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

2021 Annual Report on Radiation and Nuclear Safety in the Republic of Slovenia

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2021 Annual Report on Radiation and Nuclear Safety in the Republic of Slovenia

January 2023

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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.

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SUMMARY

In 2021, the Krško Nuclear Power Plant (NPP) operated safely. The Krško NPP reported two events, which did not affect the population or the environment.

During the outage, which took place in spring 2021, almost all work under the third phase of the security improvements from the Safety Upgrade Programme (SUP) were completed. By installing additional safety systems, the Krško NPP increased the plant's resilience to natural and other unlikely extreme events, thus approaching the safety level of new power plants.

The only activity of the last period of the SUP, which is still not entirely completed, is the construction of a dry spent fuel storage facility. The construction started in April 2021 and is planned to be finished in 2022, while the transfer of the first part of the spent fuel elements to the dry storage facility is planned for 2023.

In 2021, the Third Periodic Safety Review (PSR) began in the Krško NPP. The final safety review report, which will also include a comprehensive assessment of the facility's safety and a plan of modifications and improvements based on the findings of the review, will be submitted for review and approval to the Slovenian Nuclear Safety Administration (the SNSA) in 2023. The SNSA's approval is a condition for a further ten years of operation.

In 2021, the process of obtaining environmental approval to extend the operating period of the Krško NPP from 40 to 60 years was also initiated.

The Agency for Radwaste Management (ARAO) continued its activities for the construction of a low- and intermediate-level radioactive waste repository in Vrbina near Krško. In 2021, following the completion of the public exhibition and cross-border assessment, an environmental approval was issued, but not yet a building permit. Given the dynamics of the implementation of the activities and conduct of the authorities involved, the challenge that the storage facilities for such waste at the Krško NPP will be filled up and that there will be no repository available, remains very relevant.

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

In 2021, the planned monitoring of radioactivity in the environment went smoothly. Based on the results of the measurements, we established that the dose to the population of Slovenia due to the presence of artificial radionuclides in the environment is below all statutory limits and is comparable to previous years. Furthermore, operational monitoring of all facilities was carried out according to the planned annual programmes, and the activities of released radioactive substances into the environment were below the authorised limit values. As a result, the burden on the population was lower than prescribed and negligible compared to the natural background.

In 2021, there were no major problems for radiation practitioners. The SNSA dealt with a total of 35 intervention cases, of which most were related to the supervision of new practitioners regarding their obligations with reference to carrying out radiation measurements (radioactive waste facilities).

The year 2021 was still marked by the Covid-19 epidemic. The Krško NPP and other licensees adapted their work to the conditions, thus preventing the epidemic from having harmful effects on nuclear and radiation safety. It should be noted that during the epidemic the Krško NPP successfully carried out all planned activities during the one-month outage, which was a result of good preparation and the effective implementation of all necessary protective measures at the facility. As part of its activities, the SNSA and other administrative bodies also monitored the

impact of Covid-19 on nuclear and radiation safety and adapted their work to the epidemiological conditions by always performing their administrative and supervisory tasks effectively.

Taking into consideration the climate change and energy crisis, the possibility of expanding the programme of the use of nuclear energy for peaceful purposes has also been seriously considered in the Republic of Slovenia for some time. The experiences of comparable countries in Europe and worldwide show that one of the preconditions for such an expansion is the timely strengthening of the institutional-administrative framework. For some time, the SNSA has been pointing out that in Slovenia we are increasingly facing the challenge of providing enough experts with the necessary competencies in various areas of nuclear and radiation safety, also considering the change in generations. While there is a current noticeable shortage, particularly in the public sector, the shortage will also affect all other stakeholders in the face of additional needs, and it should therefore be analysed as soon as possible by assessing the envisaged need to provide the necessary competencies in the various areas of nuclear and radiation safety and by providing mechanisms to ensure them.

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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 (the SNSA). The content of the report is contributed by other state bodies involved in protection against ionising radiation and nuclear safety, as well other institutions in this field. The most important contributors in 2021 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 (the Krško NPP), Žirovski Vrh Mine, d. o. o., the Jožef Stefan Institute (JSI), 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 2021 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 a 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 2021, the Krško NPP produced 5,705,951.3 MWh (5.7 TWh) gross electrical energy from the output of the generator, which corresponds to 5,418,643.3 MWh (5.4 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 2021

Safety and performance indicators	Year 2021	Average (1983–2021)
Availability [%]	90.7	87.98
Capacity factor [%]	92.9	86.87
Forced outage factor [%]	0.0	0.91
Gross production [GWh]	5,705.95	5,242.55
Fast shutdowns – automatic [number of shutdowns]	0	2.10
Fast shutdowns – manual [number of shutdowns]	0	0.13
Unplanned normal shutdowns [number of shutdowns]	0	0.67
Planned normal shutdowns [number of shutdowns]	1	0.79
Event reports* [number of reports]	0	3.87
Duration of the refueling outage [days]	34.1	47.9

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

Table 2: Time analysis of the operation of the Krško NPP in 2021

	Hours	Percentage
Number of hours in a year	8,760	100
Duration of plant operation (on grid)	7,941	90.7
Duration of shutdowns	819	9.3
Duration of the refueling outage	819	9.3
Duration of planned shutdowns	819	9.3
Duration of unplanned shutdowns	0.0	0.0

The operation of the Krško NPP in 2021 is shown in Figure 1. The plant's operation was stable in 2021. It shut down only once, in April, due to the regular outage. The plant operated at a reduced rate in October, due to the checking and repair of a leak in the main condenser chamber and the testing of turbine valves, which had a duration of 24 hours. The corrective actions found leaking pipes and patched them. The leaking was stopped and the plant continued to operate at a full rate.

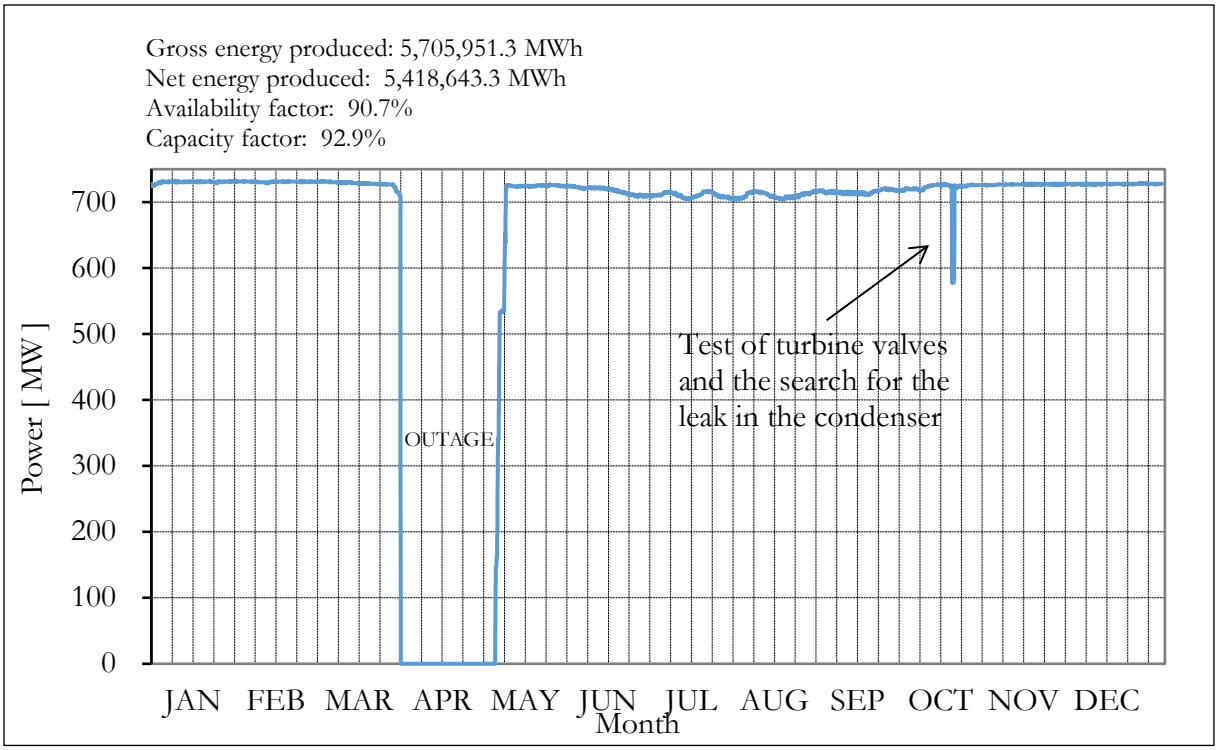

Figure 1: Operating power diagram of the Krško NPP in 2021

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

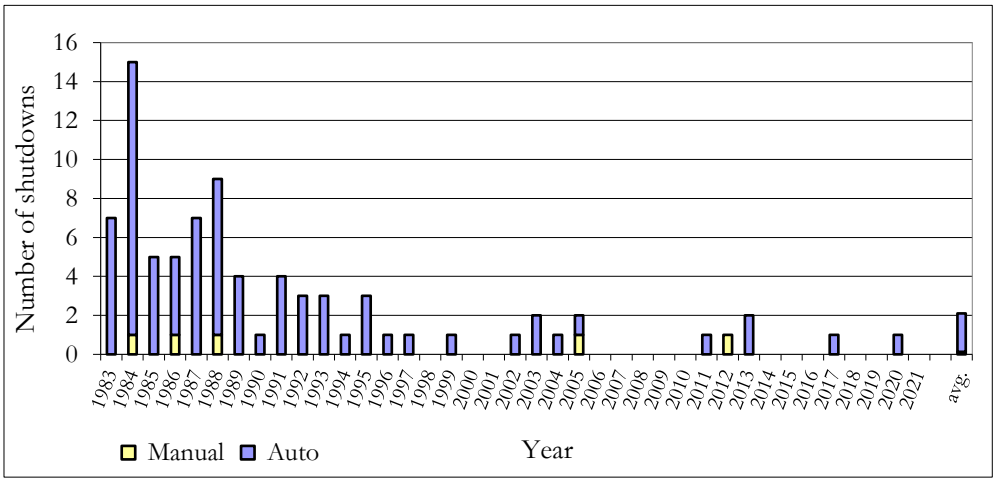

Figure 2: Fast reactor shutdowns – manual and automatic

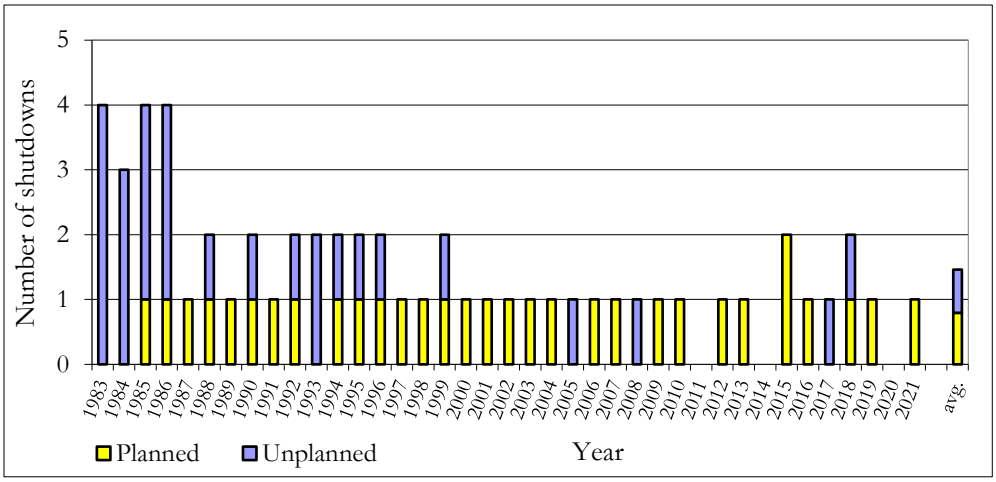

Figure 3: Normal reactor shutdowns – planned and unplanned

Shutdowns are divided into two groups: fast and normal. Fast shutdowns are caused by the operation of the 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 207 times during its operation (1981–2021), of which 139 during commercial operation. There have been 139 fast shutdowns. During commercial operation, there have been 82 fast shutdowns, of which 77 automatic and 5 manual. There have been 68 normal shutdowns in total. During commercial operation, there have been 57 normal shutdowns, of which 28 due to outage, while 26 were unplanned and 3 planned. 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, 2017, and 2020. Furthermore, 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). There were no fast shutdowns in 2021.

Figure 4 shows the number of abnormal events according to Article 30 of the *Rules on the safety assurance of radiation and nuclear facilities* (Official Gazette of the Republic of Slovenia, Nos. 76/17 and 76/17 – ZVISJV-1; hereinafter: Rules JV9). In 2021, there were no abnormal events according to Article 30 of Rules JV9. The Krško NPP is obliged to report all events that could reduce the level of nuclear safety to the regulatory body. Abnormal events are described in Chapter 2.1.1.2.

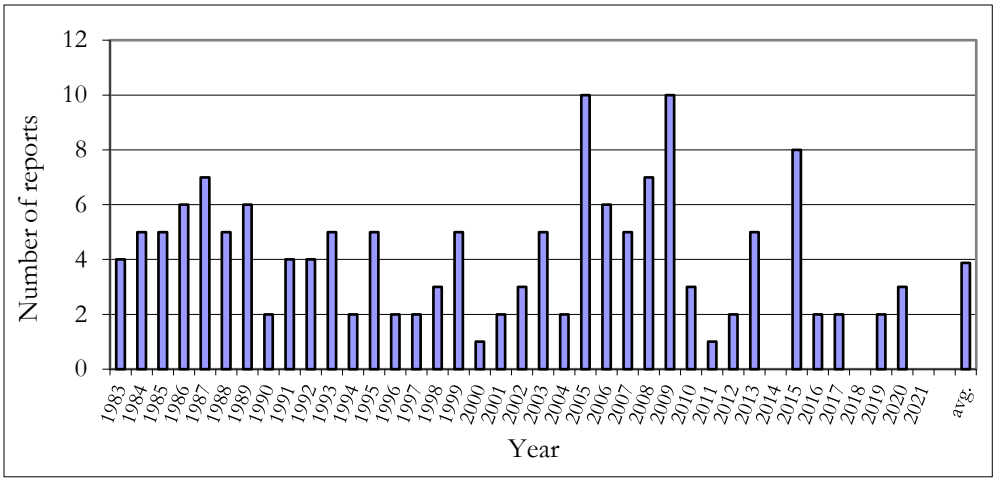

Figure 4: Number of abnormal events per year

Figure 5 presents data on different means of electricity production in Slovenia, specifically electricity production in nuclear, hydro, thermal, and solar power plants. In 2021, the production of electrical energy was 14.7 TWh, of which 36.9% was produced by the Krško NPP.

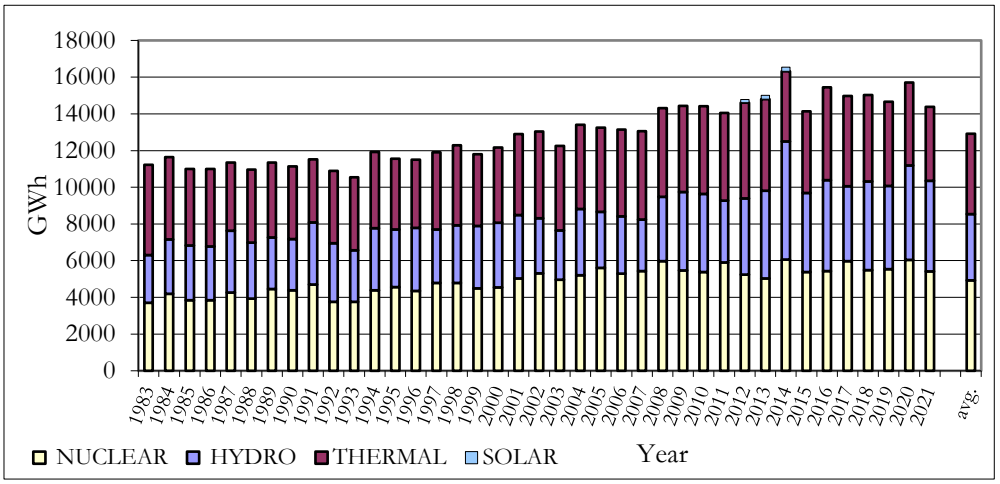

Figure 5: Production of electrical energy in Slovenia

References: [1], [2]

The Slovenian Nuclear Safety Administration's Process of Monitoring the Krško NPP by Means of Safety-Performance Indicators

The SNSA monitors the management and operation of the Krško NPP through its set of Safety Performance Indicators (SPIs). In 2021, the SNSA monitored 39 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 warning or alarm value of the SNSA has reached the, 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 NPP or where the SNSA will carry out a more thematic inspection.

From the indicator showing the activity of the primary coolant (Figure 6), during the period between May and December 2021 (the 32nd fuel cycle), the specific activities of xenon ^{133}Xe and iodine radionuclides ^{131}I and ^{134}I were reduced to approximately 1/2 of the value of the 31st fuel cycle. During the 2021 outage, it was found that there were no leaking fuel assemblies. Based on

the obtained radiological data, it is concluded that there is a high probability that by the end of December 2021 there were no leaking or damaged fuel elements in the middle of the 32nd fuel cycle.

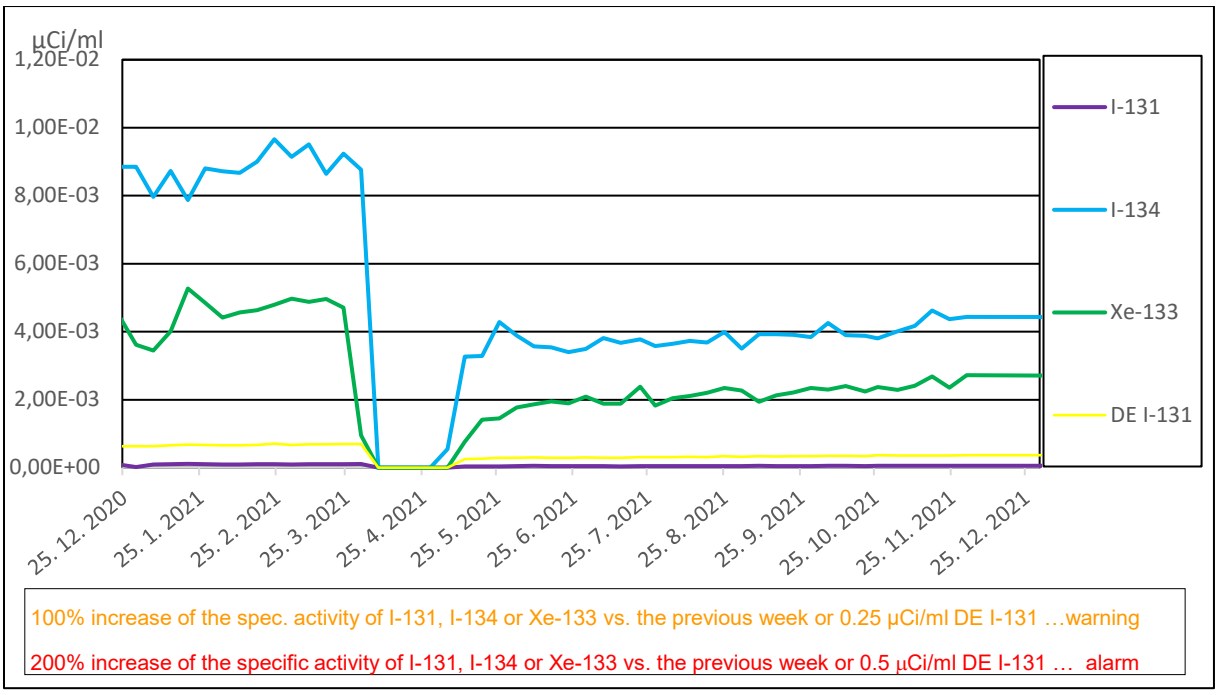

Figure 6: Primary coolant-specific activity – 31st and 32nd fuel cycle

The indicators in Figure 7 show the risk of the unplanned unavailability of equipment under the Krško NPP Technical Specifications. In the case of a huge increase in unplanned unavailability, the indicator may reflect equipment degradation and a deficient maintenance programme, which is not in accordance with the value of the indicator and the operation of the Krško NPP.

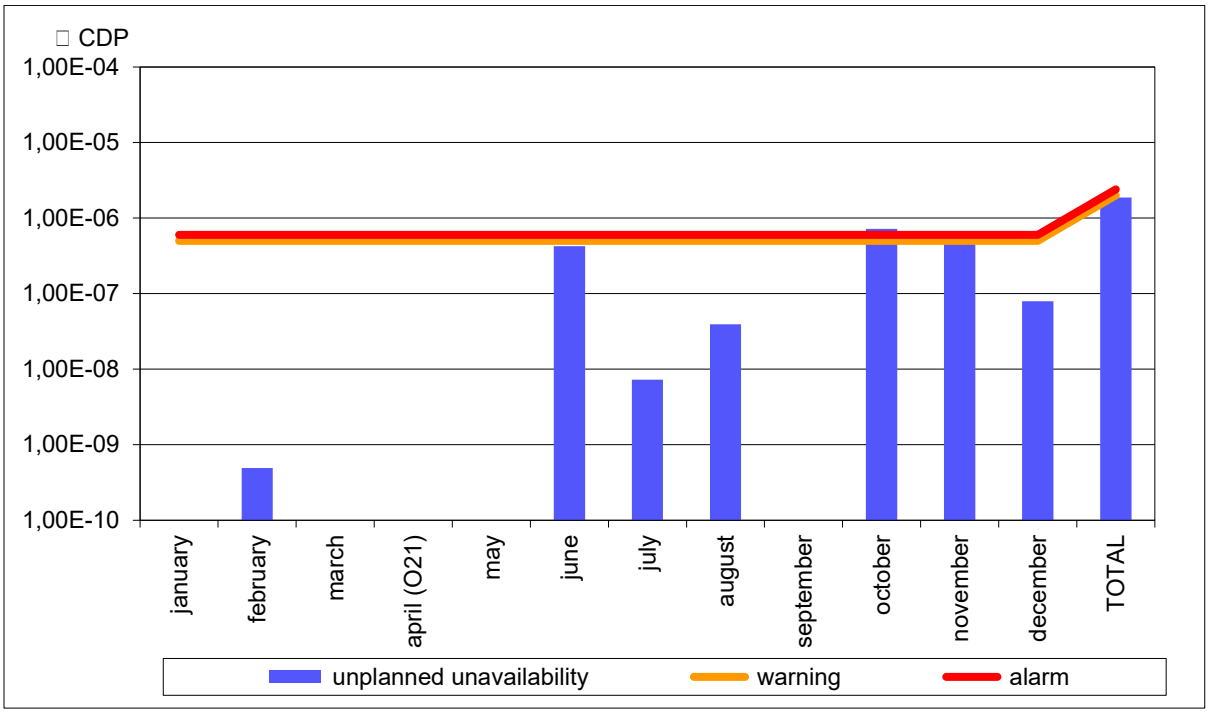

Figure 7: Risk due to the unplanned unavailability of equipment

The collective dose indicator (Figure 8) shows the annual collective effective dose of a whole body, the total for the Krško NPP workers, external workers, and visitors. The value of the collective dose in 2021 was 925.3 man-mSv and therefore larger than the alarm value for years with an outage (860 man-mSv). The reason for the increased value of the collective effective dose is the intensive implementation of the Safety Upgrade Programme and the unpredictable need for additional work on some outage activities. Furthermore, during the entire year of 2021 there were additional works on the maintenance of equipment for drying radioactive waste.

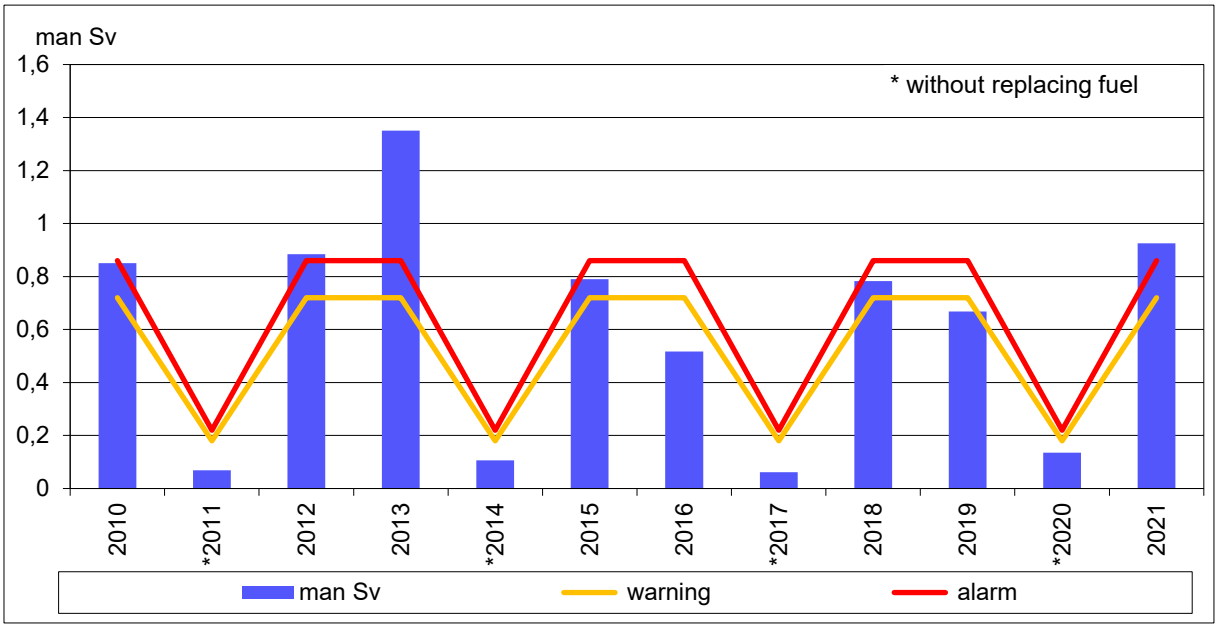

Figure 8: Collective dose

There were no fires in 2021 (Figure 9). There was one fire event. Also, there were 19 fire alarms, of which 12 were justified alarms and 7 false alarms. An alarm line with a value of 45 represents an alarm or activation, while an alarm line with a value of 8 represents a fire event.

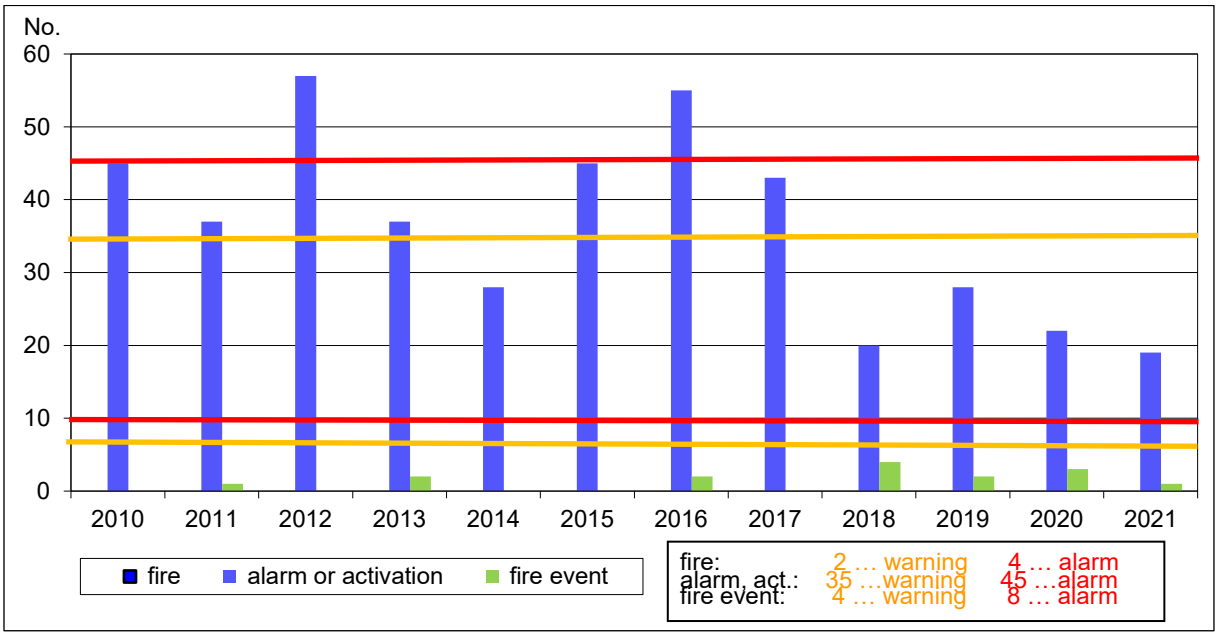

Figure 9: Fire safety

In 2021, 65 temporary modifications were concluded. The number of unfinished modifications at the end of the year was 17 (the value for a warning is 35, the value for an alarm is 50), while the number of newly opened modifications was 51 (Figure 10).

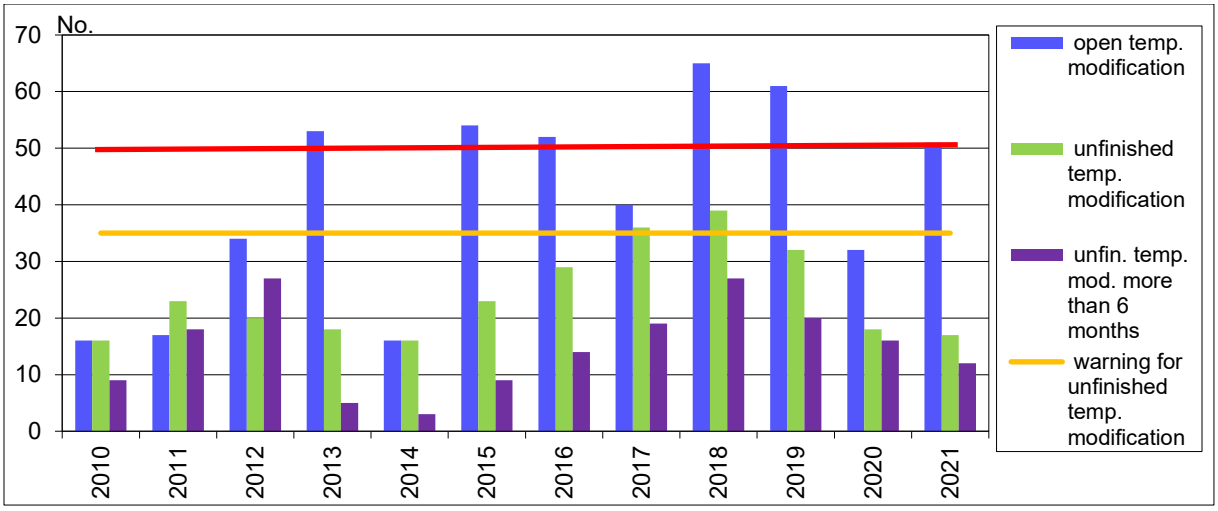

Figure 10: Temporary modifications

2.1.1.2 Abnormal Events and Operating Experiences in the Krško NPP

The reporting of abnormal events is determined by Rules JV9. These Rules determine the list of events that must be specially reported by nuclear power plant operators. The Krško NPP must also follow the additional reporting requirements prescribed in its Technical Specifications. In accordance with the mentioned rules, the Krško NPP reported one event. In addition, the Krško NPP reported one more event in accordance with the Rules on the physical protection of nuclear facilities, nuclear and radioactive materials, and the transportation of nuclear materials.

Starter motor air leak when starting diesel generator No. 2

On 11 February 2021, the regular monthly test of the diesel generator No. 2 was performed according to the procedure "Operability test of diesel generators 1 and 2". At 07:43, entry into the NEK operating conditions and limitations of LCO-3.8.1.1 action B (LCO: Limiting Conditions for Operation) was announced due to preparations for and the execution of the test. At 09:14, diesel generator No. 2 tried to run but failed. After 5 seconds from the activation for the start, there was an activation of local alarms and consequently alarms in the main control room. The personnel present near diesel generator No. 2 for the duration of the test stated that an unusual noise was heard from the air motors when attempting to start. The diesel generator rocked, but there was not enough power to turn the flywheel to successfully start the engines. The surveillance test was interrupted and a corrective programme request was written. At 10:12, diesel generator No. 2 was declared inoperable and entry into LCO 3.8.1.1 was declared. A minor air leak was observed on the rear side of the 2DGA-M07 starter motor when the restart failed. This was followed by the disassembly of the starter motor and connecting pipelines and the reassembly of a new starter motor from stock and connecting pipelines. After the work was completed, as a test after the maintenance intervention, a local start-up of the diesel engine followed at 450 revolutions with the starting airline A closed. The start-up of the diesel engine was successful and without any special features.

At 15:02, a repetition of the surveillance test of diesel generator No. 2 was carried out, which was successfully run to 750 revolutions with half of the starting air. At 3:11 p.m., a start-up time of 9.1s was measured. The test took place without any special features and was successfully completed at

16:37. Diesel generator No. 2 was declared operational and LCO-3.8.1.1, action B, was also completed.

The direct cause of the event was a minor air leak on the rear side of the 2DGA-M07 starter motor housing (Figure 11). The air leak occurred because part of the cork gasket was missing on the outside of the starter motor. All seals on the starter motors were replaced.

The Krško NPP and the SNSA studied the event in detail and carried out a detailed analysis.

Figure 11: Starter motor 2DGA-M07

References: [3], [4]

The loss of the power supply of the Krško NPP's technical protection systems due to the failure of the uninterruptible power supply

On 7 October 2021, at 3:30 p.m., the power supply of internal transformer stations TP1 and TP2 was planned to be switched off. The switchover procedure requires the shutdown of all transformer substations for approximately 30 minutes, while the technical protection systems are powered during the switchover from the Uninterrupted Power Supply (UPS) and after a few seconds from TP3, which is powered by a diesel generator.

At 3:35 p.m., transformer stations TP1 and TP2 were shut down, diesel generator TP3 started in 10 seconds, and the UPS power supply failed. The detection on the fence remained, but other technical protection systems failed. There was a 10-minute interruption of the operation of the technical protection systems. The deficiencies were corrected within two hours of the event.

The direct cause of the event was the failure of the UPS. The root cause is the poor maintenance of the UPS power supply.

The Krško NPP and the SNSA studied the event in detail and performed an analysis.

References: [5], [6]

2.1.1.3 Periodic Safety Review

Second Periodic Safety Review of the Krško NPP

On 30 May 2014, the SNSA approved the Second Periodic Safety Review (PSR2) and the resulting implementation plan. The Krško NPP reports to the SNSA every six months in accordance with the SNSA decision on progress regarding the changes and improvements in the 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. For five actions, the Krško NPP requested an extension in May 2019. In June 2019, the SNSA approved an extension of the implementation deadlines for five actions from the PSR2 implementation plan. In 2020, the Krško NPP completed two of the five actions and in 2021 two of the five actions. The Krško NPP applied for an extension of the deadline until 31 January 2022 regarding the Action PSR2 4.5-02 – Severe Accident Phenomenological Evaluations Upgrade, with a deadline of 31 December 2021.

