasks in radiation protection.

In 2019, the Inspectorate carried out 194 inspections. Of these, 8 were in-depth inspections of exposure to radon; the SRPA issued 7 warnings regarding the required reduction of exposure. In medicine and veterinary medicine, 14 in-depth inspections were performed. During inspections, 4 X-ray devices held in reserve were sealed. A total of 5 decisions requiring harmonisation with the valid regulations were issued, 9 requests to submit evidence regarding corrected authorised deficiencies, 37 requests to submit evidence regarding termination of the use of an X-ray device, and 123 requests regarding harmonisation with the existing legislation were issued. The SRPA took action in 3 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.

In 2019, the SRPA continued the programme for the systematic surveillance and measurement of radon to the same extent as in 2018. In 2018, the programme had been expanded in comparison to previous years. The number of measurements in schools and kindergartens increased and measurements in dwellings were included in the programme for the first time.

The SRPA continued to finance the radiation monitoring of food and drinking water.

In 2019, 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 materials. In the field of patient exposure, the SRPA financed a study on patient exposure due to radiological procedures and a quality control test of one SPECT and one planar gamma camera at the Maribor University Medical Centre and the Slovenj Gradec General Hospital.

The SRPA continues to perform records management of radiation sources used in medicine and veterinary medicine; the Central Records of Personal Doses (CRPD) is regularly updated and the development of the Register of Radon Measurements, which started in 2018, continued.

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. Despite the new permanent employment in 2019, additional staffing in the near future is necessary to ensure fulfilment of the legally defined obligations and an appropriate level of radiation protection.

Reference: [30]

8.8 AUTHORISED EXPERTS

Authorised radiation and nuclear safety experts

Operators of radiation and nuclear facilities must obtain expert opinions provided by authorised experts related to specific interventions in facilities. In 2019, there were no major changes in experts' activities in comparison to previous years. The expert organisations maintained the level of competence and the equipment used was well maintained and updated. The organisations had well established quality management programmes. The majority of them had certified programmes in compliance with the ISO 9001:2008 standard. In 2019, special focus was devoted to the independence of opinions related to Krško NPP modifications. Research and development activities are an important part of the work of approved experts. It must be noted that some expert organisations participated in international research projects very successfully.

In 2019, the SNSA considered two applications for the extension of approvals. The SNSA extended both approvals on the basis of Article 89 of the ZVISJV-1. No new approvals were issued.

In 2019, altogether 17 legal entities were approved by the SNSA.

The SNSA website provides information on authorised experts in various fields addressing specific questions of radiation and nuclear safety.

Approved Radiation Protection Experts

Approved Radiation Protection Experts (RPEs) advise persons who carry out a radiation practice with regard to all issues important for radiation protection. They provide expert opinions on such issues and, in cooperation with persons carrying out a radiation practice, prepare radiation protection evaluations and reports on reviews of radiation protection evaluations. 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 2019, the SRPA issued 4 radiation protection expert approvals to natural persons and 1 approval to a legal person, the IOS, for training courses in radiation protection.

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 2019 no approvals for dosimetry services were issued. The process of extending the authorisation of the Krško Nuclear Power Plant to perform measurements of personal neutron doses began. The approval was issued in early 2020.

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 2019, the SRPA issued 4 approvals for medical physics experts.

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 2019, the SRPA prepared 7 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* (Official Gazette RS, Nos. 18/18 and 86/18) define a special approval for institutions carrying out the governmental Programme of Systematic Surveillance 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* (Official Gazette RS, No. 39/18). In 2019, the SRPA issued one approval to an institution performing radon measurements. A competing company appealed the issued approval. The appeal procedure is continuing at the second instance in 2020.

8.9 THE NUCLEAR INSURANCE AND REINSURANCE POOL

The Nuclear Insurance and Reinsurance Pool (hereinafter: the Nuclear Pool GIZ) insures and reinsures against nuclear threats. 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.

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.

Among six insurance and reinsurance companies in 2019 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 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 damage 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 for due to 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 2019, 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.

9 NON-PROLIFERATION AND NUCLEAR SECURITY

9.1 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. Based upon the NPT, the Member States are parties to "safeguard agreements", which have been complemented by the "Additional Protocol". Every five years, NPT Review Conferences are held, which are milestone gatherings where the successfulness of the implementation of the NPT is addressed, together with political and security questions related to nuclear non-proliferation. 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, following the three standard-format meetings in 2017, 2018, and 2019 – i.e. NPT PrepCom – Preparatory Committees). A half a century has passed since the signing of the NPT. The third NPT PrepCom meeting took place from 29 April to 10 May 2019 (in New York). The European Union prepared several cluster-based statements that presented the common views of its Member States – also those of Slovenia. At the same time, Slovenian representatives – during the third 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 the SNSA to a certain extent, will be following NPT-related themes.

Reference: [31], [32], [33]

9.2 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 back in 1996 and ratified it in 1999. Currently, there are 184 states that have signed the treaty, 168 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 for 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 2019, fortunately, no "unusual seismic events" or nuclear tests (assessed as having a human cause or due to an explosion) took place in the world.

On 25 September 2019, an Article XIV-related conference took place. Around 85 high-level States' representatives took part in it (Slovenia was represented by the then-Minister of Foreign Affairs). Such conferences, held biennially, also "produce" a common statement; the last one endorsed gave strong support and appealed to those countries that have not signed or ratified the treaty to do so – and accelerate endeavours in this vein to ensure the treaty's entry into force – as a final goal.

Reference: [34], [35], [36], [37], [38], [39]

9.3 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 Mark II Research Reactor, at the Central Storage for Radioactive Waste in Brinje, and at the other "minor" 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 ten IAEA/EURATOM inspections in Slovenia in 2019 (four out of them were conducted independently by EURATOM). The SNSA's staff participated in the majority of these international inspections, which took place at two out of three nuclear facilities. There were also four international inspections in 2019 held on the premises of domestic "minor holders of nuclear material". In 2019, no international inspections were conducted based upon the requirements under the Additional Protocol.

