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

Annual Report 2006 on the Radiation and Nuclear Safety in the Republic of Slovenia

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ANNUAL REPORT 2006 ON THE RADIATION AND NUCLEAR SAFETY IN THE REPUBLIC OF SLOVENIA

June 2007

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

- Slovenian Radiation Protection Administration,
- Administration for Civil Protection and Disaster Relief of the RS,
- Ministry of the Interior,
- Ministry of Agriculture, Forestry and Food and,
- Ministry of Economy.

The report was approved by the Expert Council for Radiation and Nuclear Safety on 22.5.2006.

May 2007

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URSJV NUMBER: URSJV/RP-068/2007
ISSN NUMBER: ISSN 1580-0628
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1 INTRODUCTION

In the year 2006 there were no major problems in the area of protection against ionizing radiation and nuclear safety in Slovenia. There were no events that would present a radiological threat to the population.

The Nuclear Power Plant operated without any unexpected shutdowns and produced 5.5 TWh of electrical energy in total. The fuel cycle, which for the first time lasted 18 months, ended with the outage in spring 2006. During the outage the rotors of both low-pressure turbines were replaced, and as a consequence the plant's electrical power was increased by 20 MWe without any change at primary side. Due to the fuel cycle extension to 18 months, the Nuclear Power Plant Krško was compelled to increase liquid tritium effluents into the Sava River. After carrying out extensive analyses, the SNSA approved increased liquid tritium effluents. On the other hand, in the framework of the same licensing process, the SNSA compensated for this relaxation by reducing the limit for activation and fission products to one half.

The monitoring of radiological contamination of the environment and population in Slovenia did not show any deviation from normal values. There were no significant anomalies in the use of sources of ionizing radiation in industry and medicine. In spring 2006 the project of upgrading of the early warning network for the detection of raised levels of radiation in environment was completed. The number of measuring stations increased from 42 to 77.

At the beginning of the year the National Assembly of the Republic of Slovenia adopted the "Resolution on the National Radioactive Waste Management and Spent Nuclear Fuel Programme". In the process of site selection for the disposal of low and medium-level radioactive waste, the Agency for Radwaste Management carried out on-site measurements in the community of Krško and prepared a proposal for the construction of an underground disposal in the form of silos. The process of obtaining the consent of local communities continues in 2007.

The detection of orphan sources in the shipments of scrap materials continues. However, the number of detected sources has not increased in comparison to the previous years, mainly due to improved awareness of scrap raw-material importers and installation of fixed portal monitors at the Port of Koper and at the international border crossing Obrežje. The portal monitors were provided by the Government of the United States of America on the basis of the bilateral agreement.

On the basis of the governmental decision of the Republic of Slovenia a notice for a public tender was issued for a research project on nuclear energy issue, in order to strengthen the efforts in the nuclear field. Five related projects were selected and funded.

In the years 2005 to 2007 the Republic of Slovenia has been a member of the Board of Governors of the International Atomic Energy Agency (IAEA). In the autumn of 2006 Slovenia began its one-year presidency of the Board of Governors of the IAEA. On behalf of Slovenia, Mr. Ernest Petrič, the Slovenian Ambassador to Austria, presides over the Idea's executive body.

This report contains the essential data on the status in the areas of radiation protection and nuclear safety in the country, and is aimed at a wider group of interested public. At the same time an extended version is prepared (Ref. 1) consisting of all details and data which would be of interest to a narrower group of professionals. It is available in electronic form on CD-ROM and on the homepage of the SNSA (www.ursjv.gov.si).

2 OPERATIONAL SAFETY

2.1 Operation of Nuclear Facilities

According to the Act on Ionizing Radiation Protection and Nuclear Safety, a nuclear facility is defined as "a facility for the processing or enrichment of nuclear materials or the production of nuclear fuel, a nuclear reactor in critical or sub-critical configuration, a research reactor, a nuclear power-plant and heating plant, a facility for storing, processing, treating or depositing nuclear fuel or highly radioactive waste, and a facility for storing, processing or depositing low or medium radioactive waste". Three nuclear facilities operated in 2006 in Slovenia: the Nuclear Power Plant Krško, the Research Reactor TRIGA of the Jožef Stefan Institute and the Central Interim Storage for Radioactive Waste at Brinje.

2.1.1 Nuclear Power Plant Krško

2.1.1.1 Operation and Performance Indicators

In 2006, the Krško Nuclear Power Plant (NEK) produced 5,548,257.2 MWh (5.5 TWh) gross electrical energy on the output of the generator, which corresponds to 5,289,474.6 MWh net electrical energy delivered to the grid [1, 2]. The annual production was 1.72% more than planned. The reactor was critical for 7,945.53 hours or 90.70% of the total number of hours in this year. The thermal energy production of the reactor was 15,477,385.8 MWh.

The most important performance indicators are shown in Table 1, and their changes through the years are shown in the following parts of this report. The performance indicators confirm the stable and safe operation of the power plant [3, 4].

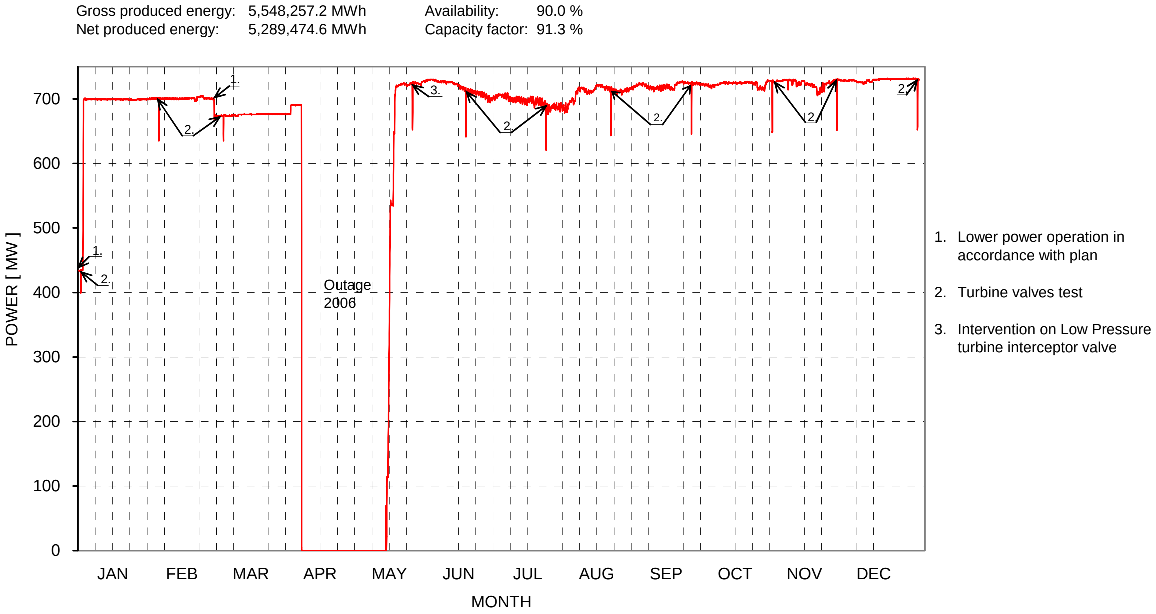
Table 1: The most important performance indicators in 2006

Safety and performance indicators	Year 2006	Average (1983-2006)
Availability [%]	90.00	84.87
Capacity factor [%]	91.34	81.73
Forced outage factor [%]	0.00	1.18
Realized production [GWh]	5,548.26	4,731.51
Fast shutdowns – automatic [Number of shutdowns]	0	2.84
Fast shutdowns – manual [Number of shutdowns]	0	0.34
Unplanned normal shutdowns [Number of shutdowns]	0	0.96
Planned normal shutdowns [Number of shutdowns]	1	0.79
Number of events	6	4.21
Refueling outage duration [Days]	36.9	48.9
Fuel reliability indicator (FRI) [GBq/m3]	$2.34 \cdot 10^{-3}$	$8.47 \cdot 10^{-2}$

In 2006, there was only one shutdown in the Krško NPP. The reason was a refueling outage which lasted between 8 April and 14 May.