Third Periodic Safety Review of the Krško NPP

On 23 December 2020, the SNSA approved the programme for the Third Periodic Safety Review (PSR3) of the Krško NPP, in which the scope, content, and timeline for the review were determined. The third PSR will be completed in 2023 with the PSR report, which will contain a global safety assessment of the facility and a plan for changes and improvements based on the review findings. Altogether, the operator will review 18 safety factors, of which three are new: radioactive waste and spent fuel; security; and radiation protection.

Separately from the PSR3 programme, the review programme of the safety factor Physical Security was approved on 23 February 2021. The review of the safety factor Physical Security is performed as a separate process, as appropriate protection of classified information has to be ensured.

In 2021, the Krško NPP selected the subcontractors and delivered the documentation to those that were contracted. The review was then performed for separate safety factors, including Plant Walkdowns, Inspections, and Staff Interviews. A report on compliance with the operating license conditions and the regulatory requirements was prepared. The Krško NPP also prepared a new revision of the report on compliance with the requirements and guidelines of US legislation and this report is the basis for reviewing the safety factor Plant Design.

By end of 2021, one of the contractors completed three topical reports from the area of safety analyses. The reports are being reviewed by the Krško NPP and upon completion will be delivered to the SNSA for regulatory review. In 2022, all of the topical reports for other areas will be delivered to the SNSA.

2.1.1.4 The Krško NPP Safety Upgrade Programme

In September 2011, the SNSA issued a decision for the Krško NPP, in which it set the 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 performed an analysis of the needed improvements and based thereon prepared a proposal for the SUP, which was reviewed by the SNSA and approved in February 2012.

The implementation of the Krško NPP's SUP will soon be finished. All of the original SUP improvements had been completed by the end of 2021. Additional improvements include the installation of high-temperature RCP seals and the construction of a spent fuel dry storage (SFDS).

The Krško NPP's SUP is divided into three phases.

Phase I, which was implemented in 2013:

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

Phase II was planned to be implemented by end of 2019 and was completed in 2021:

- additional flood protection of the nuclear island and all the new systems, structures, and components (implemented in 2015/2016);
- the installation of pressuriser bypass relief valves, qualified for severe accidents (implemented in 2018);
- the 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 (implemented in 2020);
- the installation of a fixed spray system on the spent fuel pool with provisions to use mobile equipment (implemented in 2020);
- the 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; (planned to be finished in October 2019, but, due to a delay on the part of the supplier of the pump, completed in April 2021);
- an upgrade of the electrical power supply (provisions to connect an additional mobile 2 MW diesel generator, seismic requalification of the 3rd emergency bus, an upgrade of the connection between the 400 V safety buses and mobile diesel generators, etc.) (implemented in 2018);
- the replacement of the existing remote shutdown panels with the installation of an emergency control room (ECR) with capabilities to shut down the reactor and maintain a long-term safe shutdown state (implemented in 2018/2019);
- the installation of additional instrumentation dedicated to severe accidents, with an independent power supply (implemented in 2018);
- the installation of ECR habitability systems, which will ensure a safe long-term environment for operators even in the event of severe accidents (implemented in 2020); and
- the 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 a severe accident (implemented in 2021).

Phase III, which was also completed by the end of 2021:

- the installation of additional injection systems for the reactor cooling system / containment and steam generators with dedicated reservoirs of cooling water (also borated) capable of being replenished with water from underground wells – the Bunkered Building 2 (BB2) project (implemented in 2021);
- the installation of reactor coolant pump high-temperature seals (implemented in 2021);
- the construction of a dry spent fuel storage facility (implementation is underway, although delayed; to be completed by the end of 2022).

With the above-mentioned SUP improvements and upgrades, the risk has been drastically decreased and the robustness of the Krško NPP improved. This is best seen from the probabilistic safety assessment (PSA) results, where core damage frequency has been reduced by around 75%. With SUP implementation, unfiltered releases have also been reduced by about 70% mainly due to the filtering effect of the passive containment filtering vent system (PCFVS) and additional preventive DEC A systems, such as alternative injection systems other than the primary (ASI – Alternative Safety Injection) and secondary systems (AAF – Alternative Auxiliary Feed Water) and the removal of the residual heat from the primary system and the containment (ARHR – Alternative Residual Heat Removal).

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 in English is published on the ENSREG website (*European Nuclear Safety Regulators Group*). 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 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 the revised WENRA (*Western European Nuclear Regulators Association*) SRL[1] requirements – implemented in December 2016;
- several measures to improve emergency preparedness (such as supplementing the national nuclear and radiological emergency response plan, preparing the national strategy for nuclear and radiological accidents, the preparation of additional new internal procedures to be used in the event of nuclear or radiological accidents, enhancing the training of intervention personnel, enhancing cooperation with neighbouring countries on emergency preparedness, the coordination of the emergency preparedness plans of Slovenia and Croatia, the enhancement of the Krško NPP's exercise plan, a review of radiological monitoring in Slovenia was performed and 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 an emergency (e.g. long-term loss of the electrical power supply), protection against external hazards (floods, earthquakes) – all of the mentioned inspections in this area were implemented in 2021 and will also be carried out after the completion of the action plan in accordance with the annual inspection plans;
- an additional deterministic accident analysis carried out with the computer programme MELCOR – the action is completed, analyses with MELCOR will also be carried out in the future, as needed;
- the enhanced communication of the parties involved in the nuclear industry (the power plant, technical support organisations, the regulatory body) – two conferences implemented;
- education and training of the SNSA staff as regards accident management and the defence-in-depth concept – the action was fully implemented; in 2021 refresher training of emergency analysis group members took place with a lecturer from the SNSA, but the training with a lecturer from the Krško NPP was postponed until 2022 due to the pandemic;
- the invitation of international peer review missions – three of the planned missions have been implemented thus far: the IRRS mission (*Integrated Regulatory Review Service*) for the review of the regulatory infrastructure, the EPREV mission (*Emergency Preparedness Review*) for the review of emergency preparedness, the OSART mission (*Operational Safety Review Team*) for the review of the operational safety of the nuclear power plant; the IRRS mission and EPREV follow-up mission are planned again at the SNSA in 2022;
- an upgrade of the system for data transfer between the power plant and the SNSA during an emergency (ERDS – *Emergency Response Data System*) – implemented;

1 WENRA SRL – WENRA Safety Reference Levels are harmonised requirements for nuclear power plant safety, which apply to all European power plants

- an upgrade of the Krško NPP's probabilistic safety analysis (PSA) for the shutdown states and the spent fuel pool, where the analysis of internal and external hazards is still in progress (internal flooding, fires, and earthquakes);
- a review and enhancement of the Krško NPP's safety culture assessment process with the development of a process for self-assessment at the SNSA – also in progress; in 2021 a project group for safety culture assessment was formed.

Most of the above actions were implemented or are a part of the continuous improvement process (for example, legislation is currently being revised again, to include some of the newest IAEA design requirements; in April 2022, the SNSA was again being reviewed by an IAEA IRRS mission, and will be again in 10 years, etc.). There are always new ways to improve the processes that ensure and enhance nuclear and radiation safety.

The final version of the Action Plan (December 2021) is published on this website.

References: [7], [8], [9], [10], [11], [12], [13], [14]

2.1.1.5 The Krško NPP Spent Fuel Dry Storage

In 2021, the main focus was on the procedure for approving a safety-relevant modification of the Krško NPP represented by the new storage of spent fuel in accordance with the requirements of the *Ionising Radiation and Safety Protection Act* (Official Gazette of the Republic of Slovenia, Nos. 76/17, 26/19, and 172/21, hereinafter: ZVISJV-1). There is an extensive licencing procedure, which was not completed in 2021.

In April 2021, the Krško NPP started the construction of a dry storage building on the basis of the issued building permit for the dry storage facility of spent fuel and the SNSA provisional decision. The process of obtaining a permit to operate the storage had not yet been completed by the end of 2021.

The construction of the dry spent fuel storage is expected to be completed in 2022; the first transfer of spent fuel elements from the spent fuel pool to the dry spent fuel storage facility is planned for 2023.

2.1.1.6 Long-term Operation of the Krško NPP (2023–2043)

In 1983, the Krško NPP obtained a permit for regular operation and began commercial operation. At the time of construction, the facility was expected to operate for 40 years. Subsequently, during this period, many safety and other upgrades of the power plant were carried out, and from various analyses that were made during this time there follows the possibility of extending the operating life of the NPP, taking into account the aspects of energy needs, climate change, and economics, as well as established solutions also elsewhere in the world. Slovenia (GEN energija) and Croatia (HEP) are the owners of the Krško NPP on the basis of 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 of the Republic of Slovenia, No. 5/03 – International Treaties), which regulates status issues related to the Krško NPP, supported the extension of the Krško NPP's operating period until 2043.

Hitherto, some of the necessary technical prerequisites for the long-term operation of the NPP have already been implemented. In 2012, the SNSA issued decisions No. 3570-6/2009/28 and No. 3570-6/2009/32, which approved the necessary changes to the Krško NPP Safety Report and related documentation, which until then limited the operating period to 40 years. The approved changes now enable the operation of the NPP for a further 20 years, i.e. a total of 60 years, subject

to the successful completion of the ten-year Safety Review, the next one in 2023 (see Chapter 2.1.1.1).

For extended operation from 2023 to 2043, the Krško NPP must obtain an environmental protection consent (OVS). The process of obtaining an OVS is led by the Ministry of the Environment and Spatial Planning (MESP) and takes place in accordance with the *Environmental Protection Act* (ZVO 1, Official Gazette of the RS, Nos. 39/06, 49/06 – ZMetD, 66/06 – odl. US, 33/07 – ZPPlan, 57/08 – ZFO-1A, 70/08, 108/09, 108/09 – ZPPlan-A, 48/12, 57/12, 92/13, 56/15, 102/15, 30/16, 61/17 – GZ, 21/18 – ZNOrg, 84/18 – ZIURKOE, and 158/20).

In October 2021, the Krško NPP applied to the MESP for an Environmental Consent for the project: long-term operation from 40 to 60 years. The SNSA is included in the procedure as an opinion giver, and gave a positive opinion on the intended intervention in accordance with the legislative requirements under Article 52 of ZVO-1.

The next step in the process is, according to the provisions of the Aarhus and Espoo Conventions, public disclosure and cross-border assessment, which began to take place in the first half of 2022.

2.1.1.7 The Pre-SALTO Mission to the Krško NPP

Slovenia invited the IAEA pre-SALTO (*Safety Aspects of Long-Term Operation*) mission prior to the beginning of the Krško NPP's long-term operation in order to verify the quality and adequacy of the Ageing Management Programme with the subject programmes and procedures of the Krško NPP, as these are the key factors for safe long-term operation.

Prior to the pre-SALTO mission, the Krško NPP carried out some additional activities in the framework of the preparations for long-term operation. The most notable were the establishment of the Department of Engineering Support for Long-term Operation, the new long-term operation programme, upgrades of the existing corrective action programme for better ageing management involving operating experiences as well as new programmes for the ageing management of active components and technological obsolescence.

The pre-SALTO mission took place at the Krško NPP between 5 and 14 October 2021. Members of the SNSA participated in the mission three times: at the entrance meeting, in discussions with the team leader after the end of the mission, and at the exit meeting. The findings of the pre-SALTO mission included 9 good performances, 9 suggestions, and 5 recommendations; some of the latter refer to several review areas concurrently. For reviewing and potential commenting, the SNSA and the Krško NPP received from the IAEA a preliminary (draft) report with the mission's findings. The final report was issued by the IAEA at the end of January 2022. An action plan was established at the Krško NPP as part of the corrective programme in order to address all the issues from the pre-SALTO mission. The pre-SALTO action plan will also be independently reviewed within the preparation process of the PSR3 Action plan.

2.1.1.8 Technical Improvements and Modifications

In addition to the 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 based on global practice, operational experiences, 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 2021, the SNSA approved 5 modifications and agreed to 25 modifications. During the safety evaluation screening, the Krško NPP did not identify any open safety issues for 408 modifications.

Therefore, the Krško NPP only informed the SNSA of those 408 modifications. As of 31 December 2021, there were 17 active temporary modifications, 51 were open in 2021, and 39 were opened and closed. There are 26 such temporary modifications that opened before 2021 and closed in 2021. There were five temporary modifications already started in 2020 and they relate to: "Emergency Airlock" video surveillance, increasing the time delay for the failure of the "IA904CPR-003" component to low cooling water flow, installing pressure indicators on the cooling water lines of water supply seals, the preparation of the measurement site for measuring the vibrations of the control valves during a turbine valve test and a change of components in the "FS6746" system.

In 2021, the Krško NPP issued the 28th revision of the "Updated Safety Analysis Report", which considered the changes approved up to 1 November 2021.

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 Topical Peer Review of the Ageing Management Programme (TPR – AMP)

The purpose of Topical Peer Reviews (TPR) is to carry out a review of a certain area that is important for nuclear safety; such a review is executed simultaneously in all European countries. The first TPR is dedicated to the ageing of nuclear facilities and a review of the Ageing Management Programme (AMP). After the execution of comparative reviews of technical reports, prepared also by the SNSA in cooperation with the Krško NPP, and the formation of generic and specific country findings, the preparation of Action Plans for each participating country followed. The SNSA sent its national Action Plan to the ENSREG in September 2019.

The Action Plan defines the scope and time frame of the necessary improvements and actions to be implemented, which were identified during the TPR process. The SNSA defined nine actions in the national TPR Action Plan from the areas of electrical cables, concealed pipework, reactor pressure vessel, the concrete containment structure, and in general the Ageing Management Programme of the Krško NPP. Actions from the first three mentioned areas were carried out in 2020 in accordance with the schedule of the Action Plan. In 2021, the SNSA checked the progress in the area of the general Ageing Management Programme and concrete containment structure.

One of the anticipated actions regarding the general Ageing Management Programme is reviewing the scope of this programme and (if necessary) its updating in line with the new IAEA Safety Standard. The review of the Krško NPP's AMP was to be part of the 3rd Periodic Safety Review (PSR3), where the review from the perspective of the requirements under IAEA *SSG-48*, *"Ageing Management and Development of a Programme for Long-term Operation of Nuclear Power Plants"*, was also planned to be performed. The SNSA has already reviewed and approved the programme for PSR3, which is based on IAEA SSG-25, "Periodic Safety Review for Nuclear Power Plants", and is extended with requirements from Slovenian legislation (the JV9 Rules). The other action that addresses the general Ageing Management Programme refers to the identification of ageing mechanisms and the implementation of appropriate measures during extended shutdowns of the NPP. The SNSA has reviewed the legislation regarding this matter and prepared appropriate amendments to the JV9 Rules. These amendments are included in the new revision of Rules JV9, which was submitted to public proceedings as a draft version in December 2021.

In March 2021, the SNSA carried out a thematic inspection of concrete structures important to safety, including the containment concrete shield building, which is also subjected to activities within the TPR Action Plan. The conclusions of the inspection were that the Krško NPP follows the development of the relevant Non-Destructive Examination (NDE) methods and applies them appropriately. These methods include, above all, the georadar method, which can detect segregation states in concrete up to a depth of three meters, and ultrasound inspection methods

(UT) that enable the detection of non-homogeneities, cracks, and other concrete damage. Apart from that, the Krško NPP carries out appropriate activities in order to ensure that the buried part of the containment is surrounded by a chemically non-aggressive environment.

The Krško NPP has also made a commitment within the TPR Action Plan that it would revise the programme TD-2N " Structures Monitoring Programme" to include a section addressing the NDE of inaccessible parts of the concrete shield building structure. The TD-2N programme was still not revised in 2021, partly due to the Covid-19 epidemic and partly due to the IAEA Pre-SALTO mission that took place at the Krško NPP in October 2021; the NPP aims to include some pre-SALTO mission findings into the revision of the TD-2N programme, which should be available no later than in April 2022, and reviewed by the SNSA accordingly.

The SNSA submitted a status report on the implementation of the TPR Action Plan to ENSREG at the end of May 2021. Apart from two actions that were delayed due to the above-stated circumstances, all other actions from the TPR Action Plan were completed in time. The next reporting on the TPR Action Plan implementation status is scheduled for 2023.

2.1.1.10 2021 Outage

After 18 months of safe and stable operation, a regular outage commenced in the Krško NPP on 1 April; it ended on 5 May as planned.

During the 2021 outage, the following important activities were performed, in addition to changing part of the fuel (the replacement of 56 of the 121 fuel elements): extensive maintenance work and some technological improvements/modifications or upgrades, which will continue to ensure a high level of nuclear and radiation safety. Among the most important activities were the overhaul of the electric motor pump for auxiliary feed water on train B, work on the diesel generator DG2, and activities involving non-destructive testing under the ten-year plan of in-service inspections of the primary circuit and reactor vessel. A sample of the U-tubes of both steam generators was inspected by the eddy current method. The electric motor of reactor cooling pump No. 1 was replaced with a refurbished one, and extensive work was also done on the turbine, with the associated valves and condenser.

Regular outage activities were executed professionally and in accordance with approved procedures. The results of inspections and tests showed no unexpected equipment deficiencies or deviations, with a few exceptions. The important events during this outage were primarily the leakage in the isolation valve of the system for alternative residual heat removal (ARHR), regarding which the NPP plans to change the design; the cutting of the pipeline of the auxiliary feedwater system (AF) without the required prerequisites; the occurrence of foreign material in different components and systems; insufficient reach of the crane inside the fuel handling building (FHB) after the implementation of the seismic reinforcement; a 24-hour test of the diesel generator DG1 without a fast start-up; and the possibility of damaging ties and connecting welds of the cross-under pipeline between the high-pressure turbine and steam reheater. The cause of the majority of these events was a human factor. The Krško NPP therefore intends to improve the procedures, work processes, and workers' training in order to avoid the reoccurrence of similar events.

The post Fukushima Accident SUP in the Krško NPP is nearing completion. The SUP enables the NPP to be aligned with the requirements of the Design Extended Conditions (DEC) through system adaptation and the implementation of additional safety systems. In such a manner, the Krško NPP approaches the safety level of new NPPs. Another 13 upgrades were completed during this outage, which will increase the power plant's resilience to natural and other unlikely events. The important actions carried out in this area were the activities on Bunkered Building 2 (BB2), and on new alternative systems for reactor cooling by means of residual heat removal (the ARHR

system), emergency safety injection (the ASI system), as well as providing alternative auxiliary feedwater to the steam generators (the AAF system).

The 2021 outage was also extremely demanding due to the Covid-19 epidemic, which all the parties involved had to take into account, as they had to adapt their outage activities accordingly. The SNSA and the Krško NPP had several meetings prior to the outage and carefully planned and studied the different scenarios that could have evolved due to the epidemic. Difficulties linked to potential equipment supply difficulties, the rivalry of domestic – or foreign – subcontractors, the possibility of contagion during the outage, etc., had to be taken into account. Therefore, alternative scenarios were formulated during the outage preparation, but in the end, there was no need to use them during the outage.

Before the outage commenced, the SNSA reviewed and approved the implementation of many outage activities. The inspectors and other members of the SNSA team were present on the site throughout the outage. The SNSA carefully monitored all outage activities, with an emphasis on ensuring nuclear and radiation safety during the shutdown of the power plant. During this year's outage, it also intensively monitored the implementation of all safety measures related to the Covid-19 epidemic. Experts from domestic- and foreign technical support organisations (TSOs) provided additional professional help in monitoring the outage activities. The Krško NPP restarted the production of electric energy only after confirmation from the TSOs that all the activities had been appropriately executed, that all tests had been successful, and that nuclear safety had been appropriately dealt with. In this way, the minimal impact of the NPP on the environment was achieved.

The next regular outage is scheduled for the fall of 2022.

2.1.1.11 Nuclear Fuel Integrity, Reactor Coolant Activity and Fuel Assembly Inspections

The year 2021 comprised a part of fuel cycle 31, which started on 28 October 2019 and ended on 1 April 2021, and part of fuel cycle 32, which started on 4 May 2021. Fuel cycle 32 will last 18 months, until the refuelling in October 2022.

In cycle 32, there was a controlled power decrease on 17 and 18 October 2021 from 100% to 80% power due to corrective works to find the location of a leakage in the condenser and to tighten the leakage spot. Simultaneously, the testing of turbine valves and the main steamline isolation valves was performed. At the end of 2021, the core burnup reached 20,961 MWD/MTU, which corresponds to 515.4 Effective Full Power Days (EFPD). At the end of 2021, in fuel cycle 32, the core burnup reached 9,710 MWD/MTU, which corresponds to 238.9 EFPD.

The condition of the fuel assemblies in the reactor (fuel cladding integrity) is monitored indirectly through measurements of specific activities of the reactor coolant in conditions of stable operation and during transient events. Isotopes of xenon, krypton, and iodine indicate fuel defects; from measurements of specific activities of iodine isotopes, the defect size and coolant contamination can be determined. From specific activities of caesium isotopes, the burnup of damaged fuel can be estimated. In the event of fuel rod cladding degradation, solid particles can be detected in the coolant, such as Neptunium (^{239}Np) or Barium (^{140}Ba).

At the end of the year 2021, analyses of isotopes' specific activities indicated that there were no leaking fuel rods in the cycle 32 core.

Inspections of fuel assemblies during the 2021 refuelling outage

Using the In-Mast Sipping (IMS) method, an inspection of cladding integrity was performed for all 121 fuel assemblies of the fuel cycle 31 core. The inspection showed that there was one suspect fuel assembly, AK23. This fuel assembly was not planned for reload into the core of fuel cycle 32 and was stored in the spent fuel pool. Taking a conservative view, this fuel assembly was marked

as a suspected leaker. The results of the inspection of fuel assemblies' cladding tightness are shown in Figure 12.

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. No anomalies were found.

An Underwater Visual Inspection (UWTV) was performed for all four sides of 146 fuel assemblies (all 121 fuel assemblies from the core of fuel cycle 31 and 20 fuel assemblies from fuel cycle 30). All fuel assemblies planned for the original core design and for the revised core design of fuel cycle 32 were inspected. Mechanical damage to the first distancer grid was found on fuel assembly AL48 and therefore this fuel assembly cannot be employed for further use in the core. A revised core design for fuel cycle 32 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 primary coolant activity, there were no leaking fuel rods and it was expected that the IMS inspection would detect a suspect fuel assembly. UT inspection is used to detect leaking fuel rods in a tight fuel assembly.

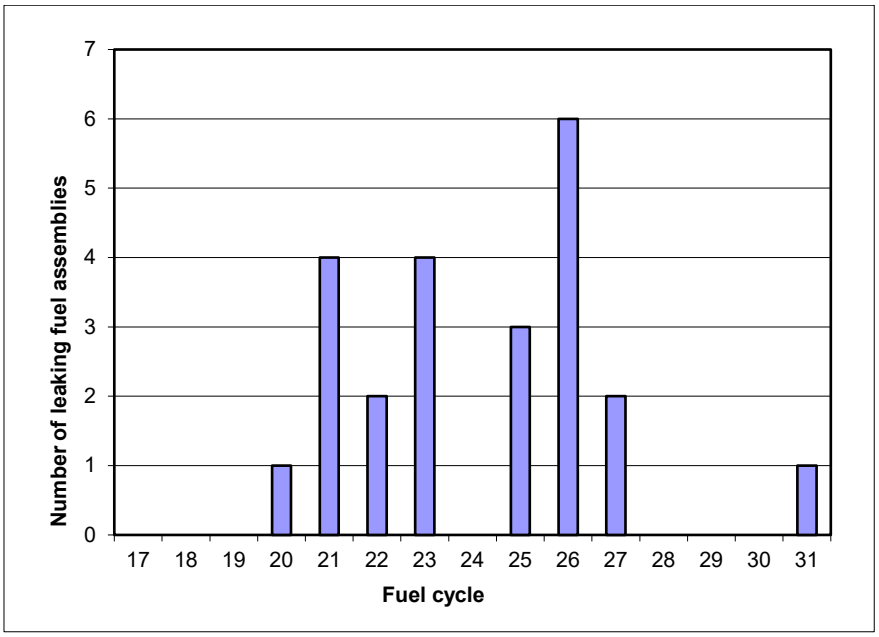

Figure 12: Results of fuel integrity inspections by the IMS method during outages since 2000 (fuel cycle 17)

Reference: [1]

2.1.1.12 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 the 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"*.

In 2022, the SNSA will send the observations regarding the positive and negative safety culture from the 31st fuel cycle to the Krško NPP. After that, the observations will be discussed jointly by the working group of the SNSA and the Krško NPP experts.

2.1.1.13 Inspection Reviews

In 2021, 52 planned inspections were performed in total at the Krško NPP. There were no reactive inspections related to abnormal events. Two unannounced inspections were also carried out within the scope of the planned ones.

According to the Annual Plan of the Radiation and Nuclear Safety Service for the year 2021, topics for the inspection supervision of the Krško NPP are divided into 8 groups, namely:

- general inspection,
- operation, equipment qualification, ageing management,
- design basis,
- safety analyses,
- management for safety, human factors, training, safety documentation, operating experiences,
- emergency response, security, cybersecurity,
- radiation protection, radioactive waste, radiological impacts, decommissioning, and
- outage.

Most of the inspections lasted one day. Permanent inspection supervision with the involvement of inspectors, experts from the Nuclear Safety Division and TSOs was carried out throughout the duration of the outage in April and early May 2021. The focus of these inspections was on activities important for ensuring a high level of nuclear safety and the safe long-term operation of the Krško NPP after 2023. Regarding the long-term operation, an additional week-long inspection was carried out, during which the NPP activities ensuring the efficiency and integrity of the safety-related equipment were verified.

In 2021, inspectors issued 38 requests to the Krško NPP for corrections of deviations, the implementation of improvements or additional reporting. Most of the requirements have already been properly met, but for some of them the deadline for fulfilment has not yet expired. Two warnings were issued due to a violation of the provisions determined in the legislation. The first case was related to the installation of additional fire detectors as a result of a request by the fire inspector, whereby the Krško NPP overlooked that such installation results in a change in the Technical Specifications, which must be approved by the SNSA. The second case was related to the testing of the emergency diesel generator. Although the testing was correct in terms of its scope, it did not completely meet the requirements of the Technical Specifications regarding the procedure used. The Krško NPP has already carried out the appropriate improvements for both non-compliances.

The SNSA Inspection Service (hereinafter the SNSA Inspection) concludes that the Krško NPP operated safely in 2021, i.e. without causing harm to people and the environment. The implementation of activities during the 2021 outage enables safe and reliable operation for the next 18 months. The deviations identified were regularly analysed and corrected within the implementation of the Corrective Programme. The SNSA Inspection unit assessed the activities of most organisational units of the Krško NPP as good.

In the area of the protection of exposed workers against radiation, the Krško NPP is also supervised by the Slovenian Radiation Protection Administration (SRPA). In 2021, the SRPA carried out three inspections at the Krško NPP, including one joint inspection with the SNSA. Inspection areas included the radiation exposure of workers during the outage, including their personal contamination, supervision of the radiation levels and contamination of the working environment, "ALARA" (*As Low As Reasonably Achievable*) planning of the outage in 2021, the

training of workers in radiation protection and the implementation of measures for the prevention and management of infections with the Covid-19 infectious disease. No deficiencies were identified.

Reference: [1]

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 2021, the reactor operated for 167 days, during which it released 128.2 MWh of heat. Operations were 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; 70 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 641 samples were irradiated in the carousel and the irradiation channels. In 2021, the reactor operated more than in any of the last 10 years.

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 Agency for Radwaste Management, Ljubljana, (ARAO) regularly carried out radioactive waste treatment and preparations for the purpose of radioactive waste storage.

In 2021, there were three automatic reactor shutdowns. One was due to a power exceedance in safety channel 2, another one due to operator error, and the third due to a disturbance in the power switch of the LIN channel. The power exceedance in safety channel 2 was caused by a too large flux tilt while the reactor power in the LIN channel was still 250 kW. The trouble was eliminated by more precise calibration of safety channel 2, which indicated slightly higher power. Disturbances in the power switch of the LIN channel occur during automatic switching between the ranges of 300 mW and 1 W and it has not yet been possible to eliminate such.

There were no violations of the operational limits and conditions referred to in the Safety Analysis Report in 2021.

On 8 January 2021, an unintentional intrusion into the controlled area of the JSI Reactor Centre occurred. The event did not affect nuclear safety and the JSI notified the SNSA of the event. In 2021, there were some fire alarms but these were not caused by a fire. The fire alarms were caused by construction works or the use of a kitchen. Such minor events are promptly analysed and, if needed, corrective actions are defined.

The performance indicators regarding the doses acquired by the operating staff and researchers showed values far below the regulatory limits. The collective dose in 2021 was 1.82 man-mSv for operating staff and 3.34 man-mSv for personnel carrying out work at the reactor. The doses in 2021 were the highest in last ten years. The probable cause is the higher intensity of works.

2.1.2.2 Nuclear Fuel

In 2021, 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 2021, inspections of 15 fuel elements were

performed and no anomalies were detected. All fuel elements were photographed; the pictures were reviewed and stored for possible future analysis. The length of fuel elements was measured.

The JSI reported on the fuel balance monthly to the Euratom and to the SNSA. In 2021, the Euratom performed an inspection of the status of the nuclear material.

2.1.2.3 Staff Training

In 2021, a fire simulation exercise inside the reactor hall was successfully performed and consisted of the evacuation of operating staff and the JSI radiation protection service.

From 29 November to 3 December 2021, three operators visited the World Nuclear Exhibition in Paris, France. This is the largest reactor fair in this part of the world and is organised biannually.

One operator successfully passed the exam on 15 December 2021 and thus fulfilled the condition for license extension.

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 years 2020–2021.

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 2021, a refurbishment of the automatic measurement system for meteorological and radiological data was performed.

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). In 2021, all safety-relevant SSCs were inspected and no noncompliant SSCs were found.

2.1.2.5 Periodic Safety Review

The second Periodic Safety Review programme of the nuclear facility that comprises the TRIGA Mark II Research Reactor and the hot cell facility was approved in 2021. The programme for the second Periodic Safety Review determines the content, scope, and timeline of the review and was prepared according to the Rules on the safety assurance of radiation and nuclear facilities and includes a review of three new safety factors: Radioactive Waste and Spent Fuel, Physical Security, and Radiation Protection. The review of the safety factor Physical Security has to performed separately and in accordance with requirements for the protection of classified information.

2.1.2.6 Inspection Reviews

In 2021, there were three inspection reviews of the TRIGA Mark II Research Reactor.

The inspection review comprised of review of work orders, approved modifications in implementation, pulses and their characteristics, core changes and a review of the scheme, a review of aging management and preventive maintenance, a review of the assessment of foreign operational experiences, equipment qualification, improvements in fire safety – fire sectors and long-term operation. One inspection review was dedicated to review compliance with cybersecurity requirements.

It was agreed that some activities for 2021 would include corrections to procedures and the delivery of certain procedures to the SNSA. These activities were completed in 2021.

There were no non-compliances or violations found that would require inspection actions.

An inspection review of radioactivity in the environment around the Reactor Infrastructure Centre was performed and is described in Chapter 3.3.4.

Regarding 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 2021.

References: [15], [16], [17]

2.1.3 The Central Radioactive Waste Facility (CSRW)

The Central Radioactive Waste Facility (CSRW) in Brinje is operated by the ARAO. The facility's operating licence was renewed for a further 10 years in 2018. The modifications and improvements resulting from the action plan from the first periodic safety inspection of the facility shall be implemented and reported regularly to the SNSA. Preventive period maintenance, inspections, and tests of components, systems, and structures have been carried out.

Records of radioactive waste and nuclear materials, preventive and corrective maintenance, changes, operational events, and experiences have been carefully maintained. The ARAO monitored foreign and its own operational experiences, following the development of technology in the field of nuclear and radiation facilities and innovations in the field of radioactive waste management. The changes were considered in accordance with the law and communicated accordingly.

More information on the acceptance of radioactive waste at the CSRW in 2021 and the state of stored waste at the end of 2021 is available in Chapter 6.4.

Regarding the radiation protection of exposed workers, the ARAO is also supervised by the SRPA. In the year 2021, one joint inspection with the SNSA Inspection was carried out. The areas of control included the organisation of the Radiation Protection Service and the training of its workers in radiation protection, as well as the implementation of measures to prevent and control infections with the Covid-19 infectious disease. An inconsistency was detected in the certificate of the Institute of Occupational Safety (IOS), where the training duration is 40 hours over three working days. Subsequently, the ARAO additionally explained that, in addition to listening to the content on the Institute of Occupational Safety (IOS), training for works at the CSRW and the LILW repository, as can be seen from the certificate, was also completed.

References: [15], [18]

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 2016 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 2021 was the eleventh year (the sixth 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.

The protection of exposed workers from the radiation of the Žirovski Vrh uranium mine is also inspected by the SRPA, which did not perform any inspection in 2021 due to the low radiation loads.

References: [15], [18], [19]

2.2 RADIATION PRACTICES AND THE USE OF RADIATION SOURCES

The 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 industry and in other areas, 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 2021, 48 licenses to carry out radiation practices, 10 extracts from the register of radiation practices, 26 licenses for the use of a radiation source, 95 extracts from the register of radiation sources, 8 approvals for external operators of radiation practices, 2 decisions on the termination of the validity of a license to carry out radiation practices, one decision on sealing an X-ray device, and 3 decisions on unsealing an X-ray device were issued by the SNSA.

In 2021, 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 must 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 2021, 55 editions of the leaflet had been issued, two of them in 2021.

At the end of 2021, 212 organisations in industry, research, and the state administration in the Republic of Slovenia were using 429 X-ray devices, and 706 sealed sources were being used in 72 organisations. As many as 24 radioactive sources were stored at 15 organisations, which are intended to be handed over to the ARAO in the future, among them 6 empty shielding containers with depleted uranium, which will not be handed over to the ARAO but will be reused as needed.

Ionisation smoke detectors, utilising isotope ^{241}Am, form a special group of radiation sources. According to the registry of radiation sources, there were 18,719 ionisation smoke detectors being used at 243 organisations at the end of 2021. In addition, 212 ionisation smoke detectors were stored on users' premises. Among them, 105 were stored on the premises of companies dealing with the maintenance, mounting, and dismounting of ionisation smoke detectors. The number of detectors transferred to the CSRW has increased recently. In October 2021, 1,049 ionisation smoke

detectors were transferred by the ARAO from the central storage facility to the German company Gamma Service Group GmbH, and in December 2021, an additional 1,031, all together 2,080. By the end of 2021, as many as 9 different companies obtained a licence to carry out the radiation practice of maintaining (mounting, dismounting) ionisation smoke detectors. All of these are published on the SNSA website.

2.2.2 Inspections of Sources in Industry, Research, and Education

In 2021, the SNSA Inspection conducted 80 inspections related to the SNSA's competences in the field of radiation practices. This number is larger than the number of inspections conducted in the year before, when 57 inspections were carried out. This increase can only partially be attributed to the relaxations of the Covid-19 epidemic-related measures, which enabled on-site inspections. Epidemiological conditions were better in 2021 than in 2020. Namely, inspection interventions contributed substantially as the number of interventions increased to 35 in 2021, while in 2020 only 13 interventions were carried out.

The SNSA Inspection was also heavily involved in inspections focused on measures set to limit the epidemic. Inspectors conducted 128 on-site inspections in high risk epidemiological conditions. For all other inspections, the inspectors systematically inspected the influence of the epidemic on operator safety measures as well as measures set to limit the epidemic. No major non-compliances related to the mentioned measures were identified but several good practices well beyond the legal requirements were identified.