9.4 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 Nur-Sultan (Kazakhstan) in June 2019.

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 2019, the Commission had seven regular and 15 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 2019, certain delays occurred during the preparation and finalisation of the Annual Report (covering 2018) of the aforementioned Commission, so it has not yet been endorsed by the Slovenian Government.

References: [40], [41], [42]

9.5 PHYSICAL PROTECTION OF NUCLEAR MATERIAL AND FACILITIES

The operators of nuclear facilities and holders 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 2019, 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), the SNSA's proposal on performing inspection controls of nuclear facilities and the transport of nuclear material, tasks vis-à-vis the changes to the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-1); subsequently, the Commission also considered issues concerning the direct implementation of the amended act – ZVISJV-1 – in particular those related to procedures for the background checking and vetting of foreign nationals.

The Ministry of the Interior issued two decisions (approvals) regarding physical protection plans, namely for the transport of nuclear (fissile) material and for the Krško NPP.

The Inspectorate of the Ministry of the Interior – based upon its Annual Plan of Activities in 2019 – carried out one inspection control of a nuclear facility (the Krško NPP). The control included its direct measures and physical protection of the nuclear facility, changes since the last inspection, and the Security Control Centre in the plant.

In the scope of the General Police Directorate, several threat assessments were carried out in the course of 2019: for the transport of nuclear (fissile) material – nuclear fuel, for nuclear facilities, as well as a revised threat assessment for the transport of radioactive material (cat. 1 and 2). In June 2019, the Police escorted a transport of nuclear fuel (from the Port of Koper to the Krško NPP).

In 2019, 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 2019, the representatives from the Ministry of the Interior participated in two dedicated meetings at the IAEA headquarters (in July and in November, in Vienna) where the amended convention (the CPPNM/A) was considered.

The Ministry of the Interior was also involved in the process of preparing some changes to Article 155 of the ZVISJV-1 (involving "background checks" or "security vetting") and has carried out new duties since the Act entered into force. These responsibilities include procedures regarding applications, collaboration with other security services, and finalisation of the administrative procedures (ending with a decision, and maintaining the registry files). In total, as many as 453 procedures were completed addressing foreign nationals (to be employed/contracted by 57 different companies); two negative decisions were also issued in this scope.

9.6 CYBER SECURITY

Cyber-attacks are becoming more frequent and sophisticated, and malicious actors are more motivated and focused on the nuclear sector. In response to these evolving cyber threats, the SNSA is actively involved in cyber security. The SNSA extensively cooperates with the IAEA to develop computer security guidance, exercises, and implement training courses. In 2015, the SNSA established a national cyber security working group, which focuses on maintaining a circle of trust, and the exchange of experiences and knowledge. In January 2019, the SNSA organised the first national cyber security exercise at nuclear facilities, named KIVA2019. Key stakeholders from the national nuclear sector, as well as several external observers, participated. The main goal of the exercise was to test the existing internal procedures, information exchange, reporting, assistance, and cooperation in the event of a nuclear facility cyber-attack. The exercise showed that many challenges remain in this area that we must address. The need to harmonise the response to cyber-attacks and to define appropriate communication protocols was unanimously recognised. All participants welcomed the exercise and expressed support and encouraged the organisation of such events in the future.

9.7 ILLICIT TRAFFICKING IN NUCLEAR AND RADIOACTIVE MATERIALS

At the beginning of 2019, a Regulation on the verification of the radioactivity of shipments that could contain radiation sources of unknown origin was adopted. The regulation upgraded and replaced the Decree on the Radioactivity Verification of Scrap Metal Shipments from 2007. The new Regulation defines the requirements and rules of conduct for radiation protection measures to be observed by the sender, acquirer, and transport organiser when scrap metal shipments are imported or exported to or from the Republic of Slovenia, during the transit of shipments of scrap metal with increased radiation, and in domestic traffic with scrap metal shipments. The regulation also redefines the requirements and rules of conduct regarding the radiation protection measures to be implemented by operators of major post offices, airports, ports, waste and scrap metal processing plants, and other waste collectors, waste treatment operators, electrical and electronic waste treatment operators, as well as operators of municipal waste management centres. The new regulation entered into force on 2 March 2019, with the obligations for new contractors coming into force twelve months after its entry into force, i.e. on 2 March 2020.

In 2018, the new Rules on Radioactivity Monitoring were adopted, which, among other things, determine the conditions for obtaining and issuing authorisation for providers of radioactivity measurements of shipments. In addition to shipments of scrap metal, the rules also newly concern shipments of other waste, electrical and electronic equipment waste, and imported goods that could be contaminated. These rules extend the validity of the authorisation from two to a maximum of five years.

There was a total of 22 authorised providers of radioactivity measurements of scrap metal shipments in 2019. The list of authorised providers of radioactivity measurements of shipments is published in Slovenian on the SNSA website.

In 2019, the SNSA extended the validity of the authorisation to seven providers of radioactivity measurements of shipments of scrap metal and issued one new authorisation. The 22 measurement providers stated in their annual reports that they performed a total of 97,515 measurements of shipments of scrap metal in 2019. Increased radiation was detected by four measurement providers in a total of eight shipments.

To assist and consult other authorities, as well as collectors and processors of scrap metal raw materials, a system of permanent preparedness has been established at the SNSA. In 2019, the SNSA dealt with a total of 16 interventions. In most cases there was an increased dose field detected during the transport of scrap metal raw materials over the territory of Slovenia. More information about such interventions is presented in Chapter 2.2.2 (Inspection of radiation sources in industry, research, and education).

