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

Annual Report 2015 on Radiation and Nuclear Safety in the Republic of Slovenia

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August 2016

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

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

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SUMMARY

In 2015 there were no significant events in the field of nuclear safety and radiation protection. The Krško Nuclear Power Plant operated without any major problems. The annual electricity production was slightly lower than in the record year before due to the regular spring outage. Fuel damage occurred before the scheduled outage, therefore a significant design modification of the core bypass flow was implemented, which is likely to eliminate similar problems in the future.

The intergovernmental Slovenian-Croatian commission for monitoring the performance of the contract on the ownership of the Krško NPP met after several years in summer 2015. It confirmed the owners' intention, the Slovenian company GEN Energija and the Croatian Hrvatska Elektroprivreda, to extend the operational lifetime of the NPP from 2023 until 2043. They also confirmed the project for the construction of the dry storage of spent fuel at the NPP site and the preparation of the new Programme for Decommissioning and Disposal of Radioactive Waste.

The Krško NPP has submitted an application for the extension of the period for the implementation of planned safety updates in order to prolong the operational lifetime of the NPP and on the basis of the lessons learned from the Fukushima accident in 2011. Due to the complexity and cost, it will not be possible to fully carry out the projects by 2018, therefore the anticipated deadline for the implementation will be extended for two fuel cycles – until the year 2021. Part of the projects have already been implemented.

ARAO, the Agency for Radwaste Management, has continued its activities for building a low- and intermediate-level radioactive waste disposal site in Vrbina, Krško, which is expected to start its trial operation in 2020. In the future, it would be reasonable to slightly amend the legislation in this area, because now the ARAO has problems due to the certification programmes being delayed by the Government and the delay in the signing of appropriate agreements.

The long-term management of the Jazbec mine waste disposal site at the former Žirovski Vrh uranium mine was assumed by ARAO. The execution of two studies on the Boršt hydrometallurgical tailings were ordered by the Ministry for the Environment and Spatial Planning. These two studies should form the basis for completing the remediation of the disposal site and handing over its long-term management to the ARAO.

In 2015 there were no major problems at the organisations and institutions that carry out radiation activities. At the same time, there were only a few interventions with regard to finding sources of ionising radiation in the field.

On 23 September 2015, the National Assembly of the Republic of Slovenia adopted amendments to the Act on Ionising Radiation Protection and Nuclear Safety, which has been in preparation for two years, but could not be adopted due to the change in government in 2014. The amendment of the Act simplifies certain administrative procedures and introduces a number of additions due to the latest findings.

In 2015 the SNSA prepared the Resolution on the National Programme for the Management of Radioactive Waste and Spent Fuel Management for the period 2016-2025. The public debate and interdepartmental coordination were carried out by the end of 2015, so its adoption is scheduled for 2016.

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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 communicating recent developments in the area of ionising radiation protection and nuclear safety to the general public. 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.

In creating the report, the Slovenian Nuclear Safety Administration (SNSA) performs the role of editor, while the content of the report is also provided by other state bodies whose competences include ionising radiation protection and nuclear safety, as well as other institutions in this area. Of these, the most important are 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 Administration of the Republic of Slovenia for Food Safety, Veterinary and Plant Protection, the Ministry of the Interior, the Agency for Radwaste Management (ARAO), the Nuclear Insurance and Reinsurance Pool, the Krško Nuclear Power Plant (Krško NPP), the Žirovski Vrh Mine d.o.o., Jožef Stefan Institute (JSI), the Institute of Occupational Safety (IOS) and the Fund for Financing the Decommissioning of the Krško Nuclear Power Plant and Disposal of Radioactive Waste from the Krško NPP, and others.

The year 2015 passed, as did 2014, without any major accidents, therefore we can summarise that the fundamental objective of nuclear and radiation safety was definitely 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 includes all details and data that might be of interest to the narrower group of professionals. It is available on the SNSA website.

2 OPERATIONAL SAFETY

2.1 Operation of Nuclear and Radiation Facilities

2.1.1 Krško Nuclear Power Plant

Annual production of electricity in Krško NPP was 5,648,288.7 MWh (5.6 TWh) gross and 5,371,662.3 MWh (5.4 TWh) net. In the spring of 2015 a regular refuelling outage was carried out, during which the fuel was replaced and all necessary regular maintenance was carried out. During the outage an important change was also made that is likely to eliminate damage to nuclear fuel, which occurred due to baffle jetting – a jet of water being forced through gaps between the baffle plates that impinged on some of the fuel rods in the core. The upflow conversion changed the coolant flow path between the core barrel and the baffle plate from the downflow direction to upflow.

2.1.1.1 Operation and Performance Indicators

The most important performance indicators of the Krško NPP are shown in Table 1, 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 2015

Safety and performance indicators	Year 2015	Average (1983–2015)
Availability [%]	89.36	86.89
Capacity factor [%]	92.07	85.47
Forced outage factor [%]	0	1.04
Gross production [GWh]	5,648.29	5,115.24
Fast shutdowns – automatic [number of shutdowns]	0	2.27
Fast shutdowns – manual [number of shutdowns]	0	0.15
Unplanned normal shutdowns [number of shutdowns]	0	0.73
Planned normal shutdowns [number of shutdowns]	2	0.82
Event reports [number of reports]	8	4.30
Duration of the refuelling outage [Days]	36.0	50.1
Fuel reliability indicator (FRI) [GBq/m^3]	$1.52 \cdot 10^{-2}$	$6.73 \cdot 10^{-2}$

The operation of the Krško NPP in 2015 is shown in Figure 1. It can be seen that the Krško NPP's operation in 2015 was stable. Besides the shutdown due to the regular refueling outage, the plant was shutdown one other time, due to the replacement of the reactor coolant temperature detectors. In the summer months, net energy production was lower due to the Sava River flow being lower and the use of cooling towers.

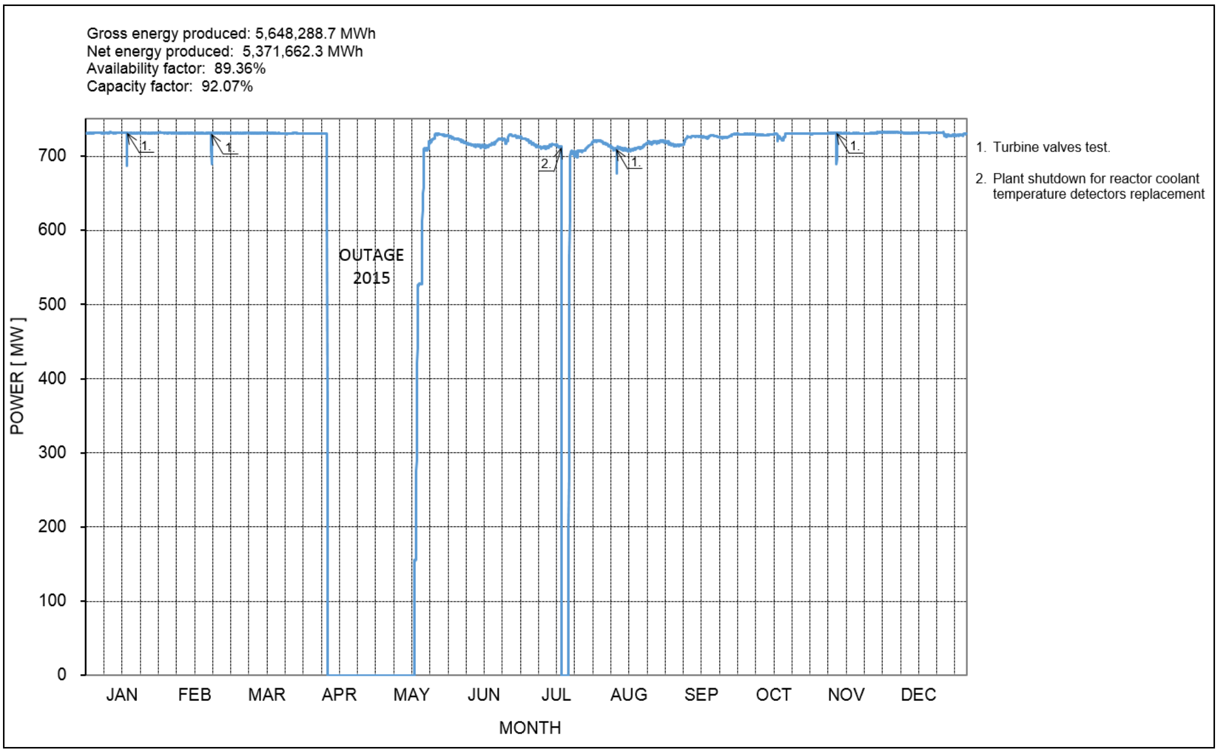


Figure 1: Operating power diagram of Krško NPP in 2015

Figures 2 and 3 show the number of plant shutdowns.

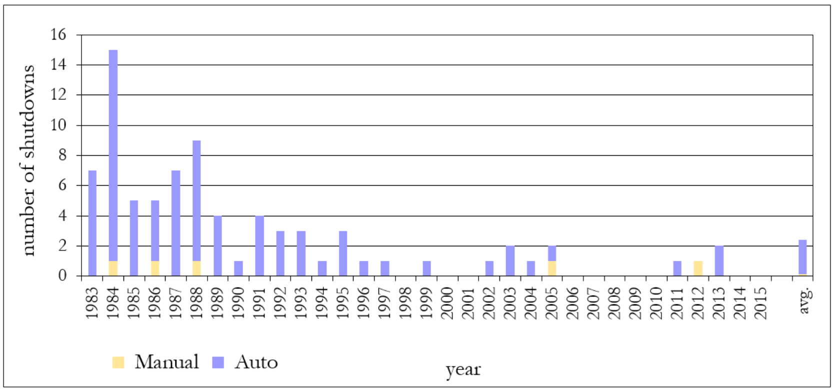


Figure 2: Fast reactor shutdowns – manual and automatic

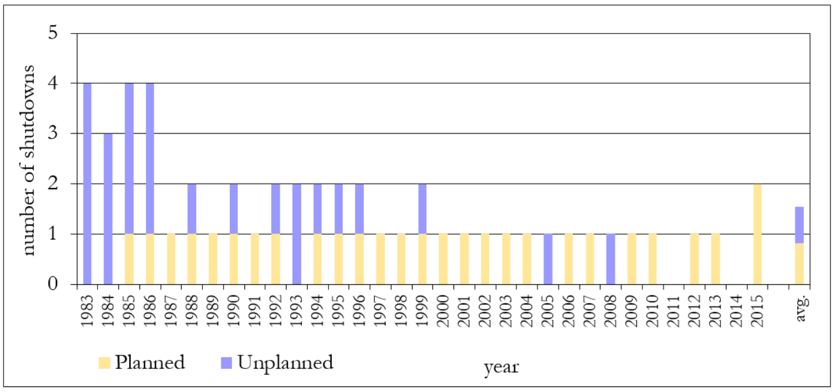


Figure 3: Normal reactor shutdowns – planned and unplanned

In 2015 there were two normal shutdowns, one due to a refueling outage and the other due to the replacement of the reactor coolant temperature detectors. There were no fast reactor shutdowns in 2015.

Figure 4 presents the availability factor. In 2015 the plant was not available during the regular refueling outage and the July shutdown for the replacement of the reactor coolant temperature detectors, thus its availability factor was 89.36%.

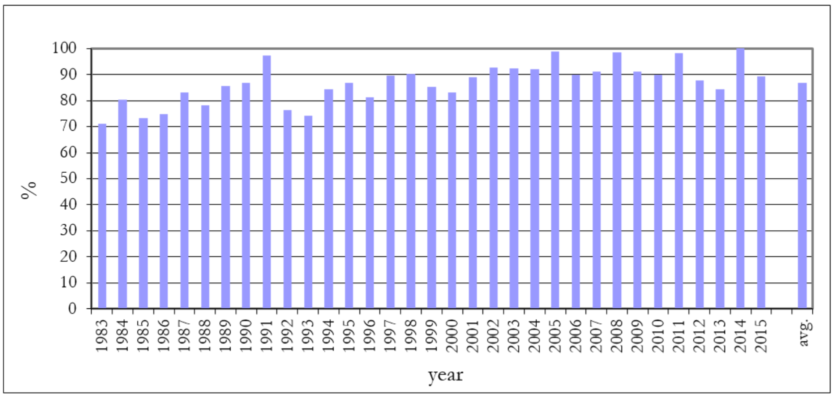


Figure 4: Availability factor

Figure 5 presents data on different means of electrical energy production in Slovenia, specifically electricity production in nuclear, hydro, thermal, and solar power plants. In 2015 the production of electrical energy reached a value of 14.4 TWh, which is less than previous years mostly due to the lower production of the hydro power plants and the Krško NPP.

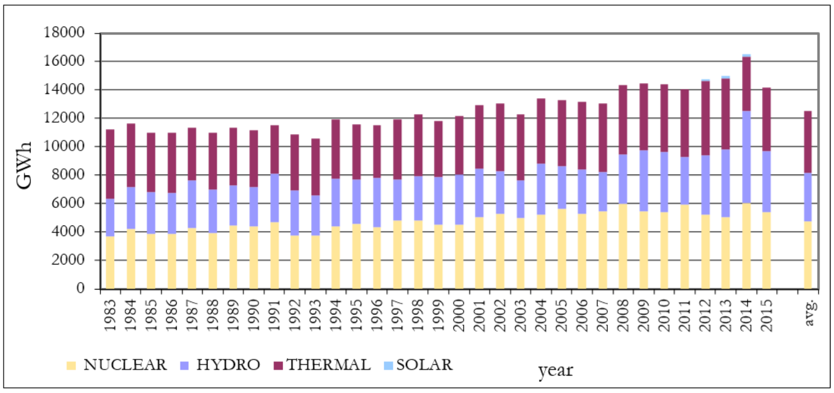


Figure 5: Production of electrical energy in Slovenia

Figure 6 shows the unplanned capability loss factor. It is calculated as the rate between the unplanned loss of energy generation and the reference energy generation (maximum energy generation under average weather conditions). A low value of this indicator shows good maintenance of important equipment. In 2015 the Krško NPP had some energy losses due to a one-day outage extension, thus the value of this indicator is 0.31%.

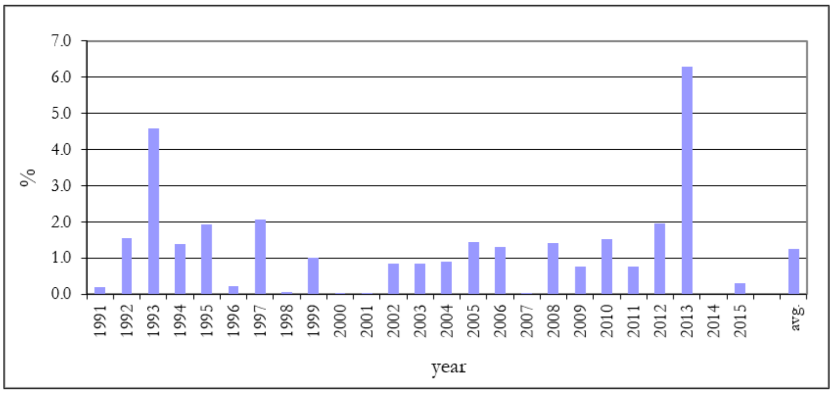


Figure 6: Unplanned capability loss factor

The collective exposure to radiation is shown in Figure 7. The low value of this indicator shows high effectiveness of exposure control, as well as the commitment of management to radiological protection. In 2015 the value of this factor was 790.19 man mSv, which is a value similar to other years with a refueling outage.

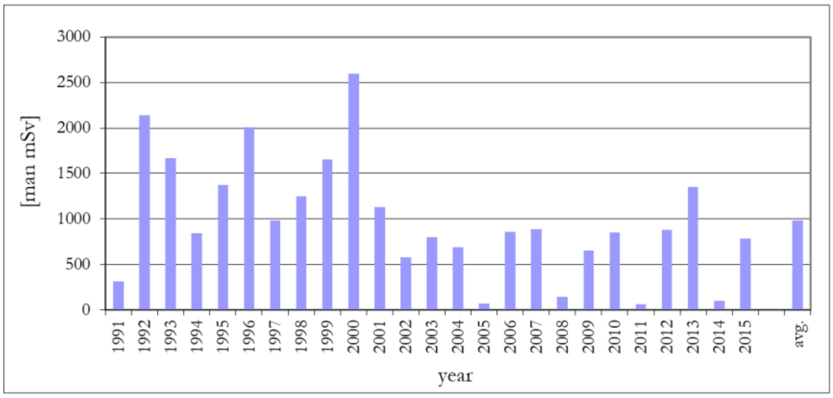


Figure 7: Collective exposure to radiation in the Krško NPP

The purpose of the unavailability factors given in Figures 8, 9 and 10 is to show whether important safety systems can ensure their function in the event of an accident.

Figure 8 shows the unavailability factor of the safety injection system. In 2015 the value of this factor was 0.0013, which is less than the Krško NPP's goal value (0.005). All unavailability of this system was due to planned on-line maintenance.

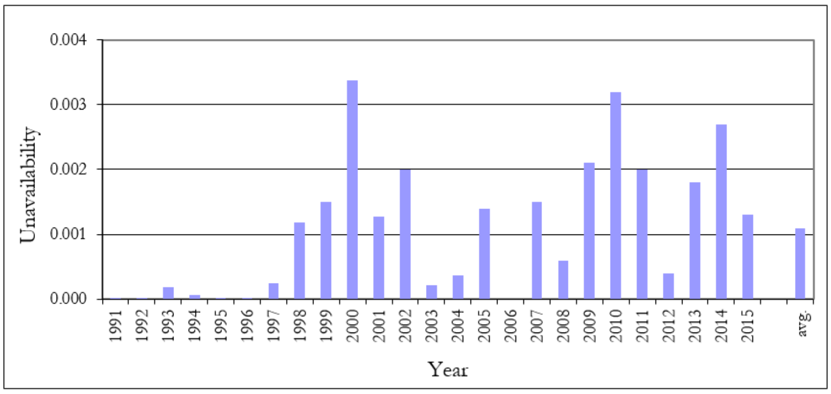


Figure 8: The unavailability of the safety injection system

The unavailability factor of the emergency power supply (the emergency diesel generators), is shown in Figure 9. This system is important when the normal off-site and on-site power supplies are not functioning. The operability of the diesel generators has been stable in recent years. In 2015 this system was completely available, thus the value of this factor is 0.

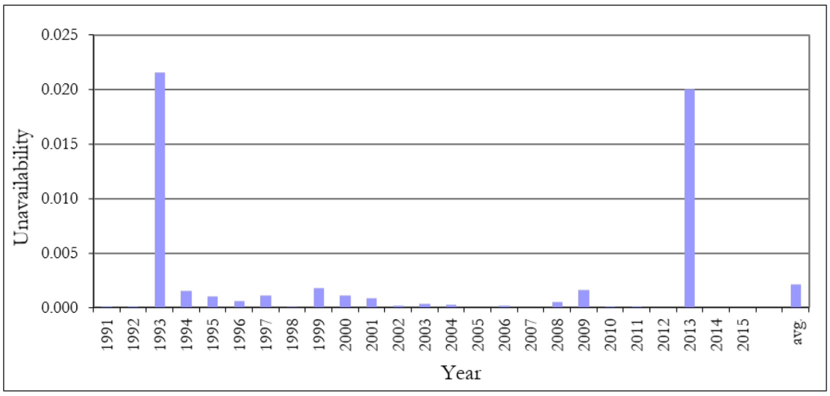


Figure 9: The unavailability of the emergency power supply

Figure 10 presents the unavailability factor of the auxiliary feedwater system. This system is used to supply water to steam generators when the main feedwater system is unavailable. In 2015 the value of this indicator was 0.0002, which is below the Krško NPP's goal value (0.005). In 2015 this system was unavailable only during the planned on-line maintenance.

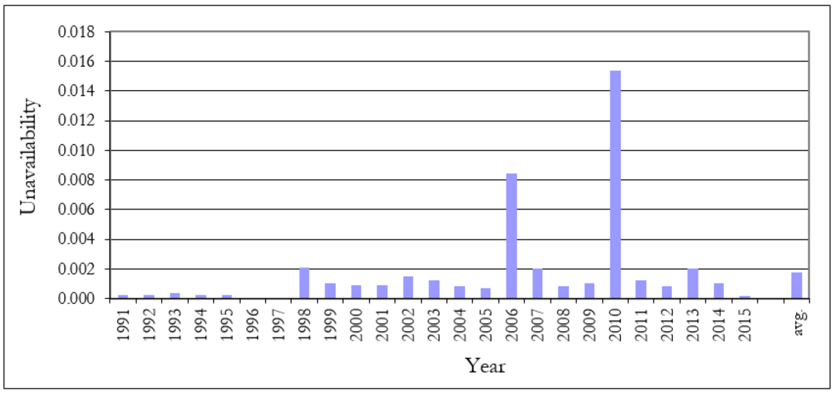
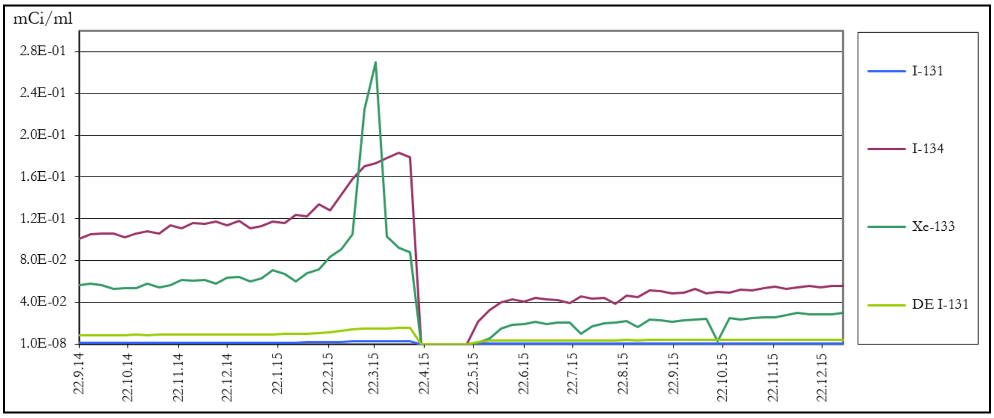


Figure 10: The unavailability of the auxiliary feedwater system

2.1.1.2 SNSA Oversight of the Krško NPP through Safety and Performance Indicators

In 2015 the SNSA monitored a set of 37 safety and performance indicators (hereinafter SPIs). The SPIs help in identifying very early possible problems that can have an influence on nuclear safety. The set of SPIs includes margins for warnings and alarms. The Krško NPP has time to prepare corrective actions that prevent further worsening of the situation. The SNSA collects information once per month and informs the Krško NPP of the situation regarding the SPIs. In 2015 the SPIs did not show significant negative trends.

From the SPI that shows the activity of the primary cooling system (Figure 11), a significant increase of the ^{133}Xe xenon and iodine isotope ^{134}I is noted in the period between January and April 2015 (the 27th fuel cycle). During the outage in 2015 it was determined that the reasons for the increased activity of the primary cooling system were open defects on the fuel assembly (see Section 2.1.1.3). After the outage (the 28th fuel cycle) until the end of 2015, increased activities of xenon and iodine were measured due to the high background activity due to the fission material that remained in the reactor cooling system and the internal components of the primary system due to open defects of the fuel rods in the previous cycle.



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

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

Figure 11: Activity of the primary cooling system – 27th and partly 28th fuel cycle

2.1.1.3 Abnormal Events in the Krško NPP

Event reporting is defined by the Rules on the Operational Safety of the Radiation of Nuclear Facilities and Technical Specifications. These Rules define the list of events that have to be specially reported by nuclear power plant operators. Krško NPP reported eight events for which there was no need to shutdown the plant. These events were as follows:

- Open defects of a fuel assembly during the 2015 outage;
- Failure of the resistance temperature detector (RTD) in the primary cooling system;
- Failed test of the diesel fire pump on 18 June 2015;
- Partial loss of operability of the Passive Containment Filter Venting system (PCFV);
- Failed test of diesel generator No. 2 on 6 August 2015;
- Fuel leak during the test of diesel generator No. 1 on 24 September 2015;
- An earthquake on 1 November 2015;
- Failed test of diesel generator No. 3 on 12 November 2015;

These events did not threaten nuclear and radiation safety. The SNSA monitored and analysed all eight events. The most important are presented below.

Open defects of a fuel assembly during the 2015 outage

In the 2015 outage fuel integrity inspections were performed during the core unload and two leaking fuel assemblies were found there. This was expected according to the measured activities of the reactor coolant in fuel cycle 27. When a fuel assembly was extracted from the core, a 13 cm long part of cladding detached from a fuel assembly was found. At the same time, fuel pellets from this part of fuel rod fell out. These fuel pellets were probably caught in the fuel assembly grids or they were carried onto the reactor cooling system. Detailed inspection of the spent fuel pool showed that two fuel rods were broken and another two rods were lowered to the bottom nozzle, with the suspicion that one of them could have cladding damage. There was a 3 cm long foreign object (debris) stuck in the grid of one fuel rod. The damaged fuel assembly was stored in the spent fuel pool. Inspection of the bottom supporting core plate was also performed and three larger pieces of debris of tubular shape were found; two were 7 cm long and one was 13 cm long. The longest piece of debris was part of a fuel rod. Open defects of fuel assemblies due to baffle jetting occurred already in fuel cycle 26 and were discovered during the 2013 outage. Among the corrective actions foreseen in the root cause analysis of the fuel damage (prepared by the fuel provider Westinghouse after the 2013 outage) was also the modification of the upflow conversion (UFC). The UFC modification was implemented by Krško NPP during the 2015 outage. This action should eliminate the effect of baffle jetting (a jet of water being forced through gaps between the baffle plates and impinging on some of the fuel rods in the core) and therefore eliminate the cause of such fuel damage in the future. After the 2013 outage a provisional corrective action preventing baffle jetting was performed by armouring the fuel assemblies at core locations where the baffle-jetting effect was the worst. This armouring was performed for four fuel assemblies. The fuel damage in fuel cycle 27 did not occur at a location of armoured fuel assemblies but instead at another nearby location. Another credible cause of the fuel assembly damage was debris in the reactor cooling system. Several pieces of debris were caught in the fuel assemblies and later removed from all fuel assemblies used in the core for fuel cycle 28. The Krško NPP also cleaned up the debris from the reactor pool and the reactor pressure vessel interior.