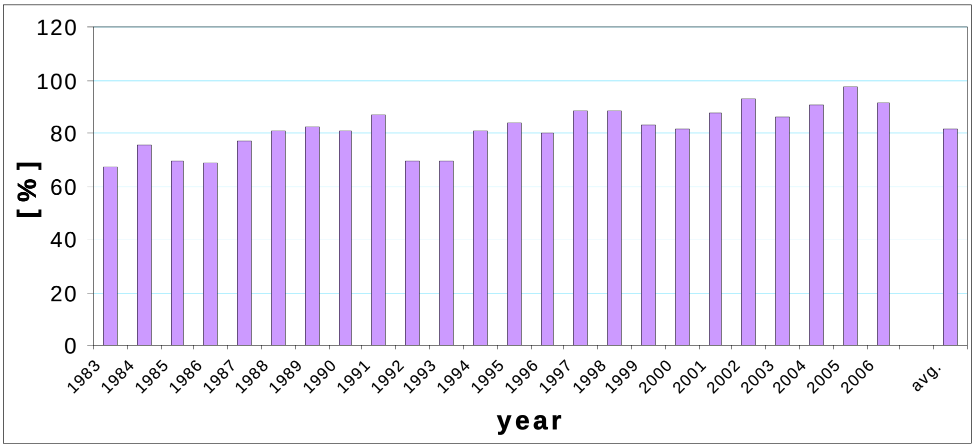
The shutdown and low power operations are shown in Figure 1.

Figure 1: Operating power diagram for the Krško NPP in 2006



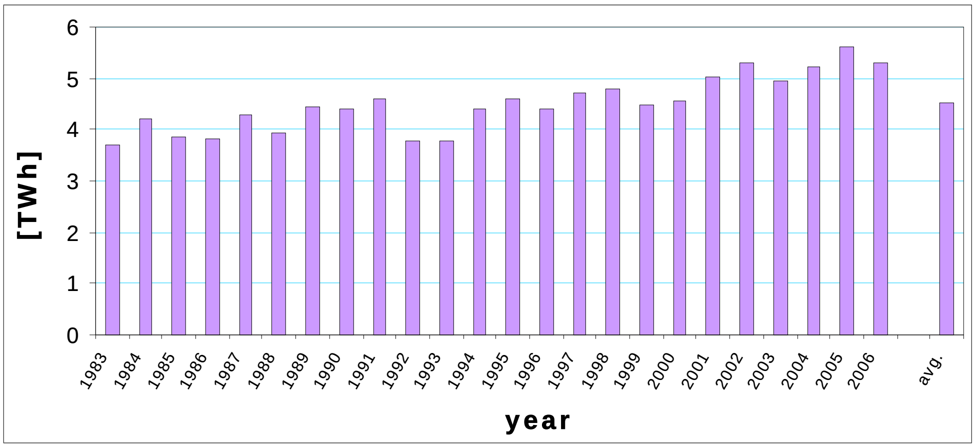
The load factor is a quotient between the actual produced electrical energy and the energy which could be produced if the plant had operated at maximal capacity. Figure 2 shows the load factors for the Krško NPP. The value in 2006 was 91.34%, which is lower than the year before when there was no annual outage. The load factor is used worldwide for the evaluation of effectiveness of nuclear power plants' operation.

Figure 2: Load factor at the Krško NPP



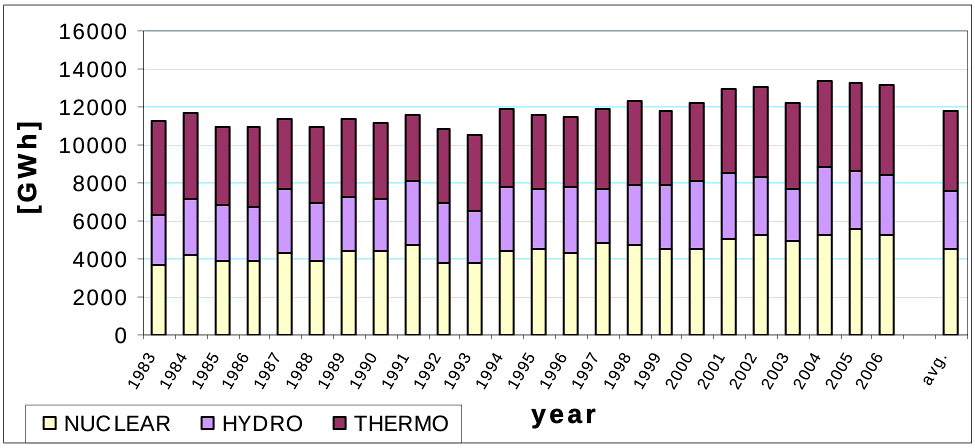
In Figure 3, the production of electrical energy is presented for the years of commercial operation. In the year 2006 the production of electrical energy was lower than the year before, when the plant operated without outage, none the less the production was quite high and it reached the value of 5.29 TWh.

Figure 3: Production of electrical energy in the Krško NPP



In Figure 4, the comparison between productions of electrical energy in Slovenia produced in nuclear, hydro and thermo power plants is shown. In recent years the production of electrical energy in Slovenia has stabilized at around 13 TWh.

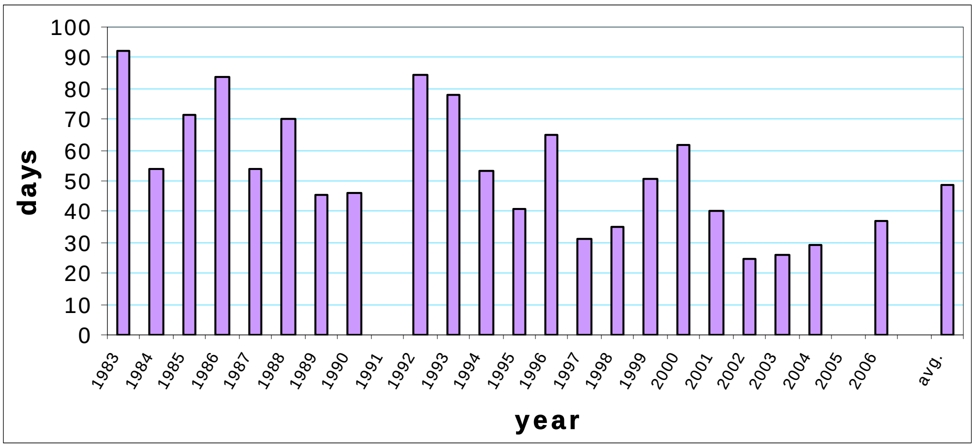
Figure 4: Production of electrical energy in Slovenia



In Figure 5 durations of refueling outages in the Krško NPP are shown. The refueling outage in 2006 was planned to last 32 days, but it was prolonged to 36.9 days due to steam leakage near the drainage line on the main steam system.