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 2019, Slovenia (the SNSA) reported to the IAEA "Incident and Trafficking Database" (ITDB) once, using so-called "batch reporting". Two "discoveries" (unauthorised storages) were highlighted, both of them included Ra-226 (the first one from late-2018, detected in Jesenice; the second one from the town of Ravne na Koroškem, in 2019). The SNSA's representative took part in the IAEA-led efforts in Vienna to prepare a guiding document on comprehensive reporting to the IAEA ITDB. The IAEA has stepped up its efforts to promote this database – which includes 140 participating states at the moment.

In October 2019, representatives from the SNSA, the Financial Administration ("Customs"), the Market Inspectorate, the Ministry of the Interior, as well as mail/airport organisations (i.e. Pošta Slovenije, d.o.o., and Fraport Slovenija, d.o.o.) 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. In addition, the requirements under the new Decree on checking the radioactivity of consignments that could contain orphan sources were addressed – as this regulation will be fully mandatory in March 2020.

In December 2019, representatives from the SNSA and the Financial Administration ("Custom Control") visited the largest national airport and quickly checked the status of the detection equipment deployed there. In addition, the meeting served for the purpose of familiarising the participants with the status and procedures for dealing with in-coming/out-going shipments of packages with radioactive content. Awareness-raising is an underlying method of encouraging further proactiveness.

References: [43], [44], [45]

10 INTERNATIONAL COOPERATION

10.1 COOPERATION WITH THE EUROPEAN UNION

Working Party on Atomic Questions (WPAQ)

In the first half of 2019, the WPAQ was presided over by Romania. During this period the WPAQ continued to discuss the legislative proposals of regulations regarding the financing of and assistance for the decommissioning of nuclear facilities; the final texts were not harmonised by the end of the Romanian Presidency. The discussion on the conclusions regarding the Topical Peer Reviews (TPR) on ageing management of European nuclear installations was concluded and the contents of the Euratom Report under the CNS was confirmed. The delegates also discussed the various possibilities of the use of nuclear technologies for non-energy purposes. Finland assumed the presidency of the WPAQ in the second half of 2019. During this period the Working Party did not discuss any legislative proposals. The delegates were acquainted with subjects such as the European Commission Report on harmonisation of the requirements for nuclear installations, responsible radioactive waste management, the use of nuclear technologies for non-energy purposes and the management of radioactive waste from non-energy sources. The preparations for the review meeting under the CNS were also in progress and the delegates were informed of the outcomes of the IAEA General Conference and the OECD/Nuclear Energy Agency (NEA) Steering Committee Meeting.

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 Member States of the European Union. Representatives of the European Commission collaborate in the group on an equal basis. The role of the 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 2019, the delegates approved the guidelines for reporting under the Council Directive on nuclear safety and were informed of the delays regarding the implementation of the national action plans developed after the post-Fukushima stress tests. The countries were instructed to submit their answers to the survey on the aging management of nuclear installations and a discussion on the next cycle of TPR also began. Every two years the ENSREG hosts a special topical conference and in 2019 the following topics were discussed: TPR and ageing management, decommissioning and radioactive waste management, and supply chains and knowledge management. The Slovenian representatives also participated in the ENSREG's working groups, namely in the Working Group on Nuclear Safety and the Working Group 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. In 2019, the committee discussed the plans for the establishment of proton therapy centres for cancer treatment in the EU, the activities of the EC

Joint Research Centre (JRC) regarding emergency preparedness, the regulation of food and fodder contamination after a nuclear emergency, and updates regarding the implementation of the SAMIRA (*Strategic Agenda for Medical, Industrial and Research Applications of Nuclear and Radiation Technology*) Project studying 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). In 2019 no meetings of the respected committee were held.

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. In 2019 no meetings of the committee were held.

10.1.1 Cooperation in EU Projects

In the project "*Training and Tutoring for Nuclear Safety Regulatory Bodies' Experts and their Technical Support Organisations and Technical Competences*", the SNSA cooperates within a consortium led by the Italian company ITER. The SNSA mostly provides mentoring and occasionally takes part in implementing training courses for the personnel of nuclear and radiation safety regulatory bodies from partner countries. No mentoring or training courses were held in 2019; however, preparatory activities were carried out for the implementation of the training course "*Requirements and Safety Evaluation NPP SAR*", which took place in January 2020.

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 Bushehr 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, and in transferring the nuclear regulatory methodology of experienced EU regulatory bodies 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. The SNSA completed most of its project tasks in 2017 and 2018. In 2019, the SNSA performed several additional tasks regarding the management system (the organisation of training courses) and a review of the Safety Analysis Report for the new Bushehr NPP, in particular the areas related to the probabilistic safety analyses.

The same consortium of the so-called first Iranian project described above applied for the second Iranian project, i.e. "*Support to the Iranian Nuclear Regulatory Authority – INRA*". For this project, the consortium was augmented with the German company TÜV Nord. The assignments of the SNSA include the further development of the management system of the Iranian regulatory authority, which should soon be implemented by the nuclear safety centre, for which the SNSA developed a feasibility study within the first Iranian assistance project. The SNSA has also been active in the area of emergency preparedness by organising workshops on informing the public during an emergency and on the national emergency response plan, as well as by drafting a proposal for the further enhancement of INRA capabilities in this area, including the draft instructions for the operation of the future INRA emergency response centre. Several tasks in the area of the management system have also been performed. Due to the unstable political situation in Iran, the project activities have slightly decelerated since some of the planned events had to be postponed to a later period.

Since 2019 the SNSA, together with the Slovak and the Hungarian regulatory body and the company ENCO, has been participating in the project "*INSC – Support to the regulatory authority of Ghana*". The objective of the project is to assist the Ghanaian regulatory body for nuclear safety in strengthening the knowledge and expertise of its staff to achieve the highest possible level of regulatory independence. The SNSA will participate in the development of a strategic plan of the regulatory body and in the enhancement of the management system, resulting in its successful performance during an external audit. The project kick-off meeting took place in December 2019.