The Krško NPP and the SNSA thoroughly examined the event and performed an analysis of thereof.

Failure of the resistance temperature detector (RTD) in the primary cooling system

On 28 May 2015, when the Krško NPP was operating at 100% power (after the end of the outage of 2015) there occurred a failure in the resistance temperature detector (RTD) on cold leg No. 2 of the primary cooling system. Krško NPP carried out wiring from the active to the reserve RTD. On 3 June 2015 the spare RTD also failed. The operators used the abnormal operating procedure, due to the failed channel of the narrow range of the reactor coolant loop temperature. They entered the limiting conditions of operation (LCO). Upon termination of the functioning of the reserve RTD, a variation in the functioning of RTD cold leg No. 1 was also observed, consequently the RTD was rewired from the active to the reserve RTD. Due to the setting of the temporary modification, LCO 3.0.3 was activated on 3 June 2015 from 6:29 to 6:53 (LCO 3.3.1 was not fulfilled due to the unavailability of two temperature channels in the primary cooling system). On 17 July 2015, the Krško NPP was preventively shut down. During the shutdown, Krško NPP replaced all four RTDs on cold leg No. 1 and cold leg No. 2 with new ones, carried out a balancing of reactor coolant pump No. 1 due to increased vibrations and obtained the information (measuring vibrations in cold leg No. 2) needed to analyse the root cause of the failure. The corrective measures will be determined based on the results of the root cause analysis, which will be implemented during the outage in 2016.

The Krško NPP and the SNSA have thoroughly reviewed the event and performed an analysis thereof.

Additional corrective measures will be determined after the results of the root cause analysis are known.

The earthquake on 1 November 2015

On 1 November 2015, at 8:52 in Stojanski vrh Gorjanci (8 km from NEK) there occurred a strong earthquake (with a local magnitude of 4.2). The earthquake was felt by all the residents of Slovenia, Western Croatia, Istria, Trieste and Graz. In the narrower area the intensity was VI-VII, according to the European seismic scale (EMS-98 Source: Environmental Agency website). The main earthquake was followed by dozens of aftershocks (69 aftershocks occurred up to and including 11 May 2015). An aftershock at 9:07 was also detected with seismic instrumentation at the Krško NPP. During the event, the plant operated continuously at full power. All major safety components were able to perform their functions. The control systems functioned properly in automatic mode. All systems of external and internal power supply were available. After the earthquake an alarm was activated in the main control panel. The alarm was activated also due to the current decline in the flow of the seal water system heater drain pump No. 3, which was at that time in standby mode. There was also an automatic system start-up of flushing traveler grids on train B of the essential service system and the switch-off of a transformer (400kV/110kV) substation in the plant due to activated Bucholz protection. No other alarms or system responses were activated by the earthquake.

In accordance with the procedure for the "determination of the degree of danger," the event was classified at 9:08 as an "abnormal event". Plant personnel were activated. With the preliminary examination of the records of the seismic instrumentation panel, they verified that it had not attained the acceleration and velocity structures that would have required a plant shutdown. The first notice of the event at the Krško NPP was sent by fax at 9:37 to the SNSA, which was 29 minutes after the announcement of an emergency, or 14 minutes late. The second notice was at 10:17, the third at 10:31, and the fourth at the end of the emergency at 11:01. The third and fourth faxes were forwarded to the ReCO Brežice and CORS. Krško NPP carried out a review of the structures, systems and components in accordance with the procedures of the protocol "NPP Response to an Earthquake" and did not identify any discrepancies. At 10:38, the ELES switched on the transformer (400kV / 110kV) in the distribution transformer station "RTP Krško". At 10:43, the Krško NPP declared that emergency had been called off. The plant continued to operate at full power without alarms or deviations due to seismic shock.

The NPP and SNSA discussed the event in detail, an analysis of the event was prepared along with corrective measures, which mainly consist of improvements for faster and better reporting of a Krško NPP emergency.

2.1.1.4 Periodic Safety Review

On May 30 2015, the SNSA approved the PSR2 and the resulting implementation plan, which must be implemented by the Krško NPP by 30 May 2019. The final report of the Krško NPP on the periodic review concludes that there are no major irregularities, that the plant is safe, as was planned, and would operate safely. Areas were also identified in which improvements can be introduced, especially regarding procedures, the management of the qualification and aging of materials, emergency preparedness, improving the design bases and issues in the field of plant safety analyses (deterministic and probabilistic analyses and analyses of potential threats and hazards). The NPP reports on the progress of the implementation of the planned changes and improvements of the PSR2, which includes 225 improvements, to the SNSA every six months, in accordance with the decision of the SNSA. In total, by 31 December 2015, 123 actions had been completed, among them 71 out of 71 actions scheduled for completion in one year, 32 out of 83 actions scheduled for completion in three years, and 20 out of 71 actions scheduled for completion in five years. Among the undertaken actions, five of those are at the stage of physical performance, such as the construction of storage facilities for radioactive waste or approving a prepared action by means of an administrative procedure. For nine actions the SNSA needs an additional explanation or analysis. The SNSA and NPP resolve open issues through working meetings and the SNSA expects that they will be completed in 2016.

2.1.1.5 Nuclear Fuel Integrity, Reactor Coolant Activity and Fuel Assembly Inspection

The year 2015 comprised a part of fuel cycle 27, which started on 18 November 2013 and ended on 11 April 2015 with the refuelling outage, and a part of cycle 28, which started on 16 May

2015. Cycle 28 will last 18 months, until the refuelling outage in October 2016. Of the 56 new fuel assemblies in the cycle 27 core, 20 are 4.4% enriched and 36 are 4.8% enriched. The new fuel assemblies have an additional protective oxide layer on the bottom part of the fuel rods' cladding.

The condition of 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 show 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 burn-up 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).

With the start of cycle 27, the failed fuel action plan was upgraded to comprise five action levels based on the estimated number of damaged fuel assemblies and specific activities of the iodine isotopes ^{131}I and ^{134}I. The estimate also takes into account the correction due to the specific activity of isotope ^{134}I that is derived from contamination of the primary circuit as a consequence of the open fuel defects in fuel cycles 26 and 27. Every action level includes corrective and preventive actions in the event of the degradation of fuel assembly conditions and in the event of open defects in the fuel rods, as was seen in fuel cycle 26.

In fuel cycle 27, the first indications of fuel leakage were observed on 5 February 2015. Specific activities of isotopes ^{133}Xe, ^{131}I and ^{85m}Kr increased until the end of the fuel cycle. High specific activities of xenon and iodine isotopes were measured from the start of fuel cycle 28, which is a consequence of tramp fission material remaining in the primary circuit due to the open defects in fuel rods in the previous fuel cycle. At the end of year 2015, analyses of isotopes' specific activities showed that there were no leaking fuel rods in the cycle 28 core.

Specific coolant activities in cycle 27 reached 3.2% of the dose equivalent ^{131}I limit and 1.8% of the $47/\bar{E}$ reactor coolant gross activity limit (mean energy $\bar{E}$ = 0.46 MeV). Specific coolant activities in cycle 28 at the end of 2015 reached 0.9% of the dose equivalent ^{131}I limit and 1.2% of the $47/\bar{E}$ reactor coolant gross activity limit (mean energy $\bar{E}$ = 0.22 MeV).

The Fuel Reliability Indicator (FRI) is an indicator of fuel damage and is used for comparison with nuclear power plants around the world. FRI values are determined from specific activities of ^{131}I corrected by the contribution of ^{134}I from contamination of the reactor cooling system and normalised to a constant value of the reactor coolant clean-up rate and reactor operating power. An FRI value equal to or below $5 \cdot 10^{-4}$ µCi/g ($1.85 \cdot 10^{-2}$ GBq/m³) represents fuel with no damage according to internationally adopted criteria. Exceeding this limit is not a criterion for deeming there to exist open defects of fuel rods. In fuel cycle 27, the FRI values reached values of $2.5 \cdot 10^{3}$ µCi/g, which is above the limit for leaking fuel. In fuel cycle 28, at the end of 2015, the FRI values reached values of $1 \cdot 10^{-6}$ µCi/g, which is below the limit for leaking fuel. Figure 12 shows a comparison of the FRI values for the last five fuel cycles.

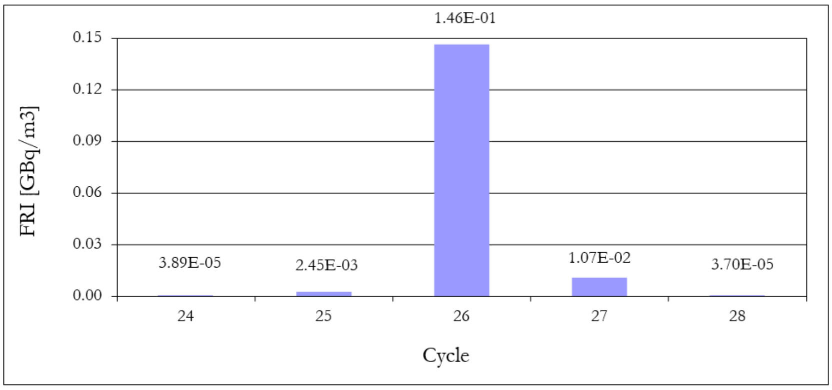


Figure 12: The Fuel Reliability Indicator (FRI) for the last 5 fuel cycles

Fuel Assembly Inspections during the 2015 outage

The inspection of the cladding integrity of all 121 fuel assemblies from the core of fuel cycle 27 was performed according to the In-Mast Sipping (IMS) method. Leakage was detected in two fuel assemblies: AE03 and AE24. By ultrasonic inspection (UT), a leaking fuel rod, K13, was found in fuel assembly AE24. By visual inspection, open fuel damage was found in fuel assembly AE03. In accordance with the FOSAR method, the search and removal of the debris on the fuel assemblies was performed.

The results of Post-Irradiation Examinations (PIE) of the fuel assemblies and a Failure Mode and Effects Analysis (FMEA) showed that the damaged mechanisms of the leaking fuel assemblies AE03 and AE24 are due to vibrations of the fuel assemblies (grid-to-rod fretting, GTRF) and due to debris in the reactor cooling system (debris fretting, DF). One possible action is to improve the fuel assembly robustness against damage due to vibration and debris.

The inspection of 33 new and 10 old control and safety rod clusters was performed by Eddy Current Testing (ECT) along the whole length of the rods. The results showed that cluster R128 is not appropriate for further use and it was replaced by cluster R37 in the core of fuel cycle 28.

During the outage a design modification of the core bypass flow was implemented. This is an important improvement aimed at eliminating the root cause of the extensive visible damage to the fuel assemblies that occurred in cycles 26 and 27. This action changed the direction of the coolant flow through the volume behind the reactor baffle plates from a downward direction to an upward direction and therefore significantly decreased the transversal coolant flow through the gaps between the baffle plates, which had caused the fuel damage.

2.1.1.6 The Krško NPP Safety Upgrade Programme

Soon after the Fukushima accident, in September 2011, the SNSA issued a decision that the Krško NPP had to perform a Safety Upgrade Programme. The plant performed an analysis of the required improvements and based thereon prepared a draft Safety Upgrade Programme (SUP), which was reviewed by the SNSA and approved in February 2012.

The original deadline for the SUP was December 2016, but it was later extended to December 2018. In December 2015, due to the inability to implement the extremely complex and wide-ranging upgrade programme, as well as some financial constraints, the Krško NPP applied for another extension of the deadline for implementing the third phase of the SUP to December 2021. The application also envisions some changes to the Programme itself. One major change is the revision of the alternative ultimate heat sink (UHS), which will be ensured with a combination of protected reservoirs of cooling water and the capability to be replenished from underground wells. Furthermore, the injection of cooling water to primary and secondary systems is to be implemented. The application is still pending a final decision.

The Krško NPP's SUP is divided into three phases. Phase I was implemented in 2013. Phase II, which is underway and is to be implemented by end of 2018, includes:

- Flood protection of the nuclear island;
- The installation of pressuriser bypass relief valves, qualified for severe accidents;
- The acquisition of a mobile heat exchanger with provisions for quick connections to the reactor cooling system and spent fuel pool;
- The installation of a fixed spray system for the spent fuel pool with provisions to use mobile equipment and different sources of water;
- An upgrade of the Bunkered Building 1 (BB1) electrical power supply (with provisions to connect an additional mobile 2 MW diesel generator, seismic requalification of the 3rd emergency bus, an upgrade of the connection between 400 V safety buses and mobile diesel generators, etc.);
- The installation of an emergency control room (ECR) with capabilities to shut the reactor down and maintain a long-term safe shutdown state. The ECR will include habitability systems for ensuring a safe long-term environment for the operators even in the event of severe accidents;
- The installation of additional instrumentation dedicated to severe accidents with an independent power supply; and
- An upgrade of the operational support center and technical support center (emergency centers) to ensure a safe long-term environment for the operators even in the event of severe accidents.

Phase III, regarding which the plant applied for an extension until 2021 (pending the decision of the SNSA):

- The Bunkered Building 2 (BB2) – installation of additional injection systems for the reactor cooling system / containment and steam generators capable of ensuring reactor cooling for at least 30 days (additional reservoirs of cooling water (also borated) capable of being replenished with water from underground wells).

The Post-Fukushima Action Plan

In December 2012 the SNSA prepared a comprehensive action plan (The Slovenian National Action Plan, NAcP) based on the lessons learned from the Fukushima accident. The document was published on the SNSA website. The Action Plan comprises all activities that when implemented would further reduce the risk due to external and other hazards that could affect the Krško NPP site.

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

The Slovenian Action Plan was, together with the action plans of EU countries, Switzerland and Ukraine, peer reviewed within the ENSREG workshop in April 2013 in Brussels and again in April 2015 when progress regarding the implementation of the action plans was reviewed. The final report commended the overall progress of the Slovenian implementation of the post-Fukushima measures, and as the major benefits highlighted the good preparedness for severe accidents, which is regularly trained for on the Krško NPP's full-scope simulator, the relatively fast inclusion of the upgraded WENRA safety Reference Levels in the draft amendments to the legislative rules (to be adopted by the end of 2016), as well as the enhancement of cooperation with Croatia in the area of emergency preparedness.

The implementation of most of the actions from the Action Plan started already in 2013 and continued in 2014 and 2015. Currently, the following are being implemented:

- Legislative changes;
- Activities to improve emergency preparedness and cooperation with Croatia in this area;
- SNSA process enhancements;
- Two additional international missions have been invited, both for 2017 – the OSART mission to review plant operations, and the EPREV mission to review the country's emergency preparedness and capabilities;
- Upgrades of the Krško NPP's probabilistic safety assessment (PSA for the spent fuel pool);
- Preparations for the construction of the dry spent fuel storage.

The updated Action Plan (December 2014) is available on the SNSA website.

2.1.1.7 Technical improvements and modifications

The SNSA devotes a great deal of attention to reviewing modifications and improvements in the Krško NPP. The modifications and improvements result from international practice, operational experience and the newest insights in nuclear technology. Modifications can strongly influence the safety of nuclear objects and therefore must be rigorously controlled and appropriately documented.

In 2015 the SNSA approved 6 modifications and agreed to 27 modifications. During the preliminary safety evaluation, the Krško NPP found no open safety issues for 331 modifications. Therefore, the Krško NPP only informed the SNSA of those 331 modifications. As of 31 December 2015, there were 23 active temporary modifications. 54 temporary modifications were begun and 47 were completed in 2015. Among active modifications, 3 temporary modifications were approved in 2013 that were to be completed in 2016 and one from 2010 is to be completed in 2017.

In 2015 the Krško NPP issued the 22nd revision of the "Updated Safety Analysis Report", which took into account the changes approved up to 1 November 2015.

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

2.1.1.8 External impacts on operational safety

In 2007 the preparations began for the National Spatial Plan (NSP) for the area of the Brežice Hydro Power Plant (HPP), which was completed with the issuance of the decree on the NSP in June 2012. Analyses of the Brežice HPP on the Krško NPP and proposals for mitigation measures were compiled in a special report (see ref. No. 18), which was issued in September 2015. The HPP investor HESS and the Krško NPP signed an agreement for financing the preparation and implementation of these measures by HESS. The measures comprise nine design modifications of the Krško NPP cooling systems, building a river dam, drainage systems, control of groundwater, and environmental monitoring. The building permit procedures and implementation of the design modifications in the Krško NPP are in the process of being carried out in the period from 2014 to 2017.

In the period from 2008 to 2013, the preparations of the NSP for the area of the Mokrice HPP was being carried out and in 2015 the preparations for the project of acquiring the building permit and the procedure for issuing the environmental consent were being carried out. In August 2015 the SNSA granted environmental consent with regard to the impact on the flooding safety of the Krško NPP, on the seismic stability of the area, and on environmental monitoring of the Krško NPP.

Procedures for the preparation of the NSP for the HPPs on the middle Sava River are being carried out. In 2014 the SNSA issued guidelines for the NSP of the HPP chain on the Ljubljana and Litija sections of the Sava River. The guidelines are related to the impacts of HPPs on the nuclear safety of the Krško NPP, the TRIGA Research Reactor, and the Central Storage for Radioactive Waste in Brinje (CSRAO).

The preparation of the NSP for connecting the road from Krško to Brežice has been proceeding since 2006. The impact of the road on the nuclear safety of the Krško NPP is due to its location inside the area of limited use of space around the Krško NPP and the impact of the road on the flooding safety of the Krško NPP. Also connected to this NSP is the project of building a bridge over the Sava River on a new road connection from Krško to Brežice, for which the SNSA has already issued consent for the project to acquire a building permit.

The Seismic Safety of the Krško NPP

At the beginning of 2015, GEN energija d.o.o., the NPP investor, presented to the SNSA its latest findings regarding the project task "Seismic Hazard Analysis regarding Krško NPP 2", which was carried out by Rizzo Associates and the Geological Survey of Slovenia. The envisaged content of the project was presented at that time. According to the presentation, the work will consist of providing necessary input data (a seismic catalogue, seismic sources, a seismotectonic model, etc.), carrying out a probabilistic seismic analysis, and the reaction of the proposed location to seismic waves, taking into account the specific properties of soil. The purpose of the mentioned activities is to analyse the adequacy of micro locations from the perspective of modern standards and safety requirements.

The risk to the Krško NPP due to aicraft hazard

In 2012, on the initiative of the SNSA, a working group (WG) was established in order to avoid future abuses, which have been noted repeatedly in the past. The WG consisted of representatives of the Ministry of Defence, the Agency for Civil Protection and Disaster Relief, Slovenian Air Navigation Services, NPP Krško, and the SNSA. The SNSA prepared the first draft of the agreement on cooperation between these organisations in July 2013. Ratification of the agreement was expected in May 2016.

2.1.1.9 Inspection review

In 2015 the SNSA performed 67 inspections of the Krško NPP. All inspections were regular since the NPP operated smoothly without unplanned events that might cause a need to perform reactive inspections. Three of inspections were unannounced.

Based on the inspections, the SNSA concluded that during the 27th fuel cycle and the refueling outage in 2015, the Krško NPP encountered some problems regarding the safety equipment. The problems were related to the leakage of nuclear fuel, the degradation of in-core detector thimbles, the failure of some reactor coolant temperature detectors, and to the new passive autocatalytic recombiners (PAR). However, the requirements of the Technical Specifications were not violated in any of these cases. The identified problems related to the important safety equipment and were analysed and solved in a due time within the implementation of the Krško NPP corrective programme. Therefore, a high level of nuclear safety was maintained throughout.

In order to implement the required corrective activities related to the failed reactor coolant temperature detectors, the Krško NPP underwent a few days of forced outage in July 2015. During this outage, the SNSA inspectors verified the adequacy of the actions performed by the operator. The failed temperature detectors were replaced. Furthermore, measurements and an analysis of vibrations were carried out. The results of the vibration analysis will be taken into account in the root cause analysis. Corrective actions are to be implemented in the outage in 2016. During the 28th fuel cycle, the SNSA inspectors will be continuously monitoring the reliability of the reactor coolant temperature measurement system. Furthermore, inspectors will review the root cause analysis results and the implementation of corrective actions in the outage in 2016.

The Krško NPP 2015 refueling outage was carried out professionally. The modification of the core bypass flow conversion installed in order to prevent repetition of the nuclear fuel leakage was successfully implemented. Based on the inspections performed, the SNSA concluded that the Krško NPP is prepared for safe operation until the next refueling outage starting in October 2016.

Inspections confirmed that the Krško NPP operated safely, without causing harm to people and the environment in 2015. The SNSA inspections assessed the activities of most of the organisational units of the operator as good. The inspections showed a high level of safety culture of the majority of the experts. This is reflected in the high quality of the activities carried out where safety was a priority, as well as in identifying potential problems based on the NPP's own and foreign operational experience and the tendency towards the implementation of appropriate corrective measures.

2.1.1.10 The 2015 Outage

The refueling outage at the end of the 27th fuel cycle took place from 11 April to 17 May 2015. The overall assessment of the SNSA is that the activities were carried out comprehensively and by taking into account high standards of radiation and nuclear safety. Unforeseen complications were promptly and professionally resolved by the Krško NPP.

Regular outage tasks, i.e. refueling and inspection of the fuel, periodic maintenance, and inspection and testing of equipment were carried out professionally. The tasks were performed in accordance with the approved procedures. In general, the results of the inspections and tests did not show unexpected defects in the equipment. However, a few cases of unexpected defects were identified. The main unforeseen events of the outage included the failure of the primary coolant temperature detectors, problems with the testing of the passive autocatalytic recombiners for hydrogen, damaged thimble guides for fission cells, damage to the fuel in the 27th fuel cycle and the loss of a reactor coolant pump due to a fault on the 400 kV transmission line between Krško NPP and Maribor.

The Krško NPP carried out a great number of preventive maintenance works, replacements, and modernisation of the equipment. As a general rule, the full scope of activities was carried out and the quality of the tasks performed was good. Nevertheless, certain deviations were not fully resolved, but thus far they do not jeopardise safety. The number of events and deviations were comparable with previous outages.

External control of outage activities was provided by independent technical support organisations. Such control was established years ago. The technical support organisations communicated their observations and comments to the SNSA and the NPP at weekly meetings.

Mutual cooperation between the NPP and the technical support organisations was generally very good. Those responsible for the individual activities in the NPP were open and always ready to provide the requested information. Cooperation with the technical support organisations that regularly provided all necessary information was very good.

One of the most important and demanding changes in this outage was the change in the direction of the core bypass flow. Despite an early but incomplete application, the progress of the review and eventually the authorisation did not occur without any problems. Namely, access to the documentation was limited. Shortcomings were identified in communication among the drafters of documents (Westinghouse), experts preparing expert opinions, and the SNSA. It must be stressed that the NPP guided the whole process related to technical support very well and professionally.

The SNSA has reviewed the summary report on the outage prepared by the technical support organisations and has as well proposed recommendations. During thematic inspections of the NPP, the explanations related to the implementation of recommendations and deadlines for the implementation thereof were submitted.

In the field of the radiation protection of exposed workers, the Krško NPP is also supervised by the Slovenian Radiation Protection Administration (SRPA). In 2015 the SRPA conducted five inspections that dealt with the 2015 outage, the contamination of surfaces with alpha particles due to fuel damage, and the training of workers in the radiation protection unit. The SRPA confirmed 9 evaluations of the protection of workers exposed to radiation with regard to external organisations or firms.

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 its operation is carried out by the personnel of the Reactor Infrastructure Center (RIC).

In March 2015, the JSI approved a long-term operation strategy for the reactor, which foresees an extension of reactor operation until at least the end of 2026.

2.1.2.1 Operation

In 2015 the reactor operated for 141 days and released 109.8 MWh of heat during operation. The operation was carried out according to a programme that is approved for each week by the head of the RIC and the JSI radiation protection service. The reactor operated in stationary mode and in pulse mode – 42 pulses were performed. The reactor was mostly used as a neutron source for neutron activation analysis, for irradiation of electronic components or other materials, and for educational purposes. A total of 869 samples were irradiated in the carousel and the channels, as well as 31 in the pneumatic post.

In the Hot Cell Facility (OVC) of the Department of Environmental Sciences, the JSI radiation protection service and the ARAO regularly carried out radioactive waste treatment and preparations for the purpose of radioactive waste storage. In 2015 there were three automatic reactor shutdowns, two of which were caused by the central alarm being activated and one due to a failure in a relay of the central alarm. The central alarm collects radiological alarms and generates a signal for fast shutdown of the reactor. The signal can also be triggered by a central alarm disturbance and this occurred twice in the past year. The third automatic shutdown due to a relay failure was corrected on the same day with the replacement of the relay.

There were no violations of the operational limits and conditions under the Safety Analysis Report in 2015. There were also no events in 2015 that required reporting to the SNSA.

The operational indicators regarding the acquired doses of the operating staff and those conducting experiments showed values far below the regulatory limits. The collective dose in 2015 was 594 man µSv for operating staff and 876 man µSv for personnel carrying out research work at the reactor (operating staff, members of the JSI radiation protection service, experimenters).