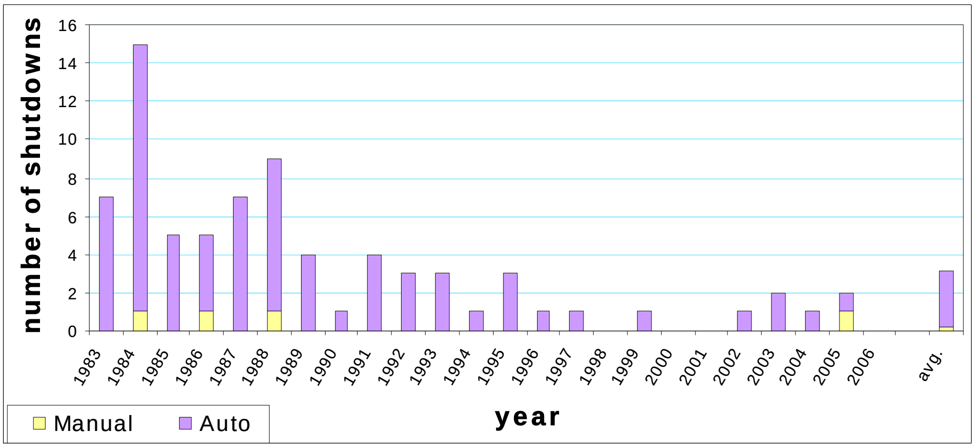
There is a noticeable trend in shortening of outages, but this is a general trend in nuclear industry. Shortenings can be achieved by better planning, by considering experiences and by rescheduling certain activities to the time of operation.

Figure 5: Duration of outage in the Krško NPP



In Figures 6 and 7, the number of reactor shutdowns is shown.

Figure 6: Fast reactor shutdowns – manual and automatic



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

In Figure 6 we can notice gradual stabilization of fast reactor shutdowns (in the last decade the average is less than one per year). In the year 2006 there were no fast reactor shutdowns.

Figure 7: Normal reactor shutdowns – planned and unplanned

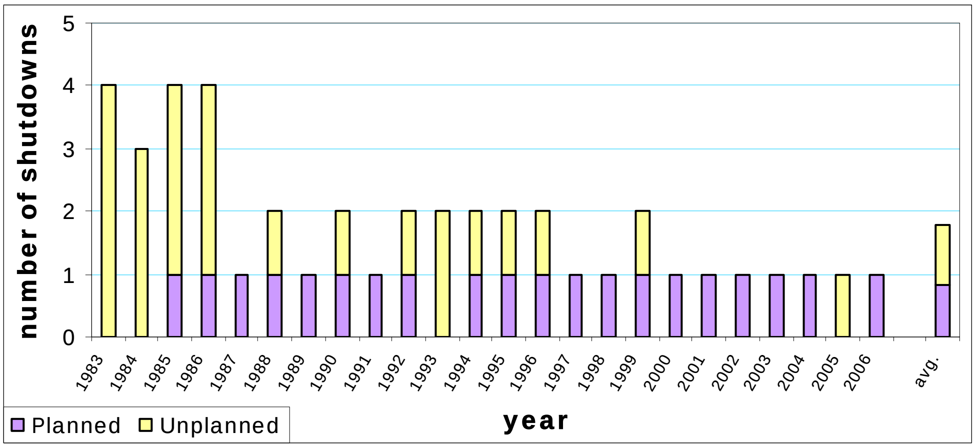
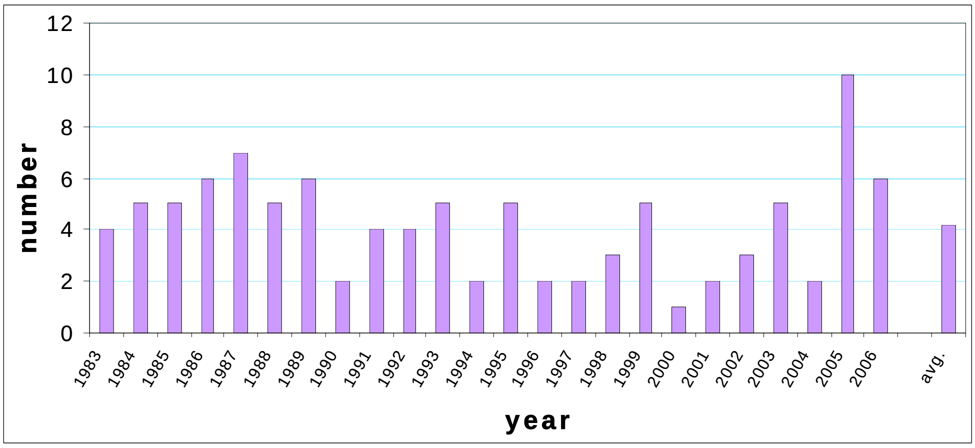


Figure 8 shows the number of abnormal events per year. In the year 2006 there were 6 abnormal events. The Krško NPP is obliged to report to the regulatory body about every event that could reduce nuclear safety. The abnormal events are described in detail in Chapter 2.1.1.2.

Figure 8: Number of abnormal events



The collective exposure to radiation is shown in Figure 9. For 2006 it was 857.3 man mSv, which is above the target value of INPO (650 man mSv) and above the target value of NEK (800 man mSv for the year 2006). This high value of collective exposure to radiation is mostly a consequence of extensive and demanding outage.

Figure 9: Collective exposure to radiation in the Krško NPP

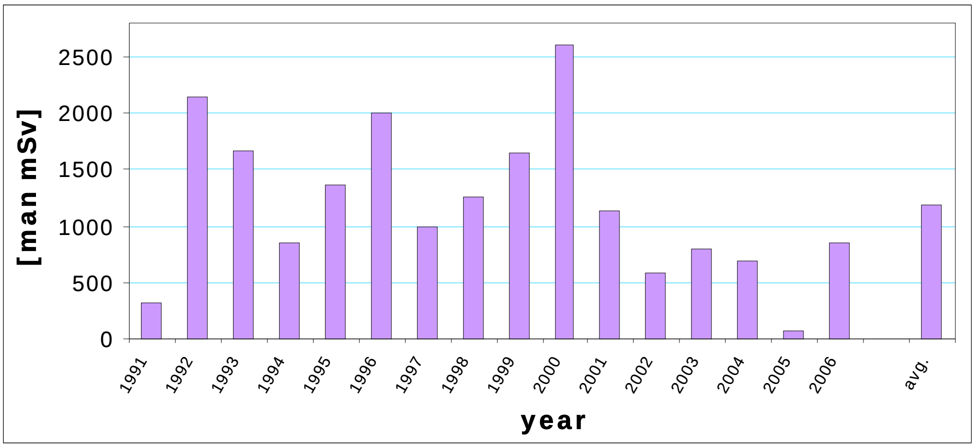
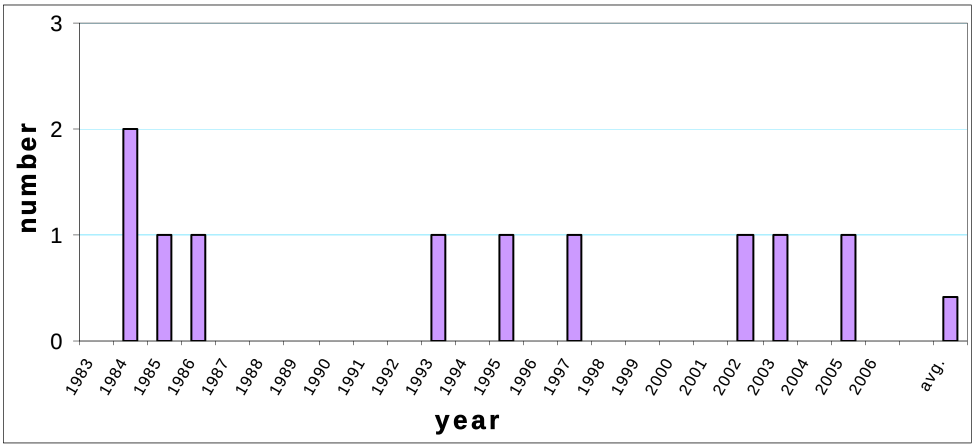