The SNSA Inspection carried out inspections on the basis of the Annual Plan of the Radiation and Nuclear Safety Service for 2021. This plan did not derogate substantially from the plans prepared by the SNSA Inspection before the epidemic. It took into account postponed inspections due to the epidemiological conditions in 2020. The SNSA Inspection also conducted inspections using video systems, as in 2020. However, the use of video systems was limited.

In line with a graded approach, SNSA inspections focused on practices related to higher risks or those where non-compliances had been already noted. It noted improvements related to security measures and emergency preparedness and the response of operators using high-activity sources.

Special attention was devoted to annual inspections of industrial radiography operators. The inspectors identified improvements in this area. However, some challenges are still present, e.g. safety systems and features to be installed in shielded enclosures dedicated to performing this practice. One regulatory decision was issued. Figure 13 shows the entrance to such a shielded enclosure with the appropriate safety systems and features, and controlling instruments installed at the entrance to the enclosure. The SNSA Inspection notes that operators using old exposure devices with depleted uranium are storing them in the CSRW, while in the past they stored them to be sold mainly abroad. In 2021, some of these devices were stored in the CSRW. Such management of the devices prevents the unnecessary proliferation of disused radiation sources and in particular disused nuclear materials.

Figure 13: The entrance to the shielded enclosure dedicated to industrial radiography with a stop button and warning light (left); and controlling instruments used for carrying out and the control of industrial radiography (right) (Photo: industrial radiography operator)

In 2021, the SNSA Inspection also inspected an operator carrying out the sterilisation of medical appliances using two accelerators. Special attention was devoted to ensuring a crew/during the epidemic and to the operability of the safety systems. Figure 14 shows an operator controlling instruments with a master key used for entering the exposure room, i.e. into a so-called bunker, the entrance to the bunker with safety systems, and the control of the bunker interior by means of video surveillance. The SNSA Inspection also performed an inspection of the new accelerator used at the port of Koper for the control of transport containers to be shipped to the USA.

Figure 14: An operator controlling instruments with a master key used for entering into the bunker (left); the entrance to the bunker with a safety system (middle); video surveillance of the bunker interior (right) (Photo: the SNSA Inspection)

In inspections of companies using portable X-ray spectrometers, the SNSA Inspection mainly identified non-compliances related to the epidemiological conditions. A large challenge are bankrupt companies. In 2021, three inspections were dedicated to smoke detectors using radioactive sources, thus the total number of all inspections conducted since 2010 related to smoke detectors reached 105. In 2021, the SNSA Inspection also followed up on the implementation of safety measures required at inspections in the past.

As already mentioned, in 2021, altogether 35 inspection interventions were conducted. In 2021, despite the epidemic, the activities of the SNSA based on 24/7 emergency preparedness were carried out as usual. The SNSA collaboration with the ARAO, qualified experts for radiation protection and other institutions in or outside the country dedicated to the management of sources of ionising radiation or radioactive waste was not disturbed. As usual, the majority of interventions were related to either scrap metal or municipal waste. Namely, altogether 28 interventions of such type were recorded. In the majority of such interventions, objects contaminated with radiopharmaceuticals in waste was found.

Three types of interventions conducted in 2021 were identified:

- interventions related to sources from past activities or present practices in Slovenia,
- interventions related to scrap metal and municipal waste, and
- other interventions; namely, in 2021, four interventions were placed in this group.

Only three interventions related to radioactive sources or radioactive waste in Slovenia were not associated with transport. The SNSA was informed that during the management of radioactive waste in a building in Ljubljana two military detectors of type DR-M3, previously used in Yugoslavia, with equipment containing radioactive source ^{90}Sr with initial activity of about 200 kBq, was identified. An inspection followed and both radioactive sources were taken over by the ARAO. Details on the DR-M3 are given in the web newsletter. The other two interventions in this group took place in Murska Sobota. Both are related to smoke detectors with radioactive sources at Mercator d.d. Details on the management of such smoke detectors are given in the Radiation News publication.

It should be mentioned that of the 28 interventions related to transport or means of transport, 21 were related to the contamination of municipal waste or hospital waste with radiopharmaceuticals in Slovenia. They triggered detector alarms in companies collecting such waste (regional centres for waste management). Namely, only in 2021 did such companies start to control either medical or mixed municipal waste. Qualified experts identified ^{131}I, ^{99m}Tc, and ^{177}Lu. Contamination has been found on handkerchiefs, diapers, and other similar objects. The supervision of medical facilities including the release of patients is conducted by the SRPA. Therefore, the SNSA informed the SRPA of all such interventions. The SNSA implemented a systematic response to such interventions, which includes, *inter alia*, the protection of the waste shipment, repeated measurements using the prescribed protocol, and when necessary, control conducted by a qualified expert and returning the shipment to the medical facility from which the shipment originated. Figure 15 shows a container with contaminated hospital waste and municipal waste that originated from hospitals also containing contaminated waste.

Figure 15: A container with contaminated hospital waste (left); municipal waste originating from hospitals also containing contaminated waste (right) (Photo: Institute of Occupational Safety)

Among the seven other interventions related to the transport of secondary raw materials, two concern interventions associated with a shipment from Bosnia and Hercegovina with an elevated dose field. The shipment has been returned to that country. One intervention was related to a wagon from Slovenia returned from Italy. A qualified expert identified natural radionuclides in isolation material that did not require any measures. On the premises of Salamon d.o.o. in Logatec, an enhanced dose field was also caused by natural radionuclides. No specific measures were needed. Three times detectors of SIJ Acroni d.o.o. measured an enhanced radiation field on a shipment from Germany. Once the shipment was not allowed to be reloaded. For the other two interventions, natural radionuclides were identified in the reloaded shipment that caused enhanced dose fields. Figure 16 shows two objects found in a shipment from the mentioned wagons at the SIJ Acroni d.o.o. site.

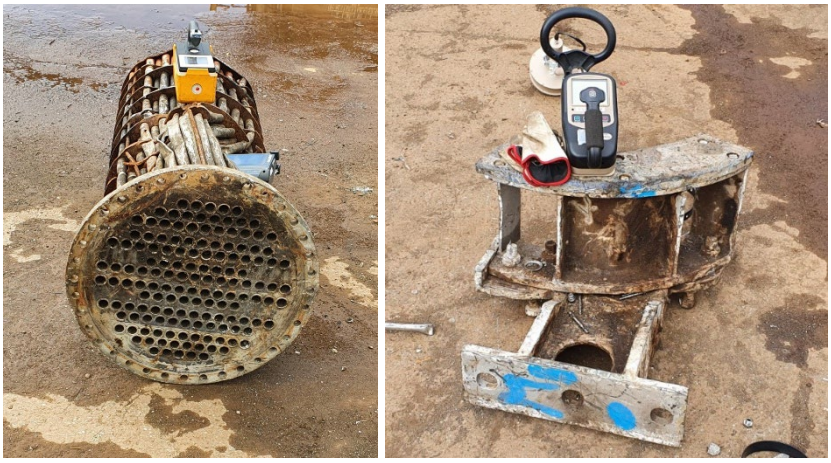

Figure 16: Two objects contaminated with ^{226}Ra in a shipment from Germany identified at the SIJ Acroni d.o.o. site (Photo: the SNSA Inspection)

Of the other four interventions, one is related to a careless driver who entered the protected zone of the JSI Reactor Infrastructure Centre. The SNSA Inspection also analysed:

- a web-based sale of smoke detectors with radioactive sources,
- a camera lens with an elevated level of thorium, thus triggering the detection system at the Post of Slovenia, and
- the RAPEX report of the Dutch regulatory authority regarding various objects, such as pendants and sleeping masks with radionuclides that might, when used for a protracted period of time, damage health; however, no such objects were found on the market by the SNSA Inspection.

2.2.3 The Use of Radiation Sources in Medicine and Veterinary Medicine

The SRPA is competent 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, 1,287 X-ray devices for medicine and veterinary medicine were installed as of the end of 2021; 175 of them were not in use (3 required servicing, 143 were in reserve, and 29 were proposed for decommissioning). The categorisation of X-ray devices based on their purpose is given in Table 3.

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

Purpose	Status 2020	New	Written-off	Status 2021
Dental	634	62	25	671
Diagnostic	319	33	15	337
Therapeutic	13	0	0	13
Simulator	3	0	0	3
Mammography	36	2	2	36
Computed Tomography CT	45	1	1	45
Densitometers	46	3	3	46
Veterinary	122	12	1	133
TOTAL	1,218	113	47	1,284

In the field of using X-ray devices in medicine and veterinary medicine in 2021, the SRPA granted 82 licenses to carry out a radiation practice and 298 licenses to use X-ray devices. One certificate of compliance for a licence granted by a foreign regulatory authority was issued for a licence to carry out a radiation practice – the maintenance of medical X-ray equipment.

In medicine (not including veterinary medicine), 516 X-ray devices were used in public hospitals and institutions and 635 in private institutions. The average age of the X-ray devices in the public sector was 10.1 years (9.9 years in 2020; 9.8 years in 2019, 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 11.1 years (10.6 years in 2020; 10.3 years in 2019, 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, 18 X-ray devices were in use in public institutions and 115 in the private sector. The average age of the X-ray devices was 17.00 years (16.1 years in 2020, 15.0 years in 2019, 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 7.9 years (7.4 years in 2020, 7.3 years in 2019, 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 provided in Table 4.

Table 4: The 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	382 (82%)	9.8	121 (18%)	11.4	13 (100%)	7.5	18 (14%)	17.0	534 (42%)	10.3
Private	85 (18%)	12.2	550 (82%)	10.9	0	0	115 (86%)	7.9	750 (58%)	10.6
TOTAL	**467**	**10.2**	**671**	**11.0**	**13**	**7.5**	**133**	**9.1**	**1,284**	**10.5**

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 such devices were classified as "fully functional".

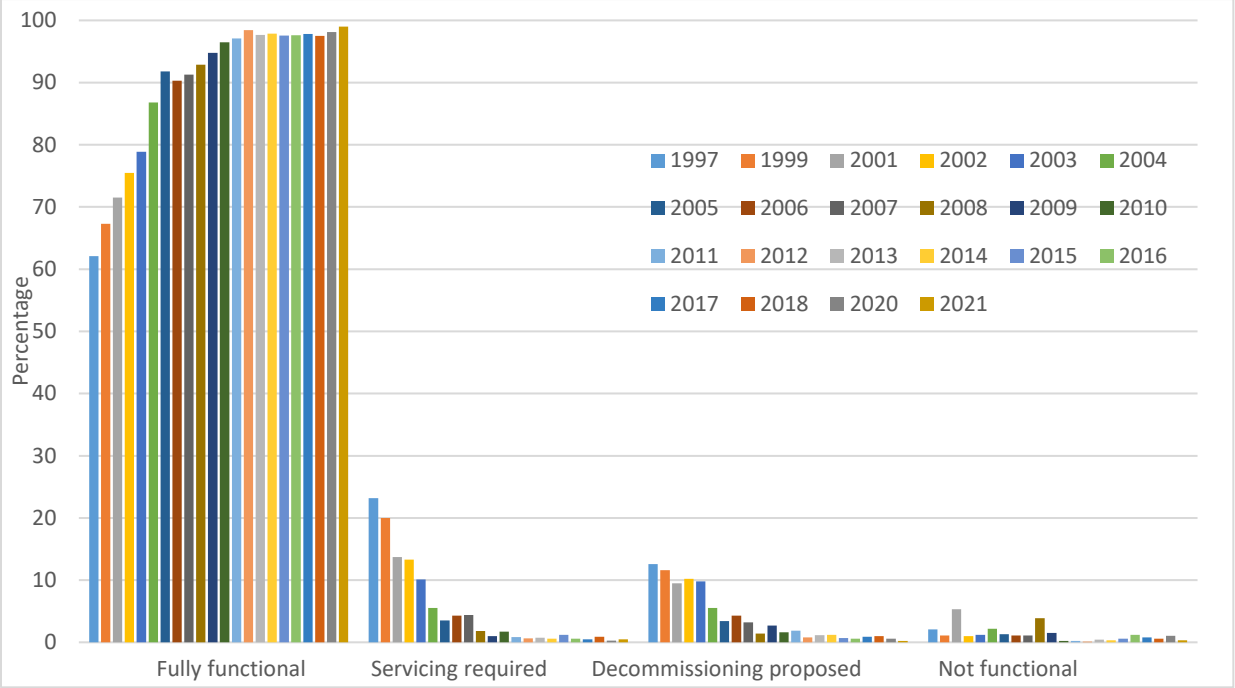

Figure 17: Percentage of diagnostic X-ray devices according to quality in the period 1997–2021

In 2021, the Covid-19 infectious disease epidemic had a significant impact on the organisation of inspections. The SRPA adapted its inspection activities to the intensive inspection guidelines on the implementation of measures to reduce the risk and spread of SARS-CoV-2 infections. As a result, 49 inspections were carried out in 2021 in the field of the use of X-ray machines and linear accelerators for radiotherapy in the health and veterinary sectors, alongside the inspection of the implementation of measures to reduce the risk and spread of the SARS-CoV-2 infection. Of these, one inspection was carried out in the field of veterinary teleradiotherapy, 42 in the field of X-ray diagnostics in healthcare facilities, 33 of which were carried out in the field of dental X-ray diagnostics and 6 in the field of X-ray diagnostics in veterinary medicine. In 15 cases, based on the findings, the SRPA inspection issued a decision requiring compliance with the valid regulations and in two cases the SRPA inspection issued a decision prohibiting the use of X-ray devices. During the inspections, 23 X-ray devices in storage were sealed.

Based on a review of the inspection reports of X-ray devices for medical use sent to the SRPA by approved technical support organisations, three inspections were conducted, during which the SRPA requested that the user provide evidence that the noted shortcomings had been eliminated. There were 28 cases in which the user was asked to present evidence relating to the cessation of the use of an X-ray device and 99 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 (IO), the University Medical Centre in Maribor, and the 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 5,549.5 GBq of isotope ^{99}Mo, 5,133.8 GBq of isotope ^{18}F, 1,018.3 GBq of isotope ^{131}I, and minor activities involving the isotopes ^{177}Lu , ^{123}I, ^{90}Y, ^{68}Ge, and ^{111}In, 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, 0.61 GBq of that isotope were imported in 2021 (more than in 2020, when 0.49 GBq of that isotope was imported). In October 2017, the Nuclear Medicine Clinic introduced new tests using Gallium ^{68}Ga in patients. This isotope emits positrons, its generator is germanium ^{68}Ge with a half-life of 271 days. The half-life of ^{68}Ga is 67 minutes. Two generators were purchased in 2021. Nuclear medicine units also use sealed calibration sources of low-activity radiation for testing the performance of devices and instruments, and for radioactive tracing.

Sealed sources for therapy are used at the IO and the Ophthalmology Clinic at the University Medical Centre Ljubljana. At the IO, 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. In 2020, the Institute of Transfusion Medicine of the Republic of Slovenia began using an X-ray machine to irradiate blood components instead of a closed source. The ^{137}Cs sealed source with an initial activity of 49.2 TBq will be submitted to a foreign acquirer in cooperation with the International Atomic Energy Agency (IAEA).

With reference to the use of unsealed and sealed sources in medicine, 5 licences to carry out a radiation practice, 6 licences to use a radiation source, 2 licences for the import of radioactive material from the USA, and 36 statements on the shipment of radioactive materials from European Union Member States were issued in 2021.

Three in-depth inspections of the use of radioactive substances in healthcare were carried out in 2021. The management of radioactive waste in the Nuclear Medicine Clinic was checked, as the SNSA Inspection has repeatedly informed the SRPA Inspection of interventions at non-hazardous waste disposal sites in Ljubljana and Celje due to elevated radiation levels in hospital or municipal waste due to radiation sources used in healthcare. In both cases, the SRPA inspector issued a warning because the control of radioactive material had been abandoned without permission from the competent authority. The possible causes of these incidents were analysed and remedial measures were introduced, such as additional markings on the radioactive waste bins, cards warning of the presence of radioactive substances on the housing of the activity distributor, mandatory measurements of all waste at the Nuclear Medicine Clinic, updated waste management instructions, and additional storage space for radioactive waste. Inspections were also carried out at the Institute of Transfusion Medicine and the IO. There were no irregularities.

Medical departments with unsealed and sealed radiation sources were reviewed (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 2021. Neither unsealed nor sealed radioactive sources were used in veterinary medicine in 2021.

Reference: [15]

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 of the Republic of Slovenia, Nos. 33/06-UPB1, 41/09, 97/10, and 56/15). All road transport of such materials must be carried out in accordance with the provisions of the *European Agreement Concerning the International Carriage of Dangerous Goods by Road* (ADR).

In 2021, 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 2021, the SNSA issued one decision to a foreign legal person approving a license for the performance of the radiation practice of the transport of radioactive material and one for the transport of radioactive and nuclear material in industry and research. In 2021, the SRPA issued one decision approving that a license for the transport of radioactive material in medicine and veterinary medicine issued by a competent authority of an EU Member State is equivalent to a license issued in accordance with Slovenian legislation.

In 2021, the SNSA issued two approvals of packages for the transport of radioactive and nuclear material (based on Article 7 of the Act on the Transport of Dangerous Goods), both on the request of the Krško NPP (taking into account the approval of the competent authorities of the country of origin, the USA), namely, the approval of packaging for the transport of nuclear material (non-irradiated – fresh nuclear fuel packed in type A packages, fissile (AF), Traveller STD packaging model, USA/9297/AF-96), and approval of packaging for the transport of nuclear material (HI-STAR 190, type B(U)F, package model USA/9373/B(U)F-96).

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 the prescribed forms (declarations of shipment) for the shipment of radioactive material between EU Member States.

In 2021, the SRPA did not issue any permits for the shipment of radioactive sources from non-EU countries. Two permits were issued for the import of radioactive material from the USA and approved 36 applications of consignees regarding radioactive material involving 79 isotopes. Each isotope from an individual producer intended for the same end user is counted separately.

In 2021, the SNSA approved 22 statementsof consignees of radioactive material from other EU Member States. The SNSA also issued three permits for the import of radioactive material, from which for one permit also two amendments were issued. In 2021, the SNSA did not issue any permits for the transit of radioactive material with significant activity.

Reference: [15]

3 RADIOACTIVITY IN THE ENVIRONMENT

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 are collected and automatically imported in a dedicated application called Radioactivity in the Environment (RVO, "**R**adioaktivnost **V** **O**kolju" in Slovenian) and are accessible on the RVO public portal on the SNSA public website (Figure 18). The public portal provides a user-friendly experience and 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. The SNSA's experts have access to additional modules, such as alarm messages in the event of elevated radiation values, real-time displays of data from field measurements obtained by mobile units or SNSA employees, and in-depth analysis. The module "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. All collected radioactivity data 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.

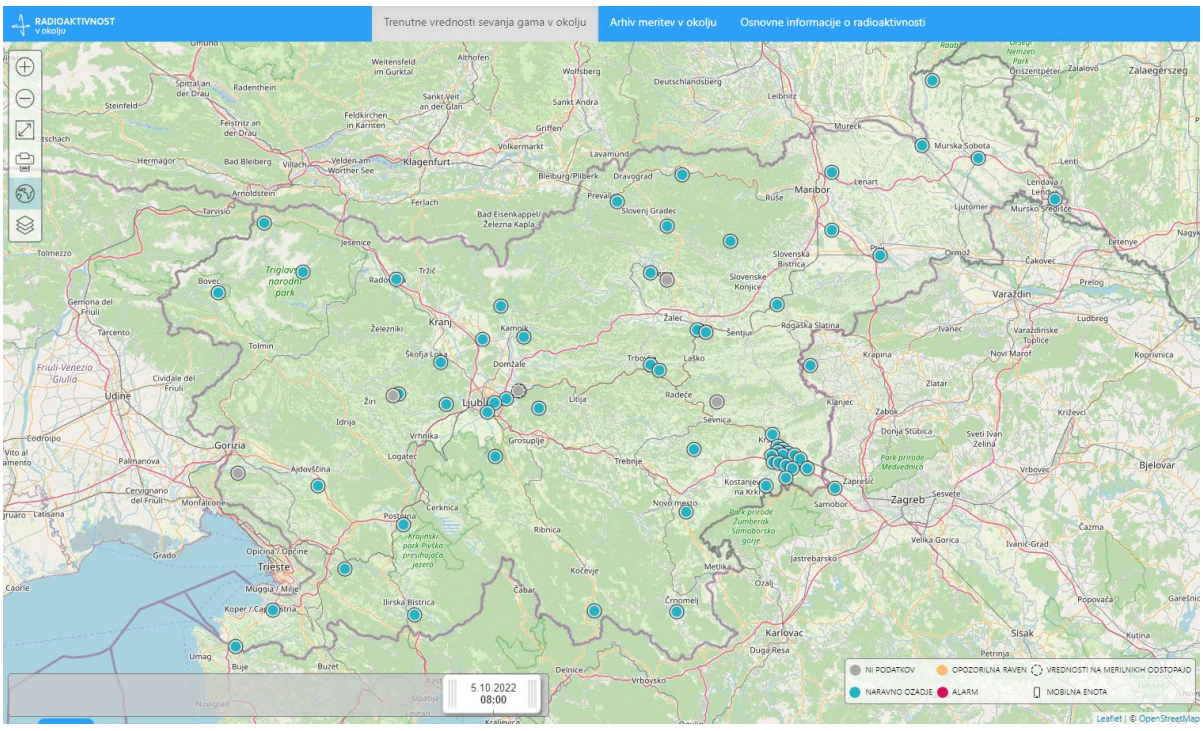

Figure 18: Basic overview of the status of the early warning network in Slovenia

In 2020, the SNSA acquired a new dose rate meter, type Envinet Mira, which was a donation from the the IAEA. The RVO portal's software had to be upgraded due to the technical requirements of the data imported from the new instrument. The Envinet Mira dose rate meter successfully passed the one-year testing period at the location Ljubljana Brinje (Figure 19) and was successfully implemented in the RVO portal.

Figure 19: The Envinet Mira dose rate meter at the Ljubljana Brinje location

In 2021, the SNSA started a large-scale project involving the complete renewal of the Early Warning Network. During this three-year project (with a timescale from 2021 to 2023), all existing MFM dose rate meters in the Early Warning Network will be replaced by Envinet Mira dose rate meters. The project is based on the successful obtainment of funds from the Republic of Slovenia and donations from the IAEA. The SNSA will acquire a total of 64 Envinet Mira dose rate meters (41 dose rate meters in 2021, 18 dose rate meters in 2022 (of which, 10 dose rate meters as donations from the IAEA donation) and 5 dose rate meters in 2023). The project started at the end of 2021 and is expected to be completed parallel to the acquisition of the final Envinet Mira dose rate meters.

3.2 ENVIRONMENTAL RADIOACTIVITY MONITORING

The 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, caesium (^{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 2021 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 steelworks 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. In 2020, another fire broke out in the Chernobyl exclusion zone, however, on a much larger scale than in 2016, and also lasted longer and was largely contained only in the next two weeks. The measurements could lead to the conclusion that although the impact of the fire was detected in Slovenia, it still did not significantly influence the effective doses received, as the additional contribution at the annual level is practically negligible.

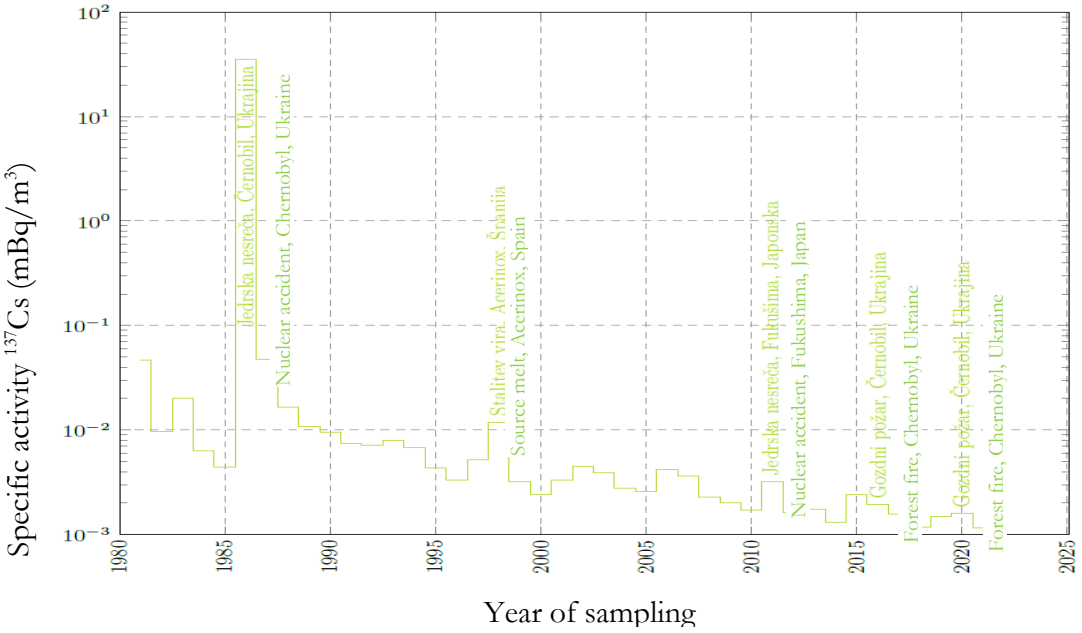

Figure 20: Average annual specific activities of ^{137}Cs in the air in Ljubljana since 1981

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 the increased use of firewood and wood fuels in the winter months (Figure 21). Based on the data on the total consumption of wood fuels in previous years, it can be estimated that a total of 3.5 GBq of ^{137}Cs was released into the air in 2021, which is, for sake of comparison, much more than is released every year by the Krško NPP (1.3 MBq in 2021).

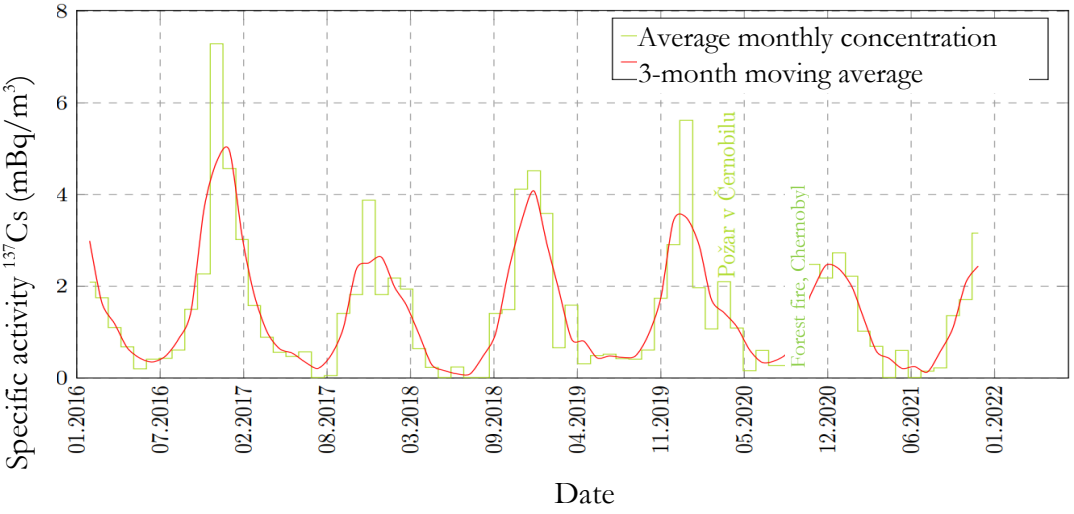

Figure 21: Seasonal variations of ^{137}Cs concentrations in the air in Ljubljana

The measurements of all environmental media were, within statistical variations, comparable to the values from previous years.

The largest contribution to the radiation exposure of the population due to the 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 to be 2.4 ± 0.2 μSv in 2021, which is 0.1% 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, for the second consecutive year, within the statistical deviations of food selection and sampling, the dose due to ingestion (the ingestion of food and beverages) is expected to be lower and is estimated to be 0.9 ± 0.5 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 exposure from other transmission pathways and is approximately 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 0.03 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 2021, the total effective dose of an adult in the central part of Slovenia arising from the global contamination of the environment with artificial radionuclides (external radiation) was estimated to be 3.4 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. The annual effective dose for an adult in 2021 was lower than in previous years, mainly due to a reduction in external radiation due to lower concentrations of ^{137}Cs activity in the soil in Ljubljana. 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 (the grey area in Figure 22) 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 2021

Transfer pathway	Effective dose [μSv per year]
Inhalation	0.0001
Ingestion (of food and beverage): drinking water food	 0.03 0.9
External radiation	2.4*
Total (rounded)	**3.3****

* 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 22 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.

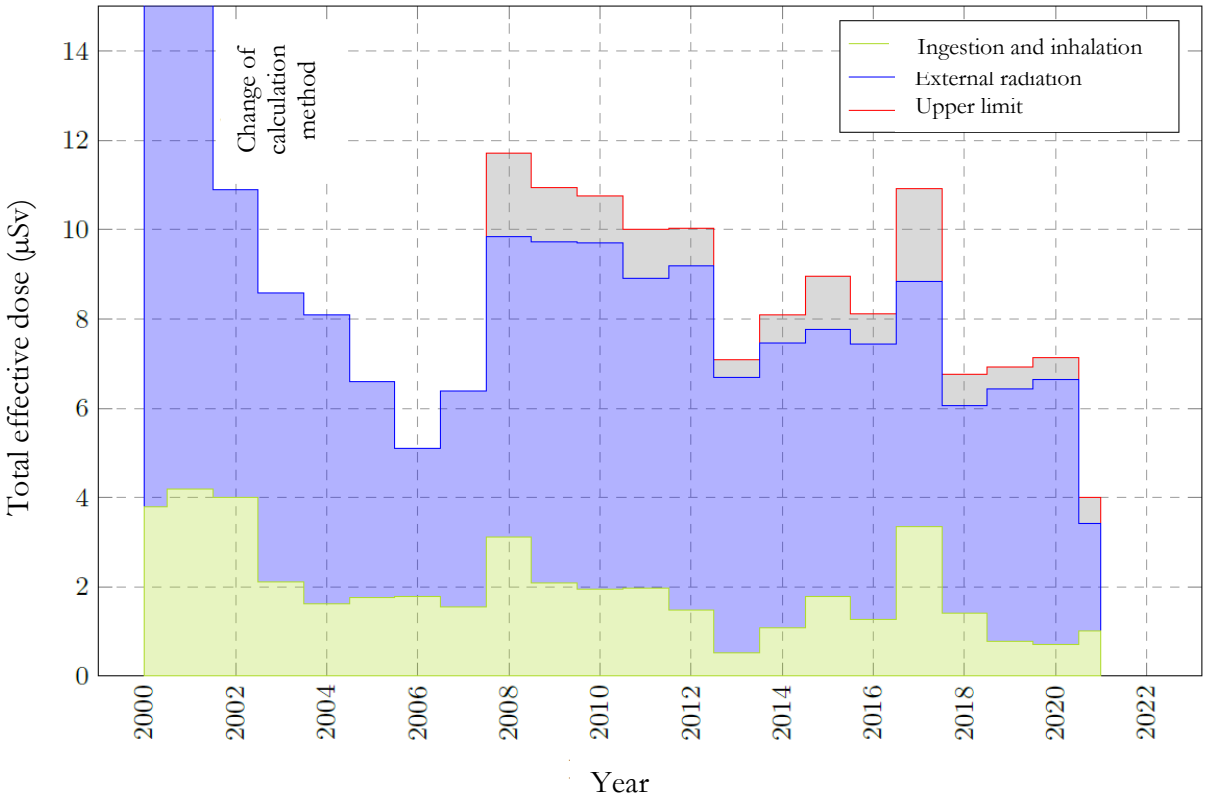

Figure 221: Estimated effective dose due to environmental contamination with long-lived artificial radionuclides for adults (Slovenian average) since 2000

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 only evaluated based 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 2021, independent verification measurements were performed, following a slightly modified programme that considered the measurements of milk and rainwater. The independent verification measurements were performed by the JSI and the IOS. The results of the measurements of liquid discharges carried out by the Krško NPP were fully consistent with the results of measurements carried out by the laboratory authorised to perform the monitoring of radiation, i.e. the JSI. However, it was not possible to compare gas emissions due to the low values, which were below the detection limit. The measurement results of samples from the environment between the authorised organisations, namely the JSI and the IOS, were comparable for milk samples and diverged for rainwater by approximately 7%.

3.3.1.1 Radioactive Discharges

In 2021, an outage took place, which typically means higher radioactive releases. The values were within the average value for 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 0.851 TBq in 2021, resulting in a dose exposure that represents 0.06% of the total limit. The predominant noble gas was the very short-lived activation radionuclide ^{41}Ar. In 2021, radioactive iodine radionuclides were detected in discharges, around 0.001% of the annual regulatory limit. The discharged activity of radioactive particulates was negligible in 2021. Regarding ^{3}H discharges into the atmosphere, a slight increase in the activity of ^{3}H in gaseous discharges was observed from year to year. This increase was mainly due to an improvement in 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 when the outage takes place.

^{3}H, bound to water molecules, predominates in liquid discharges from the plant into the Sava River. Total ^{3}H activity released in 2021 was expected to be higher and amounted to 16.1 TBq, which is 36% of the annual regulatory 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 and amounted to 35.6 MBq, or 0.04% of the annual limit (100 GBq). The amount of ^{137}C released from the NPP annually was 1.8 MBq, which is lower compared to previous years. The estimated concentration of ^{137}Cs activity in the Sava River in the vicinity of the Krško NPP due to releases was far below the detection limit; therefore, the contribution from releases cannot be separated from the global contamination. In 2021, the total activity of released ^{14}C was 0.132 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 23 shows the activity of ^{3}H released in liquid discharges from 1983 to 2021.

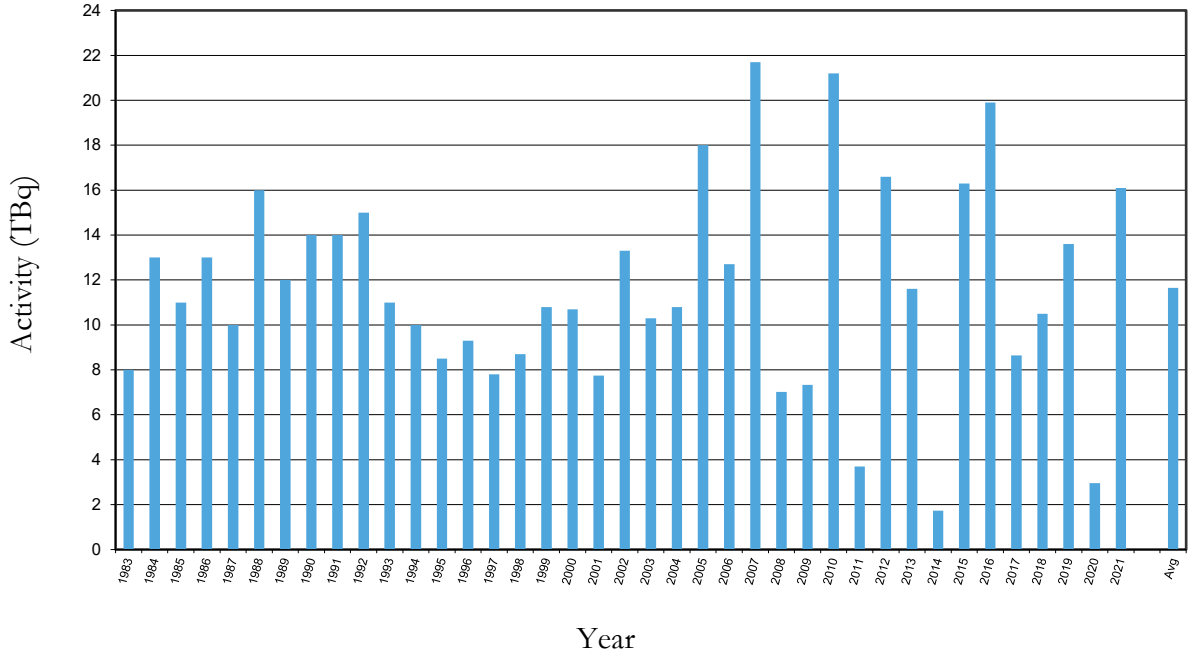

Figure 23: The activity of released ^{3}H in liquid discharges in the Krško NPP

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 (the Krško and Brežice Rivers), 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 as 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 the method of mixing liquid discharges into the Sava River.