2.1.2.2 Nuclear Fuel

In 2015 a total of 84 fuel elements were located on the reactor site. There were no spent fuel elements. All fuel elements were standard elements with 12% uranium content and 20% enrichment. Control measurements of radioactivity in the reactor building and in the reactor coolant showed that no fuel elements were damaged. The JSI reported on the fuel balance monthly to EURATOM and to the SNSA. In November 2015 EURATOM performed an inspection of the nuclear material status and the inspection findings showed no anomalies.

2.1.2.3 Staff Training

An RIC employee passed the exam for being granted an operator license for the TRIGA Research Reactor operator in May 2015. Regular training of staff was performed in line with the annual programme of expert training of TRIGA reactor operators for the year 2015.

In November 2015 a firefighting exercise was carried out with participation of professional firefighters from the Ljubljana Fire Brigade and nine units of volunteer firefighters. TRIGA operating staff and members of the JSI radiation protection service took part in the exercise. An exercise for safe operation of the bridge crane was also carried out.

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

The reactor operated in stationary mode and in pulse mode. Pulsing operation was performed in March and November in order to provide practical exercises to students of the Faculty of Mathematics and Physics of the University of Ljubljana, to check the thermo-hydraulic model and to test the resistance of electronic components in pulsing operations. The Reactor Safety Committee approved the pulsing operation in advance and the SNSA was notified of the pulsing operation.

In 2015 twenty reactor core modifications were made for the experimental purposes of the Nuclear Physics Department. Most of the new cores were established for the irradiation of electronic components with burned-up fuel (without neutrons) and the reactor did not operate with such cores.

In 2015 the following modifications to the reactor were implemented:

- An irradiation spot was established in the thermal column for the irradiation of different samples in the thermal neutron spectre;
- The standard pneumatic post was refurbished with means for the automatic irradiation of samples;

- Three ionisation cells of the nuclear instrumentation were replaced;
- Experimental equipment was removed from channel 6;
- The installation of a system for the control of reactor coolant quality, quantity, and flow commenced;
- Preparation works started for the installation of a deafening device on the release point of the pulsing rod. The influence of the deafening device on the pulsing rod drop time to the core was checked. The installation of the deafening device will continue in 2016.

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

2.1.2.5 Periodic Safety Review

The periodic safety review of the nuclear facility that comprises the TRIGA Research Reactor and the hot cell facility was completed in December 2014 with the SNSA approving the periodic safety review report with an action plan for the implementation of modifications and improvements. In 2015 the implementation of the action plan, with a total of 85 modifications and improvements, was carried out. By means of semi-annual reports, the JSI reported on the status of the implementation. Altogether, 20 actions were implemented. The implementation of the action plan of modifications and improvements should be completed by December 2019.

2.1.2.6 Review of the Safety Analysis Report

In 2015 an administrative procedure was conducted to upgrade the Safety Analysis Report of the TRIGA Mark II Research Reactor. The administrative procedure has not yet been completed and will continue also in 2016.

2.1.3 The Central Storage for Radioactive Waste in Brinje

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

The CSRW operated safely; there were no recorded incidents or accidents. All periodic preventive maintenance inspections and testing of CSRW structures, systems and components, as well as of the operability of the measurement equipment, were carried out as planned.

The ARAO gradually replaced all wooden pallets from the CSRW with new metal self-supporting pallet frames. This upgrade satisfies the efforts extending over several years to improve the safety of the CSRW and contributes to improving safety at work, as it can now handle packages of radioactive waste more easily, and the new range is flame retardant, which contributes to improving fire safety. When selecting the storage locations of individual packages in the storage area, the principle of self-shielding packages is taken into account. Packages with high activities are shielded with packages that have higher weight. The principle of combining neutron radiation sources was introduced together with the principle of the integrity of packages containing nuclear substances. The maximum allowed load floor panel was also taken into consideration. As a result of this planning, the dose rate field was lowered. The biggest difference can be seen in the reduction of the neutron dose rate observed on the manipulation path of the storage area , i.e. in places where the workers in the warehouse are more frequently located.

In the fall, work started as part of the modernisation of the physical and technical protection of the CSRW as regards improvements in the field of the technical protection of nuclear facilities and nuclear material as a result of the requirements of the Rules on the Physical Protection of Nuclear Facilities, Nuclear and Radioactive Substances and Transport of Nuclear Materials.

New ventilation for staff of the CSRW was installed with the help of local ventilation equipment, which eliminated certain problems with humidity and mildew that occurred on the outer walls. All newly introduced systems were appropriately controlled, tested, and implemented, and users were trained. The implementation plans were prepared, treated as changes, and assessed according to their significance as regards radiation and nuclear safety. The SNSA was also notified of the changes.

At the end of 2014, the ARAO submitted an application for approval of the content, scope and schedule thereof and thus preparations for the periodic safety review of the CSRW began. The SNSA has approved the content, scope and timing of the periodic safety review. The review will begin in 2016 and run for two years. The approved report of the review will provide the basis for the renewal of the license for the operation of the CSRW facility.

The acceptance of radioactive waste in the CSRW in 2015 and the inventory of the waste stored as at the end of 2015 are described in more detail in Chapter 5.4.

In 2015 the SRPA conducted inspections in the ARAO, which dealt with the training of workers in the Radiation Protection Unit.

2.1.4 The Former Žirovski Vrh Uranium Mine

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

The year 2015 was for the Jazbec mine waste disposal site the second year of the long-term management and for the Boršt disposal site the fifth year of the transitional period after the completion of the remediation.

More information on remediation activities regarding the former mining activities at Žirovski Vrh can be found in Chapter 5.6.

In 2014 the SNSA issued a permit for the closure of the Jazbec mine waste disposal site. By such, the conditions for further procedures related to the transfer of management to the ARAO were satisfied. In 2015, following the formal closure of the Jazbec mine waste disposal site, ARAO assumed the implementation of the long-term monitoring and maintenance of the landfill body itself as a part of the mandatory public service of managing radioactive waste.

2.2 Radiation Practices and the Use of Radiation Sources

The Ionising Radiation Protection and Nuclear Safety Act requires advanced notification of the intention to carry out a radiation practice or intended use of a radiation source, the evaluation of radiation exposure (before the amendment of the Act in 2015, this was termed the evaluation of the radiation exposure of workers), a mandatory licence to carry out a radiation practice, and a licence for the use of a radiation source or certificates of registration of radiation sources or a programme of radiological procedures for use in medicine.

One of the licensing documents is an evaluation of radiation protection. In the document, the nature and extent of the radiation risk of exposed workers, apprentices, students, the general population and the environment are assessed in advance. In addition, based on this assessment, a programme for the optimisation of radiation protection measures in all working conditions is drawn up. The document must be prepared by the applicant, who is obliged to consult an authorised radiation protection expert. In practice, the evaluation is prepared by an authorised expert radiation protection expert. Since the amendment of the Act in October 2015, the evaluations do not need to be approved in an separate administrative procedure by the SRPA, as previously was the case. These evaluations are now examined by the competent regulatory body (the SRPA or SNSA) during the administrative procedure for issuing a licence to carry out a radiation practice. Due to the amendment of the Act and subsidiary legislation, it is expected that the number of administrative procedures will decrease and the procedures will be more transparent from the applicants' point of view. These changes will not affect radiation safety. The authority competent for licensing in the fields of industry and research is the SNSA, while the authority competent in the field of medicine and veterinary medicine is the Slovenian Radiation Protection Administration (SRPA). In 2015 the SRPA confirmed 139 evaluations of the radiation protection of exposed workers.

2.2.1 Use of Ionising Sources in Industry, Research and Education

At the end of 2015, 161 organisations in industry, research and the state administration in the Republic of Slovenia were using 297 X-ray devices; 725 sealed sources were being used in 77 organisations. As many as 46 radioactive sources were stored at 19 organisations, which are intended to be handed over to the ARAO in the future.

In 2015, 78 licences to carry out radiation practices, 94 licences for the use of a radiation source, 14 certificates of the registration of radiation sources, 20 approvals for external operators of radiation practices, 2 decisions on the termination of the validity of licences to carry out radiation practices, 1 decision on sealing an X-ray device and 1 decision on unsealing an X-ray device were issued by the SNSA. The SRPA approved 43 evaluations of the protection of workers exposed to radiation and 9 approvals for operators of radiation practices in nuclear and radiation facilities.

Ionisation smoke detectors, utilising isotope ^{241}Am, form a special group of radiation sources. According to the registry of radiation sources, there were 24,330 ionisation smoke detectors being used at 285 organisations at the end of 2015. 271 ionisation smoke detectors were also stored at the users' premises.

2.2.2 Inspections of Sources in Industry, Research and Education

In 2015 the inspectors of the SNSA conducted 64 inspections. Among them, ten were dedicated to interventions. The number of interventions is comparable to the number of interventions in previous years. As in past years, special attention was devoted to industrial radiography, which is one of the practices associated with the largest risks. The instances of identified noncompliance included, *inter alia*, use of old X-ray machines and use of an irradiation room with inappropriate shielding.

In 2015 the inspectors continued the systematic inspection of all other practices with high-activity sealed sources. These inspections revealed that more attention should be paid to emergency exercises. Namely, not all opportunities to improve emergency preparedness and response are being realised.

During systematic inspections of licensed providers who performed measurements of the radioactivity of secondary metal raw material, inspectors determined that many of these providers still use hand-held spectrometers using X-rays without appropriate authorisations. As a result, a special inspection of a provider of these spectrometers was carried out. In 2015, for the first time, inspectors also addressed the online sale of second-hand sources of ionising radiation. Such sales can mislead the user into using sources without appropriate safety measures. In contrast to previous years, the inspectors identified noncompliance during inspections of the transport of radioactive sources. Namely, a transporter did not nominate a safety advisor for such practice. Such noncompliance was determined during two inspections. Systematic inspections of the use of smoke detectors using ionising radiation continued in 2015, i.e. altogether six inspections were conducted.

Interventions related to urgent safety measures mainly concerned sources used in Slovenia as well as sources that were used in the past. In addition, some interventions were linked to the transport of radioactive sources and radioactive waste. Among such interventions, one was related to 44 disused smoke detectors with a source of ionising radiation. These detectors were found in a garage. Namely, the owner of the garage found them while cleaning the location. Inspectors also dedicated one inspection to a disused furnace where an enhanced concentration of natural radionuclides was identified. A company performing measurement of dose rates in Italy twice identified that radioactive waste was present in cargo originating from Slovenia. Radioactive waste with ^{226}Ra was found. Only once in 2015 did inspectors not allow the entry of cargo into Slovenia. Namely, the cargo was sent back to the country of origin, i.e. Serbia. In 2015 the inspectorate of the SNSA also discussed the activities of the NPP Krško related to the above-mentioned earthquake, i.e. inappropriate activities related to this event.

The SRPA, which performs inspections related to the occupational exposure of workers, did not perform any inspections in industry, research or education in 2015.

2.2.3 Use of Radiation Sources in Medicine and Veterinary Medicine

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

X-ray Devices in Medicine and Veterinary Medicine

According to the records of the SRPA, 1,008 X-ray devices for medicine and veterinary medicine were installed as of the end of 2015; 94 of them were not in use. The categorisation of X-ray devices based on their purpose is given in Table 2.

Table 2: Number of X-ray devices in medicine and veterinary medicine by purpose

Purpose	Purpose	Status 2013	New	Written off
Dental	488	44	10	522
Diagnostic	262	48	13	297
Therapeutic	12	1	1	12
Simulator	4	1	1	4
Mammography	34	2	2	34
Computer tomography CT	27	2	1	28
Densitometers	46	0	1	45
Veterinary	64	2	0	66
TOTAL	**937**	**100**	**29**	**1,008**

In the field of the use of X-ray devices in medicine and veterinary medicine in 2015, the SRPA granted 95 licences to carry out a radiation practice and 208 licences to use X-ray devices. Furthermore, 109 confirmations of the programmes of radiological procedures and 84 confirmations of the evaluation of the protection of workers exposed to radiation were issued.

In medicine (not including veterinary medicine), 494 X-ray devices were used in private dispensaries and 448 in public hospitals and institutions. The average age of X-ray devices was 9.4 years (9.6 years in 2014, 9.5 years in 2013, and 9.1 years in 2012) in the public sector, and 10.1 years (9.9 years in 2014, 9.8 years in 2013, and 9.2 years in 2012) in the private sector.

In veterinary medicine 10 X-ray devices were in use in public institutions and 56 in the private sector. The average age of X-ray devices was 15.5 years (14.5 years in 2014, 13.5 years in 2013, and 13.8 years in 2012) in the public sector and 10.1 years (9.4 years in 2014, 9.6 years in 2013, and 8.0 years in 2012) in the private sector.

A detailed classification of X-ray devices in medicine and veterinary medicine according to their ownership is given in Table 3.

Table 3: 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. (%)		No. (%)	Age (years)	No. (%)	Age (years)
Public	330 (81%)	9.5	105 (20%)	9.7	13 (100%)	6.2	10 (15%)	15.5	458 (45%)	9.6
Private	77 (19%)	10.6	417 (80%)	10.0	0	0	56 (85%)	10.1	550 (55%)	10.1
TOTAL	**407**	**9.7**	**522**	**9.9**	**13**	**7.4**	**66**	**10.9**	**1,008**	**9.9**

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

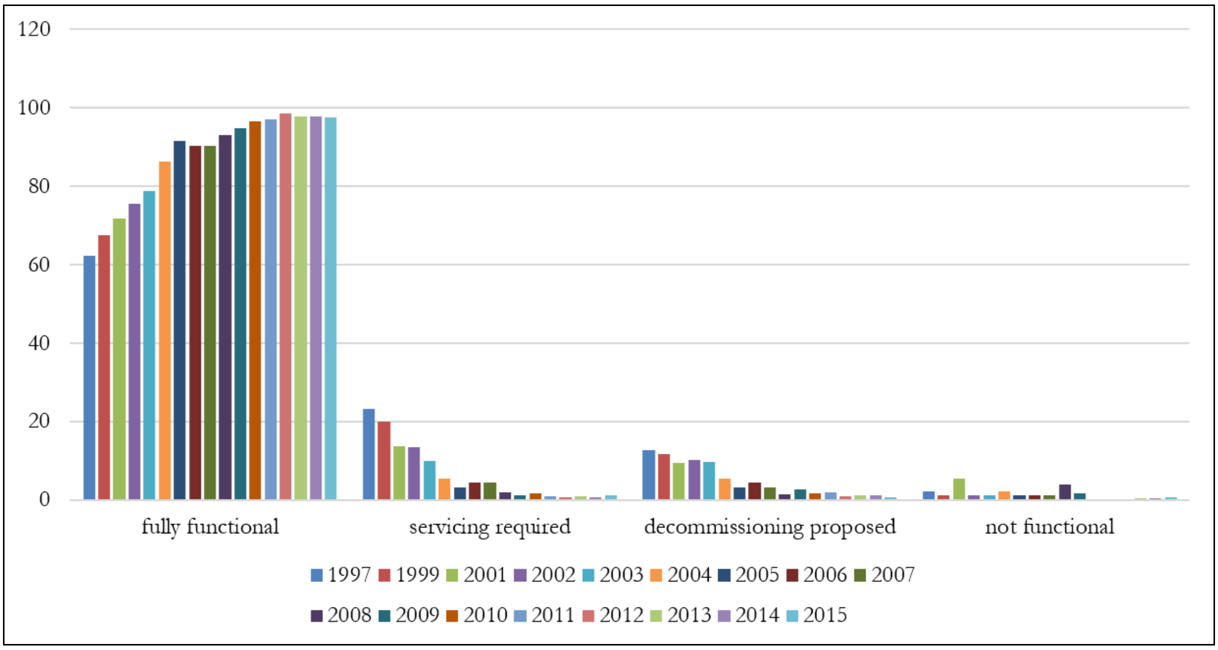


Figure 13: Percentage of diagnostic X-ray devices according to their quality in the period 1997–2015

In 2015, 13 in-depth inspections of the use of X-ray devices and linear accelerators in medicine and veterinary medicine were carried out, of which one inspection concerned veterinary use of a linear accelerator. In six cases, based on the findings of the inspection, the inspection decision was issued with requirements that needed to be fulfilled in order to ensure compliance with the valid regulations. In three cases, the equipment was sealed to prevent the potential use of equipment kept in reserve.

Based on a review of the inspection reports on X-ray devices for medical use sent to the SRPA by approved technical support organisations, 10 inspections were conducted during which the SRPA requested that the user provide evidence that the noted shortcomings had been eliminated. There were 29 cases in which the user was asked to present evidence relating to the termination of the use of an X-ray device and 171 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 Ljubljana, the Institute of Oncology, the University Medical Centre Maribor, and general hospitals in Celje, Izola, Slovenj Gradec and Šempeter pri Nova Gorica use unsealed sources (radiopharmaceuticals) for diagnostics and therapy in their nuclear medicine departments. In these nuclear medicine departments, altogether 6,557 GBq of isotope ^{99}Mo, 3,253 GBq of isotope ^{18}F, 1,061 GBq of isotope ^{131}I, and minor activities involving the isotopes ^{123}I, ^{177}Lu, ^{90}Y, ^{201}Tl, ^{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, approximately three-times higher activity of ^{99m}Tc can be eluted in one week. At the end of 2014, the Institute of Oncology started to use ^{223}Ra, which emits alpha particles. Cumulatively 1.43 GBq of that isotope were imported in 2015.

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

In 2015 the following documents with reference to the use of unsealed and sealed sources in medicine were issued: 3 licences to carry out a radiation practice, 3 licences to use a radiation source in medicine, 3 confirmations of radiological procedure programmes, 3 confirmations of the evaluation of the radiation protection of exposed workers, 2 permits for the import of radioactive material, and 20 statements on the shipment of radioactive materials from EU Member States.

Medical departments with unsealed and sealed radiation sources were surveyed (once or twice annually, depending on the source type) by the approved experts for radiation protection and medical physics at the Institute for Occupational Safety (IOS). No major deficiencies were found in 2015.

In addition to the expert reviews made by the IOS, the SRPA inspectorate also carried out two inspections at the Institute of Oncology. They dealt with a report of contamination with ^{131}I in one of the hospital rooms in 2014, radioactive waste storage and radiological procedures with an "HDR" brachytherapy device. A warning with reference to a fine was issued, because the responsible party did not send the report on the incident in time. A preventive warning was issued regarding the prohibited use of the "HDR" device until all the necessary licences are issued.

Neither unsealed nor sealed radioactive sources were used in veterinary medicine in 2015.

In the field of the transport of radioactive materials used in medicine and veterinary medicine, two certificates of eligibility for a foreign contractor carrying out a radiation practice were issued as well as one licence to carry out a radiation practice.

2.2.4 The Transport of Radioactive and Nuclear Materials

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

In 2015 the SNSA issued three approvals for transport under special arrangement to the Agency for Radioactive Waste for transport of a spent sealed source of ^{85}Kr from the producers VIPAP VIDEM KRŠKO d. d., JUTEKS d.o.o. and MELAMIN kemična tovarna d. d., to the Central Storage Facility in Brinje.

In 2015 the SNSA did not carry out any procedures for the approval of packaging for the transport of radioactive material.

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

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

In 2015 the SRPA issued two permits for the import of radioactive sources from non-EU countries and approved 20 applications of consignees of radioactive material in medicine and veterinary medicine. Each isotope from an individual producer intended for the same end user is counted separately.

In 2015 the SNSA approved 11 applications of consignees of radioactive material from other EU Member States. The SNSA also issued six permits for the import of radioactive material and one permit for multiple shipments of contaminated equipment between other EU Member States.

In 2015 the SNSA issued three permits for the transit of radioactive material with important activity.

The shipment of radioactive waste and spent nuclear fuel between EU Member States as well as between EU Member States and third countries is regulated by Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and spent fuel. In 2015 the SNSA issued one consent for the return shipment of radioactive waste that had previously been sent to Sweden for treatment.

2.3 Achieving the goals under the Resolution on Nuclear and Radiation Safety

The Resolution on Nuclear and Radiation Safety in the Republic of Slovenia for the period 2013–2023 determined the following broad-ranging goals in the field of nuclear and radiation practices:

Goal 1

Nuclear and radiation facilities and operators fulfil the statutory requirements, ensure continuous improvement of nuclear and radiation safety, and monitor international improvements in the field.

Realisation in 2015

From the above chapters it can be summarised that all nuclear and radiation facilities in the state (Krško NPP, the TRIGA Research Reactor, the Central Storage for Radioactive Waste in Brinje, and the mine disposal and mill tailings site) fulfilled the statutory requirements and fostered the improvement of nuclear and radiation safety.

3 RADIOACTIVITY IN THE ENVIRONMENT

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

Radiation protection of the population is ensured through the on-line monitoring of external radiation and radioactivity in the environment, as well as through continuous control of radioactivity in drinking water, food, feed, and products in general use on the basis of laboratory measurements.

Radioactivity released into the environment by the nuclear power plant in Krško, the former uranium mine at Žirovski Vrh, the TRIGA Research Reactor and the Central Storage for Radioactive Waste, which are both located in Brinje near Ljubljana, is monitored. The doses received by the population living in the vicinity of these nuclear and radiation facilities, which emit radioactive substances into the environment, are estimated on the basis of measured or modelled data. The doses received by the population should be lower than the dose constraints set by the competent administrative authority.

This chapter contains a summary of reports on the state of environmental radioactivity in the territory of Slovenia in 2015.

The monitoring of exposure to natural sources of radiation, especially radon, is carried out under the Government's programme of systematic inspection of working and living environments and raising awareness of the population on measures to reduce exposure due to the presence of natural radiation sources.

3.1 The Early Warning System for Radiation in the Environment

An automatic on-line warning system for environmental radioactivity has been established in Slovenia. It is intended to immediately detect elevated radiation levels in the environment and is one of the key elements of the warning and emergency response during nuclear or radiological emergencies when radioactive contamination of the environment might occur. In the event of elevated levels of external radiation and air concentrations of radioactive particles, soil, drinking water, food, and feed would be contaminated due to the subsequent deposition or rinsing of radioactive particles on the ground. Automatic probes for real-time measurements of external radiation are positioned around Slovenia. They are managed by the Slovenian Nuclear Safety Administration (SNSA), the Krško Nuclear Power Plant and all Slovenian thermal power plants. Data are collected at the SNSA, where they are constantly analysed, archived and made available to the public on the internet. If the values are elevated, an automatic alarm message is sent to the officer on duty. In 2015 there were no events that triggered an alarm due to increased radiation in the environment in Slovenia.

Since 1997, the SNSA has been sending data from the Slovenian early warning system to the European EURDEP system, based at the Joint Research Centre in Ispra (Italy), where data from the majority of European national early warning networks are collected. Through this arrangement, Slovenia also gained access to real-time data on external radiation from other participating countries. Additionally, the Slovenian data are exchanged hourly with the centres in Vienna (Austria), Zagreb (Croatia), and Budapest (Hungary).

3.2 Monitoring Environmental Radioactivity

Monitoring of the 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 fission radionuclides, ^{137}Cs and ^{90}Sr, have been monitored in the atmosphere, water, soil, drinking water, foodstuffs and feedstuffs. The part of the programme relating to the radioactivity of surface waters is covered by the periodic control of river water due to the use of the radionuclide ^{131}I in medicine. Other natural gamma emitters are also measured in all samples, while in drinking water and in precipitation the levels of tritium (^{3}H) are additionally measured.

The results of the measurements for 2015 showed that concentrations of both long-lived fission products in samples of air, precipitation, soil, milk, foodstuffs of vegetable and animal origin, and feedstuffs continued to slowly decrease and were in most cases already lower than before the Chernobyl accident. On average, the fallout of these radionuclides in Slovenia due to the Chernobyl accident was five times higher (20–25 kBq/m^2) than from all preceding nuclear weapon tests together. The highest ground contamination was measured in the Alpine and forest regions, which indirectly contributes to the increase in the amounts of these radionuclides in Alpine pastures (in milk and cheese) and in the forest ecosystem (in forest fruits, mushrooms, game). The concentrations of tritium in liquid samples (surface water, precipitation, drinking water) decrease very slowly, only a few percent per year. In Slovenia, the consequences of the releases resulting from the nuclear accident in Fukushima on 11 March 2011 were negligible. Only short-term values of the isotopes ^{131}I and ^{134}Cs in the atmosphere and in precipitation were measurable.

The biggest contribution to the radiation exposure of the public due to environmental contamination by artificial radionuclides comes from external radiation and from food ingestion. The inhalation dose from aerosols with fission radionuclides is negligible. In 2015 the effective dose from external radiation of ^{137}Cs (mainly from the Chernobyl accident) was estimated at about 6.0 µSv, which is 0.24% of the dose received by an average adult in Slovenia from natural background radiation. This value is slightly lower than the value that was measured and calculated in 2014.

The annual dose from the ingestion pathway (consumption of food and drinking water) was 1.8 µSv, which is a little more than in the previous year (1.1 µSv) . The dose in 2008 was higher due to the higher average values of the radionuclide ^{90}Sr in the selected samples of vegetables sampled in regions with higher Chernobyl contamination (Figure 14). The contribution of ^{90}Sr to the annual dose due to ingestion is 82%; the contribution of ^{137}Cs to the annual dose is 17%, while the contribution of ^{3}H to the annual dose is 1%. The annual contribution due to the inhalation of these radionuclides is only about 0.001 µSv, which is negligible when compared to radiation exposure from other transfer pathways. The effective dose from drinking water was also estimated, taking into account artificial radionuclides. Calculations have shown that on average this dose was around 0.03 µSv per year. The annual limit value of 0.1 mSv per year due to natural and artificial radionuclides in drinking water from local water supplies was not exceeded in any sample.