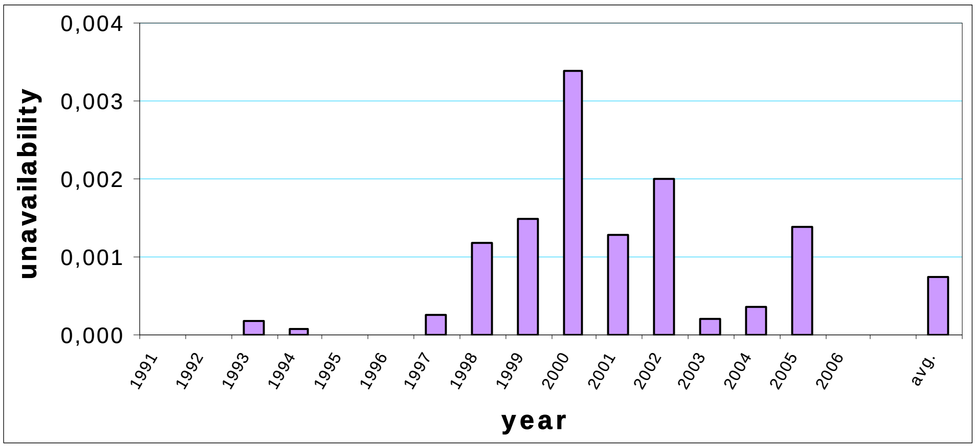
Figure 10 shows the number of unplanned actuations of the high pressure safety injection system. In the year 2006 there were no unplanned actuations of this system. The total number of actuations, since the beginning of commercial operation, is 10.

Figure 10: Number of unplanned safety injection system actuations



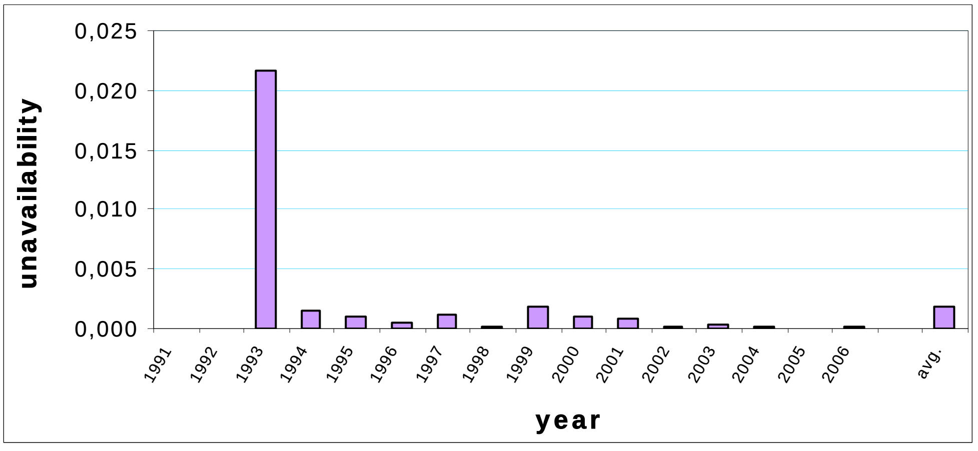
In Figure 11, the unavailability factor of the safety injection system is presented. In 2006 the value of the unavailability factor of the safety injection system was 0, which is below the target value of INPO (0.020) and also below the target value of the Krško NPP (0.005). The values of this factor were even in the past much lower than the target values. Additionally, the values decreased (compared to year 2002 and before) due to reduction of corrective maintenance on this system, which was the result of a better preventive maintenance programme.

Figure 11: Unavailability factor of the safety injection system



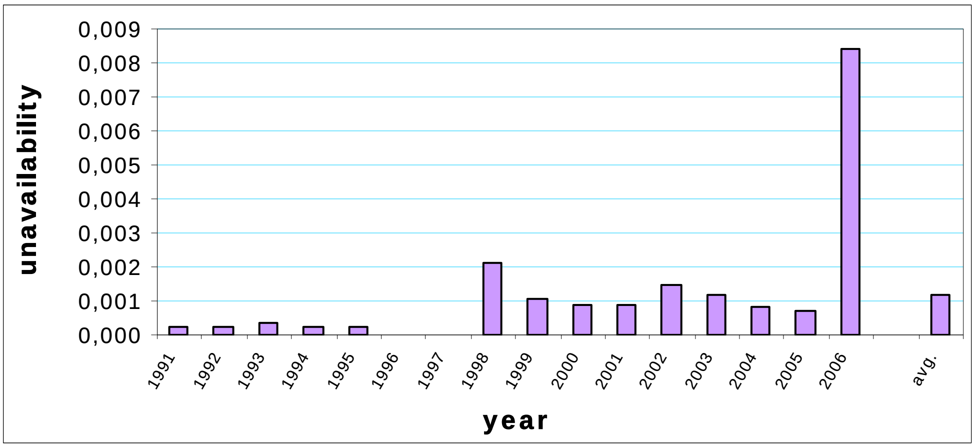
In Figure 12, the unavailability factor of the emergency AC power system is shown. The emergency AC power system, which consists of two diesel generators, has a very important role when a loss of offsite power occurs. The operability of diesel generators has been stable for several years and was also quite high in 2006, with a value of 0.0002, which is below both the INPO (0.025) and the NEK (0.005) target values.

Figure 12: Unavailability factor of the emergency AC power



In Figure 13, the unavailability factor of the auxiliary feedwater system is shown. This system feeds water into the steam generators when the main feed water system is unavailable. In 2006 the value for this factor was 0.0084, which is below the target value of INPO (0.020), but above the NEK target value (0.005). The increase of value was a consequence of a test failure of the turbine driven pump due to overheating of axial bearings, which occurred due to incorrect setting of the balance disk.

Figure 13: Unavailability factor of the auxiliary feedwater system



2.1.1.2 Inspections of the Krško NPP

During the year 2006, the SNSA Inspection carried out 53 planned inspections and one unannounced inspection at the Krško NPP. No inspections were carried out due to unusual events. The unannounced inspection was related to the review and walk-down of the Main Control Room and the NPP fence. During the outage, one inspection was performed on testing the redundant off-site power supply for the Krško NPP, namely the gas power plant TE Brestanica, which is foreseen for the safety termination of operation in the case of loss of a grid. Two inspections performed during the outage were related to transportation of fresh fuel to the Krško NPP.

During the year 2006, the Slovenian Radiation Protection Administration (SRPA) carried out 5 inspections related to the measures for protection of exposed workers against radiation, the preparation for and monitoring of the outage, and individual exposures of exposed workers.

In the year 2006 no deviation requiring immediate measures was found by the inspectors.

2.1.1.3 Abnormal events in NPP Krško

In 2006, 6 abnormal events occurred at the Krško NPP. None of these threatened nuclear or radiological safety.

Unplanned shutdown due to secondary side drain leakage

At the end of the annual outage and during the gradual reactor power rising at 2.3%, steam leakage was detected on the secondary side. Since the repair could only be performed at cold shutdown mode, the operators manually shut down the reactor. The next day the leaking crack was detected and repaired on the weld that connects the condensate trap and the drain pipe of nominal diameter 1½". Similar spots were also inspected and four crack indications were found and repaired. It is assumed that these cracks were caused by thermal fatigue of material [5]. The event postponed the beginning of the post-outage operation for about 2 days and 20 hours.