At the end of 2019 the European Commission published a notice on selecting the SNSA together with other consortium members to participate in the project "*INSC – Support to the regulatory authority of Bosnia and Herzegovina*". The objective of this project is to assist Bosnia and Herzegovina's regulatory authority for nuclear and radiation safety in issuing an operating licence for a radioactive waste storage facility and also to enhance the national capabilities in the field of radioactive waste management. The SNSA will be involved in providing support for the licencing of the radioactive waste storage facility and in training activities for the staff of Bosnia and Herzegovina's regulatory authority for nuclear and radiation safety.

10.2 THE INTERNATIONAL ATOMIC ENERGY AGENCY

Slovenia successfully continued its cooperation with the International Atomic Energy Agency (IAEA). As it does every year, in September the Slovenian delegation attended the regular annual session of the General Conference. In 2019, the Republic of Slovenia settled all of its financial obligations towards the IAEA.

Slovenia closely cooperated with the IAEA in the areas stated below.

In 2019, Slovenia, as usual, received a number of requests from the IAEA for the individual training of foreign experts during scientific visits or fellowships. Many training requests were implemented in 2019 enabling experts from Bosnia and Herzegovina, North Macedonia, Malaysia, the Philippines, Morocco, Albania, and Ghana to enhance their knowledge by participating in training at the following institutions: the Jožef Stefan Institute, the Institute of Oncology in Ljubljana, the Department of Nuclear Medicine and the Institute of Radiology at the University Medical Centre Ljubljana, the ARAO, and the SNSA.

The IAEA encourages the facilitation and development of nuclear applications and nuclear energy sciences for peaceful purposes. It therefore closely cooperates with the interested member states, regularly including Slovenia, in the field of research activities and the sponsorship of larger (national) projects within the framework of the Coordinated Research Programme.

Within the framework of the Technical Cooperation Programme, which is being carried out in biennial cycles, the 2018 – 2019 cycle comprised the following national projects:

- 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*",
- 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*", and
- the national project of the Biotechnical Faculty SLO/5/004 "*Improving Water Quality in Vulnerable and Shallow Aquifers under Two Intensive Fruit and Vegetable Production Zones*".

The activities of the national projects included scientific visits and training courses for Slovenian experts at similar institutions of other European countries.

In 2019, Slovenia, in cooperation with the IAEA, organised two national and two regional workshops and an international training course.

Several Slovenian participants took an active part in international events by providing presentations and posters. The participation of Slovenian specialists and their involvement as experts in various IAEA committees, missions, and workshops abroad were important as well.

In 2019, the SRPA continued to participate in the implementation of two projects in the field of ionising radiation in health. The first project, entitled RER/6/038 "*Applying Best Practices for Quality and Safety in Diagnostic Radiology*", is aimed primarily at the technical aspects of ensuring and verifying quality and the training of key experts, namely medical physicists, radiology engineers, and medical doctors – radiologists. The second project, entitled RER/9/147 "*Enhancing Member States' Capabilities for Ensuring Radiation Protection of Individuals Undergoing Medical Exposures*", is aimed at improving the national radiation protection systems in medicine, with an emphasis on cooperation between the regulatory bodies and professional associations and on the implementation of the international Basic Safety Standards (BSS-GSR Part 3). The project is divided into several thematic chapters. Based on the needs and existing situation, Slovenia participates mostly within the following areas:

- 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;
- 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.

Within the above project, two Slovenian representatives participated in the following events that took place in 2019: the technical meeting on updating the national profiles in the IAEA RASIMS II database and the Regional Workshop on improving patient safety and preventing skin injuries in fluoroscopically guided interventional procedures. Participation in these projects enables the selected radiology engineers, medical doctors, medical physicists, and regulatory body personnel to take part in expert training courses and workshops organised and funded by the IAEA, as well as to gain access to expert knowledge, guidelines, and relevant IAEA documents that can improve their performance.

In 2019, the IAEA continued with the implementation of the regional technical project for providing assistance to Eastern European and the former Soviet Union states in implementing their national radon programmes, as well as monitoring and raising awareness of the risks of exposure to radon in living and working environments. The SRPA coordinates participation in workshops, training courses, and other events.

10.3 THE NUCLEAR ENERGY AGENCY (NEA) OF THE OECD

The NEA is a specialised agency within the Organisation for Economic Co-operation and Development. 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 2019, Slovenian representatives participated in seven 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 Decommissioning of Nuclear Installations and Legacy Management held one meeting and one joint meeting with the Radioactive Waste Management Committee. 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, in the Working Group on Human and Organisational Factors, and in the Working Group on Risk Assessment. 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. One regular meeting of the Nuclear Law Committee was held, during which a meeting of the Contracting Parties to the Paris Convention was also organised by the NEA Secretariat regarding the enforcement of the Convention; for more information, see Chapter 8.9. The Slovenian representatives in the Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle also participated in their meetings. The representative of the SRPA participated in the meeting of the Committee on Radiological Protection and Public Health followed by the Fukushima workshop.

Slovenia also participates in the management committee of the NEA Data Bank, which provides access to a large amount of information and scientific data, and in the *International System on Occupational Exposure (ISOE).* The system is being maintained by the technical centres with the support of professional organisations, nuclear power plants, and regulatory bodies. In 2019, the representative of the SRPA did not participate in the ISOE management board meeting.

In 2019, the NEA emphasised two topical areas, deep geological repositories and small modular reactors. In December the Steering Committee organised a special Exploratory Meeting on Improving Gender Balance in Nuclear Energy, which was attended by a female Slovenian participant.

