REPUBLIC OF SLOVENIA
MINISTRY OF AGRICULTURE AND THE ENVIRONMENT
SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

Annual Report 2012 on Radiation and Nuclear Safety in the Republic of Slovenia

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June 2013

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

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

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SUMMARY

In 2012, there were no events that posed a serious radiological threat to the population in Slovenia. There were also no particularities in relation to the operation of nuclear and radiation facilities and in organizations that carry out radiation practice. There were no excessive radiological impacts on the environment.

The Krško NPP operated without any major disruptions, except for the manual shutdown which occurred due to the increased amount of flood debris in the Sava River. During this year's outage, fuel assemblies were replaced and a number of very important improvements that had been planned for several years were implemented. The third diesel generator was installed, which significantly increased the reliability of the power supply to safety related equipment, even in the worst case events. Other major work was done on the equipment, including the replacement of the reactor head and the replacement of the main generator rotor. The project of raising the flood protection dikes along the Sava River on the left bank site upstream from the Krško NPP was completed last spring, thus protecting the site against a ten-thousand-year flow.

After the stress tests campaign in 2011, the Krško NPP prepared in 2012 an ambitious programme of safety upgrades according to which a number of additional technical solutions will be implemented to the plant. These solutions will improve the capabilities for the cooling of the core in the worst case of natural or other accidents.

There were no complications in the field of radioactive waste management in Slovenia. Unfortunately, there was further delay to the planning of future repository for low- and intermediate-level waste. Since the end of 2009, when the site Vrbina near Krško was endorsed, the procedural matters have been almost halted. The investment plan for the future repository has not yet been approved and the Agency for Radwaste Management was asked to prepare its revision. In addition, the land has not been purchased, the field investigation has not been carried out and the preparatory work on the environment impact report has not yet started. With the delay on the construction of the repository, the Krško NPP's needs have been growing because of the limited capacities of their storage.

At the former Žirovski Vrh uranium mine, the final remediation of the mine has also stopped due to lack of funds. At the Boršt mill tailings site, the activities to prevent the long-term movement of the landslide were not carried out. However, monitoring and maintenance were ensured and therefore there was no immediate danger to the local population.

Due to economic crisis, the funds intended for the work of state institutions as well as the funds for research and educational work have been reduced. The work and existence of technical support organizations are also becoming more and more difficult. State institutions are forced to reduce their operation, which makes their work much more complicated. Although no major problems were detected in 2012, the risk of problems is increasing.

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1 INTRODUCTION

This report is prepared annually in accordance with the provisions of the Ionizing 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 send to the National Assembly of Republic of Slovenia. It is also the main way of communicating recent developments in the area of ionizing radiation protection and nuclear safety to the general public. It has been issued since 1985 and summarizes all events in connection with ionizing radiation protection and nuclear safety for the previous year. 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) plays a role of moderator, while the report's content is provided also by other state bodies, whose competences include ionizing 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 and Spatial Planning, 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 Llc, the Jožef Stefan Institute (JSI), the Institute of Occupational Safety (IOS), and the Fund for Financing Decommissioning of the Krško Nuclear Power Plant and Disposal of Radioactive Waste from the Krško NPP.

In 2012, the economic crisis escalated and therefore the budget funds for the operation of the ministries and regulatory bodies were reduced. The funds for research and education were also cut and the situation for technical support organisations is becoming more difficult as well. State institutions are forced to reduce material expenses, while funds allocated for the procurement of external contractors are decreasing and the wage bill is being reducing. New recruitments and promotions are limited. The measures mentioned above make the work complicated and it is becoming more and more difficult to comply with legislation requirements. Although no major problems arose in 2012, the risk of problems is increasing. In some chapters of this report, the SNSA warns about the problems that could be solved better if we have more funds. In Chapter 7.2 the risks for which the SNSA assesses that are increasing are described.

Together with this report, which is aimed at a wider interested public, an extended version in Slovene has been prepared. The extended report includes all details and data which might be of interest to the narrower group of professionals. It is available on the SNSA web page at http://www.ursjv.gov.si.

2 OPERATIONAL SAFETY

2.1 Operation of Nuclear and Radiation Facilities

2.1.1 Krško Nuclear Power Plant

2.1.1.1 Operation and Performance Indicators

In 2012, the Krško Nuclear Power Plant (the Krško NPP) operated without disturbances which could jeopardize the environment. The autumn floods have, due to debris in the Sava River, forced the operators to temporarily shutdown the plant. The activities related to lessons learned from the Fukushima accident in 2011 have intensively continued. In the spring, mostly during the regular outage, several major improvements that have been underway for several years have finally been completed. One such example was raising the flood protection dikes. Moreover, the third safety related diesel generator was installed, which significantly increased reliability of the power supply to safety related equipment and thus also reactor cooling, even in the worst case events. The reactor vessel head and the rotor of the main electrical generator were replaced as well.

In 2012, the Krško NPP produced 5,527,934.0 MWh (5.5 TWh) gross electrical energy on the output of the generator, which corresponds to 5,243,682.5 MWh (5.2 TWh) net electrical energy delivered to the grid.

In 2012, the SNSA inspectors performed 46 inspections of the Krško NPP; 44 inspections were planned, whereas two were carried out following two abnormal events:

- an occupational accident that occurred while a new reactor vessel head was being installed during refuelling outage and
- a forced reactor shutdown due to the increased flow of the Sava River.

One unannounced inspection review also took place within the regular planned inspections.

In 2012, the SNSA inspection did not identify significant deviations of the NPP operation from laws and regulations. Identified problems related to the equipment were analysed and solved in a due time within implementation of the Krško NPP corrective program.

In the field of radiation protection of exposed workers, the Krško NPP is also supervised by the Slovenian Radiation Protection Administration (SRPA). In 2012, the SRPA performed four inspections in this regard, two of them together with the SNSA inspection. No major incorrectnesses were found. The SRPA approved 4 evaluations of the protection of exposed workers against radiation.

The most important performance indicators of the Krško NPP are shown in Tables 1 and 2, while their changes through 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 in 2012

Safety and performance indicators	Year 2012	Average (1983-2012)
Availability [%]	87.63	86.5
Capacity factor [%]	86.77	84.2
Forced outage factor [%]	0.54	1.07
Gross production [GWh]	5,527.93	5,049.51
Fast shutdowns – automatic [Number of shutdowns]	0	2.43
Fast shutdowns – manual [Number of shutdowns]	1	0.17
Unplanned normal shutdowns [Number of shutdowns]	0	0.80
Planned normal shutdowns [Number of shutdowns]	1	0.80
Event reports [Number of reports]	2	4.30
Duration of the refuelling outage [Days]	43.3	43.9
Fuel reliability indicator (FRI) [GBq/m^3]	$1.52 \cdot 10^{-2}$	$6.85 \cdot 10^{-2}$

Table 2: Time analysis of the Krško NPP operation in 2012

Time analysis of production	Hours	Percentage [%]
Number of hours in a year	8,784	100
Duration of plant operation (on grid)	7,697	87.63
Duration of shutdowns	1,087	12.37
Duration of the refuelling outage	1,040	11.84
Duration of planned shutdowns	1,040	11.84
Duration of unplanned shutdowns	47	0.54

The operation of the Krško NPP in 2012 is shown in Figure 1. The figure shows that the power plant was shutdown twice. The first shutdown took place in April, as planned for the regular refuelling outage. The second shutdown was not planned and occurred in October due to the ingress of debris from Sava River and the consequent degradation of vacuum in the condenser (for details see chapter on Abnormal Events). The plant also operated at reduced power in February, when the oil was added to the reactor coolant pump no. 2, and in summer months due to the low flow of the Sava River.

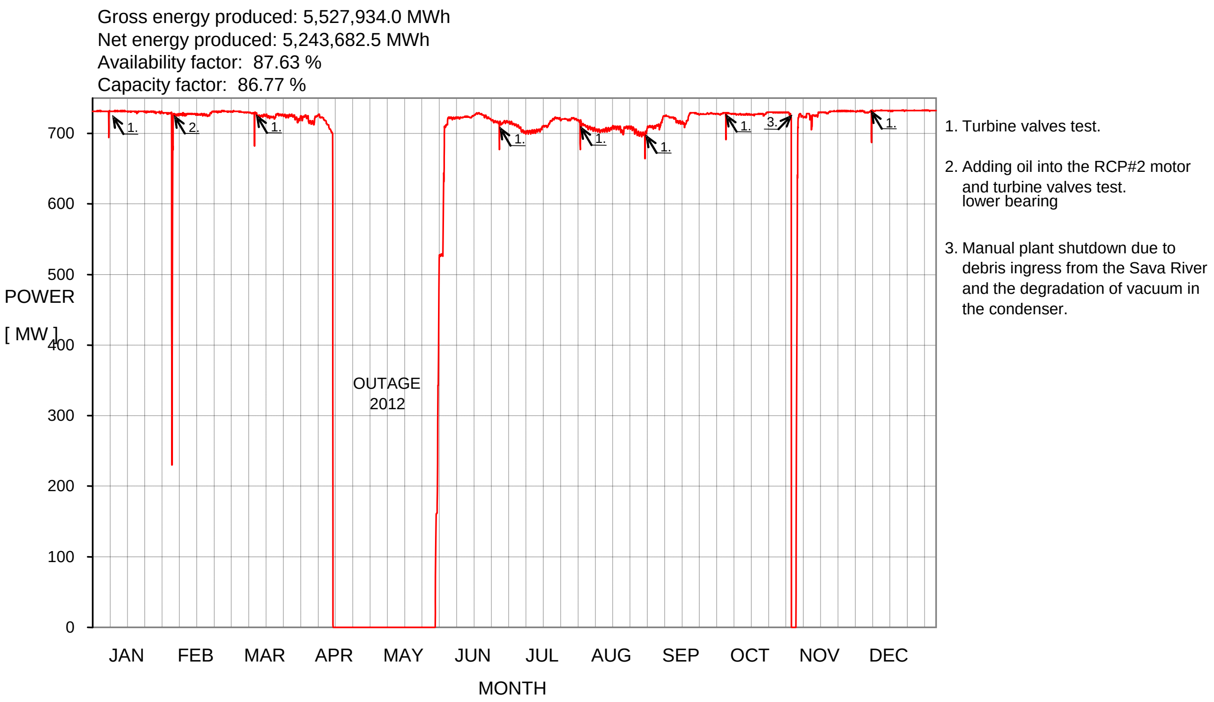

Figure 1: Operating power diagram for the Krško NPP in 2012

There are two types of reactor shutdowns, fast and normal. Fast reactor shutdowns are caused by the actuation of the reactor protection system, which can be activated manually or automatically. During normal reactor shutdowns, the reactor power reduces gradually. Normal shutdowns can be planned or unplanned. An outage is a special type of a normal, planned gradual shutdown of a reactor.

In Figures 2 and 3, the number of the plant shutdowns is shown. Figure 2 shows that the number of fast reactor shutdowns has stabilized through the years (less then one fast shutdown per year in the last 20 years). There was one automatic shutdown in 2012.

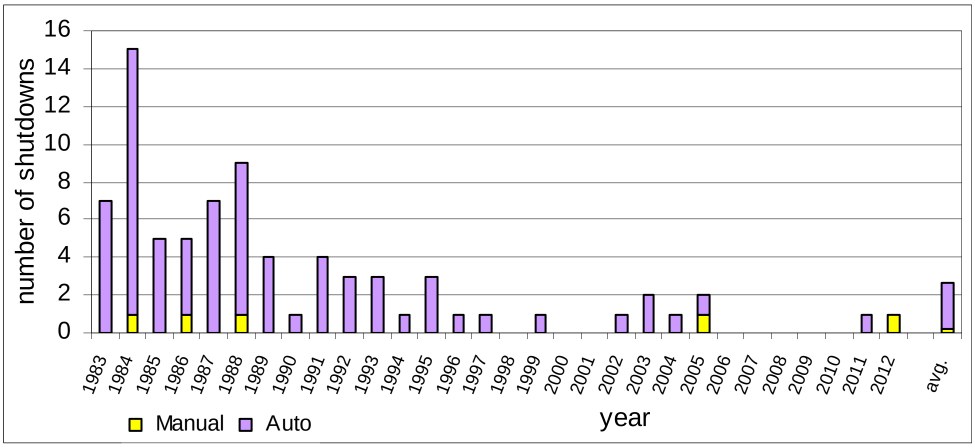

Figure 2: Fast reactor shutdowns - manual and automatic

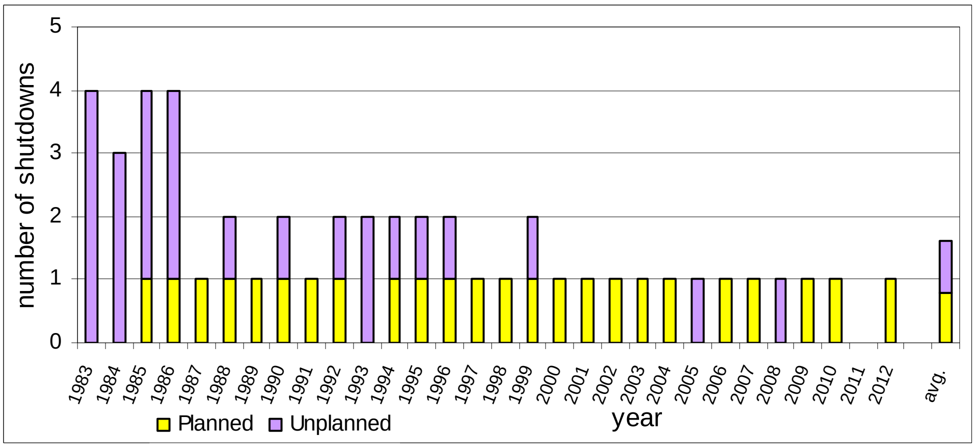

Figure 3: Normal reactor shutdowns - planned and unplanned

Figure 4 shows the number of unplanned actuations of high pressure injection system, which can be actuated manually or automatically if the pressure of the primary or secondary cooling system is low and when the pressure in the containment is high. In 2012, there was no actuation of the high pressure injection system. There were 11 actuations since the Krško NPP started its commercial operation.

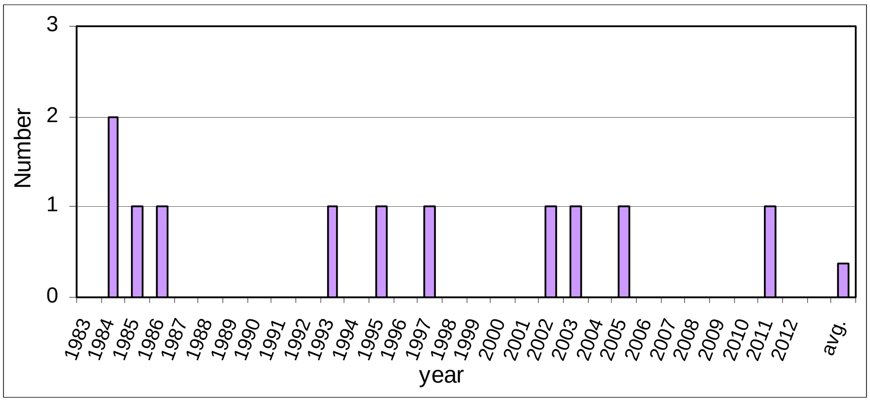

Figure 4: Number of unplanned safety injection system actuations

In Figure 5, the forced outage factor is shown. The factor is calculated as a ratio between the hours of duration of unplanned shutdowns and the number of hours in a year. In 2012, the duration of plant's unplanned shutdowns was 47 hours, thus the value of this factor is 0.54 %.

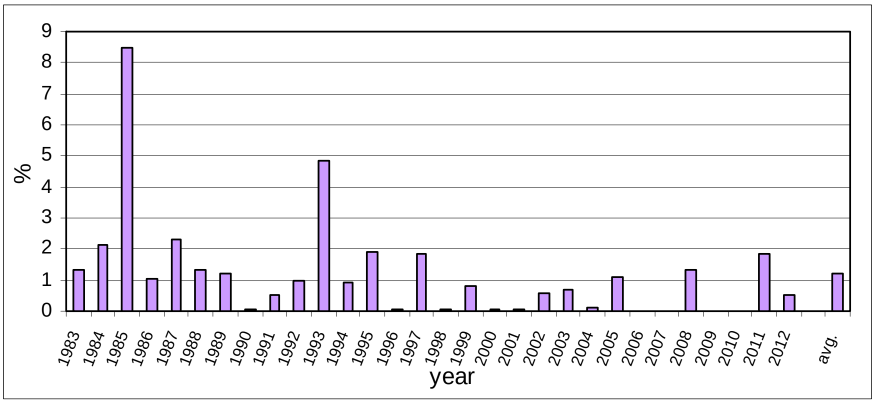

Figure 5: Forced outage factor

Figure 6 presents data on different means of electrical energy production in Slovenia, specifically the production in nuclear, hydro, thermal, and solar power plants. In 2012, the production of electrical energy reached a record value of 14.8 TWh, mostly due to the higher production of thermo power plants, as well as to a high production in hydro power plants.

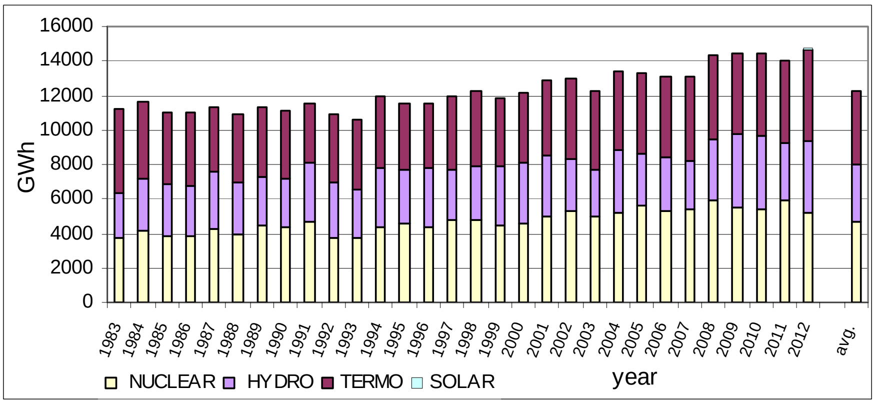

Figure 6: Production of electrical energy in Slovenia

The collective exposure to radiation is shown in the Figure 7. The low value of this factor indicates high efficiency of radiation exposure control. Its value in 2012 was 884 man mSv, which is about the average value in years with an outage.

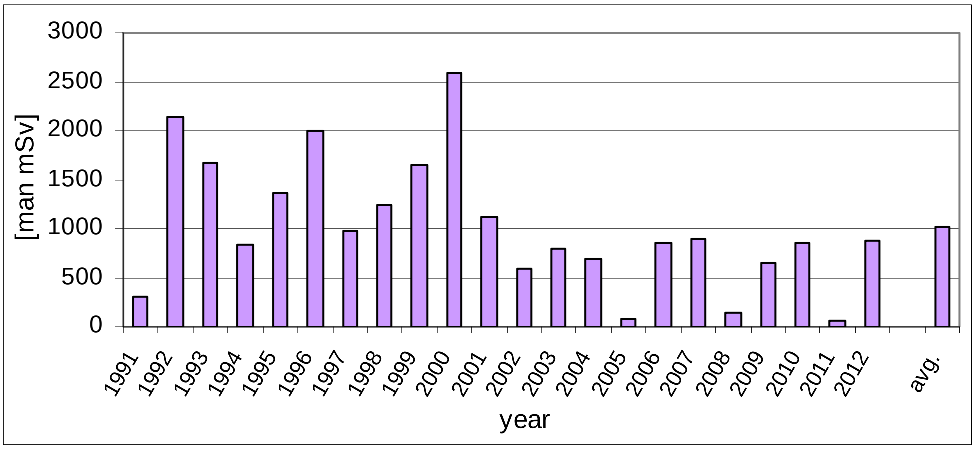

Figure 7: Collective exposure to radiation in the Krško NPP

The purpose of the inoperability factors given in Figures 8, 9 and 10 is to show whether important safety systems can assure their function in the time of normal operation, as well as in case of an accident.

In Figure 8, the inoperability factor of the safety injection system is indicated. In 2012, the value of this factor was 0.0004, which is less than the Krško NPP's goal value of 0.005. In 2012, this system was inoperable only during the planned on-line maintenance.

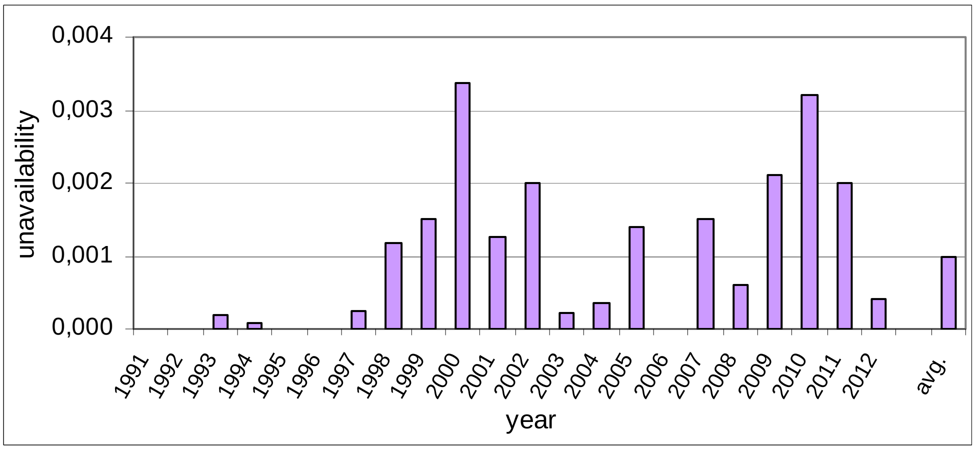

Figure 8: Inoperability of safety injection system

The inoperability factor of the emergency power supply, namely emergency diesel generators, is shown in Figure 9. This system is important when the normal offsite and onsite power supplies are lost. The operability of diesel generators, which has been stable for several years, was also high in 2012. Since the emergency diesel generators were available at all times in 2012, the value of this factor is 0, which is less than the Krško NPP's goal value of 0.005.