Unwanted actuation of the fire protection system on the main transformer No.1

On 23 January 2007 at 11:29, automatic actuation of the fire protection system on the main transformer No.1 occurred [6]. After establishing that there was no fire, the staff isolated a part of the fire protection system to stop the sprinkling water and declared its inoperability. The cause for activation was leakage on the floating valve housing. This valve is used to keep open the main local valve in case of fire. New housing was made and the next day after the successfully performed test, operability of the fire protection system was declared.

The automatic actuation of the fire protection system on the main transformer No.1 occurred under similar circumstances again on 28 January 2007 [7]. The staff isolated a part of the system, declared its inoperability and checked the floating valve but no anomalies were found. As a possible cause for actuation was presumed to be short circuits in the electric wiring or a failure on one of the fire detectors, so two relays and one fire detector were replaced with new ones. Furthermore it was decided to keep on the partial isolation of the fire protection system until the corrective action is confirmed or a different cause has been identified.

The alarm for the fire protection system switched on again on 2 February 2006 but no sprinkling water occurred since that part of the fire protection system was still isolated at that time [8].

Later the floating valve was preventively replaced and the fire protection system was declared operable. Since then no alarms have been registered. To prevent reoccurrence of the event, the NPP Krško decided to replace all fire detectors in that area during the refueling in the year 2007.

The SNSA performed an engineering evaluation of these two events and inspections followed the NPP Krško action attentively [9]. No additional corrective actions from the SNSA were requested.

Tritium release above the three-month limit

On 6 March 2006 the NPP Krško exceeded the three-month limit value for tritium release in the Sava river [10, 11]. The liquid effluent that contained tritium was released from the channel that is used for transport of fuel elements during the refueling. The channel was emptied within the planned preparation on refueling in April and due to inspection of the transport mechanism for fuel handling. By the end of March additional 90 cubic meters of liquid from the fuel elements transport channel were released. Furthermore, the boron recycling holdup tank and the condensate waste tank were emptied. Total tritium release from January to March was 9.6 TBq, while the three-month limit is 8 TBq. Subsequently, the plant's stable operation, together with corrective actions, resulted in total annual tritium release of 12.7 TBq, which is bellow the total annual limit of 20 TBq.

The tritium release above the administrative limit was the first in the history of the NPP Krško operation. As early as the beginning of December 2005, the NPP Krško informed the SNSA about a rising quantity of tritium. Tritium as radioactive waste is a by-product in every nuclear power plant. Increased production of tritium in the NPP Krško is an outcome of power up-rate in the year 2000 and prolongation of the fuel cycle from the initial 12 months, over 15, to the final 18 months. Tritium release above the limit is also a consequence of non-optimized releases and unplanned power changes that required boron dilution and boration of primary coolant during the previous year. After all, the presence of boron, which regulates the criticality of nuclear reaction, is the main source of the production of tritium.

On 24 February 2006 the NPP Krško submitted to the SNSA an application for increased limit of tritium release. Within the licensing proceeding the SNSA considered an expert analysis of influences on the environment [12], opinion of authorized experts and survey of international practice regarding radiological releases. In October 2006 the SNSA approved a new annual tritium release limit of 45 TBq, while the limits for other effluents without tritium were halved to the total annual release of 100 GBq and to the total three-month release of 40 GBq [13]. The approved new limits will come into force once the NPP Krško has arranged the technical specification for radiological releases. By the end of 2006 this modification was not performed yet, so the old release limits are still in force.

Increased vibration of the fire protection pump

During the outage, on 13 April 2006, the regular test of the fire protection system was performed when increased vibration on the electromotor of the fire protection pump was detected [14]. Consequently the fire protection system was declared inoperable. The cause for the increased vibration was operation of the pump close to its eigenfrequency, which was intensified by a reduced water level on the suction side of the pump. The pedestal of the pump and motor was braced with a steel ring and after a successfully performed test, the fire protection system was declared operable.

High temperature of the auxiliary feedwater turbine driven pump bearing

On 8 April 2006, at the beginning of the outage, the auxiliary feedwater turbine driven pump was started up as planned [15]. After 2 hours and 10 minutes of operation, the temperature of the axial bearing reached 90.6 °C, which is 0.6 °C above the 90 °C limit, and the pump was manually stopped. A similar event occurred at the plant shutdown in February 2002. In the scope of the corrective actions, the manufacturer of the pump recommended at that time new, tighter bearing clearance of 0.06 mm on the axial glide bearing. During the outage in 2004 the pump operated 1 hour and 33 minutes, and the temperature of the bearing reached a maximum of 68 °C. After the last event, the bearing was reassembled and the clearance was measured to be 0.09 mm. No damage on the gliding surface was noticed. The clearance was reset to 0.025 mm, which is within the newest recommendation of the pump manufacturer. After the outage a long term test of the auxiliary feedwater turbine driven pump was performed on 28% of reactor power. The test included a different hydraulic loading of the pump and the setting clearance was demonstrated to be proper for all regimes of the pump's operation.

Unavailable diesel fire protection pump due to planned preventive maintenance

On 12 July 2006 a part of the fire protection system was isolated due to preventive replacement of piping and valves on the external hydrant network [16]. Because the isolating valve was not tight in closed position, another valve was closed and that prevented the diesel fire protection pump from supplying the fire protection system with water. After the leaking isolating valve was repaired, the diesel fire protection pump was available again, while the part of the fire protection system remained isolated until preventive maintenance was completed. Although the diesel fire protection pump was declared as unavailable, water from the diesel pump could be pumped through the test piping of smaller diameter and for that purpose temporary instructions for operation were issued.

2.1.1.4 Nuclear fuel integrity and reactor coolant activity

The year 2006 consisted of parts of the reactor fuel cycles 21 and 22. Cycle 21 was 19 months long. For cycle 22, which is 18 months long, 56 fresh fuel assemblies were introduced in the reactor core. 32 fuel assemblies are 4.54% enriched and 24 fuel assemblies are 4.95% enriched. All of these 56 fresh fuel assemblies contain burnable absorbers 1.4X IFBA to optimize the core burnup [2, 3].

The conditions of fuel integrity in the reactor core are controlled by measuring the reactor coolant specific activities, mostly for the isotopes of iodine, cesium and noble gases.

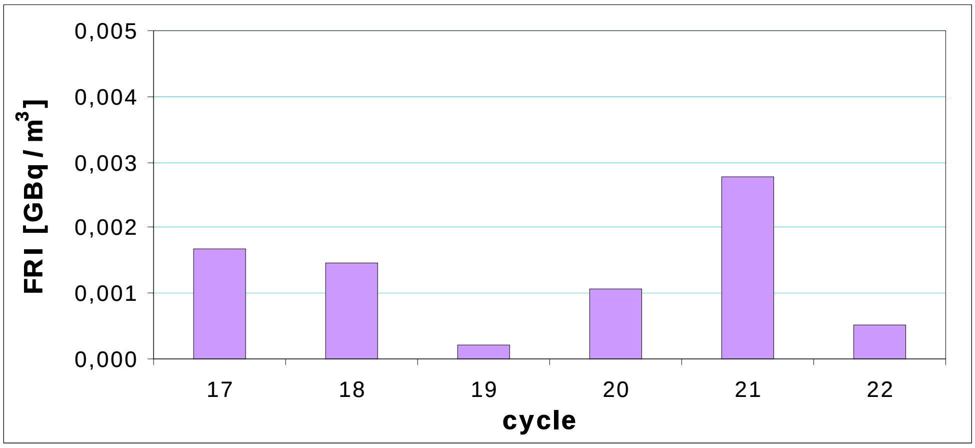
An increase in specific activities of isotopes of iodine and noble gases is defined as an event. Based on the number of such events it was estimated that in the reactor core of cycle 21 there were 6 leaking fuel rods. Low values of specific activities of iodine isotopes indicated that all of the fuel failures are of tight nature. The reactor coolant specific activities in cycle 21 reached less than 1% of the limit defined in the Technical Specifications.