In 2015 the total effective dose of an adult in Slovenia arising from the global contamination of the environment with artificial radionuclides (external radiation) was estimated at 7.8 µSv, as shown in Table 4. This is approximately 0.30% of the dose compared to the annual exposure of an adult in Slovenia received from natural radiation in the environment (2,500–2,800 µSv). In the regions with lower radioactive contamination of the soil, such as Prekmurje and the Coastal-Karst region, the corresponding dose is lower, while it is higher in the Slovenian Alpine region.

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

Table 4: Radiation exposure of the adult population in Slovenia due to global contamination of the environment with artificial radionuclides in 2015

Transfer pathway	Effective dose [µSv per year]
Inhalation	0.001
Ingestion:	
drinking water	0.03
food	1.8
External radiation	6.0*
Total (rounded)	**7.5****

* 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.

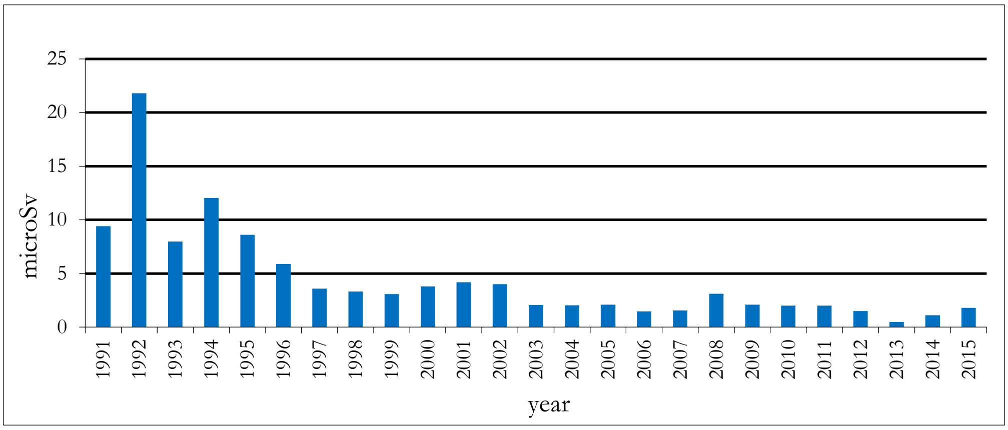


Figure 14: Annual effective doses of members of the public received by ingestion due to global radioactive contamination of the environment with the radionuclides ^{137}Cs and ^{90}Sr in Slovenia

The reason for the high value in 1992 was that game foodstuffs were taken into account when the dose estimation was calculated. Without those samples, the effective dose for that year would have been lower than 10 µSv.

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 already in the preoperational 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 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, agriculture products, 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 nuclear power plant on the environment are therefore evaluated only on the basis of data on gaseous and liquid discharges. These discharge data are used as an input for modelling the dispersion of radionuclides in the environment. The low results of the measurements in the environment of the nuclear power plant 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 2015 independent monitoring confirmed that the measurements of discharges performed by the Krško NPP were fully consistent with the results of measurements carried out by the laboratories of the authorised performers of radioactivity monitoring, i.e. the Jožef Stefan Institute (JSI) and the Institute of Occupational Health (IOS).

3.3.1.1 Radioactive Discharges

In 2015 the radioactive discharges from the NPP increased in comparison with 2014. The reasons for this can be found in the fact that a refuelling outage was carried out in 2015. From the increase of emissions it can also be concluded that the deterioration in the integrity of the fuel again took place, but to a smaller extent than in 2013.

The activity in gaseous releases is mostly produced by noble gases. In 2015 the total activity of noble gases released into the atmosphere was 3.72 TBq, which resulted in a public exposure of 0.15 μSv or 0.3% of the limit. Releases were higher than in the previous year, whereas their values were much lower than the prescribed limit values.

764 MBq (220 MBq calculated to the equivalent of ^{131}I) of radioactive iodine isotopes were released in 2015, representing 1.2% of the annual limit. Released iodine results from the leakage of nuclear fuel. The total annual release of iodine isotopes was twice that in 2013. The iodine release characteristics differed in 2015 compared to 2013. The leakage of the fuel elements began in July 2012 and then gradually increased until the refuelling outage in October 2013. Iodine isotopes were purified from the reactor coolant during the reactor operation and were therefore released in smaller amount during the refuelling outage. In 2015 the fuel began to leak just two months before the outage and thus the activities of iodine isotopes grew rapidly. Being just before the outage, there was too little time or opportunity to eliminate the iodine isotopes from the coolant during the reactor operation. As a result, the releases at the end of the fuel cycle were higher than in 2013. However, the emissions were much lower than the annual limit.

The activity of released radioactive dust particles was 1.6 MBq, which is approx. 0.01% of the annual limit. Due to discharges of tritium (^{3}H) into the atmosphere, a slight increase in the activity of ^{3}H gas emissions was observed from one year to the next due to improvements in the sampling method and laboratory analysis. The release level of tritium (^{3}H) into the atmosphere has been slowly stabilised, as expected. The activity of ^{14}C corresponds to the typical values.

In liquid discharges from the plant into the Sava River, ^{3}H predominates, bound to water molecules. Total ^{3}H activity released in 2015 was higher than in 2014, 16.3 TBq, which is 36.2% of the annual regulatory limit (45 TBq). Due to its low radiotoxity, this radionuclide is radiologically less important, despite having a higher activity compared to other radioactive contaminants. The activity of other radioisotopes in liquid discharges was similar to that in the previous year and amounted to 33.6 MBq or 0.03% of the annual limit (100 GBq). The total discharged activity of ^{14}C released into the Sava River in 2015 was 1.21 GBq, which is slightly less than in 2014, but is consistent with the estimates made on the basis of the literature and international practice (0.07 Ci/GWe per year or 1.8 GBq/year).

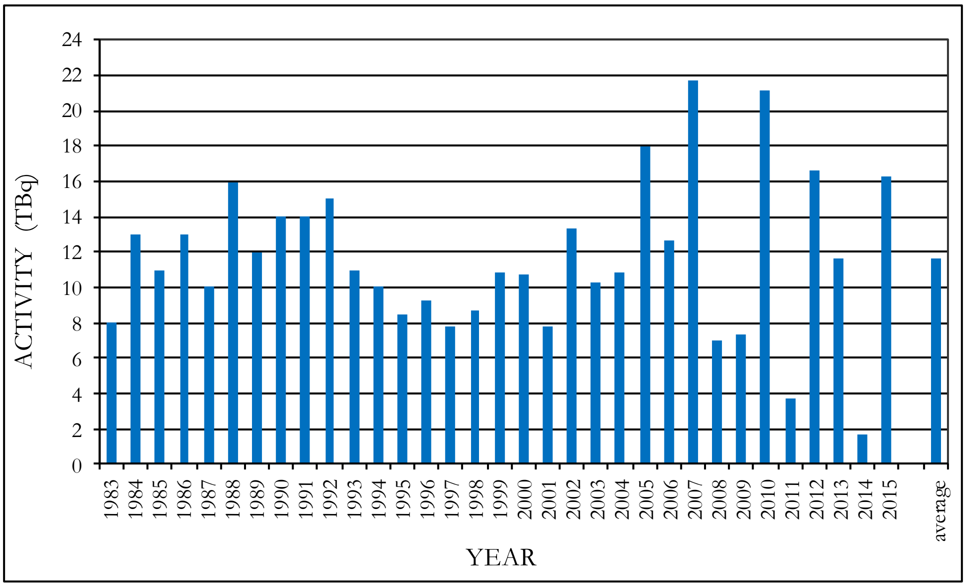


Figure 15: Activity of the released ^{3}H in liquid discharges

3.3.1.2 Environmental Radioactivity

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

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

Concerning the impact of the Krško NPP, it should be noted that the presence of the radionuclides ^{137}Cs and ^{90}Sr is a consequence of global contamination and not a result of plant operations. In 2015 the total amount of ^{3}H liquid discharges from the Krško NPP was 16.3 TBq, which is comparable to previous years with the exception of last year's release, which was very small (1.7 TBq). The concentrations of other artificial radionuclides discharged into the Sava River (^{60}Co and others) were below the detection limits in all samples. The measured concentrations of radioisotope ^{131}I into the Sava River could be caused by discharges from nuclear medicine clinics in Ljubljana and Celje, and not by the operation of the nuclear power plant.

3.3.1.3 Exposure of the Public

Dose assessment of the public was based on model calculations made by contractors. The calculated dispersion factors for atmospheric discharges, based on realistic meteorological data, showed that the most important pathways for public exposure were the ingestion of food with ^{14}C, external radiation from clouds and deposition, and the inhalation of air particles with ^{3}H and ^{14}C. The highest annual dose was received by adult individuals due to the intake of ^{14}C from vegetable food (0.1 µSv), while a ten-fold lower dose (0.016 µSv) was also received due to the inhalation of ^{3}H. The dose assessment of liquid discharges in 2015 showed that their additional contribution to the population exposure was also very low, 0.06 µSv per year, which is one order of magnitude lower than in 2013 and 2014. The difference compared to previous years is due to the contribution of ^{14}C, which was taken into account. Namely, ^{14}C has a high concentration or bioaccumulation factor. In 2013 and 2014 the highest bioaccumulation factor of ^{14}C published in the literature was taken into account (50 m^3/kg). However, a concentration factor of 2.41 m^3/kg for the year 2015 was used. This value was determined upon expert consultation at a workshop on 9 December 2015 in Ljubljana. Despite the changed methodology of evaluation of the ^{14}C specific activity in fish, ^{14}C is still the largest contributor to the total dose from all contributions (78%), where the dominant pathway is the ingestion of fish.

Table 5 shows that the estimated total effective dose of an individual who lives in the surroundings of the Krško NPP is less than 0.18 µSv per year. This value represents 0.2% of the authorised limit value (a dose constraint of 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 5: Assessment of the partial exposures of an adult member of the reference public group due to atmospheric and liquid radioactive discharges from the Krško NPP in 2015

Type of exposure	Transfer pathway	The most important radionuclides	Effective dose [µSv per year]
External radiation	Cloud immersion	Noble gasses (^{41}Ar, ^{133}Xe, ^{131m}Xe)	0.001
	Deposition	Particulates (^{58}Co, ^{60}Co, ^{137}Cs, …)	5.90E-08
Inhalation	Cloud	^{3}H, ^{14}C, ^{131}I, ^{133}I	0.016
Ingestion (atmospheric discharges)	Vegetable food	^{14}C	0.1
Ingestion (liquid discharges)	Drinking water (the Sava River)	^{3}H, ^{137}Cs, ^{89}Sr, ^{90}Sr, ^{131}I, ^{14}C	0.06
Total Krško NPP in 2015			**< 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 Research Reactor and the Central Storage for Radioactive Waste at Brinje

The TRIGA Research Reactor and the Central Storage for Radioactive Waste are both located at Brinje near Ljubljana. The samples irradiated in the reactor are analysed in the laboratories of the Department of Environmental Science of the Jožef Stefan Institute, which are located by the reactor building. Therefore, the radioactive discharges at this location arise from the reactor operation, the Central Storage for Radioactive Waste and from laboratory activities. Since the operation of the facilities was stable and there were no incidents that resulted in radioactive material being released into the environment; the results of the operational monitoring for 2015 are essentially the same as for the previous year.

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

Measurements of radioactive aerosol discharges into the atmosphere showed results below the detection limit. Discharges of ^{41}Ar into the atmosphere, calculated on the basis of the reactor operation time, were estimated at 0.9 TBq in 2015, which is comparable to previous years. The measurements of specific activities in the environment showed no radioactive contamination from the operation of the reactor. The external dose due to radiation from the cloud on an individual due to ^{41}Ar discharges was estimated, similar to previous years, at 0.02 µSv per year, under the assumption that the individual spends 65 hours per year at a distance of 100 m from the reactor when mowing grass or ploughing snow and that he stays in the cloud only 10% of the time. An inhabitant of Pšata village who lives at a distance of 500 m from the reactor receives 0.46 µSv per year. A conservative assumption was used for the dose assessment for individuals concerning liquid discharges. If river water is ingested directly from the recipient Sava River, the annual exposure is estimated at less than 0.01 µSv per year. The total annual dose for an individual, irrespective of the pathway, is still one hundred times lower than the authorised dose limit (50 µSv per year). The total annual dose of an individual from the public in 2015, irrespective of the model used, is still more than a thousand times lower than the effective dose from the natural background in Slovenia (from 2,500 to 2,800 µSv per year).

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

The estimated average radon emission in 2015 was 6 Bq/s, which is, taking into account the measuring uncertainty, similar to the emissions in 2009–2015 (Figure 16). The increase of radon (^{222}Rn) concentrations in the vicinity of the storage is not measurable and was therefore estimated by a model for average weather conditions to be around 0.36 Bq/m^3 at the fence of the reactor site. In the wastewater from a drainage collector, the only artificial radionuclide measured was again ^{137}Cs, which is a consequence of global contamination and not of storage operation. Even the ground soil in the storage vicinity does not indicate the presence of other radionuclides, except the Chernobyl contaminant ^{137}Cs and the natural radionuclides ^{7}Be, ^{40}K, as well as radionuclides of the uranium-radium and thorium decay series.

The dosimetry data show that activity took place in the CSRW at Brinje and its immediate surroundings: barrels were moved onto new metal pallets. The chambers in the CSRW were gradually emptied by relocating radioactive waste packages to the asphalted surface in front of the facility. During these operations the radioactive waste packages were positioned at locations close to external radiation dose monitoring stations. Works were conducted mainly in July, which is indicated by a minimal increase in the average dose rate in June and July at a measuring point 30 meters from the storage facility entrance (0.15 µSv/h).

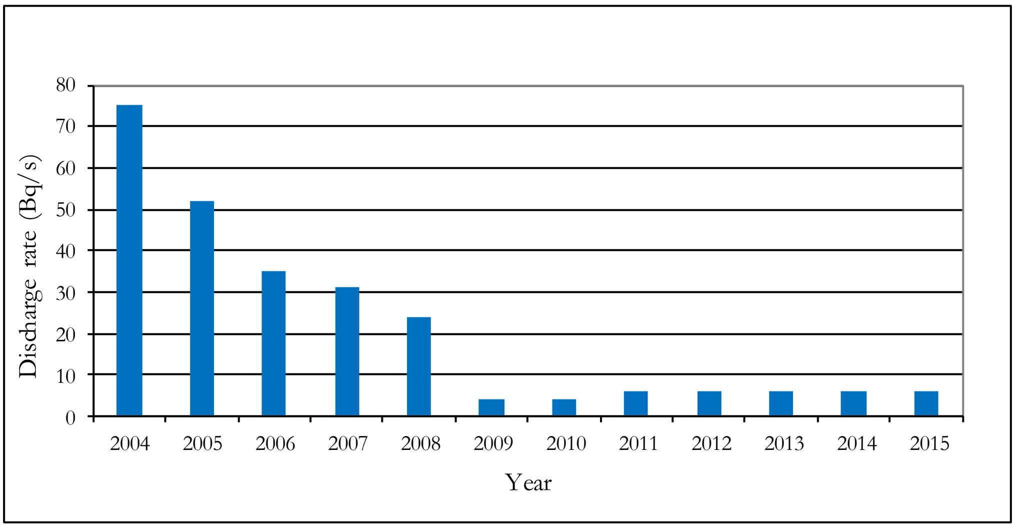


Figure 16: Emission rates of ^{222}Rn from the Central Storage for Radioactive Waste at Brinje

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 taken into account. 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. In 2015 they received an estimated effective dose of 0.90 µSv, according to the model calculation. A security officer received 0.43 µSv per year from his regular rounds, while the annual dose received by a farmer adjacent to the controlled reactor area was estimated to be only about 0.02 µSv. These values are comparable with those in 2014 and are much lower than in 2008, due to lower radon releases. Moreover, they are much lower than the authorised dose limit for individuals from the reference group of the population (100 µSv per year). The annual dose collected by an individual from the natural background is 2,500–2,800 µSv.

3.3.3 The Former Žirovski Vrh Uranium Mine

The monitoring of environmental radioactivity consists of measuring radon releases, liquid radioactive discharges and concentrations of the radionuclides in the environment. An integrated programme of measurements has been implemented, including the radionuclide-specific activities of the uranium-radium decay chain in the environmental samples, including the concentrations of radon and its decay products in the air, and 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 natural radiation background). The net contribution of the radioactive contamination of the former uranium mine is estimated by the subtraction of the radionuclides' natural background from the measured values.

Measurements of external gamma radiation in the vicinity of mine disposal sites and hydrometallurgical tailings disposal sites were also performed in 2015 in accordance with the monitoring programme. In 2015 the second year of long-term monitoring and maintenance of the Jazbec disposal site, and the fifth year following the completed remediation of the Boršt disposal site, the monitoring programme was implemented in accordance with the Safety Report for the Jazbec and Boršt disposal sites.

The safety report for the Jazbec disposal site sets out the parameters to be monitored by detailed radiological monitoring, determined on the basis of the analysis of the monitoring results from the previous period.

The financial means available to the Žirovski Vrh Uranium Mine (RŽV) were not sufficient for the implementation of the entire programme. The Uranium mine RŽV therefore decided to perform the measurements to an extent that still enabled the monitoring of emissions from mine facilities.

According to the additional contribution to the population dose from the Uranium mine RŽV in 2015, the most important part of the programme in 2015 was measuring the radon concentration and its short-lived progeny.

The radioactivity of surface waters has slowly but steadily been decreasing in recent years. In Brebovščica stream, where all liquid discharges flow from the mine and both disposal sites, only the uranium concentration was significantly elevated in relation to the natural background. In 2015 the specific activity of ^{238}U in a single sample was 221 Bq/m^3.

In 2015 the mine's contribution of radon ^{222}Rn from other disposal sites to the natural concentrations in the environment was estimated at around 2.6 Bq/m^3.

Measurements of milk in 2015 were not performed, although they were in the programme. At the Potokar location, which was scheduled for milk sampling, a sample could not be obtained because the farm had ceased activities.

The calculation of the effective dose received by the population took into account the following exposure pathways: the inhalation of long-lived radionuclides from the uranium decay series, radon and its short-lived progeny, ingestion without water contribution (the supply of the population from the public water supply), and external gamma radiation. The radiation exposure of an adult member of the public living in the vicinity of the mine was estimated at 0.066 mSv for 2015, which is slightly more than in the previous year, but still within the uncertainty of the assessment method. The exposure is low due to completed remediation at the mine disposal sites at Jazbec and Boršt and represents approximately one third of the effective dose estimated in the last decade of the 20th century. However, the most important radioactive contaminant in the mine environment still remains radon ^{222}Rn with its short-lived progeny, which contributed 0.055 mSv or 85% of the additional exposure in this environment (estimation for an adult member of the reference public group, see Table 6).

Table 6: The effective dose received by an adult member of the public living in the surroundings of the former uranium mine at Žirovski Vrh in 2015

Transfer pathway	Important radionuclides	Effective dose [mSv]
Inhalation	– aerosols with long-lived radionuclides (U, ^{226}Ra, ^{210}Pb)	0.00
	– only ^{222}Rn	0.0014
	– Rn – short-lived progeny	0.055
Ingestion	– drinking water (U, ^{226}Ra, ^{210}Pb, ^{230}Th)	(0.0133)*
	– fish (^{226}Ra and ^{210}Pb)	0.0018
	– agricultural products (^{226}Ra and ^{210}Pb)	0.0065
External radiation	– immersion in deposition (radiation from cloud and deposition)	0.0009
	– deposition of long-lived radionuclides (deposition)	–
	– direct gamma radiation from disposal sites	–
Total effective dose (rounded):		**0.066 mSv**

* Dose due to the ingestion of water from the Brebovščica stream is not included in the dose assessment because the water is not used for drinking, watering of animals, or irrigation.

The total effective dose for an adult in 2015 due to the contribution of the former uranium mine is 50% lower than in 2007 and amounted to less than one tenth of the general limit value for the population, which is 1 mSv per year. The estimated dose received by a 10-year-old child was 0.083 mSv and 0.137 mSv by a 1-year-old child. These values represent about 2% of the natural background dose due to natural background radiation exposure in the environment of Žirovski Vrh during the operation of the mine (5.5 mSv). Annual changes in effective doses due to the mine contribution are shown in Figure 17.

Measurements of the radioactivity and dose estimations for the previous several years have shown a decrease in the environmental impact and the exposure of the population due to the cessation of uranium mining and the remediation works that have already been carried out. The estimated dose exposure is one third of the authorised dose limit of 0.3 mSv per year.

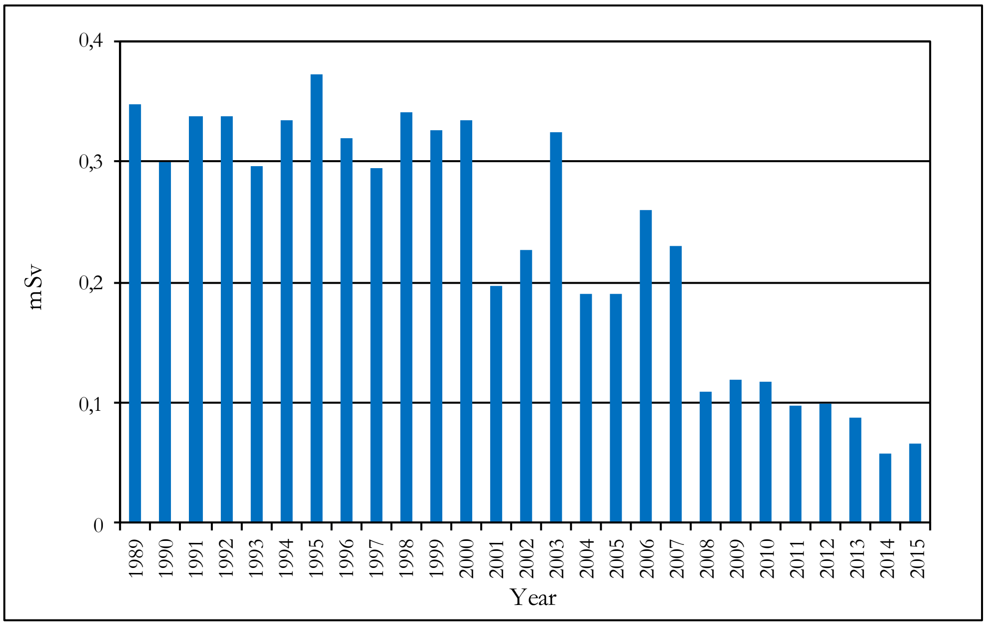


Figure 17: Annual contributions to the effective dose received by an adult member of the public due to the former Žirovski Vrh uranium mine in the period 1989–2015

3.4 Radiation Exposure of the Population in Slovenia

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

3.4.1 Exposure to Natural Radiation

The average annual effective dose from natural sources received by a single individual on Earth is 2.4 mSv, varying from only 1 mSv to up to 10 mSv at some locations. The average annual dose from natural radiation sources received by an average member of the public in Slovenia is about 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, about 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 about 0.4 mSv. The annual effective dose due to external radiation from the radioactivity of soil, building materials in dwellings and cosmic radiation together was estimated to be from 0.8 to 1.1 mSv in Slovenia.

3.4.2 Measurements of Radon in Living and Working Environments

In 2015 the Slovenian Radiation Protection Administration (SRPA) continued to implement the government programme adopted in 2006 for systematic examination of living and working environments, as well as to raise the awareness of the population regarding measures to reduce exposure due to the presence of natural radiation sources. Again, the main focus was on determining the exposure to radon because this radioactive noble gas is generally the main source of natural radiation in living and working environments. On average, it contributes more than half of the effective dose received by individuals from all natural sources of ionising radiation. It penetrates premises mainly on the ground level through various openings, such as manholes, drains, cracks or tears in the floor.

Through this programme, 144 rooms in 78 buildings were measured for radon and its progeny, mostly in kindergartens and schools. The average radon concentrations exceeded the threshold for the living environment (400 Bq/m^3) in 40 rooms of kindergartens and schools out of a total of 126 and in 3 dwellings out of a total 6. The threshold for a working environment (1,000 Bq/m^3) was exceeded in 1 room of other institutions out of a total of 6 and in Kržna cave, where all 4 measurements results were between 3,200 and 4,200 Bq/m^3. Effective doses received by staff and children were estimated on the basis of the measurement results and the occupancy time in these buildings. Out of the total of 144 estimated annual doses, 24 exceeded the threshold of 6 mSv for members of the public. The highest estimated dose was around 53 mSv in a basement dwelling in Spodja Idrija due to an average radon concentration of 2,850 Bq/m^3. The SRPA warned the owner of the living conditions and suggested possible measures, which were then applied. In 24 cases, the estimated annual doses were between 2 and 6 mSv, in 19 cases between 1 and 2 mSv, and in 77 cases less than 1 mSv.

In 2015 the SRPA conducted 13 in-depth inspections of legal entities that operate facilities with increased levels of radon. A decision ordering measures to reduce radon radiation exposure was issued in 3 cases.

3.4.3 Radiation Exposure of the Population Due to Human Activities

Higher radiation doses due to the normal operation of nuclear and radiation facilities are usually received only by local population. The exposures of particular groups of the population that are a consequence of radioactive discharges from these facilities are described in Chapter 3.3. (Operational Monitoring). In Table 7, the annual individual doses are given for the maximally exposed adults from the reference groups for all objects in consideration. For comparison, an average annual dose received by individuals stemming from the global radioactive contamination of the environment (nuclear tests and the Chernobyl accident), is also shown. The highest exposures of the population are recorded for individuals living in the surroundings of the former uranium mine in Žirovski Vrh. The exposures were estimated as amounting to a maximum of 5% of the exposure from natural sources in Slovenia. The exposure of members of the public in no case exceeded the dose levels defined by the regulatory limits.