Slovenia participates in the "International System of Occupational Exposure" – ISOE. ISOE is an information system on occupational exposure to ionising radiation in nuclear power plants, supported by the OECD / NEA and the IAEA. The information system is maintained by technical centres with the support of these organisations and with the participation of nuclear power plants and regulatory bodies. In 2019, the representative of the SRPA did not attend the regular meeting of the Management Board.

10.4 COOPERATION WITH OTHER ASSOCIATIONS

The Western European Nuclear Regulators Association

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 2019 plenary meetings were hosted in Budapest, Hungary, and Basel, Switzerland. Apart from electing new chairs and approving the Russian Federation as a new observer, the delegates discussed the following: the drafting of a new strategic plan of the Association, progress on the performance of stress tests in Belarus, and the need for the harmonisation of the national regulatory authorities' approaches to the implementation of the Safety Reference Levels (SRL). The delegates also discussed the draft report entitled "*Interfaces between Nuclear Safety and Nuclear Security*" and encouraged prompt activation of the newly established working group on cyber security and its cooperation with ENSRA. 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

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. In 2020 the INLA congress will be held in Washington, USA. In 2005 the INLA congress was organised in Portorož, Slovenia.

European Nuclear Security Regulators Association

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 March 2019 Finland hosted the plenary meeting at its regulatory body's (STUK) headquarters. The emphasis was on the following: the safety and security interface and approaches of the member states, cooperation with other organisations and subjects, the activities of the working groups (i.e. for transport/security), and the revision of the Association's Terms of Reference. The Finish regulatory body will chair the Association until the end of 2021; the next plenary meeting will be hosted by ENSI, the regulatory body of Switzerland.

Nuclear Security Contact Group

The Nuclear Security Contact Group (NSCG) 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).

The commitments from the previous nuclear security summits also include individual topic areas supported by various groups of countries. In August 2018 Slovenia submitted a formal letter through the Ministry of Foreign Affairs stating that it would join two such initiatives: INFCIRC/910 (the security of high activity radioactive sources) and INFCIRC/918 (the prevention of nuclear smuggling).

In 2019, the work of the NSCG was coordinated by Hungary and in May a plenary meeting was held in Budapest where the Slovenian representatives (from the Ministry of Foreign Affairs and the SNSA) took part. The meeting included the exchange of information about the IAEA

Conference on Nuclear Security, the IPPAS missions, the work on and struggle against nuclear terrorism, and other topics.

Association of the Heads of the European Radiological Protection Competent Authorities

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 2019.

The SRPA also participates in the working group on medical applications. Apart from exchanging important information on current radiation protection issues in the medical field, the group's activities in 2019 included preparations for the European action week on raising awareness among physicians regarding justification for ordering the performance of radiological procedures, as well as preparations for a workshop for inspectors in the field of radiotherapy. In September 2019 the SRPA hosted two regular meetings of the working group for medical applications and the working group for veterinary applications with over 40 participants from the European regulatory bodies for radiation safety.

The SRPA also actively participated in the project *European Study of Occupational Radiation Exposure – ESOREX*, which is aimed at collecting, processing, and comparing the data on ionising radiation doses received by exposed workers in different countries. 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 2019, the project was redesigned into the Network of National Dosimetry Registries within the framework of HERCA. A preliminary Action Plan was prepared and submitted to the HERCA Board of Heads.

CAMP (NRC)

An agreement with the US NRC (Nuclear Regulatory Commission of the United States) and the SNSA is the basis for cooperation in the CAMP (*Code Application and Maintenance Programme*). The 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 2019, the Jožef Stefan Institute prepared a contribution entitled "*LOCAs with loss of one active emergency cooling system simulated by RELAP5*". An JSI representative took part in the spring and autumn meetings. The representatives of the Slovenian CAMP members met in January and June at working sessions, where the national coordinator 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 the 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 institutions had a working meeting in November 2019. The National Coordinator presented the status of CSARP research in Slovenia, current activities, attendance at the EMUG (*European MELCOR User Group*) meeting, the MELCOR workshop, and the CSARP/MCAP (MELCOR Code Assessment Program) meeting, as well as the realisation of plans. All planned activities were finished, including the SNSA research project "*Analysis of the influence of radioactive substances in the NPP Krško containment on SAMG*".

European Association of Competent Authorities

The European Association of Competent Authorities (EACA) 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 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' experts. Since 2015, when Slovenia was an observer, and fully since 2017, Slovenia has taken part in the work of the EACA. In 2019, the annual meeting took place in Athens, Greece; the next meeting is to be held in Stockholm, Sweden (in spring 2020). During the meeting in Athens, Slovenia presented the data on the transport of radioactive substances collected in different countries during the winter period.

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.

10.5 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 radioactive waste management 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 these 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 responsibilities 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. After many meetings held at the levels of the Coordinating Committee as well as the Interstate Commission, a mutual solution has proven impossible for the time being.

In order to monitor the 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 of the Commission.

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

In accordance with the provisions of the Intergovernmental Treaty, in 2004 the first revision of the *Programme for Decommissioning* and the *Programme for the Disposal of LILW and SF* was prepared and approved at the 7th Interstate Commission meeting in 2005.

Due to the fact that almost 15 years have passed since the approval of the *Programme for Decommissioning* and the *Programme for the 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 Decommissioning* and the *Programme for the Disposal LILW and SF*. In 2019, the Coordinating Committee met seven 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. In 2019, the Coordinating Committee prepared the material to be discussed by the Interstate Commission regarding the activities of the Krško NPP since the 12th Interstate Commission meeting, the *Programme for Decommissioning* and the *Programme for the Disposal LILW and SF* and the material regarding the search for a mutual solution for the LILW management.

The work of the representatives of the Republic of Slovenia in the Coordination Committee was in line with 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.