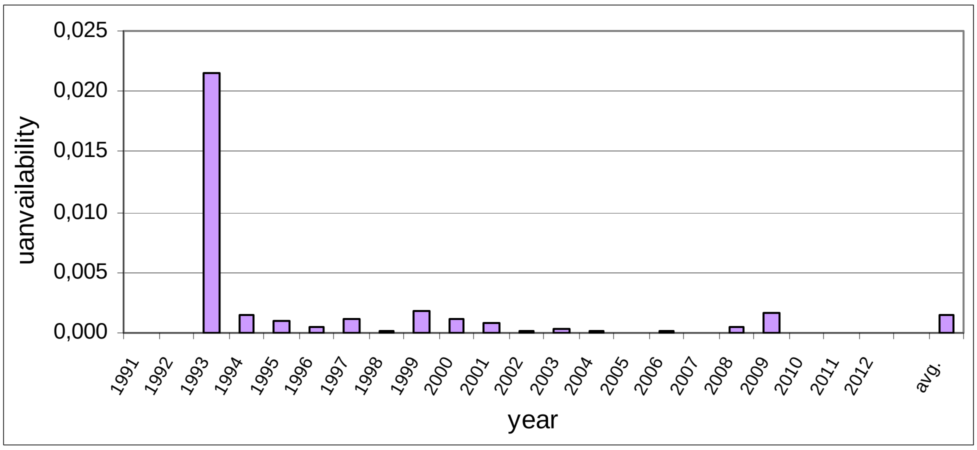

Figure 9: The inoperability of the emergency power supply

In Figure 10, the inoperability factor for the auxiliary feedwater system is shown. This system is used to supply water to steam generators when the main feedwater system is unavailable. In 2012, the value of this indicator was 0.0008, which is below the goal value of the Krško NPP of 0.005. In 2012, the system was not available only during the planned on-line maintenance.

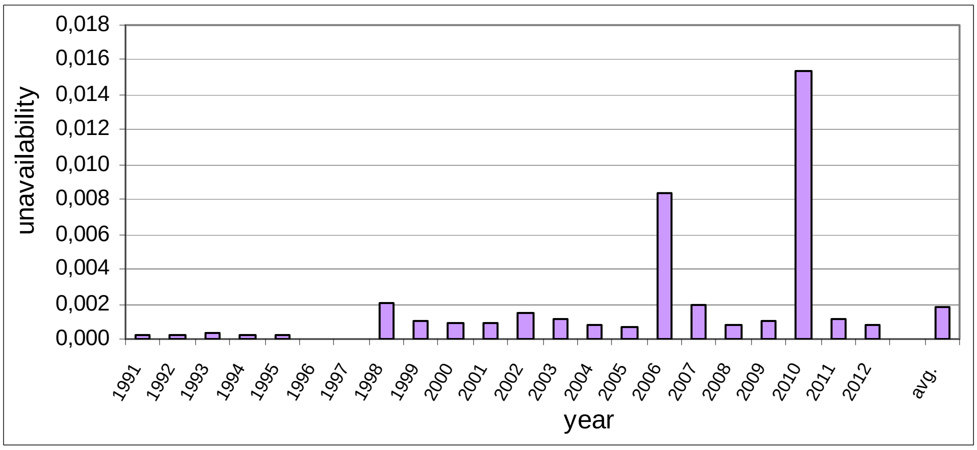

Figure 10: The inoperability of the auxiliary feedwater system

2.1.1.2 Activities for safety improvements in the aftermath of the Fukushima event

In 2012, a campaign of reviews, analyses and improvements has continued as a response to the accident at the Japanese Fukushima Daiichi NPP in March 2011.

- The peer review of stress test reports prepared by the European Union Member States together with Switzerland and Ukraine was carried out (for details see the chapter on International stress tests peer reviews).
- The Krško NPP prepared a special analysis of safety improvements and a program based on this analysis, which were both demanded by the SNSA (for details see the chapter on the Krško NPP's Safety Upgrade Program).
- In January 2012, the SNSA issued a decision which requires that the Krško NPP reviews the basis and assumptions for the National Radiological Emergency Response Plan. At the request of the Krško NPP, the SNSA in December 2012 prolonged the deadline for this analysis to 31 March 2013.

- The SNSA prepared the National Action Plan in the framework of ENSREG (for details see the chapter on The National Action Plan).

The results of performed reviews show that the Krško NPP is well prepared for all possible and even some very unlikely external threats at the site. With additional changes that are currently being implemented or are planned to be implemented, the Krško NPP will further increase its robustness as well as the nuclear and radiation safety of its employees and the public in general.

International stress tests peer reviews

At the end of December 2011, the SNSA sent its final national report on the stress tests to the European Commission. The main part of the report was comprised by the Krško NPP, which also prepared several support studies. These were also reviewed by the technical support organizations, which gave their expert opinions. The SNSA reviewed the Krško NPP's report on the stress tests as well as all support analyses and expert opinions, and based on that prepared the final national report on the stress tests.

National reports on the implementation of stress tests were then subjected to peer reviews of Member States. The peer reviews were divided into the so-called horizontal and vertical reviews.

In the horizontal review, the European experts reviewed the individual chapters of the report, namely chapters on external events, loss of all power supplies and the ultimate heat sink, and on preparedness for the management of severe accidents, and posed questions to individual countries. Then, each country prepared its answers and presented them on a joint meeting in Luxembourg, at which the member states presented individual chapters of the report and their responses to high priority questions. The answers to other questions were given to the organizers of the peer review meeting.

The second part of the reviews, the so-called vertical review, was held in each country. In March 2012, a group of experts came to Slovenia with a task to get the answers to issues that were still open, to visit the Krško NPP and to produce a final report for the country. The SNSA, together with the Krško NPP and technical support organizations, answered all questions that were still opened. Then followed the visit of the Krško NPP, which included a walkdown of all modifications implemented after the Fukushima Daiichi accident, as well as other key improvements that resulted from the first periodic safety review (e.g. the installation of the 3rd safety related diesel generator and raising the flood-protection dikes).

At the last day of the review, the abovementioned experts prepared the final country report. The report concluded that the Slovenia has efficiently and accurately implemented the stress tests and that the Krško NPP is well prepared even for worst case scenarios, due to its basic design and post-Fukushima improvements which were already implemented or were planned for the future.

Krško NPP's Safety Upgrade Program

On 1 September 2011, the SNSA issued a decision requiring the plant to reassess the strategy for managing severe accidents as well as the existing design measures and procedures, and to implement necessary safety improvements for the prevention of severe accidents and mitigation of their consequences. This program of upgrades was already envisaged in the Slovenian legislation from 2009, namely in the Rules on radiation and nuclear safety factors (JV5), which required that these improvements will have to be implemented after the plant lifetime is extended. As a response to the Fukushima Daiichi accident and since the licensing process for lifetime extension was in progress, the SNSA decided to speed up the plant's abovementioned evaluation and implementation of measures for managing severe accidents.

The Krško NPP completed the required analysis in the beginning of 2012, together with the proposal of the Safety Upgrade Program (SUP). The program includes proposals for changes and for the installation of new systems, structures and components. The changes will ensure greater reliability of power supply; improve the cooling of the reactor core; maintain the integrity of the containment; reduce potential controlled releases of radioactivity into the environment during a severe accident; control and manage severe accidents from the backup (emergency) control room; and provide alternative means for the cooling of spent fuel pool. The action plan was reviewed and approved by the SNSA in February 2012 and shall be completely implemented within the SUP by the end of 2016.

Additional systems, structures and components, which will be built in within the SUP, will be designed and structured in accordance with the requirements of design extension conditions (DEC), which were developed during the preparation of the SUP and are specific for the design and the site location of the Krško NPP. The DEC have been developed to enhance the safety of the installation by installing additional systems and structures, as well as by exploitating more efficiently the safety margins that are already installed. With the implementation of the DEC, the consequences of rare events listed below will be further significantly reduced. The Krško NPP's DEC are developed on the basis of engineering judgment as well as deterministic and probabilistic assessments.

The DEC are defined for following events:

- **earthquake**: extended design condition seismic value is 0.6 g Peak Ground Acceleration (PGA), which is twice the design basis value (0.3 g PGA);
- **flooding**: the new maximum flood level is 157.53 m (above sea level), while the existing flood protection dikes protect the plant up to the flood that corresponds to 157.10 m. Existing flood protection dikes protect the plant against the Probable Maximum Flood (PMF), i.e. 7,081 m^3/s with additional safety margin;
- **combination of earthquake and flooding**; the simultaneous occurrence of the PMF and earthquake, which would destroy the flood protection dikes;
- **combination of earthquake and fire**; fire caused by the DEC earthquake;
- **external low and high temperatures**; air temperatures with a return period of 10,000 years;
- **aircraft crash accident**: a crash of a large commercial aircraft at the maximum landing velocity;
- **fire**: fire due to the DEC aircraft crash.

In the framework of the SUP, the following improvements are foreseen:

- installation of filtered venting system for containment, capable of depressurizing containment and filtering over 99.9% of volatile fission products and particulates;
- installation of passive auto-catalytic recombiners in the containment;
- installation of additional high pressure pump for reactor cooling system injection with dedicated source of borated water;
- installation of additional high pressure pump for feeding steam generators with dedicated source of water;
- installation of additional high pressure pump for injecting into reactor coolant pump seals;
- installation of additional low pressure pump for spraying (pressure control) and flooding the containment (preventing molten core concrete interaction in case of failed reactor pressure vessel); it will also enable injection into spent fuel pool through a new spray system;
- installation of additional pressurizer relief valves qualified for severe accidents;
- installation of alternative ultimate heat sink, capable of transferring decay heat into the environment;

- acquiring a mobile heat exchanger, which will be located outside of the nuclear island with a possibility of quick connection to the reactor or the spent fuel pool;
- installation of permanent sprays around the spent fuel pool with provisions for the quick connection of mobile equipment;
- acquiring the technology and material for quick filling of possible ruptures in the spent fuel pool;
- upgrade of AC power supply (possibility to quickly connect the additional mobile 2 MW diesel generator to the 3rd safety related bus, requalification of the 3rd safety related bus, upgrade of the connection between 400 V safety related buses and mobile diesel generators);
- merging of existing shutdown panels and their functional expansion, which will enable safe shutdown of the plant and maintaining the safe shutdown conditions from one location (installation of the emergency control room);
- installation of separate dedicated instrumentation and controls for severe accidents, capable of monitoring and controlling all newly installed equipment both from the existing as well as the new emergency control room, while having completely independent power supply;
- the above mentioned emergency control room will provide for the long-term accommodation of control room staff even during severe accidents due to its air filtering and radiation protection; likewise, a capability for long term habitability and operation of the emergency support staff will be established for the same conditions;
- additional flood protection of nuclear island and all new systems, structures and components.

In addition, the Krško NPP also conducted an analysis of alternative options for the management of spent fuel. The results show that the best strategy would be to store the spent fuel in dry cask storage. The main advantages of this strategy are reducing the load to the spent fuel pool (static and dynamic loads), increasing free volume between fuel elements (smaller chance of re-criticality in case of damage in the spent fuel pool) and higher coolant/fuel rate (slower heating of the spent fuel in case of severe accident). The dry cask storage should be in operation by 2016 or by latest in 2018.

Changing the strategy for the management of spent fuel would also reflect on the issues and objectives of the existing *»Resolution on the 2006-2015 National Programme for Managing Radioactive Waste and Spent Nuclear Fuel«.*

The National Action Plan

As it was agreed in the ENSREG group, the SNSA prepared a complementary National Action Plan (NAcP) of improvements, which is based on the lessons learned from Fukushima accident in March 2011. The document was prepared in English and was published on the SNSA website. The NAcP comprises actions, with which the risk due to natural and other hazards that could effect the plant location will be greatly reduced in the next few years.

The core of the Slovenian NAcP and post-Fukushima improvements in Slovenia represents the planned Krško NPP's Safety Upgrade Program (SUP), which is described in more details in the previous chapter. Beside the implementation of the SUP, the SNSA identified 11 additional actions, with which the preparedness to severe accidents shall further increase. These actions include introducing changes to the legislation, hosting additional peer reviews, performing additional studies, enhancing the emergency preparedness, and improving the safety culture of both the operator and the regulatory body.

2.1.1.3 Abnormal Events in the Krško NPP

Event reporting is defined by the Rules on Operational Safety of Radiation or Nuclear Facilities, which in Appendix Six lists events which have to be specially reported by the operator of nuclear power plants. In 2012, the Krško NPP, in accordance with the above Rules, reported one event, which did not require stopping the plant, and one event, which required stopping the plant. There were no automatic shutdowns.

During the outage, the work accident occurred which did not have to be reported according to the above mentioned Rule. The accident is nevertheless described in this chapter.

Inoperability of Chilled Water System

The purpose of the chilled water system is to extract heat from the air conditioning units for the main control room, electrical equipment rooms, the heat exchanger of the gas stripper of reactor makeup water that fall within the safety class, and the air conditioning unit for the entrance point to the controlled area belonging to the non-safety class.

Cooling units are connected to two redundant distribution cooling loops, which supply the safety and non-safety consumers. During the event on 2 March 2012, the cooling loop A was unavailable due to repairs. On cooling loop B, the cooling unit was being changed and when the flow paths were being established, the inlet valve for the running cooling unit was accidentally slightly closed. Consequently, the cooling unit stopped working and thus there was no supply of cooling water to the air-conditioning. In case of such event, the plant has to enter into LCO 3.0.3, which means that it should be in hot standby state within 6 hours if the system is not restored. The system was restored within 20 minutes and the shutdown was not necessary.

Shutdown of the Krško NPP due to vacuum deterioration in the condenser, caused by large amounts of debris in the Sava River

On 28 October 28 2012, due to the increased flow of the Sava River, the intensive rinsing of the fallen leaves and other alluvial material clogged the cleaning devices at the inlet of the condenser cooling system in the Krško NPP. Difference level through travelling water screens of circulating water system increased for over 1 meter, resulting in automatic opening of safety hatches. Because of that, Taprogge filters and consequently pipes of the heat exchanger at the condenser partly clogged. The flow of cooling water was reduced, the temperature and pressure in the condenser increased and the vacuum in the condenser deteriorated. As safety precaution, operators manually shut down the reactor. Safety injection was not necessary. Before that, the Krško NPP operated at full power. Both pumps of the cooling tower system were in operation and the trash rack and the return channel of the travelling water screens were cleaned. The Krško NPP took all appropriate actions and all equipment was functioning as expected during the shutdown. After two days, the Krško NPP was synchronized with the grid. The event had no effects on nuclear or radiation safety.

Incident regarding the cable bridge of reactor vessel head during the 2012 outage

An accident has occurred during the outage work on the new reactor vessel head. The metal structure, through which under normal conditions cables are routed to the reactor cover, unexpectedly fell into a horizontal position when moving. Two workers were injured and the fallen cable bridge also damaged some equipment. Outage works on reactor vessel head were stopped for a few days. The event had no effect on nuclear and radiation safety, because the Krško NPP was not in operation and there was no radiation material nearby. Event analysis showed that the cable bridge fell during the lowering with winch because of incorrect cable winding and deficiencies in the design process of the equipment's supplier.

2.1.1.4 Periodic Safety Review (PSR)

A PSR is an intense systematic review of all operational and safety aspects of the NPP and must take place once every ten years.

Actions taken from the First Periodic Safety Review (PSR1) in 2003

The PSR 1 was carried out in the Krško NPP from 2001 to 2003. The Action Plan, which was prepared on the basis of the review's findings, contained 122 individual tasks. By the end of 2012, 119 of them were fully completed. The deadlines for carrying out the remaining three actions in the Action Plan, namely the review of the structural adequacy of the containment, reactor operating modes and PSA at shutdown, are extended until the end of 2015. The reason for the extension is the fact that the standardized analytical methodology for the implementation of tasks is not available.

Second Periodic Safety Review (PSR 2)

In the first half of 2010, the SNSA approved the PSR2 program. By the end of 2012, the Krško NPP delivered most of the preliminary safety factors reports to the SNSA. In the second half of 2012, the SNSA conducted a review of reports and worked on improving and adding the missing content that has not occurred in the reports at coordination meetings with the Krško NPP.

The SNSA expects that all final reports will be delivered by June 2013 and that the final report on the PSR2 review with an action plan resulting from the report will be prepared by the end of 2013.

2.1.1.5 Long-term operation of the Krško NPP

On 20 June 2012, the SNSA issued a decision approving the modifications that will enable long-term operation of the Krško NPP. By this, the extensive and long process, initiated after the first Periodic Safety Review of the Krško NPP in 2003, was completed. At that time, the Krško NPP began with the preparation and introduction of a programme for monitoring the ageing of components, which is a precondition for extending the operation of Krško NPP beyond the originally projected 40 years of life. Operators of the Krško NPP have examined thousands of electrical, mechanical and structural components and prepared programs for regular control of their aging as well as the environmental qualification of equipment. They have also performed several analyses to justify changes in those sections of the Safety Analysis Report of the Krško NPP that had operation restrictions up to 40 years.

Approving the aging management programme of the NPP is a precondition for the extension of plant's operation after the year 2023. In addition, the Krško NPP has to complete a comprehensive second Periodic Safety Review until mid-2013 and the third Periodic Safety Review in 2022 and 2023. Moreover, the Krško NPP has to carry out a series of safety improvements resulting from lessons learned after the accident in Fukushima in next few years. The basic precondition for the potential operation after 2023 is, of course, regular maintenance of operating equipment, well-trained operators and a good safety culture of all employees. All above mentioned conditions need to be fulfilled if the owners of the Krško NPP want to extend the plant's operation after the year 2023.

Reviewing and approving these modifications has been one of the most extensive projects since 2000, when the facility was modernised. After years of preparation, the Krško NPP submitted a formal application for the approval of modifications in 2009. At the SNSA, it was already agreed that the whole process should follow the requirements of the U.S. legislation, taking into consideration the fact that the U.S. company Westinghouse was the supplier of the Krško NPP and that the U.S. have experience with extending operating life of several tens of power plants. The SNSA followed the requirements that the US NRC set for their nuclear power plants.

2.1.1.6 Nuclear Fuel Integrity

The year 2012 comprised part of fuel cycle 25, which started on 31 October 2010 and ended on 13 April 2013 with the refuelling outage, and part of cycle 26, which started on 26 May 2012 and will last 18 months until the refuelling outage in October 2013.

The condition of fuel assemblies in the reactor (fuel cladding integrity) is monitored during transients and indirectly through measurements of specific activities of the reactor coolant in conditions of stable operation. Based on elevated specific activities of the isotope ^{133}Xe from 27 September 2011 onwards, it was estimated that there was one leaking fuel rod in the reactor core of the fuel cycle 25 at the end of 2011. Therefore, the specific activities of the isotopes ^{131}I and ^{85m}Kr rose ten times from the start of 2012 until the end of the fuel cycle.

In the fuel cycle 26, a large and sharp rise of xenon and iodine specific activities was noticed on 18 July 2012, which indicated a degradation of nuclear fuel integrity. Specific activities of isotopes continuously rose until the end of 2012. It was estimated that there was open leakage on one or two fuel rods.

Even with the leaking fuel, the specific coolant activities of the fuel cycle 25 reached less than 1 percent of the limit from the plant operational limits and conditions. The specific coolant activities in fuel cycle 26 at the end of 2012 were about 1.33 % of the limit for ^{131}I dose equivalent and about 1.65 % of the limit $47/\bar{E}$ gross activity of the primary coolant (mean energy $\bar{E}$ = 0.27 MeV).

Fuel Reliability Indicator (FRI) shows 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 with the contribution of the ^{134}I from tramp uranium in the reactor coolant system and normalized to a constant value of the reactor coolant purification rate and reactor operating power. A FRI value equal or below $5 \cdot 10^{-4}$ μCi/g ($1.85 \cdot 10^{-2}$ GBq/m^3) represents fuel with no damage according to an internationally adopted criterion. Figure 11 shows the FRI values for individual fuel cycles. In the second half of the fuel cycle 25, the FRI values reached the value of $1.78 \cdot 10^{-2}$ GBq/m^3, which is a bit below the criterion for leaking fuel. In the first part of the fuel cycle 26, the FRI values amounted to $1.04 \cdot 10^{-1}$ GBq/m^3, which is 5 times higher than the criterion and shows the condition of damaged fuel.

Unfortunately, the leaking fuel rods cannot be repaired or removed during power operation; this is possible only during refuelling outages. Since the determined leakage is far below the authorized limits that would require a forced shutdown of the plant and the performance of an extraordinary outage, the damaged fuel will be replaced during the regular outage in autumn 2013.

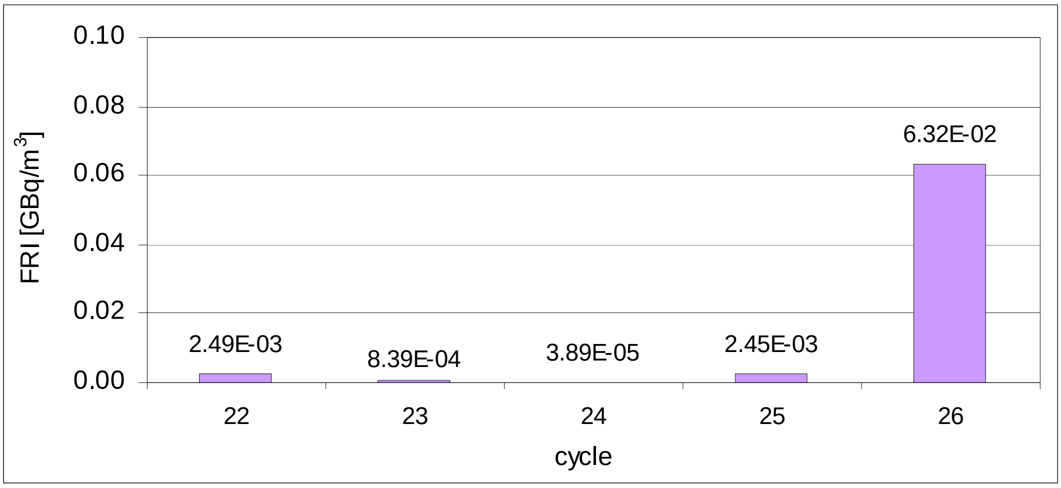

Figure 11: Fuel Reliability Indicator (FRI) for the past five fuel cycles

2.1.1.7 Modifications in the NPP Krško

In accordance with Article 83 of the Act on Ionizing Radiation Protection and Nuclear Safety, the SNSA approved 10 modifications and agreed to 11 modifications. During the preliminary safety evaluation, the NPP Krško found no open safety issues for 21 modifications. Therefore, the NPP only informed the SNSA about the changes. On 31 December 2012, there were 20 active temporary modifications. 34 active temporary modifications were opened and 37 were closed in 2012. Among active modifications, 13 temporary modifications were approved in 2011 or earlier.

In 2012, the Krško NPP issued the 19th revision of the *»Updated Safety Analysis Report«*, which took into account the changes approved up to 1 November 2012.

2.1.1.8 Refuelling Outage

A refuelling outage took place from 14 April until 27 May 2012. The main activities during this year's outage were replacing 56 fuel assemblies, preventative inspections, maintenance activities, modifications, and the modernization of systems and equipment. Of these, the most important were replacing the reactor vessel head, enhancing emergency power supply with 3rd diesel generator and replacing the electrical generator rotor. Additionally, the inside of a reactor coolant pump was inspected; two irradiation capsules in the reactor vessel were pulled out; the sludge lancing of the steam generator was performed; the ventilation unit motors of the containment were replaced; and the restoration work in the 400 kV switchyard have been carried out. As for preventive maintenance, the inspection and renovation of secondary pipelines, switching equipment, pumps, motor drives, and valves were important. Due to wear, the long-planned replacement of the transformer T2 was carried out. Also, the inspection and restoration of circulating water system and cooling towers system were conducted. In accordance with the ten-year program of in-service inspection for the period from 2002 to 2012, the U-tubes of the steam generator were inspected. Based on recommendations from industry practice, welds on the divider panel between hot and cold side of the steam generators were checked.