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

Table 7: Exposures of adult individuals from the reference population group

Source	Annual dose [mSv]	Regulatory dose limit [mSv]
Žirovski vrh Uranium Mine	0.066	0.300*
Chernobyl and nuclear weapon tests	0.03	/
Krško NPP	< 0.0007	0.050**
The TRIGA Research Reactor	0.00046	0.050
The Central Storage for Radioactive Waste	0.00002	0.100

* Limitation after the final remediation of the Žirovski Vrh uranium mine.

** Due to radioactive discharges.

4 RADIATION PROTECTION OF WORKERS AND MEDICAL EXPOSURES

Due to occupational exposure, individuals can receive substantial doses of 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 take part in regular medical surveillance programmes and have to receive adequate training. Employers have to ensure that the dose of ionising radiation is assessed for every worker performing specific activities.

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

The approved dosimetry services for 2015 were the Institute of Occupational Safety (IOS), the Jožef Stefan Institute (JSI), and the Krško Nuclear Power Plant (Krško NPP) for external exposure and IOS for radon exposure in mines and Karst caves. Currently, 14,619 persons have a record in the central registry, including those who have ceased to work with sources of ionising radiation. In 2015 the dosimetry service at the IOS took measurements of individual exposures for 4,081 workers, whereas the JSI monitored 1,828 radiation workers and the Krško NPP monitored 1,193 radiation workers. The Krško NPP performed individual dosimetry for 431 plant personnel and 762 outside workers, who received an average dose of 0.72 mSv of ionising radiation. As for other work sectors, workers in industrial radiography received the highest average annual effective dose of 0.85 mSv from external radiation, while employees in medicine received an average of 0.22 mSv. The highest average value among these, 0.50 mSv, was recorded for workers in nuclear medicine.

In 2015 the highest collective dose from external radiation was received by workers at the Krško NPP (778 man mSv), followed by air crews (334 man mSv), workers in the medical sector (248 man mSv), industry (48 man mSv) and other activities (33 man mSv).

Since 2010, the data on doses received by radiation workers who took part in NPP outages abroad and data on doses of Adria Airways flight personnel who are exposed to cosmic radiation have been included in the CRPD. In 2015 the collective dose for 35 workers in foreign NPPs was 47 man mSv (an average dose of 1.5 mSv). During Adria Airways flights, 233 workers were exposed to cosmic radiation, receiving an average dose of 1.45 mSv and a collective dose of 344 man mSv.

The highest doses are received by workers exposed to radon and its progeny. In 2015, out of 191 tourist workers, 6 workers received a dose between 15 and 20 mSv, 29 workers received a dose between 10 and 15 mSv, 44 workers received a dose between 5 and 10 mSv, 49 workers received a dose between 1 and 5 mSv, and 63 workers received a dose less than 1 mSv. The highest individual dose was 19.15 mSv. The collective dose was 932 man mSv, with an average dose of 5.1 mSv. Tourist workers in Karst caves are the category of workers most exposed to ionising radiation in Slovenia.

The findings of a study on the exposure of individuals in Karst caves, financed by the SRPA, show that the doses of tourist workers in Karst caves due to radon exposure assessed according to the ICRP 65 (International Commission for Radiation Protection) are underestimated. Due to the high unattached fraction of radon progeny, the ICRP 32 model should be used and an approximately two-times higher dose factor should be taken into account. Therefore, doses from radon and its progeny are assessed according to the ICRP 32 model in this report. 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 0.58 man mSv, whereas the average individual dose was 0.07 mSv.

The distribution of workers in different work sectors by received dose interval (mSv) is shown in Table 8.

Table 8: The number of workers in different work sectors by dose interval (mSv)

	0-MDL	MDL≤E<1	1≤E<5	5≤E<10	10≤E<15	15≤E<20	20≤E<30	E≥30	Total
Krško NPP	111	844	220	18	0	0	0	0	1,193
Industry	426	74	14	1	0	0	0	0	515
Medicine and veterinary medicine	2,659	1,104	42	0	0	0	0	0	3,805
Flights	3	26	204	0	0	0	0	0	233
Other	1,296	292	1	0	0	0	0	0	1,589
Radon	7	64	49	44	29	6	0	0	199
Total	3	15	16	1	0	0	0	0	35
Krško NPP	**4,505**	**2,419**	**546**	**64**	**29**	**6**	**0**	**0**	**7,569**

MDL – minimum detection level

E – effective dose in mSv received by an exposed worker

Training of exposed workers using sources of radiation

The education level of workers using sources of radiation is in accordance with regulations. Minor deficiencies were found regarding the timely updating of knowledge and skills in the field of ionising radiation protection. Training, refresher courses and tests were carried out by the approved technical support organisations, namely the IOS and the JSI. In 2015 a total of 2,293 participants attended courses on ionising radiation protection.

Targeted medical surveillance

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

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

Altogether, 3,191 medical examinations were carried out. Among the examined workers, 2,807 fully fulfilled the requirements for working with sources of ionising radiation, whereas 334 fulfilled the requirements with limitations. It was apparent that 16 candidates temporarily did not fulfil the requirements and 4 did not fulfil the requirements. One worker did not fulfil the requirements and other work was proposed. In 29 cases an evaluation was not possible.

Diagnostic Reference Levels for diagnostic radiological procedures

X-ray examinations that are implemented in accordance with good radiological practice provide a radiogram, which contains all the information necessary for a correct diagnosis at the lowest exposure to patients. In 1996 the International Commission on Radiological Protection introduced the concept of Diagnostic Reference Levels (DRL) 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 this department or X-ray device to a DRL value obtained on the basis of the relevant regional or local data.

By using the DRL, exposure decreases and radiological practice improves. The use of such is more efficient when national DRL values are set. Thus, following a five-year data collection project on the exposure of patients undergoing X-ray examinations in Slovenia, DRL values for fifteen X-ray examinations were presented in 2006. Due to changes in technology and professional guidance, it is necessary to regularly review Diagnostic Reference Levels. Therefore, in 2015 the SRPA continued to collect data on the exposure of patients, on the basis of which the national DRL will be updated in the near future. Regarding such, Slovenia participated in the project of the International Agency for Atomic Energy (IAEA) entitled RER-9-132 to establish DRLs for paediatric patients in radiological procedures with computer tomography. Additionally, Slovenia will be involved in establishing the international DRL at specified interventional procedures with particular attention devoted to paediatric patients.

When issuing a license for radiation practices or a license for the use of a radiation source in medicine, the level of exposure for each X-ray device or a group of such devices is compared to DRL values. If the average exposure for each examination is greater than the DRL, the SRPA requires the optimisation of that radiological procedure. Although this process is important for all radiological procedures, greater attention is devoted to procedures with high patient exposure, e.g. interventional procedures and computer tomography. In this scope, in 2015 intervention protocols for one radiological procedure were carried out.

In nuclear medicine, rather than a Diagnostic Reference Level, the recommended activities of the administered radioisotope are used. Due to the small number of departments of nuclear medicine in Slovenia, developing national values is not sensible, so international recommendations, mainly the recommendations of the ENMA, the European Association of Nuclear Medicine, are used instead, taking into account the technical characteristics of each imaging device. The SRPA checks typical amounts of administered activity when approving the programmes of radiological procedures. In addition, in 2011 systematic reviews of 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.

4.1 Exposure of patients during radiological procedures

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

Due to the increasing role of X-ray diagnostics in modern medicine and on the basis of trends in other developed countries, a further increase in population exposure is expected due to medical use of ionising radiation. Therefore, the SRPA carries out activities to improve the application of the principles of justification and optimisation, with particular attention devoted to examinations with computed tomography and interventional procedures. In the scope of this, the SRPA actively takes part in establishing the Clinical Institute of Radiology at the University Clinical Centre Ljubljana as an international competence centre for quality in diagnostic and interventional radiology with the aim of operating as a reference centre for other institutions in Slovenia. These activities are carried out in the frame of the IAEA project No. RER-6-028. In addition, together with the Clinical Institute of Radiology at the Ljubljana University Clinical Centre, the SRPA has organised regional training course in radiation protection for vascular surgeons. 25 participants from 15 countries participated in the training course. The experts leading the training course as well as other foreign participants acknowledged the high level of radiation protection demonstrated by the Clinical Institute of Radiology.

5 MANAGEMENT OF RADIOACTIVE WASTE AND IRRADIATED FUEL

In Slovenia, the only high-level radioactive waste (HLW) is the spent nuclear fuel (SNF) from the Krško NPP and the TRIGA Research Reactor. 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. A special category of waste is spent sealed radioactive sources, produced by small holders, which are stored in the Central Storage for Radioactive Waste at Brinje.

5.1 Irradiated Fuel and Radioactive Waste at the Krško NPP

5.1.1 Management of Low- and Intermediate-Level Waste

In recent years, the volume of low and intermediate-level waste has been reduced by compression, super-compaction, drying, incineration, and melting. The total volume of waste accumulated by the end of 2015 amounted to 2,264 m^3, with the total gamma and alpha activity of the stored waste amounting to $1.78 \cdot 10^{13}$ Bq and $2.54 \cdot 10^{10}$ Bq, respectively. In 2015 the equivalent of 179 standard drums containing solid waste was stored. As of 31 December, the total gamma and alpha activity of stored radioactive waste was $4.92 \cdot 10^{9}$ Bq and $2.71 \cdot 10^{6}$ Bq, respectively.

Figure 18 shows the accumulation of low- and intermediate-level radioactive waste in the Krško NPP storage. Periodical volume reductions, which are a consequence of compression, supercompaction, incineration and melting, are shown. After 1995, the accumulation of waste volume was reduced as a result of a new in-drum drying system (IDDS) for evaporator concentrate and spent ion exchange resins.

In 2006, a super-compactor was installed in the storage facility at the Krško NPP, which thus began the continuous super-compaction of its radioactive waste. In 2015 there was no supercompacted newly-generated radwaste.

The radwaste for incineration and melting is temporarily transferred to the Decontamination Building due to the lack of space in the storage facility near the super-compactor. In 2014, 350 packets of combustible waste were sent for incineration to Sweden, 316 packets of these were compressible, 4 were other packages and 30 packages of dried spent ion exchange resins from the secondary circuit. In 2015, after the incineration campaign in Sweden, 19 barrels of ashes were returned and currently stored in the Decontamination Building. In the same building, 182 packages of compressible waste were already stored for the next shipment to Sweden.

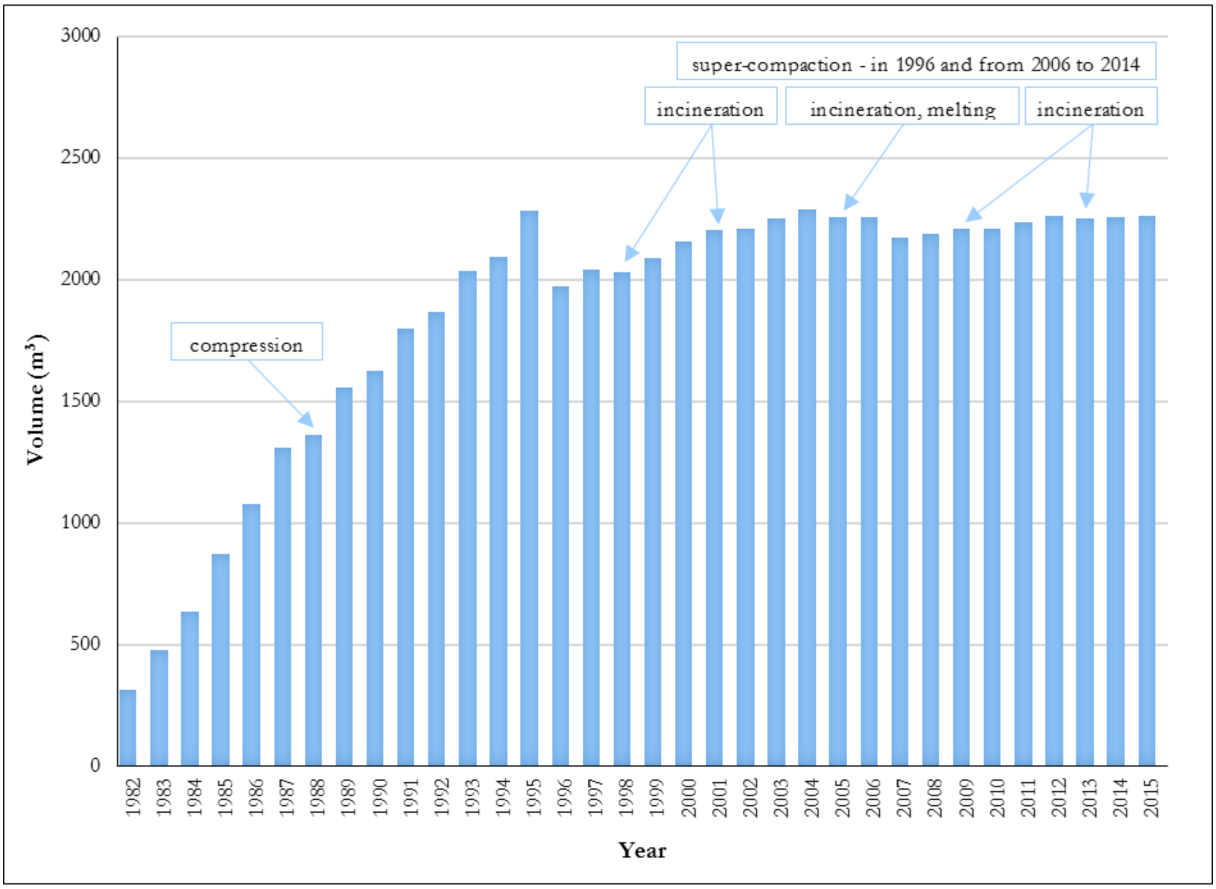


Figure 18: The accumulation of low- and intermediate-level radioactive waste in the Krško NPP storage

In 2013, the Krško NPP began to design a facility for the manipulation of the equipment and shipment of radioactive cargoes. The new building will ease the storage problems due to delays with the construction of the final repository for low- and intermediate-level waste.

5.1.2 Management of Spent Fuel

All spent fuel in the Krško NPP is stored in the spent fuel pool with 1,694 cells. At the end of 2015, the total number of spent fuel assemblies in the spent fuel pool amounted to 1,154 – including two special canisters with damaged fuel rods.

The number of annually spent fuel assemblies and the total number of such elements in the pool are shown in Figure 19.

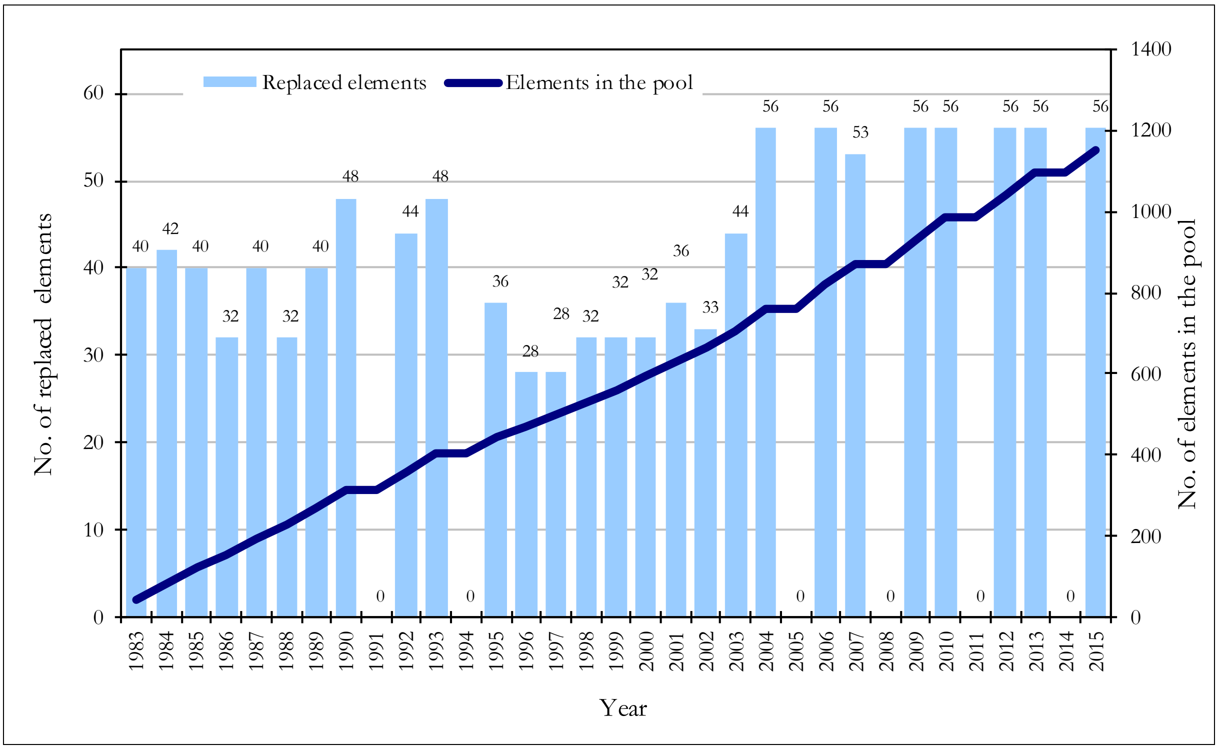


Figure 19: The number of annually spent fuel assemblies and the total number of such elements in the pool of the NPP.

Already in 2011, the SNSA issued a decision to the Krško NPP stipulating that safety measures must be undertaken in order to prevent severe accidents and/or mitigate their consequences. The decision, *inter alia*, stipulates that the nuclear operator has to address all the possibilities to decrease the risk associated with spent fuel management, having in mind also a change in the long-term strategy. In the second half of 2012, the Krško NPP prepared and submitted a document entitled "Evaluation of Spent Nuclear Fuel Storage Options".

In June 2014, four potential suppliers (for "turn-key projects") were invited to present tenders and approaches with regard to capabilities regarding the transport of spent fuel and the dry storage thereof. Based upon their approaches, the Krško NPP is to decide which of the proposed manners of storage is the most suitable.

In December 2015, the Krško NPP prepared a document entitled "Technical Specification – Spent Fuel Dry Storage Construction", which was the officially published documentation and invitation, aimed at selecting a vendor for the required equipment and a partner to carry out the project. It follows from the cited document, *inter alia*, that the timeline for the construction of the dry storage is anticipated between December 2017 and November 2018; the commencement of the movement (internal transport) of spent fuel from the existing pool into the constructed dry storage is envisaged for April 2019. The design of the dry storage specifies that the operational life be at least 60 years.

5.2 Radioactive Waste at the Jožef Stefan Institute

In 2015 approximately 200 litres of radioactive waste were produced 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. At the end of the year, this waste was still stored in the hot cell facility. The Radiation Protection Unit of the Institute plans to hand the waste over to the Central Storage Facility at Brinje, managed by the ARAO.

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

5.3 Radioactive Waste in Medicine

The Institute of Oncology in Ljubljana has appropriate hold-up 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 back to the producer or transferred to the Agency for Radwaste Management. Radioactive waste with short-lived radionuclides are stored in special storage until clearance levels are reached and then disposed as normal waste.

5.4 The Commercial Public Service for Radioactive Waste Management

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

- Accepting, collecting, transporting, processing, and storage prior to disposal, preparations for the construction of the repository, the construction of the repository and the disposal of radioactive waste and spent fuel that is not from nuclear facilities for energy production;
- The processing of radioactive waste and spent fuel prior to disposal, preparations for the construction of the repository, the construction of the repository and the disposal of radioactive waste and spent fuel from nuclear facilities for energy production;
- Management, long-term monitoring and maintenance of repositories for radioactive waste and spent fuel;
- Management, long-term monitoring and maintenance of the waste pile and mill tailings repositories produced by the extraction of nuclear mineral raw materials.

Within the public service of the management of radioactive waste from small producers, in 2015 the ARAO ensured regular and smooth collection of radioactive waste at its place of origin, its transport, treatment and preparation for storage and disposal, and management of the Central Storage Facility, as described in Chapter 2.1.3.

For processing the radioactive waste, the ARAO can independently use the premises of the hot cell facility at the Jožef Stefan Institute.

In 2015 the CSRW accepted 112 packages of radioactive waste from 76 producers, namely six packages of solid waste, 23 packages of sealed radiation sources, 80 packages of ionisation smoke detectors and 3 package of liquid waste. The total volume of stored radioactive waste was 3.2 m^3. At the end of 2015, there were 829 packages stored as follows:

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

The total activity of 92.8 m^3 of stored radioactive waste at the end of 2015 was estimated to be 3 TBq, with a total weight of 52.8 tonnes.

In 2015 over 4,000 pieces of ionising smoke detectors, mostly with the radionuclide ^{241}Am and a small number of detectors with radionuclides ^{226}Ra and ^{239}Pu, were transported from the CSRW into the hot cell facility. The ionisation smoke detectors were sorted according to the type of radionuclide. Those containing the radionuclide ^{241}Am were disassembled into radioactive and non-radioactive parts; those that contained ^{226}Ra or ^{239}Pu were sorted and repacked. The contaminated housing of such smoke detectors have been compressed continuously. Non-radioactive components that meet the conditions for unconditional clearance of the radioactive substance were handed over to waste management companies.

In January 2015, the ARAO accepted in the CSRW a drum of solidified radioactive waste with radionuclide ^{3}H from December 2014. In early 2015 the ARAO solidified in the hot cell facility another 45 liters and 2.1 MBq of liquid radioactive waste with radionuclide ^{14}C. The results were two drums of solid waste, which were transferred to the CSRW. In December 2015, at two locations of producers, the ARAO took possession of another 200 liters of liquid radioactive waste with radionuclide ^{3}H and 1 liter of liquid waste with radionuclide ^{14}C and transported them to the hot cell. This waste will be solidified and taken to the CSRW in 2016. The processing and preparation of the waste in the hot cell caused a small amount of radioactive operational waste, such as smears, gloves, etc., which were stored in the CSRW.

At the end of 2015, the ARAO began the public service of implementing long-term surveillance and maintenance of the area of the Jazbec mine waste pile. In connection therewith, the Regulation on the Method, Objective and Conditions of the Mandatory Public Service of Long-term Monitoring and Maintenance of the Repository of the Waste Pile and Mill Tailings Produced by the Extraction of Nuclear Mineral Raw Materials was adopted on 9 October 2015. A licence for the implementation of the long-term monitoring and maintenance of the Jazbec mine waste pile was issued to the ARAO on 3 June 2015.

5.5 Disposal of Radioactive Waste

The ARAO continued activities for the construction of a repository for low- and intermediate-level radioactive waste in Vrbina near Krško, which is expected to begin trial operation in 2020.

In the future, it would be reasonable to slightly amend the legislation in this area, because currently every year ARAO faces stress due to delayed approval of the programmes by the Government and the signing of appropriate contracts. The work programme and the ARAO financial plan for 2015 were approved by the Government in May 2015; the contract with the NPP Fund was then signed in July 2015.

At the end of 2015, work on the project documentation for obtaining a construction permit for the repository for low- and intermediate-level radioactive waste in Vrbina at Krško was completed. The documentation will be further revised and reviewed. In parallel with the work on the project solutions, also work on other tasks was carried out; the environmental impact report was prepared and the preparation of reference documentation and a draft safety report began. The year 2015 saw the completion of the field investigation, the purchase of the land needed for the repository, as well as the upgrading of the safety analyses to the extent necessary for an environmental impact assessment.

In 2015 all the land required for the construction of the repository was secured. All contracts and registration of modifications in the Land Registry were finalised. On 31 August 2015, the last contract for the purchase of land for the construction of the repository was signed and in September the contract was certified. Expropriation procedures were not necessary because the contracts were concluded with all the owners. There were also activities for the transfer of the management of shares owned by the Republic of Slovenia from the Farmland and Forest Fund of the Republic of Slovenia to the ARAO.

In early 2015, a major project involving research on the geosphere and hydrosphere for the needs of the LILW repository was completed. The final report was reviewed in early 2015 and then revised in March 2015. Additional geotechnical research and research on the aggressiveness of soil on the concrete was carried out. Within the framework of the project and in order to formulate an appropriate basis for obtaining a construction license, a hydraulic analysis of the LILW repository impact area was carried out. The regular monitoring of the underground water in the area of the disposal site continued.

In 2015 work on the project for preparing safety analyses and acceptance criteria continued. Reports covering the assessment of all proposed optimisations for the LILW repository were prepared and the initial activities required to produce analyses and reports on the assessment of transboundary impacts and a revision of the report on the operational safety of the LILW repository were carried out. Based on the revised acceptance criteria and the updated report on the inventory, a "Preliminary Disposability Assessment" report was completed. In 2015 the ARAO produced a design basis for the draft safety report, as required by the ZVISJV and the relevant by-laws. Work on preparing an environmental impact assessment report started at the beginning of 2015. Based on the provided bases and design, an expert basis for assessing the environmental impact (air quality, soil quality, noise protection and the burden of agricultural products) was prepared in August and a review thereof was also carried out. The environmental impact assessment report, prior to review, was submitted in December and will be further harmonised and completed with a draft safety report and reviewed in accordance with the legal requirements and internal regulations.

5.6 Remediation of the Žirovski Vrh Uranium Mine

The remediation of the Žirovski Vrh uranium mine has been in progress since 1992. Both the uranium processing plant and the mine, together with the various accompanying objects, have been successfully decommissioned.