The Interstate Commission held a meeting in Zagreb, Croatia, on 22 January 2019 and discussed the report on the activities of the Krško NPP since the 11th meeting of the Commission and the report on the work of the Coordinating Committee. The Commission also provided the basis for the Coordinating Committee to receive additional expert assistance.

One of the meetings of the Interstate Commission was also held in Bled, Slovenia, on 30 September 2019; the participants discussed the report on the activities of the Krško NPP since the 12th meeting of the Commission and the report of the Coordinating Committee's work. The Commission decided that the prepared *Programme for Decommissioning* and the *Programme for the Disposal LILW and SF* were suitable for further legislative procedures in both countries. Based on the report of the

Coordinating Committee, the Interstate Commission also stated that a mutual solution to the disposal of LILW is not possible. The Commission was also informed of the status of both national decommissioning funds.

10.6 COOPERATION WITHIN THE FRAMEWORK OF INTERNATIONAL AGREEMENTS

In early April the SNSA hosted 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. 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 the organisational issues, new developments in the field of legislation, regulatory activities and inspection, important issues and challenges regarding the surveillance of nuclear power plant operation, security, relevant operational events, plans for the construction of new power plants and international cooperation. The participants also received information regarding the status of the common project in which all four regulatory authorities cooperate, i.e. providing assistance to the Iranian regulatory authority within the INSC – the Instrument for Nuclear Safety Cooperation. Slovenia reported on the progress in the implementation of the Safety Upgrade Programme (SUP) in the Krško NPP, on the status of the new spent fuel dry storage project, and on the progress regarding the implementation of the emergency preparedness Action Plan.

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 the SNSA in Ljubljana. The subjects of discussion were new developments regarding legislation, radiation monitoring, emergency preparedness, nuclear waste management, and an update of the Slovenian nuclear programme status since the last meeting. Slovenia reported on the adoption of the secondary nuclear and radiation safety legislation and Austria provided an update on the transposition of the EU directives, the adoption of its new radiation protection act, and on a comprehensive national radon project. The participants also agreed on the successful performance of a regional emergency preparedness exercise organised by the IAEA in Vienna regarding harmonisation of the cross-border protection measures during a nuclear emergency; Austria, Croatia, and Slovenia participated in this exercise. Slovenia also provided detailed reports about the following: the operation of the NPP Krško, in particular regarding the planned outage and four operational events, the successful implementation of all OSART mission recommendations, the progress of SUP implementation, the status of the new spent fuel dry storage project, and on the activities of the TPR Action Plan. The Austrian delegation also visited the Central Storage for Radioactive Waste in Brinje near Ljubljana.

In December a regular meeting with Croatia in accordance with the bilateral agreement on the early exchange of information during a radiological emergency event was held in Ljubljana. The topics of the meeting included new developments in both regulatory authorities and in the field of legislation. The Croatian delegation reported on the reorganisation of its state administration resulting in the transfer of jurisdiction and responsibilities of the former national regulatory body for nuclear and radiological safety to the Directorate for Civil Protection with the Ministry of the Interior. The Slovenian delegation reported on the recent developments in the areas of legislation and emergency preparedness, including important updates to the emergency preparedness communication tool "KID", to which Croatia gained on-line access. The positive outcomes of the regional exercise in Vienna were discussed during this meeting as well. Both countries maintain permanent cooperation in the area of emergency preparedness and response, including the harmonisation of protective measures during a potential emergency at the Krško NPP. The Croatian participants also visited the SNSA emergency response centre.

10.6.1 The Convention on Nuclear Safety (CNS)

In February 2019, the SNSA started the preparations for the eighth review meeting of the contracting parties to the Convention on Nuclear Safety (hereinafter: the Convention) to be held in Vienna in March 2020. The main activity was the preparation of the national report on the implementation of the provisions of the Convention since the last review meeting, held in 2017.

The national report focuses mainly on the safety of the Krško Nuclear Power Plant, which the SNSA assessed operated safely in the given period since no major problems or deviations were encountered. The main highlight of this reporting period was the implementation of the post-Fukushima National Action Plan and within it, the Krško NPP Safety Upgrade Programme (SUP). The challenges based on the findings of the previous review meeting include the construction of a spent fuel dry storage and the need for harmonising the emergency response with the neighbouring countries.

The report also addresses other topics related to the Krško NPP operation, such as: the promotion of a culture of safety, knowledge management, regular international peer reviews, screening and analysis of foreign operating experiences, siting, licencing, and modifications. Additional relevant topics, i.e. effective public communication, stable funding, a state-of-the-art regulatory and legal framework, reducing received radiation doses, emergency preparedness, assessment and verification of safety, design, and construction, and severe accident management, were also included in the report.

The report was published in mid August on a special IAEA webpage accessible to all Convention parties. By the end of November, the parties had reviewed the national reports and posed and exchanged questions. Slovenia asked 91 questions to other parties and received 99 questions related to its own report (10 of which were duplicates).

11 USE OF NUCLEAR ENERGY IN THE WORLD

As of the end of 2019, there were 443 nuclear reactors for electricity production operating in 30 countries. There are 53 nuclear reactors under construction; in 2019 construction on reactors began in Russia, Great Britain, China, and Iran. There were six new grid connections, two in China, three in Russia, and one in the Republic of Korea. 13 reactors were permanently shut down, five in Japan, two in the United States of America, and one each in Taiwan, Russia, Switzerland, Germany, Sweden, and the Republic of Korea.

In Europe, there are nuclear power plants under construction in Finland, Slovakia, Belarus, France, Russia, Turkey, Ukraine, and Great Britain.

Detailed data on the number of reactors by country and their installed power is presented in Table 11.