The highest annual dose received by adult individuals was due to the intake of ^{14}C from vegetable food (0.14 μSv), while a lower dose (0.019 μSv) was also received due to the inhalation of ^{3}H and ^{14}C. The liquid discharges in 2021 contributed to the additional exposure of individuals from the population (similar to previous years, 0.016 μSv) – 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 the 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 0.18 μSv. This value represents 0.4% of the authorised limit value (the dose constraint is 50 μSv per year), or 0.008% 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 2021

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)	$5.8 \cdot 10^{-4}$
	Deposition	Particulates: (^{58}Co, ^{60}Co, ^{137}Cs …)	$7.4 \cdot 10^{-12}$
Inhalation	Cloud	^{3}H, ^{14}C	0.019
Ingestion (atmospheric discharges)	Vegetable food	^{14}C	0.14
Ingestion (liquid discharges)	Ingestion of fish (from the Sava River)	^{3}H, ^{137}Cs, ^{89}Sr, ^{90}Sr, ^{131}I, ^{14}C	0.016
Total the Krško NPP in 2021		**< 0.18***	

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

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

The TRIGA Mark II Research Reactor and the CSRW 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 JSI, which are located near the reactor building. Therefore, the radioactive discharges at this location arise from the reactor operation, the CSRW, 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 2021 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 very low results, which are similar to or below the detection limit. Discharges of the noble gas ^{41}Ar into the atmosphere, based only on reactor operation time, were estimated at 1.1 TBq in 2021, which is approximately 50% more than in 2020 (0.7 TBq), when there was a reduced number of operating hours of the reactor, and similar to that in 2019 (1.2 TBq). There were no liquid releases, as in 2021 the presence of artificial radionuclides was not detected in either the containment tank of the O-2 section, or in the drainage tank of the reactor.

The programme for taking specific activity measurements in the environment showed no radioactive contamination from the operation of the reactor. The activities of artificial radionuclides in all of the measured samples were below the detection limit, with the exception of ^{137}Cs, which is a result of global contamination. The external dose from the cloud shine due to ^{41}Ar

discharges on an individual who mows grass or shovels snow 65 hours annually at a distance 100 m from the reactor and only stays 10% of his or her time, in the cloud was estimated at 0.02 μSv per year. A resident of Pšata, a settlement at a distance of 500 m, receives 0.6 μSv per year for a year-round stay. The values are higher than in 2020, when there was a reduced number of operating hours of the reactor. As there were no liquid releases, no exposure occurred along this exposure route. The total annual dose received by an individual from the population in 2021 was slightly higher than 1% of the authorised dose limit, which is 50 μSv/year, or several thousand times less than the effective dose from 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 CSRW in 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 2021 was 13 Bq/s, which is 30% higher than in the previous year, but still within the measurement uncertainty of the values, measured in the previous years (Figure 24). 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 facility was not measurable in 2021 and was therefore estimated by a model for average weather conditions to be approximately 0.7 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. One sample showed that ^{40}K activity was slightly pronounced at 460 Bq/m^3. The slightly higher concentration of ^{40}K activity is probably related to cleaning the facility after the pressure was changed, as the cleaning residues had drained into an underground reservoir. 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 the radionuclides of the uranium-radium and thorium decay series.

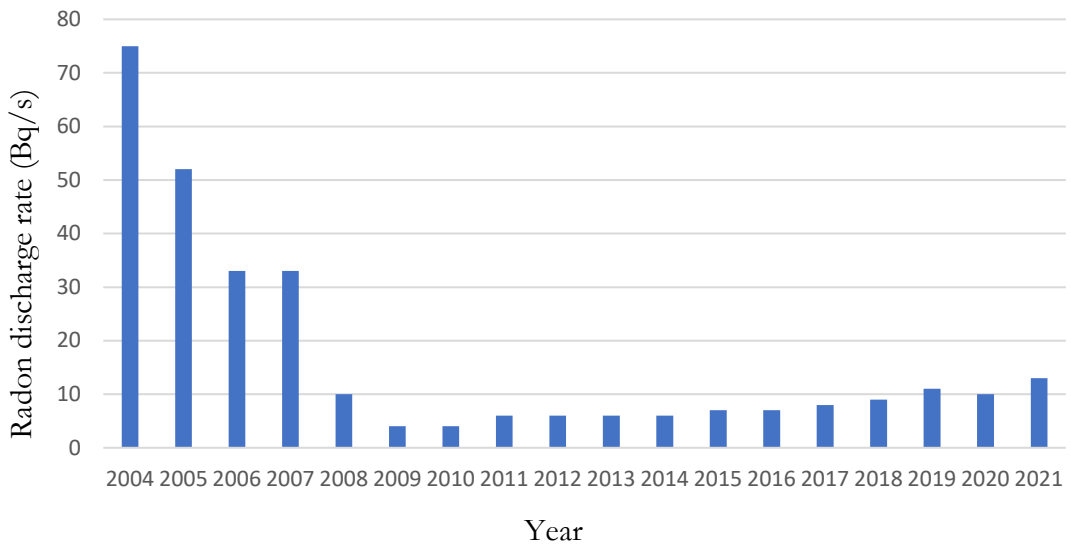

Figure 24: ^{222}Rn emissions from the Central Radioactive Waste Storage Facility in Brinje

For the 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 < 2 μSv in 2021, which amounts to 2% of the authorised dose limit for individuals from the reference group of the population (100 μSv per year). A security officer at the Reactor Centre received < 1 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 0.1 μSv per year. The values are comparable to the year 2020, and are much lower than in 2008 due to the 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.

3.3.3 The Former Žirovski Vrh Uranium Mine

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 the 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, the 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 site operators are responsible for implementing the environmental monitoring programme.

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 2021 was already the eleventh 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.

3.3.3.1 Radioactive Releases

In 2021, measurements of liquid discharges showed that they were within the authorised limit values for the Boršt disposal site. Measurements of discharges carried out for Jazbec and for mine water also confirmed that the activities of natural radionuclides are below the authorised limits set in 2019. Concerning gas discharges, the measurements made it possible to estimate the radon discharge from disposal site surfaces and the state of the multilayer soil cover. At the Boršt disposal site, the measured values were below the authorised limits. Regarding the Jazbec disposal site, this restriction was lifted in 2019, therefore the measurements are used to estimate the state of the multilayer soil cover. In 2021, the measured values were comparable to previous years.

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 recent years, the radioactivity in surface waters has been slowly but steadily decreasing. Due to a different dynamic of closing both the Jazbec and Boršt disposal sites, the programme for monitoring radioactivity in the Todraščica and Brebovščica Streams has changed. In 2021, it was difficult to ascertain the overall state of the environment and make a comparison with past measurements as the collection and analysis of data were carried out separately by the operators of both disposal sites. In 2021, the concentration in the water of the Brebovščica Stream in the settlement of Gorenja Dobrava was 247 Bq/m^3 for ^{238}U and 5.8 Bq/m^3 for ^{226}Ra. According to the data collected on currents and concentrations, it can be estimated that discharges from both disposal sites are approximately ten times lower than the contribution of the mine. The contribution of the Boršt disposal site has decreased following rehabilitation works and is similar to, if not lower than, the contribution of the Jazbec disposal site.

Just as in the previous years, in 2021 the most important part of the programme was measuring the radon concentrations. For 2021, it is estimated that the contribution of ^{222}Rn from the remaining mining sources to the natural concentrations in the environment was approximately 3.3 Bq/m^3, which is the same as in 2020.

In 2020, the effective dose assessment was carried out separately for both the Jazbec and Boršt disposal sites for the first time. For Jazbec, the calculation was done based on the new methodology described in the Amendment to the safety report from 2019. Only the contribution of radon and its short-lived progeny inhalations was assessed in 2021. The estimated dose due to ingestion and external radiation is conservatively estimated at 40 μSv/year and is not calculated from the measurements. It is important to add that the value of 40 μSv/year is overestimated and can lead to the wrong conclusion that those doses have increased for the population, but the actual value assessed through models and the above-mentioned available patterns does not actually exceed 10 μSv/year. Due to higher concentrations of radon in the valley of the Brebovščica Stream due to the Boršt disposal site, the corresponding effective dose has been estimated. As the values are low,

only the inhalation dose of radon and its short-lived progeny is mentioned, which in 2021 was estimated at 2.1 ± 0.6 μSv.

In 2021, the total effective dose received by an adult member living in the surroundings of the former uranium mine was estimated at 0.124 mSv (Table 7), which is the same as in 2020. However, the most important source of radioactive contamination from the mine environment is still ^{222}Rn with its short-lived progeny, which contributed 0.080 mSv of additional exposure in this area.

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 2021

Transfer pathway	Important radionuclides	Jazbec [mSv]	Boršt [mSv]	Effective dose [mSv]
Inhalation	- aerosols with long-lived radionuclides (U, ^{226}Ra, ^{210}Pb)	-	-	(pathway no longer exists)
	- only ^{222}Rn	0.0019	0.00005	0.0019
	- Rn – short-lived progeny	0.080	0.0021	0.082
Ingestion	- drinking water (U, ^{226}Ra, ^{210}Pb, ^{230}Th)	0.040 (the total contribution is estimated according to the amendment of the safety report, including mine water)	(0.004) *	0.040
	- fish (^{226}Ra in ^{210}Pb)		(0.002) **	
	- agricultural products (^{226}Ra in ^{210}Pb)		(0.007) **	
External radiation	- immersion and deposition (radiation from the cloud and deposition)		0.00025	
	- deposition of long-lived radionuclides (deposition)		-	
	- direct gamma radiation from disposal sites		-	
Total effective dose (rounded):		0.122	0.0026	0.124 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 lower than the authorised limit value of 0.3 mSv per year, which is determined for all facilities after the remediation (the mine and the Boršt and Jazbec disposal sites) (Figure 25). Higher values in comparison to 2019, when the effective dose received by an adult member of the public was estimated at 71 μSv/year, were only a consequence of compliance with the new methodology, which is in accordance with the newly valid safety report for disposal sites and with the instructions from the *Rules on radioactivity monitoring* (Rules JV10, Official Gazette of the Republic of Slovenia, Nos. 20/07, 97/09, 76/17, 26/19, 172/21 – ZVISJV-1 and 27/18). The values are actually similar to those from 2019 and are in accordance with the average from previous years. Considering the old calculation methodology, the effective dose for an adult member of the public would be estimated at 76 μSv/year.

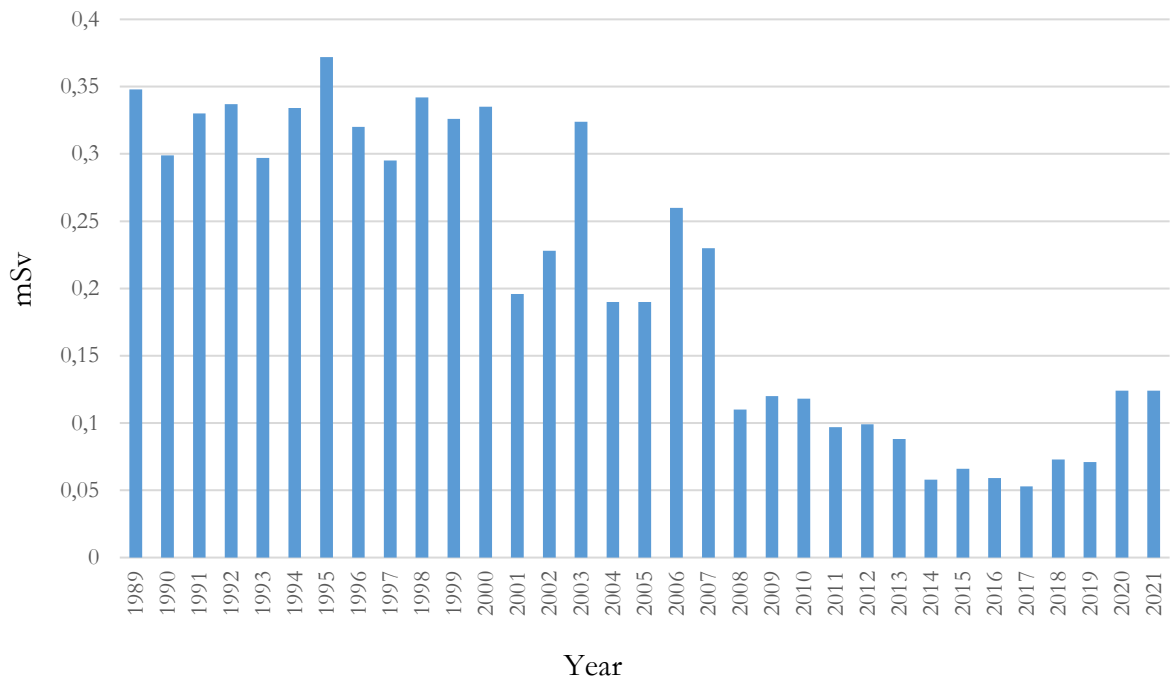

Figure 25: Annual contributions to the effective dose received by an adult member of the public due to the former Žirovski Vrh Uranium Mine in the period 1989–2021

3.3.4 Operational Monitoring Inspections

In 2021, the SNSA Inspection performed one inspection related to operational monitoring, namely, at the JSI, focusing on the operational monitoring at the RIC location in Podgorica, Brinje 40, Dol pri Ljubljani.

Operational monitoring is defined in Article 159 of the ZVISJV-1. The JSI Programme of Measurements is based on the SNSA decision issued in 2000. The programme was updated in 2013 and as such is in line with the Rules JV10, Annex 5: Structure of the programme for operating monitoring of the radioactivity of a research reactor. The programme is harmonised with the currently valid Rules JV10.

The authorised annual dose limit for members of the public from the RIC reference group given in the SNSA decision from 1992 is 50 μSv. The calculated dose for a member of the public using data from monitoring of emissions and imissions is negligible, as is evident in the JSI report Environmental Monitoring of Radioactivity at the JSI Reactor Centre for 2021, Chapter 4.

In the inspection, the SNSA inspected the results of measurements conducted in line with the above-mentioned programme. No non-compliances related to the programme or related to the values measured were identified. This was also noted in the JSI report mentioned above. The inspection did not have any comments on the report.

Article 20 of the Rules JV10 addresses the performance of environmental monitoring of radioactivity in the vicinity of the radiation, nuclear, or other installation, as well as measurements of the emissions of radioactive discharges. At the same time, the first indent of Article 33, of the Rules JV10, requires that a competent authority ensure independent measurements of emissions and imissions. These measurements should not be carried out by the same laboratory that performs the same measurements for the concerned operator. In 2021, independent measurements were conducted by a technical support organisation, namely the IOS. The IOS laboratory conducted such independent measurements, namely gamma ray measurements using a sample taken from the air filter installed in the reactor chimney. The analysis is available in the JSI report mentioned above.

Taking into account the prescribed acceptance criteria, all results showed very good agreement. No non-compliances were identified during the SNSA inspection.

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

3.4.1 Exposure to Natural Radiation

The average annual effective dose from natural sources received by a single individual on Earth is 2.4 mSv, varying from only 1 mSv and even exceeding 10 mSv at some locations. The average annual dose from natural radiation sources received by an average member of the public in Slovenia is approximately 2.5 to 2.8 mSv. Higher values are found in areas with higher concentrations of radon in living and working environments. 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 The 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.

The programme in 2021 consisted of measurements in organisations that produce thermal insulation or waterproofing finished products (FRAGMAT TIM d. o. o., Laško, and ISOMAT d. o. o., Mežica) and in organisations that produce or use geothermal energy (the kindergarten Mavrica, Brežice, and Ocean Orchids d. o. o., Dobrovnik). Radioactivity was estimated from the environmental dose equivalent H*(10)), with calibrated hand-held meters, with spectrometric analyses of input raw materials and finished products, and with measurements of radon concentrations in the buildings.

In Slovenia, radiation exposure from the natural background is estimated at 2.5–2.8 mSv/year; consequently, the additional exposure of workers in this case is negligible. In the kindergarten of Brežica and the company Ocean Orchids d.o.o., there were no direct sources of radiation in the area. Geothermal energy could lead to the accumulation of elevated levels of natural radionuclides on water filters or to increased radon concentrations on such premises. The measured and calculated activities were low, and employees would not receive an additional effective dose. In FRAGMAT TIM, d. o. o., and ISOMAT, d. o. o., there were no direct sources of radiation.

Although a material that may have a high content of natural radionuclides is used, there was no exposure for the employees. The measured and calculated activities were low, and employees would not receive an additional effective dose.

3.4.3 Programme of Systematic Surveillance and Measurements of Radon in Working and Living Environments

Radon is a natural radioactive gas. In most cases it is the dominant source of natural radiation in living and working environments. On average, it contributes more than half of the effective dose due to natural ionising sources. It penetrates buildings mainly from the 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 *Decree on the national radon programme* (Official Gazette of the Republic of Slovenia, Nos. 18/18, 86/18, and 152/20) was adopted in 2018. Together with the ZVISJV-1, 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 sets 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 2021, the SRPA issued an authorisation to the JSI.

From January to November 2021, 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, 43 additional continuous measurements for weekly monitoring of the timing of radon progeny and radon, and 17 measurements of potential radon sources originating from soil, shafts, or openings into rooms. A total of 255 rooms were measured in 101 buildings. The average radon concentrations exceeded the reference level of 300 Bq/m^3 in 61 buildings (60%) and in 124 rooms (49%). The value of 900 Bq/m^3 was exceeded in 38 rooms (15%). 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 131 estimated annual doses, none exceeded the threshold of 6 mSv for members of the public. The highest estimated dose was around 4.5 mSv in the lecture room of Nazarje Primary School due to an average radon concentration of 2,300 Bq/m^3. In 15 cases, the estimated annual doses were between 2 and 6 mSv, in 57 cases between 1 and 1.99 mSv, and in 59 cases less than 1 mSv. In the majority of buildings with high radon concentrations measurements and protection measures are being continued.

In 2021, the SRPA conducted 9 in-depth inspections of public facilities with increased radon concentrations (Bogomirja Magajne Divača Primary School with a branch school in Senožeče, Medvode Kindergarten, Sežana Kindergarten with units in Komen, Senožeče, and Lehte, the Begunje branch school of Notranjski odred Cerknica Primary School, the Ljubljana Health Centre – Šiška unit, Nazarje Primary School, Braslovče Primary School with branch schools in Letuš and Gomilsko, the Zara Ljubljana clothing store, and Žužemberk Primary School with branch schools in Šmihel, Dvor, and Ajdovec). The highest radon concentration – approximately 4,100 Bq/m^3 – was measured in the summer at the drinking water pumping station Dol near Stari trg on the Kolpa River. Eight warnings with requests to reduce radon concentrations (ventilation, time limitation, remediation, and additional and control measurements) were issued. Furthermore, 3 inspection orders were issued to Notransjki odred Cerknica Primary School, the Ljubljana Health Centre, and Nazarje Primary School. Additional and control measurements are continuing in most buildings.

In 2021, 61 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 national 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 areas with a higher radon concentration. In the scope of the programme, Radonova Laboratories AB performed 480 basic measurements using nuclear track detectors for assessing average monthly or bimonthly radon concentrations in 58 municipalities (Ankaran, Bloke, Bohinj, Borovnica, Brda, Brezovica, Celje, Cerknica, Črnomelj, Divača, Dobrepolje, Dolenjske Toplice, Gorenja vas – Poljane, Grosuplje, Hrpelje – Kozina, Idrija, Ig, Ilirska Bistrica, Ivančna Gorica, Jesenice, Kočevje, Komen, Kostanjevica na Krki, Ljubljana, Logatec, Log – Dragomer, Loška dolina, Loški Potok, Metlika, Mežica, Miren – Kostanjevica, Mirna Peč, Mokronog – Trebelno, Mozirje, Nova Gorica, Novo mesto, Osilnica, Pivka, Postojna, Radovljica, Ravne na Koroškem, Ribnica, Semič, Sežana, Slovenj Gradec, Sodražica, Straža, Šentjernej, Škofja Loka, Škofljica, Šoštanj, Tržič, Velike Lašče, Vrhnika, Vuzenica, and Žužemberk). The measurements were mostly performed in buildings at the ground floor level (in rooms such as living rooms or bedrooms). The measurements were performed mainly in the areas with higher radon concentrations defined by the Decree on the national radon programme and also in areas where additional measurements should be carried out. The average radon concentration exceeded the reference value of 300 Bq/m^3 in 195 cases (41%). Of these, a value of 900 Bq/m^3 was exceeded in 83 cases (17%) and a value of 2,000 Bq/m^3 in 25 cases (5%). The highest radon concentration, i.e. 10,470 Bq/m^3, and the second highest, 6,430 Bq/m^3, were measured in the basements of residential houses in Loška dolina and Logatec. In 47 cases, radon concentrations were between 200 and 299 Bq/m^3, in 100 cases between 100 and 199 Bq/m^3, and in 136 cases lower than 100 Bq/m^3. The measurement contractor 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.

For many years, cooperation with school principals, teachers, journalists, and members of the public has been increasing. The SRPA provides them relevant information and lends out radon detectors for preliminary radon concentration measurements in the working or living environment. The SRPA purchased 56 such detectors between 2015 and 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 facilities. In 2021, radon detectors were borrowed 73 times (78 in 2020, 117 in 2019, 24 in 2018, 17 in 2017, 8 in 2016, and 3 in 2015).

In 2021, the development of the *Register of Radon Measurements* continued. All measurement performers are to 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 2021, 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 JSI. Altogether, 160 samples were analysed from water supply systems. The sampling covered the entire area of Slovenia, while in 2021 greater emphasis was placed on the sampling of smaller water supply systems. The gross alpha concentration values were up to 0.14 Bq/kg, with an average value of 0.024 Bq/kg. The values for gross beta concentrations were up to 0.31 Bq/kg, with an average value of 0.06 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 2020.

Reference: [15]

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. Table 8, presents the annual individual doses of 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 of 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 higher values in comparison to 2019, when the effective dose received by an adult member of the public was estimated at 71 μSv/year, were only a consequence of compliance with the new methodology, which is in accordance with the newly valid safety report for the Jazbec and Boršt disposal sites and with the instructions from the *Rules on radioactivity monitoring*. In no case did the radiation exposure of individuals from the public exceed the regulatory limits.

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	0.124	**0.300
Chernobyl and nuclear tests	0.004–0.007	/
Krško NPP	<*0.00018	***0.050
TRIGA Mark II Research Reactor	0.0006	0.050
The Central Storage for Radioactive Waste	0.002	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 2021.

** 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.

References: [19], [20], [21], [22], [23]

4 RADIATION PROTECTION OF EXPOSED 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.

The 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 2021 were the IOS, the JSI, and the Krško NPP. The IOS was approved for the assessment of radon exposure in mines and Karst caves. Currently, 19,450 persons have a record in the CRPD, including those who have ceased to work with sources of ionising radiation. The Krško NPP performed individual dosimetry for 433 plant personnel and 900 external workers, who received an average dose[2] of 0.91 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 0.18 mSv. Workers in industry received an average annual effective dose of 0.30 mSv, of which the maximum received effective dose for workers performing industrial radiography was 0.49 mSv.

In 2021, the highest collective dose from external radiation was received by workers at the Krško NPP (925 man-mSv), followed by workers in the medical and veterinary sector (265 man-mSv) workers in industry (44 man-mSv), and workers in other activities (38 man-mSv).

Since 2010, the CRPD has included personal doses received by employees of Slovenian companies when performing radiation activities abroad. High individual doses from external radiation are received by workers who carry out maintenance work at nuclear power plants abroad, and who are also involved in work at the Krško NPP and industrial radiography. It is important that for these workers that contributions from all activities be taken into account in the calculation of the annual individual dose. In 2021, due to the Covid-19 epidemic, only one person performed work involving exposure to ionising radiation, both in Slovenia and abroad, and received a total annual effective dose of 3.17 mSv.

The highest doses are received by workers exposed to radon and its progeny. In 2021, 2 tourism workers out of 102 received a dose between 15 and 20 mSv, 10 workers received a dose between 10 and 15 mSv, 22 workers received a dose between 5 and 10 mSv, and 51 workers received a dose between 1 and 5 mSv and 17 workers below 1 mSv. The highest individual dose was 18.9 mSv. The collective dose was 445 man-mSv, with an average dose of 4.4 mSv. The collective dose and the average individual dose are lower than in the pre-epidemic period (1,135 man-mSv and 6.7 mSv for 2019), but higher than in 2020 (191 man-mSv and 2.7 mSv). Tourism workers in Karst caves are the most exposed group 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 tourism 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

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

of radon progeny in the atmosphere of Karst caves, the ICRP 32 model should be used and an approximately two-times higher dose factor should be taken into account. Therefore, the received doses from radon and its progeny are assessed according to the ICRP 32 model in this report. The doses calculated in such a manner are thus twice as high as those calculated according to the ICRP 65 model.

At the Žirovski Vrh Uranium Mine, 8 workers received a collective dose of 0.62 man-mSv, whereas the average individual dose was 0.08 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–ND	ND ≤ E < 1	1 ≤ E < 5	5 ≤ E < 10	10 ≤ E < 15	15 ≤ E < 20	20 ≤ E < 30	E ≥ 30	Total
Krško NPP	319	724	268	22	0	0	0	0	1,333
Industry	520	135	13	0	0	0	0	0	668
Medicine and veterinary medicine	3,327	1,439	34	1	0	0	0	0	4,801
Other	1,573	393	2	0	0	0	0	0	1,968
Radon	0	25	51	22	10	2	0	0	110
Abroad	0	0	1	0	0	0	0	0	1
Total	**5,739**	**2,716**	**369**	**45**	**10**	**2**	**0**	**0**	**8,881**

ND – detection level

E – effective dose in mSv received by an exposed worker

Training of exposed workers using sources of radiation

Training in radiation protection for workers using sources of radiation is carried out 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, and the JSI. The training of the Krško NPP's external workers is carried out by the NPP in cooperation with the JSI. In 2021, a total of 3,034 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;
- IOS, d. o. o., Ljubljana;
- Aristotel, d.o.o., Krško;
- The Krško Health Centre; and
- The Ljubljana Health Centre.

Altogether, 3,605 medical examinations were carried out. Of the examined workers, 3,134 completely fulfilled the requirements for working with sources of ionising radiation, whereas 397 fulfilled the requirements with limitations, 37 candidates temporarily did not fulfil the requirements,

and 8 did not fulfil the requirements, 1 worker did not fulfil the requirements and other work was proposed for him. In 28 cases an evaluation was not possible.

Reference: [15]

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 *Dose DataMed2* project, which was carried out under the framework of the European Commission. The results of the study showed that the average inhabitant of Slovenia receives approximately 0.7 mSv per year from medical procedures. The most important contribution comes from Computed Tomography (CT), which contributes approximately 60% of the total dose. Classic X-ray diagnostics contribute approximately 20%, while interventional procedures and examinations in nuclear medicine contribute approximately 10%. The results show that the exposure of the population in Slovenia is slightly below the European average, which is 1 mSv per year per capita.

Due to the increasing role of X-ray diagnostics in modern medicine and on the basis of trends in other developed countries, a further increase in the exposure of the population 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.

The second fundamental 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 considered 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 referring 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 (computed 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 by more complete fulfilment of referrals and/or by the use of a unified health information system, such as is already in use in other European regions and countries.

In 2020, Slovenia was selected to participate in the *"European coordinated action on improving justification of computed tomography"* (EU-JUST-CT) project, which aims to assess the justification of referrals for CT scans. For this purpose, the SRPA will collect data on referrals for all CT examinations performed in Slovenia during the selected period and a specially trained team of radiologists, selected in cooperation between the European Association of Radiologists and the Slovenian Association of Radiologists, will evaluate their justification according to a prepared methodology.

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 ICRP 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 the official DRR values in Slovenia for 29 X-ray examinations were presented. Due to changes in technology and professional guidance, it is necessary to regularly review the DRR. 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 IAEA projects (RER-9-147 and RER-6-038) regarding the radiation protection of patients in radiological procedures and quality improvement in such procedures. The two projects were concluded at the end of 2021.

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 specific X-ray device is compared to the national DRR in the process of issuing a license to carry out a radiation practice and for the use of a radiation source in medicine. If the average patient exposure for a specific examination exceeds the DRR, the SRPA requires that optimisation of the procedure protocols be carried out. This process is important for all radiological procedures, with special attention devoted to procedures involving high patient exposures, foremost interventional procedures and computed 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 2020, the SRPA funded the continuation of automatic data collection. At the end of 2021, about 60% of all CT devices in Slovenia, including mammography under the DORA programme (the national breast cancer screening programme) and many other X-ray machines, were already covered by the automatic patient exposure data collection system, which, in addition to determining the average dose for standard examinations, also allows monitoring of other parameters, such as the width of the distribution, the gender or age distribution, etc. The data collected are anonymised and contain information on the sex and age of the patient, as well as all of the parameters necessary for dose estimation. The data will, *inter alia*, enable the establishment of diagnostic reference levels for paediatric patients and for a number of procedures for which DRRs have not been established thus far. This exposure tracking is not intended for individual dose assessment of radiological procedures for a single patient. In fact, any patient or his or her legal representative can obtain information on the dose received as a result of a radiological procedure from the physician responsible for the radiological 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 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.

Reference: [15]

6 MANAGEMENT OF RADIOACTIVE WASTE AND IRRADIATED FUEL

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 the event of the 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 are stored in the CSRW.

6.1 IRRADIATED FUEL AND RADIOACTIVE WASTE AT THE KRŠKO NPP

6.1.1 Management of Low- and Intermediate-Level Waste

The total volume of waste accumulated by the end of 2021 amounted to 2,333 m^3, with the total gamma and alpha activity of the stored waste amounting to 18.5 TBq and 26.9 GBq, respectively. In 2021, the equivalent of 245 standard drums containing solid waste and 32 tube-type-containers (TTC) were produced, with a total beta-gamma and alpha activity of 4.16 GBq and 3.05 MBq, respectively.

Figure 26 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.

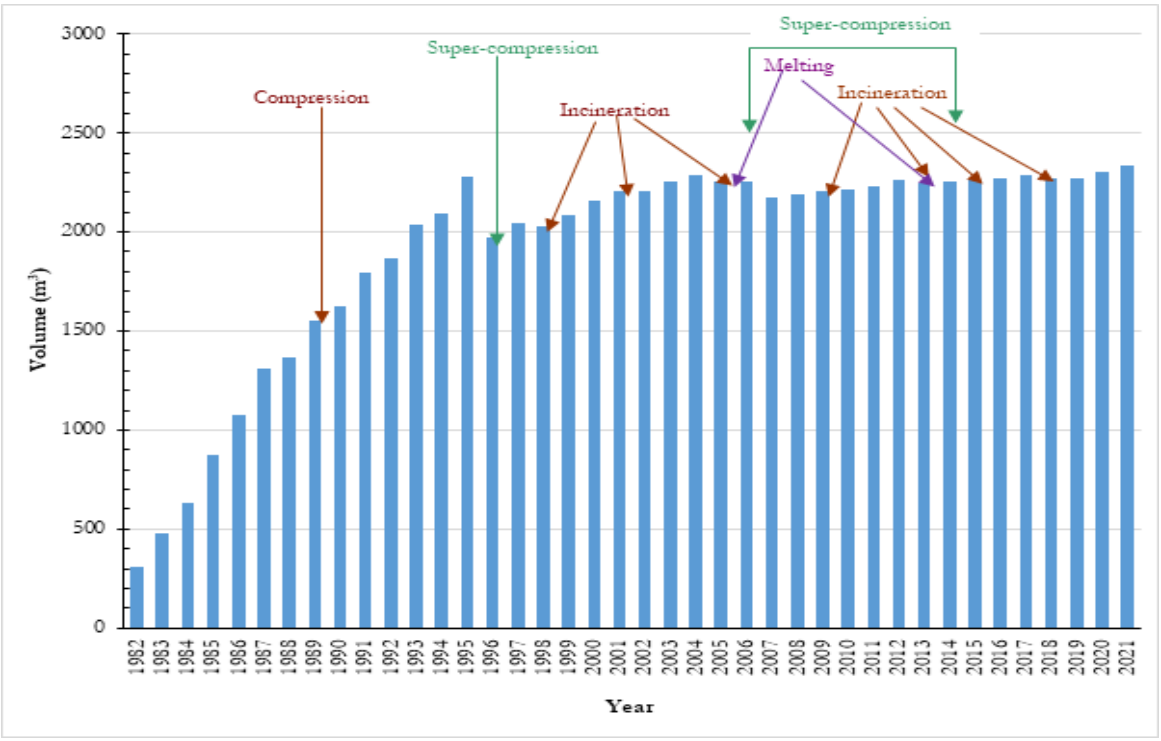

Figure 26: The accumulation of low- and intermediate-level radioactive waste in the Krško NPP storage

In 2018, the Krško NPP built a facility for manipulating equipment and shipments of radioactive cargo (WMB – Waste Manipulation Building) and thus eased the problems caused by delays in the construction of a Low- and Intermediate-Level Radioactive Waste (LILW) repository. The new structure enabled the removal of the measuring equipment and the super-compactor from the temporary storage. Waste packages for storage or incineration are being prepared in the new building.

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. At the end of the year 2021, 167 packages of compressible waste and 96 packages of other waste were stored in the new WMB building. Furthermore, 53 packages of dried secondary spent resins (BR) and 371 packages of compressible waste awaiting further treatment were temporarily stored in the Decontamination Building.

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 spring 2021, a regular outage took place, with the shipment of 56 elements of fresh fuel to the Krško NPP already at the end of 2020. At the end of 2021, a total of 1,379 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 27.