The majority of technical work on both disposal sites was successfully concluded, but a non-stable landslide beneath the Boršt disposal site has prevented its final closure. The rock beneath the hydrometallurgical tailings at the site has been sliding despite the completed remediation work at the site; the sliding is larger than is accepted and determined in the safety analysis report, thus further remedial actions are required for the Boršt site, while the closing work at the Jazbec has been finished.

In 2015 the company RŽV, d.o.o., carried out ongoing activities during the fifth year of the transitional period of the Boršt disposal site and the second year of the long-term management of the Jazbec disposal site: sampling, measurements, control of the overall state, maintenance, collecting and storing of information, record keeping, preparation of reports for the authorities, etc.

Assessment of the overall state of the remediated mine facilities was performed and even intensified at the request of the mine inspectorate because the rock base of the Boršt disposal site is still moving. The request of the mining inspector to complete the mining project by implementing emergency drainage measures to reduce the level of groundwater was, however, not fulfilled due to a lack of funds. These measures should be implemented in the future as continued movements could result in damage to the already implemented measures (the collapse of the drainage system, damage to the cover, etc.).

An inspection of the concrete lining of the passageway of the tunnel, the shotcrete lining of the entrance of the tunnel, and the landslide beneath the Boršt disposal site was carried out. In addition, the functioning of the drainage wells was assessed and the movement of the landslide was measured by a special extensometer placed in a tunnel. Shifts on the surface of the Boršt disposal site were constantly monitored by a GPS system and regularly reported to the Inspectorate for Energy and Mining and the SNSA.

In 2015 the consequences of the two extreme weather events that occured in 2014 (heavy icing - accumulation of ice on trees in February and flooding in October) were remedied. During the icing the guardrails of both landfills were damaged, while the consequences of the heavy rains in October were the blocked inflow of object B, a damaged road to the landfill, a damaged landfill guardrail, the filling of a culvert in trench 2, the erosion of the ditch embankment of trench 2, and two small landslides in trench 2.

The remediation of the consequences of these events returned the damaged objects to their original state by the end of summer 2015.

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

In 2015 the contractor Geotrias d.o.o. prepared a study entitled "Spread modeling of the hydrometallurgical tailings of the Boršt disosal site in the event of a complete collapse of the disposal site". In the study, the distribution of tailings in the event of an extraordinary event (e.g. intensive rain or an earthquake) was assessed. The study was performed to assess the possible gradual erosion of surface cracks in the disposal site's cover and the deformation of the landfill body due to rainfall with a return period of 100 to 1,000 years. In such event, material would be deposited downstream throughout the valley. On the basis of the study, the MOP ordered another study on the radiation exposure of residents and the workers who would carry out the remediation of the deposited material on the riverbeds of the Todražica, Brebovščica and Poljanska Sora Rivers. That study had not been competed by the end of 2015. Both studies will serve as a basis for further measures and for the closure of the disposal site.

Financing the activities of the RŽV from the budget was covered by a contract for temporary financing. Details on this monitoring project can be found in Chapter 3.3.3.

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

The Fund for Financing the Decommissioning of the Krško NPP and the Disposal of Radioactive Waste from the Krško NPP (hereinafter "the Fund") was established pursuant to the Act on the Fund for Financing the Decommissioning of the Krško NPP and the Disposal of Radioactive Waste from the Krško NPP (consolidated text – Official Gazette RS, Nos. 47/03, 68/08, 77/08 – ZJS-1, hereinafter: the Fund Act).

The Fund is not financed from the national budget, the operational costs are covered from the income of the Fund's operation.

Until March 2003, contributions to the Fund were paid by the Krško NPP. Since the amendments to the Fund Act in 2003, the company GEN energija, d.o.o., is liable for paying contributions to the Fund (which in July 2006 was renamed GEN energija, d.o.o.).

In 2004, the "Programme for the Decommissioning of the Krško NPP and the Disposal of Low- and Intermediate-Level Waste and Spent Fuel" (hereinafter "the Programme") was prepared. It determined the new levy per kWhe to be paid. The Government of the Republic of Slovenia was informed of the Programme at its 93rd regular session on 7 October 2004. The Programme was approved on 4 March 2005 during the 7th session of the Interstate Commission for Monitoring the Inter-governmental Agreement between the Government of Slovenia and the Government of Croatia (hereinafter "the Inter-governmental Agreement"). Since April 2005, the company ELES GEN, d.o.o., has been paying into the Fund EUR 0.003 per kWhe of electrical energy produced by the NPP and sold in Slovenia.

The above-mentioned levy is based on calculations determined in the Programme prepared in 2004, whereas the assumptions for the repository changed in the meantime. According to the Inter-governmental Agreement, the Programme has to be reviewed every five years. The revision should have been carried out by the end of 2009, but it had not been finished by the end of 2015. In the report on the Fund's audit for the period 2006-2009 entitled "The assurance of funds for the decommissioning of the Krško NPP and for the disposal of radioactive waste from the Krško NPP", the Court of Audit drew attention to the fact that a review of the Programme had been delayed and there is a question as to whether enough funds will be collected in time.

Since 1998 the Fund has been co-financing the "Work Programme of the Agency for Radwaste Management", namely, the projects concerning the safe management of low- and intermediate-level radioactive waste. In 2015 the Fund paid to ARAO a total of EUR 3.5 million. From 1998 until the end of 2015, the Fund paid a total of EUR 37.23 million to the ARAO for the activities implemented by the ARAO. This amount includes compensation paid to the local municipality of Krško totalling EUR 14.9 million.

In 2015 the Decree on the Criteria for Determining the Compensation Rate Due to the Restricted Use of Areas and Intervention Measures in Nuclear Facility Areas entered into force. With the amendment of the Decree in June 2015, the Fund is obliged to pay compensation for the limited use of land only to the Municipality of Krško, which is where the LILW repository is to be located.

In 2015 the Fund paid to the the municipalities of Brežice, Kostanjevica na Krki and Kozje just compensation for December 2014. Based on a recalculation, the difference was paid to the municipalities of Brežice, Kostanjevica na Krki and Kozje at the end of August and in September 2015, whereas the municipality of Kozje returned the overpayment of compensation to the Fund's account.

In 2015 the ARAO paid EUR 5.5 million to the municipalities of Krško, Brežice, Kostanjevica na Krki and Kozje as compensation for the limited use of land. Since 2004, municipalities have received EUR 32 million as compensation for the limited use of land.

The company GEN energija, d.o.o., paid a total of EUR 8.06 million into the Fund in 2015. With that contribution, the company fully and within the agreed deadline fulfilled all obligations to the Fund. The contribution is defined on the basis of levying half of the electrical energy produced by Krško NPP. In comparison to 2014, 11.20% less funds were paid. In 2015 the Krško NPP annual production of electrical energy was lower due to the annual outage, which started on 11 April and finished on 17 May.

From 1995 to 2015 the Fund received a total of EUR 169.2 million from the Krško NPP and GEN energija, d.o.o.

Figure 20 shows the assets of the Fund as of 31 December 2015, where EUR 188.7 million represents the financial portfolio (the data relates to the book value and does not include unallocated funds, interest accrued, interest purchased and dividends in the amount of EUR 2.2 million) and EUR 69.2 million represents payments to the ARAO and municipalities. (Assets paid to co-finance the ARAO's activities and assets paid to municipalities as compensation for the limited use of land in the amount of EUR 69.2 million are not valorised.). Payments to the ARAO and municipalities are 36.7% of the Fund's financial portfolio.

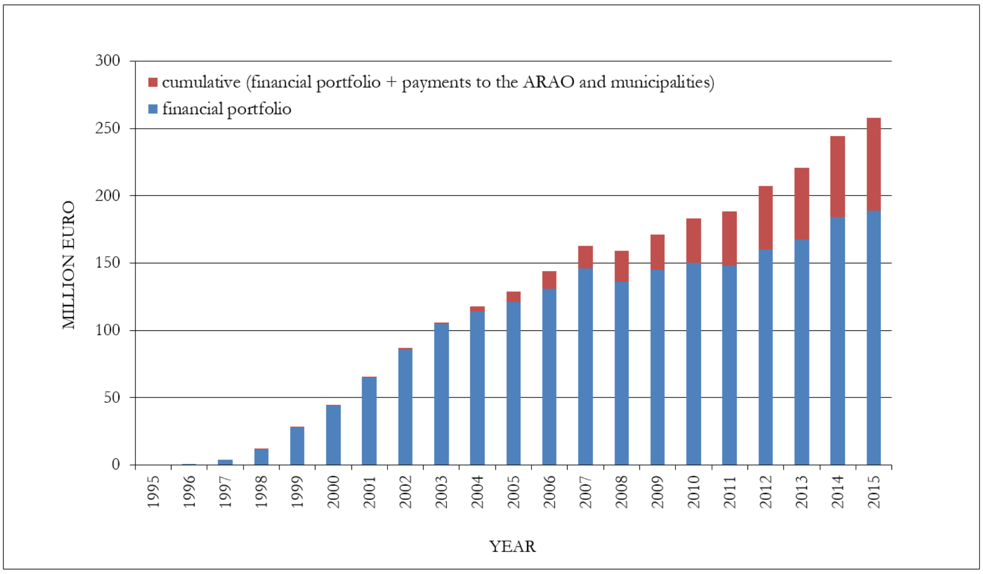


Figure 20: Total assets of the Fund in euro millions as of 31 December 2015

Concerning the actual structure of investments in 2015 in comparison to the end of 2014, the share of state securities increased by 5.83 percentage points. In investment equity mutual funds and ETFs, the share increased by 1.68 percentage points. There was a decrease in the share of 100% state-owned bonds (3.2 percentage points). The share of deposits (2.71 percentage points) and bank bonds (2.32 percentage points) slightly decreased.

As of 31 December 2015, the Fund managed EUR 188,694,589.97 of financial investments in securities. 10.52% of this sum was invested in banks in the form of deposits; 52.34% in state securities; 6.91% in bonds that are 100% state-owned; 3.17% in corporate non-financial bonds; 6.43% in bond funds; 19.29% in mutual funds (equity and mixed funds) and ETFs; and 1.35% in stocks. The structure of the financial portfolio does not take into account the unallocated funds in the transactional account amounting to EUR 56,045.22. The amount of EUR 188,694,589.97 relates to book value and does not include interest accrued, interest purchased and dividends in the amount of EUR 2,183,200.18. Taking into the account the amount mentioned and the funds in the transactional account, the assets of the Fund at the end of the year amounted to EUR 190,933,835.37.

In its investment policy for 2015, the Fund mainly planned investments in government securities and short-term deposits.

In 2015 the Fund created EUR 12.5 million of income, which is 4.02% less than expected. In respect of planned financial income, the income from interest is lower than planned, due to lower interest rates on the money market. In comparison to 2014, the income from the contribution of GEN energija, d.o.o. was 11.20% lower due to lower production of electrical energy in 2015.

The expenses reached EUR 9.4 million, which was 19.29% lower than planned and 26.23% higher than in 2014. The Fund had a surplus of income over expenses in the amount of EUR 3.1 million, which is 128.88% more than planned. This surplus derived from lower expenses in 2015. The realisation of a surplus of income over expenses for 2015 was 53.43% lower than in 2014.

In 2015 the Fund received EUR 72.4 million from repayments of granted loans (due and sold investments) and assets from sold capital shares. Received repayments of granted loans and assets from sold capital shares were 33.4% lower than planned, due to lower sales than planned. The granted loans (new investments) and the increase in capital shares amounted to EUR 75.4 million, which was EUR 3 million more than the received repayments of granted loans.

In 2015 the yield of the portfolio, calculated on the bases of the internal rate of return (IRR), was 3.2%.

The expenses of managing the portfolio in relation to the financial portfolio amounted to 0.25%.

Primarily, the Fund must ensure the security of its assets (with a conservative investment policy), but at the same time it has to monitor the situation on the financial markets and fulfil the obligations defined by law. All important risks were successfully managed also in 2015.

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

In Slovenia, the Joint Convention applies to the safety of spent fuel management in the Krško NPP and in the IJS Reactor Infrastructure Centre, as well as to the safety of the operational waste in the Krško NPP, the safety of waste from the decommissioning of the Žirovski vrh Uranium Mine and the safety of the waste from small producers that is stored in the Central Interim Storage for Radioactive Waste in Brinje. The Review Meetings of the contracting parties take place every three years in Vienna. At the end of 2015, the Joint Convention was in effect in 70 countries, including Slovenia.

The Fifth Review Meeting took place from 11 to 22 May 2015. A total of 61 delegations of contracting parties to the Joint Convention attended. Slovenia participated in country group 1, together with the USA, Poland, Slovakia, Iceland, Bulgaria, Indonesia, Kazakhstan and Portugal.

The National Report was prepared in 2014 by the Slovenian Nuclear Safety Administration with contributions by the Slovenian Radiation Protection Administration, the Krško NPP, the Jožef Stefan Institute, the Agency for Radwaste Management, the Žirovski Vrh Mine d.o.o., the Institute of Oncology, and the Clinic for Nuclear Medicine at the Ljubljana University Medical Centre. The report and the presentation were well accepted.

Slovenia was asked to report at the Sixth Review Meeting, scheduled for May 2018, on the licensing, construction, and operation of the LILW repository and the spent nuclear fuel dry storage, on the preparation and approval of the revised Decommissioning Programme of the Krško NPP, and on the disposal of LILW and HLW, on completing ongoing efforts for the remediation of former uranium mine sites, and on preserving the technical capabilities of nuclear institutions, including the regulatory body and associated funding constraints.

6 EMERGENCY PREPAREDNESS

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

Nuclear or radiological accidents are emergencies that directly threaten people and the environment and may require protective and other actions. In general, an emergency may not necessarily entail an accident. There may be a decrease in the level of nuclear or radiation safety, warranting an appropriate response by the authorities.

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

6.1 The Slovenian Nuclear Safety Administration

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

In an emergency the SNSA emergency team is activated, led by the emergency team director. There are 18 positions in the team, working in two shifts per day.

The SNSA's capability to act is ensured by the regular training of emergency team members, activation tests and exercises, regular tests of computers and other equipment and participation in international activities, as well as through regular reviews of all relevant procedures and checklists.

Since tasks during an emergency mostly differ from regular work, training of the emergency team members is very important. Therefore, the SNSA conducted 151 individual and group training exercises, tests and exercises totalling 239 hours in 2015. The SNSA also participated in the regular annual emergency exercise of the Krško NPP in 2015 and in several international exercises, i.e. ConvEx and ECUREX.

Based on a comprehensive analysis of the SNSA performance during the national exercise in 2014, the SNSA carried out a comprehensive revision of its emergency preparedness and response, and in this context the emergency team was reorganised, the method of teamwork was also changed and, in addition, extensive modernisation of equipment was carried out. The development of improvements was carried out at the beginning of the year, also taking into account international guidelines. The implementation thereof took the greater part of a year. Changes were validated by further exercises.

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

6.2 Administration of the RS for Civil Protection and Disaster Relief

In accordance with its statutory powers, the Administration for Civil Protection and Disaster Relief (ACPDR) maintained and ensured preparedness and developed procedures for the effective response of the system for protection against natural and other disasters to nuclear and radiological emergencies in 2015.

The ACPDR, in cooperation with the Ministry of Health, the Municipalities of Krško and Brežice and the Krško Nuclear Power Plant (NEK), prepared new guidelines in 2015 for the continuation of the pre-distribution of potassium iodide tablets in the area of 10 km around the NPP. New recipients of tablets (newborns and persons migrating into the area) are given a free prescription by their doctor. Potassium iodide tablets can then be picked up at local pharmacies using the health insurance card. The ACPDR also maintains the website www.kalijevjodid.si, where visitors can obtain more information on the tablets, the iodine thyroid-blocking protective action, and pre-distribution.

Members of different rescue and other departments and units are included in the response to nuclear or radiological emergencies. For successful performance they must be adequately equipped and trained. In 2015 the ACPDR prepared a programme of supplementary training for rescue and other departments and units that are to respond to nuclear and radiological emergencies. The first training course was conducted at the Training Centre for Civil Protection and Disaster.

The Inter-ministerial Commission for coordinating the implementation of the national radiation plan continued its work in 2015. Among other matters, it monitored the working group for preparing the basis for threat assessment in the event of a nuclear accident at the Krško NPP, which was tasked with studying the existing planning basis and proposing amendments and changes, taking into account past nuclear accidents, international guidelines, especially the recently issued document of the International Atomic Energy Agency EPR-NPP, as well as dose calculation models. The Working Group prepared a final report in 2015, in which it proposed changes that were taken into account in the preparation of a new version of the Threat Assessment in the Event of an Emergency at Nuclear Facilities and due to Radioactive Substances, Version 4, drawn up by the SNSA. Based on the updated threat assessment, the ACPDR prepared a draft of the revised national radiation emergency plan.

6.3 The Krško NPP

In 2015 the activities of the Krško NPP in the area of preparedness for emergencies included the following:

- training, drills and exercises;
- maintenance of support centres, equipment and communications;
- updating the document "Krško NPP Protection and Rescue Plan", procedures and other documentation;
- replacing staff and appointing new members to the emergency organisation.

The training of licensed personnel whose activities are related to nuclear safety, and personnel who have to refresh their knowledge in compliance with Slovenian legislation was fully performed as planned. Furthermore, the staff of the Krško NPP actively cooperated with the planners and providers of protection and rescue services at the local and national levels, as well as with the administrative authorities, namely the SNSA and the ACPDR.

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

Goal 10

In the use of nuclear energy and radiation activities in the Republic of Slovenia, appropriate attention is devoted to emergency preparedness and response so that in such an event the impact on people and the environment is minimal.

Realisation in 2015

From the above, it can be concluded that with regard to the use of nuclear energy and radiation-implementing activities in the Republic of Slovenia, the SNSA appropriately addresses emergency preparedness and response. The Interministerial Commission for coordinating the implementation of the national plan meets regularly and is responsible for directing and coordinating preparedness at the national level. Emergency preparedness and response are regularly tested by SNSA by means of exercises.

7 SUPERVISION OF RADIATION AND NUCLEAR SAFETY

7.1 Education, Research, Development

In 2015 no major changes in education, research and development regarding nuclear and radiation safety occurred. Unfortunately, the trend of declining resources for these purposes has continued, which may jeopardise the long-term existence and further development of Slovenian research in the field of nuclear safety.

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

The objectives in education, research and development that should be achieved in the period 2013–2023, as foreseen in the Resolution, are:

Goal 9

The system of authorised experts enables the optimum expertise in the decision-making of regulatory bodies on radiation and nuclear safety, with the producer or applicant bearing the costs of the preparation of an expert opinion.

Realisation in 2015

The SNSA prepared an initiative to raise funds for research and development in the field of nuclear safety and organised several meetings of the top management of the Energy Directorate at the Ministry of Infrastructure, the Department of Science at the Ministry of Science, Education and Sports, the Agency for Radioactive Waste, the Fund for the Decommissioning of NEK, GEN Energija, NPP Krško, and the SNSA. The exchange of views proved that there was no comprehensive picture regarding how much money is actually spent annually to finance a nuclear expert outside the NPP, so the representatives of all the participating organisations were asked to send information on any financial resources they have invested in recent years in the activities conducted by domestic contractors. Thus, the SNSA came to the conclusion that in 2014, 4.5 million euros had been spent for Slovenian institutions engaged in the field of nuclear safety and in work related to the exploitation of nuclear fission. Of this, the Agency for Research and Development spent approximately 1.4 million euros only for research activities. It follows that Slovenia annually spends enough resources for the financing and survival of about 70 nuclear experts. This demonstrates the need to steer such activities in the long term and to not leave them completely to the market and individual contracts between investors and contractors.

The SNSA has therefore been focussing on the preparation of a wider strategy of research and development in the field of nuclear safety, which would serve as the basis for the selection of research areas for future funding of the Agency for Research and Development and as a reference point when concluding individual contracts for the developmental needs of individual clients.

Goal 11

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

Realisation in 2015

At the Faculty of Mathematics and Physics of the University of Ljubljana, the Physics Department conducted the second cycle of the Nuclear Engineering master's degree programme; in the 2015/16 school year five students were enrolled in this programme. They joined five other students, who had enrolled in the programme in the past two years. The nuclear engineering programme is composed of four specialised courses, while approximately half of the additional credits are acquired in other study programmes.

In 2015 five students completed the Nuclear Engineering master's degree study programme. The programme was implemented by teachers – associates from the Jožef Stefan Institute, the Faculty of Electrical Engineering and the Faculty of Mechanical Engineering. They all participate in this programme in the context of additional employment or on the basis of a contract with the Faculty of Mathematics and Physics as the home institution of the study programme. No permanent position for a Nuclear Engineering professor was available at the University of Ljubljana.

There are 14 students in the doctoral programme "Mathematics and Physics" within the module Nuclear Engineering, most of them employed at the Jožef Stefan Institute. In 2015 one student finished PhD studies.

The Faculty of Energy at the University of Maribor, which is located in Krško, also offers a study programme in the field of nuclear energy. This Faculty implements a study programme entitled "Energy" at all three Bologna stages, which includes subjects in the nuclear field.

The Faculty of Civil Engineering at the University of Maribor has discontinued its Nuclear Energy study programme. Of the three enrolled students, one switched to the Faculty of Energy in Krško, the other one graduated and the third discontinued his studies.

It is assessed that in the current situation in Slovenia, the scope of the study programmes and the number of students roughly correspond to the needs of the profession.

Goal 12

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

Realisation in 2015

Activities carried out in this area are described in Goal 9.

7.2 Legislation

On 23 September 2015, the National Assembly of the Republic of Slovenia adopted amendments to the Act on Ionising Radiation Protection and Nuclear Safety (ZVISJV-D), which entered into force on 17 October 2015. ZVISJV-D is the most important act in this area. The Act simplifies certain administrative procedures by:

- merging into a single administrative procedure radiation protection assessments of exposed workers and the license to carry out a radiation practice;
- streamlining the issuance of licenses for the use of radioactive sources; and
- eliminating the need for a certificate of entry in the register of radiation sources as a special administrative decision and instead requiring only registration under the simplified procedure.

Several amendments have been introduced as a consequence of the lessons learned following the Fukushima Daiichi Nuclear Power Plant accident and the European stress tests:

- a new article on the design basis of nuclear facilities and another article on the extended design basis of nuclear facilities;
- new provisions on safety culture management systems; and
- new provisions to prevent the incorporation of non-conforming, counterfeit, fraudulent and suspect items into nuclear and radiation facilities.

Other topical amendments include:

- dental X-ray diagnostics (with the exception of dental computed tomography) and X-ray bone-density measurements are not included in the practices for which it is necessary to implement measures for the protection of exposed workers;
- a new provision related to the construction of new nuclear facilities allowing the investor to submit progressively and in parts the required documentation that must be included with the application for construction consent;
- clear definitions regarding the obligations of the Agency for Radioactive Waste Management related to the provisions governing the implementation of various public utility services (management of radioactive waste, radioactive waste disposal, long-term monitoring and maintenance of mining disposals and tailings);
- provisions concerning the vetting of persons working in nuclear facilities; and
- more detailed determination of different types of operational monitoring (pre-operational, operational and post-operational).

The Act also includes minor, editorial corrections as well as the elimination of minor inconsistencies and deficiencies that have been identified during the application of the Act. In 2015 also four implementing decrees and/or rules were adopted based on the main Act on Ionising Radiation Protection and Nuclear Safety, namely:

- Decree Amending the Decree on the Criteria for Determining the Compensation Rate due to the Restricted Use of Areas and Intervention Measures in Nuclear Facility Areas (Official Gazette, No. 64/15);
- Decree on the Method, Subject and Conditions for the Provision of the Obligatory Public Utility Service of Long-term Monitoring and Maintenance of Landfills of Mining and

Hydrometallurgical Tailings from Extraction and Exploitation of Nuclear Minerals (Official Gazette, No. 76/15);

- Rules Amending the Rules on the Requirements of Using Ionising Radiation Sources in Healthcare (Official Gazette, No. 75/15); and
- Rules on Monitoring Radioactivity in Drinking Water (Official Gazette, No. 74/15).

A detailed presentation of the already adopted legislation and legislation under preparation is available on the SNSA website.

At the end of 2015 the SNSA prepared amendments of two key rules that govern the operation of nuclear and radiation facilities. With these amendments the latest WENRA requirements will be transposed in the Slovenian legal system. Rules are expected to be adopted by the summer of 2016.
At the end of 2015 the SNSA also prepared a draft of the new Regulation on Authorised Experts for Nuclear and Radiation Safety. Based on the expert groundwork and the subsequent proposal of the Agency for Radioactive Waste Management, in 2015 the SNSA drafted the Resolution on the National Programme for the Management of Radioactive Waste and Spent Fuel Management for the Period 2016-2025 (ReNPROG), which will replace a similar resolution from 2006. The public debate and interdepartmental coordination ware carried out by the end of 2015, so its adoption is scheduled for the spring of 2016. This national programme is also the basis for the fulfilment of Article 11 of Council Directive 2011/70 / Euratom of 19. 7. 2011 on establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (EU Official Journal L 199, 2. 8. 2011), which requires Member States to ensure the implementation of their national programme covering all types of spent fuel and radioactive waste under its jurisdiction and all stages of spent fuel and radioactive waste from generation to disposal.

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

As regards the legislative and institutional framework, the resolution sets two goals.

Goal 7

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

Realisation in 2015

The SNSA transposes the EU legislative framework (directives) into the legal system of the Republic of Slovenia in the field of nuclear and radiation safety in a successful and timely manner, regularly coordinates domestic regulations with accepted WENRA standards and promptly fulfils its commitments under all international treaties to which Slovenia is a party. This is recognised by the informal and formal responses Slovenia receives in this area from comparable regulatory bodies around the world, and by reviews received as part of regular reporting (based on the commitments made in international treaties and/or membership in various organisations and associations).