The most extensive modification in the 2012 outage was replacing the reactor vessel head and all associated equipment. With the new reactor vessel head, the managers of Krško NPP made the monitoring of the reactor vessel integrity significantly easier and cheaper. Since serious damage to the reactor vessel head was found about a decade ago in the Davis Besse NPP, inspections in all similar plants were greatly intensified. The best solution was replacing the existing reactor vessel head with a more modern one, which has been made in the Krško NPP as well.

One significant improvement made during the 2012 outage was also the introduction of third safety diesel generator. Thus, the reliability of electricity supply in the case of any emergency, for example earthquake, collapse of the electricity grid, flooding and other, has increased significantly. Increased redundancy of resources and their separation reduced the total probability of damage to the reactor core.

The implementation of outage activities, especially those which are important to ensuring a high level of nuclear safety, was monitored by SNSA. Expert basis for the assessment of important outage activities were prepared by technical support organizations, which had no comments on the quality of the work that was carried out. The SNSA estimates that Krško NPP is able to operate safely until the next outage. Nevertheless, an appropriate action plan was prepared by the SNSA to improve the work relating to the monitoring of outage activities.

2.1.1.9 External influences on the operational safety of the NPP Krško

In the scope of the construction project of hydro power plants (HPP) chain on the lower Sava River, four HPPs were constructed, namely the HPP Vrhovo in 1993, the HPP Boštanj in 2006, the HPP Arto-Blanca in 2009, and the HPP Krško in 2012. In 2012, the national spatial plan (NSP) for the HPP Brežice was concluded with a governmental decree. For HPP Mokrice, the basis studies were prepared and the NSP was presented to the public both in Slovenia and in Croatia. The HPPs on the lower Sava River have influence on the flooding hazard of the Krško NPP because of the faster transfer of the flood waves, decrease of flooding areas along the Sava riverbed upstream from the Krško NPP, dam rupture waves, operational waves (sudden opening of dam gates) and floating sediments that can harm the safety relevant cooling systems of the Krško NPP. The effect of the HPP Brežice will be the most important because of a higher level of the Sava River at the Krško NPP due to accumulation basin, which will require extensive modifications of the Krško NPP systems. The influence of HPP Mokrice on the Krško NPP is small and relevant only to the impact on flooding in the area of the HPP Brežice and on the construction of the HPP Brežice. In April 2012, the SNSA gave a positive opinion on the NSP draft and also issued design conditions for the preparation of environmental impact assessment and the project for acquiring the construction permit for the HPP Brežice.

The SNSA also followed the preparation of HPP chain on the middle Sava River, which could influence the flooding hazard of the Krško NPP and the quality of the water in Sava River that is used by the Krško NPP.

After many years of preparations, the raising of flood protection dykes along Sava River and its tributary Potočnica was finished in July 2012. This was one of the most important actions resulting from the First Periodic Safety Review. The bases for raising the flood protection were the new hydrologic analyses on probable maximum flood, rupture waves in case of destruction of dams on the Sava River and high-flow waves according to new data on the Sava River flow. Hydraulic calculations showed that the dykes would be overflowed at a value of 1.5 times the probable maximum flood flow. The analyses of safety margins and of the setting of cliff edge effect conditions in the course of the stress tests confirmed that the flooding safety of the Krško NPP is thus ensured also for the occurrence of extreme natural events that would exceed the Krško NPP design bases.

In 2012, the SNSA issued several consents for the construction in the area of limited use due to the nuclear facility the Krško NPP. The preparation of the National Spatial Plan (NSP) for the connecting road from Krško to Brežice and obtaining consents for the project for acquiring a building permit for a bridge across the Sava River in Krško were in progress. Project conditions for the gas distribution network and consents for the construction of transformer stations, industrial plant for plastification of metal products, industrial facility for mechanical treatment of mixed municipal waste and sewage, as well as consents for the removal of existing dwelling house, construction of a new house, and for the legalization of the additions of the residential house have been issued.

2.1.2 TRIGA Mark II Research Reactor in Brinje

Operation

In 2012, the TRIGA Research Reactor operated for 147 days. The reactor was mostly used as a neutron source for neutron activation analysis, for irradiation of electronic components and for educational purposes. A total of 1,307 samples were irradiated in the carrousel and the channels, as well as 37 in the pneumatic post.

In 2012, there were ten automatic reactor shutdowns, four of which occurred during practical exercises for trainees, five were caused by an operator error during the reactor start-up and one was caused by too short reactor period during the reactor start-up. Forced shutdowns during practical exercises and routine reactor start-ups were anticipated, since they are a part of educational process and training. The cause of most forced shutdowns was errors at switchover of the nuclear instrumentation linear channel meter. During shutdowns, the rated reactor power was not exceeded.

There were no violations of the operational limits and conditions from the Safety Analysis Report in 2012. There were also no events that would require reporting to the SNSA in 2012.

Operational indicators for acquired doses of the operating staff and experimenters show values far below the regulatory limits. The collective dose was 32 man μSv for operating staff and 189 man μSv for personnel who carry out the works at the reactor (operating staff, members of the radiation protection unit, experimenters).

In 2012, the SRPA performed an inspection at the Reactor Centre in cooperation with the SNSA, which dealt with procedures relevant to the reviews of the controlled area of the TRIGA reactor.

Nuclear Fuel

In 2012, 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 percent of uranium content and 20 percent enrichment. Control measurements of radioactivity in the reactor building and in the reactor coolant showed that no fuel elements were damaged. An inspection of 30 fuel elements from reactor core was carried out. The institute reported monthly on the fuel balance to the EURATOM and the SNSA.

Modifications, inspections of the systems, structures and components of the nuclear facility, fire safety and physical security

In 2012, no changes were made to the safety analysis report of the TRIGA reactor. Nine reactor core modifications were made for the experimental purposes of the institute's nuclear physics department and for pulsing operation for students.

Institute personnel and authorized external organizations conduct periodic inspections and periodically control the safety of relevant structures, systems and components (SSC). The inspection did not find any deficiencies.

The periodic safety review of the research reactor TRIGA and the hot cell facility continued. The operator reported on the timely progress of the periodic safety review and issued one topical report on the review.

In 2012, the administrative procedure was conducted to update the Safety Analysis Report of the TRIGA Mark II Research Reactor. The procedure will continue in 2013.

International mission INSARR

In November 2012, the international mission INSARR (Integrated Safety Assessment for Research Reactors) performed a safety review of the TRIGA Reactor. The mission is described in more detail in Chapter 9.2.

2.1.3 The Central Storage for Radioactive Waste in Brinje

Central Storage for Radioactive Waste (CSRW) at 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 working measuring equipment and utilities were carried out as planed.

As the operator of a nuclear facility, the ARAO prepared in 2012 a decommissioning program for the CSRW and the assessment of fire hazard. The ARAO also revised documents on the analysis of radiation hazards in case of scattered radioactive waste and fire in the CSRW.

In October 2012, an exterior wall was reconstructed to prevent the water flowing into the entrance hall of CSRW at the junction of the wall and the pipe with the optical installation.

The CSRW accepted 93 packages of radioactive waste from 63 producers, namely four packages of solid waste, 22 packages containing sealed radioactive sources and 67 packages with ionization smoke detectors. The total volume of the waste was 1.8 m^3. At the end of 2012, there were 742 packages stored in the CSRW, namely:

- 418 packages of radioactive waste (solid waste, sorted according to the compressibility, burn, shape and size),
- 152 packages containing sealed radiation sources,
- 166 packages with ionization smoke detectors,
- 6 packages of mixed waste from medicine.

At the end of 2012, there was 89.1 m^3 of the stored waste with the total estimated activity of at 3.1 TBq and a total weight of 49.1 tons in the storage.

2.1.4 The Former Žirovski Vrh Uranium Mine

In the area around Žirovski vrh, the excavation of uranium ore took place from 1982 to 1990. The ore was processed into uranium concentrate. Mill tailings were disposed of on the Jazbec mine waste pile and hydrometallurgical tailings were disposed of on the Boršt site. In 1990, after the exploitation of uranium ore was temporarily stopped and subsequent decision on permanent cessation was made, the process of the remediation of mining and its consequences has started. More information on remediation activities due to former mining activities at the Žirovski vrh can be found in Chapter 5.5.

2.2 Radiation Practices and the Use of Sources

Ionizing Radiation Protection and Nuclear Safety Act requires an advanced notification of intention to carry out radiation practice or intended use of a radiation source, the evaluation of 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 the registration of radiation sources. The competent authority for licensing in the area of industry and research is the SNSA, while the competent authority in the area of medicine and veterinary medicine is the Slovenian Radiation Protection Administration (SRPA). Despite the fact that licence holders are periodically notified about the expiry of their licences, some of them still do not apply for the renewal in due time and do not inform the SNSA about changes regarding the radiation protection officers. Prescribed supervision of radiation sources is exercised by authorized experts, either the Institute of Occupational Safety or the Jožef Stefan Institute.

One of the licensing documents is an evaluation of the protection of exposed workers against radiation, which has to be approved by the SRPA. In the document, the nature and the extent of radiation risk for exposed workers, apprentices and students are assessed in advance. In addition, a programme for the optimization of radiation protection measures in all working conditions is drawn up on the basis of this assessment. The document must be prepared by the applicant, who is obliged to consult an approved radiation protection expert. The evaluation can also be prepared by an authorized expert in this field. In 2010, the SRPA approved 173 such evaluations. An examination of radiation sources according to the legislation is conducted by the authorized radiation protection experts

2.2.1 Use of Ionizing Sources in Industry and Research

In 2012, the SNSA issued 60 licences to carry out radiation practices, 85 licences for the use of a radiation source, 5 certificates of registration of radiation sources, 8 approvals to the external operators of radiation practices, 5 decisions to terminate the validity of licences to carry out radiation practices, 3 decisions to seal an X-ray device, and 1 decision on conditional clearance regarding radioactive material. The SRPA approved 52 evaluations of the protection of exposed workers against radiation and 5 approvals for operators of radiation practices in nuclear and radiation facilities.

At the end of 2012, based on the registry of radiation sources, 129 organizations in industry, research and state administration in the Republic of Slovenia were using 238 X-ray devices; 778 sealed sources were used in 84 organizations. As many as 67 radioactive sources intended to be handed over to the Agency for Radwaste Management in the future have been stored at 23 organizations.

Maintaining and updating the registries are crucial for the efficient control over radioactive sources. Due to the increased number of recorded radioactive sources, the existing system is becoming more and more inefficient and can not be thoroughly updated due to lack of financial resources.

Ionization smoke detectors, comprising isotope ^{241}Am, form a special group of radiation sources. According to the registry of radiation sources, 25,253 ionization smoke detectors were used at 296 organizations by the end of 2012. 315 ionization smoke detectors were stored on user's premises.

In the last few years, the SNSA has put a lot of effort into registering all ionization smoke detectors and now calls on all users to notify the SNSA about their use. The success of this effort can be seen in the increasing number of detectors registered and of those transferred to the Central Storage for Radioactive Waste. Tens of proposals for inspection control were submitted, in particular for those companies which dealt with or have been dealing with the radiation practice of maintaining (mounting, dismounting) ionization smoke detectors. By the end of 2012, as many as 12 different companies obtained the licence to carry out such radiation practice.

In one case of transfer of old ionization smoke detectors in Central Storage for Radioactive Waste, the ionization smoke detectors which primarily used radionuclide ^{239}Pu of Russian producer and had an individual activity about 37 MBq were recognized. Since they are considered as nuclear material, the Agency for Radwaste Management reported to the European

Commission. It was found in the SNSA archives that ionization smoke detectors of this type were used in more than 30 facilities in Slovenia. Due to lack of funds, the SNSA can not launch a large scale campaign to identify the facilities in which such smoke detectors could be located and order their safe removal and storage in Central Storage for Radioactive Waste.

The distribution of application of radioactive sources according to their purpose and mode of use, excluding X-ray devices and ionization smoke detectors, is shown in Figure 12.

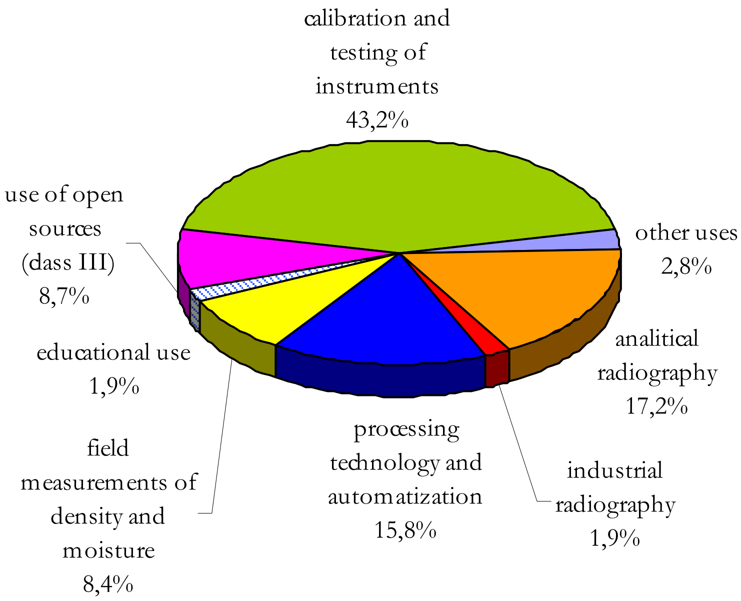

Figure 12: Distribution of application of radioactive sources according to their purpose and mode of use

2.2.2 Inspections of sources in industry, research and education

In 2012, altogether 52 inspections were conducted, among them two inspections of the transport of nuclear fuel and radioactive materials related to activities of a research reactor in Vienna.

Two inspections were exceptional. In the company Temat d.o.o., an operator of the x-ray device used in industrial radiography entered a laboratory when the machine was in operation. In only a few seconds, the operator received the effective dose which was a few times higher than a dose constraint applicable for such practice and valid for a period of one month. At company Union d.d., an operator was replacing the x-ray tube in a liquid level meter. The unprofessional replacement was the cause for the exposure, because the x-ray beam was directed toward the operator.

In 2012, the inspection conducted 10 inspections related to the servicing and storage of smoke detectors using ionising radiation. The collaboration with the Agency for Radwaste Management (ARAO), which stores all radioactive waste in the Central Storage for Radioactive Waste (CSF), was very close. The inspection unit continued with systematic inspections of companies approved for measurements of radioactivity in shipments of scrap metal.

Altogether, 13 inspections of the SNSA inspection unit were associated to interventions in 2012. Also, two on-site inspections were carried out.

In the company Štore Steel d.o.o., the accident happened during technological process. Melted materials were accidentally poured all over a radioactive source holder. During the accident, the holder collimator was open and the operators could not close it. Later, the damaged holder was replaced by the company Berthold Technologies, which provided maintenance to the steel producer.

The company Dinos d.d. found one smoke detector using ionising radiation in the scrap metal. The company workers put the detector in a plastic bag and kept it in a holder used for this purpose. Measurements carried out by the ARAO showed no contamination. The radioactive waste with activity of 2.7 MBq of ^{241}Am was stored in the CSF by the ARAO. Figure 13 shows the preparation of radioactive waste, which was carried out by two ARAO workers.

Figure 13: Preparation of radioactive waste (Photo: the ARAO)

The company Dinos d.d. also detected enhanced dose rate at its premises in Naklo. The dose rate was measured at the surface of a bag with scrap materials. The expert found a military gyroscope and dial, which were contaminated with radioisotope ^{226}Ra. The experts carried out decontamination due to the parts and fragments of both items and prepared radioactive waste which was stored in the CSF by the ARAO.

Italian experts found ^{152}Eu source with a dose rate of about 7 mSv/h at the contact. The source was found in the cargo of the company Brandal d.o.o. from Postojna. Altogether, 14 tons of scrap steel and lead were loaded. The source was stored by a company in Italy.

Five interventions were related to the source of ionising radiation or radioactive waste from abroad. Companies and customs detected a source by instruments and informed the SNSA. A source was sent back to a consigner without any delay. The SNSA informed regulatory authorities of the neighbouring countries. Sources were transported by road or by train. The consigners were situated in Bosnia and Herzegovina, Czech Republic, Croatia, Hungary, and Serbia.

In 2012, there were four suspicions about the presence of a source or radioactive waste in a cargo. Later, these suspicions were not confirmed.

In 2012, the tight financial situation made the work of the SNSA inspection unit difficult. The condition of the necessary equipment became worse, i.e. condition of the car, of the computer equipment and of the protection equipment. The possibilities to take part in additional educational expert courses decreased. Smaller financial resources also required reducing the continuous preparedness, which is necessary to carry out interventions. Preparedness of inspectors is also a part of the emergency preparedness in a case of radiological or nuclear accident. Despite that the inspection unit assured protection of a general public and the environment against ionising radiation.

The inspection of activities with ionising sources concerning protection of workers is carried out by the Slovenian Radiation Protection Administration (SRPA). In 2012, four inspections were carried out. The inspection in company Zarja elektronika d.o.o., Kamnik, was related to the contamination with ^{241}Am, which occurred when smoke detectors using ionising radiation were being dismantled. Since this was not the first time that such contamination occurred at the site, the revision of the document Assessment of Radiation Protection of Exposed Workers was proposed. In companies Pivovarna Union d.d. and Temat d.o.o. as well as in the Slovenian National Building and Civil Engineering Institute, the inspections were carried out in collaboration with the SNSA inspectors. All these inspections were initiated by high readings of personal dosimeters of workers. A written order was issued to Pivovarna Union d.o.o. to assure the accurate assessment of doses received by workers, as well as to carry out an exceptional medical exam and to review the document Assessment of Radiation Protection of Exposed Workers. Due to a delay in the process, the written order related to the execution was also issued.

A verbal as well as a written order prohibiting the work of the worker involved were issued to Temat d.o.o. The duration of the prohibition was connected to the validity of worker's medical exam, which had to be positive in order to remove the prohibition. A written order on changing the document Assessment of Radiation Protection of Exposed Workers was also issued.

At the Slovenian National Building and Civil Engineering Institute, only a dosimeter was exposed, so no worker received additional dose. The warring was issued.

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 data from the registry of the Slovenian Radiation Protection Administration, 907 X-ray devices were used in medicine and veterinary medicine by the end of 2012. The categorization of X-ray devices based on their purpose is given in Table 3.

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

Purpose	Status 2011	New	Written off	Status 2012
Dental	440	34	12	462
Diagnostic	264	17	16	265
Therapeutic	10	0	0	10
Simulator	3	0	0	3
Mammography	37	3	4	36
Computer tomography CT	26	1	1	26
Densitometers	46	2	2	46
Veterinary	54	6	1	57
Total	**880**	**63**	**36**	**907**

In the field of the use of X-ray devices in medicine and veterinary medicine in 2012, the SRPA granted 109 licences to carry out a radiation practice and 214 licences to use X-ray devices. Also, 123 confirmations of the programmes of radiological procedures and 110 confirmations of the evaluation of protection of exposed workers against radiation were issued.

In medicine, 443 X-ray devices were used in private dispensaries and 405 in public hospitals and institutions. The average age of the X-ray devices was 9.1 years in public sector, which is the same as 2011, and 9.2 years in the private sector, which is an increase from 8.8 years in 2011. In veterinary medicine, 50 devices were used in private dispensaries and 9 in public institutions. The average age of the X-ray devices in veterinary medicine was 13.8 years in the public sector, which is an increase from 13.4 years in 2011, and 8.0 years in the private sector, which is an increase from 7.5 years in 2011. A detailed classification of X-ray devices in medicine and veterinary medicine according to their ownership is given in Table 4.

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

Owner -ship	Diagnostic		Dental		Therapeutic		Veterinary		Total	
	No. (%)	Age (y)	No. (%)	Age (y)	No. (%)	Age (y)	No. (%)	Age (y)	No. (%)	Age (y)
Public	298 (79 %)	9.3	96 (21 %)	8.4	11 (100 %)	8.7	9 (15 %)	13.8	414 (46 %)	9.2
Private	77 (21 %)	9.6	366 (79 %)	9.1	0	0	50 (85 %)	8.0	493 (54 %)	9.1
Total	**375**	**9.3**	**462**	**9.0**	**11**	**8.7**	**59**	**8.9**	**907**	**9.1**

All X-ray devices are examined by approved radiation protection experts at least once a year. The devices are classified, with regard to their quality, into the following groups: »perfect«, »service required«, »disuse proposed« and »out of order«. The analysis of data for recent years is presented in Figure 14. It shows that more than 95 % of devices were classified as »perfect devices« in the last five years.

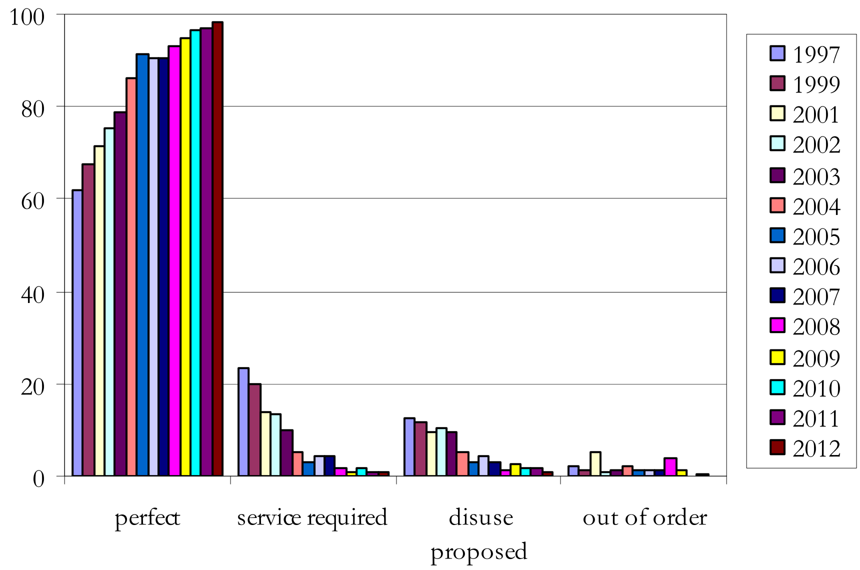

Figure 14: Percentage of diagnostic X-ray devices according to their quality for the period 1997–2012

In 2012, 11 in-depth inspections of the use of X-ray devices in medicine and veterinary medicine were carried out. On the basis of inspection findings, a decision was issued demanding compliance with existing regulations in 6 cases. In 4 cases, the equipment was sealed to prevent the potential use of equipment kept in reserve.

Based on the review of inspection reports on X-ray devices for medical use, sent to the SRPA by approved technical support organisations, 8 inspections were conducted during which the SRPA requested the user to provide evidence that the noted shortcomings were eliminated. 21 cases in which the user was asked to present evidence relating to the termination of the use of an X-ray device and 98 procedures with the requirements to comply with the applicable legislation were performed.