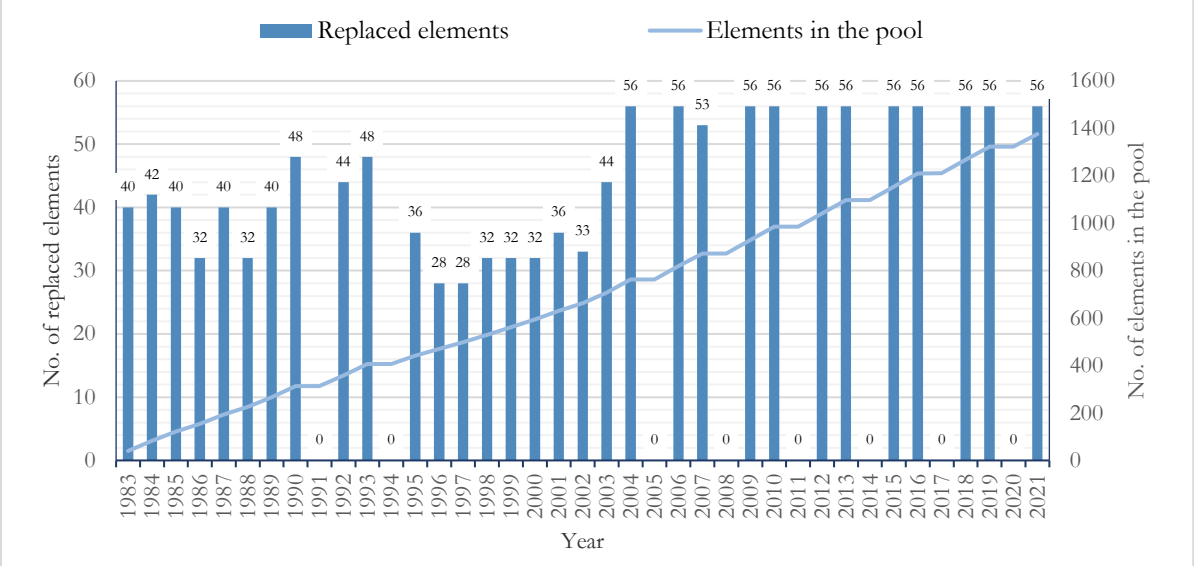

Figure 27: The number of annually spent fuel assemblies and the total number of such elements in the pool of the Krško NPP

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 JSI annually produces up to 2 drums (< 0.5 m^3) of solid radioactive waste. No radioactive waste was transferred to the CSRW in 2021.

Equipment, tools, packaging, or other materials (waste protective plastics, irradiated samples, and other substances) in the controlled area are also monitored. These objects may be cleared if they meet the requirements as to the maximum permitted activity or surface contamination.

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 is stored in a special storage facility until clearance levels are reached and then disposed of as normal waste.

Reference: [15]

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 (i.e. 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 2021 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, the 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 JSI.

In 2021, the ARAO accepted 100 packages of radioactive waste from different producers, namely 10 packages of solid waste, 13 packages of sealed radiation sources, and 77 packages of ionisation smoke detectors. The total volume of the stored radioactive waste was 1.9 m^3. As of the end of 2021, there were 673 packages stored, as follows:

- 433 packages of solid radioactive waste (sorted according to compressibility, combustibility, shape, and size),
- 164 packages of sealed radiation sources, and
- 76 packages of ionisation smoke detectors.

The total activity of the 88.4 m^3 of stored radioactive waste as of the end of 2021 was estimated to be 3.2 TBq, with a total weight of 49.5 tons.

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

Utilisation of the 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 sealed 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 sealed 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 at the end of 2021 did not increase compared to December 2020.

In 2021, the ARAO obtained permission for the clearance of waste, which thus met the conditions for the clearance of radioactive material. The total amount of material to which the clearance procedure was applied was 1.6 tonnes. This freed up an additional 1.8 m^3 of space in the CSRW. The material was handed over to authorised collectors of secondary raw materials and of waste generated during construction works.

In order to reduce the volume of RW in the CSRW and to provide storage space, 2,080 ionisation smoke detectors in two dangerous goods transports were taken for recycling abroad, where they will also remain.

6.4.2 The Management, Long-term Control, and Maintenance of the Jazbec Mine Tailings Disposal Site

In 2021, 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 situation is appropriate. Maintenance work in 2021 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, its support posts, and a stone fold on the retaining wall of one of the inflow structures were carried out. The cleaning of the two largest reservoirs at the diversion of the Jazbec Stream into Brdarčkova grapa was 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. 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. The results of radiological monitoring in 2021 are comparable with the results from previous years, which proves that the condition of the Jazbec mine tailings disposal site is stable after closure and that the safety functions achieved through the environmental rehabilitation of the area are being maintained.

6.4.3 Disposal of Radioactive Waste

In 2021, work on activities related to the preparation of the documentation necessary to obtain approvals and permissions for the LILW repository continued on the project documentation,

regarding which the revision of the project for obtaining a building permit was completed and the project for the implementation of the technical work required for the tender for the construction contractor for the LILW repository was prepared. Also, the work on other documentation was carried out, regarding which the final form for the Safety Report for the LILW repository and the environmental protection consent for the LILW repository were issued. In December 2021, the Government of the Republic of Slovenia decided to designate the LILW repository as a state infrastructure facility.

The preparation of the location for the LILW repository in Vrbina in Krško was regulated based on the National Spatial Plan. In 2020, the rights were acquired regarding most of the land, while in 2021, the conclusion of servitude contracts, which were not concluded in 2020, continued. In 2020, an agreement on the use of water land under the management of the Directorate of the Republic of Slovenia for Water for four plots of land was obtained, and in early 2021, the signature on the agreement on the use of water land was verified. The right to build regarding the lands managed by the Slovenian Water Agency was arranged.

Most of the required field research for the LILW repository has already been carried out in recent years. However, research data that will be used in the upgrading of the hydraulic, hydrological, and geological models of the wider area of the LILW repository site are still being obtained.

Work related to the preparation of project and other documentation, and consulting services in the field of design and construction continued; in September 2021, a supplement to the leading folder of the Project for obtaining a building permit (repository facilities and infrastructure facilities) and Project for construction were prepared and then submitted in final form in November 2021. In February 2021, a tender for the construction of the LILW repository for phase I was published, and in November 2021, a tender for phase II was published. In August 2021, the Minister of Infrastructure adopted a decision on the approval of the investment programme for the LILW repository in Vrbina, Krško (rev. E, July 2021), where the value of the investment was confirmed and approved and its inclusion in the plan of development programmes in the Republic of Slovenia was determined.

Activities related to the project for the preparation of safety analyses and waste acceptance criteria continued, and the Implementation Plan for 2021 was prepared and revised. 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 the safety analyses and the development of acceptance criteria continued for the phase of the acquisition of the building permit and the preparation of the Safety Report. At the end of 2021, discussions with the Krško NPP about the processes before LILW disposal and the criteria therefor, as well as the acceptance of waste from the Krško NPP, began. The safety report was being prepared in the years 2019, 2020, and 2021, and at the beginning of 2021 a positive opinion from the authorised nuclear and radiation safety expert on the Safety Report and on the Project Bases for the construction phase was obtained. The completed final Safety Report with all reference documentation was submitted to the SNSA in November 2021.

In 2021, work on cross-border assessment activities continued. Answers to Croatia's additional questions, coordinated with the SNSA, were prepared in February 2021 and forwarded to Croatia in March. In May 2021, the Ministry of the Environment and Spatial Planning (MESP) received a letter from Croatia for an additional explanation regarding the location for preparation of waste for disposal. In June 2021, the MESP informed the Environmental Agency of the Republic of Slovenia of the completed cross-border assessment. At the beginning of 2021, some hearings and clarifications were announced as part of the process of obtaining environmental consent. The environmental consent was issued in June 2021, while the supplementary decision was issued in July 2021.

In February 2021, a tender for construction phase I of the LILW repository was publicly announced, at the end of May 2021 a decision on the published tender was made, which was followed by the State Audit Commission review process. A tender for construction phase II of the LILW repository was published in November 2021, a tender for the implementation of external quality control at the location of the LILW repository was published in March 2021. The contract with the selected contractor was signed in October 2021.

In July 2019, an application was submitted to the SNSA for the issuance of a construction permit. In 2020 and 2021, the documentation was intensively reviewed and updated. An expert in the area of the application of concrete, appointed by the SNSA, actively monitored the study of the production, suitability, and characteristics of the final concrete mixtures for the implementation of the secondary reinforced concrete lining of the LILW repository silo and participated in the review of the documentation for the issuance of construction consent, which related to concrete structures, the properties thereof, and processes affecting the long-term safety of the repository. The expert concluded its review in August 2021, when a final opinion was delivered. The SNSA completed the review of the completed documentation and the complete application for issuing an opinion on construction towards the end of the year, while the opinion had not yet been issued by the end of 2021.

Reference: [18]

6.5 REMEDIATION OF THE ŽIROVSKI VRH URANIUM MINE

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 buildings.

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, 2021 was the eleventh year (the sixth additional year) of the transitional period of long-term management.

In 2021, 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. The maintenance work, sampling, analyses and measurements for which the RŽV is equipped, and its staff trained for, were carried out in full. All environmental impact controls, occupational health and safety measures, ionising radiation protection measures, Boršt landfill management, and tasks to ensure that the company carries out all its necessary tasks were carried out. 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 and 2017, additional measures were taken to increase the stability of the disposal site, related to groundwater dewatering. A total of 1,796.5 m of drainage wells were drilled and 1,342.5 m of these wells were piped.

In 2021, 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 at the point where the drainage tunnel passes through the landslide. Due to the ground rising, the wooden floor between the 195 m and 210 m stations was rehabilitated again. In March 2021, a new automatic extensiometer was added to the existing mechanical extensiometer. It enables a visual readout of the displacement value, which takes displacement measurements on a continuous basis and also records the date and time of the measurement. The extensiometer sends the data via SMS to a database accessible online. Drainage well outflows were monitored by manual measurements and by continuous flow meters.

Monitoring the stability of the Boršt disposal site is an important task of the transitional period as well as for the long-term period ensuring timely action in the event of need. 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 GPS (Global Positioning System) at the Boršt disposal site will be achieved. The advantage of the precision surveying is high accuracy, while the GPS has the advantage of enabling the continuous monitoring of movements and thus has the ability to determine the impact of extreme events on the lansdslide's stability.

Until 2018, there was only one point on the surface of the deposited hydrometallurgical tailings in the Plaz network. In order to monitor disposal movements in more detail, it was decided in 2018, on the proposal of the Expert Project Council, to add additional points on the disposal site, which were included in the Vrtine-2 network. The results of the measurements show that all points of the network, with the exception of three points in the eastern part of the disposal site outside the landslide, moved significantly. The directions and magnitudes of the movements were expected and are 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. With the shift of the Boršt Gorenja Weather Station to the top plateau of the landfill, the GPS system computer equipment was moved to the new location of the weather station and all three system checkpoints were preserved. The measured horizontal movement for the period from March 2020 to April 2021 is 16.2 mm (II-GPS). The vertical movement (settlement) in the same period was measured at point II-GPS and was 7.9 mm. As part of technical monitoring, "Precise geodetic measurements of the stability of the Boršt disposal site" were carried out in April 2021 in the Plaz geodetic network, which connects the Boršt disposal site with the wider surroundings, and in the Vrtine-2 geodetic network, which connects checkpoints along the 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 are maintaining 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 southwest 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.

A revision of the Safety Analysis Report for the Boršt disposal site without Chapter 1, which relates to the scope of the national infrastructure object and the ownership of the plots, was carried out. In addition, the expert opinion on the Safety Analysis Report was prepared. The Safety Analysis Report for the Boršt hydrometallurgical tailings disposal site is the basic document for its closure and the transition to long-term monitoring 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

6.6.1 Fulfilment of Legislative and Contractual Obligations and Proceeds from the Contributions for Decommissioning

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* (Official Gazette of RS, Nos. 47/03 – UPB and 68/08). It was established under a special law as a "*sui generis*" fund.

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.

As of 31 December 2021, the Fund's financial portfolio in securities (the book value) amounted to EUR 220,858,564, EUR 8,623,086 more than in 2020.[3] Considering that the unallocated funds in the bank account amounted to EUR 2,826 accrued interest to EUR 36,444, and interest purchased and claims to dividends to EUR 1,183,913, the Fund's portfolio as of 31 December 2021 amounted to EUR 222,081,747.

On 14 July 2020, the Interstate Commission confirmed the third revision of the Programme for the Decommissioning of the Krško NPP and the third revision of the Programme for the Disposal of LILW and High-Level Waste of the Krško NPP. Based on both programmes, on 23 July 2020, the Government of the Republic of Slovenia adopted the decision that the company GEN Energija, d.o.o., has to contribute EUR 0.0048 to the Fund for each kWh of electricity generated at the Krško NPP, starting from 1 August 2020.

In 2021, GEN energija, d.o.o., paid 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 0.0048 per kWh of electrical energy produced in the Krško NPP and sold in Slovenia. The Slovenian and Croatian shareholders – GEN energija, d.o.o., and Hrvatska elektroprivreda – each take over one half of the electricity generated by the Krško NPP; therefore, the calculation of the contributions is carried out based on calculating half of the electricity generated by the Krško NPP[4].

In 2021, the company GEN energija, d.o.o., paid a total of EUR 12.9 million for its decommissioning contributions into the Fund, thereby fully settling all of its liabilities to the Fund deriving from decommissioning contributions and within the agreed deadlines. From 1995 to 2021, the Fund received a total of EUR 226.7 million from the Krško NPP[5] and GEN energija, d.o.o.

Payment contributions in the preceding years:

- in 2020: EUR 10.9 million; average contribution EUR 3.6 per MWh (until September the contribution was EUR 3.0 per MWh, afterwards EUR 4.8 per MWh),
- in 2021: EUR 12.9 million; contribution: EUR 4.8 per MWh,

[3] The book value does not include unallocated funds in the bank account, accrued interest, interest purchased, and claims to dividends.

[4] On 13 January 2022, the Government of the Republic of Slovenia adopted the decision that GEN Energija, d.o.o., has to contribute EUR 0.012 to the Fund for each kWh of electricity generated at the Krško NPP, starting from 1 January 2022.

[5] Until March 2003, the contributions to the Fund were paid by NEK d.o.o.

- in the period 1995–2021: EUR 226.7 million (on average EUR 8.4 million per year).

Financing of the ARAO's activities

The Fund co-finances the ARAO's activities based on the provisions of the Act on the Fund for Financing the Decommissioning of the Krško NPP and the Disposal of Radioactive Waste from the Krško NPP. The ARAO's activities are based on the ARAO's Working Programme, which is accepted by the ARAO Management Board and subsequently confirmed by the Government of the Republic of Slovenia. Payments are mostly related to activities for a planned repository for low and intermediate level radioactive waste, and in a small segment also to long-term strategies for handling radioactive waste and spent fuel management.

In 2021, the Fund paid a total of EUR 2.3 million for the ARAO's activities. From 1998 until the end of 2021, the Fund paid a total of EUR 48.5 million to the ARAO for activities implemented by the ARAO. This amount includes compensation totalling EUR 14.9 million, which was paid by the ARAO to the local Municipality of Krško. The realisation of payments to the ARAO in 2021 was only 14.12% of that planned. The ARAO planned to start the construction of the repository for low and intermediate level radioactive waste in Vrbina, but despite the efforts of all contracting parties, the construction of the facility did not start in 2021.

Compensation for the limited use of land in the nuclear facility area

Since 2004, the Fund has been liable for the payment of compensation for the limited use of land in the nuclear facility area to some of the local communities. Based on the amended legislation, which entered into force in 2015, the Fund is obliged to pay compensation for the limited use of land just to the Municipality of Krško. Before 2015, it was obliged to pay compensation also to the Municipalities of Kostanjevica na Krki, Brežice, Sevnica, and Kozje.

In 2021, the Fund paid EUR 5.9 million to the Municipality Krško as compensation for the limited use of land in the nuclear facility area. Between 2004 and 2021, the Fund paid a total of EUR 67.4 million to the municipalities eligible for compensation.

Payments to the ARAO and compensation for the limited use of land

In the period from 1995 to 2021, the total amount of transfers to municipalities and the ARAO amounted to EUR 115.9 million (the amounts paid to co-finance the activities of the ARAO and to municipalities as compensation for the limited use of land are not valorised). Payments made to the ARAO and municipalities accounted for 52.49% of the Fund's financial portfolio as of 31 December 2021, which amounted to EUR 220.9 million (book value). Figure 28 shows the sum of the book value of the financial portfolio and compensations paid in the period from 1995 to 2021.

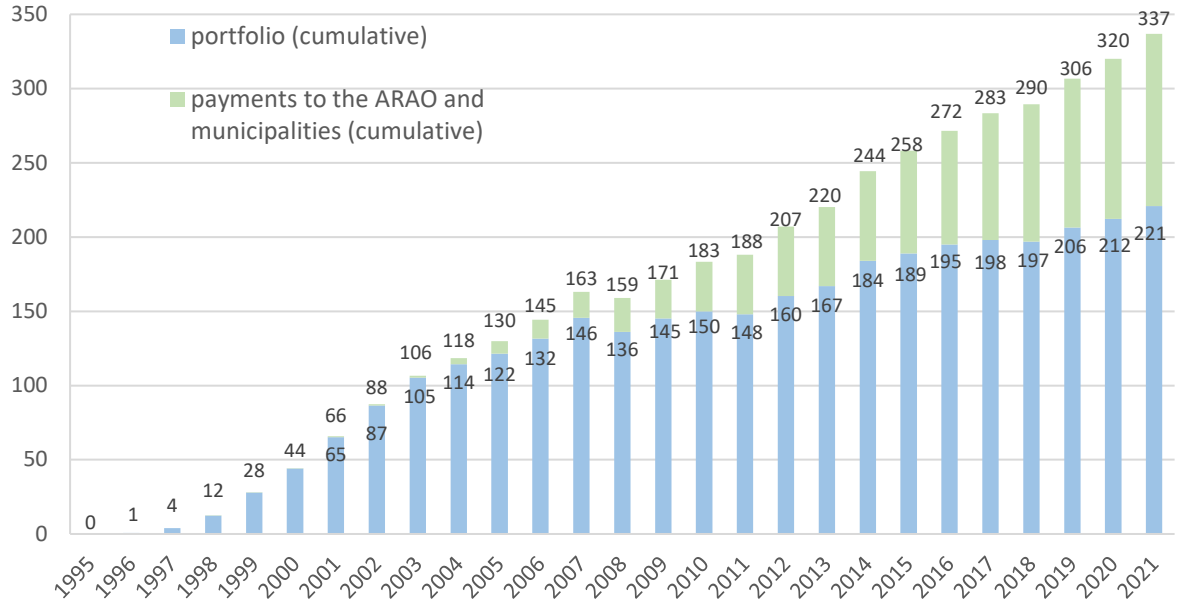

Figure 28: Presentation of the Fund's assets as of 31 December 2021 in EUR million

6.6.2 Investments and Business Operations in 2021

The Fund is defined as a conservative fund, whose financial portfolio consists of safe investments. At the end of the year, the financial portfolio consisted of more than 140 different investments in securities dispersed under individual asset classes, credit grades, regions, sectors and maturities, taking into account that only the bond of the Republic of Slovenia with maturity date in 2030, as an individual investment, exceeded 2% of the portfolio's value, whereas the ten largest investments of the Fund represented only 14.37% of the portfolio's value. In 2021, all investment activities were carried out in compliance with the Investment Policy of the Fund for 2021,[6] or in the framework of asset classes deriving from that policy.

In 2021, the Fund generated revenue of EUR 16.9 million, more than planned. The revenues from the contribution were 12.34% higher than in 2020, mostly due to the higher amount of the contribution per kWh. As was planned, the revenues from the contribution for decommissioning in 2021 amounted to EUR 12.9 million. The Fund generated revenue of EUR 4 million, slightly more than was planned. In 2021, the costs of the Fund reached EUR 8.9 million, among them the majority comprises payments to the ARAO and the Municipality Krško for compensation for the limited use of land in the nuclear facility area. In 2021, the Fund had a surplus of revenues over expenses in the amount of EUR 8 million.

Due to uncertainties and fluctuations on the markets, the Fund operated successfully also in 2021, with a yield of 2.07%, which is in the framework of the planned investment policy of the Fund for 2021. The year 2021 was still marked by the Covid-19 epidemic, and at the same time also inflationary pressures, which intensified uncertainties on the capital markets and led to extreme volatility and a decrease in yields on bond markets.

In 2021, the yield of the portfolio exceeded the yields of bond investments funds, which are in their structure similar to the Fund's operation and had an extremely negative yield in 2021. The

[6] The investment policy of the Fund for 2021 was accepted at the 35th correspondence session of the Fund's Management board and adopted by the Government of the Republic of Slovenia at its 63rd regular session on 11 March 2021.

yield of the portfolio is lower than was planned in the 3rd revision of the Programme for decommissioning. Mostly due to the significantly changed conditions on the capital markets.

Also in 2021, 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. In the future, the Fund will be devoting special attention to following and managing the various types of risks to which it is exposed in portfolio management. From a managerial point of view, a conservative investment policy and defined investment principles will be pursued.

Reference: [24]

7 EMERGENCY PREPAREDNESS

Emergency preparedness and response is an essential part of ensuring nuclear and radiation safety. During a nuclear or radiological emergency, all competent organisations and authorities in Slovenia must take appropriate actions according to their pre-prepared response instructions or emergency plans.

Nuclear and radiological accidents are emergencies that directly threaten the population and the environment and require that protective actions be taken. In general, every emergency does not entail the occurrence of an accident. Such can only be a degradation of nuclear or radiation safety, which also requires an appropriate response from the authorities.

In Slovenia, the response of the organisations and competent authorities to an emergency is determined by the *National Emergency Response Plan for Nuclear and Radiological Accidents*. The national plan is prepared by the Administration for Civil Protection and Disaster Relief (ACPDR) in cooperation with ministries, state authorities, and professional organisations. Plans are also prepared at regional, local, and facility levels. In accordance with the requirements of the *Ionising Radiation Protection and Nuclear Safety Act*, operators of radiation activities who are not required to prepare a protection and rescue plan must prepare instructions for a response in the event of an emergency. These response instructions are based on expected events and scenarios.

7.1 THE SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

At the SNSA, the responsibility for emergency preparedness and response falls under the Emergency Preparedness Division, whose basic tasks are:

- to provide all necessary competencies and means of the SNSA Emergency Response Team,
- to ensure that the Emergency Response Team's procedures are up to date and comprehensive, and
- to ensure that the equipment, premises, and documentation for the Emergency Response Team's needs are adequate and operational and that all members of the Team are properly trained for all their tasks during an emergency.

In the event of an emergency, the SNSA's Emergency Response Team (ERT) is activated, led by the Emergency Team Director (ETD). The operational management of the ERT is carried out by the head of the ERT, who is also the deputy of the ETD. The ERT consists of incoming and outgoing communicators, who communicate with external organisations, three expert groups (the Nuclear Accident Analysis Expert Group (NAAEG), the Dose Assessment Expert Group (DAEG), and the Cyber Security Expert Group (CSEG)) and technical support, a representative of the NPP off-site centre, a representative of the CP Headquarters, and a representative of the Inter-ministerial Operational Group. The CSEG was included in the ERT in 2021 to facilitate the need for expert support in the event of emergencies caused by a cyber-attack. The CSEG's task is to connect key domestic and foreign stakeholders, namely managers of nuclear facilities, industry, transport, suppliers of computer equipment, the administrative authority for information security, and technical support organisations, cooperation with the NAAEG and the DAEG, and informing and advising ETD. The full composition of the ERT now has 21 members (previously 19), and members work in two shifts.

The SNSA's ability to respond in the event of an emergency is ensured through regular training of ERT members, regular maintenance and checking of the operation of software and other

equipment, regular reviews of all relevant organisational procedures and instructions, participation in international activities, and testing the preparedness and response system by means of domestic and international exercises.

As the tasks during an emergency differ significantly from the regular work of SNSA employees, the training programmes of the SNSA Emergency Response Team members are very important. The Covid-19 epidemic influenced the implementation of training programmes and exercises at the SNSA also in 2021. From January to June 2021 and from November until the end of the year 2021, most of the SNSA staff was working from home, with the aim of significantly reducing the staff present at the SNSA headquarters. Most of the training programmes and exercises were adjusted to this situation and conducted remotely using various on-line solutions or were conducted in small groups. The SNSA Emergency Response Team members also attended many IAEA webinars and on-line workshops on emergency preparedness and response. Therefore, in 2021, the SNSA conducted 120 individual and group training courses, tests, and exercises, totalling 396.5 hours. The SNSA participated in the regular annual exercise of the Krško NPP in spring 2021. It was carried out in two iterations due to the situation with Covid-19, as this was the only way to ensure the epidemiological recommendations to prevent the spread of the Covid-19 disease and to comply with the measures valid at the time of the exercise. The SNSA also participated in several international IAEA exercises: ConvEx-2a, 2b, and ConvEx-3. The largest of these was the ConvEx-3 exercise, which was also an exercise of the European Commission – ECUREX 2021. It took place continuously for two days and involved the scenario of a nuclear accident at the Barakah nuclear power plant, in the United Arab Emirates. The purpose of the exercise was to test the international procedures in the field of emergency preparedness and response, including the exchange of information between countries, public information, assessment, and prognosis procedures, and lastly also requesting and offering international assistance. This was the first exercise in history where a selected team of experts was actually sent to the field as part of the verification of international assistance procedures.

Due to the measures taken during the Covid-19 epidemic, several exercises were cancelled in 2021, including the national exercise on preparedness for a nuclear accident at the Krško NPP and the regular annual emergency exercise of the Krško NPP in the autumn.

Despite the epidemic, the SNSA regularly cooperated with other organisations in the country and abroad in the area of emergency preparedness. In this manner, i.e. the transfer of lessons learned and good practices, its preparedness constantly improves. One of the key tasks that the SNSA carried out in 2021, in cooperation with other organisations participating in the response system in the event of a nuclear and radiological accident, was the development of the *Protection Strategy for a nuclear and radiological accident*, which was adopted by the Government of the Republic of Slovenia in July 2021. The protection strategy is a key document that provides guidelines for the adoption of protective actions in the event of a nuclear and radiological accident in Slovenia or a nuclear accident abroad. It is also a strategic document and the basis for the implementation of the renewal of the existing national plan. It was developed based on the international recommendations of the ICRP and IAEA standards, considering regulations in the field of radiation protection, the Hazard Assessment in the event of a nuclear and radiological accident in the Republic of Slovenia, and the Risk Assessment for nuclear and radiological accidents in Slovenia. The stated strategy is also one of the key tasks of the Action Plan for the implementation of the recommendations and suggestions of the international EPREV review mission (Emergency Preparedness Review Mission), carried out in 2017 under the auspices of the IAEA, which will check progress in this area at the EPREV follow-up mission in autumn 2022.

7.2 ADMINISTRATION OF THE REPUBLIC OF SLOVENIA FOR CIVIL PROTECTION AND DISASTER RELIEF

In 2021, the ACPDR maintained and ensured preparedness and developed procedures for an effective response to nuclear and radiological emergencies, in accordance with its statutory powers. The ACPDR also carried out tasks from the Action Plan after the EPREV mission and preparations for the renewal of the National Emergency Response Plans.

As the organisation responsible for the tasks from the action plan, the ACPDR prepared a proposal for a supplementary training programme in the event of a nuclear or radiological accident, which will be intended for those performing tasks immediately before such an accident. The ACPDR also participated in the coordination of the *Protection Strategy in the event of a nuclear and radiological accident in the Republic of Slovenia*, which was adopted in 2021, the preparation and coordination of the Procedures for decontamination and Arrangements for the termination of a nuclear and radiological emergency. Work was also carried out on the renewal of the *National Emergency Response Plan for Nuclear and Radiological Accidents*, to which the contents of Articles 10a and 10b of the Decree on the Content and Elaboration of Protection and Rescue Plans will be added (Official Gazette of the Republic of Slovenia, Nos. 24/12, 78/16, and 26/19), solutions from the *Protection Strategy in the event of a nuclear and radiological accident* and the Arrangements for the termination of a nuclear and radiological emergency.

The ACPDR was actively involved in the preparations for the EPREV follow-up review mission, which will take place in Slovenia in October 2022. As part of the preparations, in cooperation with the SNSA, it determined the organisations and ministries that are to participate in the mission, informed them of the mission and invited them to participate. Activities were also carried out in the field of providing the preliminary distribution of potassium iodide tablets to the inhabitants of Posavje. The ACPDR continues to maintain a website where the public can obtain more information on iodide tablets, the iodine thyroid blocking protective action, and preliminary distribution.

In 2021, the ACPDR participated in international ConvEx exercises (2a, 2b, and 3). All envisaged nuclear and radiological accidents, where the Republic of Slovenia tested the system of information exchange and the provision of international assistance through the *Response and Assistance Network* (RANET) and the *Unified System for Information Exchange in Incidents and Emergencies* (USIE). The planned national exercise on the topic of preparedness for a nuclear accident at the Krško NPP was not carried out in 2021 due to the Covid-19 epidemic. The exercise was postponed until 2022, in accordance with the *Exercise Plan of the defence system and the system of protection against natural and other disasters in 2022*, which was adopted by the Government of the Republic of Slovenia by agreement No. 84300-1/2022/4 on 27 January 2022.

7.3 THE KRŠKO NPP

In 2021, the activities of the Krško NPP in the area of preparedness for emergencies included the following:

- training and drills,
- maintenance of support centres, equipment, and communications,
- updating of the document "The 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 (13 persons passed the initial training for Emergency Response Team members).

In 2021, the Krško NPP conducted a series of training courses with a total of 1,475 participants from the Krško NPP and 282 participants from supporting organisations. Due to the epidemiological situation in Slovenia, only the spring emergency exercise was performed in 2021, while the autumn emergency exercise, scheduled for November, was not conducted. In total, emergency staff consists of 426 persons. In December 2021, the construction of the new Operational Support Centre was completed in the Krško NPP as part of the Safety Upgrade Programme (SUP).

Furthermore, in 2021 the staff of the Krško NPP actively cooperated with the planners and providers of protection and rescue services at the local and national level, as well as with the administrative authorities, namely the SNSA and the ACPDR.

References: [1], [24]

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 the legal requirements, provide for the continuous improvement of nuclear and radiation safety, and closely follow developments in the international arena.

Measures for achieving the goal:

- Operators and providers of radiation practices maintain a high level of radiation and nuclear safety and also safety culture.
- State bodies monitor and encourage if needed the measures proposed by operators and providers of radiation practices aimed at improving nuclear safety.
- State bodies actively encourage research, education, and training at the national and international arena.

Realisation in 2021:

The Safety Upgrade Programme, which was designed after the accident at the Fukushima NPP, has been concluded. In 2021, the third and final phase of the programme took place. The main works included the design and start of construction of key additional safety systems and a dry spent fuel storage facility. The 3rd periodic safety review started, which will be especially important for the extension of the Krško NPP's operation.

Complying with the legal requirements, conducting inspections of applications for safety upgrades and issuing permits, and continuously checking and improving the level of nuclear safety in all nuclear and radiation facilities and activities in Slovenia are the main priorities in this area.

Security concerns are implemented on several levels and in different activities. The facilities ensure the continuous improvement of the project, proper and quality maintenance, and the inspection of equipment, the use of operational experiences, the quality training of employees and similar. The administrative body, in accordance with the legislation, which is constantly tested and improved as regards the effectiveness of control, monitors the operation of facilities. Based on the findings or possible deviations, improvement measures are planned and implemented.

The operators of nuclear facilities were facing challenges caused by the epidemic in 2021 as well. Those challenges were successfully resolved without any influence on or threat to nuclear safety.

Activities in the areas of research, education, and training are described in the description of Goal 12.

Objectives of International Cooperation

Goal 2

In principle, the Republic of Slovenia joins international conventions, agreements, contracts, or other types of cooperation that enable the quick and equal exchange of information or mutual assistance to ensure nuclear and

radiation safety and reduce risks for people and the environment both on the territory of the Republic of Slovenia and elsewhere.

Slovenian state authorities and other organisations in the field of nuclear and radiation safety and physical protection join international associations based on the needs and benefits they can derive from such membership. This type of association must contribute to the maintenance of nuclear and radiation safety in Slovenia at a comparable international level.

International cooperation must be encouraged and maintained in all areas of nuclear and radiation safety, including in science and education.

The Republic of Slovenia or Slovenian state authorities and other organisations in the field of nuclear and radiation conclude bilateral agreements on cooperation in the field of nuclear and radiation safety, if in this way they make it easier to achieve the set goals. Such agreements are especially important if they enable Slovenia to have quick access to information in the event of a radiological accident on the territory of another country.

Measures for achieving the goal:

- Slovenian organisations actively monitor and, if necessary, join international associations.
- Competent organisations regularly report in accordance with the commitments of international agreements.
- Representatives of the Republic of Slovenia monitor developments in the international arena and, if necessary, initiate procedures for the accession of Slovenia to any new or amended international agreements.
- Slovenian state authorities maintain existing bilateral agreements and, if necessary, conclude new ones.

Realisation in 2021:

Slovenian authorities and other organisations in the field of nuclear and radiation safety and physical protection attempted, despite the epidemic, to be actively involved in international associations in line with the needs and benefits of membership in organisations such as the WENRA, the ENSRA, and the HERCA, as well as in the working groups thereof. They also participated in the Euratom – Fission Research Programme Comitology Committee and followed the work of the consultative Committee of the Instrument for Nuclear Safety Cooperation. In 2021, such cooperation was limited to online meetings with all the advantages and drawbacks thereof.

Regarding the Horizon Europe research programme, Slovenian representatives are involved in the preparation of the Euratom Research Programme, namely of the so-called "work programmes" within the committee covering fission and fusion.

The Republic of Slovenia or its national authorities and other organisations in the field of nuclear and radiation safety and physical protection conclude bilateral cooperation agreements in order to achieve their goals and ensure a high level of nuclear and radiation safety. Such agreements enable Slovenia to quickly exchange information during potential radiological emergencies in other countries and also to gain other information during regular meetings. In 2021, the planned bilateral activities were either cancelled or postponed, except for the bilateral meeting with Austria, which was held in person in Ljubljana, as well as the meeting with Croatia, which took place virtually. In addition, everything necessary was prepared for signing the Memorandum of Understanding between the SNSA and the Moroccan administrative authority, but the signing has not yet taken place as we await an opportunity of a physical meeting of the heads of both administrative bodies.

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.

Measures for achieving the goal:

- Representatives of the Republic of Slovenia actively participate in meetings of EU working bodies.
- The state actively supports and co-finances the participation of Slovenian researchers in research projects of the European Commission (Euratom).

Realisation in 2021:

The Republic of Slovenia was active, within the restrictions imposed to limit physical meetings, in the Working Party on Atomic Questions of the Council of the EU and in the group established by Article 31 of the Euratom Treaty and followed the work of the groups established by Articles 35, 36, and 37 of the Euratom Treaty. The Slovenian representatives attended the ENSREG autumn and spring plenaries virtually, as well as the ENSREG Working Groups meetings. They also actively cooperated in the implementation of assistance to third countries, which is financed by the European Commission. In 2021, the SNSA, together with the consortium, was successful in a call for assistance to the Belarus regulatory body, whose fate is highly uncertain in 2022. Remark: This project was cancelled by the EC in autumn 2022.

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.