Goal 8

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

Realisation in 2015

The organisation of administrative bodies/regulatory authorities in the field of nuclear and radiation safety in the Republic of Slovenia is adequate and in 2015 there was no need for any substantive changes.

7.3 The Expert Council for Radiation and Nuclear Safety

The Expert Council for Radiation and Nuclear Safety provides expert advice to the Ministry of the Environment and Spatial Planning and to the Slovenian Nuclear Safety Administration in the 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.

The Expert Council for Radiation and Nuclear Safety convened two regular sessions and two correspondence sessions in 2015. In addition to the regular reporting of the SNSA Director to the Council on the status of nuclear and radiation safety, the Council considered the following subject areas: Resolution on the 2016-2025 National Programme for Managing Radioactive Waste and Spent Nuclear Fuel, a proposal concerning the establishment of a research and development fund for nuclear and radiation safety, which is needed for the efficient work of the regulatory body, the training of employees working in organisations of radiation protection and the staff responsible for radiation protection from ionising radiation protection, the intention to amend the rules on the obligations of person carrying out a radiation practice and persons in the possession of an ionising radiation sources.

At the correspondence sessions the Expert Council considered a report which has to be submitted to the European Commission in accordance with the Council Directive 2011/70/Euraton of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. It also considered the Slovenian Report under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. In 2015 the Council also approved the Annual Report on Radiation and Nuclear Safety for 2014 in Slovenia.

The last Council session was attended by the Minister of the Environment and Spatial Planning. Members of the Council informed the Minister of urgent questions in the nuclear and radiation field in Slovenia, such as the shortage of human and financial resources, difficulties in the implementation of a specific project due to a lack of coordination among and within some ministries, the dilemma of the Krško NPP regarding the operation of the NPP due to the large amounts of radioactive waste, Slovenia's need for a radioactive waste repository and the lack of applied sciences in the nuclear and radiation field.

7.4 The Slovenian Nuclear Safety Administration

The Slovenian Nuclear Safety Administration (SNSA) performs administrative and developmental tasks in the field of nuclear and radiation safety, radiation practices and the use of radiation sources (with the exception of medicine and veterinary medicine), environmental protection against ionising radiation, physical protection of nuclear materials and facilities, 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 or nuclear emergency events with the State Civil Protection Headquarters in the determination of protective measures for the population and in informing the public.

The legal basis for its administrative and professional tasks in the field of nuclear safety and radiation protection and inspection are given by the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV) and implementing decrees and rules adopted on its basis, by the Liability for Nuclear Damage Act (Official Gazette SFRJ, Nos. 22/78 and 34/79) and the Insurance of the Liability for Nuclear Damage Act (Official Gazette SRS, No. 12/80), both of which are still valid until full implementation of the new Liability for Nuclear Damage Act (Official Gazette, No. 77/10), by the Transport of Dangerous Goods Act (Official Gazette, No. 33/06 and subsequent amendments) and bylaws within the wider area of nuclear and radiation safety as well as ratified and published international agreements in the field of nuclear energy and nuclear and radiation safety. A detailed presentation of the legislation in force is available on the SNSA website.

At the beginning of 2015, the SNSA employed 41 civil servants, while as of the end of the same year, the number of employees had increased to 42. Since 2011 there had been no new employment in the SNSA due to the very strict employment policy of the Government. Luckily there were no massive departures of employees, except for the individual retirement of some servants (in 2011, 2013 and 2015). In September of 2015, for the first time after four years, the SNSA was able to recruit a new employee, to substitute for one on maternity leave. At the end of the 2015, two positions were available for a limited time for work on technical assistance projects.

In 2015 the situation regarding the financial and human resources slightly improved, so that also the risks associated therewith, on which the SNSA has reported in recent years, declined slightly. It is also noteworthy that in 2015 the Republic of Slovenia settled its debt to the International Atomic Energy Agency.

Through its Rules of Procedure, the SNSA implements a management system that is compliant with ISO 9001. As a basic orientation, the Mission and Vision of the SNSA are defined as follows:

MISSION:

We ensure that the harmful effects of ionising radiation on humans and the environment are prevented or limited as well as that sources of ionising radiation are only used for peaceful purposes.

VISION:

To ensure the highest level of radiation and nuclear safety, to minimise the radiation burden on people and the environment, to ensure the use of ionising radiation sources only for peaceful purposes. At home and abroad, the SNSA is a respected regulatory authority due to its professionalism, independence, and attitude towards its customers.

In recent years it has been observed that the SNSA is not only comparable to similar regulatory bodies round the world, but also that some of those regulators may be even inspired by the SNSA. Therefore, the SNSA has prepared a more ambitious second sentence for its:

VISION:

Due to its professionalism, independence and attitude towards customers at home, the SNSA is a highly respected administrative authority, while abroad it serves as a model for similar regulatory authorities in the field of nuclear and radiation safety.

The fulfilment of other Requirements in Respect of Workers Performing Duties and Tasks in Nuclear and Radiation Facilities

In 2015 the Expert Commission for the Verification of Professional Competences and Fulfilment of other Requirements in Respect of Workers Performing Duties and Tasks in Nuclear and Radiation Facilities (hereinafter: the Commission) carried out exams for Senior Reactor Operators and Reactor Operators of the Krško NPP. The Commission also organised exams for the licensing of the reactor operators of the TRIGA reactor. Extensions of licenses were granted to three senior reactor operators and to six reactor operators of the Krško NPP. In 2015 no exams for the licensing of shift engineers were performed. In 2015, for the first time, exams for the licensing of reactor operators were not held.

One candidate received a Reactor Operator license for the TRIGA reactor for the first time. No exams for a Storage Facility Manager license at the Central Radioactive Waste Storage Facility were held in 2015.

The SNSA granted the appropriate licenses to all the mentioned candidates from the Krško NPP and the JSI.

7.5 The Slovenian Radiation Protection Administration

The Slovenian Radiation Protection Administration (SRPA), a regulatory body within the Ministry of Health, performs specialised technical, administrative and developmental tasks, as well as inspection tasks related to carrying out activities involving radiation and the use of radiation sources in medicine and veterinary medicine; 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 radioactive contamination of foodstuffs and drinking water; 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 2015 the SRPA had five employees.

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

The SRPA supervised radiation practices in medicine and veterinary medicine and the use of radiation sources in these activities, the protection of exposed workers in nuclear and radiation facilities, and radon exposure. Altogether, 99 permits to carry out a radiation practice, 211 permits to use radiation sources and 2 permits to import radioactive sources were granted. Additionally, 112 programmes of radiological procedures, 139 evaluations of the protection of exposed workers, 2 certificates of eligibility for foreign contractors involving radiation, 20 statements of consignees of radioactive materials and 67 certificates of received individual doses were confirmed. In 2015 the SRPA granted 1 approval for the status of radiation protection expert to natural persons, 1 approval to an organisation that performs tasks involving radiation protection experts and 4 approvals to natural persons for the status of medical physics experts.

In 2015 the Inspectorate carried out 247 inspections. Of these, 13 were in-depth inspections of exposure to radon; the SRPA issued 3 decisions requiring a reduction in exposure. In medicine and veterinary medicine, 15 in-depth inspections were performed. A total of 6 decisions requiring the correction of established deficiencies, and 3 decisions requiring the sealing of X-ray devices were issued. Ten requests to submit evidence regarding corrected authorised deficiencies, 29 requests to submit evidence regarding the termination of the use of an X-ray device and 171 requests regarding harmonisation with the existing legislation were issued. The SRPA took action in two cases, when the operational monthly personal dose of 1.6 mSv was exceeded.

Thus far, the SRPA has operated with a small number of employees and modest financial resources. Despite this, a high level of radiation protection was ensured in its areas of competence. The SRPA does not have any internal financial or staff reserves and any further reduction of resources would mean that the SRPA will not be able to carry out its legally binding obligations and that the level of radiation safety would decrease.

As requirements for performing radiological procedures were changed by the new ZVISJV-D, dental X-ray diagnostics (with the exception of dental computer tomography) and densitometry are not considered to be practices that require radiation protection measures for exposed workers. In general, such employers no longer have to ensure evaluation of radiation protection. Workers have to undergo training for persons performing radiological procedures (the novelty introduced by ZVISJV-D) and need to be included in the personal dosimetry system.

The characteristics of dental X-ray diagnostic and densitometry and the situation in those fields were described in the report prepared by the Institute of Occupational Safety (IOS) at the request of the SRPA. Based on that report, evaluations of the radiation protection of exposed workers and on results of individual dosimetry SRPA has adopted a position regarding dental X-ray diagnostic and densitometry and published it on its website.

If based on the results of individual dosimetry measurements or on regular or extraordinary radiation source checks it is established that workers could receive doses above the dose limit for members of the public, the employer has to provide an evaluation of the radiation protection of exposed workers and ensure that the full scope of the radiation protection measures for workers are in place.

Thus far, persons performing radiological procedures in dental care and densitometry have to provide a programme of radiological procedures and arrange annual checks of radiation sources performed by an approved radiation protection expert.

All of the described changes are aimed at simplifying the administrative procedures in the field of radiation protection.

At the same time as the new ZVISJV-D was prepared, the SRPA prepared Rules on Monitoring Radioactivity in Drinking Water. These Rules transpose Council Directive 2013/51/Euratom of 22 October 2013 laying down requirements for the protection of the health of the general public with regard to radioactive substances in water intended for human consumption into the Slovenian legal framework. The SRPA has prepared new Rules on the Requirements of Using Ionising Radiation Sources in Healthcare. Both Rules were published in the Official Gazette of the Republic of Slovenia at the end of 2015. At the same time, the SRPA has started to draft changes to legislative acts that are necessary due to the new ZVISJV.

7.6 Approved experts

Approved experts for radiation and nuclear safety

The operators of radiation or nuclear facilities must obtain the expert opinion of approved experts with regard to specific interventions in their facilities. In 2015 there were no major changes in the operations of the experts in comparison to previous years. Their staffs maintained their level of competence and the equipment used was well maintained and updated. The organisations established quality management programmes certified in compliance with the ISO 9001:2008 standard. The approved experts provided professional support to the Krško NPP by preparing independent reviews. An important part of their work focused on the independent review and assessment of plant modifications.

Research and development activities are an important part of the work of approved experts. Certain organisations successfully participated in international research projects.

In 2015, 20 legal entities and 1 natural person were approved by the SNSA to perform the tasks of an Approved Expert for Radiation and Nuclear Safety. In this year the SNSA did not approve any new experts, and also did not modify or extend any existing approval.

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

Approved Radiation Protection Experts

Approved radiation protection experts cooperate with employers in drawing up evaluations of the protection of exposed workers against radiation, give advice on the working conditions of exposed workers, on the extent of the implementation of radiation protection measures in supervised and controlled areas, on the examination of the effectiveness thereof, on the regular calibration of measuring equipment, and on the control of the usefulness of protective equipment, and carry out training of exposed workers in radiation protection. Approved radiation protection experts regularly monitor the levels of ionising radiation, the contamination of the working environment, and the working conditions in supervised and controlled areas. Approval can be granted to individuals to provide expert opinions and present topics relating to training on radiation protection, as well as to legal entities to give expert opinions, perform control measurements and technical checks of radiation sources and protective equipment, and to carry out training regarding radiation protection for occupationally exposed workers. Individuals can obtain an approval if they have appropriate formal education, work experience and expert skills. Legal entities can obtain an approval if they employ appropriate experts and have at their disposal appropriate measuring methods accredited according to the SIST EN ISO/IEC 17025 standard. Authorisations are limited to specific expert areas.

In 2015 the SRPA issued two approvals regarding radiation protection experts; one to a natural person and one to a legal entity. Approvals were granted on the basis of the opinion of a special commission that assesses whether candidates fulfil the requirements.

Inspection was performed by the SRPA to one of the institutions performing training of exposed workers, regarding the training of workers in radiation protection units.

Approved Dosimetry Services

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

In 2015 SRPA did not issue any approvals for dosimetric services.

Approved Medical Physics Experts

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

In 2015 the SRPA authorised 4 medical physics experts. The granting of such approval was based on the opinion of a special commission that assessed whether the candidates fulfilled the requirements.

Approved medical practitioners

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

In 2015 the SRPA did not prepare any opinions with regard to the fulfilment of the requirements for carrying out medical monitoring of exposed workers.

7.7 The Nuclear Insurance and Reinsurance Pool

The Nuclear Insurance and Reinsurance Pool (hereinafter: The Nuclear Pool GIZ) insures and reinsures against nuclear threats. It has been operating since 1994.

In 2015 the members of the pool were: the (re)insurance company Triglav, d.d.; the reinsurance company Sava, d.d.; Adriatic Slovenica, d.d.; the reinsurance company Triglav Re, d.d.; the insurance company Maribor, d.d.; the insurance company Tilia, d.d.; and the insurance company Merkur, d.d.. Its headquarters is at the Triglav insurance company.

The Nuclear Insurance and Reinsurance Pool insures domestic nuclear installations and reinsures foreign nuclear installations within the capacities and interests provided by the Nuclear Insurance and Reinsurance Pool members on a yearly basis. The third-party liability of nuclear operators with headquarters in the Republic of Slovenia is insured in accordance with the Act on Liability for Nuclear Damage, which entered into force on 4 April 2011. Under this policy, the Nuclear Insurance and Reinsurance Pool covers risks as prescribed by law, thereby ensuring payments to victims in the event of a nuclear accident. Costs, interests and expenses that the insured is obliged to pay to the claimant in respect of a nuclear incident are also covered. The insurance policy covers legal liability arising from the insured's operations when damage is caused by accidents at nuclear installations during the period of insurance coverage. The Nuclear Insurance and Reinsurance Pool participates in third-party liability insurance risk up to its capacity level, while the rest of the risk is reinsured by foreign pools.

8 NON-PROLIFERATION AND NUCLEAR SECURITY

8.1 The Treaty on the Non-Proliferation of Nuclear Weapons

The main aim of the Treaty on the Non-Proliferation of Nuclear Weapons (hereinafter NPT), which has been in force since 1970, is to curb further proliferation of nuclear weapons, to provide security to those countries that have decided not to pursue nuclear weapon capabilities, as well as to encourage further actions that would pave the way for the elimination of nuclear weapons.

For a number of years, the international community has devoted salient efforts to nuclear non-proliferation. During the Gulf crises and following the discovery of non-authorised activities in North Korea (DPRK), a number of violations of the NPT were brought up. A small number of countries (India, Pakistan, Israel, DPRK), not being NPT signatories or unilaterally withdrawn from the NPT, have further pursued their nuclear weapons programmes. The past situation with the Iranian case has shown that their declared peaceful nuclear programme has not been transparent; however, the year 2015 brought a significant breakthrough in the negotiation process, culminating with the Joint Comprehensive Plan of Actions (JCPoA), as well as with the United Nations' Security Council Resolution 2231 (2015), and in particular with the "Adoption Day" (i.e. 18 October 2015) of the JCPoA. The IAEA is the inspection powerhouse ("watchdog") of the obligations under JCPoA.

Between 27 April and 22 May 2015, the 9th Review Conference on the Treaty on the Non-Proliferation of Nuclear Weapons took place in New York. The overview and progress from 2010 onwards with regard to the implementation of NPT obligations were considered. Although intensive consultations among the participating states took place, there was no agreement reached on the significant part of the final document. One of the diverse views was undoubtedly the question of the Middle East as a nuclear-weapons-free zone (as well as free of other weapons of mass destruction); beside this, no text was agreed upon with regard to efficient measures towards disarmament.

8.2 The Comprehensive Nuclear Test Ban Treaty

The Comprehensive Nuclear Test-Ban Treaty (CTBT) is one of the international instruments aimed at combating the proliferation of nuclear weapons. Slovenia signed the treaty on 24 September 1996 and ratified it on 31 August 1999. Currently, there are 183 states that have signed the treaty, 163 of them have also ratified it. The CTBT will enter into force when it is ratified by the remaining 8 out of the 44 countries listed in Annex II of the Treaty (Egypt, India, Iran, Israel, China, Pakistan, North Korea and the USA).

On 29 September 2015, the 9th Conference on Facilitating the Entry into Force of the CTBT took place in New York, in the framework of the high-level meeting of the General Assembly of the United Nations. Karl Erjavec, the Minister of Foreign Affairs, led the Slovene delegation. The objective of the conference was to review previous endeavours for the promotion of the relevant adoptions and ratifications with regard to those countries that have not taken these steps thus far.

8.3 Nuclear Safeguards in Slovenia

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

In Slovenia, all nuclear material, namely the fresh and spent fuel at the Krško NPP, the Jožef Stefan Institute, the Central Storage for Radioactive Waste in Brinje, and at the other holders of small quantities of nuclear material, is under the supervision of international inspection.

All holders of nuclear material are obliged to report directly to the European Commission with regard to the quantities and status of their nuclear material, in accordance with Commission Regulation (EURATOM) No. 302/2005 on the application of EURATOM safeguards. Copies of reports are sent to the SNSA, which maintains a registry of nuclear material.

There were six IAEA/EURATOM inspections in 2015. SNSA staff took part in all six inspections that took place at all three nuclear facilities in Slovenia. There were no international inspections in 2015 held on the premises of small holders of nuclear material.

8.4 Export Control of Dual-use Goods

The SNSA together with the Ministry of Foreign Affairs follow the activities of the Nuclear Suppliers Group (NSG) and the Zangger Committee. The mission of both associations is to prevent the export of dual-use goods, i.e. goods that might be used for manufacturing nuclear weapons, to those countries that wish to acquire such weapons. The annual Plenary Week of the NSG was held between 1 June and 5 June in Bariloche, Argentina.

On the basis of the Act on Export Controls of Dual-Use Goods, a special Commission for the Export Control of Dual-Use Goods ("KNIBDR") has been functioning at the Ministry of Economic Development and Technology. Dual-use goods are goods that can be used not only for civil but also for military purposes (including nuclear weapons and other weapons of mass destruction). The Commission is made up of representatives of the Ministry of Economic Development and Technology, the Ministry of Foreign Affairs, the Ministry of Defence, the Ministry of the Interior, the Police, the Financial Administration, the Slovenian Intelligence and Security Agency, the Chemicals Office, and the SNSA. 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 2015 the Commission had 10 regular and 27 correspondence sessions. The role of the SNSA in the Commission is primarily related to the export of goods that might be used in the production of nuclear weapons or nuclear dual-use items.

8.5 Physical Protection of Nuclear Material and Facilities

The operators of nuclear facilities and carriers of nuclear material implemented physical protection measures in accordance with their plans on physical protection approved by the Ministry of the Interior (hereinafter: the MI).

At the beginning of 2015, the MI – based upon the prior consent of the SNSA – issued its decision on the confirmation of the physical protection plan for the Central Storage for Low and Intermediate Level Radioactive Waste; the cited plan was updated by the Agency for Radwaste

Management (ARAO). Other physical protection plans have remained valid, based upon their prior confirmation from the MI.

At the beginning of 2015, within the frame of changes and amendments to the main Nuclear Act (ZVISJV), several changes and amendments of the chapter dealing with physical protection were harmonised among the involved stakeholders. In September 2015, the Act on the changes and amendments to the ZVISJV was published (ZVISJV-D, published in the Official Gazette of the Republic of Slovenia, No. 74/15). In the field of the physical protection of nuclear facilities, the new revision of the ZVISJV more precisely specifies adequate background checking and security vetting of personnel working in nuclear facilities.

The role of the Commission on the Physical Protection of Nuclear Facilities and Nuclear and Radioactive Material 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 the physical protection of such facilities. In 2015 three regular sessions of the Commission were held; the Commission considered three proposals regarding the threat assessment for Slovenian nuclear facilities (for the current year). The Commission gave a positive opinion to the Police in all cases; the threat assessments were valid throughout 2015 or until next revision.

In 2015 the Commission considered the presentation and design phase of the envisaged repository facility for low and intermediate level radioactive waste in Vrbina, Krško (close to the Krško NPP site). The project was presented by the Agency for Radioactive Waste Management and the project team. Based upon the legislation (ZVISJV-D), the construction of such a disposal facility requires an initial threat assessment already in the project phase, well before the placement of radioactive material in the facility. Based on the application (the applicant was the ARAO), the Police prepared the first threat assessment, which was subsequently addressed by the Commission – which issued a positive opinion regarding the matter.

In September 2015, the Police Administration of Novo mesto and the Krško NPP carried out an exercise with the aim of responding to a potential threat scenario. The activities took place inside and outside the Krško NPP site. The exercise was a step towards more efficient cooperation on the local and regional levels in the sphere of ensuring physical protection of the nuclear facility, and Police-Krško NPP cooperation, which has been nurtured since 1977. The exercise confirmed the adequate capacities and cooperation of the responsible services and units.

The Inspectorate of the MI, in cooperation with the SNSA, carried out three inspections of nuclear facilities in 2015. The inspections addressed the Krško NPP and the TRIGA Research Reactor and site (no anomalies were found); the third inspection, of the Central Storage for Radioactive Waste in Brinje, found only a minor non-conformity (with regard to entry doors), therefore a warning was issued together with a time limit for rectifying the non-conformity.

In 2015 regular training programmes were in place for the security staff protecting nuclear facilities or the transport of nuclear material.

8.6 Illicit trafficking of nuclear and radioactive materials

In 2015 the SNSA issued 22 approvals for measuring the radioactivity of scrap metal shipments. All except two scrap metal recyclers submitted annual reports, which showed that 52,467 measurements of shipments were carried out in 2015 in Slovenia. Elevated dose levels were measured in four cases.

A duty officer at the SNSA was available to provide assistance and consultation to other state offices and scrap metal recyclers. In 2015, 11 calls to the duty officer were registered, of which three were due to radiation sources or increased radiation, one as a result of increased NORM radiation, and seven due to the transport of radioactive materials, false alarms, and equipment transport to the Krško nuclear power plant.

The SNSA regularly receives and to a certain extent analyses the 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 of nuclear and other radioactive material. In 2015 Slovenia (the SNSA) reported three times to the IAEA "Incident and Trafficking Database" (ITDB): three devices with ^{85}Kr sources were discovered in Kočevje (November), followed by thorium nitrate found on the premises of a university faculty in Ljubljana (November), and uranyl nitrate found on the premises of a national laboratory in Ljubljana (December). All "historical sources" were transferred to the Central storage for radioactive waste (Brinje).

At the end of November 2015, representatives from the SNSA, the Customs Administration, the Market Inspectorate, the Ministry of the Interior, as well as the mail/airport organisations (i.e. Pošta Slovenije d.o.o. and Aerodrom Ljubljana d.d.) met and reviewed the current situation in the area of the illicit trafficking of nuclear and other radioactive material. In September 2015, the experts from the SNSA and the Customs Administration prepared a short seminar for selected postal employees. In February 2015, the SNSA and the Customs Administration met with representatives from Pošta Slovenije d.o.o. and Aerodrom Ljubljana, d.d., in order to discuss detection capabilities, the current situation, and challenges.

Mention should also be made of the training course, including exercises, for police officers, firemen, customs and other officers organised by the Ministry of the Interior at the end of May 2015; representatives from the USA FBI also participated as lectures. The main topics were the use of advanced detection devices for the detection of radiation and investigation techniques and the trafficking of radioactive material.

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

Goal 6

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

Realisation in 2015

As can be seen from the previous chapters, Slovenia has completely achieved the set goal.

9 INTERNATIONAL COOPERATION

9.1 Cooperation with the European Union

In 2015 all EU Member States were obliged to report to the European Commission on the implementation of the provisions of Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste. The first Slovenian report was prepared. The report describes for each article of the Directive how the respective provisions were met by the licensees as well as by the regulatory body.

Working Party on Atomic Questions (WPAQ)

The aim of the Latvian presidency programme was to support initiatives and measures in the field of radiation and nuclear safety at the international and EU levels. The presidency programme was focused on a Diplomatic Conference on the Convention on Nuclear Safety, the preparations for the 5th Review Meeting of the Contracting Parties of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, Euratom agreements with third countries and activities in international organisations and associations.

During the Luxembourg presidency, the WPAQ dealt with the eligibility of medical imaging involving exposure to ionising radiation. An important topic was also the measures for nuclear and radiological emergencies in the vicinity of nuclear power plants, which were issued in the form of Council Conclusions. *Inter alia*, they discussed changing the guidelines issued in 2007, dealing with cooperation within international conventions, which include the European Atomic Energy Community and the Member States as the convention parties.

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 administrative bodies responsible for nuclear safety, radiation protection and the safety of radioactive waste from all 28 Member States of the European Union. Representatives of the European Commission collaborate in the group on an equal basis.

In 2015 ENSREG considered the HERCA-WENRA emergency recommendations for response in the event of nuclear or radiological emergencies, which should be observed by member states as a guideline in regulating this area. They also discussed how to carry out a topical peer review in line with the Nuclear Safety Directive, which must be carried out in 2017. As the peer review topic, the extension of the lifetime of nuclear power plants was chosen.

Consultative Committees under the Euratom Treaty

Within the framework of the European Treaty, which is 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. In 2015 the central topic discussed at the Committee was the transposition of the new European Directive on ionising radiation protection (the so-called EU BSS) into the national legislation of the Member States.

According to the Euratom Treaty, the EU Member States are required to establish a system of radiation monitoring in the government and to regularly report to the European Commission on the results under Article 35. The Commission has the right to verify whether such a system is in place and in line with the established requirements (Article 36). In 2015 Slovenian representatives did not attend the meeting under this Article.

The Consultative Committee under Article 37 mainly works on a correspondence basis and when the European Commission's opinion is needed on major reconstruction works or the construction of new nuclear facilities.