Table 11: The number of reactors by country and their installed power

Country	Operational		Under construction	
	No.	Power [MW]		No.
Belarus			2	2,220
Belgium	7	5,930		
Bulgaria	2	1,966		
The Czech Republic	6	3,932		
Finland	4	2,794	1	1,600
France	58	63,130	1	1,630
Hungary	4	1,902		
Germany	6	8,113		
The Netherlands	1	482		
Romania	2	1,300		
Russia	38	28,415	4	4,525
Slovakia	4	1,814	2	880
Slovenia	1	688		
Spain	7	7,121		
Sweden	7	7,725		
Switzerland	4	2,960		
Turkey			1	1,114
Ukraine	15	13,107	2	2,070
The United Kingdom	15	8,923	2	3,260
Europe total	**181**	**160,302**	**15**	**17,299**
Argentina	3	1,633	1	25
Brazil	2	1,884	1	1,340
Canada	19	13,554		
Mexico	2	1,552		

Country	Operational		Under construction	
	No.	Power [MW]		No.
USA	96	97,565	2	2,234
Americas total	**122**	**116,188**	**4**	**3,599**
Armenia	1	375		
Bangladesh			2	2,160
India	22	6,255	7	4,824
Iran	1	915	1	974
Japan	33	31,679	2	2,653
China	48	45,518	10	9,448
Korea, The Republic of	24	23,123	4	5,360
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:	**138**	**113,027**	**34**	**35,427**
South Africa	2	1,860		
World total	**443**	**391,377**	**53**	**56,325**

Reference: [46]

12 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 2019

In 2019, 24 event reports were published via the NEWS system. There were 16 events rated level 2, seven events rated level 1, and one event rated level 0. The reports were divided into the following groups: four events in NPPs, three events in nuclear or radiation facilities, three events involving the exposure of personnel in hospitals or the pharmaceutical industry, three events involving the exposure of workers during the performance of radiography, and ten events involving radioactive sources that were stolen, lost, or found as orphan sources.

A potential event in France was rated as level 2 according to the INES scale, where the degradation of defence in depth was found at 13 units of different NPPs. In the event of an earthquake, differential movement of the diesel generator and nearby civil engineering structures would occur, which could lead to damage to the piping connected to the diesel generator and could stop the operation of the diesel generator. The consequences would be a loss of AC power for safety systems that ensure the cooling of the fuel in the reactor core and the spent fuel pool. Repairs will be carried out before the NPPs are restarted.

An event rated as level 2 occurred during an NPP outage. This event involved a violation of OL&Cs during operations to drain the primary coolant system. The event was caused by several human errors and noncompliance with general operating rules. The reactor vessel coolant level decreased uncontrollably due to incorrect actions by staff, but the uncovering of fuel in the reactor core did not occur.

Two separate level 2 events that degraded the radiation safety of workers occurred in 2019 in the same unit of a Mexican NPP. During the first event, the radiological shield for the protection of personnel was not in place. This radiological shield protects personnel from excessive exposure in the event of entry into an area with a dose rate higher than 10 mSv/h. During the second event, a door leading to another area with a high dose rate was closed but not secured with a padlock. This would allow entry to personnel, who would then be exposed. Both events showed degraded defence in depth, but there was no actual exposure of workers.

A level 2 event occurred in a radwaste storage where intermediate level radioactive waste from the reprocessing of spent fuel is stored in a silo, partly in the form of liquid waste. It was found that there was a leakage of about 1 m^3 per day of liquid radioactive waste from the silo into the ground. This amounts to the release of approximately 8 TBq of ^{137}Cs into the environment over a period of five months. The spread of contamination into the ground is very slow and therefore this is a minor risk to the public and environment. The rating of the event is based on the contamination of a facility area that is not expected by design.

Two events occurred in radioisotope processing and handling facilities. In the first event, three workers were contaminated by ^{99}Mo from contaminated tools and a container lid where a bottle containing ^{99}Mo was placed. The estimated equivalent doses to the skin of the hands was 377 mSv, 732 mSv, and 1,444 mSv, for the three workers. This is higher than the annual dose limit for two workers and the rating is level 2 on the INES scale. In the second event, three workers were exposed to ^{241}Am from a vacuum cleaner filter. Following the failure of the vacuum cleaner, the isotope was dispersed into the room and contaminated the workers' lungs. This caused the internal contamination of workers and doses for two of these workers exceeded the annual dose limit, so the rating is level 2 on the INES scale.

Another event related to work in nuclear facilities was the overexposure of a contractor who occasionally performs maintenance work in nuclear facilities. The dosimeter showed a dose of 156 mSv over a period of 4 months. This exposure was in excess of the annual dose limit of 1 mSv for a member of the population and the event rating was level 2 on the INES scale.

Three level 2 events occurred in hospitals and caused the contamination and overexposure of workers. In the first event, a droplet of ^{68}Ga solution sprayed out and resulted in the contamination of a worker's right eye. The assessed dose was 27 mSv, which exceeds the annual limit of 20 mSv. The second event was the contamination of the hands of two workers by ^{18}F, which is used for Positron Emission Tomography (PET). The skin dose to the skin of the hands was estimated at 2,000 mSv for both workers, which exceeds the annual dose limit of 500 mSv. The third event is based on a dose to the hands of 723 mSv, which was measured by the dosimeter of a worker in the nuclear medicine department of a hospital. The exposure exceeded the 500 mSv annual dose limit for the exposure of hands. The events were also caused due to failure to use adequate personal protective equipment.

Three level 2 events were reported due to the overexposure of workers during the performance of radiography with ^{192}Ir. In the first event, the worker received a dose of 193.40 mSv. The causes of the event were an unshielded radiation source which was not in a safe position and the failure of a safe access interlock to the bunker. The second event was the overexposure of two workers performing non-destructive testing in a bunker. The source was not placed in its shielded position after the irradiation was completed. The electronic dosimeters worn by the workers were switched off and did not alert them. The radiation protection officer did not perform the prescribed radiation measurement to check that the source was placed in a shielded position. The workers received doses of 100 mSv and 30 mSv, respectively. The third event was also overexposure due to a source that was not put into the shielding device. The worker failed to observe the visible alarm and bypassed the audible alarm of the room and also failed to observe his electronic dosimeter upon entry into the room. The worker received an exposure of 81.49 mSv.