Measures for achieving the goal:

- The Republic of Slovenia regularly pays the IAEA membership fee and a voluntary contribution for technical assistance in the amount proposed by the IAEA secretariat each year.
- Considering the financial possibilities, Slovenia is increasing its financial aid for aid projects to third countries.
- Organisations and individuals from the Republic of Slovenia compete for the implementation of technical assistance projects and implement them mainly in the countries of the Western Balkans and the Mediterranean, as well as in other areas of the world where Slovenian experience can contribute to development.
- Organisations and individuals in the Republic of Slovenia organise work meetings, workshops, courses, seminars, and similar events with international participation.

- Organisations in the Republic of Slovenia accept candidates from other countries for training.
- Organisations from the Republic of Slovenia apply for technical cooperation projects with the IAEA in areas where they do not have fully developed capacities.
- Slovenian experts participate in international missions in other countries.
- At intervals of three to five years, the Krško Nuclear Power Plant invites the international group OSART or WANO, which checks all aspects of its operation.
- The Slovenian Nuclear Safety Administration invites the IRRS international group to review its work at intervals of no more than 10 years.
- The Ministry of the Interior invites the international IPPAS group to review measures for the physical protection of nuclear facilities and activities at intervals of no more than 10 years.
- If necessary, the Republic of Slovenia invites international groups from individual fields of activity.

Realisation in 2021:

Slovenia regularly pays the IAEA its share to the regular budget as well as contributions to the technical cooperation fund, resulting in the stable financing of the IAEA and its undisturbed project implementation.

In the area of technical cooperation, Slovenia supported the implementation of projects that showed significant development potential, particularly in the countries in its geographical vicinity and in the countries with similar programmes or technologies, mostly in the areas where the Slovenian experts were able to offer assistance. In 2021, the technical cooperation programme cycle 2020–2021 was completed, in which Slovenia received guaranteed funding for a joint SNSA and ARAO national project, but its implementation was severely hampered by the epidemic and a significant number of resources were redistributed from the training programme to the purchase of equipment. For the new 2022–2023 cycle, four projects were approved in November, namely the joint SNSA and ARAO project, the Nuclear Medicine Clinic project, and the Biotechnical Faculty project, which have guaranteed funding, while the JSI project is still awaiting funding.

In 2021, Slovenian experts did not participate in IAEA IPPAS missions. This year, there were no prior activities within the 10-year goal and cycle of such missions in Slovenia. The latter shall be pursued more actively in the next few years.

The SNSA will also continue to encourage and provide the assistance of Slovenian experts to third countries, as organised by the IAEA, and will also train IAEA fellows, organise IAEA courses and workshops, and invite international expert missions to review and assess the Slovenian nuclear facilities and institutions in order to receive an independent assessment of the domestic capabilities. Therefore, in 2021, Slovenia invited the mission to verify the implementation of the findings of the EPREV Action Plan, which will take place in October 2022. In 2021, there were intense preparations for two missions, i.e. those of the IRRS (a review of the administrative framework and both administrative authorities) and ARTEMIS (a review of the national RAW and spent fuel management programme), which will be carried out under the coordination of the IAEA in April and May 2022.

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 committees, the NEA Data Bank and subcommittees important for ensuring a high level of nuclear and radiation safety.

Measures for achieving the goal:

- The Republic of Slovenia regularly pays membership fees to the NEA and the Data Bank.
- Slovenian representatives actively participate in the meetings of OECD/NEA committees and selected subcommittees and, based on the results of the meetings, propose improvements in the country.
- The state actively supports and co-finances the participation of Slovenian researchers in OECD/NEA research projects.

Realisation in 2021:

The financial obligations towards the NEA were settled on time. The Slovenian representatives are actively involved in the work of the 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 nuclear research and science. In 2021, all meetings were held virtually.

Goal 6

As Slovenia does not have any intention to pursue the 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.

Measures for achieving the goal:

- All organisations in the Republic of Slovenia fully support the work of international inspectors in the field of safeguarding nuclear materials (safeguards).
- Slovenian representatives monitor the work of international organisations related to the non-proliferation of nuclear weapons and dual-use goods and attend meetings within the framework of personnel and financial capacities.

Realisation in 2021:

Slovenia is committed to its obligations regarding safeguards, supports the work of 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 on its human and financial resources as well as its priorities, Slovenia contributes to the global endeavours towards nuclear non-proliferation and nuclear security. Chapter 9.3 describes in detail the objectives achieved.

Legislative Objectives

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.

Measures for achieving the goal:

- The state bodies referred to in subchapter 6.1 of the Resolution regularly monitor international developments in the field of nuclear and radiation safety, compare them with domestic legislation, and, if necessary, propose changes thereto.

Realisation in 2021:

In the field of nuclear and radiation safety, the SNSA strives to transpose the acquis Communautaire (directives) into the legal system of the Republic of Slovenia on an ongoing and timely basis, to harmonise domestic regulations with adopted WENRA standards, and to fulfil commitments under all of the important international treaties to which it is party. Also in 2021, the work done in this area was to a large extent conditioned by the efforts to harmonise domestic legislation with international developments and best practices, and above all by the already established international commitments and standards. Chapter 8.3 describes the achieved goals in detail.

Institutional Framework Objectives

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.

Measures for achieving the goal:

- The regulation of administrative control of radiation protection and nuclear safety will be adjusted in terms of status and organisation for the sake of optimal regulation for the efficient and expedient performance of administrative, development, or professional tasks in this segment of state jurisdiction. The adjustments will relieve the state budget and achieve the financial stability of the administrative body, more economical operations and the elimination of administrative obstacles, independence from influence on decision-making on administrative matters, and effective personnel and financial flexibility.

Realisation in 2021:

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 2021, as there was no need for it. However, with the amendment to the *Ionising Radiation Protection and Nuclear Safety Act* (ZVISJV-1B, Official Gazette of the RS, No. 172/21), which entered into force in mid November 2021, the competence to supervise the operations of the operator of the mandatory state economic public service for the management of radioactive waste changed, which means that it was transferred from the previous Ministry of Infrastructure to the MESP. This, of course, means that even with such a changed jurisdiction, the complete independence of the administrative functions of the SNSA over the ARAO must be guaranteed.

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.

Measures to achieve the goal:

- By promoting and financing of directed development tasks, it is ensured that authorised experts cover all areas of nuclear and radiation safety. Their independence from the operators of nuclear and radiation facilities or providers of radiation practices is thus ensured.

Realisation in 2021:

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 Ionising Radiation Protection and Nuclear Safety Act 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 2021, 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 2021 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 regarding the realisation of Goal 12.

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.

Measures to achieve the goal:

- The Inter-ministerial Commission for monitoring the implementation of the National Emergency Response Plan for Nuclear and Radiological Accidents coordinates the actions of the responsible state bodies.
- The response system is regularly tested through emergency exercises.

Realisation in 2021:

In August 2021, the Government of the Republic of Slovenia adopted a Decision on amending the decision on the appointment of the Inter-ministerial Commission for monitoring the implementation of the National Emergency Response Plan for Nuclear and Radiological Accidents, but the Inter-ministerial Commission did not meet in 2021. Work on the renewal of emergency response plans for a nuclear and radiological accident was carried out in accordance with the Action Plan following the EPREV mission (See Chapter 7).

In 2021, despite the continuation of the Covid-19 epidemic and based on the activities summarised above (Chapter 7), emergency preparedness and response were appropriately addressed by the regulatory body responsible for nuclear safety and by the regulatory body responsible for protection against natural and other disasters, as well as by other entities involved in an emergency response. In addition, the response system for nuclear and radiation safety was regularly tested in domestic and international exercises.

Objectives in the Field of Competencies and Professional Support

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.

Measures to achieve the goal:

- Slovenian educational institutions provide appropriate study programmes, with the state financially supporting those internationally comparable and recognised.
- Operators of radiation and nuclear facilities, contractors of radiation practices, and the national authorities responsible for nuclear and radiation safety support and participate in educational programmes in the fields of physics, reactor engineering, nuclear safety, control of severe accidents due to core meltdown, technologies, nuclear decommissioning, and radioactive waste management.

Realisation in 2021:

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 carried out. In the school year 2021-22, three students enrolled in the programme, who, together with eight students in the second year and six foreign students, are attending six 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 2021, one graduate finished a master's degree in nuclear engineering. The study programme was carried out by teachers who are members of the JSI, 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.

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*). In the 2020 school year, four students enrolled in the second year of the nuclear engineering master's programme in Ljubljana. In 2021, two students received their master's degree from the Nuclear Engineering programme in Ljubljana, and two from the Finnish Lappeenranta University of Technology, and their master's degrees were also recognised by the University of Ljubljana. In 2020-21, there were six foreign students in the second year of the SARENA programme in Ljubljana. The change also has a positive effect on domestic students. In the school years 2020 to 2023, four professional subjects will be taught in English each year in the third semester, which are part of the nuclear engineering programme and part of the SARENA international nuclear engineering programme.

Currently, there are 10 students in the "mathematics and physics" doctoral programme within the nuclear engineering module; in 2021 one student enrolled in the first year. In 2021, two students finished PhD studies. Two foreign students abandoned their PhD studies during the epidemic.

We assess that in the current circumstances in Slovenia the scope of studies and the number of students provide an approximately 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.

Measures to achieve the goal:

- The country actively supports and co-finances the participation of Slovenian scientific and research organisations in international research projects and programmes under the auspices of the EU, OECD/NEA, USNRC, and similar recognised organisations.
- Research programmes financed from the state budget or other sources enable basic research in the field of nuclear and radiation safety.
- Funds collected from the operators of nuclear and radiation facilities and augmented by means of the state budget enable applied research and development in support of resolving the ongoing challenges in the field of nuclear and radiation safety in the economy. The SNSA, in cooperation with the users, set up a programme of research and development.
- It is necessary to motivate research organisations to participate in applied research for the economy.

Realisation in 2021

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 research studies from the Slovenian Research Agency (SRA) in 2021 was slightly less than EUR 2.7 million. Since the average cost of one expert, 1 FTE (FTE – Full Time Equivalent), is approximately EUR 75,000 per year, the amount represents sufficient funding for around 37 experts. The total amount for applied projects, research studies, and the legal obligations under the ZVISJV-1 in 2021 was EUR 11 million.

Funding for research activities, especially in the field of applied projects, is largely left to the needs of individual stakeholders (operators of nuclear facilities, investors, public institutions, the regulatory authority, etc.) and market forces in ordering such services. To ensure equal and sufficient coverage of all areas of nuclear and radiation safety in the country, it would make sense to prepare a broader research and development strategy in the field of nuclear safety, which would be the basis for selecting research areas in SRA tenders and a reference point for concluding a director's service contract for the developmental needs of individual clients.

The SNSA adopted the Research and Development Strategy at the SNSA in 2020, but unfortunately, the funds of the SNSA intended for financing development tasks are very limited. In 2021, the SNSA ordered 4 research and development projects with a total amount of EUR 86,400.

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.

Measures to achieve the objectives:

- The Krško NPP is to store LILW in the existing storage facility and use already established methods of storage and waste acceptance criteria, modified procedures for optimising the radioactive waste management and procedures for reducing the volume of already generated waste and using space for manipulation equipment and shipments of radioactive cargoes between the auxiliary building and the interim LILW storage facility – permanently until the removal of the LILW from the location.
- The construction of a facility for manipulation equipment and radioactive waste shipments between the auxiliary building and the interim LILW storage in the Krško NPP by 2016.
- Waste conditioning for the disposal of LILW from the Krško NPP and LILW from other holders during the operation of the repository (envisaged between 2020 and 2025, or in 2028 in the case of the extended scenario for disposal) may also be implemented by the Krško NPP on behalf of the Service of General Economic Interest (SGEI) provider of radioactive waste management.
- The operator of the TRIGA Research Reactor is to manage the radioactive materials generated during the operation of the research reactor in accordance with the established procedures for collection, sorting, separation, clearance, and temporary storage in the hot cell facility and the release of waste to the SGEI provider of radioactive waste management for the purpose of storing waste at the CSF and its final permanent disposal.

Realisation in 2021:

The radioactive waste at the Krško NPP, the TRIGA Mark II Research Reactor, and the CSRW 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, a Waste Manipulation Building in the Krško NPP was constructed and equipped. Preparation for the disposal of LILW is planned later.

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.

Measures to achieve the objectives:

- Radiation sources are to be primarily returned to suppliers or manufacturers. Should this not be possible, they are to be transferred to the mandatory SGEI provider of radioactive waste management for appropriate treatment, conditioning, and storage in the CSF – permanently.
- The CSF operator is to arrange for a Periodic Safety Review, and the renewal and extension of the operating license of the CSF for another 10 years, before the end of 2018.
- The state is to ensure conditions for the regular SGEI provision of radioactive waste management from take over and transport to treatment, storage, and disposal – permanently.

Strategy 3

Users of sealed radiation sources will, as a rule, return 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.

Measures to achieve the objectives:

- Sealed radiation sources are to be returned primarily to suppliers or manufacturers. Failing that, they are to be delivered to the SGEI provider of radioactive waste management for storage in the CSF – permanently.
- Solid radioactive waste is to be stored primarily in storage rooms until reaching unconditional or conditional clearance levels. Failing that, it is to be handed over to the SGEI provider of radioactive waste management for storage in the CSF – permanently.
- The dilution and dispersion of transitional liquid radioactive waste and discharges of radioactive effluent into the sewerage system are to be in accordance with the authorised limits for release into the environment – permanently.

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.

Measures to achieve the objectives:

- The Government is to ensure the conditions for the regular operation of the intergovernmental commission as a body for monitoring the implementation of the Bilateral Slovenian-Croatian Agreement on the Krško NPP with a view to seeking safe, effective, and economical joint solutions – permanently.
- LILW acceptance criteria are to be determined by 2017.
- A building permit for the repository shall be obtained by the end of 2017.

- The revision of the investment programme for the construction and operation of the LILW repository, in which it will be necessary to re-examine the volume of radioactive waste to be disposed of and the relationship between the various funders. A building permit shall be obtained by the end of 2017.
- The repository is to be constructed between 2017 and 2019.
- Trial operation of the repository in 2020 and 2021.
- The storage of radioactive waste from small producers at the LILW repository site, provided that the feasibility study regarding the further operation of the CSF in 2024 shows that this is the most appropriate solution – with the disposal of waste to commence in 2025.

BASELINE SCENARIO (without an agreement with the Republic of Croatia)

- Regular operation of the repository in the period between 2022 and 2025, during which the repository is to accommodate half of all LILW from the Krško NPP and the waste from the CSF.
- The temporary standby period of the repository until 2050, during which the operational storage of LILW in the Krško NPP and the CSF, or at the LILW repository site, will be carried out appropriately and when required (in accordance with the results of the eligibility study concerning the further operation of the CSF under Strategy 8).
- In 2050, the repository restart of operations is planned to accommodate the remaining radioactive waste from the NPP, the CSF, and from the decommissioning of the TRIGA Research Reactor.
- The repository is to operate until 2061.
- According to the analysis results of the need for further disposal, the operation of the repository is to continue after 2061, otherwise the repository will be closed down in 2062, and long-term monitoring and maintenance will begin.

EXTENDED SCENARIO (with an agreement with the Republic of Croatia by 2023)

- The temporary standby period of the repository until 2050 – radioactive waste generated from the operation of the Krško NPP is to be stored in the Krško NPP.
- The construction of a second silo in the period between 2049 and 2050.
- The restart of the operations of the repository in the period between 2051 and 2061, during which the second half of the radioactive waste from the operation and decommissioning of the Krško NPP is to be disposed of, as well as the radioactive waste from small producers and the radioactive waste from the decommissioning of the TRIGA Research Reactor.
- According to the analysis results regarding the need for further disposal, the operation of the repository is to continue after 2062, with the possibility of constructing additional silos, otherwise the repository is to be shut down in 2062 and long-term monitoring and maintenance will begin.

Realisation in 2021:

The Interstate Commission operates and regularly monitors the implementation of the BHRNEK interstate agreement and issues decisions for effective and safe solutions for the management of radioactive waste and spent fuel. The acceptance criteria for disposal were prepared in 2017 and approved by the SNSA within the framework of issuing an opinion on construction. The building permit had not yet been issued by the end of 2021. In August 2021, the investment programme for

the LILW Vrbina repository, Krško, was approved, revision E, July 2021. The construction and goals that follow the construction are planned later. Other options for preparing waste for disposal are being sought. Details are available in Chapter 6.4.3.

Strategy 5

Spent fuel from the Krško NPP is to be stored in the spent fuel pool and in 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.

Measures to achieve the objectives:

- The Government is to ensure conditions for the regular operation of the intergovernmental commission as a body for monitoring the implementation of the Bilateral Slovenian-Croatian Agreement on the Krško NPP with a view to seeking safe, effective, and economical joint solutions – permanently.
- The Krško NPP is to construct a dry storage facility for spent fuel at the Krško NPP site for an operational life of 60 years with the possibility of extending its operation. The dry storage facility is envisaged to become operational by 2018.
- The Krško NPP, as the holder of spent fuel, is to carry out an analysis of the possibilities, safety, and economic feasibility of spent fuel reprocessing.
- The SGEI provider of radioactive waste management, research institutions, and authorised radiation protection experts are to monitor international developments regarding spent fuel and HLW management – permanently.
- The national spatial plan determining the location of the spent fuel and HLW repository is to be adopted by 2055.
- The spent fuel and HLW repository is to be constructed in the period between 2055 and 2065.
- The commissioning of the spent fuel repository is to start in 2065.
- The closure of the repository and the commencement of the regulatory control and maintenance of the repository is to begin after 2075.

Realisation in 2021:

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. In 2020, the MOP issued a building permit for the facility. In 2021, the main focus was on the approval of the safety-relevant modification of the Krško NPP, which is the new storage facility for spent fuel, in accordance with the requirements of the ZVISJV-1. It is an extensive administrative procedure that, in addition to the approval of the construction of a new building, also includes the approval of the transfer of spent fuel from the spent fuel pool to the new dry storage building. The procedure was not completed in 2021. Construction of the dry spent fuel storage building began in early 2021. The dry storage building is expected to be completed in 2022, and the transfer of spent fuel elements from the spent fuel pool to the dry storage building (first transfer) is planned for 2023.

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 fourth revision of the Decommissioning Programme and the RAW and Spent Fuel Disposal

Programme from the Krško NPP, the ARAO carries out activities that will serve as support for the preparation of both documents, such as the disposal of RW and SF in deep wells, the formation of scenarios for the disposal of RW and SF in traditional repositories, and disposal in a regional or multinational repository. The siting of such a repository and the goals that follow this are foreseen for a later date.

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.

Measures to achieve the objectives:

- Updates of the Programme for the Krško NPP Decommissioning and the Programme for the Disposal of LILW and Spent Nuclear Fuel are to be made, during the validity of this document, every five years – at the end of 2016 and at the end of 2021.
- In drawing up the Programme for the Krško NPP Decommissioning and the Programme for the Disposal of LILW and Spent Nuclear Fuel, it is necessary to consider new and changed facts, to introduce and apply new and improved methods of dismantling and decontamination, and to carry out an analysis of strategies regarding immediate and deferred dismantling.
- The ministry responsible for energy is to ensure the provision of regular financial resources to the Fund for the Decommissioning of the Krško NPP with a view to collecting the funds on time, taking into consideration all scenarios, including the reduction of compensation rates for the restricted use of land. Deadline: by the end of 2016 or until the approval of the Programme for the Krško NPP Decommissioning and the Programme for the Disposal of LILW and Spent Nuclear Fuel.

Realisation in 2021:

The Programme for the Krško NPP Decommissioning and the Programme for the Disposal of LILW and SF, for both the third revision thereof, were approved at the 14th session of the Interstate Commission in July 2020. At the same session, the Interstate Commission also adopted the decision that the ARAO, the Krško NPP Fund, and Krško NPP, d.o.o., would begin activities to carry out the next, fourth, revision of the Decommissioning Programme of the Krško NPP and the Programme for the Disposal of LILW and SF. Based on the third revision of the Programme for the Disposal of LILW and SF and the Decommissioning Programme and other expert bases, a projection of the costs of RW and SF management for the Krško NPP was prepared for the Krško NPP Fund until the end of the life of all facilities, and on this basis, by a decision of the Government of the Republic of Slovenia in July 2020, the amount of the contribution paid to the Fund by GEN energija, d.o.o., as the Slovenian owner of the Krško NPP, was increased. More details are available in Chapter 6.6.

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.

Measures to achieve the objectives:

- The operator and the owner of the TRIGA Research Reactor are to explore the possibility of extending the agreement with the USA on the repatriation of spent fuel originating from the U.S. by May 2019.
- If possible, the spent fuel from the TRIGA Research Reactor is to be returned to the United States two years after the shut-down of the TRIGA Research Reactor.
- Should the return of spent fuel to the United States not be possible, the operator and the owner of the TRIGA Research Reactor and the SGEI provider of radioactive waste management are to jointly find a solution for the storage of spent fuel from the research reactor after the cessation of its operation. A solution is to be found by the end of 2022.
- A detailed decommissioning programme for the TRIGA Research Reactor is to be drawn up by 2020.
- The SGEI provider of radioactive waste management is to seek possible reprocessing, storage, and disposal options for spent fuel from the TRIGA Research Reactor in parallel with seeking solutions for the final disposal of the spent fuel and HLW generated by the Krško NPP – permanently.

Realisation in 2021:

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 final clearance and the elimination of the need for storage, the facility is to be decontaminated and handed over for other purposes.

Measures to achieve the objectives:

- The SGEI provider of radioactive waste management that manages the CSF is to conduct an eligibility analysis and assess the need for the continuation of the operation of the CSF after 2025, when the disposal of radioactive waste from the CSF in the LILW repository is envisaged. The eligibility analysis is to be made by 2024.
- Depending on the results of the eligibility analysis regarding the continuation of the operation of the CSF after 2025, either the procedures for the decontamination of the CSF are to commence or the CSF is to continue its operation.
- Radioactive waste from small producers is to be stored in the LILW repository site, provided that the aforementioned eligibility analysis shows that the continuation of the operation of the CSF is the most appropriate solution – the storage of waste is to commence in 2025.

Realisation in 2021:

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. The preparation of an analysis of the justification and need for the continuation of CSF operation after 2025 is planned later.

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.

Measures to achieve the objectives:

- The SGEI provider of radioactive waste management is to perform long-term monitoring and maintenance of the national infrastructure facility – the Jazbec mine tailings disposal site – permanently.
- The Žirovski Vrh Mine (RŽV d.o.o.) is to carry out the remediation of the Boršt hydro-metallurgical tailings disposal site by applying measures necessary to fulfil the conditions for the closure of the Boršt disposal site by the end of 2017.
- The SGEI provider of radioactive waste management is to begin long-term monitoring and maintenance of the national infrastructure facility – the Boršt hydro-metallurgical tailings disposal site – and conclude the task by 2018.
- The SGEI provider of radioactive waste management is to perform long-term monitoring and maintenance of the Boršt hydro-metallurgical tailings disposal site – permanently.

Achieving the goal in 2021

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. Remediation works are mostly finished at the Boršt hydrometallurgical tailings disposal site. 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. In 2021, the revisions of the Safety Report for the Boršt disposal site and the expert opinion for the Safety Report without the first chapter, which refers to the scope of the state infrastructure facility and the ownership of land, were also carried out. In 2021, the company GeoTrias, d.o.o., carried out a study entitled The Variants and Probability of the Scenarios of Possible Movements of the Boršt Landslide, in which it checked the probability of the occurrence of the most unfavourable scenario, in which the landslide would slide into the valley of the Potoška grapa, the Todračica River would be temporarily damned, and there would be a breakthrough of the resulting barrier, as well as the release of radioactive material from the hydrometallurgical tailings disposal site, downstream. The study concluded that there is a very low probability of the damming the Todračica River, and to a limited extent. The authors of the study assume that only a portion of the landslide material would travel to the valley, so the damming of the stream in the sense of complete damming would not occur.

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.

Measures to achieve the objectives:

- The authorities responsible for nuclear and radiation safety are to implement the programme for the systematic screening of the living and working environment [19] – permanently.

- The programme for the systematic screening of the living and working environment is to also ensure the detection of materials/activities that generate materials/waste containing naturally occurring radionuclides.

Realisation in 2021:

Activities are ongoing and described in Chapter 3.4.2 and Chapter 3.4.3.

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.

Measures to achieve the objectives:

- The discharge of liquid and gaseous radioactive waste into the environment if such waste is generated by nuclear and radiation facilities and radiation practices in accordance with the prescribed limits – permanently.
- The holders of radioactive waste must ensure minimal and controlled release of radioactive waste into the environment – permanently.
- Any changes to the prescribed limits must be made in accordance with the rules and in a transparent manner.

Realisation in 2021:

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 2021, in order to reduce the volume of RAW in the CSFW and create storage space, the ARAO sent 2,080 ionisation smoke detectors for recycling abroad, where they will also remain.

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.

Measures to achieve the objectives:

- National authorities are to monitor the adequacy of the legislative and institutional solutions and, where appropriate, propose amendments thereto – permanently.
- The state is to ensure that research and development activities be carried out in the field of radioactive waste and spent fuel management through the ARAO or as part of a wider research programme implemented in accordance with the Resolution on Nuclear and Radiation Safety – permanently.

Realisation in 2021:

The strategy is ongoing; the details can be found in Chapter 8.3 and Chapter 8.4.

8.3 LEGISLATION IN THE FIELD OF NUCLEAR AND RADIATION SAFETY

The most important regulation in the field of nuclear and radiation safety in the Republic of Slovenia is the *Ionising Radiation Protection and Nuclear Safety Act*. It 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), for the second time in 2004 (ZVISJV-B, Official Gazette of the Republic of Slovenia, No. 46/04), for the third time in 2011 (ZVISJV-C, Official Gazette of the Republic of Slovenia, No. 60/11) and for the fourth time in 2015 (ZVISJV-D, Official Gazette of the Republic of Slovenia, No. 74/15).

Following a series of amendments to the 2002 Act, the new *Ionising Radiation Protection and Nuclear Safety Act* (ZVISJV-1) was adopted and published in the Official Gazette of the Republic of Slovenia, No. 76, on 22 December 2017, and entered into force on 6 November 2018. The amendment to the Act already followed in the following year, when the ZVISJV-1A was published in the Official Gazette of the Republic of Slovenia, No. 26/19 of 26 April 2019, and entered into force on 11 May 2019. The adopted amendment to the Act regulated the security clearance procedure for foreign nationals in a substantively similar manner as determined for citizens of the Republic Slovenia.

Even in the following years, unfortunately, the basic law in the field of nuclear and radiation safety in the country was not without interventions. Thus, in 2020, the SNSA prepared a proposal for the *Amendments to the Act on Protection against Ionising Radiation and Nuclear Safety (ZVISJV-1B*). The proposed amendments to the Act were published on the eDemocracy website on 16 November 2020, and at the end of December 2020, before the internal legal procedure for its adoption continued, the draft was sent, in accordance with Article 33 of the *Treaty on the Establishment of the European Atomic Energy Community (Euratom)*, via the Slovenian Permanent Representation in Brussels, also to the European Commission, Directorate for Energy. The adoption process then continued in 2021 and ended with the publication of the ZVISJV-1B in the Official Gazette of the Republic of Slovenia, No. 172/21 of 29 October 2021, which entered into force on 13 November 2021.

At the end of 2020, Slovenia received a letter of formal notice from the European Commission due to the non-notification of all regulations for the transposition of the so-called BSS Directive (Council Directive 2013/59/Euratom of 5 December 2013, on the establishment of basic safety standards for protection against the dangers of ionising radiation and on the repeal of Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom, and 2003/122/Euratom). In response to the letter of formal notice, Slovenia undertook to eliminate the alleged violations by adopting amendments to some valid regulations and by adopting a new one; the commitment specifically referred to:

- amendments to the Act on Protection against Ionising Radiation and Nuclear Safety,
- amendments to the Rules on special radiation protection requirements and the method of dose assessment,
- new Rules on radioactive waste and spent fuel management, and
- Rules on requirements for new constructions and interventions in existing buildings in order to protect the health of individuals from the harmful effects of radon.

By the end of 2021, three of the above-mentioned regulations had been adopted, published in the Official Gazette, and entered into force.

Thus, already at the beginning of March 2021, the amendments to the *Rules on special radiation protection requirements and the method of dose assessment*, adopted by the Minister of Health and prepared by the SRPA and the SNSA, were published in the Official Gazette of the Republic of Slovenia, No. 30/21. In addition to some minor editorial corrections, the adopted amendments mainly relate to the scope and content of the assessment of eligibility for the use of a new type of radiation activity, the use of a new type of radiation source, or the implementing of a new method of using an already tested radiation source. Another more extensive and substantively important amendment concerns the assessment of doses during an emergency, in which protection and rescue plans are used in the event of a nuclear or radiological accident.

On 30 July 2021, the new *Rules on radioactive waste and spent fuel management* were published in the Official Gazette, which came into force on 14 August 2021. The new Rules basically follow the rules from 2006. With the new Rules, the requirements of WENRA (Western European Nuclear Regulators Association) and provisions regarding the determination of releases of radioactive substances into the environment in accordance with the BSS directive are transposed to the Slovenian legal system. Also, some other provisions have been supplemented with the knowledge and experiences from years of use of the current Rules and alignment with the ZVISJV-1A. The Rules also prescribe new requirements regarding acceptance criteria for the storage and disposal of radioactive waste and spent fuel. The public service provider must make changes to the acceptance criteria within three years of the entry into force of the new Rules.

Amendments to the ZVISJV refer to amendments to Article 3 (with the addition of a new definition of the term radiological object), Article 42 (with cooperation between authorised experts in radiation protection and authorised experts in medical physics), Article 49 (with additions to the data contained in the database on personal doses of exposed workers), Article 54 (with mandatory data on radiation doses received in the current calendar year and in the last five calendar years, which the external contractor must send to the operator of the facility or the radiation contractor before starting work on controlled area activities), and Article 137 (with the addition of the content of the permit for the use of a radiation source, which, in terms of operating conditions and restrictions regarding highly active radiation sources, must also contain minimum criteria for the efficiency of the source, source container, and additional equipment). In addition, the provisions regarding regulated professions have also been changed, i.e. Articles 13, 14, and 15, as they contained, *inter alia*, references to articles of the Act that do not regulate regulated professions. Terminologically, the texts of Articles 158 and 159 of the Act (on the monitoring of radioactivity in the environment) were harmonised. The provision on checking the effectiveness of measures to reduce radon concentrations in Article 68 of the Act was somewhat amended and the terminologically harmonised text in Articles 66, 70, and 181 of the Act regarding exposure to radon was also supplemented. Furthermore, the provision of Article 178 regarding the inspection supervision of construction measures for new buildings and interventions in existing buildings was added to protect people's health from the harmful effects of radon. These amendments to the Act also change the ministry responsible for supervising the operations of the mandatory state economic public service for radioactive waste management in Article 122 of the Act. The amendment to the Act (ZVISJV-1B) was published in the Official Gazette of the Republic of Slovenia, No. 172/21 of 29 October 2021, and entered into force on 13 November 2021.

The last of the regulations, whose adoption and implementation announced the elimination of the alleged violation in the transposition of the BSS directive, is the *Rules on requirements for new constructions and interventions in existing buildings to protect human health from the harmful effects of radon*. The legal basis for the adoption of the Rules is the ZVISJV-1B, which in the third paragraph of Article 70 stipulate that the minister responsible for construction and the minister responsible for health determine the requirements for new buildings and interventions in existing buildings, which ensure

the protection of human health from the harmful effects of radon. A green light for the proposal of the Rules had to be obtained from the European Commission in two separate procedures: on the basis of Article 33 of the Euratom Treaty, as well as in accordance with Directive (EU) 2015/1535 of the European Parliament and of the Council of 9 September 2015 laying down a procedure for the provision of information in the field of technical regulations and of rules on Information Society services (codification). While waiting for a positive response from the Commission (in both cases, the deadline is three months), a public discussion and interdepartmental coordination were held, but had not been completed by the end of 2021.

In 2021, after several years of preparation, the SNSA, in cooperation with the Ministry of Infrastructure and the Ministry of Finance, intensively coordinated the proposal for the new *Decree on the method and subject of and conditions for performing the public utility service of radioactive waste management* and the new Ordinance establishing a public service for radioactive waste management – the ARAO. One of the main goals of the new regulations is to determine the organisational form and conditions for the operation of the Radwaste Agency, which will enable it to perform its tasks more efficiently, especially activities related to the construction of a low- and intermediate-level waste disposal site in Vrbina. Instead of the current form (public service), the transformation of the ARAO into a public company has been proposed from the very beginning. However, this intention was abandoned during interdepartmental coordination with the Government Service for Legislation, and so no change in the organisational form of the mandatory state public service of radioactive waste management took place, and it was therefore envisaged that it would continue to be implemented in the form of a public service. However, one of the changes in the new Decree and new Ordinance, which is in accordance with the latest amendments to the ZVISJV, is the transfer of the authority to supervise the operations of the Radwaste Agency from the previous Ministry of Infrastructure to the Ministry of the Environmentand Spatial Planning, and the second is that the seat of the Radwaste Agency is now in Krško and no longer in Ljubljana. Although repeated interdepartmental coordination was already completed at the beginning of 2021, the process of adopting both regulations in the field of the mandatory state public service of radioactive waste management was not fully completed in 2021.

In 2018, the European Commission issued a letter of formal notice to the Republic of Slovenia due to the non-fulfilment of obligations referred to in certain provisions of Directive 2011/70 Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, which relate to the content of the Slovenian *Resolution on the National Programme for the Management of Radioactive Waste and Spent Fuel (for the period 2016–2025)*. In response to the letter of formal notice, the Republic of Slovenia clarified and eliminated some of the Commission's findings, while for others it undertook to eliminate them by adopting a new resolution, the preparation of which it intends to initiate, even though the current resolution was adopted for the period from 2016 until 2025. According to the timeline, which is also known to the European Commission, the new resolution should be adopted by the National Assembly by the end of 2022. In 2021, the Radwaste Agency, as a provider of the mandatory state public service of radioactive waste management, in accordance with ZVISJV-1, prepared the professional basis for the Resolution on the National Programme for the Management of Radioactive Waste and Spent Fuel for the Period 2023–2032, with a more detailed breakdown of the measures for reducing the generation of radioactive waste, its processing before disposal, and its disposal, as well as measures for the processing and disposal of radioactive waste. In mid September 2021, the SNSA issued a consent for these expert bases and (in accordance with ZVISJV-1) sent them to the MESP and the Ministry of Infrastructure, which prepared the National Programme for the Management of Radioactive Waste and Spent Fuel for acceptance by the Government of the Republic of Slovenia and later by the National Assembly. Together with expert bases for the National Programme, the SNSA also sent an explanation of its opinion to the Ministry of Environmental Protection and Spatial Planning for the purpose of deciding whether a comprehensive

environmental impact assessment should be carried out for the National Programme for the Management of Radioactive Waste and Spent Fuel. The further procedures necessary for the adoption of the resolution did not continue in 2021.

Another important resolution, i.e. the *Resolution on Nuclear and Radiation Safety*, which was adopted in mid 2013 and is valid until 2023, is slowly approaching the end of its validity, and therefore in the second half of 2021 the SNSA started internal activities to prepare a new resolution for a new ten-year period. Thus, the first draft was prepared in November, and the internal discussion and process of coordination at the level of the SNSA will be the basis for the proposal, which will be sent for public discussion in 2022 and the formal continuation of the legislative process, which is expected to be completed by the end of 2023 with its adoption by the National Assembly of the Republic of Slovenia.