Tight fuel failures were found also in the reactor core of cycle 22. Based on the number of events it was estimated that 4 fuel rods were leaking. Restrictive actions were introduced in September 2006 to preserve the fuel integrity and restrict the consequences. The frequency of sampling and radiochemical analyses was increased and the reactor ramp rate was limited. Possible deviations in the fuel fabrication process were evaluated and an estimate of potential fuel leakers was made.

The mechanism of fuel failure has not been identified yet. All accessible data were evaluated and all possible leakage mechanisms were checked that could be connected with fuel operation history, design characteristics and fabrication of fuel assemblies. The conclusion is that the main and most obvious cause for fuel failure could not be determined.

Figure 14 shows the fuel reliability indicator (FRI), which is derived from specific activities of iodine isotopes 131I and 134I. The FRI values that are below the INPO target vales of 2·10-2 GBq/m3 represent a fuel without failures. In cycle 21 the FRI values increased but remained below the target value because of the tight nature of the failures with only a small fuel leakage.

Figure 14: Fuel reliability indicator (FRI)



During the refueling outage in 2006 all fuel assemblies of cycle 21 were examined for cladding leakage with the In-Mast Sipping (IMS) technique. The results showed three failed fuel assemblies and a suspicious one. Leaking fuel were not planned to be inserted in the new reactor core and were eliminated from further use. According to the fuel warranty, the fuel producer regularly examines the leaking fuel with an ultrasonic technique. During the 2006 outage this ultrasonic examination was not performed due to several failures of mechanical and electronic equipment. Ultrasonic examination will be performed in 2007. The five failed fuel assemblies (one from cycle 20 and four from cycle 21) were checked by means of underwater visual examination and all of the results were inside the acceptance criteria for such examination.

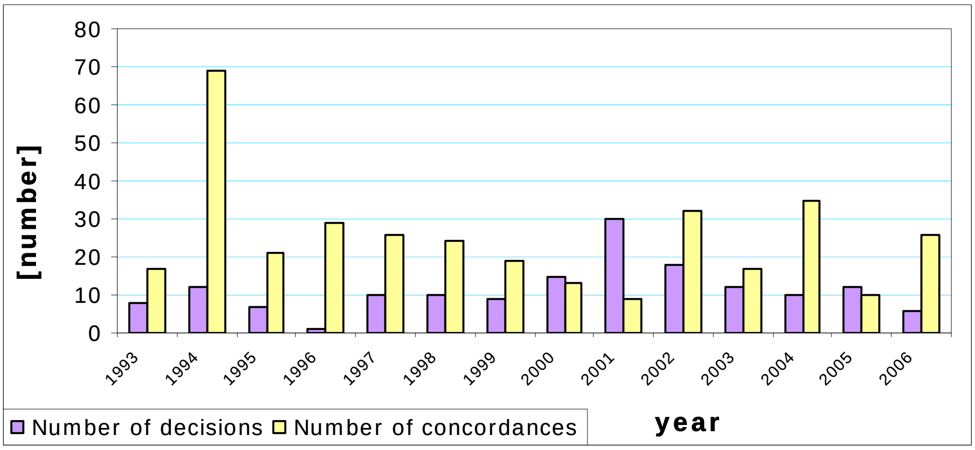
2.1.1.5 Modifications in the Power Plant

Changing of the project and design basis of the nuclear facility or the conditions of exploitation of the nuclear power plant are among the most important activities which can influence nuclear safety. Due to this fact all modifications have to be under rigorous control and properly documented.

Following proper administrative procedures, the SNSA approved 6 modifications on the facility, and agreed to 26 other modifications. For 25 modifications, the NPP Krško found out during the preliminary safety evaluation that there was no open safety issue, so it only informed the SNSA about those changes. On 31 December 2006, the number of open temporary modifications was 27. Figure 15 shows the number of approved modifications through the years.

In the year 2006, the Krško NPP issued the 13th revision of the Updated Safety Analysis Report, in which all modifications confirmed until November 2006 were considered.

Figure 15: Modifications approved by concordance or decision



2.1.1.6 Refueling outage 2006

The refueling outage 2006, in the period 8 April to 14 May 2006, was very demanding mainly due to replacement of low pressure turbines. With this modification, the Krško NPP gained additional 20 MW of electric power with the same reactor power because of better efficiency of the secondary circuit. Many outage activities were performed also by domestic and foreign contractors.

SNSA inspectors continuously supervised the performance of outage activities while the SNSA division of nuclear safety performed occasional control over the activities for the implementation of design modifications. Outage oversight was performed also by authorized experts and their findings and recommendations for improvements were compiled in an outage report. The general opinion is that the outage was well planned and that its realization was efficient [17]. This was evident in the most demanding and long lasting tasks (e.g. replacement of low pressure turbines). There were no direct violations of operational limits and conditions.

Figure 16: Replacement of low pressure turbines during the refueling outage 2006.

2.1.1.7 Environmental influence at the Krško NPP

National spatial plan (DLN) for the airport Cerklje

The Ministry of Defense is planning an expansion of the airport Cerklje and increase of its air traffic. Intragovernmental reconciliation of viewpoints has been under way since 2005 regarding this issue. Based on this activity a small group of experts has been established to review and determine the potential impact of the airport expansion on the NPP Krško safety. Within the scope of preparations for the national spatial plan for the airport Cerklje, a demand for guidelines was issued at the end of the year 2006 by the Ministry of the Environment and Spatial Planning to the SNSA as one of the holders of spatial planning in this proceeding.

National spatial plans for Krško and Brežice hydro power plants

The river Sava is essential for assurance of nuclear safety of Krško NPP. For this reason, the SNSA actively entered the preparation process for the national spatial plan (DLN) for the Krško hydro power plant. This process started in 2003 and ended in October 2006 when a decree on the DLN was issued [18]. In April 2004 the SNSA issued guidelines with conditions for the construction and operation of the Krško hydro power plant. These guidelines were appropriately considered in the decree and will be followed in the construction process of the Krško hydro power plant as well as in the preparation process for the DLN for the Brežice hydro power plant.

The main requirements of the SNSA guidelines are:

- the risk of flooding at the Krško NPP shall not increase and this must be achieved by appropriate upgrading of flooding protection dikes,
- the risk of flooding at the Krško NPP due to flooding caused by the Krško hydro power plant dam failure in case of an earthquake shall be evaluated and according to the results appropriate upgrading of flooding protection dikes shall be performed,
- the Krško hydro power plant operation shall not deteriorate the quality of water in the Sava river that is used for the Krško NPP cooling systems,
- the Krško hydro power plant operation shall not decrease the Sava river flow below the value of 100 cubic meters per second and the river flow shall not change rapidly.