Unsealed and Sealed 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 near Gorica, use unsealed sources (radiopharmaceuticals) for diagnostics and therapy in their nuclear medicine departments. In nuclear medicine departments, altogether 6,923 GBq of isotope ^{99}Mo, 2,852 GBq of isotope ^{18}F, 1,010 of isotope ^{131}I, and minor activities of isotopes ^{177}Lu, ^{123}I, ^{201}Tl, ^{90}Y and ^{111}In were applied for diagnostics and therapy. Isotope ^{99}Mo is used as a generator for isotope technetium ^{99m}Tc, which is extracted at nuclear medicine departments and used for diagnostics. From the initial activity of ^{99}Mo, approximately three times higher activity of ^{99m}Tc can be eluted in one week.

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, 3 sources of ^{192}Ir, one of them with initial activity of 440 GBq and two with initial activity of 47 GBq, and 3 sources of ^{90}Sr (initial activities up to 740 MBq) are used. At the Clinic of Ophthalmology, 5 sources of ^{106}Ru with initial activities up to 37 MBq for were used for treating eye tumours. At the Blood Transfusion Centre of Slovenia, a device with ^{137}Cs with the initial activity of 49.2 TBq is used for irradiation of blood components.

Sealed sources of minor activities are used for the operational testing of various devices and measurement equipment at some nuclear medicine departments. The SRPA registry shows that there are still 1,933 ionization smoke detectors with ^{241}Am in 18 medical facilities.

In 2012, the following documents with reference to the use of unsealed and sealed source in medicine were issued: 4 licences to carry out radiation practice, 3 licences to use radiation sources in medicine, 4 confirmations of the evaluation of protection of exposed workers against radiation, 2 confirmations of radiological procedures' programmes, 1 permission for the import of radioactive materials, 19 statements on the shipments of radioactive materials from EU member states and one certificate of compliance with criteria for practices involving radiation workers employed by a foreign legal person. No open or sealed radioactive sources were used in veterinary medicine in 2012.

Medical departments with unsealed and sealed radiation sources were surveyed by the approved experts for radiation protection and medical physics. No major deficiencies were found, but the dose constraint was exceeded in one case.

In addition to the expert reviews, the SRPA inspectorate also carried out three inspections, one at the Clinical Institute for Clinical Chemistry and Biochemistry, one at the Institute of Oncology and one at the General Hospital in Izola.

Inspection at Clinical Institute for Clinical Chemistry and Biochemistry focused on facilities, radiation sources, workers, IOS reports and solid radioactive waste containing ^{125}I. A decision of conditional clearance of radioactive waste was issued. The overview of the General Hospital in Izola dealt with smoke detectors, the situation in nuclear medicine and instructions for the management of radioactive waste. In this case, appropriate warnings were issued. The inspection at the Institute of Oncology dealt with workers, IOS reports, records of radiation sources, facilities, and internal rules for handling unsealed and sealed radiation sources. The inspector suggested that internal rules should be updated.

2.2.4 Transport of radioactive and nuclear materials

Transport of radioactive and nuclear materials is regulated by the Act on 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 2012, SNSA issued one approval for transport under special arrangement to Agency for Radioactive Waste for transport of spent sealed sources in a form of liquid level measurement devices from the producer Kemiplas, d.o.o. to Central Storage Facility in Brinje.

The Ionizing Radiation Protection and Nuclear Safety Act, which was amended in 2011, now defines the transport of radioactive materials as a radiation practice. Thus, the transport of radioactive materials is allowed only if the licence to carry out radiation practice has been obtained, which is a similar arrangement to that for the transport of nuclear material. From the enforcement of amendments, the SNSA systematically treats such transportation as radiation practice, when it comes to prolonging or amending a licence or issuing a new licence for carrying out radiation practice for carriers of such materials and companies that use radioactive sources on the field.

In 2012, the SNSA also considered an endorsement of packaging for the transport of fresh fuel for the NPP Krško and two packagings for the transport of nuclear material for an Austrian research reactor. More information on the transport of nuclear materials for an Austrian research reactor can be found in Chapter 2.2.5.1. The packaging for transport of nuclear material is approved by the minister, competent for the environment.

2.2.5 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 for the shipment of radioactive material between EU Member States.

In 2012, the SRPA issued one permit for the import of radioactive sources from non EU countries and approved 19 forms of the consignees of radioactive material for a total of 31 isotopes. Each isotope from an individual producer intended for the same end user is counted separately.

In 2012, the SNSA approved 11 forms of the consignees of radioactive material from other EU Member States. The SNSA also issued 5 permits for the import of radioactive material; 4 permits for multiple import; one permit for the shipment of contaminated equipment in the EU Member States and one permit for the shipment of contaminated equipment out of EU Member States, as well as and one permit for import and export of contaminated equipment; one permit for the export of radioactive material; and two licenses for the transit of nuclear material for Austrian research reactor. More information on the last two shipments can be found in Chapter 2.2.5.1.

In 2012, the SNSA also issued three licenses for the transits of radioactive sources with important activity, namely for the transit of ^{60}Co with the activity of almost 4 PBq from Hungary to Jordan, the transit of new sources of ^{60}Co from Germany to Croatia with a total activity of 203 TBq, and the transit of spent ^{60}Co sources from Croatia to Germany with a total activity of nearly 70 TBq.

The shipments of radioactive waste and spent nuclear fuel among EU Member States as well as among EU Member States and third countries are regulated in the Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and spent fuel. In 2012, the SNSA issued one authorization for the shipment of radioactive waste to

Sweden for its conditioning, two consents for the return of radioactive waste, and one consent for the transit of spent fuel.

2.2.5.1 Shipments of nuclear material for the research reactor TRIGA in Austria

As a part of non-proliferation activities, highly enriched uranium and fresh or spent nuclear fuel have been returned to the countries of origin, namely the USA or Russia. for many years. Slovenia contributes to these efforts by allowing such shipments to pass through the country.

The last two similar transits of nuclear material took place in October and November 2012. In the first shipment, there were 77 slightly irradiated fuel elements with a total mass of 15 kg of uranium for the use in the Austrian research reactor TRIGA from Vienna. The second shipment contained 82 irradiated fuel elements with low enriched uranium and 9 fuel elements with highly enriched uranium with a total mass of 16 kg of uranium, which the same reactor in Vienna returned to the country of origin, the USA. In the last shipment, there was also a Pu/Be source with a mass of about 112 g, destined to the same consignee. Both shipments were transported with trucks by road through the border crossing Šentilj to the Port of Koper, where the consignment was transferred to a ship (Figure 15).

Preparations for the shipments lasted a few months. They were highly coordinated and professionally involved the following national authorities and companies: the SNSA, the Ministry for the Interior, the Police, the SRPA, the Customs Administration, the Ministry of Infrastructure and Spatial Planning, the Port of Koper d.d., the Jožef Stefan Institute, and the main Slovenian organizer, the company NJK IMP, d.o.o., from Koper. Both shipments between Vienna and USA were coordinated by the American Department of Energy and Austrian state organizations. They were carried out by companies EDLOW International and Nuclear Cargo + Service. All costs were covered by the foreign organizers.

The SNSA verified the adequacy of endorsed packagings for nuclear material and issued two consents to the physical protection plans, two approvals for the carrier to act on behalf of the user of nuclear material in relation to the insurance for responsibility for nuclear damage, a license to perform radiation practice – transportation of nuclear material, consent for the transit of spent fuel according to the Council Directive 2006/117/EURATOM on the supervision and control of shipments of radioactive waste and spent fuel, and two transit licenses. The Police and the Ministry of the Interior have prepared the threat assessment for the material in transport and approved two Physical Protection Plans that were prepared for the carrier Nuclear Cargo + Service form Germany by the company NJK IMP, d.o.o.

Figure 15: Transfer of container with the Austrian consignment on the ship in the Port of Koper

3 RADIOACTIVITY IN THE ENVIRONMENT

Protection against ionizing radiation is implemented for three categories, namely radiation workers, patients in medical diagnostics that use radiation, and the general population. Protection of the population is ensured by the competent authorities through measuring radioactivity throughout Slovenia, with special attention to the protection of populations living in the vicinity of nuclear and radiation facilities.

The main purposes of radioactivity monitoring in the environment are monitoring the levels of radioactive contamination, following trends in concentrations of radionuclides in the environment, and providing timely warning in case of sudden increases in radiation levels in Slovenia.

Radiation protection of the population is ensured through the on-line monitoring of external radiation levels and of 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 the laboratory measurements.

Supervision of nuclear and radiation facilities is carried out through operational monitoring; its programme is drawn up by the competent authority, whereas the operator is liable for the implementation of this programme. The control of emissions from all facilities and the extent of radioactivity in the surrounding areas are covered by this programme. Sampling and measurements of samples are carried out by accredited technical support organizations, which are in turn authorized by competent administrative authorities.

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 controlled. Doses to 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. Received doses for the population should be lower than the dose constraints set by the competent administrative authority.

The monitoring of radioactivity in the environment that is a result of global contamination from the Chernobyl nuclear accident and past nuclear testing has been carried out in Slovenia for over five decades and mainly involves tracking long-lived fission radionuclides ^{137}Cs and ^{90}Sr by different transmission pathways.

This chapter contains a summary of reports on the state of environmental radioactivity on the territory of Slovenia in 2012.

3.1 Early Warning System for Radiation in the Environment

An automatic on-line warning system for environmental radioactivity is 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. In case 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 Slovenian thermal power plants. Data are collected at the SNSA, where they are constantly analysed, archived and displayed on the internet for the public. If the values are elevated, an automatic alarm is sent to the officer on duty. In 2012, there were no events that would trigger an alarm due to increased radiation in the environment.

Since 1997, the SNSA has been sending data from the Slovenian early warning system to the European system EURDEP with its centre 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, Slovenian data are daily exchanged with the centres in Vienna (Austria), Zagreb (Croatia) and Budapest (Hungary).

3.2 Monitoring of 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 and drinking water, as well as in foodstuffs and feedstuffs. Part of the monitoring programme related to the radioactivity of surface waters also includes periodic control of the river water contamination with ^{131}I due to the use of this radionuclide in medicine. Other natural gamma emitters are also measured in all samples, while in drinking water and precipitation, the levels of tritium (^{3}H) are additionally measured.

The results for 2012 showed that concentrations of both long-lived fission products in samples of air, precipitation, soil, milk, foodstuffs of vegetal and animal origin, and feedstuffs continued to slowly decrease and were in most cases already lower than before the Chernobyl accident. At the time of the Chernobyl accident, approximately five-times higher contamination (20–25 kBq/m^2) was measured on average in Slovenia, compared to the total contribution of all nuclear bomb tests in the past. The highest contamination of the soil was measured in the Alpine and forest regions, which indirectly contributes to the enhanced contents of these two radionuclides in areas of Alpine pastures (milk and cheese) and forest ecosystem (forest fruits, mushrooms and game). Concentrations of tritium in liquid samples, namely from surface waters, precipitation and drinking water, decrease very slowly, by only few percents per year.

In Slovenia, 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 atmosphere and in precipitations 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 2012, the effective dose from external radiation of ^{137}Cs (mainly from the Chernobyl accident) was estimated at about 7.7 μSv, which is 0.32 % of the dose received by an average adult in Slovenia from natural background radiation. This value is similar to the one that was measured and calculated for the previous year (7.0 μSv).

The annual dose from the ingestion pathway (consumption of food and drinking water) was 1.5 μSv, which is comparable with doses in previous years. The dose for 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 16). The contribution of the ^{90}Sr to the annual dose due to ingestion is 67%, while the contribution of the ^{137}Cs to the annual dose is 33%. The annual contribution due to the inhalation of both radionuclides is only about 0.001 μSv, which is negligible when compared to the radiation exposure from other transfer pathways. The effective dose for drinking water, taking into account artificial radionuclides, was also estimated. Calculations have shown that on average this dose was around 0.047 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 2012, the total effective dose of an adult individual in Slovenia arising from the global contamination of the environment with artificial radionuclides was estimated at 9.2 µSv, as shown in Table 5. This is approximately 0.4% of the dose compared to the annual exposure of 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, results differ considerably from year to year. Most importantly, these values are far below the limit values.

Table 5: Radiation exposure of the adult population in Slovenia due to global contamination of the environment in 2012

Transfer pathway	Effective dose [µSv per year]
Inhalation	0.001
Ingestion (food and drinks):	
drinking water	0.047
food	1.5
External radiation	7.7*
Total (rounded)	**9.2****

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

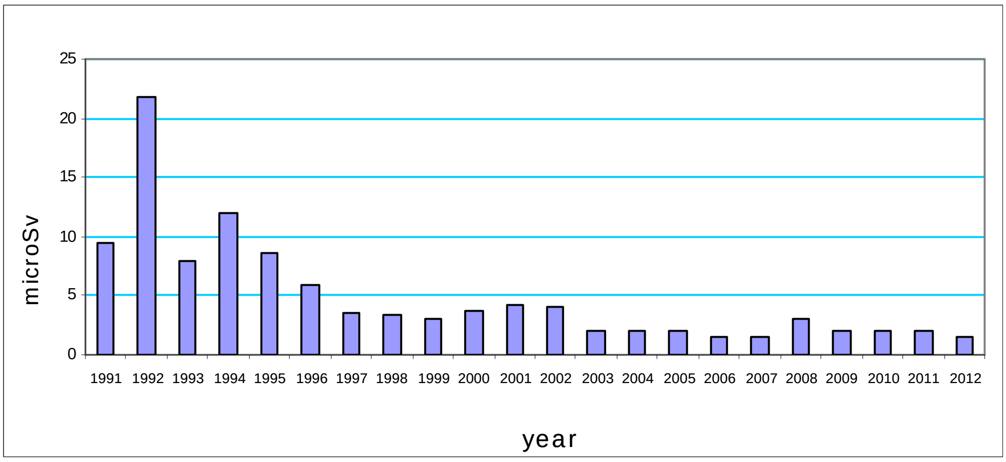

Figure 16: Annual effective doses to members of the public received by ingestion due to global radioactive contamination of the environment with the radionuclides ^{137}Cs and ^{90}Sr in Slovenia

The reason for 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 discharges radioactive substances into the environment is required to be subjected to the control. Radioactivity measurements in the surroundings of the installations must be performed in the pre-operational period, during operation, and for a certain period after the installation ceases to operate. The goal of operational monitoring is establish whether the discharged activities are within the authorized limits, whether radioactivity concentrations in the environment are inside the prescribed limits and whether population exposure is 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 measuring of gaseous and liquid radioactive discharges and by carrying out radioactivity measurements of environmental samples. The measured values of analysed radionuclides in environmental samples, namely 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 are therefore evaluated only on the basis of data on gaseous and liquid discharges. Discharge data are used as an input for modelling the dispersion of radionuclides to the environment. Low results of environmental measurements 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 for immediate sampling and analysis of contaminated samples.

In 2012, 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 authorized performers of radioactivity monitoring, the Jožef Stefan Institute (JSI) and the Institute of Occupational Health (IOS).

3.3.1.1 Radioactive discharges

In 2012, the total activity of noble gases released to the atmosphere was 1.42 TBq, which resulted in the public exposure of 0.13 μSv or 0.26% of the limit (set at 50 μSv per year). Calculated doses depend on dilution coefficients and composition of discharged noble gases. The released activities of iodine isotopes in 2012 were 10.9 MBq, which is 0.04 % of the annual limit. This is comparable to the years with refuelling outages. The activity of dust particles was 0.18 MBq, which is 0.001 % of the limit. The activity of alpha emitters was below the detection limit. Discharges of tritium into the atmosphere caused a slight increase of the ^{3}H activity in gaseous releases due to the improvements of sampling method and laboratory analysis. The release level of the ^{3}H is expected to stabilize in the upcoming years. The activity of ^{14}C corresponds to the values that are typical for the years without refuelling outages.

In liquid discharges from the plant to the Sava River, the tritium (^{3}H), bound to the water molecules, prevails. The total released activity of ^{3}H in 2012 was 16.6 TBq, which is 36.9 % of the annual regulatory limit (45 TBq). The value is comparable to the values from years with the refuelling outage. Because of its low radiotoxicity, this radionuclide is radiologically less important despite having a higher activity compared to other radioactive contaminants. The total discharged activity of fission and activation products was higher than last year due to the refuelling outage and unplanned automatic shutdown. It amounted to 100 MBq, which represents 0.1 % of the annual operational limit value (100 GBq).

3.3.1.2 Environmental radioactivity

The monitoring programme of environmental radioactivity from the abovementioned discharges comprises the following measurements of 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 agricultural and animal origin (including milk),
- in soil on cultivated and uncultivated areas,
- measurements of ambient dose equivalent of external radiation 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 a global contamination and not a result of plant operations. The measurable contribution of the plant operations results in higher concentrations of tritium (^{3}H) in the Sava River downstream of the plant. As in previous years, the measurements of water from the Sava River showed an increase of the ^{3}H concentration, which is a result of liquid effluents of the Krško NPP. An annual average concentration of ^{3}H (5.4 ± 2.0 kBq/m^3), measured at Brežice, was eight times higher than the average measured concentration (0.70 ± 0.03 kBq/m^3) at the reference site in Krško (in front of the paper mill) and higher than in 2011 (1.4 ± 0.2 kBq/m^3). A direct correlation between ^{3}H discharges and ^{3}H concentration in underground water can be seen from the data from the VOP-4 and Medsave boreholes, where maximum measured values correspond to higher discharges from the Krško NPP. Measured average annual ^{3}H concentrations in the water from other boreholes, pipelines and water catchments are comparable with those measured in previous years, which means that the Krško NPP has negligibly small or no influence. The concentrations of other artificial radionuclides discharged to the Sava River (^{60}Co and others) were below the detection limits in all samples. The measured concentrations of radioisotope ^{131}I in the Sava River could be caused by discharges from the clinics of nuclear medicine in Ljubljana and Celje, not by the operations 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 tritium and ^{14}C. The highest annual dose was received by adult individuals due to the intake of ^{14}C from vegetable food ingestion (0.03 μSv only from ingestion of local apples), while a ten-fold lower dose was received due to the inhalation of tritium. The dose assessment of liquid discharges in 2012 showed that their additional contribution to the population exposure was very low, at less than 0.02 μSv per year. The levels of external radiation in the immediate vicinity of some structures of the NPP were higher than in the natural surroundings, but the plant's contribution is hardly measurable at the perimeter fence. It was estimated that the plant-related external exposure was less than 0.3 μSv per year. This estimation is similar to those in recent years and it is now based on more realistic data than in the first period of plant operation, when the estimated values of external dose were higher by at least one order of magnitude.

Table 6 clearly shows that the total effective dose for an individual who lives in the surroundings of the Krško NPP is less than 0.3 μSv per year. The contribution of ^{14}C ingestion is higher than in 2011, because most of the releases occurred during the annual outage, when all crops have not yet been picked. This value represents less than 0.4 % of the authorized limit value (dose constraint of 50 μSv per year) or less than a ten thousandth of the effective dose received by an average Slovenian from natural background radiation (2,500–2,800 μSv per year).

Table 6: Assessment of partial exposures of adult member of the public due to atmospheric and liquid radioactive discharges from the Krško NPP in 2012

Type of exposure	**Transfer pathway**	**Most important radionuclides**	**Effective dose [μSv per year]**
External radiation	Cloud immersion Deposition	Noble gases (^{41}Ar, ^{133}Xe, ^{131m}Xe) Particulates (^{58}Co, ^{60}Co, ^{137}Cs, …)	0.007 <2E-9
Inhalation	Cloud	^{3}H, ^{14}C	0.0054
Ingestion (atmospheric discharges)	Vegetable food	^{14}C	0.29*
Ingestion (liquid discharges)	Drinking water (the Sava river)	^{3}H, ^{137}Cs, ^{89}Sr, ^{90}Sr, ^{131}I	<0.02*
Total Krško NPP in 2012			**<0.3****

* The total amount of Krško NPP contributions is not listed, since all contributions can not be simply summed up because of different reference groups of the population.
** This assessment did not take into account that the person spent 20% of the time outdoors and that the shielding factor for being in a house is 0.1.

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, potential radioactive discharges at this location come from the operation of the reactor, from the Central Storage for Radioactive Waste and from the work in the laboratories. The operation of the facilities was stable and there were no incidents that would result in radioactive material being released to the environment; thus the results of the operational monitoring for 2012 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 air and underground water, as well as measurements of external radiation, radioactive contamination of the soil and radioactivity of the Sava River sediments.

Measurements of radioactive aerosol discharges into the atmosphere showed results below the detection limit. Discharges of ^{41}Ar to the atmosphere, calculated on the basis of the reactor operation time, were estimated to 0.9 TBq in 2012, 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 the radiation from the cloud on an individual because of the ^{41}Ar discharges was estimated 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 for only 10 % of his time. An inhabitant of Pšata village who lives at a distance of 500 m from the reactor receives 0.46 μSv per year. For the dose assessment for individuals for liquid discharges, a conservative assumption was used. If the river water is ingested directly from the recipient River Sava, the annual exposure is estimated to 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 authorized dose limit of 50 μSv per year. The total annual dose for an individual from the public in 2012, irrespective of the model used, is still more than thousand times lower than effective dose from the natural background in Slovenia, which is from 2,500 to 2,800 μSv per year.

The monitoring programme of 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, coming from the stored ^{226}Ra sources), radioactive waste water from 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 distances from the storage, and as dry deposition on soil near the storage.

The estimated average radon emission in 2012 was 6 Bq/s, which is, taking into account the measuring uncertainty, similar to the emissions in 2009, 2010 and in 2011, as shown in Figure 17. The increase of radon ^{222}Rn concentrations in the vicinity of the storage was not measurable and was therefore estimated by a model for average weather conditions to be 0.3 Bq/m^3 at the fence of the reactor site. In the waste water from a drainage collector, the only artificial radionuclide measured was ^{137}Cs, which is a consequence of global contamination and not of storage operation. The concentrations of radionuclides were far lower than clearance levels and also lower than the derived concentrations for drinking water.