In 2021, the SNSA also started a more extensive review of two fundamental regulations from the narrower field of nuclear safety, i.e. the *Rules on radiation and nuclear safety factors* and the *Rules on ensuring safety after the start of operation of radiation or nuclear facilities*. Both regulations were not amended after the ZVISJV-1 was adopted in 2017, as they underwent thorough updates in 2016. Nevertheless, according to the judgement of the SNSA, both regulations need to be updated again, which primarily means alignment with the WENRA reference levels (requirements) and established international standards, especially those adopted within the framework of the IAEA. Of course, during the implementation of these two regulations, the need for some additional editorial corrections and adjustments also became apparent. After the completion of the internal coordination of the draft of the two regulations at the SNSA level, both were published at the end of 2021 on the e-Democracy website and on the SNSA website, but the public debate was not completed in 2021.

In 2021, the work of the representatives of the Ministry of the Interior and the SNSA on the review of regulations in the field of physical protection continued. The review and exchange of expert opinions hitherto indicated that after eight years of the application of both regulations (*Rules on the physical protection of nuclear facilities, nuclear and radioactive substances, and the transport of nuclear substances* and the *Order on determining the programme of basic professional training and the programme of periodic professional development of security personnel, which carries out the physical protection of nuclear facilities, nuclear or radioactive substances, and the transport of nuclear substances*) many changes and corrections were necessary, which, however, will not drastically change the way the area is regulated. Regarding the Rules, changes are indicated, such as regarding physical and technical security measures in the protected area, the preparation and content of a threat assessment, and the content of physical protection plans. Regarding the Order, the proponents supplemented the basic professional training programme for security personnel and the periodic professional development programme; some new training content was added, and concepts were adjusted based on the starting points from the ZVISJV-1 (e.g. the security culture). The process of adopting both regulations was not completed in 2021.

8.4 THE EXPERT COUNCIL FOR RADIATION AND NUCLEAR SAFETY

The Expert Council for Radiation and Nuclear Safety provides expert advice to the 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 2021, the Expert Council for Radiation and Nuclear Safety convened one regular session, which was held virtually, and three correspondence sessions. At the regular session, the SNSA director reported on the status of nuclear and radiation safety. The Council took note of amendments to the draft of the Ionising Radiation Protection and Nuclear Safety Act, considered the proposals for new Rules on Radioactive Waste and Spent Fuel Management, for the Protection Strategy in the Event of a Nuclear and Radiological Emergency, as well as for the Rules on requirements for new constructions, interventions, or renovations of existing buildings in order to protect human health from the adverse effects of radon. The Council also considered and approved the 2020 Annual Report on Radiation and Nuclear Safety in the Republic of Slovenia, the Third National Report of the Republic of Slovenia in accordance with Council Directive 2011/70/Euratom on the responsible and safe management of spent fuel and radioactive waste.

8.5 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, 64/19, 64/21, 90/21, 101/21, and 117/21) determines that the Slovenian Nuclear Safety Administration (the 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 treaties 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 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.

8.5.1 The SNSA During the Covid-19 Epidemic

In 2021, the Covid-19 epidemic also strongly affected life and work both at the SNSA and in Slovenia and elsewhere in the world.

In 2021, the SNSA was also forced, as were other areas of the state administration, to organise work at home, while the implementation of key matters was also ensured at the headquarters of the administration. This type of work organisation was carried out for almost the entire first half

of 2021, and after a partial normalisation of life, in the second part of the year it was necessary to switch to a so-called "on duty" organisation of work, which lasted until the end of the year.

The organisation of work carried out in such manner did not pose a particular challenge for the SNSA management, as the SNSA was already well organised in 2020; the determination of "teams" (those working at home and, in parallel, those working at the SNSA Headquarters) went smoothly, through the long-term planning of employees, who were included in the relevant lists according to weekly schedules, which were included in an attachment to the issued decision on work at the SNSA and the order to work at home. The equipment of work associates, who had the necessary laptops, mobile phones, and other necessary IT equipment, was also above average, all of which provided the basis for the smooth organisation of remote work.

Throughout the year, the SNSA headquarters had enough protective masks (some of which were received from the released commodity reserves) and disinfectants.

According to an internal assessment, approximately 90% of the employees of the SNSA were vaccinated. This fact, as well as other measures and conditions (the organisation of work at home, sufficient equipment with protective equipment, committed adherence to the recommended measures by colleagues), is also to be attributed to the fact that only four cases of self-isolation due to risky contacts were recorded during the year, of which three then resulted in infections (a total of five cases).

Due to the emergence of the much more virulent strain of the new delta variant of the Covid-19 virus, in mid 2021 the Government prescribed the mandatory fulfilment of one of the conditions for work, i.e. recovery or previous illness or vaccination, which was also mandatory for work in the state administration since mid September. Thus, based on the *Ordinance on the method of meeting the condition of morbidity, vaccination and testing to curb the spread of SARS-CoV-2 virus infections*, the SNSA also adopted the Protocol for the prevention of the spread of infections with the SARS-CoV-2 virus at the SNSA on 21 September 2021.

Also in 2021, the internal procedure OP 1.32 *Operation of the SNSA in exceptional circumstances*, which the SNSA prepared and adopted during the first wave of the epidemic in 2020, was implemented. It covers the organisation of work from home, the employer's obligation to ensure a safe and healthy working environment, the obligation to perform other work due to exceptional circumstances, the use of annual leave in exceptional circumstances, the allowance for work in risky conditions, public procurement during exceptional circumstances, and other specifics of work in exceptional circumstances, such as the use of videoconferencing systems, the cancellation of business trips and meetings, the publication of notices about the operation of the SNSA for clients and other notices on the website, as well as conducting inspections. The entire procedure is described, from the declaration of exceptional circumstances at the national level, the implementation of the ordered protective measures, to the relaxation of the ordered measures and the return of employees to work on the business premises.

In 2021, despite the exceptional circumstances due to the Covid-19 epidemic, the SNSA carried out all administrative functions in an unreduced extent and within the legal deadlines, as well as all (emergency) inspections.

Regular services and procedures related to the issuance of permits and registrations of radiation sources were carried out by the SNSA, as usual, electronically or by mail, and as a result there was no extension of the deadlines otherwise permitted by the governmental decree. The SNSA regularly monitored the operation of nuclear and radiation facilities and was in daily contact with the Krško NPP and, if necessary, also with other operators. Inspections were not interrupted. Gradually, virtual inspections also began to be carried out. Inspectors also checked compliance with measures to limit the spread of the Covid-19 infectious disease. Some more demanding inspections were postponed, and some are planned in such a way that one inspector is present on site, while other

inspectors and professional colleagues participate remotely via video conference or entirely via video conference.

All business trips, training courses, education courses, workshops, and seminars were generally cancelled or, as in 2020, carried out virtually.

8.5.2 Organisational Chart of the SNSA

The Personnel Plan of the MESP for the years 2021 and 2022 also shows the unchanged personnel policy for the SNSA and set a quota of 41 employees. The SNSA continues to resolve the staff shortage with short-term project jobs.

At the beginning of 2021, 43 civil servants were employed at the SNSA, and 46 civil servants were employed in the middle of the year and at the end of the year. During the year, 3 civil servants left, of which 1 civil servant retired. The number of employees includes all employees who are employed for a fixed or indefinite period, regardless of the source of funding. As of 31 December 2021, 3 civil servants were financed from project jobs, 1 had a job due to a temporary increased scope of work, and 1 was employed for a replacement period, i.e. a total of 5 fixed-term jobs. Of the 46 employees, 5 of them were not included in the staffing plan, which is why the SNSA consistently met the specified employment quota even at the end of 2021.

The composition of 46 employees on the last day of 2021 was as follows:

- 44 employees in official and 2 employees in technical positions;
- 5 temporary employees:
- gender: 22 women, or 48%; 24 men, or 52%;
- age: the average age of employees was 50.6 years, ranging from 25 to 68 years of age.

As a result, the demographic trend of population aging also followed the aging of the working population, as shown by the data on the age structure of employees at the SNSA.

The level of professional qualification of the 46 employees at the SNSA is shown in Table 10.

Table 10: Level of professional qualification of the employees at the SNSA

Level of professional qualification	Number of employees	Percentage (%)
Higher Education	6	13%
University Degree	19	41%
Master's Degree	10	22%
Doctorate	11	24%
Total	46	100%

Despite the reduction in the number of employees over the last fifteen years, the SNSA ensures and maintains a high level of nuclear and radiation safety in the country through effective optimisation of its work. However, the SNSA points out the lack of staff and the related challenges of ensuring the necessary competencies in various fields of nuclear and radiation safety, as well as the fact that internal reserves are practically exhausted, as its scope of work has also formally expanded over the years, and thus has acquired an increasing additional workload. The new European Directive on the basic safety standards of radiation protection brought several new additional tasks to the SNSA, and the burdens occasionally increase even in an *ad hoc* manner.

The assignment of additional tasks and the expansion of the scope of work represent even more pressure for civil servants because the level of the average age of employees is increasing year by year, and in the next year or two there will be a large-scale change of generations. Thus, at least four managerial employees will leave the SNSA due to retirement, and it is increasingly difficult to find replacement jobs for work in the public administration, as salaries, especially for experts in technical and natural sciences, are not competitive with those in the private sector. Even otherwise, potential personnel for replacement jobs are not adequately qualified for tasks in the field of nuclear and radiation safety, and their additional training and development is time-consuming and financially demanding.

A similar image applies to the entire country, where we are increasingly faced with the challenge of providing enough experts with the necessary competencies in various fields of nuclear and radiation safety. This is even more so because the change of generations and the associated retirement of some of the most qualified experts is also happening as regards operators of nuclear facilities and radiation operators, as well as in the field of so-called authorised organisations.

The SNSA warns that in the light of preparations for the possible expansion of the nuclear option (in addition to the extension of the life of the NPP, also the construction of a new power plant), it will be necessary in the future to analyse the situation with an assessment of the anticipated needs for ensuring the necessary competencies in various areas of nuclear and radiation safety and to envisage mechanisms for their provision. In particular, the construction of a new nuclear power plant would significantly increase the demand for additional technical personnel. If there is currently a noticeable shortage especially in the public sector, with additional needs, the shortage will also affect all other stakeholders. The SNSA has already made an analysis of the necessary personnel that it would need for the efficient and timely implementation of its administrative, inspection, and other professional tasks, which are foreseen in the licensing of a new nuclear power plant. The analysis for the current administration already shows a critical lack of personnel, and the need for new personnel will increase significantly in the event of the construction of another nuclear power plant.

8.5.3 Training

In 2021, as in all previous years, the SNSA devoted a great deal of attention to education and training, with the aim of monitoring and developing the careers of civil servants and creating conditions for improving the professional qualifications of all employees, although this was often prevented or at least complicated due to the Covid-19 epidemic. For this purpose, as it does every year, it adopted an internal *Education, Training, and Development Plan*, which is based on the actual needs of the SNSA and is prepared in accordance with the financial possibilities of the SNSA. Events (courses, workshops, conferences) were cancelled quite a few times, but as a rule they were moved to a virtual environment.

In 2021, attention was focused on those forms of training that are the most important for the field of work of the SNSA and can be carried out by domestic providers. Thus, seven SNSA employees were sent to study the selected content of the course TJE (NPP theory), four employees attended the course OJT (nuclear technology fundamentals), five employees were sent to the course JEK 4 (nuclear energy in brief), and one employee to the course OTJE (nuclear power plant technology fundamentals). The SNSA employees also participated in training courses and passed an exam in the field of protection against ionising radiation, namely seven of them for the so-called RZ-2 course (radiological protection) and four for the so-called RZ-3 course. All of the mentioned forms of training were carried out at the Educational Centre for Nuclear Technology – ICJT, which is part of the Jožef Stefan Institute.

Regardless of the Covid-19 epidemic, other forms of training and education were also carried out, mainly in virtual form, which were organised abroad, mainly within the framework of the IAEA and the NEA.

The above statistics do not include the participation of SNSA employees in a wide variety of international working groups, committees, and associations, which also took place mostly in virtual form.

Based on appropriate education or additional training, the SNSA has appointed:

- an responsible person for protection against radiation, who, based on Article 52 of the ZVISJV-1, is responsible for the implementation and planning of protection measures against ionising radiation in accordance with the Act,
- a workers' representative for health and safety at work in accordance with the *Health and Safety at Work Act* (Official Gazette of the Republic of Slovenia, No. 43/11),
- an authorised person for the protection of personal data 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 natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation),
- the person authorised to refer SNSA employees to periodic preventive health examinations, and
- a consultant for help and information on measures available in connection with protection against sexual and other harassment or ill-treatment in accordance with the *Decree on Measures to Protect the Dignity of Employees of the State Administration* (Official Gazette of the Republic of Slovenia, Nos. 36/09, and 21 /13 – ZDR-1).

The SNSA has a system for ensuring competencies and optimising internal organisation, which is called SAT-URSJV. It systematically defines the necessary competencies for individual jobs. Competencies are created based on work tasks, which are also determined for individual positions. Work assignments are determined based on many years of experience. The basis is the Rules of Procedure of the SNSA, where the processes are defined, and the work tasks are then defined in more detail on basis of the processes. The success of the implementation thereof is checked in annual interviews, where the competencies of the employees are also checked. On such basis, the SNSA training plan for each process and specifics for each job are prepared and adopted. Special attention is devoted to new employees, for whom a special training plan is prepared. Monitoring the career development of employees is also an important part thereof. In addition to the necessary training for the continuous development of competencies, the career plan also includes a development plan and a promotion system, which is adapted to the abilities of employees and the needs of the SNSA.

8.5.4 Informing the Public

The SNSA's internal acts, especially the *Act on the internal organisation and systematisation of jobs at the SNSA* and the *SNSA's Rules of Procedure*, stipulate that the public nature of its work, which the SNSA imposes in addition to the general legislation and the ZVISJV-1, is ensured by the director, mainly by issuing official messages and in other ways that enable the public to become familiar with the work of the SNSA and the resolution of issues in its field of work.

The SNSA informs the public mainly by publishing information through its websites. In the second half of 2020, the *Accessibility of Websites and Mobile Applications Act* entered into force, which regulates measures to ensure the accessibility of websites and mobile applications for all users, and in

particular for users with various forms of disabilities. All content intended for publication online must be prepared in a format that is accessible to vulnerable groups.

The website's online content is constantly updated, with individual content being given in several places. More important topics and news can also be highlighted, allowing users to quickly access such matters.

The "News" column is intended for current events related to the work of the administration, which the SNSA tries to keep fresh and informative. In 2021, 36 such news items were published, i.e. an average of three per month.

An important place is occupied by the catalogue of information of a public nature, created according to the requirements of the *Public Information Access Act* and the corresponding EU regulation. On this basis, the SNSA received 8 requests for access to public information in 2021 and granted all of them in full.

In 2021, the SNSA continued the practice of publishing *Radiation News* (Slo.: Sevalne novice), which it started more than fifteen years ago. Two issues (Nos. 54 and 55) were prepared, which were also published on the SNSA website as Radiation News No. 54, published in April 2021, presenting the amendments to Annexes A and B to the *European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)*, and which reported on the adoption of the Amendments to the *Rules on special radiation protection requirements and the method of dose assessment*, where the scope and content of the assessment of eligibility for the implementation of a new type of radiation activity, the additional content for the assessment of eligibility for objects of general use, the use of which may constitute a new type of radiation activity, are additionally determined. Provisions have also been added for assessing doses in the event of an emergency. In that issue, information was also published as regards the Incident and Trafficking Database (ITDB) of the IAEA, which is one of the most recognisable "products" of this organisation in the field of nuclear security. Radiation News No. 55 published brief information on the training of persons participating in the transport of dangerous goods (drivers and class 7), and a more extensive overview of 13 intervention inspection cases dealt with by nuclear and radiation safety inspections in 2020 was also given.

Since 2010, the SNSA has also been preparing the so-called "News from Nuclear Slovenia", with a standardised content design updated twice a year. In April 2021, issue 24 was published, and issue 25 in October. Both issues were also prepared and published in the Slovenian version.

In 2021, as in previous years, the SNSA organised a meeting with interested non-governmental organisations in the field of environmental protection. Among those invited, only the Association of Ecological Movements of Slovenia (*Zveza ekoloških gibanj Slovenije*) took part in this meeting, which took place on 24 September 2021. The discussion was about current topics in the nuclear field, regarding the low- and intermediate-level radioactive waste disposal site, and the storage capacities at the Krško Nuclear Power Plant, the project to extend the operational life of the NPP and the environmental consent required for this extension, the acceptability of the nuclear option in Slovenia and other issues related to the possible new nuclear power plant, and also regarding the position and financing of non-governmental organisations.

Undoubtedly, the preparation of the annual Report on Radiation and Nuclear Safety in the Republic of Slovenia, the preparation of which is determined by the ZVISJV-1, also belongs to the aspect of informing the public. The report for 2020 was considered and adopted by the Government of the Republic of Slovenia at the 255th correspondence session on 18 August 2021 thereof and forwarded to the National Assembly of the Republic of Slovenia. The Commission of the National Council of the Republic of Slovenia for Local Self-Government and Regional Development took note of the report at its 68th session on 6 September 2021, and the Committee of the National Assembly for Infrastructure, Environment, and Space, as the parent working body, took note of the report at its 31st session on 8 September 2021.

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

8.5.5 The Expert Commission for the Verification of Professional Competencies and the Fulfilment of Other Requirements in Respect of Workers Performing Duties and Tasks in Nuclear and Radiation Facilities

In 2021, the Expert Commission for the Verification of Professional Competencies and the Fulfilment of Other Requirements in Respect of Workers Performing Duties and Tasks in Nuclear and Radiation Facilities (hereinafter the Commission) held seven meetings. The first meeting of the Commission was dedicated to the organisational preparation of the exams to verify the professional competencies of the operating personnel of the NPP, i.e. the main reactor operators, reactor operators, and shift engineers. The meeting was held by correspondence to ensure the implementation of protective measures during the Covid-19 epidemic. The remaining meetings were dedicated to conducting exams.

In the fall of 2021, the Commission organised six exam dates for eight candidates from the operating staff of the Krško NPP. Extensions of licenses were granted to three Senior Reactor Operators, and one Shift Engineer. Altogether, three candidates acquired a Senior Reactor Operator license for the first time and one candidate acquired a Shift Engineer license for the first time. In 2021, there were no candidates for obtaining the first Reactor Operator license for the Krško NPP.

In 2021, one candidate successfully passed the exam and renewed a TRIGA Research Reactor Shift Supervisor Operator license.

In 2021, no license exams for a CSRW Storage Facility Manager were conducted.

Based on the proposals of the Commission, the SNSA issued the appropriate licenses to the mentioned candidates.

8.6 THE SLOVENIAN RADIATION PROTECTION ADMINISTRATION

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

As a special operational unit within the SRPA, the Inspectorate for Radiation Protection is responsible for monitoring sources of ionising radiation used in medicine and veterinary medicine and for the implementation of legislation on the protection of people against ionising radiation. In 2021, the SRPA had 6 employees.

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 relevant Act (ZVISJV-1); issuing approvals 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.

In 2021, due to the Covid-19 epidemic, the SRPA made all the necessary arrangements to ensure that work ran as smoothly as possible, considering all the measures to prevent the spread of the epidemic. SRPA employees worked primarily from home and attended all meetings and international meetings online. The SRPA kept stakeholders regularly informed via its official website. Only the radon monitors loan project was temporarily suspended. In 2021, there was one case of a coronavirus infection among SRPA staff.

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, 87 permits to carry out a radiation practice, 304 permits to use radiation sources, 21 certificates of received individual doses, one permit for the export of radioactive substances, and 36 statements by recipients of radioactive materials were confirmed. In 2021, the SRPA issued 14 approvals to natural or legal persons performing professional tasks in radiation protection.

In 2021, the Inspectorate carried out 202 inspection procedures. Of these, 9 were in-depth inspections due to exposure to radon; the SRPA issued 3 inspection decisions and 8 warnings regarding a required reduction of exposure. In medicine and veterinary medicine, 61 in-depth inspections were performed, including in-depth inspections on measures against the spread of Covid-19 were inspected. During inspections, 23 X-ray devices held in reserve were sealed. A total of 15 decisions requiring harmonisation with the valid regulations were issued and 2 decisions prohibiting use of an x-ray device. Two more inspections of nuclear and radiological facilities were carried out in cooperation with the SNSA. The scope of the inspectorate's field work has been significantly increased compared to previous years. On the basis of the inspection of reports on X-ray devices intended for medical use, 3 requests to submit evidence regarding the correction of deficiencies, 28 requests to submit evidence regarding the termination of the use of an X-ray device, and 99 requests regarding harmonisation with the existing legislation were issued. There were no cases of an exceeded monthly personal dose of 1.6 mSv in 2021. The SRPA Inspection took action on two occasions, in the case of an elevated dosimeter reading resulting from a CT scan of luggage at the airport and in the case of an exceedance of the operational monthly dose limit for the equivalent dose to the arms. Comprehensive monitoring was ensured through the cooperation of expert institutions, which regularly review the situation in this area.

In 2021, the SRPA continued to finance the programme for the systematic surveillance and measurements of radon in schools and kindergartens and in dwellings.

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

In 2021, the SRPA financed the 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 for secondary schools and an analysis of the impact of radon on lung cancer incidence. In the field of patient exposure, the SRPA financed a study on patient exposure due to radiological procedures.

At the end of 2021, the SRPA started intensive preparations for an independent international peer review of the legislative and regulatory framework for nuclear and radiation safety in Slovenia (The Integrated Regulatory Review Service, IRRS). The IRRS review mission took place in April 2022 and was conducted by the IAEA and international experts in the field of nuclear safety and radiation protection. In preparation for the mission, the SRPA, in cooperation with the SNSA, prepared the responses to the self-assessment questionnaires and an action plan to address the

shortcomings in autumn 2021. A preparatory meeting was organised at the SNSA headquarters in November 2021, which was attended by representatives of the both Slovenian administrations, IAEA representatives, and the mission management.

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

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 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 the Republic 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; furthermore, the performance of the SRPA in 2021 was also affected by the implementation of preventative measures to prevent the spread of Covid-19. Despite the new permanent employment in 2019, additional staffing in the near future is necessary to ensure the fulfilment of the legally defined obligations and an appropriate level of radiation protection.

Reference: [15]

8.7 AUTHORISED EXPERTS

Authorised Radiation and Nuclear Safety Experts

In 2021, seventeen legal entities were authorised to perform the tasks of authorised experts for radiation and nuclear safety. In 2021, based on Article 89 of the ZVISJV-1, the SNSA extended the validity of existing authorisations to six authorised experts. In addition, it also issued a change in the authorisation of the Institute for Metal Structures (IMK), which changed its legal status from an institute to a limited liability company. No new authorisations were issued this year.

In 2020, altogether 17 legal entities were authorised by the SNSA.

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

Approved Radiation Protection Experts

The ZVISJV-1 determines the operation of several types of authorised organisations and experts in the field of radiation protection, authorised by the SRPA. The *Rules on the Authorisation of Radiation Protection Experts* (Official Gazette of the Republic of Slovenia, No. 47/18) and the *Rules on the Authorisation of Contractors of Professional Tasks in the Field of Ionising Radiation* (Official Gazette of the Republic of Slovenia, No. 39/18) determine the method of authorisation and the conditions for obtaining authorisations and also the requirements for the accreditation of laboratories according to the SIST EN ISO/IEC 17025 standard.

In accordance with the ZVISJV-1, special expert commissions were appointed to verify the fulfilment of the conditions for performing the tasks of authorised experts for a period of five years, which began their work in 2006. In 2020, the Minister of Health reappointed these commissions to continue their work.

The lists of authorised organisations and experts are available on the SRPA website.

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 2021, the SRPA did not issue any authorisations for dosimetry.

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 ensure and verify the quality of radiological procedures in medicine. Only natural persons can become approved medical physics experts. In 2021, the SRPA issued 8 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 2021, no opinions on eligibility for carrying out the medical monitoring of exposed workers were issued.

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 2021, the SRPA issued approval to perform radon measurements to the JSI.

Reference: [15]

8.8 THE NUCLEAR INSURANCE AND REINSURANCE POOL

The Nuclear Insurance and Reinsurance Pool (hereinafter: Nuclear Pool GIZ) insures and reinsures against nuclear threats. The Nuclear Pool GIZ operates as an economic interest association (GIZ). It was founded in 1994, when eight members (insurance companies and a reinsurance company based in the Republic of Slovenia) signed the Agreement on the Establishment of a Pool for the Insurance and Reinsurance of Nuclear Threats.

In 2021, the members of the Nuclear Pool GIZ were the following (re)insurance companies: Zavarovalnica Triglav, d. d., Pozavarovalnica Sava, d. d., Generali zavarovalnica, d. d., Pozavarovalnica Triglav, Re, d. d., Zavarovalnica Sava, d. d., and Merkur zavarovalnica, d. d.

In 2021, the following members had the largest shares in the GIZ Nuclear Pool: the insurance company Triglav, d. d., the reinsurance company Sava, d. d., and the reinsurance company Triglav Re, d. d.

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

Reference: [26]

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 the "safeguards agreements", which have been complemented by the Additional Protocols. Every five years, NPT Review Conferences are milestone gatherings where the successfulness of the implementation of the NPT is addressed, packed 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 *Comprehensive Nuclear-Test-Ban Treaty* (hereinafter: CTBT), and the universality of the NPT.

In 2021, the Slovenian institutions – with Ministry of Foreign Affairs (MFA) as the coordinator and focal point – in the run-up to the forthcoming 10th NPT Review Conference (envisaged in January 2022) reviewed and amended the national report on the implementation of this treaty (i.e. *"Implementation of the Action Plan of the 2010 Review Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, Report"* submitted by Slovenia). Preparatory work for this important conference was followed also by the EU (the Working Party on Non-Proliferation and Arms Exports – it subgroup on non-proliferation and disarmament (CONOP)). The SNSA followed the issues from the capital (and the MFA actively, throughout the year).

References: [27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37]

9.2 COMPREHENSIVE NUCLEAR-TEST-BAN TREATY

The 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 185 states that have signed the treaty, 170 of which have also ratified it (no changes since last year; furthermore, the International Monitoring System (IMS) network has currently as many as 302 stations). In addition to the detection of nuclear tests, monitoring stations can also be used for other civil purposes, e.g. in order to detect tsunamis. The pivotal challenge of the CTBTO – whose new Executive Secretary is the renowned nuclear expert, Robert Floyd – 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. Despite its non-universality, the CTBT has positively contributed to a decrease in the number of nuclear tests.

Slovenia has cooperated 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. The former Executive Secretary of CTBTO (Lassina Zerbo) has visited Slovenia several times in the past and participated in meetings, e.g. at the Bled Strategic Forum (BSF). In 2021, the quite long process of selecting the new Executive Secretary was finally concluded.

In 2021, fortunately again, no "unusual seismic events" or nuclear tests (assessed as having a human cause or due to an explosion) took place in the world.

On 23 September 2021, the 12th Conference under Article XIV took place. Numerous highly-ranked officials took part in it; the Slovene national statement was presented by Foreign Minister Logar. During this biennial event, the concluding statement was endorsed by all participants – and it gives a strong supportive voice to the importance of the treaty and as well appeals to those countries that have not signed or ratified the treaty to do so – and thus accelerates the years-long efforts to ensure the treaty's full entry into force (as the final goal).

The past year also marked by the 25th anniversary of the publication and commencement of the signing of the treaty.

9.3 NUCLEAR SAFEGUARDS IN SLOVENIA

At the international level, nuclear safeguards are regulated by the NPT 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 CSRW in Brinje, and at the other "minor holders 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 six IAEA/Euratom inspections in Slovenia in 2021. The SNSA's staff participated during nearly all of these international inspections, which took place at the Krško NPP and on the premises of one of the domestic "minor holders of nuclear material". All inspections were conducted jointly – i.e. by the IAEA and Euratom at the same time. No inspection was conducted based upon the Additional Protocol (complementary access) this year.

The European Commission holds periodic meetings with the Member States' representatives, dealing with "safeguards-related issues" (in Luxembourg), namely the "Meeting with Member States on Euratom Safeguards Implementation". The last such "in-person" meeting took place before the epidemic in 2019; in April 2021, only a virtual meeting was held, and the European Commission's officers summed up the main conclusions on safeguards in 2019/2020 as well as briefed the audience on future tasks and challenges. The EU Member States' representatives gave their short summaries in the traditional *tour de table* setting. In the second half of 2021, the European Commission contacted the EU Member States (nuclear regulators and nuclear operators/holders), in order to deliver a dedicated questionnaire on the current Commission Regulation (Euratom), No. 302/2005 on the application of Euratom safeguards.

References: [37], [38], [39], [40], [41]

9.4 EXPORT CONTROL OF DUAL-USE ITEMS

The SNSA, together with the MFA, follows the activities of the *Nuclear Suppliers Group* (NSG) as well as 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 countries that wish

to acquire such weapons. The annual Plenary Week of the NSG was held in a "congested, hybrid manner" in Brussels in June 2021 – at the end of the Belgian chairmanship. In addition to this, the NSG conducted a set of technical (virtual) meetings, while the reporting of the Chair was also done by virtual means.

On the basis of the *Act Regulating the Control of Exports of Dual-Use Items*, a special Commission for the Export Control of Dual-Use Goods 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 2021, the Commission had no regular (i.e. "in-person") sessions but as many as 21 correspondence sessions took place in the reporting period. 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 2021, the Annual Report (covering the year and work throughout 2020) of the aforementioned Commission was endorsed by the Slovenian Government. No special outreach (awareness raising-like) activities for exporters or research institutions (academia) took place in 2021. Finally, the "*Ordinance on the establishment, composition, tasks and working methods of the Commission for the control of exports of dual use items*" was published in 2021.

References: [42], [43], [44]

9.5 PHYSICAL PROTECTION OF NUCLEAR MATERIAL AND FACILITIES

The operators of nuclear facilities and carriers of nuclear material implemented physical protection measures in accordance with their physical protection plans approved by the Ministry of the Interior based upon prior consent and issued by the SNSA.

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 2021, two regular sessions of the Commission were held. The Commission considered proposals regarding the threat assessment for the Slovenian nuclear facilities, the future disposal of low- and intermediate-level radioactive waste (Vrbina) and transports of radioactive material on roads. The Commission and its work were affected by the epidemic situation and Covid-19; nevertheless, all "must-be-done" activities were accomplished regarding the area of the physical protection of nuclear facilities and nuclear and radioactive material.

The Commission's members were also informed of the proposal to amend the second-tier regulations in the area of physical protection, based upon the Ionising Radiation Protection and Nuclear Safety Act. It is anticipated that both pieces of regulation will be approved in 2022.

The Ministry of the Interior issued one decision (approval) regarding physical protection plans, namely for the Krško NPP (a prior opinion was issued by the SNSA).

The Inspectorate of the Ministry of the Interior – based upon its Annual Plan of Activities in 2021 – carried out one inspection control of a nuclear facility (the Krško NPP). The control included supervision of compliance and measures regarding both the main alarm centre and the secondary

alarm centre on-site. The Krško NPP's alarm centre has not been certified within the prescribed timeframe. A decision was issued for such certification to be accomplished by June 2023.

In the scope of the General Police Directorate, several threat assessments were carried out in the course of 2021 for nuclear facilities, as well as a revised threat assessment for the transport of radioactive material (on roads).

Throughout 2021, 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 nuclear facilities. No information was collected regarding criminal groups or individuals threatening the security of nuclear facilities or persons who would attempt to access radioactive material in an unauthorised way.

In 2021, the Ministry of the Interior was also involved in the process of "background checks" (or "security vetting") of foreign nationals, based upon Article 155 of the ZVISJV-1. In total, as many as 641 such procedures were completed addressing foreign nationals. 196 different legal persons (employing foreign nationals) were informed of the outcomes of these procedures. In only one case were security-related concerns present – and a decision was issued on a security concern regarding a person's work in a nuclear facility.

The Ministry of the Interior and the SNSA participated in some virtual meetings, encompassing the issues of "Insider Threat Mitigation" as well as a seminar on good practices and shared experiences from the past IPPAS missions.

In February 2021, a virtual meeting of the Preparatory Committee of the *Convention on the Physical Protection of Nuclear Material* (CPPNM/A) conference was held, organised by the IAEA, with the participation of numerous delegates of States Signatories. By the end of 2021, a string of virtual, "open-ended meetings" had been held; the participants dealt with the agenda and rules of procedures for the conference. The meetings were followed by several Slovenian counterparts (the MFA, the SNSA, the Ministry of the Interior).

In 2021, the collaboration amongst the Ministry of the Interior, the Police, the SNSA, the operators of nuclear facilities, and other relevant organisations in the sphere of physical protection was constructive and appropriate despite the Covid-19 situation.

Reference: [45]

9.6 CYBERSECURITY

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 has been actively involved in cybersecurity since 2012. The SNSA extensively cooperates with the IAEA to develop computer security guidance and exercises and to implement training courses. Since 2015, the SNSA has been coordinating a national cybersecurity working group, which focuses on maintaining the circle of trust, and the exchange of experiences and knowledge.

In 2020, the SNSA produced the content of a new process, No. 10, entitled "Information security". This process was based on the requirements of the *Information Security Act* and the *Decree on Information Security in the State Administration*. In 2021, the process was updated based on the lessons learned.

As part of updating the process No. 10, the SNSA has already started developing new guidelines for the implementation of cybersecurity inspections in nuclear facilities as well as drafting organisational procedures for the SNSA cybersecurity incident response team (CSIRT).

Following the highly successful implementation of the KiVA[2019] exercise, in 2020 and 2021, the SNSA prepared and organised the second national cybersecurity exercise KiVA[2022], which will take place in 2022.

During 2021, the SNSA collaborated with IAEA in the preparation of several technical instructions, assisted the Romanian administrative authority with drafting instructions for inspections in this domain, carried out a full-day training course for employees and operators of nuclear facilities about new cyber threats, as well as organised numerous meetings with the Government Information Security Office and the National Cybersecurity Response Centre SI-CERT (*Slovenian Computer Emergency Response Team*).

9.7 ILLICIT TRAFFICKING IN NUCLEAR AND RADIOACTIVE MATERIALS

At the beginning of 2019, the *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 implemented by waste and scrap metal processing plants, and other waste collectors, waste treatment operators, electrical and electronic waste treatment operators, operators of major post offices, airports, ports, as well as operators of municipal waste management centres, and measures to prevent the excessive exposure of workers and the population, and environmental contamination due to insufficient control over radiation sources of unknown origin, and to prevent major property damage while eliminating the consequences of excessive radiological contamination.

There were a total of 28 authorised providers of radioactivity measurements of scrap metal shipments in 2021. The list of authorised providers of radioactivity measurements of shipments, along with the validity of their authorisation as well as the nature, scope, and the extent of radioactivity monitoring subject to such authorisation is published in Slovenian on the SNSA website.

In 2021, the SNSA issued five new authorisations. The measurement providers stated in their annual reports that they performed a total of 188,625 measurements of shipments in 2021. Increased radiation exceeding 50% of the dose rate of the natural background was detected by six measurement providers in a total of 23 shipments.