Ten events involved radiation sources that were temporarily out of administrative control because they were stolen, lost, or found as orphan sources. In one event the source was not recovered. In all other events these sources were found later, and the irradiation devices were confirmed to be intact and thus there was no risk to the public. Two events with stolen sources were reported. In the first event, a density gauge with category 2 sources ^{241}Am/Be and ^{137}Cs was stolen from a vehicle. These sources have not been recovered yet and the event is provisionally rated as level 2. The second event was the theft of a Troxler moisture/density gauge with a category 4 source ^{137}Cs from a parked vehicle during the night. On the same day the police found the device in bushes 4 km away. The event was rated as level 1.

In three cases a source was lost during transport because the sources fell from the vehicle. The first event was the loss of a category 4 source ^{137}Cs, which was found undamaged by the police the next day at a local scrap metal dealer. The second event occurred following a traffic accident in which two workers died and the driver was severely injured. The police secured the vehicle but by then a gauge with a category 2 radiation source ^{192}Ir had disappeared. The source was found two days later at a scrap metal dealer 10 km from the accident site. In the third event, a category 3 source of ^{192}Ir fell from a vehicle. The driver was retracing the same route to search for the projector when he was called by a shopkeeper who had found the company's telephone number on the source container. All three events were rated as level 1.

A category 3 source $^{241}Am/Be$ of a well-logging geophysical probe was dropped to the bottom of a 1,800-meter-deep well because the probe head break off. Measurements showed that the well was not contaminated and that the source remained intact. The source was successfully retrieved after 16 days using modified retrieval technology. The event was rated as level 1. Another event was the loss of a brachytherapy seed of ^{137}Cs at an oncology hospital. This was a category 5 source and the provisional INES rating is level 0.

Three events involved the discovery of orphan sources. The first event occurred in a large European port where on three occasions ^{60}Co category 3 sources were found in scrap metal containers. In the three shipments identical sources were found, five in the first case, three in the second case, and one in the third case. The origin of the ^{60}Co sources was not identified even after inquiries in different countries. The event was rated as level 2 based on the criteria of degradation of defence in depth. A similar event occurred in a neighbouring country where at a metal recycling company near a large port a ^{60}Co source was found. The scrap metal delivery originated from Western Africa. The event was rated level 1 based on the activity of the recovered source. The third event was the finding of a ^{226}Ra source of category 4 in a transport container with scrap metal. The source was a static eliminator. The event was rated as level 1.

In Slovenia there were no events in the year 2019 that required reporting according to the INES criteria. The SNSA dealt with three events at the Krško NPP, with one rated as level 1 on the INES scale and the other two unrated. These events are described in Chapter 2.1.1.2.

Other Internationally Interesting Events in 2019

The IAEA website for reporting emergencies posted reports on other events in 2019 that were not included in reporting through the NEWS system for INES event reporting. Most of these events were not rated according to the INES criteria.

Three events involved NPPs. The first event in a Ukrainian NPP was a fire in an autotransformer connecting switchyard and the NPP was disconnected from the grid and shut down. The event was rated as level 0 on the INES scale. The second and third events were notifications of two earthquakes in France that did not cause any damage to NPPs and other nuclear facilities in the vicinity. After the second earthquake, the stronger one, one of the NPPs was preventively shut down for inspection of the reactors. The NPP was restarted after the checks had been completed.

Two events concerning the spread of contamination from the Fukushima accident were reported. The first event was the flooding of large container bags with contaminated material from off-site decommissioning works. Heavy rain swept 10 bags into a river. Subsequently, 7 bags were recovered; some contaminated material was dispersed by water. The second event was the leakage of contaminated water from a drain sump pit of the exhaust stack in Fukushima NPP. The leakage of the sump pit was discovered after a typhoon hit the NPP a month prior to the event.

Seven events involved radiation sources. Four of these were events with stolen radiation sources and all these events occurred in Latin America. In two of these events the thieves stole vehicles with ^{192}Ir sources in radiographic cameras. After a search mission, a few days later the police found the devices with intact sources. In the other two events density/moisture gauges containing sources $^{241}Am/Be$ and ^{137}Cs were stolen from parked vehicles. The sources were not found by search missions.

A well logging probe containing a tritium source and two ^{137}Cs sources was stuck and the sources could not be recovered from the logging well. The sources were not damaged. The drilling hole was then blocked with a concrete plug and therefore three lost sources will remain buried in the well, 3.8 km under the surface.

Two findings of orphan sources were reported. A portal monitor at the gates to a storage of scrap metal detected elevated radiation and between the waste material a ^{137}Cs source was found in an iron box. The dose rate on the contact with the iron box was 70 mSv/h; the source activity and origin were not reported. The other event was the finding of a white plastic bucket with glass and plastic containers with labels of radioactive substances at a garbage container site. The radioactive materials were marked as uranyl chloride, uranyl nitrate, and uranyl sulphate. The event is still being investigated.

At a meeting of the IAEA group for the exchange of information on operational experiences, an INES level 2 event at a NPP of an Asian country was presented. The event occurred during reactor physics tests prior to NPP start-up to power operation. A deviation in the control rods performance caused the reactor power to rise to 18%, which is beyond the operational limits and conditions of the 5% power limit. The reactor operators shut down the reactor by inserting the control rods. A power increase of such magnitude during the event can also be attributed to inappropriate actions by operators. During the event no fuel assemblies were damaged.

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