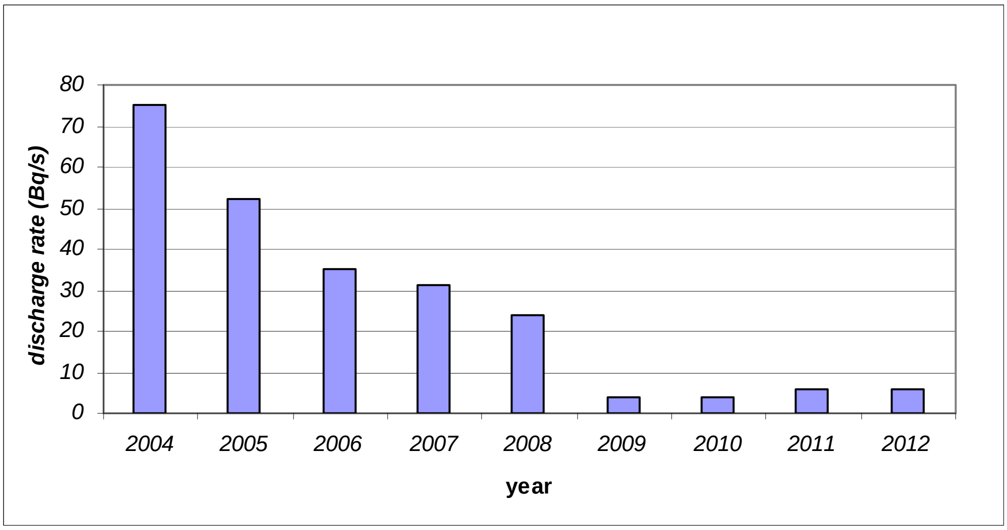

Figure 17: Emission rates of ^{222}Rn from the Central Storage for Radioactive Waste at Brinje

For the dose assessment of the most exposed members of the public, the inhalation of radon decay products and direct external radiation 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 2012, they received an estimated effective dose of 0.86 μSv, according to the model calculation. The security officer received about 0.4 μSv per year from his regular rounds, while the annual dose to the farmer adjacent to the controlled reactor area was estimated to be only about 0.02 μSv. These values are comparable with those in 2011 and are much lower than in 2008, mostly due to lower radon releases. Moreover, they are much lower than the authorized dose limit for individuals from the reference group of the population (100 μSv per year). The annual dose collected by an individual from natural background is 2,500–2,800 μSv.

3.3.3 The Former Žirovski Vrh Uranium Mine

The monitoring of environmental radioactivity of the former uranium mine at Žirovski Vrh, which is currently in the post-operational phase, consists of measuring radon releases, liquid radioactive discharges and concentrations of the radionuclides in the environment. An integrated programme of measurements is 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 Gorenja vas to Todraž. For the evaluation of the impact of uranium mining and milling, the relevant measurements of radionuclides of natural origin have to be carried out at reference points outside the influence of mine and repository discharges as an approximation for natural radiation background. The net contribution of radioactive contamination is assessed by correcting the measured values with regard to the natural background of the measured examined radionuclides.

In 2012, measurements of external gamma radiation in the vicinity of mine repositories and hydrometallurgical tailings repositories were performed in smaller extent as in years from 1992 to 2010. Some measurements were not performed in full range due to financial constraints. The most important part of the programme in 2012 was measuring the radon concentration, according to the additional contribution to the population dose from the uranium mine sources.

Radioactivity of surface waters has been slowly but steadily decreasing in recent years, especially ^{226}Ra concentrations in the Brebovščica, the main recipient stream, where the concentrations are already close to the natural background level, which was 4.3 Bq/m^3 in 2012. Only the concentrations of uranium ^{238}U in the Brebovščica stream (an average calculated from quarterly concentrations in 2012 was 169 Bq/m^3) are still increased, since all liquid discharges from the mine and from disposal sites flow into this stream. In 2012, the mine's contribution of radon ^{222}Rn from the repository sites and the mine to the natural concentrations in the environment is estimated at around 3.1 Bq/m^3.

The calculation of the effective dose for the population took into account the following exposure pathways: the inhalation of long-lived radionuclides from the decay series of uranium, radon and its short-lived progeny, ingestion, and external gamma radiation. Radiation exposure of an adult member of the public living in the vicinity of the mine was estimated at 0.099 mSv for 2012, which is almost the same as for the last year. The exposure is low because the restoration at the mine repositories at the Jazbec and Boršt sites was finished 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 0.066 mSv or two-thirds of the additional exposure in this environment (Table 7).

Table 7: Effective dose for an adult member of the public living in the surroundings of the former uranium mine at Žirovski Vrh in 2012

Transfer pathway	Important radionuclides	Effective dose [mSv]
Inhalation	– aerosols with long-lived radionuclides (U, ^{226}Ra, ^{210}Pb) – only ^{222}Rn – Rn – short-lived progeny	0.00 0.0016 0.066
Ingestion	– drinking water (U, ^{226}Ra, ^{210}Pb, ^{230}Th) – fish (^{226}Ra in ^{210}Pb) – agricultural products (^{226}Ra and ^{210}Pb)	(0.0108)* <0.0006 <0.03
External radiation	– immersion and deposition (radiation from cloud and deposition) – deposition of long-lived radionuclides (deposition) – direct gamma radiation from disposal sites	0.001 / /
Total effective dose (rounded):		**0.099 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 individual in 2012 due to the contribution of the former uranium mine is 50% lower than in 2007 and amounted to only one-tenth of the general limit value for the population, which is 1 mSv per year. The estimated dose was 0.145 mSv for a 10-year-old child and 0.133 mSv for a 1-year-old child. These values represent about 2% of the natural background dose in the environment of Žirovski Vrh during the operation of the mine, which was 5.5 mSv. Annual changes of effective doses due to the mine are shown in Figure 18.

Measurements and dose estimations for the last several years have shown that the environmental impacts and exposure of the population have decreased because of the cessation of uranium mining and the restoration works which have been already carried out. The estimated dose exposure is already only about one-third of the authorized dose limit of 300 μSv per year.

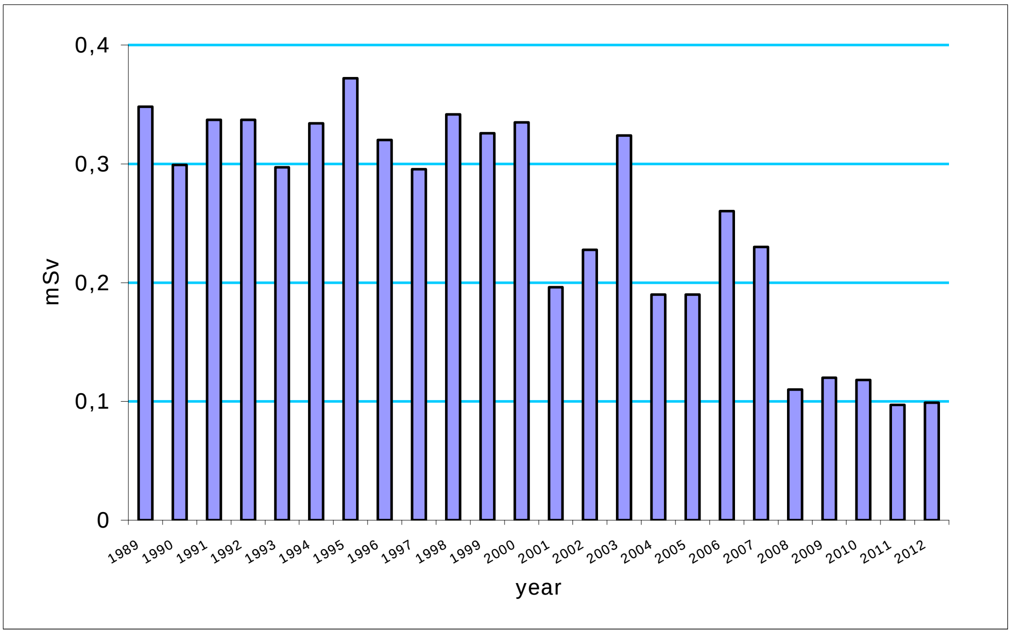

Figure 18: Annual contributions to the effective dose for an adult member of the public due to the former Žirovski Vrh uranium mine in the period 1989–2012

3.4 Radiation Exposures of the Population in Slovenia

Every inhabitant of the 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 radiation material enters the body by inhalation, ingestion of food and drink, 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 to a single individual on Earth is 2.4 mSv, varying from only 1 mSv to up to 10 mSv on different locations. The average annual dose from natural radiation sources for average member of the public in Slovenia is about 2.5 to 2.8 mSv per year. Higher values are found in areas with higher concentrations of radon in living and working environment. From 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 the 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 the external radiation from soil radioactivity, 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 environment

The Slovenian Radiation Protection Administration (SRPA) continued to implement the government program adopted in 2006 for systematic examination of living and working environment, as well as to raise the awareness of the population on 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 environment. On average, it contributes more than half of the effective dose received by individuals from all natural sources of ionizing radiation. It penetrates the premises mainly on ground level through various openings, such as manholes, drains, cracks or tears in the floor.

Through this program, 89 rooms in 65 buildings have been measured for radon and its progeny, mostly in kindergartens and schools. Effective doses for staff and children were estimated on the basis of the measurement results and the occupancy time in these buildings. Seven of the estimated annual doses exceeded the threshold of 6 mSv for the members of the public. The highest estimated dose was approximately 15 mSv. In 26 cases, estimated annual doses were between 2 and 6 mSv, in 17 cases between 1 and 2 mSv, and in 39 cases less than 1 mSv.

In 2012, the SRPA conducted six in-depth inspections of legal persons who operate facilities with increased levels of radon. In one case, the decision ordering measures to reduce radiation exposure was issued. The remediation was promptly undertaken and was finished in 2012.

3.4.3 Radiation exposure of population due to human activities

Additional radiation exposures due to the regular operation of nuclear and radiation facilities are usually attributed only to local populations. The exposures of particular groups of the population, which are a consequence of radioactive discharges from these facilities, are described in the Chapter 3.3. In Table 8, the annual individual doses are given for the maximum exposed adults from the reference groups for all objects in consideration. For comparison, an average annual dose for individuals, related to 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 at Žirovski Vrh. The exposures were estimated at a maximum of 5 % of the exposure from natural sources in Slovenia. In no case, the exposure of members of the public exceeds the dose levels defined by the regulatory limits.

The population is exposed to radiation also because of 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 mining and processing of raw materials containing uranium or thorium.

Table 8: Exposures of adult individuals from the general population due to the operation of nuclear and radiation facilities and due to general contamination in 2012

Source	Annual dose [mSv]	Regulatory limit [mSv]
Žirovski vrh Uranium Mine	0.099	0.300*
Chernobyl and nuclear weapon tests	0.0089	/
Krško NPP	< 0.0003	0.050**
TRIGA Reactor	0.00002	0.050
Central Storage for Radioactive Waste	0.00002	0.100

* Limitation after the final restoration of disposal sites.

** Due to radioactive discharges.

4 RADIATION PROTECTION OF WORKERS AND MEDICAL EXPOSURES

Due to occupational exposure, individuals can receive substantial doses of radiation. Therefore, organizations that carry out radiation practices should optimize working activities to decrease the dose of ionizing radiation to a level as low as reasonably achievable (ALARA). Exposed workers take part in regular medical surveillance programme and have to receive adequate training. The employer has to assure that the dose of ionizing 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 external exposure of all exposed workers and annually or semi-annually for internal exposures to radon.

The approved dosimetry services for 2012 were the Institute of Occupational Safety (IOS), the Jožef Stefan Institute (JSI) and the Krško Nuclear Power Plant (Krško NPP). Additionally, the approval was granted to the IOS to perform internal dosimetry for radon exposure in mines and Karst caves. Currently, 11,897 persons have their records in the central registry, including those who have ceased working with sources of ionizing radiation. In 2012, the dosimetric service at the IOS took measurements of individual exposures for 3,850 workers, whereas the JSI monitored 911 radiation workers and the Krško NPP 1,160 radiation workers. The Krško NPP performed individual dosimetry for 438 plant personnel and 722 outside workers, who received an average[1] dose of 0.79 mSv of ionizing radiation. As for other work sectors, the workers in industrial radiography received the highest average annual effective dose of 1.43 mSv from external radiation, while the employees in medicine received on average 0.30 mSv. The highest average value among these, 0.83 mSv, was recorded for workers in nuclear medicine.

In 2012, the highest collective dose from external radiation was received by workers in the Krško NPP (870 man mSv), followed by radiation workers in the medical sector (359 man mSv). The total exposure of workers in industry was 72 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 2012, the collective dose for 18 workers in foreign NPPs was 44 man mSv (the average dose of 2.45 mSv). This group of workers otherwise received the highest individual dose from external radiation. Workers who take part in outages in nuclear power plants abroad are usually also involved in outage works at the Krško NPP and perform industrial radiography. In Table 9, their doses are included in different categories, so the total individual doses can not be seen. The most exposed individual in this group received an annual dose of 10 mSv and seven individuals received annual doses between 5 and 10 mSv.

During Adria Airways flights, 230 workers were exposed, who received an average dose of 1.01 mSv and a collective dose of 228 man mSv.

The highest doses are received by workers exposed to radon and its progeny. In 2012, 29 out of 139 tourist workers in Karst caves received an effective dose between 5 and 10 mSv and 9 workers received an effective dose between 10 and 15 mSv, whereas none of the workers received a dose exceeding 15 mSv. The highest individual dose was 13.6 mSv. The collective dose

[1] All average doses in this section are calculated per number of workers who received a radiation dose above the minimum detection level.

was 518 man mSv, with an average dose of 3.75 mSv. Tourist workers in Karst caves are the category of workers most exposed to ionising radiation.

The findings of a study on the exposure of individuals in Karst caves show that the doses assessed according to the ICRP[2] 65, which the tourist workers in Karst caves received from radon exposure, 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 manner are thus twice as high as those calculated according to ICRP 65 model, which was used in the past.

At the Žirovski Vrh Uranium Mine, eight workers received a collective dose of 0.7 man mSv, whereas an average individual dose was 0.1 mSv. The collective dose was 0.7 man mSv.

The number of workers by dose intervals in different work sectors is shown in Table 9.

Table 9: Number of workers in different work sectors by dose intervals (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	61	798	293	8	0	0	0	0	1,160
Industry	368	72	17	3	0	0	0	0	460
Medicine and veterinary	2,361	1,119	84	1	0	0	0	0	3.565
Air flights	5	68	157	0	0	0	0	0	230
Radon	1	39	69	29	9	0	0	0	147
Other	467	250	16	3	0	0	0	0	736
Total	**3,263**	**2,346**	**636**	**44**	**9**	**0**	**0**	**0**	**6,298**

MDL – minimum detection level
E – Effective dose in mSv received by an exposed worker

Training of 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 refreshment of knowledge and skills. Training, refreshment courses and tests were carried out by the approved technical support organizations, namely the IOS and the JSI. In 2012, a total of 1,681 participants attended courses on ionizing radiation protection.

Targeted medical surveillance

In 2012, the medical surveillance of radiation workers was performed by five approved occupational health institutions, namely the Clinical Institute of Occupational, Traffic and Sports Medicine, Ljubljana; the IOS, Ljubljana; Aristotel d.o.o. Krško; Health Centre Krško; and Health Centre Škofja Loka.

Altogether, 2,821 medical examinations were carried out. Among examined candidates, 2,514 fully fulfilled requirements for working with sources of ionising radiation, whereas 273 fulfilled requirements with limitations. 16 candidates did not fulfil requirements temporarily, two did not fulfil requirements and other work was proposed to them, and one did not fulfil any requirements. In 15 cases, the evaluation was not possible.

[2] ICRP stands for the International Commission on Radiological Protection, which, among other tasks, periodically recommends methods for dose assessments.

Diagnostic reference levels for diagnostic radiological procedures

X-ray examinations that are implemented in accordance with good radiological practice give 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 (DRR) to promote the optimization of radiological procedures. The level of patient's 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 DRR value obtained on the basis of the relevant regional or local data.

By using the DRR, the exposure reduces and radiological practice improves. Their use is more efficient when national values of DRR are set. Thus, following a five-year data collection project on the exposure of patients undergoing X-ray examinations in Slovenia, DRR values for fifteen X-ray examinations were presented in 2006. Due to changes in technology and professional guidance, it is necessary to regularly review diagnostic reference levels. Therefore, in 2012, the SRPA continued to collect data on the exposure of patients, on the basis of which national DRR will be updated in the near future.

When issuing a permit for radiation practices or a permit for the use of radiation source in medicine, the level of exposure for each X-ray device or a group of such devices is compared to DRR values. If the average exposure for each examination is greater than DRR, the SRPA demands that the radiological procedure is optimised.

In nuclear medicine, rather than diagnostic reference level, the recommended activities of 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 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 programs of radiological procedures. In addition, systematic reviews of typical values of 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

In 2012, Slovenia concluded its participation in the »Dose DataMed2« project as a test country and received expert assistance. The project ran under the guidance of the European Commission. In the project framework, the first systematic assessment of public exposure from the medical use of ionising radiation was carried out.

This extensive project consisted of evaluating the frequency of selected radiological procedures and evaluating the average patient exposure from those procedures. Due to very limited resources, the SRPA chose the simplest approach, based on the exposure assessment for 20 radiological procedures that contribute most to the collective exposure of the public as well as on the assessment of exposure from diagnostic procedures in nuclear medicine. The frequency of procedures was assessed with a questionnaire that was distributed among institutions performing those procedures in Slovenia. Patient exposure for different types of procedures was assessed on the basis of data from the programmes of radiological procedures.

The results of the study show that the average exposure (effective dose) from diagnostic medical procedures in Slovenia is about 0.7 mSv per capita. Approximately 60 % of that comes from computer tomography and about 10 % from examinations in nuclear medicine.

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 are 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 Spent Nuclear Fuel

All spent fuel in the Krško NPP is stored in the spent fuel pool with 1,694 cells. In the spring of 2012, a regular outage was held (the shipment of fresh fuel arrived in the NPP at the end of 2011). At the end of 2012, 1,041 fuel assemblies were stored in the pool for spent fuel taking into account also the container with fuel rods ("reconstitution"). The number of annually spent fuel assemblies and the total number of such elements in the pool are shown in Figure 19.

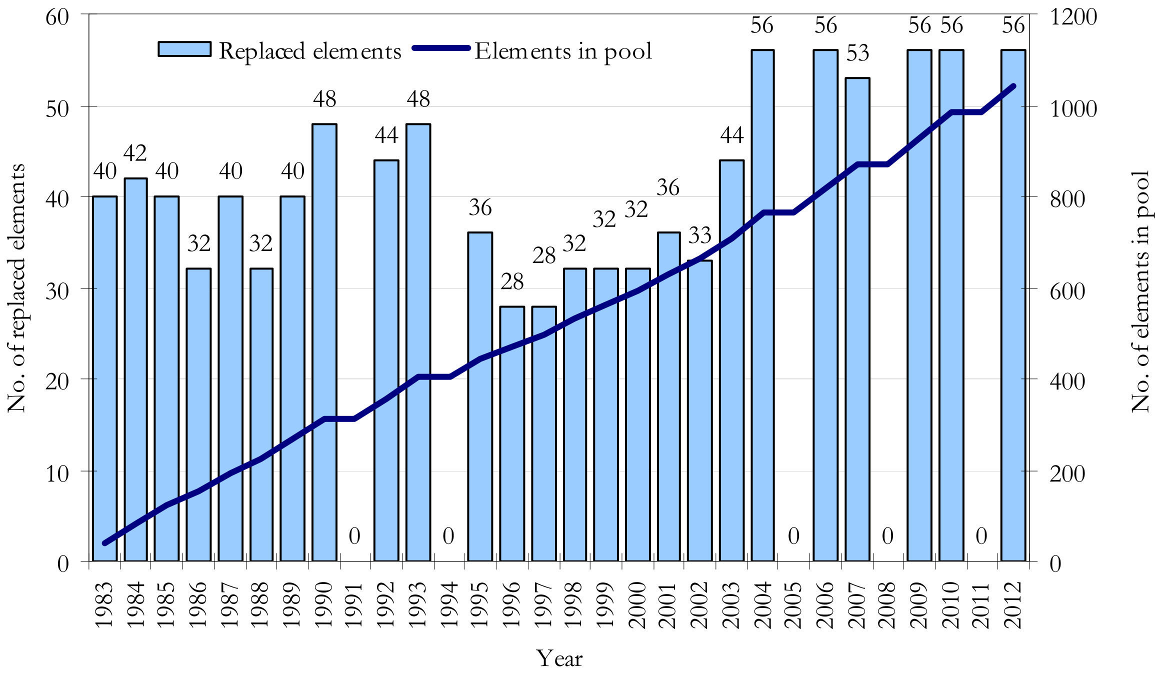

Figure 19: The number of annually spent fuel assemblies and the total number of such elements in the pool NPP

5.1.2 Management of Low- and Intermediate-Level Waste

In recent years, the volume of low- and intermediate-level radioactive waste (LILW) has been reduced by compression, super-compaction, drying, incineration, and melting. The total volume of waste accumulated by the end of 2012 amounted to 2,262 m^3. The total gamma and alpha activity of the stored waste were $2.04 \cdot 10^{13}$ Bq and $2.64 \cdot 10^{10}$ Bq respectively. In 2012, the equivalent of 118 standard drums containing solid waste was stored. On 31 December, the total gamma and alpha activity of stored drums was $8.74 \cdot 10^{11}$ Bq and $3.39 \cdot 10^{8}$ Bq respectively.

Figure 20 shows the accumulation of low- and intermediate-level radioactive waste in the Krško NPP storage. Periodical volume reductions, which are a consequence of compression, super-compaction, incineration and melting, are marked. After 1995, the accumulation of waste volume has reduced as a result of a new in-drum drying system (IDDS) for evaporator concentrate and spent ion exchange resins.

In 2006, the super-compactor was installed in the storage facility at the Krško NPP, which thus started with the continuous super-compaction of its radioactive waste. In 2012, 10 standard drums with other waste were super-compacted. Super-compacted radioactive waste has been stored in the tubular container TTC.

Waste 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 2012, 250 packets of combustible radioactive waste were sent to incineration.