To assist and consult with 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 2021, the SNSA dealt with a total of 35 such reports. The majority of interventions were related to the transport of municipal waste (28). In most cases, the source was hospital waste from hospitals using radioactive sources. More information about such interventions is presented in Chapter 2.2.2.

The SNSA regularly receives and to a certain extent analyses information on incidents and trafficking cases in foreign countries. The SNSA disseminates this information appropriately to other Slovenian stakeholders whose scope of responsibilities also includes (combating) illicit trafficking in nuclear and other radioactive material. In 2021, Slovenia (the SNSA) reported to the IAEA Incident and Trafficking Database (ITDB) four "events", namely two "discoveries" of luminous items with ^{226}Ra (a button-like item – the shipment was denied by Italy), one – most probably – luminous switch, the detection and recovery of ^{152}Eu (a radioactive lightning arrestor), and a flask with a U substance (a "historical source", stored for quite some time in the town of Škofja Loka) – which, as with the other items, were transferred to CSRW Brinje.

The annual meeting of the SNSA and other institutions (amongst others, the Financial Administration (Customs), the SRPA, the Market Inspectorate, the Ministry of the Interior, the Civil Aviation Agency, and others) was held in two dedicated virtual-only meetings in September 2021. The first one was special, *per se,* due to the involvement of the IAEA's staff, being directly responsible and dealing with the ITDB. The second, "classical one", followed the usual course, where the stakeholders exchanged their approaches regarding the topic, challenges, as well global issues and patterns, underpinning the need to exchange relevant information also in the future.

The SNSA briefly marked the 25th anniversary of the Slovenian participation in the ITDB in one of the editions of Radiation News in 2021. Also, a poster and an article were prepared in the frame of the annual nuclear conference (NENE 2021), held in Bled, Slovenia, in September 2021. The SNSA's staff again presented the Decree on checking the radioactivity of shipments of metal scrap as well as endeavours to prevent unauthorised trafficking of nuclear and radioactive material in the frame of the annual conference (8th REC2021) in Rimske Toplice, Slovenia, in October 2020.

References: [46], [47], [48]

10 INTERNATIONAL COOPERATION

10.1 COOPERATION WITH THE EUROPEAN UNION

Working Party on Atomic Questions (WPAQ)

In the first half of 2021, Portugal assumed the presidency of the Council of the EU. During this period, the work of the WPAQ was mainly dedicated to coordinating meetings and tasks in the framework of the implementation of the Convention on the Physical Protection of Nuclear Material, the Convention on Nuclear Safety, and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, as well as to concluding the process of implementing regulations on the financing of the decommissioning of nuclear facilities. The European Commission has set up a special expert group to address the financial aspects of decommissioning and the management of radioactive waste and spent nuclear fuel, in which Slovenia also participates, and has organised a mission in Belarus to review the implementation of the recommendations resulting from the stress tests for their nuclear power plant. During the second half of 2021, when Slovenia assumed the presidency of the Council of the EU, new rules of the Euratom Supply Agency (ESA) were adopted, and the negotiations on cooperation with the United Kingdom continued after their exit from the EU. The presiding country presented its activities in the field of nuclear technology and ensuring security, namely the research of the Reactor Physics Department at the JSI and the organisation of the planned international exercise regarding cybersecurity at nuclear facilities (KiVA).

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 2021, the delegates discussed the preparations for the second Topical Peer Review (TPR), established a group for implementing stress tests in Turkey, and took note of the implementation of the Action Plan prepared after the stress tests at the nuclear power plant in Belarus, where the epidemic made it impossible to carry out a full-scale observation mission. A new financial mechanism to assist third countries in ensuring nuclear safety (European Instrument for International Nuclear Safety Cooperation, EI-INSC) was presented. The ENSREG conference was postponed for one year due to the epidemic. 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. The Slovenian representative chaired the working group for natural radionuclides, which mainly dealt with the preparation of a document on radionuclides

in building materials on the basis of the requirements of the Directive on establishing basic safety standards for protection against the dangers arising from exposure to ionising radiation (the BSS Directive). The representative also collaborated in the taxonomy working group, which analysed the results of the technical study to determine whether nuclear energy meets the criteria of technical solutions addressing the struggle against climate change and can thus be financed from EU funds under the so-called Green Deal.

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 system is established and whether it complies with the established requirements (Article 36). In 2021, the respective committee held a virtual meeting with the following main themes: verification processes in the Member States, the presentation of the project entitled "*Inventory of Member States' Environmental Radioactivity Monitoring Systems*", and the development of tools for reporting and collecting data on discharges and measurements in the environment.

The Consultative **Committee under Article 37** has correspondence meetings, as needed, wherein the European Commission provides its opinion on major reconstruction projects or the construction of new nuclear installations. There were no meetings of the Committee in 2021.

10.1.1 Cooperation in EU Projects

Since 2017, the SNSA has 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, as well as the Austrian company ENCO. The SNSA completed most of its project tasks in 2017 and 2018. In 2021, no activities on this project were performed by the SNSA.

The same consortium of the so-called first Iranian project described above applied for the second Iranian project, i.e. "*INSC – Support to the Iranian Nuclear Regulatory Authority – INRA*". For this project, the consortium was augmented by the German company TÜV Nord. The assignments of the SNSA include the further development of the management system of the Iranian regulatory authority, which is also meant for the nuclear safety centre, for which the SNSA developed a feasibility study within the first Iranian assistance project. In 2021, the SNSA was also active in emergency preparedness and prepared two virtual workshops on this topic, as well as drafted the technical specifications for the emergency communication system and an overview of the management system procedures. Due to the unstable political situation in Iran (elections and the new leadership of the INRA) and the epidemic, the project activities have slightly decelerated since workshops and training courses were organised virtually, while other events (e.g. training programmes in the EU) were postponed.

In 2019, the project "*INSC – Support to the regulatory authority of Ghana"* was launched, in which the SNSA has been participating together with the Slovak and the Hungarian regulatory bodies and the company ENCO. The objective of the project is to assist the Ghanaian regulatory body for nuclear safety in strengthening the knowledge and expertise of its staff in order to achieve the highest possible level of regulatory independence. In 2021, the SNSA completed all the tasks regarding the development of a strategic plan of the regulatory body, while the activities regarding the enhancement of the management system are still being carried out. In the area of the strategic

plan, a virtual workshop (so called "on-the-job-training") was organised. In the area of the management system, the SNSA reviewed procedures and co-organised a virtual workshop.

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. In 2021, the SNSA participated in a workshop in Sarajevo on a legislation review of issuing an operating licence for a radioactive waste storage facility and reviewed and complemented drafts of beneficiary rules on licencing, and reviewed safety assessment and inspection procedures. In the third quarter of 2021, the practical training of beneficiary experts was also carried out in Slovenia (so-called "on-the-job training"). This project went on as planned and the epidemic had little impact on it.

In 2020, the SNSA, together with the Slovak and Hungarian regulatory bodies and the company ENCO, was selected to participate in the so-called third Iranian project "*INSC – Enhancing the capabilities of the Iranian Nuclear Regulatory Authority (INRA) for an effective nuclear safety culture and implementation of the highest nuclear safety and radiation protection standards*". The objective of this project is to achieve an effective nuclear safety culture and implementation of the highest nuclear safety and radiation protection standards by the INRA. The SNSA will participate in the review of the implementation of the stress tests action plan, the development of the nuclear safety centre management system, and in drafting the technical specifications for equipment needed for emergency preparedness activities. In 2021, the SNSA was involved in setting up the management system of the nuclear safety centre, while it was not involved in other activities. The epidemic caused significantly fewer working days than originally planned.

In 2020, Slovenia was selected to participate in a European project entitled "*European coordinated action on improving justification of computed tomography*" (EU-JUST-CT), which is used to assess the eligibility of referrals to CT examinations. Therefore, the SRPA will collect data on referrals to all CT examinations carried out in Slovenia during the selected period, and a specially trained group of radiologists selected in cooperation between the European Society of Radiologists and the Slovenian Association of Radiology will evaluate their eligibility in accordance with the prepared methodology.

Reference: [15]

10.2 THE INTERNATIONAL ATOMIC ENERGY AGENCY

Slovenia's close and successful cooperation with the International Atomic Energy Agency (IAEA) continued in 2021. As is the case every year, in September 2021, the Slovenian delegation attended the regular annual session of the General Conference, which due to the epidemic took place in a hybrid form once again. In 2021, the Republic of Slovenia settled all financial obligations to the IAEA.

In 2021, Slovenia received a smaller number of application requests for the training of foreign experts. If the epidemic situation had improved, experts would have been trained. So, only a two-week scientific visit of two Croatian experts at the Institute of Oncology was completed.

The IAEA encourages the dissemination and development of applied science in the field of the use of atomic energy for peaceful purposes. The IAEA closely collaborates with interested Member States, including Slovenia in the field of research and the funding of larger (national) projects within the Coordinated Research Projects (CRPs).

Within the framework of the Technical Cooperation and Assistance Programme, which is implemented in two-year cycles, the current two-year programme started on 1 January 2020 and will last until 31 December 2021.

In 2021, the activities of the national projects of the annual cycle continued to be carried out. The Institute of Oncology, Ljubljana, and the Department of Nuclear Medicine are cooperating in the project 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 Nuclear Safety Administration of the Republic of Slovenia and the Radioactive Waste Agency ARAO SLO/9/020 "*Enhancing the Capacities of the Regulatory Authority and the Implementing Organisation on Radioactive Waste Management for the Safe Operation of Nuclear and Radiation Facilities*" has been carried out since the beginning of 2021 and will continue in 2022.

The training of Slovenian experts through fellowships and scientific visits is carried out within national technical assistance projects as well as some regional and interregional ones.

In 2021, a limited number of workshops, training programmes, seminars, and conferences took place in person due to the epidemic, and most of them were organised virtually by IAEA. Slovenia was planning to organise three workshops on the following subjects: safety culture, the aftermath of a nuclear accident, and digital instrumentation systems in nuclear power plants. The first two events were eventually carried out virtually, while the third one took place in Ljubljana. Although the IAEA had to organise several international events in virtual form, Slovenian experts actively participated in IAEA activities by presenting papers and posters, and also contributed as experts and lecturers in IAEA missions and meetings.

Slovenia is involved in the work of committees established within the Safety Standards Commission. Namely, in EPReSC – the Emergency Preparedness and Response Standards Committee, NUSSC – the Nuclear Safety Standards Committee, RASSC – the Radiation Safety Standards Committee, TRANSSC – the Transport Safety Standards Committee, WASSC – the Waste Safety Standards Committee, and NSGC – the Nuclear Security Guidance Committee.

A Slovenian representative has also been nominated to the Steering Committee on Denials of Shipment of Radioactive Material.

At the end of 2021, the IAEA projects in the field of the use of ionising radiation in healthcare were concluded. The SRPA participates in a project (RER/6/038 "*Applying Best Practices for Quality and Safety in Diagnostic Radiology*") aimed at improving quality and safety in diagnostic radiology primarily in terms of quality assurance and verification. The project is also aimed at training key professionals, including a practical part, thus the implementation of project activities was mostly not transferred to a virtual form, but the majority of the activities were focused on the preparation of a "manual" for the implementation of technical quality control of X-ray devices. The other project with the involvement of the SRPA is entitled "*Enhancing Member States' Capabilities for Ensuring the Radiation Protection of Individuals Undergoing Medical Exposure*", which is aimed at improving the radiation protection system in the medical use of ionising radiation, with an emphasis on strengthening cooperation between the competent administrative authorities and professional associations, and on the implementation of international safety standards (the IAEA GSR Part 3) in the medical use of ionising radiation. Slovenia is primarily interested in optimisation with an emphasis on the design of diagnostic reference levels for CT examinations of paediatric patients, the design and implementation of guidelines for referrals to radiological examinations, and improving emergency reporting systems in radiotherapy and radiological examinations with high patient exposure. In 2021, in cooperation with the IAEA regarding the application of ionising radiation in healthcare, a Slovenian representative attended the coordination meetings of these projects and various online seminars organised by the IAEA on a significantly larger scale than before the start of the Covid-19 epidemic.

The SRPA has been participating in IAEA regional projects in the field of radon since 2014. In 2018, a four-year regional project "*Enhancing the Regional Capacity to Control the Long-term Risk to the Public due to Radon in Dwellings and Workplaces*" was launched. The objective of the project is to assist the countries of Eastern Europe and the former Soviet Union in the implementation of the national radon programmes, and monitoring and building awareness of the risks due to radon in the living and working environment. The SRPA is responsible for coordinating participation in workshops, training course,s and other meetings in this field. In May 2021, a SRPA representative attended a workshop entitled "*Regional Workshop on Protection against Radon in Workplaces*". The SRPA reported on Slovenia's progress and exchanged experiences with other countries. The countries were instructed on how to proceed with the work in their respective countries. Due to the epidemic, most workshops were carried out in virtual form. Despite the problems due to the epidemic, the project is on-going and is expected to be successfully completed with a workshop in Athens in May 2022.

Reference: [15]

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 the safe, environmentally sound, and economical use of nuclear energy for peaceful purposes. Slovenia has been a full member of the NEA since 2011.

In 2021, Slovenian representatives participated in eight standing committees as well as in several working groups within the committees. Due to the epidemic, the regular committee and working group meetings were mostly held virtually. The Steering Committee, which is the governing body of the NEA and oversees the work of the standing committees, held two regular meetings. The Regulators' Forum was also organised during the Radioactive Waste Management Committee meeting. 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; the Slovenian representatives also participated in the Working Group on Human and Organisational Factors. Slovenian delegates took part 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 several meetings of the Contracting Parties to the Paris Convention were also organised by the NEA. Slovenian representatives also participated in the regular yearly meetings of the Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle, the Nuclear Science Committee, as well as the Committee on Radiological Protection and Public Health.

Slovenia is also active 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 2021, the representative of the SRPA participated in the ISOE management board regular meeting.

In 2021, the Nuclear Energy Agency also discussed the development of its strategic plan for the period from 2023 to 2028: the member states as well as the standing committees participated in the discussion. At OECD level, a new IPAC (International Plan for Action on Climate) programme was launched, which is expected to last two years, comprising action control activities, peer reviews, dialogue and joint learning, data collection, and the preparation of new policies, including economic

instruments. The new FIDES (Framework for Irradiation Experiments) project will consist of a network of reactors and experimental installations that will allow further research to verify the properties of materials, specifically studying the behaviour of materials at different temperature, pressure, and radiant loads, which could no longer be carried out after the closure of the Halden reactor in Norway. The Slovenian representative also took part in the launch of activities in the new Task Group on Improving the Gender Balance in the Nuclear Sector (GB-TG).

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 objectives of WENRA are to develop a common approach to nuclear safety, to provide independent reviews of nuclear safety in candidate countries for accession to the EU, and to exchange experiences in the field of nuclear safety. The Association consists of eighteen member states and thirteen observers, also including non-European states.

During the virtual plenary meeting, the participants founded a working group for the second TPR, which prepared proposals for relevant technical basis, including technical specifications that need to be established on the Safety Reference Levels (SRL) and focused on differences in implementation among countries. The first SRL periodic review of 2014 is expected to be completed in 2024 and will include ongoing working groups. With regard to the expansion of membership, a decision was taken that the US and Canadian regulatory bodies should join WENRA. Delegates reviewed the implementation of the Association's strategy and found that the objectives were properly met. The Slovenian representatives also actively participated in WENRA working groups, namely the Reactor Harmonisation Working Group, the Working Group on Waste and Decommissioning, and the Working Group on Research Reactors.

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.

INLA operates in six working groups, namely: Safety and Regulations, Nuclear Liability and Insurance, International Nuclear Trade/New Built, Radiological Protection, Waste Management, Nuclear Security and Non-Proliferation, Transport and Nuclear Fusion.

As a rule, the INLA organises a congress every two years, the last one was in Abu Dhabi in 2018, and the Congress, which was scheduled for 2020 in Washington, was postponed for one year due to the Covid-19 epidemic and was postponed again in 2021 and is to be held from 23 to 27 October 2022.

In 2005, the INLA congress was organised in Portorož, Slovenia.

The European Nuclear Security Regulators Association

The European Nuclear Security Regulators Association (ENSRA) is an association consisting of 16 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.

The regular annual (plenary) meeting did not take place in person due to the epidemic. Nevertheless, a virtual meeting was held in June 2021 devoted to a set of themes, e.g. the formation of the ENSRA's Troïka in the nearer future (France will join in 2022, Slovenia will follow in 2023), preliminary exchanges of views regarding the forthcoming CPPNM/A conference, co-operation with other organisation, etc.; in 2021, a short, dedicated ENSRA document on nuclear security-related inspections was published. The association was headed by the representative of the Finnish regulatory body (STUK). The next meeting is foreseen at some time in 2022. In April 2021, the SNSA endorsed ENSRA's newest Terms of Reference (also on behalf of the Ministry of the Interior).

On 19 October 2021, the SNSA hosted a meeting of the ENSRA and WENRA joint working group, which is working on a unified approach to the preparation of cybersecurity legislation in nuclear facilities. The central topic was the presentation of existing cybersecurity systems in the nuclear sector by French, British, and Slovenian participants.

Reference: [49], [50], [51]

The 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.

A number of thematic areas have resulted from past summits and different groups of states have been set up to promote these endeavours. In September 2018, Slovenia (through the Ministry of Foreign Affairs) officially sent a letter (*note verbale*), stating that it would join two specific initiatives, i.e. INFCIRC/910 (the security of high-activity radioactive sources) and INFCIRC/918 (countering nuclear smuggling). In 2020, the SNSA co-operated with the Ministry of Foreign Affairs (and the Ministry of the Interior, too) to become an associate member of INFCIRC/908 – the initiative on mitigating insider threats.

There were no special (plenary-like) meetings of NSCG in 2020 or 2021 – due to the epidemic and Covid-19. Referring to the initiative under INFCIRC/908, it is worth mentioning an invitation to Slovenia (the SNSA) to take part in a virtual panel on insider threats in the framework of the international INMM/ESARDA conference at the end of August 2021.

Reference: [52], [53], [54], [55], [56], [57], [58]

CAMP (NRC)

An agreement with the US NRC (the United States Nuclear Regulatory Commission) 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 programmes that are developed under the programme. The latest versions of software tools are currently available to users.

For 2021, the JSI prepared a contribution entitled "RELAP5 and TRACE simulation of the Bethsy 9.1b test with accuracy quantification"

At the CAMP 2021 autumn meeting, the JSI presented a 2022 in-kind contribution entitled "RELAP5 and TRACE simulation of the total loss of feedwater in two-loop PWR", which was

approved by the Technical Programme Committee. For this in-kind contribution, it is proposed to use the TRACE computer programme to analyse the scenario of the extended project disaster loss of the entire power supply for the NEK power plant. At the virtual "Spring 2021 CAMP Meeting", a JSI representative presented a paper entitled "TRACE and RELAP5 comparison of simulations for Semiscale natural circulation tests S-NC-2 and S-NC-3". At the fall 2021 CAMP Meeting, a JSI representative presented the contribution "Status of CAMP Activities in Slovenia".

The representatives of the Slovenian CAMP members met in June and December 2021 at virtual working sessions, where the national coordinator presented 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 Programme). 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 programme MELCOR for the simulation of severe accidents in nuclear power plants.

In 2021, the representatives of the Slovenian and Croatian CSARP institutions had an online working meeting. The National Coordinator presented the status of CSARP research in Slovenia, past activities, attendance at the virtual CSARP/MCAP (MELCOR Code Assessment Programme) meeting, fusion MELCOR activity, as well as the realisation of plans. Additionally, the representative pointed out the issue of funding MELCOR activities. The participants of the meeting agreed that even with consideration of the planning of the second nuclear power plant, it would make sense to provide the JSI with sufficient long-term stable funding for MELCOR activities. This would allow the JSI to set up a team to carry out analyses using the MELCOR programme, which would also include younger researchers to whom knowledge would be passed on. At the meeting, the FER representative (Faculty of Electrical Engineering and Computing) gave an overview of the status of the CSARP research programme in Croatia.

The 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 online meetings in 2021.

The SRPA also participates in the HERCA working group on medical applications of ionising radiation. As the Covid-19 epidemic has had a profound impact on the work of all administrative authorities, especially those related to the functioning of health systems, the regular activities of the working group have been impaired, and communication between the competent administrative authorities on the response to the epidemic played an important role in 2021.

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 the organisation of personal dosimetry 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 as the Network of National Dosimetry Registries within the framework of HERCA. In 2021, the results of a questionnaire for regulatory authorities on the registration of the personal doses of exposed workers were collected and presented to the HERCA Committee.

In 2021, two representatives of the SNSA who take part in the HERCA WGE – Working Group on Emergencies attended two regular meetings online where the collaboration with WENRA was discussed, in particular the coordination of emergency preparedness (criteria for safeguards, cross-border cooperation, the monitoring strategy for radioactivity during an emergency and the exchange of measurements, etc.). One of the tasks that Slovenia has in this group is to prepare Country Fact Sheets of member states with key information on the preparedness and response to nuclear and radiological disasters in European countries.

The 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 an 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 2016, the SNSA has taken part in the work of the EACA.

The annual, "in-person" meeting of the Association, scheduled for 2021 was (again) postponed until 2022. Nevertheless, two virtual meetings were held in May and October. They were devoted to a number of themes, e.g. denials of shipments of radioactive material, national transport-related approaches and briefings, co-operation with the IAEA (TRANSSC), etc. The representatives were active in reviewing some changes brought up by the ADR-2021 revision.

Reference: [59]

The European ALARA Network

Along with 20 other 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.

Reference: [15]

10.5 AGREEMENT ON THE CO-OWNERSHIP OF THE KRŠKO NUCLEAR POWER PLANT

In 2021, the Intergovernmental Commission of the Krško NPP met only once at a meeting in Bled on 20 October 2021. The Intergovernmental Commission discussed the operations of the Krško NPP since its previous 14th session on the fulfilment of the objectives of the third revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste and Spent Nuclear Fuel from the Krško NPP, the start of the preparation of the fourth revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste and Spent Nuclear Fuel from the Krško NPP, and a report on the state of funds

collected in the Slovenian and Croatian funds for financing the decommissioning and storage of the radioactive waste and spent nuclear fuel of the Krško NPP.

The Intergovernmental Commission received a report from the Krško NPP's management regarding the operations of the plant and assessed that the Krško NPP achieved excellent work, safety, and economic results, and operated responsibly, safely, and reliably.

At the 15th session, the Intergovernmental Commission also appointed a Coordination Committee to monitor the takeover of low- and intermediate-level radioactive waste from the Krško NPP in 2023-25 by the Slovenian Radwaste Agency and the Croatian Fund, and to monitor the preparation of the fourth revision of the Krško NPP Decommissioning Programme and the Programme for the Disposal of Radioactive Waste and Spent Nuclear Fuel from the Krško NPP. The Coordination Committee, together with the Krško NPP, the Radwaste Agency, and the Fund, was tasked with preparing a report by the next Intergovernmental Commission's session on the activities related to the handover of low- and intermediate-level radioactive waste from the Krško NPP to the Radwaste Agency and the Fund in the years 2023-25. The Intergovernmental Commission also instructed the Coordination Committee to coordinate the agreement regarding the servicing of the low- and intermediate-level radioactive waste takeover at the Krško NPP site in an appropriate form at the expense of one and/or the other party. Meeting the acceptance criteria for disposal or long-term storage remains the responsibility and under the authority of the ARAO and the Fund. The Intergovernmental Commission also took note of the reports on the state of funds collected in the Slovenian and Croatian funds for financing the decommissioning and storage of the radioactive waste and spent nuclear fuel of the Krško NPP as of 31 December 2020.

Reference: [60]

10.6 COOPERATION WITHIN THE FRAMEWORK OF INTERNATIONAL AGREEMENTS

10.6.1 Bilateral Agreements

In 2021, 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, did not take place. The main objective of such meetings is to share experiences and inform each other of important developments in the field of nuclear safety. Therefore, the participating countries only exchanged short written summaries of the important events.

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 held on 4 and 5 October 2021 in Ljubljana. The participants exchanged information, experiences, and updates in the areas of legislation, radiological monitoring, emergency preparedness, radioactive waste management, the operation of research reactors in both countries and the Krško NPP. Both countries have concluded the transposition of the provisions of the relevant European Union directives into domestic legislation, and the Austrian delegation also reported on continued modernisation of the Austrian national waste management facilities in Seibersdorf. Slovenia also reported on the status of a new low- and intermediate-level radioactive waste repository in Vrbina near Krško, the operation of the Krško NPP, the performed regular outage, and the NPP Safety Upgrade Programme, especially the construction of a dry storage for spent nuclear fuel and the upgrading of systems for the safe shutdown of a power plant in the event of a severe nuclear accident. Slovenia also presented the SNSA action during the Petrinja earthquake in December 2020 and the reasons for the automatic shutdown of the power plant.

On 10 December 2020, a regular annual meeting following the bilateral agreement with the Republic of Croatia on the early exchange of information in the event of radiological danger took place in a form of a video conference.

Participants presented innovations in both administrative bodies in the areas of legislation, emergency preparedness, and the implementation of radiological monitoring. Both countries are coordinating legislation with the European acquis and are preparing changes or new national programmes for the management of radioactive waste. The Slovenian side invited its Croatian colleagues to participate as observers in the Emergency Response Centre at the SNSA in one of the future exercises in the event of an emergency in the Krško NPP, and both bodies will continue the process of coordinating safeguards in the event of an emergency at the Krško NPP. Slovenia presented a project on renovating the early warning system for measuring radioactivity in the environment, while the Croatian side presented a process for exchanging data from its similar system. Both sides stressed the importance of continued good and regular cooperation and effective communication and information in all areas of nuclear and radiation safety.

10.6.2 The Convention on Nuclear Safety (CNS)

The eighth review cycle according to the Convention on Nuclear Safety should have been concluded in spring 2020 by holding the review meeting of the contracting parties, which was postponed due to the epidemic. In December 2020, the meeting chair, Ms Dana Drabova, sent a written notice to all contracting parties with a proposal on how to continue and conclude the eighth review cycle. The main point was to hold a joint meeting for the eighth and ninth review cycles in 2023.

From 23 to 25 March 2021, a meeting of CNS officials was held in Vienna, where all officials of this cycle were invited to retain their duties and perform them during the ninth cycle or at the ninth review meeting. They also decided that a joint review meeting for the eighth and ninth cycles would be held in March 2023 and that the groups of countries from the eighth cycle should be maintained in the ninth cycle.

On 20 October 2021, there was a meeting of the CNS contracting parties, where they confirmed the composition of the groups of countries for the joint eighth and ninth review meetings. The list was supplemented by members joining the CNS after the organisation's meeting for the eighth review meeting. Slovenia is in the second group, along with France, Spain, the Czech Republic, the Netherlands, and Belarus as nuclear states, and non-nuclear Libya, Niger, Portugal, Syria, Australia, Cuba, and Morocco.

At the meeting, delegates agreed on establishing a working group to discuss proposals to improve the review process. Concrete proposals from the working group will be submitted by the parties for consideration at the joint eighth and ninth review meeting. The meetings of this working group will take place at the IAEA headquarters in Vienna in 2022.

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

At the end of 2021, the Joint Convention was in effect in 86 countries, including Slovenia.

The 7th national report, prepared in 2020, will be presented at the seventh review meeting of the Contracting Parties, which, due to the Covid-19 crisis, was postponed from 2021 to 2022, and is to be held in Vienna from 27 June to 8 July 2022.

During the 7th review cycle, the national reports of other contracting parties were reviewed in 2021. Slovenia posted ninety-four questions to twenty-three countries, and received seventy-one questions from sixteen contracting parties, to which it had to answer by the end of March 2022.

11 USE OF NUCLEAR ENERGY IN THE WORLD

As of the end of 2021, there were 441 nuclear reactors for electricity production operating in 32 countries. There are 53 nuclear reactors under construction, of which the construction of 10 nuclear power plants began in 2021: 6 in China, 2 in India, and one in each in Turkey and Russia. There were six new grid connections – three in China and one each in India, Pakistan, and the United Arab Emirates. In 2021, ten nuclear power plants were permanently shut down, three in both Germany and Great Britain, and one in each of the following countries: the United States of America, Russia, China, and Pakistan.

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

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

Table 11: The number of reactors in 2021 by country and their installed power

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
Belarus	1	1,110	1	1,110
Belgium	7	5,942		
Bulgaria	2	2,006		
The Czech Republic	6	3,934		
Finland	4	2,794		
France	56	61,370	1	1,630
Hungary	4	1,916		
Germany	3	4,055		
The Netherlands	1	482		
Romania	2	1,300		
Russia	37	27,727	4	3,759
Slovakia	4	1,868	2	880
Slovenia	1	688		
Spain	7	7,121		
Sweden	6	6,882		
Switzerland	4	2,960		
Turkey			3	3,342
Ukraine	15	13,107	2	2,070
The United Kingdom	1	6,848	2	3,260
Europe total	**161**	**144,152**	**15**	**16,051**
Argentina	3	1,641	1	25
Brazil	2	1,884	1	1,340
Canada	19	13,624		
Mexico	2	1,552		
USA	94	95,523	2	2,234
Americas total	**119**	**114,224**	**4**	**3,599**

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
Armenia	1	448		
Bangladesh			2	2,160
India	23	6,885	8	6,028
Iran	1	915	1	974
Japan	33	31,679	2	2,653
China	50	52,170	15	15,002
The Republic of Korea	24	23,091	4	5,360
Pakistan	6	3,256		
Taiwan	3	2,859		
The United Arab Emirates	2	2,762		
Asia and the Middle East total:	**146**	**121,303**	**31**	**31,203**
South Africa	2	1,854		
World total	**428**	**381,533**	**50**	**50,853**

Reference: [35]

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. There were no events in Slovenia in 2021 that would require reporting according to the INES criteria. The events in the Krško NPP in 2021 were rated at level 0 on the INES scale or were not rated in cases where the INES criteria were not applicable.

INES events in the year 2021

In 2021, 13 event reports were published via the NEWS system. There was one event rated at level 3, eight events rated at level 2, three events rated at level 1, and one event rated at level 0. The reports were divided into the following groups: three events at NPPs, one event in a research reactor, one event in a spent fuel storage, one event involving the exposure of personnel in medicine, six events involving the exposure of workers during the performance of radiography, and one event involving a radioactive source that was stolen and later found.

The worst event in 2021 occurred at a Japanese steelworks during the inspection and calibration of an X-ray meter. Two workers repaired the X-ray device while it was still powered because they believed that they had closed the irradiation window shutter before entering the irradiation room. But the shutter was open and the workers were exposed to the X-rays. The next day the workers observed irradiation symptoms and they were admitted to a hospital, where they remained for treatment for the next six months. The event was rated at level 3 on the INES scale based on the observed deterministic effects of the irradiation of the two workers. The exposure assessment of the workers during the event is still being examined and will be reported when the investigation is completed.

Two events at NPPs were a consequence of automatic shutdowns due to a loss of external electric power. At the first NPP, which has two units, after the loss of the electric power supply, two gas turbines automatically started and provided an emergency power supply. The cooling of both reactors was provided by an emergency feed pump, while other pumps did not start, because one was in maintenance, and two others did not start due to an automatic control system issue. The cooling was adequate. The event was rated at level 2 on the INES scale based on the degradation of defence in depth, because three feed pumps did not work. Another event occurred at a NPP with four units, where strong electric grid fluctuations resulted in changes in the frequency and voltage of the plant equipment, which led to the automatic shutdown of four reactors. The electricity supply was provided by emergency diesel generators with an automatic start. Only one diesel generator of unit 3 did not automatically start, which was later started manually. The event was rated as a level 0 event because all safety functions were ensured during the event.

The third event at a NPP was the external contamination of a worker with a hot particle during the performance of a valve sealing check. Based on an estimate of the equivalent dose to the worker's skin, which exceeded the annual limit, the event was rated as level 2 on the INES scale.

An event in a research reactor occurred during the production of medical isotopes where the reactor operated outside the authorised limits. The defence in depth for a possible reactor criticality event was degraded and the assigned rating of level 2 reflects the safety culture issues of the operational staff.

In an interim spent fuel storage facility, the required nitrogen pressure has to be maintained. The pressure drop in one of the monitoring spaces required the refill of nitrogen, but the operator did not perform all the required measures from the facility's operational limits and conditions. Based on the safety culture inadequacies, the event was rated at level 1 on the INES scale.

An event in a hospital occurred during the injection of a diagnostic radiopharmaceutical into a patient when some liquid was spilled on the hand of the medical worker. In spite of hand protection with a rubber glove, the equivalent dose to the skin was assessed as 517 mSv, which is above the annual limit. The event was rated at level 2 on the INES scale.

Other than the above-mentioned level 3 event in Japan, there were reports of five other events with doses during the performance of radiography. Four events were rated at level 2 based on exceeded dose limits and one event was rated at level 1 based on the degradation of defence in depth. The events were caused by different malfunctions of radiography devices, with the contributing causes including the poor safety culture of the workers, such as the practice of not wearing personal dosimeters while performing radiography or missing procedures for coping with an event.

An event was reported where a radiographic camera was stolen with an ^{192}Ir source of 2.023 TBq activity, which is a category 2 source. Robbers stopped the vehicle transporting the source and stole the vehicle along with the source. Two days later, the source was found in the intact shielding. The event was rated according to the degradation of defence in depth as a level 1 event on the INES scale.

Other Internationally Interesting Events in 2021

The IAEA website for reporting emergencies posted reports on other events in 2021 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.

International attention was attracted by an event at a NPP where the increased activity of the primary coolant was caused by fuel rod cladding leakage. The operational limits were not breached and there were no radioactivity releases into the environment, which was also confirmed by environmental radiation monitoring.

An emergency at a NPP attracted wide attention when a fire in the main electrical transformer occurred. It was extinguished within 15 minutes and the NPP was shut down. The fire did not affect the safety systems, plant staff, or the environment. The report notified that the INES rating was level 0.

A third event at a NPP was a minor leakage of secondary non-radioactive coolant. The repairs required plant shutdown, while the nuclear safety of the plant was not affected.

In 2021, several seismic events were reported. Three earthquakes affected NPPs in the northeast of Japan. These earthquakes did not damage any equipment and the NPPs had already been shut down since the Fukushima accident in 2011. There were no tsunamis caused by earthquakes.

Two events were caused by exposure during the performance of radiography and while entering a room in which X-ray measurements of layer thickness were being carried out. The equivalent doses to the workers were much higher than the annual limit and they received medical treatment. Exact data on the health consequences were not published. However, based on the reported description, both events could be rated at least at level 2 on the INES scale.

Four events related to found or lost radioactive sources. In a scrap metal transport, a source was found with a serial number that made it possible to track its provenience and research how control over the source was lost. Another event was reported regarding abandoned sources of a known producer that is no longer operating. Possibilities were explored for the treatment of these devices

for the separate storage of radioactive material. The third event was the notification of a missing category 4 source that was used for the level measurement of liquids. The search action at scrap metal collectors was not successful. The fourth event was the notification of 15 missing sources for soil moisture measurements that disappeared from an area affected by armed conflict in Syria. The serial numbers and activities of the sources were notified. According to the INES criteria, these four events would be rated at level 1 in cases where there was no exposure of the population by the sources; however, this cannot be concluded for some of these events.

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