9.1.1 Cooperation in EU Projects

SNSA participates in three projects:

- the project "Enhancing the Capacity and Effectiveness of the Thai Regulatory Body and Developing a National Waste Management Strategy"; the consortium consists of the Slovenian Nuclear Safety Administration, the Austrian company Enconet and the Belgian companies BEL-V and IRE-Elit. The SNSA is responsible for the preparation of the regulatory body strategy, comprising an action plan for its implementation, updating Thailand's regulatory framework, safety assessment and inspection of research reactors, preparation of drafts of legislation regarding radioactive waste management and enhancing knowledge in the field of naturally-occuring radioactive materials (NORM).
- the project "Training and Tutoring for Experts of the Nuclear Regulatory Authorities and their TSOs for Strengthening their Capabilities" is implemented by a consortium led by the Italian company ITER. The SNSA provides tutoring for the staff of regulatory bodies in the field of nuclear and radiation safety from partner countries and participates in the preparation of the courses and workshops.
- the project "Further Enhancement of the Technical Capacity of Nuclear Regulatory Bodies of West Balkan States"; the main goal of the project is to accelerate the transposition of the EU Acquis into the legislation of recipient states and to promote the functioning of their regulatory bodies to a level comparable with similar EU institutions. At the same time, the project helps recipient states in some specific areas e.g. the radiation protection of patients, procedures for responding in the event of emergencies, radiation monitoring at borders, the strategy for radioactive waste management, and the decommissioning of nuclear reactors. The SRPA also participates in the project.

ESOREX

For several years, the SRPA has been involved in the project "The European Study of Occupational Radiation Exposure – (ESOREX)". The ESOREX project is dedicated to the collection, processing and comparison of occupational doses data at the international level. Within the project framework, countries share experiences on organising individual monitoring and managing the national data registry. The project is supported by the European Commission, but it is not limited to EU Member States. In 2013, ESOREX started to prepare an internet platform for the exchange of information, which will be maintained by the Member States after the conclusion of the project. The preparation of the platform is directed by the ESOREX Steering Group, consisting of representatives of the five Member States (including a representative of Slovenia), a representative of the European Commission and a representative of UNSCEAR. In 2015 the project and data exchange platform were completed.

ENETRAP III

In 2014 the SRPA became a partner in the the project "The European Network on Education and Training and Radiological Protection – ENETRAP INFORMATION", which is intended to coordinate training in radiation protection at the EU level and the mutual recognition of qualifications of skilled workers and experts. Slovenia joined the project as a test country with regard to the mutual recognition of experts in radiation protection. In 2015 the SRPA participated in the project with a comparison of authorisation practices for radiation protection experts and reviewed a draft of the European recommendations for authorisation.

9.2 The International Atomic Energy Agency

In 2015 Slovenia successfully cooperated with the International Atomic Energy Agency (IAEA). The Slovenian delegation in 2015 also attended the regular annual session of the General Conference. Slovenia closely cooperated with the IAEA in these areas:

- Slovenia received 23 individual applications for the training of foreign experts in Slovenia in 2015 and one group application for the training of 11 candidates under the Eastern European Research Reactors Initiative. 14 training requests were implemented, four training application requests were rejected by the Slovenian institutions, while the remaining applications for training will be implemented in 2016.
- The Jožef Stefan Institute, Department of Nuclear Medicine, Institute of Biomedical Informatics of the University of Ljubljana, the Institute of Civil Engineering and the Institute of Oncology Ljubljana actively participated in coordinated research projects. They were involved in sixteen research projects, which had already been launched in 2015 or earlier. Three coordinated research projects were successfully completed in 2015.
- In November 2015, the Board of Governors approved two national projects. The ARAO's project "Supporting Radioactive Waste Management Activities for the Implementing Organisation" and the SNSA's project "Enhancing the Regulatory Oversight of the Nuclear Safety Administration". The assignments within the project of the Jožef Stefan Institute's entitled "Feasibility Study and Installation of a Thermal Neutron Driven 14 MeV Neutron Converter into the TRIGA Research Reactor" were also underway.
- In 2015 Slovenia organised four regional training courses of the IAEA.
- The participation of Slovenian specialists and their involvement as experts in various IAEA committees, missions and workshops abroad is important as well.
- In 2015 representatives of the ARAO and the SNSA actively participated in the final activities of an interregional project on strengthening cradle-to-grave control of radioactive sources in the Mediterranean Region. Slovenian representatives, as they did last year, successfully and actively participated in regional projects on extending and diversifying the application of nuclear technology in the cultural heritage, improving the operation and safety of nuclear reactors through regional operation, networking, coalitions and the dissemination of best practices, capacity-building for the long-term operation of nuclear power plants, strengthening the inspection facilities and programmes of the regulatory body, harmonisation of national capacities for emergency responses and the management of fruit flies in the Balkans and Eastern Mediterranean.

At the end of 2015, the first phase of two regional projects on ionising radiation in medicine was completed. One regional project is intended to upgrade the system of quality assurance and quality control in diagnostic radiology. One of the key objectives set by the SRPA under this project is the establishment of the Clinical Institute of Radiology as an internationally recognised center of competence in the field of diagnostic and interventional radiology. The Institute could have the role of a reference centre for other institutions in the country.

In the first phase of the project the SRPA was involved in developing guidelines for reference centers. Some other Slovenian hospitals were also invited to collaborate in the project through the participation of selected radiological engineers in training courses organised by the IAEA. The other project is aimed at improving the system of radiation protection in the medical use of ionising radiation. It is divided into several thematic areas. On the basis of the country's needs and the current situation, Slovenia took part in the establishment of Diagnostic Reference Levels with an emphasis on paediatric patients and interventions emphasising interventional radiology.

The very good results of the past projects on the use of ionising radiation in medicine led to the proposal of a new regional project in 2014, which was made by Slovenia with the support of thirteen countries in this field for the 2016–2017 cycle. Following the approval of the proposal, Slovenia as a leading country actively took part in the further design of the project.

For many years, the SNSA was more than a year behind with the payment of the membership contribution to the IAEA. In 2015 it made remarkable progress and succeeded in eliminating all the debts and even paid a part of its annual obligations for 2016.

9.3 The Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development

Since 2011, Slovenia has been a full member of the Nuclear Energy Agency (NEA) of the Organisation for Economic Cooperation and Development (OECD). The mission of the NEA is to assist its member countries in maintaining and further developing the scientific, technological and legal bases required for the safe, environmentally friendly and economical use of nuclear energy for peaceful purposes. The Agency also closely collaborates with the International Atomic Energy Agency in Vienna and the European Commission in Brussels.

In 2015 Slovenia actively participated in five standing committees, namely the Radioactive Waste Management Committee, the Committee on Radiation Protection and Public Health, the Committee on the Safety of Nuclear Installations, the Committee on Nuclear Regulatory Activities, and the Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle. The representatives of the Nuclear Law Committee and Nuclear Science Committee did not attend last year's meetings. Slovenian representatives also participate in working groups of the standing committees, namely the Working Group on Risk Assessment, the Working Group on the Integrity and Ageing of Components and Structures, the Working Group on the Analysis and Management of Accidents and the Working Group on Operating Experience. In 2015 the NEA worked intensively on a new strategic plan for the period after 2017. The current plan refers to the period from 2011 to 2016. At the end of 2015, the NEA issued a publication entitled Five Years after the Fukushima Daiichi Accident.

Slovenian institutions (the NPP, the SNSA, and the SRPA) continue to participate in the International System of Occupational Exposure – ISOE. ISOE is an information system on occupational exposure to ionising radiation in nuclear power plants, supported by the OECD/NEA and the IAEA. The Information System is maintained by technical centres with the support and cooperation of both of the organisations mentioned, nuclear power plants and regulatory bodies.

9.4 Cooperation with Other Associations

The Western European Nuclear Regulators Association (WENRA)

WENRA (The Western European Nuclear Regulators Association) is an informal association consisting of representatives of nuclear regulatory authorities from European countries with nuclear power plants. The main objective of WENRA is to develop a common approach to nuclear safety within the standards (the so-called Reference Levels) and WENRA is one of the leading associations in the field of nuclear safety. Slovenia applied WENRA Reference Levels as the basic guidelines for the development of domestic legislation.

In 2015 Slovenian representatives participated in two regular WENRA meetings and meetings of two working groups (RHWG and WGWD). At the WENRA meetings member states and working groups reported on their activities. In 2015 Ukraine became a member state of WENRA and Belarus was invited as an observer. The observer status for the Canadian administrative body and the Japanese administrative body was confirmed, but the request of the International Atomic Energy Agency was rejected. The priority task of the Reactor Harmonisation Working Group (RHWG) is the preparation of technical specifications for the first topical peer review required by the amended Directive on Nuclear Safety. Monitoring of the implementation of modified post-Fukushima WENRA requirements is also an important task. The Working Group on Waste and Decommissioning (EGWD) examines the requirements (Reference Levels) for waste management.

The European Nuclear Security Regulators Association (ENSRA)

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

ENSRA's plenary meeting was held in Budapest and in the Paks NPP. In 2015 ENSRA mainly dealt with the exchange of information on important security challenges and security legislation. Furthermore, the information exchange system with WENRA and a new website, www.ensra.org, were established.

The International Nuclear Law Association (INLA)

The International Nuclear Law Association (INLA) is an international association of legal and other experts in the field of the peaceful use of nuclear energy. The objectives of the INLA 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 500 members from more than 50 countries and international organisations.

In October 2014, the INLA held its Congress in Buenos Aires, Argentina; the Congress is normally organised every two years. The next Congress will be held in 2016 in New Delhi, India.

CAMP (NRC)

Research development programme CAMP (Code Application and Maintenance Programme), directed by the US NRC (the US Nuclear Safety Regulator), enables cooperation in the maintenance and application of software in the field of accident prevention and the management of accidents, incidents and unusual events in nuclear power plants. The Krško NPP, the Jožef

Stefan Institute and the SNSA are involved in the programme. The Slovenian National Coordinator of the CAMP programme is the Jožef Stefan Institute, which regularly monitors and reports on the activities of CAMP and actively cooperates and contributes to the development and use of computer programmes.

In 2015 the Jožef Stefan Institute prepared the "RELAP5 Analysis of the Mitigation Strategy for an Extended Blackout Power Condition in the PWR". The purpose of the analysis was to examine the core cooling possibilities of the Krško Nuclear Power Plant, including the use of mobile equipment in the event of complete loss of power and an evaluation of the necessary cooling capacities of the power plant under different assumptions regarding equipment availability.

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

A representative of the SRPA is a member of the Association of the Heads of European Radiological Protection Competent Authorities – HERCA. In 2015 the Association dealt with proposals for the implementation of the Euratom Drinking Water Directive and the Basic Safety Standards Directive. Furthermore, within the framework of its working groups, HERCA also addressed the issue of the agreement with CT device producers regarding the justification of procedures, the prescribed criteria, education and training in this field, an internationally interoperable system for monitoring the exposure of workers, an agreement between Member States on joint response in the event of emergencies with a data exchange system for radiological monitoring, and the use of nuclear medicine procedures in veterinary medicine.

The European ALARA Network

As one of 20 European countries, Slovenia participates in the European ALARA Network (EAN). The EAN is dedicated to optimising radiation protection and sharing good ALARA practices in industry, research and medicine. In the framework of the EAN, international workshops on specific fields are organised. In addition, the EAN issues a newsletter on practical implementation of the ALARA principle, examples of good practices and other news on radiation protection. The EAN has 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.

International cooperation in the field of the management of radioactive waste and spent fuel

Slovenia is included in two international associations in the field of the development and approach to international solutions for the disposal of radioactive waste. The ARAO has been involved in a working group of the Europen Repository Development Organisation Working Group (ERDO-WG), which develops and promotes the concept of a joined repository. Its future goal is to build up a shared repository including the selection of the location. Slovenia also participates in the IFNEC – the International Framework for Nuclear Energy Cooperation, an association in the field of nuclear energy also dealing with the issue of an international repository.

The ARAO also participated in some of the activities of various European technology platforms, namely Implementing Geological Disposal of Radioactive Waste–Technology Platform (IGD-TP), which is aimed at enhancing knowledge and competencies to develop a geological repository for spent fuel and high-level radioactive waste, which is planned to be built in one of the EU countries by 2025. In addition to its involvement in associations and platforms, the ARAO also maintains permanent contacts with similar European organisations for the management of radioactive waste. It collaborates with Sogin from Italy, COVRA from the Netherlands, ANDRA from France, and with the Croatian organisation the Fund for the Decommissioning of the Krško NPP. ARAO has established contacts with many other organisations, such as NDA (the United Kingdom), ENRESA (Spain), and SURAO (the Czech Republic).

9.5 Agreement on the Co-ownership and Management of the Krško Nuclear Power Plant

In accordance with Article 18 of the Intergovernmental Agreement, the Interstate Commission was established. The purpose of the Intergovernmental Commission is to monitor the implementation of the Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on regulating the status and other legal relations as regards investments in the Nuclear Power Plant, and its exploitation and decommissioning (Official Gazette RS, No. 5/03 – International Treaties). The Intergovernmental Commission monitors the implementation of the Agreement, confirms the Programme on Radioactive Waste and Spent Fuel Management and the NPP Krško Decommissioning Programme. It also deals with open questions that refer to the relationship covered by the bilateral agreement.

In 2015 the Government appointed new Slovenian members. The president of the Croatian delegation convened the 10th session of the Interstate Commission on 20 July 2015 on the premises of the Krško NPP. The Slovenian delegation's position was adopted by the Government of the Republic of Slovenia.

At the session, the Interstate Commission adopted the report of the Krško NPP Management Board. The Commission also confirmed that the operative provisions of the Intergovernmental Agreement had been responsibly and successfully implemented since the last session and that the plant had achieved excellent operational, safety, economic and investment results. In line with the Intergovernmental Agreement and taking into account that the SNSA had approved modifications of the Final Safety Analysis Report and the Technical Specifications for the extension of the lifetime of the Krško NPP from 40 to 60 years, the Interstate Commission confirmed the decision of the NPP owners to extend the operation of the plant until 2043. In line with international practice and recommendations and with the goal of ensuring sustainable nuclear safety, the Interstate Commission approved the construction of a dry spent fuel storage within the Krško NPP perimeter. The dry spent fuel storage will be financed by the owners and the construction costs are included in the Krško NPP operating costs.

The Interstate Commission agreed with the joint report of the Agency for Radioactive Waste Management and the Krško Nuclear Power Plant Decommissioning Fund as regards the status of the second revision of "The Krško Nuclear Power Plant Decommissioning Programme and the Disposal of Low and Intermediate Level Radioactive Waste and Spent Fuel". Due to the new circumstances related to the extension the lifetime of the Krško Nuclear Power Plant, the Interstate Commission decided to stop all activities related to the unfinished second revision of "The Krško Nuclear Power Plant Decommissioning Programme and the Disposal of Low and Intermediate Level Radioactive Waste and Spent Fuel". The Commission determined that the preparation of a new revision should begin.

9.6 Cooperation within the Framework of International Agreements

In April the SNSA hosted the so-called Quadrilateral Meeting in Begunje na Gorenjskem. This is a regular annual meeting of the nuclear regulatory bodies of the Czech Republic, Hungary, Slovakia and Slovenia, which all have bilateral agreements with each other. The main topics of the meeting were staff aging, international inspection missions, implementation of the post-Fukushima measures and preparations for the EU peer review of national action plans. The interesting topic were also reports about the recent events in the nuclear facilities.

In October, representatives of Austria and Slovenia convened at their annual meeting in Rogaška Slatina in Slovenia. Both sides informed each other of major developments regarding legislation, radiation monitoring, emergency preparedness, waste management, changes and important events in the Slovenian nuclear programme.

In November 2015 the sixth bilateral meeting between Slovenia and Croatia took place in Ljubljana. During the bilateral meeting, both sides described their main developments in the field of legal frameworks, waste management, and emergency preparedness. There was also a report on the recommendations and suggestions of the IRRS mission organised in June 2015 in Croatia.

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

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

Goal 2

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

Realisation in 2015

The Slovenian authorities and other organisations in the field of nuclear and radiation safety and physical protection were actively involved in international associations and institutions.

International cooperation should be encouraged and maintained in all areas of nuclear and radiation safety, including science, research, education and assistance to third countries. Slovenia participated in the committee Euratom – Fission and in the committee Instrument for Cooperation in the Field of Nuclear Safety.

In 2015 regular bilateral meetings were held and information exchange on the basis of bilateral agreements was ongoing.

Goal 3

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

Realisation in 2015

The Republic of Slovenia was active in the Working Party on Atomic Questions of the Council of the EU in the group established by Article 31 of the Euratom Treaty. The activities of groups established by Articles 35, 36 and 37 of the Euratom Treaty were followed and the Slovenian representatives attended and actively participated in ENSREG meetings. They also cooperated in the implementation of assistance to third countries, which is supported by the European Commission.

Goal 4

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

Realisation in 2015

The Slovenian membership fee and all obligations to the IAEA were fully paid. This allows stable financing and smooth implementation of IAEA projects.

In the area of technical cooperation, Slovenia supports projects that have great potential in particular in countries within the geographical vicinity, in countries with similar programmes or technology, and particularly in areas where Slovenian experts are able to provide their assistance.

The Republic of Slovenia will receive technical assistance especially in the areas where no domestic capabilities are available to achieve the given nuclear and radiation safety goals.

The Republic of Slovenia will continue to support and encourage its experts to pursue professional work in third countries within the framework of the IAEA, to organise courses and workshops, and to invite international expert advisory groups to join periodic advisory missions to Slovenian facilities and institutions in order to independently verify the country's capabilities.

Goal 5

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

Realisation in 2015

The annual fee for the NEA and the Data Bank was fully paid. Slovenian representatives actively participate in committees and working groups of the NEA and their contribution is highly appreciated and on time.

10 USE OF NUCLEAR ENERGY IN THE WORLD

At the end of 2015, there were 441 nuclear reactors for electricity production operating in 33 countries. There are 66 nuclear reactors under construction. In 2015 the construction of one new nuclear power plant started in the United Arab Emirates. In 2015 five new nuclear nuclear power plants were put into operation, of which one was in Russia and four in China.

In 2015 seven nuclear power plants ceased operation, of which one in Germany, one in Great Britain and five in Japan. In Europe, there are nuclear power plants under construction in Finland, Slovakia, France, Russia, Ukraine and Belarus. Detailed data on the number of reactors by country and their installed power is presented in Table 9.

Table 9: The number of reactors by country and their installed power

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
Belarus			2	2,218
Belgium	7	5,927		
Bulgaria	2	1,926		
Czech Republic	6	3,904		
Finland	4	2,752	1	1,600
France	58	63,130	1	1,630
Hungary	4	1,889		
Germany	8	10,799		
Netherlands	1	482		
Romania	2	1,300		
Russia	35	25,443	8	6,582
Slovakia	4	1,814	2	880
Slovenia	1	696		
Spain	7	7,121		
Sweden	10	9,651		
Switzerland	5	3,333		
Ukraine	15	13,107	2	1,900
United Kingdom	15	8,883		
Europe total	**184**	**162,157**	**16**	**14,810**
Argentina	3	1627	1	25
Brazil	2	1,884	1	1,245
Canada	19	13,500		
Mexico	2	1,330		
USA	99	98,639	5	5,633
Americas total	**125**	**116,980**	**7**	**6,903**
Armenia	1	375		

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
India	21	5,308	6	3,907
Iran	1	915		
Japan	43	40,290	2	2,650
China	31	26,635	23	23,128
Korea, Republic of	24	21,667	4	5,420
Pakistan	3	690	2	630
Taiwan	6	5,028		
United Arab Emirates			4	5,380
Asia and Middle East total:	**130**	**100,908**	**41**	**41,115**
South Africa	2	1,860	2	
World total	**441**	**381,905**	**66**	**62,828**

11 RADIATION PROTECTION AND NUCLEAR SAFETY WORLDWIDE

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

INES events in the year 2015

In 2015, 21 event reports were published via the NEWS system. The reports were divided into the following groups: 1 event in a NPP, 3 events concerning releases of radioactive water from the Fukushima Daiichi NPP, 1 event during transport of radioactive material, 8 events concerning finding radioactive sources and 5 events involving the overexposure of workers with radioactive sources. The highest rating was level 3 and was determined for two events involving the overexposure of workers during the performance of radiography. There were 9 level 2 event reports published and 7 reports on level 1 events. For 3 events in the Fukushima Daiichi NPP, the INES rating was not determined. In 2015 there were no events in Slovenia that needed to be reported according to the INES criteria.

A level 3 event occurred during the performance of industrial radiography in a thermal power plant in Argentina. Two workers were exposed to an unshielded radiation source ^{192}Ir with an activity of 1.62 TBq and they received doses of 310 mSv and 1.85 mSv, respectively. The dose estimate for one worker's left hand index finger, which was the most exposed, was between 10-15 Gy. This was confirmed also by medical examination when deterministic effects of exposure were observed on this finger. The assessment of the incident showed that safety procedures were not fully observed.

A level 3 rating was also issued for an event in Iran. One of two industrial radiographers who were involved in an oil refinery project dismantled the guide tube of a gamma ray projector without noticing that the ^{192}Ir source with an activity of 35 Ci was detached and stocked in the guide tube. He put the guide tube in the car between the seats, where during the night both radiographers slept in these chairs for about 6 hours and 4 hours, respectively. When some mild symptoms of nausea and vomiting appeared, the first radiographer suspected the presence of a source nearby and he found it by using a survey meter. Subsequently, the second radiographer returned the source to the projector. The estimated doses received by the radiographers are 1.6 Gy and 3.4 Gy, respectively. Due to the high doses, both of the radiographers were taken to the hospital for further medical surveillance and possible treatment.

Three INES level 2 events occurred involving the the overexposure of workers during the performance of radiography. The causes of the events were similar; either the source was stuck in a guide tube or it dropped out of a guide tube and was not returned in a shielded radiographic projector. Workers did employ electronic dosimeters which alerted them to elevated radiation and this allowed for timely measures to avoid higher doses and deterministic effects of irradiation. In one event it was determined that the workers had not adhered to the procedures and that they were relying on a failed radiation monitor.

Three INES level 2 events occurred involving the overexposure of workers in different facilities. In an isotope manufacturing facility, a technician transferred a drawer with a ^{60}Co source with an activity of 135.6 TBq. Due to careless handling of the drawer, the source slid out of the shielding. The technician received a dose of 56.2 mSv. The second event occurred in another radioisotope processing facility. During an inspection of nuclear materials, a radiation worker accompanying the inspectors entered a hot cell containing ^{192}Ir sources with a total activity of 33.3 TBq. The worker remained inside the cell for about 1 minute and received a dose of 31 mSv. The doses received by the 3 inspectors were from 1 to 8 mSv, which is less than the annual limit. A third event occurred in a hospital where a nuclear medicine technologist received a dose of 110 mSv in a four-month period. The circumstances of the event were not described in the INES report.

One event occurred in a NPP where a worker was contaminated on his chin while he carried out maintenance work on the primary cooling system. The evaluation of the dose that was received by the worker was above the annual limit and this criterion led to a rating of level 2 on the INES scale.

Three events occurred in the Japanese NPP Fukushima Daiichi. The event reports described the leaking of radioactive water that was highly contaminated in a severe accident in 2011 and was then released into the sea. For these three events, the measurements did not show any seawater contamination above the limits. The INES rating for the event was not given because after natural catastrophic events and severe nuclear accidents the conditions of facilities are very degraded and such a comparison to events in other nuclear power plants is not possible.

A transport incident involving a gamma ray projector with a category 2 source was reported. The transport arrangements failed to comply with the requirements in the transport approval of the regulator and in the event of an accident the source could have been ejected from its shielding and could have led to the irradiation of individuals in the vicinity of the accident site. The causes of the event include a lack of safety culture in the transport company, which justified the event receiving a rating of level 2.

Most events were connected to lost, stolen and found radioactive sources. A level 2 event occurred at a university and was caused by inappropriate storage of radioactive sources and shortcomings in the radiation protection culture and could have resulted in the exposure of the persons present in the room. Another seven events were rated as level 1. Four of these were events involving stolen radioactive sources. Thieves either stole vehicles used to transport radioactive sources or they stole devices containing radioactive sources. The authorities launched search actions in the vicinity and subsequently most of the stolen sources were found undamaged and inside their shielding containers. In some cases, the sources were damaged and the contamination was spread to rooms and the environment. Persons were exposed to the sources while working on disassembling the sources to be sold to scrap metal dealers. Three events were reported involving finding orphan sources in scrap metal transport. The cargo was unloaded and category 4 radioactive sources were found therein. All these sources were stored in radioactive waste storage facilities.

Other Internationally Interesting Events in 2015

The IAEA website reported on three events that were not reported according to the INES criteria.

A construction company reported on a missing source of ^{241}Am-Be, which is a category 5 source and part of a nuclear gauge. This was determined at a company abroad where the gauge was exported for repairs. The search was initiated at locations where it was possible that someone could have removed the source from the gauge.

Close to the boundary of an Asian country, the police stopped a person carrying a package with a ^{137}Cs category 5 orphan source. The package with the source was transported to a safe and secure storage. The investigation into the origin of the orphan source is being carried out by the regulatory body. The INES rating for the event was not reported but according to INES criteria, this event could be rated as level 0.

The third event occurred in a company where industrial radiography is carried out. The operator of an X-ray generator entered the bunker and she was exposed to the beam of an X-ray tube for several minutes. The dose received by the operator was 82 mSv, which is higher than the annual limit of 20 mSv. The contributing cause of the event was that the safety device that stops X-ray emissions when the bunker doors are open had been intentionally disabled. This included a protecting switch that was turned off even though it was designed to turn off the X-ray generator when the door to the bunker was opened. The regulator considers this to be a violation of regulations. This event was rated as level 2 according to the INES scale.

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