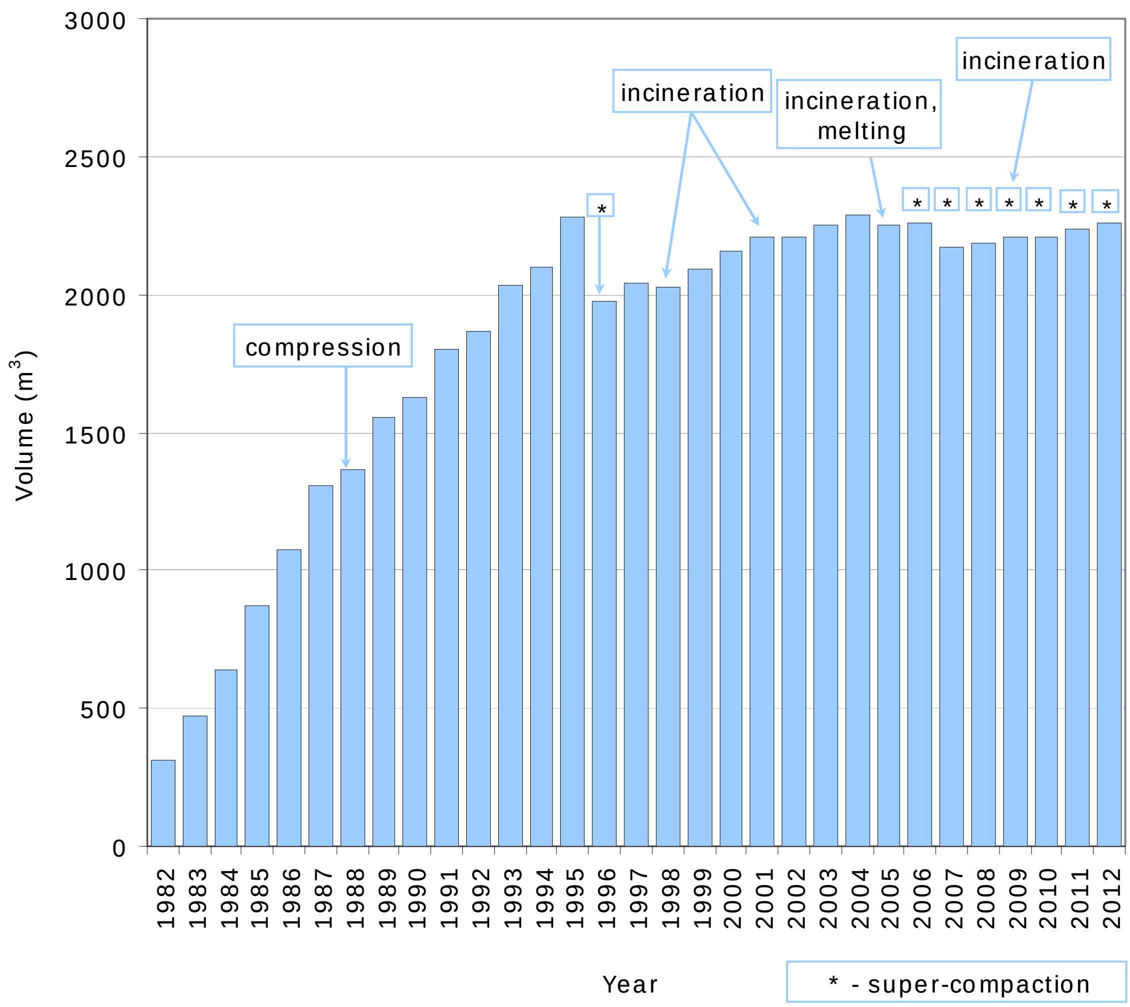

Figure 20: Accumulation of low- and intermediate-level radioactive waste at the storage in the Krško NPP

5.2 Radioactive waste at the Jožef Stefan Institute

In 2012, approximately 400 litres of radioactive waste was 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. In 2012, 200 litres more of radioactive waste was produced than in previous years due to the replacement of ion exchange resins. The Radiation Protection Unit of the Institute plans to hand the waste over to the Central Storage Facility at Brinje, managed by the ARAO.

During the decontamination and decommissioning of buildings used for the processing of uranium ore, which took place from 2005 until 2007, as many as 31 drums of waste contaminated with naturally occurring radioactive material (NORM) were produced. Part of this material, 12 drums, was transferred to the Central Storage Facility already in February 2010. In accordance with the SNSA's decision, the Institute sent part of the material, namely 12 drums of contaminated construction material and soil, which were conditionally cleared, to a municipal landfill in June 2011. Since it is not allowed to dispose off metal pieces and wood on any municipal landfill, the remaining 7 drums are still temporarily stored at the location of the Reactor Centre in Brinje.

5.3 Radioactive waste in medicine

As the largest user of radioactive iodine ^{131}I, 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 or more after approved radiation protection experts carry out preliminary measurements of specific activities. Adequate temporary storage for radioactive waste was also arranged in the new building of the Institute of Oncology. Sealed radioactive sources which are no longer in use were returned to the producer or handed over to the Central Storage in Brinje. Short-lived solid radioactive waste is temporarily stored in a special storage for decay and is then disposed off as non-radioactive waste. However, the Clinic for Nuclear Medicine at the University Medical Centre in Ljubljana has not yet built a system for holding up liquid waste. In the course of renovation of the University Medical Center, the Clinic intends to build new premises with an appropriate system for holding up liquid waste. Since only ambulant treatment is carried out in other Slovenian hospitals, patients leave the hospital immediately after receiving a therapeutic dose and therefore the hold-up tanks are not necessary.

5.4 Commercial Public Service for Radioactive Waste Management

5.4.1 Commercial Public Service for Radioactive Waste from Small Producers

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

- collecting the radioactive waste from small producers, in cases of accidents or when the waste holder can not be identified;
- transport, radioactive waste treatment for storage and disposal, storage and disposal;
- managing the collected radioactive waste in a prescribed manner;
- managing the Central Storage for Radioactive Waste in Brinje.

Within the public service for the management of radioactive waste from small producers, the ARAO in 2012 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 hot cell facility at the Jožef Stefan Institute, where the processing and preparation the ionization smoke detectors were carried out in the first stage. The ARAO processed approximately 2.3 m^3 of ionization smoke detectors, which resulted in about 130 litres of radioactive waste as well as two 210 litre drums of contaminated housings that are planned for conditional clearance. Also, 8 drums (1.68 m^3) of non-radioactive waste resulted from the processing, which were inspected by radiation protection expert who determined that they match the unconditional clearance levels. The SNSA was informed about the intended clearance.

5.4.2 Delays in Planning of the Low- and Intermediate-Level Waste Repository

At the end of 2009, a Decree on Detailed Plan of National Importance for the LILW repository in Vrbina in Krško municipality was adopted, which was a huge success for the ARAO and for the whole country. The decree was published on 31 December 2009 and thus the procedure for the siting of the repository was finished. Unfortunately, the matters have been moving very slowly since then. In 2012, the Ministry of Infrastructure and Spatial Planning has still not confirmed the investment program of the future repository. The Radioactive Waste Management Agency was asked to prepare the revision of the investment programme and therefore it was not possible to proceed with the necessary steps. The ARAO has not yet started to buy land, the additional field studies has not been ordered and the preparation of environmental impact assessment and safety analysis report for the repository has not begun The start of the repository operation is therefore moving further into the future. According to the estimations made at the end of 2012, the repository will not be built before 2019.

With the delay on the construction of the repository, the Krško NPP's needs have been growing. Because their LILW storage is filling up, temporary solutions to assure the normal operation of the plant will have to be found.

In 2012, the second part of the ARAO Work Programme, which among others includes financial resources for the implementation of the project for LILW repository, was also not approved.

The Investment programme, 2^{nd} revision, was prepared by the ARAO and sent to the Ministry of Infrastructure and Spatial Planning for approval. On 28 December 2012, the ARAO was asked to prepare another revision. Depending on the needs and planned activities, a time schedule of activities to be carried out until obtaining a construction license was amended and prepared in detail. Preparations for the call for the implementation of planning services were carried out. The tender for field investigations was carried out but is not yet concluded.

In 2012, the ARAO resubmitted to the competent ministry the proposal for the management of state assets, which is approved by the Government of the Republic of Slovenia. The preparations for purchasing the land necessary for building the LILW repository continued. The analysis of the owners' structure for the complete area of LILW repository was prepared, which is a good basis to start purchasing land or making servitude.

In the framework of the project, the monitoring of the underground water continued. The study »The Review and Preparing of the Parameters for Modelling Biosphere« was prepared, which will be a good basis for preparing the biosphere model in the future. The model will be used to calculate dose rates of a critical group of public.

In the field of safety analyses and waste acceptance criteria, the work on the first phase of the project continued and was concluded. Based on the preliminary design, field investigation results and waste characterization, new safety analysis and waste acceptance criteria were prepared. With regard to the location and type of the repository (silo type), scenarios or events that can happen during the operation and after the closure of the repository were selected. Based on that, the conceptual, computer and mathematic models were prepared, with which the calculations to prove safety were made. The results confirmed that the location and the disposal concept are adequate, since the assessed impacts are going to be smaller than the limits of impact that are allowed for a facility such as a LILW repository. In a framework of the project, new waste acceptance criteria were prepared. They represent an improvement from previous work and are prepared for the chosen location and the chosen disposal technology. The review of all safety analysis reports and waste acceptance criteria were finished, as well as the second revision of the functional analysis for the LILW repository.

5.5 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 remediation of the landslide is required. The rock beneath the hydrometallurgical tailings at the site has been sliding despite the finished remediation work at the site; the sliding is larger than it is acceptable according to the safety analysis report.

In 2012, the company RŽV d.o.o. carried out the ongoing activities at the both disposal sites, namely sampling, measurements, control of the overall state, maintenance, collecting and storing information, record keeping, preparing reports for the authorities, and other.

Maintenance works included cleaning the channels used to outlet the storm water at both disposal sites, removing the bushes along both disposal sites and infrastructure facilities, and mowing the grass on the disposal site surfaces and alongside them (Figure 21).

Figure 21: Cleaning the deposits of the measuring point after a rainfall (left) and removing the bushes along the protective fence at the Boršt disposal site (right)

The overall state of the final remediated mine facilities was monitored. The control was tightened on the request of the mine inspectorate because the rock base of the disposal and disposal site Boršt itself is still moving and is not stable. The inspector's request to conclude a mine project, namely the implementation of intervention drainage measures for decreasing of level of underground water according to mine project, was not complied with due to lack of funds.

The control of the concrete lining on the passage of the tunnel through the landslide beneath the Boršt disposal site was carried out. In addition, the functioning of the drainage wells and moving of the landslide with extensometer placed in a tunnel was also monitored. In May, when the earthquake shook the Friuli-Venezia Giulia region, the extensometer showed a shift of 9 mm. Shifts at the surface of the Boršt disposal site were constantly monitored with the GPS system and regularly reported to the SNSA and the Inspection for energy and mining.

Monitoring the stability of the Jazbec site and the Boršt site is an important task within overall control of the disposal site. After the final settlement of the both sites and when work activities in the area, where the geodetic grids of control points for monitoring stability are located, were finished, the conditions for continuous (on-line) monitoring using a GPS system via satellites as well as for the qualitative periodical geodetic monitoring were created. Geodetic monitoring was not carried out due to lack of funds.

Since the RŽV d.o.o. did not received any funds from the state budget in the first half of the year, the company financed regular activities during that time from its own funds which should be otherwise used to pay the compensation to the municipality Gorenja vas – Poljane for the limited use of the area.

A contract for the temporary funding of activities was signed only on 31 May 2012 and first funds from the state budget were allocated in July. Because of financial difficulties, the monitoring, foreseen in the safety cases for both disposal sites, was not implemented. Regardless of the reduced implementation of radiological monitoring, the acquired results were sufficient to estimate the dose to an individual of population. Details on monitoring can be found in Chapter 3.3.3. On 31 December 2012, the Ministry of Agriculture and the Environment ensured financing for some of the expired liabilities and activities of RŽV d.o.o. prescribed by law by allocating the funds from its own state budget items.

RŽV d.o.o. has submitted an application to the SNSA to approve the closure of Jazbec disposal site. During the administrative procedure, a party hearing took place and by the end of 2012, all amendments of the safety analysis report were implemented. During the procedure for closure of the disposal site, the SNSA will also decide on the termination of the radiation facility status and, based on the governmental decision, issue a decision on the facility of national infrastructure. Governmental decision was issued on 20 December 2012. By the end of 2012, an approval for closure and the decision on the facility of national infrastructure were not yet issued. After adequate licensing, the Agency for Radioactive Waste will take over the implementation of the public commercial service for the long-term surveillance and maintenance of the disposal site.

In 2012, the SRPA approved an amendment of the assessment of the radiation protection of exposed workers.

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

The Fund for Financing the Decommissioning of the Krško NPP and for the Management of Radioactive Waste from the Krško NPP (hereinafter »Fund«) was established pursuant to the Act on the Public Fund for Financing Decommissioning of the Krško Nuclear Power Plant Krško and Disposal of Radioactive Waste from the Krško NPP.

In 2004, the *»Programme for the Decommissioning of the Krško NPP and Disposal of Low- and Intermediate-Level Waste and Spent Fuel«* (hereinafter »Program«) was prepared. It determined the levy per kWhe to be paid. The Government of the Republic of Slovenia was informed about the Program on its 93rd regular session on 7 October 2004. The Program 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. Since April 2005, the company ELES GEN, d.o.o., which was renamed to GEN energija, d.o.o. in July 2006 when the company's founding act was amended, is paying 0, 003 EUR per kWhe to the Fund.

Since 1998, the Fund is financing the *»Work programme of the Agency for Radwaste Management«,* namely the projects referred to the safe management of low- and intermediate-level radioactive waste. In 2012, the Fund paid a total of 3.9 million euro to the ARAO, which is 4.2 % less than in 2011. From 1998 until the end of 2012, the Fund paid a total of 26.04 million euro to the ARAO for the activities implemented by the ARAO.

Based on Article 11 of the Decree on the criteria for setting compensation level payable for limited use of space within the area of a nuclear facility, the Fund is obliged to pay compensation for the limited use of space within the area of a nuclear facility. Since 2004, the municipalities have received 20.8 million euros as a compensation for the limited use of land.

The current contribution to the fund is 0.003 euro per kWhe of the Slovenian share of energy produced in the NPP Krško. The company liable to pay the contribution is GEN energija d.o.o., which paid a total of 7.9 million euro into the Fund in 2012. With that contribution, the company fully and in agreed deadline fulfilled all obligations to Fund deriving from the contribution for decommissioning. In comparison to 2011, 11.2 % less funds was paid. In all the years of its existence, the fund received a total of 144.5 million euro from the Krško NPP and GEN energija d.o.o.

In 2012, the actual structure of investments was slightly deviating from expected, namely for 0.66 percentage point in investments in corporate bonds. In investments in bank finance bonds, the actual share was deviating for 0.03 percentage point from expected (the lower limit of the range). The reason for such deviation is a decrease in the value of some bonds in the portfolio and the fact that the funds from reselling were not compensated with investments in particular corporate bonds but with investments in mutual funds and ETFs in the same investment grade.

The structure of the Fund's investments at the end of 2012 differs from the previous year mostly in grade of state securities, where the share increased for 11.52 percentage points.

As of 31 December 2012, the fund managed 160,345,569 euros of financial investments in securities. 23.76% of the sum was invested in banks in the form of deposits, CDs and MM Funds; 40.06 % in state securities; 13.08 % in bonds, which are 100 % state-owned; 4.34 % in corporate non-financial bonds; 4.97 % in corporate financial bonds; 6.07 % in bond funds; 6.17 % in mutual funds (equity and mixed funds) and NTFs; and 1.55 % in stocks.

In its investments policy for 2012, the Fund planned mainly investments in bonds, deposits and CDs.

In 2012, the Fund created 14 million euros of income, which is at the planned level. The income was 3.36 % lower as in 2011. The expenses reached 7 million euros, which was 17.88 % lower than planned and 2.13 % lower than in 2011. The fund has a surplus of income over expenses in the amount of 7 million euros, which is 28.44 % more than planned.

In 2012, the Fund received 82.3 million euros 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 are as planned. The granted loans and the increase of capital shares amounted to 89.3 million euros, which is 7 million euros more than the received repayments of granted loans.

In 2012, the yield of the portfolio, calculated on the bases of internal rate of return (IRR), was 7.62 %. The expenses of portfolio managing in relation to the financial portfolio amounted to 0.26%.

5.7 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 the 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, of the decommissioning waste from the Žirovski vrh Uranium Mine and of the waste from small producers which is stored in the Central Interim

Storage for Radioactive Waste in Brinje. The Review Meetings of contracting parties take place every three years in Vienna. At the end of 2012, the Joint Convention was in effect in 64 countries, including Slovenia.

The Fourth Review Meeting, chaired by Chang-Sun Kang from South Korea, took place from 14 to 23 May 2012. 54 delegations of contracting parties to the Joint Convention attended. Slovenia participated in the country group 4, together with Moldova, Argentina, Ukraine, Denmark, Czech Republic, Montenegro, United Kingdom, Australia, and Indonesia. Among the officers of this country group was also Nadja Železnik from the Agency for Radwaste Management, who had a role of a coordinator.

The National Report was prepared in 2011 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 Llc, the Institute of Oncology, and the Clinic for Nuclear Medicine at the University Medical Centre in Ljubljana. The report and the presentation were well accepted. It was concluded that Slovenia presented a comprehensive national report which satisfactorily addressed all relevant issues regarding the safety of spent fuel management and radioactive waste management, including the measures that were taken based on the lessons learned from the Fukushima accident, and that the situation in the country in this regard is well under control.

Slovenia was asked to report at the Fifth Review Meeting scheduled for May 2015 on licensing, construction and operation of the LILW repository, on agreement with Croatia about the solution for the Krško NPP waste disposal, on approval of the Krško NPP decommissioning plan, on delicensing and institutional monitoring for the mill tailing pile of former uranium mine, on preparation of the revised National Radwaste Managements Programme, and on reassessment of spent fuel management practice onsite the NPP due to lessons learned from Fukushima .

6 EMERGENCY PREPAREDNESS

Emergency preparedness is an important part of the comprehensive system for ensuring a high level of nuclear and radiation safety. During an emergency, competent organizations must be prepared to take appropriate action according to emergency plans.

Nuclear and radiological accidents are incidents that pose a direct threat to the people as well as to the environment and demand prompt protective measures. In general, every incident is not yet an accident. They could also be, for example, reductions in nuclear or radiation safety, which also require an appropriate response from the relevant 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 when dealing with an emergency, whereas the Slovenian Nuclear Safety Administration (SNSA) gives advice and makes recommendations.

6.1 Slovenian Nuclear Safety Administration

At the SNSA, the responsibility for the emergency preparedness response falls under the Emergency Preparedness Division. The division's primary functions are:

- providing training, staff and the appropriate response of the SNSA emergency team,
- maintaining the team's documentation and procedures,
- maintaining the team's equipment and keeping the emergency centre operational.

The SNSA's capability to act is ensured by the regular training of emergency team members, the response verification and exercises, regular checks of computers and other equipment and participation in international activities, as well as through regular reviews of all associated organizational regulations and guidelines.

In 2012, the SNSA carried out 78 training sessions, running to a total of 241 hours, with 464 participants or 1,040 man-hours of training. Exercises are considered as part of training. The SNSA also participated in the 2012 annual Krško NPP exercise and in several international ConvEx and ECURIE exercises.

The area of emergency preparedness is usually one of the first areas affected by the lack of resources. If the Emergency Preparedness Division had enough human and financial resources, additional staff would be employed. Thus, the division would be able to carry out the adequate number of training events and exercises, so that the SNSA would respond excellently to any accident. Furthermore, due to the increased number of employees at the SNSA, the work of the emergency team could be organized in three shifts, since the current solution with a 12-hour shift is difficult to carry out if a major accident takes place, which would last for a long time. The SNSA would increase its activities at the national level and help the Administration for Civil Protection and Disaster Relief (ACPDR) and other organizations bring the preparedness for nuclear or radiological emergency to the appropriate level. Since there is a high probability of failure of regular communications, for example of a GSM network, and using a satellite network as a backup is essential, satellite communication and data transmission would be established. The division would also acquire new computer equipment, because now all the work is based on the already outdated equipment. The computerized calling system would be purchased for the activation of the emergency team. Last but not least, all members of the team would each receive its own mobile phone.

6.2 Administration of the RS for Civil Protection and Disaster Relief

In 2012, the Administration for Civil Protection and Disaster Relief (ACPDR) maintained and ensured preparedness as well as developed procedures for the effective response of the system for protection against natural and other disasters to nuclear or radiological emergencies.

The ACPDR continued with the implementation of a new concept that involves a prior distribution of potassium iodide tablets for the case of nuclear or radiological emergency. The Plan of Distribution of Potassium Iodide Tablets in Case of Nuclear or Radiological Emergency was prepared, which sets out the scope and method of the prior distribution of potassium iodide tablets as well as the extent and distribution of potassium iodide tablets in case of an accident. In 2013, the tablets will be pre-distributed to people aged up to 40 years with permanent and temporary residence in the area of 10 km around the Krško Nuclear Power Plant, as well as to schools, kindergartens and companies in the area. In 2012, the tablets were distributed to the part of the emergency personnel throughout the Republic of Slovenia, as well as to the region's and municipality's civil protection units. For the rest of the population, 19 regional hospitals have received stockpiles of tablets.

In preparation for the pre-distribution of potassium iodide tablets to the population in an area of 10 km around the Krško NPP, the ACPDR held a series of consultations on the subject of iodine prophylaxis and pre-distribution of potassium iodide tablets in cooperation with the Slovenian Nuclear Safety Administration, the Ministry of Health, Municipalities of Krško and Brežice, and the Krško NPP.

6.3 The Krško NPP

In 2012, the activities of the Krško NPP in the area of preparedness for emergencies included:

- training, drills and exercises (the annual Krško NPP exercise),
- 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 organization.

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

In 2012, the Krško NPP mobile unit carried out one tour with the mobile unit of the Institute of Occupational Safety and one tour with the IJS mobile radiological laboratory. That was less than in 2011, when three such tours were carried out.

6.3.1 The Annual Exercise Krško NPP 2012

Staff's operational exercise 2012 was held on 14 November 2013, from 4 p.m. to 8. p.m. The SNSA, Brežice Regional Notification Centre and Notification Centre of the Republic of Slovenia also participated in the exercise.

The exercise was a routine annual test of the complete Krško NPP preparedness in the case of an emergency. Based on the scenario, the tests of individual components within the scope and in accordance with the assumptions set in the decision to carry out exercises were performed.

Exercise has shown that the Krško NPP was adequately prepared to deal with the simulated incident. Minor deficiencies were identified and are being eliminated in accordance with the action plan and the Krško NPP corrective program.

7 CONTROL OVER RADIATION AND NUCLEAR SAFETY

7.1 Legislation

The most important piece of legislation in the field of nuclear and radiation safety in the Republic of Slovenia is the Ionizing Radiation Protection and Nuclear Safety Act (ZVISJV, Official Gazette RS, No. 102/04 – official consolidated text). It was amended for the first time in 2003 (Official Gazette RS, No. 24/03 – ZVISJV-A) and for the second time in 2004 (Official Gazette RS, No. 46/04 – ZVISJV-B). In 2011, the act was amended for the third time (Official Gazette RS, No. 60/11 – ZVISJV-C).

Based on the ZVISJV, 28 implementing regulations were adopted by the end of 2011, namely seven governmental decrees, ten rules issued by the minister of the environment, nine rules issued by the minister of health, and two rules issued by the minister of the interior.

In 2012, no new legislation in the field of nuclear and radiation safety was adopted. As for the laws of the former common state, only a small part of the Regulation on maximum permitted levels of radioactive contamination of human environment and on decontamination (Off. Gaz. SFRY, no. 8 / 87) is still applied.

The SNSA issues practical guidelines that are published on the SNSA website. Guidelines are non-binding documents intended for licensees to obtain their rights and legal benefits easier and faster. In 2012, the SNSA issued and published a document »The Content of the Safety Report of the Low-and Intermediate-level Radioactive Waste Repositories« (PS 1.03). The Administration also prepared two guidelines, namely »Dealing with Changes in Radiation or Nuclear Facility« (PS 1.02) and »The Content of the Safety Analysis Report of Radiation or Nuclear Facilities« (PS 1.04).