The conditions from the SNSA guidelines were properly implemented in the updated DLN and in the draft decree on the DLN for the Krško hydro power plant. In June 2006 the SNSA issued a positive opinion on both the DLN and the draft decree, since it was assured appropriately that the Krško NPP safety and operation were not jeopardized. The Decree on the DLN for the Krško hydro power plant states that the SNSA can give suggestions on the operational license for the Krško hydro power plant and approves the license, and that the flooding protection dikes for downstream facilities (including the Krško NPP) shall be upgraded appropriately before the Krško hydro power plant reservoir is filled with water.

2.1.2 TRIGA research reactor

2.1.2.1 Operation

In 2006, the TRIGA Mark II research reactor of the Jožef Stefan Institute operated for 216 days and released 210.8 MWh of heat. Irradiations were performed in the carrousel and F-channels (838 samples), with the pneumatic post (595 samples) and with the fast pneumatic post system (430 samples). In 2006 the reactor was mostly used as a neutron source for neutron activation analysis [19]. The TRIGA reactor was also used for teaching of Krško NPP operators and for the training course "Basis of NPPs' technology".

The TRIGA reactor operated according to the programme approved by the reactor manager and the section for ionizing radiation protection. The reactor operated only in stationary mode. In the year 2006 there were no emergency events.

In 2006 there were two forced (automatic) shutdowns caused by loss of power supply.

2.1.2.2 Fuel

The number of fuel elements did not change in 2006. By the end of the year there were 94 standard TRIGA fuel elements with 19.9% enrichment at the site, which were located in the reactor or at the fresh fuel storage. There were no fuel elements in the spent fuel storage pool. There were no spent fuel elements. The radiation monitoring system in the reactor building and the reactor coolant activity measurements showed that there were no leaking fuel elements in the year 2006.

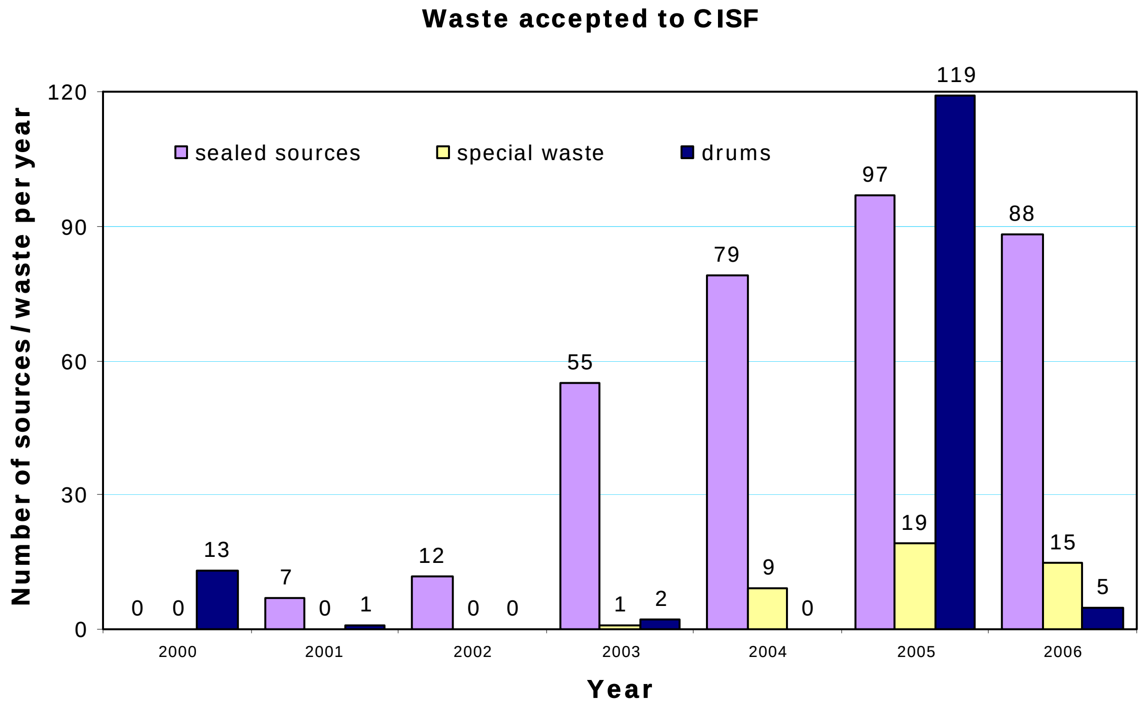
2.1.3 The Central Interim Storage for Radioactive Waste at Brinje

The Central interim storage for radioactive waste at Brinje (CISRW) is operated by the Agency for Radioactive Waste Management (ARAO). After a complete reconstruction of the storage in 2005 the ARAO obtained a license for trial operation and started regularly accepting radioactive waste from small producers. During the trial operation some minor deficiencies emerged. In December 2006 two extra underground water monitoring wells were finished, a wind gauge was built and new electrical connection was set. For the year 2007 an upgrading of the existing control system in the storage is planned. Following evaluation and gained experience during the trial operation the ARAO shall in 2007 supplement the Safety Analysis Report and apply for the operational license at the SNSA.

In May 2006 the ARAO obtained a license to carry out radiation practice as a transactor of public service of small users' radioactive waste management that includes maintenance, production, calibration and other similar works to be performed on radiation sources during takeover of radioactive waste from generators, during takeover of radioactive waste at the place of origin in case of accidents and during takeover of radioactive waste in case the waste generator cannot be found and determined.

In 2006 the ARAO accepted for storage radioactive waste from 57 generators, in the form of 88 packaging units of sealed sources, 15 special waste items and 5 drums. The total volume of the waste stored was 3 m3. Also 823 ionizing smoke detectors were stored. At the end of 2006, the total of 776 packaging units were accepted, among which there were 303 drums, 188 special waste items and 285 sealed sources. The total activity of the 81 m3 waste stored is estimated at 3.5 TBq.

Figure 17: Number of radioactive waste items annually accepted in the Central interim storage at Brinje



Remarks:

- In 2001 one drum was accepted as a result of repacking of radium sources
- In 2003 two drums were accepted as a result of repacking of cobalt sources
- In 2005 95 drums were accepted as a result of the Phare project »Characterization of Institutional Low and Intermediate Level Radioactive Waste in the Central Storage Facility for Waste from Small Producers in Slovenia at Brinje«, 24 drums were accepted from other users

2.2 Radiation practices and the use of sources

The Act on Protection against Ionizing Radiation and Nuclear Safety stipulates reporting an intention to carry out practices involving radiation or use of a radiation source, evaluation of protection of exposed workers against radiation, a permit to carry out a practice involving radiation and a permit to use a radiation source.

The nature and extent of radiation risk for exposed workers, apprentices and students based on the evaluation of protection of exposed workers against radiation shall be determined in advance. In addition, based on this evaluation a programme for optimization of radiation protection measures in all working conditions is made in advance. The document must be prepared by the applicant, who is obliged to consult an authorized expert in protection against radiation. If the applicant has insufficient knowledge and expertise related to the field of radiation protection, the evaluation can be prepared by an authorized expert in this field. The evaluation has to be approved by the Slovenian Radiation Protection Administration (SRPA), where in total 120 approvals were issued in 2006.

During the year 2006, the SNSA Inspection carried out 30 inspections and interventions of 24 legal persons connected with performance of a radiation practice in industry and research area, transportation of nuclear goods as well as transportation of goods containing, among others, radioactive materials. The SNSA Inspection carried out 14 planned regular inspections of persons carrying out a radiation practice, 2 planned regular inspections of a carrier of nuclear material and 14 interventions of persons carrying out a radiation practice as well as of carriers of scrap materials.

The SNSA Inspection considered a report of a group of individuals about a potential repository of radioactive waste from the Krško NPP having been discarded in an abandoned mine on the location near the village Dečno selo. In this regard the SNSA cooperated with other institutions and finally found out the suspicion was not grounded.