In 2012, the SNSA began preparing the text of a Resolution on Nuclear and Radiation Safety in Slovenia for the period from 2013 to 2023. Although Slovenia already has an existing legislative and administrative framework in the field of nuclear and radiation safety, which is largely in line with international standards, this resolution meets the umbrella gap - the fundamental political orientation towards and commitment to nuclear and radiation safety as a priority over all other aspects of nuclear energy and ionizing radiation in the country.

The implementation of the resolution and its fundamental principles ensures that economic, social and other needs are met by the use of radiation sources and the peaceful use of nuclear technology, deriving from constraints imposed by the legislative framework in the field of radiation and nuclear safety. At the end of 2012, an expert discussion on the content of the resolution was concluded and the draft was sent to the Slovenian Government. It is expected that the resolution will be adopted by the Slovenian Parliament in 2013.

Detailed information regarding executive acts and acts under preparation can be found at the SNSA website http://www.ursjv.gov.si/si/zakonodaja_in_dokumenti/.

7.2 Slovenian Nuclear Safety Administration

The Slovenian Nuclear Safety Administration (SNSA) performs specialized technical and developmental administrative tasks as well as tasks of inspection in the areas of radiation and nuclear safety; carrying out practices involving radiation and the use of radiation sources, except in medicine and veterinary medicine; protection of the environment against ionizing radiation; physical protection of nuclear materials and facilities; non-proliferation of nuclear materials and safeguards; radiation monitoring; and liability for nuclear damage.

Legal bases for its administrative and expert tasks in the area of nuclear safety, radiation protection and inspection are provided by the legal framework presented in detail at the SNSA website http://www.ursjv.gov.si.

In the beginning of 2012, the SNSA had 43 employees. During the year, a fixed-term contract ended for one trainee after completing his traineeship. To compensate for a longer sick leave, one public servant was employed, so by the end of 2012, the SNSA had 43 employees.

All SNSA activities are carried out in accordance with the management system based on the requirements of the ISO 9001:2008 standard and the requirements of the IAEA standards relating to management systems. In 2007, the SNSA management system was also certified.

In January 2012 and January 2013, the SNSA successfully passed regular annual external control audit. Since no non-conformances were identified, the certification body confirmed that the introduced management system is implemented in line with the ISO 9001:2008 standard.

The certification of the SNSA management system in the next three-year period is questionable due to restricted financial resources.

In 2012 as well as in previous years, in spite of tight financial situation and very limited financial resources, the SNSA paid special attention to qualification, education and training of its employees, with a purpose to follow their careers and to create the conditions for improving their qualifications.

The SNSA is aware of the importance of being open to the public. This is ensured by publishing information in newspapers, on radio and television, and on the internet. The SNSA website offers general information about the SNSA, information for the public, legislation, agreements and standards in this field, annual and other reports, information on meetings, workshops, invitations for tenders and projects co-financed by the International Atomic Energy Agency, data on radiation monitoring, and links to the websites of other regulatory authorities, organizations and research centres. The SNSA constantly updates the website and thus tries to ensure that the level of information is interesting for the general public as well as for experts.

In 2012, the Expert Commission for the Verification of Professional Competence and Fulfilment of other Requirements in Respect of Workers Performing Duties and Tasks in Nuclear and Radiation Facilities (in short the Commission) carried out exams for senior reactor operators, reactor operators and shift engineers of the Krško NPP. There were no exams for licensing of shifts engineers and reactor operators in the TRIGA reactor in 2012.

Six candidates gained their licence for reactor operator of the Krško NPP for the first time and two candidates gained the licensee for senior research operator for the first time. Extensions of licenses were granted to twelve senior reactor operators, ten reactor operators and five shift engineers. The SNSA granted the appropriate licenses to all Krško NPP candidates.

Due to budget cuts and constraints in human and financial resources deriving from these cuts, long-term risks for direct violations of Slovenian legislation in the functioning of the SNSA are increasing. The increased risks could lead to the following:

1. increased likelihood of a nuclear or radiological accident due to lack of expertise of the SNSA staff and the inability of performing an adequate number of inspections,
2. inability to participate in the development of international safety standards and in their transfer into daily practice in Slovenia due to financial constraints,
3. inability to maintain and develop the legislative framework in the field of nuclear safety,
4. losing the ability to detect an increased radioactivity in the environment and intervene in the case of such event,
5. impaired ability to act in the event of a nuclear or radiological emergency,

6. inability to report to the Parliament, the EU and under international conventions,
7. violations of international agreements and a loss of reputation of Slovenia
8. inefficient operation of the SNSA, which would impose an unnecessary burden on its clients.

The individual chapters of this report highlight the actions for reducing risks that could be performed if sufficient human and financial resources were available.

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 to the Slovenian Nuclear Safety Administration in the field of radiation and nuclear safety, 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 use of radiation sources other than those used in health and veterinary care.

In 2012, the Expert Council convened two regular and two correspondence sessions. In addition to the regular reporting of the SNSA Director to the Council on the news and developments in the field of radiation and nuclear safety between the meetings, the Council also considered a draft of national strategy on nuclear safety and a text of the Resolution on Nuclear and Radiation Safety, which represents the umbrella document with general guidelines in the field of nuclear and radiation safety; an investment programme for the repository of low- and intermediate-level waste; a programme of safety modifications to upgrade the Krško nuclear power plant; implemented and planned measures of the Krško NPP connected to stress tests; the 2012 fuel outage; standard problems of nuclear expertise; and the initiative of the SNSA to become a public agency.

The regular sessions considered and adopted three practical guidelines, the Annual Report on Radiation and Nuclear Safety in Slovenia for 2011, and the Slovenian Report for the second Extraordinary Meeting of the Parties of the Convention on Nuclear Safety.

7.4 Slovenian Radiation Protection Administration

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

As a special operational unit within the SRPA, the Inspectorate for Radiation Protection is responsible for the surveillance of sources of ionizing radiation used in medicine and veterinary medicine and for the implementation of legislation on protection of people against ionizing radiation. In 2012, 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 of issuing permits and certificates as prescribed by the Act; issuing approval to radiation protection experts; performing inspections; informing and increasing public awareness about procedures of health protection against the harmful effects of radiation; and co-operation 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, protection of exposed workers in nuclear and radiation facilities, and radon exposure. Altogether, 113 permits to carry out a radiation practice, 217 permits to use radiation sources and one permit to import radioactive sources were granted. Additionally, 125 programmes of radiological procedures and 173 evaluations of protection of exposed workers were confirmed. Furthermore, 19 statements of consignees of radioactive materials and one approval for foreign external operator of a radiation practice were issued. In 2012, the SRPA granted eight approvals for radiation protection experts (4 to natural persons and 4 to legal entities) and three approvals for legal entities performing the monitoring of individual exposure to ionizing radiation.

The Inspectorate carried out 159 inspections. Of these, there were 14 in-depth inspections in medicine and veterinary medicine. 6 decisions requiring correction of established deficiencies, 4 decisions requiring sealing of X-ray devices, and one decision regarding the clearance of radioactive material were issued. Eight requests to submit the evidence regarding corrected authorised deficiencies, 21 requests to submit the evidence regarding the termination of use of X-ray device and 98 requests regarding the harmonisation with the existing legislation were issued. The SRPA took action in six cases, when operational monthly personal dose of 1.6 mSv was exceeded.

Within the scope of use of radiation sources in industry and research, the SRPA carried out 4 in-depth inspections, three of them regarding the exceeding operational monthly personal dose of 1.6 mSv. As for the radiation protection of exposed workers, the SRPA surveyed the Krško NPP, the JSI and the ARAO in 2012. Altogether, 5 in-depth inspections were performed in these institutions. The SRPA also supervised the Žirovski Vrh mine, the Postojna Cave and the Škocjan Caves, as well as primary schools, kindergartens, hospitals and other public buildings with increased radon concentrations. Six in-depth inspections were carried out. One decision for the reduction of ionising radiation was issued. The SRPA also participated in two technical reviews in the Idrija Mercury Mine. As for other natural sources of ionizing radiation, the SRPA supervised flight operator Adria Airways.

So far, the SRPA operated with a small number of employees and modest financial resources. Despite this, the high level of radiation protection was assured in its areas of competence by efficiently optimising working processes and using available resources. Thus, the SRPA does not have any internal financial or staff reserves and any further reducing 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 reduce.

7.5 Approved experts

The Ionizing Radiation Protection and Nuclear Safety Act defines the activities of several types of approved experts. The SNSA approves experts for radiation and nuclear safety, whereas the radiation protection experts, dosimetric services and medical physics experts are approved by the SRPA. The approvals for medical practitioners are issued by the Ministry of Health.

Approved experts for radiation and nuclear safety

The Ionizing Radiation Protection and Nuclear Safety Act contains a requirement that the operators of radiation or nuclear facilities must get the expert opinion of approved experts on specific interventions in the facilities. From the reports of approved experts, it can be concluded that in 2012, there were no major changes in their operations in comparison to previous years. Their staffs maintained their level of competence and the equipment used was well kept and updated. The organizations established quality management programs certificated in compliance with the standard ISO 9001:2008. The approved experts provided professional support to the

Krško NPP by preparing independent expertise. An important part of their work focused on an independent review and assessment of plant modifications.

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

In 2012, the Commission for the Verification of Compliance with Requirements of Approved Experts considered five applications for the extension of approval. All five approvals have been extended. The approval of one person was terminated.

In 2012, 17 legal entities and 1 natural person have been approved by the SNSA to perform tasks of an Approved Expert for Radiation and Nuclear Safety.

The SNSA website http://www.ursjv.gov.si/si/info/za_stranke/ provides information on approved experts in various fields of radiation and nuclear safety in the section »Pooblaščeni izvedenci za sevalno in jedrsko varnost«.

Approved radiation protection experts

Approved radiation protection experts co-operate with employers in drawing up evaluations of the protection of exposed workers against radiation; give advice on working conditions of exposed workers, on the extent of 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 usefulness of protective equipment; and perform training of exposed workers in radiation protection. Approved radiation protection experts regularly monitor the levels of ionizing radiation, contamination of the working environment and working conditions in supervised and controlled areas. The approval can be granted to individuals for giving expert opinions and for presentation of topics relating to training on radiation protection, as well as to legal entities for giving expert opinions, performing control measurements and technical checks of radiation sources and protective equipment, and for performing training in radiation protection for occupationally exposed workers. Individuals can acquire approval if they have appropriate formal education, working experience and expert skills. Legal entities can get the approval if they employ appropriate experts and have at their disposal appropriate measuring methods accredited according to the standard SIST EN ISO/IEC 17025. Authorizations are limited to specific expert areas.

In 2012, the SRPA issued eight approvals to radiation protection experts, four to natural persons and four to legal entities. Approvals were granted on the basis of the opinion of a special commission which assesses whether candidates fulfilled requirements.

Approved dosimetric services

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

In 2012, the SRPA granted three such approvals. The granting of all approvals was based on the opinion of a special commission which assessed whether candidates fulfilled requirements.

Approved medical physics experts

Approved medical physics experts give advice on the optimization, measurement and evaluation of 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 2012, the SRPA did not issue any approval for medical physics experts.

Approved medical practitioners

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

In 2012, the SRPA did not issue any recommendation for medical practitioners.

7.6 The Nuclear Insurance and Reinsurance Pool

The Nuclear Insurance and Reinsurance Pool is a special insurance company, which deals with the insurance and reinsurance of nuclear risks.

The Nuclear Insurance and Reinsurance Pool has been operating since 1994, when eight members (insurance and reinsurance companies with their registered offices in Slovenia) signed a contract to establish the Nuclear Insurance and Reinsurance Pool.

In 2012, the members of the pool were the insurance company Triglav, Ltd.; the reinsurance company Sava, Ltd.; Adriatic Slovenica, Ltd.; the reinsurance company Triglav Re, Ltd.; the insurance company Maribor, Ltd.; the insurance company Tilia, Ltd.; and the insurance company Merkur, Ltd. The first four companies listed above had the biggest shares in the pool.

The third-party liability of nuclear operator with headquarters in the Republic of Slovenia is insured in accordance with the Act on Liability for Nuclear Damage that entered into force on 4 April 2011. Under this policy, the Nuclear Insurance and Reinsurance Pool covers up to the amount of insurance specified in the insurance policy, as well as costs, interest and expenses that the policy holder must reimburse to the victim of a nuclear incident. The insurance covers the legal liability arising from the operation of policyholder and its possession of property when an accident in nuclear installation causes damage during the insurance period.

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

8 NON-PROLIFERATION AND NUCLEAR SECURITY

8.1 The Treaty on Non-Proliferation of Nuclear Weapons

Over the last few years, the international community has focused more attention on nuclear non-proliferation. A few countries which are not contracting parties to the Treaty on Non-Proliferation of Nuclear Weapons, namely India, Pakistan, North Korea and Israel, continue to implement their nuclear weapons programmes. The situation in Iran shows that their civil nuclear programme is not always transparently presented. In September 2012, the Board of Governors of the IAEA adopted a resolution which again expressed concerns about the unresolved issues regarding the Iranian nuclear programme, including a lack of co-operation, the non-implementation of the Additional Protocol as well as the absence of the possibility to the IAEA to credibly find out whether all nuclear material in this country is meant for peaceful use. The Board of Governors of the IAEA examined four reports of the Director General on Iran, as well as one on the Democratic Republic of North Korea and Syria.

The next Review Conference on the Treaty on Non-Proliferation of Nuclear Weapons is to take place in 2015. The first out of three Preparatory Meetings was held in Vienna from 30 April to 11 May 2012. The main topic of this meeting was the Action Plan endorsed at the previous conference in 2010. The next Preparatory Meeting will take place in Geneva in spring 2013.

Slovenia completely fulfils its obligations under the adopted international agreements and treaties. Together with other countries, it endeavours to prevent the further expansion of nuclear weapons.

8.2 Nuclear safeguards in Slovenia

At the international level, nuclear safeguards are regulated with the Treaty on Non-Proliferation of Nuclear Weapons and the Treaty Establishing the European Atomic Energy Community. In the process of Slovenia's accession to the EU, the legal frameworks had to be adapted. Slovenia now 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 report directly to the European Commission about their quantities and status of nuclear material, in accordance with Commission Regulation (EURATOM) No. 302/2005 on the application of EURATOM safeguards. The copies of reports are sent to the SNSA, which maintains its registry on nuclear material.

There were six IAEA/EURATOM inspections in 2012, whereas EURATOM carried out one inspection by itself; no anomalies were found during any inspection. In accordance with legislation, the Slovenian holders of nuclear material reported to the EURATOM.

8.3 CTBT

The Comprehensive Nuclear Test-Ban Treaty (CTBT) is one of the international instruments, aimed at combating proliferation of nuclear weapons. Slovenia signed the treaty on 24 September 1996 and ratified it on 31 August 1999. The CTBT provides for the establishment of the Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO). At the moment, the tasks of the CTBTO are performed by the Preparatory Commission (PrepCom), which is setting up a monitoring system to detect nuclear explosions. As a signatory, Slovenia has followed the activities of the CTBTO.

In the margins of the UN conference on 27 September 2012 in New York, a 6th ministry conference on supporting non-proliferation of nuclear weapons and putting the CTBT into force was held The conference issued a joint statement emphasizing that the enforcement of the CTBT is a key step to reduce and eliminate nuclear weapons. This can be achieved by constraining the development and improvement of nuclear weapons. Slovenia took part at the 6th ministry conference on ministerial level and thus showed support for achieving the final goal of eliminating nuclear weapons.

8.4 Export control of dual-use goods

In the scope of international activities in this area, the SNSA and the Ministry of Foreign Affairs participate in the Nuclear Suppliers Group (NSG) and the Zangger Committee. Slovene representatives attend sessions of both organizations. The mission of both bodies is to prevent the export of dual-use goods, i.e. goods which might be used for manufacturing nuclear weapons, to those countries that wish to acquire such weapons. Annual plenary week of the NSG was held in June 2012 in Seattle, USA.

On the basis of the Act on Export Controls of Dual-Use Goods, a special Commission for the Export Control of Dual-Use Goods was established at the Ministry of Economy. 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 Economic Development and Technology, the Ministry of Foreign Affairs, the Ministry of Defence, the Ministry of the Interior, the Customs Administration, the SNSA, the Slovenian Intelligence and Security Agency, and the Chemicals Office. 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 2012, the commission had 7 regular and 14 correspondence sessions. The role of the SNSA in this commission is primarily related to the export of goods which might be used in the production of nuclear weapons or nuclear dual-use items.

In May 2012, a large international conference on export control of dual-use items took place in Portorož, Slovenia. Around 300 delegates from 75 states as well as invited representatives from international organisations participated in the conference.

8.5 Physical protection of nuclear material and facilities

The operators of nuclear facilities implemented physical protection measures in accordance with their plans on physical protection, which were approved by the Ministry of the Interior. The operators also checked if their plans were in line with the threat assessments for 2012, issued by the Slovenian Police. Annual training sessions for guards of nuclear facilities and materials during transport were held. The Reactor Infrastructure Centre of the Jožef Stefan Institute and the Agency for Radwaste Management organised an exercise in the frame of emergency event; security staff in charge for physical protection of those two facilities co-operated in this exercise.

The systems of physical protection are supervised by the Inspectorate for Interior Affairs of the Ministry of Interior in co-operation with the SNSA. In 2012, the Inspectorate for Interior Affairs initiated a procedure of inspection control in the areas of physical protection during the transport of nuclear material en route through Slovene territory. In two cases, decisions on conditions were issued. Due to the non-accomplishment of arrangements from 2011, an administrative violations procedure was initiated for a company and its responsible person.

In March 2012, the Slovene Government appointed a new Commission on physical protection of nuclear facilities and nuclear and radioactive material. The commission gives its opinions on the threat assessment of nuclear facilities and nuclear and radioactive material, monitor and coordinate the implementation of measures for physical protection of nuclear facilities and nuclear and radioactive material, make suggestions to improve these measures, as well as make proposals in the preparation of legislation in the area of physical protection of nuclear facilities and nuclear and radioactive material. In 2012, one regular session of the commission was held. The commission accepted a proposal regarding the threat assessment for the transit of nuclear material across the Slovene territory.

Multiple proposals of the second-level legislation have been prepared, namely the Rules on the physical protection of nuclear facilities, nuclear and radioactive material and transport of nuclear material; the Rule on low programme of initial professional training and programme of periodic professional training of security staff, when performing work on physical protection of nuclear facilities, nuclear and radioactive material and transport of nuclear material; the Rules on procedure of the Commission on physical protection of nuclear facilities and nuclear and radioactive material. The legislation, mentioned above, has been sent to the procedure for acceptance and approval.

In the last third of 2012, two transports (shipments, transits) of nuclear material through Slovene territory required physical protection. The protection of both was carried out without peculiarities.

At the beginning of October 2012, a regular annual meeting of the ENSRA (European Nuclear Security Regulators Association) was held in Switzerland. Unfortunately, Slovene representatives from the SNSA and the Ministry of the Interior did not participate due to financial reasons.

8.6 Illicit trafficking of nuclear and radioactive materials

By the end of 2012, the SNSA issued 21 approvals for measuring the radioactivity in scrap metal shipments. All approved organisations, except one, sent their annual reports to the SNSA. According to those reports, 41,661 measurements of shipments were carried out in 2012. In five cases, the doses were elevated.

To provided assistance and consultation to other state offices and scrap metal recyclers, a duty officer was available 24/7 at the SNSA until November 2012, when his availability was reduced to the period from 8:00 on Mondays to 22:00 on Fridays due to lack of financial resources. Eleven calls to the duty officer were registered in 2012. The SNSA regularly receives information on incidents in other countries, analyses it and, if appropriate, sends it to those authorities which also deal with illicit trafficking of nuclear and radioactive material.

In 2012, the IAEA hosted its periodic meeting with the points of contact in the Member States, responsible for ITDB (Illicit Trafficking Database). Nearly 90 points of contact, including the Slovenian, attended the meeting.

In September 2012, the representatives from the SNSA, the Customs Administration and the Ministry of the Interior met and reviewed the current situation in the area of illicit trafficking of nuclear and other radioactive material.

9 INTERNATIONAL COOPERATION

9.1 Cooperation with the European Union

Working Party on Atomic Questions (ATO)

In the first half of 2012, Poland handed over the EU presidency to Denmark, and in the second half of 2012, Cyprus took over the presidency. In the Working Party on Atomic Questions (ATO), the discussion about the conclusion of the stress tests of the EU nuclear power plants came to an end after the national reports were reviewed in the beginning of 2012.

ATO also began to discuss a draft regulation on the Instrument for Nuclear Safety Cooperation, which covers the period after 2014. The ATO delegates received details about negotiations of the Euratom with Canada, Russian Federation and the Republic of South Africa. The ATO also dealt with proposals for financing the decommissioning of nuclear power plants which were shut down when Slovakia, Lithuania and Bulgaria entered the EU. The stress tests carried out by the Ukraine and Switzerland were presented at the ATO. Experts from Belarus and Turkey also took part in reviewing national reports, although these two countries do not have nuclear power plants. At the end of the Cyprus Presidency, the initial discussion about the proposal for a regulation on the registration of carriers of radioactive materials took place.

A draft directive on basic safety standards for the protection against ionizing radiation (BSS) was a permanent item on the agenda. The SRPA closely followed the discussion about this directive and took part in the meetings. For the BSS Directive, a technical group was founded, which held its first meeting in July. The draft directive on radioactive contamination of water and human food was also considered in that meeting.

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. The group is composed of the highest representatives of regulatory bodies responsible for nuclear safety, radiation protection and the safety of radioactive waste from all 27 Member States of the European Union. The representatives of European Commission take part in the ENSREG under the same rules as other members.

ENSREG's role is to help establishing conditions for continuous improvement and to reach a common understanding in the areas of nuclear safety and radioactive waste management. The Chairman of the Nuclear Safety Regulators Group by mid-2012 was Dr. Andrej Stritar, the SNSA Director, who finished his second extended term of office after five years.

In 2012, the Nuclear Safety Regulators Group held four meetings, where members mainly discussed the end of the campaign stress tests in European nuclear power plants, the Action Plan after the stress tests and the proposed changes in the Nuclear Safety Directive.

Consultative Committees under Euratom

Within the framework of the European Atomic Energy Community Treaty (Euratom), there are at present several technical and consultative committees dealing with different areas in the field of nuclear energy. The SNSA representatives are active in committees under Articles 31, 35/36 and 37.

The committee under Article 31, chaired by the SNSA employee Dr. Helena Janžekovič, prepares recommendations for the European Commission regarding legal acts in the field of radiation protection and public health. Also in 2012, the committee dealt with experiences gained from the nuclear accident in the Fukushima NPP in Japan. Other topics covered radioactive waste, especially workshops in this area. The committee considered a document aimed at establishing a uniform system for the registration of carriers of radioactive materials in the EU. The other items on the committee's agenda were radioactivity in the water, changes in the ECURIE notification system in the event of a nuclear or radiation emergency, and scanners used for security check-ups at the airports.

Euratom requires Member States to establish a system of radiation monitoring in the environment and consequently report to the European Commission within the committee under Article 35. In 2012, the committee under Article 35 did not have any meetings.

The main task of the committee under Article 37 is to prepare opinions for the European Commission regarding the impact of an individual nuclear object on adjacent Member States. Representatives mainly meet by correspondence. In 2012, the Slovenian representative did not attend any meeting of the working group under this Article.

Consultative Committees of the European Commission

The Consultative Committee Instrument for Nuclear Safety Co-operation (INSC) advises the European Commission on issues regarding the assistance to third countries in the area of nuclear and radiation safety. In 2012, the INSC discussed their annual programme, which comprises a joint programme for Ukraine and Armenia together with plans for seven activities aimed at assisting the regulatory bodies. The programme also includes providing support to the Mexican and Brazilian regulatory body in performing stress tests as well as implementing measures in case of a severe accident in line with European practices. A significant financial contribution was foreseen for the Chernobyl Fund, while some resources were also allocated for establishing a radiological laboratory with a mobile unit in Iraq. Assistance will also be provided to Kyrgyzstan, where the EU aims to assist in remediation of former uranium mining areas. In Malaysia, assistance will focus on the activities of the regulatory body in the area of radioactive waste management.

The Consultative Committee Euratom-Fission is a group of experts whose role is to advise the European Commission regarding nuclear research projects, which are completely or partially financed by the EU. The Committee discussed the 2012 annual programme and the 2013 work programme. Member States were also informed that the funds will now focus on programs rather than on individual projects, as was the case until now. The Committee got acquainted with the future EU energy policy called »Energy Roadmap 2050«. Future research plans and expectations, which should be realized in the framework of a new research program »Horizon 2020«, were presented.

Cooperation in EU Projects

Cooperation in the Project of Training and Tutoring for the Third Countries

In 2012, a project on education and mentoring in the field of nuclear safety for the administrative authorities of third countries started. This project is funded by the European Commission and implemented by a consortium led by the Italian company ITER. Among other consortium members, the Jožef Stefan Institute and the SNSA also participate in the project. In November, the Jožef Stefan Institute carried out a course on safety of nuclear power plants, after which the Brazilian and Mexican expert continued with two months of tutoring that provided them with the practical knowledge and experiences of the SNSA in overseeing a nuclear power plant.

Assistance in Removing the Radioactive Lightning Rods in the Western Balkan Countries

As a member of a consortium, the SNSA participated in the technical assistance project »Management of Sealed Radiation Sources, including Lightning Rods, in the former Yugoslav Republic of Macedonia, Kosovo (as defined in UNSCR 1244/99) and in Montenegro« funded by the European Commission. A consortium was led by a consulting company ENCONET Consulting GmbH from Austria. The SNSA prepared an assessment of regulatory and administrative framework in the field of radioactive waste management in Montenegro and Macedonia, as well as the criteria for preparing safety reports and procedures for removing and disposing of radioactive lightning rods and other sealed sources. The consortium assisted Macedonian and Montenegrin regulatory bodies in reviewing safety reports and working procedures for disposing of radioactive lightning rods, evaluated software for data management of sealed sources and defined radiological equipment necessary for removing radioactive lightning rods.

»Dose DataMed 2« Project

In 2010, Slovenia joined the project *»Dose DataMed 2«*, which is carried out under the auspice of the European Commission and coordinated by the Finnish regulatory authority. The project estimated the contribution to the total dose received by patients in diagnostic procedures in medicine.

In 2012, the SRPA, in cooperation with the Slovenian Radiologists' Association, began the process of introducing diagnostic criteria for radiological check-up in Slovenia. Experience in developed countries shows that it would be reasonable to use common diagnostic criteria developed on the basis of a systematic review of scientific literature and established practices. However, the development of such diagnostic criteria for Slovenia would significantly exceed the available resources, so the decision was made to transfer and adapt diagnostic criteria used abroad. After a review, the British diagnostic criteria were selected, as they have for more than a decade long tradition. A professional association of radiologists, namely The Royal College of Radiologists or RCR, updates the criteria regularly in accordance with the technological development and new findings. Currently, the process of acquiring consent from the RCR to adapt and use their diagnostic criteria in Slovenia is under way. At the same time, the SRPA, in collaboration with the Medical Chamber of Slovenia, is preparing training for referrals, since the successful transfer of diagnostic criteria in practice is based on their use by referrals.

ESOREX

For several years, the SRPA has been involved in project the European Study of Occupational Radiation Exposure (ESOREX). The ESOREX project is dedicated to collection, processing and comparing occupational doses data at the international level. In the project framework, countries share experience on organising individual monitoring and managing national data registry. The project is supported by the European Commission, but it is not limited only to EU Member States. In 2012, the participating institutions continued to collect and share data.

9.2 International Atomic Energy Agency

In 2012, Slovenia successfully cooperated with the International Atomic Energy Agency (IAEA). The Slovenian delegation also attended the regular annual session of the General Conference. The most important Slovenian activities are as follows:

- In 2012, Slovenia received 13 individual applications and one group application for training of foreign experts in our country. Seven trainings were implemented; two training applications were withdrawn by the IAEA; four individual applications will be implemented in 2013. Three training applications received in 2011 were also realized in 2012.

- Slovenia submitted five new proposals for research contracts, which were prepared at the Jožef Stefan Institute, the Agency for Radwaste Management, the Department for Nuclear Medicine and the Institute of Oncology Ljubljana. Twelve research contracts were in progress from previous years.
- A new biennial technical cooperation cycle started in 2012. Activities, such as trainings, an expert mission, visits of foreign experts and consultations with them, planning of premises adjustment, and equipment procurement, which was planned under the three national projects, started to be implemented. The funds for these activities were assured from the Agency's regular budget.
- Participation in the workshops, training courses and technical meetings organised by IAEA is still one of the most important options for professional training of Slovenian experts, since in most cases, the IAEA covers the costs of participation.
- Slovenia continues with its active policy of hosting activities organized by the IAEA. In 2012, Slovenia hosted five such events, namely workshops, courses and meetings.
- It is important to mention that the experts from Slovenia continued to take part in various IAEA committees, expert missions and workshops abroad.

In 2012, an IAEA project in the field of the optimization of medical use of ionizing radiation, in which the Slovenian Radiation Protection Administration has been collaborating since 2005, was completed. In the first phase of the project, the SRPA was actively involved in the field of radiation protection in intervention procedures with an emphasis on interventional cardiology. In that time, the SRPA established a good overview over the situation in Slovenia and started optimising the procedures where needed. During the last period, the SRPA's involvement in this project was focused on the optimization of computed tomography (CT) examinations in paediatric patients. Due to extremely good project results, Slovenia, with a support of seven countries, made an initiative for the project to be extended for the period 2014 – 2017.

In 2012, the cooperation of the Republic of Slovenia with the IAEA was completed with outstanding contributions to the IAEA budget amounting to 267,124 euros due to inability to pay this amount. Taking into account the funding provided in the state budget of the Republic of Slovenia, the amounts payable to the IAEA regular budget will be behind one year. If this is going to continue, the status of payment in arrears will become even worse. In such case, the Agency may decide to withdraw Slovenia's voting rights, which would be a precedent for a developed country. At the same time, this situation would have significant side effects for our country, especially when a new two-year period (2016 – 2018), when Slovenia is to become a member in the Board of Governors, is approaching. Payment in arrears will also affect the credibility and relationship of the Slovenian representatives which are working for or participating in the IAEA, or are otherwise connected with the organisation. Beside Slovenia, the only EU country that has not settled the payment towards the IAEA's regular budget is Spain. Furthermore, Slovenia is the only EU country that has not paid in full its obligations to the Technical Assistance and Cooperation Fund.

INSARR Mission

From 12 to 16 November 2012, the International Atomic Energy Agency conducted a review of the safety of the research reactor TRIGA Mark II on the request of the Slovenian Government. The mission members reviewed all safety aspects of the research reactor and compared them with the IAEA safety standards. All over the world, 81 similar missions known under the acronym INSARR (INtegrated Safety Assessment for Research Reactors) have been implemented so far. First such mission at the TRIGA Research Reactor was carried out in 1992.

The mission concluded that the reactor operates well and in line with the international standards and accepted practices. The mission recognized two good practices and gave advice on possible improvements, for which 16 recommendations and 8 suggestions were proposed.

The recommendations for safety improvements cover both technical and organizational factors, as well as the improvements of procedures and the update of the safety analysis report. The recommendations regarding the organization are aimed at improving the allocation of responsibilities in the organization and operation of the reactor and in an independent safety oversight within the institute. It was recommended to the Slovenian government to provide adequate resources to ensure and improve the safety of the research reactor, which would include means to employ a full-time head of reactor at the »Jožef Stefan« Institute. The mission also concluded that the regulatory supervision by the SNSA is appropriate. The experts suggested extending the scope of inspection controls to include checking the compliance of operational conditions and limits and reviewing the results of periodic tests.

9.3 Organisation for Economic Cooperation and Development – Nuclear Energy Agency

2012 was the first year that Slovenia participated as full member in 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 cooperated closely with the Atomic Energy Agency in Vienna and European Commission in Brussels and Luxembourg. The NEA implements specific scientific projects, including verification and benchmarking of scientific results, which will pave the way to further progress.

In March, the SNSA organized a meeting of Slovene representatives in the NEA committees in order to exchange experiences. Representatives pointed out the principle of reciprocity meaning that only representatives who participate in the meetings should get information. Slovenian representatives, who work as researchers, have stressed that they would like to get directions from state institutions about their priority research areas. In addition to research and information, the NEA also offers other benefits, such as carrying out international exercises, having access to scenarios, sharing experiences, following developments in the field of liability for nuclear damage, and other. Most of the representatives mentioned the impact of the accident in Fukushima Daiichi on the work in their group.

The cooperation of Slovenia, namely the Krško NPP and the SRPA, in the International System of Occupational Exposure (ISOE) continues. The ISOE is an information system on occupational exposure to ionizing radiation in nuclear power plants, supported by the OECD / NEA and IAEA. Information system is maintained by several technical centres with the support of above mentioned organizations and with cooperation of nuclear power plants and administrative authorities. With its full membership in OCED, Slovenia has been moved from a technical centre financed by IAEA to the European technical centre. New status of our country brings the legal liability for paying the membership fee for the cooperation of the regulatory body in the ISOE. Due to lack of financial resources in 2012, the SRPA was not able to pay the membership fee. In long range, this means that the SRPA will not be able to participate in the ISOE.

Financial constraints also restricted the participation of Slovenian members in the work of the NEA committees, which in turn means lower flow of information on the latest findings and experiences from abroad to Slovenia. The strange situation occurred because since Slovenia became a member of the OECD/NEA in 2011, its representatives participated less in the work of the committees and subcommittees as they did before when Slovenia was just an observer.

9.4 Cooperation with Other Associations

Western European Nuclear Regulators' Association (WENRA)

WENRA is an informal association consisting of representatives of nuclear regulatory authorities from European countries with nuclear power plants. The main objectives of WENRA are to develop a common approach to nuclear safety and to exchange experiences between the chief nuclear safety regulators in Europe.

In 2012, the main WENRA committee and its working group dealt primarily with lessons learned from the Fukushima accident. In connection with this event, the committee stressed the importance of the independence of the nuclear safety regulatory body. WENRA pointed out that regularly implementing periodic safety reviews should be a priority, as well as providing mutual assistance in cases of emergencies. Furthermore, cultural aspects and efforts to strengthen nuclear safety were taken into account when looking for improvement, no matter how high nuclear safety is in a respective country. The technical aspects, which include events resulting from natural disasters, as well as ensuring the integrity of the containment and response to serious accidents, were mentioned. The stress tests, which were in its final stage in the EU when WENRA meeting took place, were also discussed. Special working groups were created to examine the specific experiences that were discussed and to make suggestions on how to continue. The WENRA working groups tried to prepare a common platform for selected key safety parameters, which will need to be taken into account when designing new nuclear power plants. Moreover, the groups completed the reference levels for radioactive repositories, which were also published.

The International Nuclear Law Association

The International Nuclear Law Association (INLA) is an international association of legal and other experts in the field of peaceful use of nuclear energy. Objectives of the INLA are to support and promote studies in and knowledge of legal issues related to the peaceful use of nuclear energy, focusing on the protection of people and their environment, on promoting exchange of information among its members, and on cooperation with similar associations and institutions on a scientific basis. INLA has more than 500 members from more than 50 countries and international organizations.

In October 2012, the INLA congress was held in Manchester, United Kingdom. The congress is normally organized every two years. The SNSA, which is a member of the Association, did not nominate their representatives for the congress due to financial restrictions.

CAMP

Under the agreement with the US NRC (Federal administrative authority for nuclear safety of the U.S.), the SNSA cooperates in international research and development activities, coordinated by the US NRC under the CAMP programme (Code Application and Maintenance Programme). The CAMP programme facilitates cooperation in the field of maintaining and using software to prevent and control accidents and abnormal events in nuclear power plants. Slovene National Coordinator of the CAMP programme is the Jožef Stefan Institute under the auspices of the Krško NPP and the SNSA.

From 30 May to 1 June 2012, the Jožef Stefan Institute organized a summit »Spring 2012 CAMP Meeting« in Ljubljana. 65 representatives from 21 countries, including ten from Slovenia, attended the meeting.

Association of the Heads of European Radiological Protection Competent Authorities

A representative of the SRPA is a member of the Association of the Heads of European Radiological Protection Competent Authorities - HERCA. In 2012, the association dealt with radiation protection measures and their harmonization in case of an emergency and the preparation of the training for inspectors in the clinical aspects of radiological procedures. HERCA also strengthened their cooperation with radiology equipment manufacturers and international organizations in the field of radiation protection.

European ALARA Network

As one of 20 European countries, Slovenia is participating in the European ALARA Network (EAN). The EAN is dedicated to optimising radiation protection and sharing good ALARA practice in industry, research and medicine. In the framework of the EAN, international workshops in specific fields are organised. In addition, the EAN issues a newsletter with information on practical implementation of the ALARA principle, examples of good practice and other news. 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 in the framework of the EAN. The SRPA is active in the ERPAN (European Radioprotection Authorities Network), which is dedicated to the exchange of operational information on surveillance and measures in radiation protection. In 2012, the EAN organized a workshop titled »Existing exposure ALARA and Situations«, which was held in Dublin, Ireland.

9.5 Cooperation in the Framework of International Agreements

Slovenia is a party to numerous bilateral and multilateral agreements in the field of nuclear and radiation safety, safeguards of nuclear materials, notification and response during a nuclear accident, physical protection of nuclear objects, nuclear non-proliferation, and nuclear liability.

Bilateral Co-operation

In June, the Czech regulatory body in Prague hosted a so called Quadrilateral Meeting, namely a regular annual meeting of Czech Republic, Hungary, Slovakia and Slovenia, whose regulatory bodies have signed bilateral agreements amongst them. Participants exchanged information on developments in their countries in the past year. A similar bilateral meeting was organized in October in Graz between Slovenian and Austrian regulators.

On 18 September, at the margins of IAEA General Conference, the SNSA Director Andrej Stritar and the Chairman of the National Nuclear Agency of the Republic of Albania Milo Kuneshka signed a Memorandum of Understanding on the exchange of information between both institutions. This Memorandum of Understanding will facilitate the exchange of information on nuclear safety, regulatory oversight of nuclear and radiation facilities, and control of radiation sources including transport of radioactive materials and radioactive waste.

The Second Extraordinary Meeting of the Parties to the Convention on Nuclear Safety

The second extraordinary meeting of the Parties to the Convention on Nuclear Safety was held in Vienna from 27 to 31 August. It was dedicated to improving nuclear safety, reviewing the national post-Fukushima actions and exchanging experiences among the participating countries after the events in Fukushima. Each country, including Slovenia, prepared a report on the measures taken in a respective country following the accident at Fukushima. The meeting was an opportunity for an intensive exchange of views on the implemented actions as well as on future plans.

Intergovernmental Agreement on the Co-ownership of the Krško NPP

Irrespective of the importance of the Intergovernmental Agreement on the Co-ownership of the Krško NPP for operation of the Krško NPP and for the electricity power system in Slovenia, the Interstate commission responsible for the implementation of the Agreement has not hold any meetings since 2010.

Also in 2012, no meeting of the Expert Council for following the development of the second revision of the Krško NPP's Decommissioning and Disposal of Radioactive Waste and Spent Fuel Programme (the Decommissioning Programme) was held. In 2011, the professional organizations the Agency for Radwaste Management (ARAO) and the Agency for Special Waste (APO) prepared the second revision of the Decommissioning Programme. Due to the disagreements among the members of Expert Council from Slovenian and Croatia relating to proposed decommissioning scenarios, there was no common agreement on the adoption of the Decommissioning Programme.

In 2012, new members of Slovenian delegation of the Interstate Commission were appointed. The Republic of Croatia was informed about the new members and was requested to inform the Republic of Slovenia about the new members of Croatian delegation of the Interstate Commission.

10 USE OF NUCLEAR ENERGY IN THE WORLD

At the end of 2012, there were 437 nuclear reactors for electricity production operating in 31 countries. In 2012, three new nuclear power plants were put into operation, of which two were in South Korea and one in China. Two nuclear power plants in United Kingdom and one in Canada ceased operation. The construction of seven new nuclear power plants started in 2012, of which four were in China and one in Russia, South Korea and United Arab Emirates.

In Europe, there are nuclear power plants under construction in Finland, France, Ukraine, and Slovakia. New builds are planned in Poland, Hungary and Czech Republic. Detailed data on the number of reactors by country and their installed power is given in Table 10.

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

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
Belgium	7	5,927		
Bulgaria	2	1,906		
Czech Republic	6	3,804		
Finland	4	2,752	1	1,600
France	58	63,130	1	1,600
Hungary	4	1,889		
Germany	9	12,068		
Netherlands	1	482		
Romania	2	1,300		
Russia	33	23,643	11	9,297
Slovakia	4	1,816	2	880
Slovenia	1	696		
Spain	8	7,560		
Sweden	10	9,395		
Switzerland	5	3,278		
Ukraine	15	13,107	2	1,900
United Kingdom	16	9,231		
Europe total:	**185**	**161,984**	**17**	**15,277**
Argentina	2	935	1	692
Brazil	2	1,884	1	1,245
Canada	19	13,500		
Mexico	2	1,530		
USA	104	101,276	1	1,165
Americas total:	**129**	**119,125**	**3**	**3,102**
Armenia	1	375		
India	20	4,391	7	4,824
Iran	1	915		
Japan	50	44,215	2	2,650
China	17	12,860	28	27,844
Korea, Republic of	23	20,739	4	4,980
Pakistan	3	725	2	630
Taiwan	6	5,028	2	2,600
United Arab Emirates			1	1.345
Asia total and Middle East:	**121**	**89,248**	**46**	**44,873**
South Africa	**2**	**1,860**		
World total	**437**	**372,217**	**66**	**63,252**

11 RADIATION PROTECTION AND NUCLEAR SAFETY WORLDWIDE

The International Atomic Energy Agency maintains a system for reporting on significant events in nuclear power plants, research reactors and fuel cycle facilities, as well as on events associated with radiation practices and the transport of radioactive materials in member states. The system is known as The International Nuclear and Radiological Event Scale (INES).

Member states report internationally on more significant events rated at Level 2 or higher and on events that have caught the interest of international public. In 2001, a web-based communication system for publishing event reports NEWS, which can be found at http://www-news.iaea.org was created.

INES events in 2012

In 2012, 23 event reports were published in the system NEWS. 4 reports covered events in NPPs, while 2 reports dealt with events in other nuclear facilities. 1 event was connected to transport, whereas 7 events were linked to orphan sources. 9 reports treated the excessive radiation exposure of workers while using radiation sources or irradiation devices. The reports on these events were classified at INES Level 2 or less, except for two events, when the workers were excessively exposed to radiation while performing radiography, that were classified at INES Level 3.

One of two events classified at INES Level 3 occurred while handling a radiographic camera. A ^{192}Ir radiation source with an activity of 3.2 TBq detached from the guide tube, but the worker did not notice it. On the basis of biological dosimetry, the workers' dose was estimated at 1.86 Gy to whole body and 70 Gy to his finger.

The second event classified at Level 3 on INES took place when 3 workers were excessively exposed while performing radiography with a ^{192}Ir radiation source with an activity of 2.5 TBq. The source detached and got stuck inside the guide tube. By calculations, the dose was assessed at 2.02 Sv for the most exposed worker and at 0.81 Sv for the other two workers.

Seven events were classified at INES Level 2 due to the excessive exposure of workers while working with irradiation devices, performing radiography and setting the radiation source into an irradiation device. One event occurred when an irradiation device was disassembled in lead foundry with an unnoticed source remaining inside the device.

An event which happened during an outage in a NPP was also classified at INES Level 2. Due to human error, the offsite power supply was lost. An emergency diesel generator failed to start and the other emergency diesel generator was unavailable because of maintenance.

Three events in NPPs were classified at INES Level 1. First event took place because the allowed outage time for equipment, which was outlined in the plants' operational limits and conditions, was not observed during power operation. During the second event, workers were exposed to radioactive tritium. The third event was a fire inside the reactor building of a NPP that was extinguished by plant personnel and firemen of local fire brigades. Several hours later, a reactor coolant leakage from a reactor coolant pump was detected. The leakage was fixed after 12 hours.

In nuclear fuel fabrication plant, an INES Level 2 event occurred. The inadequate control over nuclear materials leads to the risk of a criticality event.

Two events when radiation sources were stolen were revealed. The first event was classified as INES Level 2. It occurred when 3 level gauges, each containing a ^{137}Cs radiation source with an activity of 51.5 GBq, were stolen from a factory. Police caught the thieves and recovered radiation sources. The second event, classified at Level 1 on INES, occurred when workers performing radiography at a construction site were robbed and an industrial radiography camera containing a ^{192}Ir radiation source with an activity of 380 GBq was stolen. Police searched the surrounding area and found the source still intact near the construction site.

Among the events related to orphan sources, the highest rating at INES Level 2 was given to an event, when a ^{137}Cs source with an activity of 100 GBq was found in a cargo of scrap iron. The second event, classified at INES Level 1, happened when a ^{241}Am radiation source was melted together with the cargo of scrap metal. A third event, classified at INES Level 1, took place when an old ^{137}Cs source from an industrial densitometer was lost. Two INES Level 0 events occurred in ports when elevated radiation was detected in cargos of scrap iron containing radiation sources ^{137}Cs and ^{90}Sr with very low activities. Another event classified at INES Level 0 was reported in a port when an elevated radiation was detected due to iron products contaminated with ^{60}Co isotope.

INES events in Slovenia

In Slovenia, there were two events in 2012 that were both classified at Level 1 on INES. The SNSA reported on both events in the newsletter *»Sevalne novice«* as well as in the news on the SNSA internet site. The first event occurred in August in the company Temat d.o.o. during the performance of industrial radiography. The second event took place in October during the replacement of an X-ray tube in the company Union d.d. where X-ray devices are used in process techniques and automatics. Description of both events is included in Chapter 2.2.2, while INES event reports are published on the subpage »INES dogodki« of the SNSA internet site.

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