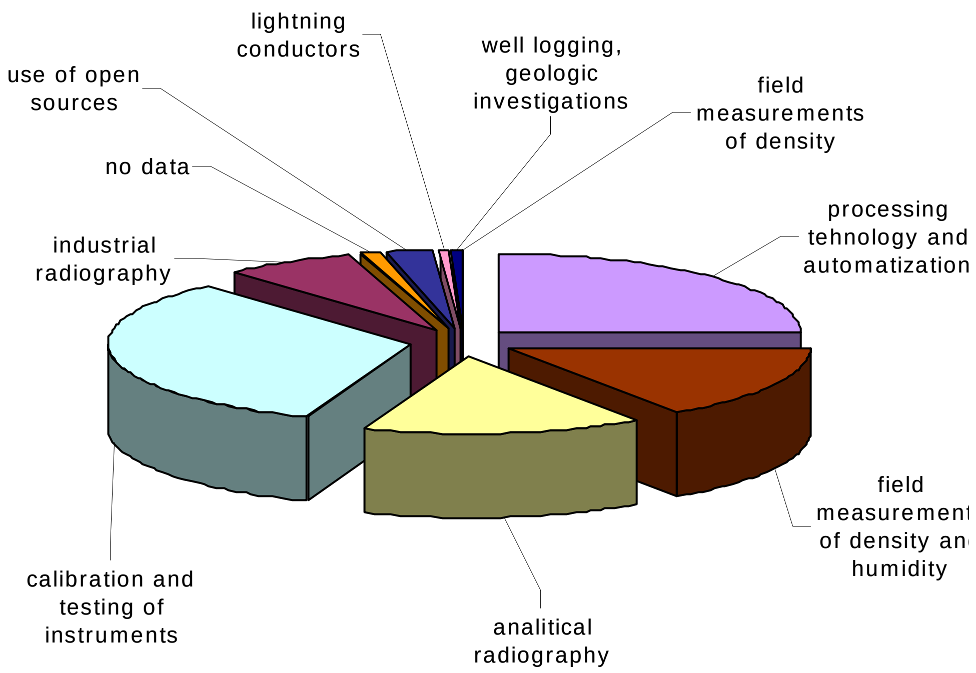
2.2.1 Use of ionizing sources in industry and research

In 2006, 32 licenses to carry out practices involving radiation were issued, 1 decree on cessation of carrying out practices involving radiation, 71 licenses to use a radiation source, 42 certificates of entry in the register of radiation sources, 12 approvals issued to external operators of practices involving ionizing radiation and 1 consent to construction in the area of restricted land use. In the field of use of radiation sources in industry and research the SRPA approved 42 evaluations of protection of exposed workers against radiation. The valid licenses issued in accordance with the act from 1984 have almost all been replaced by the new ones according to the 2002 Act.

In 2005, 62 organizations in the Republic of Slovenia used 142 X-ray devices in industry and research, most of them for industrial radiography, and for cargo and luggage inspection.

658 sealed sources were used in 87 organizations, the majority of them were used in technological and automation processes, field measurements of density and humidity, and industrial radiography. The devices used were industrial X-ray devices, devices containing ^{192}Ir radionuclide for non-destructive material inspection, devices containing ^{85}Kr, ^{241}Am, ^{60}Co and ^{90}Sr radionuclides in technological and automation processes, devices containing ^{137}Cs and ^{241}Am/Be radionuclides for field measurements of density and humidity. Some organizations were servicing smoke detectors containing ^{241}Am radionuclide.

Figure 18: Distribution of application of radioactive sources according to their purpose and mode of use, excluding ionizing smoke detectors.



In accordance with the register of radiation sources at the end of 2006 there were 25.028 detectors in use at 273 organizations. In addition there were 1.691 detectors stored at users' premises.

Due to successful reconstruction of the CISF at Brinje, handover of the spent sources no longer in use from users to the ARAO increased.

In 2006 the Institute of Occupational Safety performed 1033 surveys at holders, while the Jožef Stefan Institute performed surveys of only 8 radiation sources.

During the year 2006 the SNSA Inspection carried out 16 planned inspections at altogether 15 legal persons from industry, research or transport of nuclear material.

No serious violations were found, but deficiencies related mainly to record keeping were discovered. They referred to radiation sources data or safety measures. The deficiencies also related to unsuitable placing of warning signs for radioactivity or warning signs for ionizing radiation, procedures for safety use of radiation sources, inadequate medical surveillance of exposed workers and renewal of examinations concerning radiation protection. The SNSA Inspection also often identified inadequate procedures related to the notification system in case of emergency. In addition, it was also evident that users of radiation sources followed the provisions of the updated Slovenian legislation with great difficulties. These provisions are based on EURATOM Directives of the EU and are given for example in the Decree on activities involving radiation (Official Gazette RS, No. 9/2006), the Rules on the use of radiation sources and on activities involving radiation and the Regulation on the use of radiation sources and on practices involving radiation (Official Gazette RS, No. 27/2006).

One of the users of sources which were also inspected had a temporary storage of a large quantity of radioactive liquid waste. The waste was properly treated by the user and altogether five 200 liters barrels were prepared to be stored in the Central Interim Storage for Radioactive Waste.

2.2.1.1 Interventions

In 2006 the SNSA Inspection was engaged in nearly the same number of cases as in previous years that is altogether in 14 cases.

Interventions related to findings of sources

Four interventions related to findings of radioactive material and altogether four radioactive sources were found. Two of them were later stored in the Central Interim Storage for Radioactive Waste, one source was stored in Italy and one in Croatia. Three sources related to transport of radioactive material in scrap materials and one source was incorrectly stored by a user of radioactive sources.

Interventions related to dosimetry of occupational exposure

In four cases the results of dosimetry of occupational exposure demonstrated that dosimeters were not treated according to prescribed procedures. A dosimeter should be used only at workplaces, otherwise it should be stored at a site where no occupational exposure is possible. During inspections it was found that measured high doses were actually due to unsuitable storage of dosimeters in time intervals when workers were not occupationally exposed at all. Such handling of dosimeters demonstrated a bad safety culture.

Suspicion related to infringement of safety measures

Four interventions related to suspicion concerning infringement of safety measures during either transport or storage of radioactive or nuclear material. The suspicion was not confirmed in any of these cases.

The majority of interventions, namely five, related to data given by the SNSA or SRPA, while three were based on reports of customs officers. In addition, three interventions were based on initiations of scrap material collectors or users of sources.

2.2.2 Use of ionizing sources in medicine and veterinary medicine

2.2.2.1 X-ray devices in medicine and veterinary medicine

According to data from the register of the Slovenian Radiation Protection Administration (SRPA), 768 X-ray devices and one cobalt therapeutic device were used in medicine and veterinary medicine at the end of 2006. The categorization of the X- ray devices based on their purpose is given in Table 2.

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

Purpose	Status 2005	New	Written off	Status 2006
Dental	376	29	23	382
Diagnostic	257	17	19	255
Therapeutic	6	1	0	7
Simulator	2	0	0	2
Mammography	34	2	1	35
Computer Tomography CT	20	3	2	21
Densitometers	34	3	2	35
Veterinary	29	5	3	31
TOTAL	**758**	**60**	**50**	**768**

With regard to use of x-ray devices in medicine and veterinary medicine in 2006 the SRPA granted 62 permits to carry out a radiation practice, 136 permits to use X-ray devices, 62 confirmations of evaluation of the protection of exposed workers against radiation and 57 confirmations of the programme of radiological procedures.

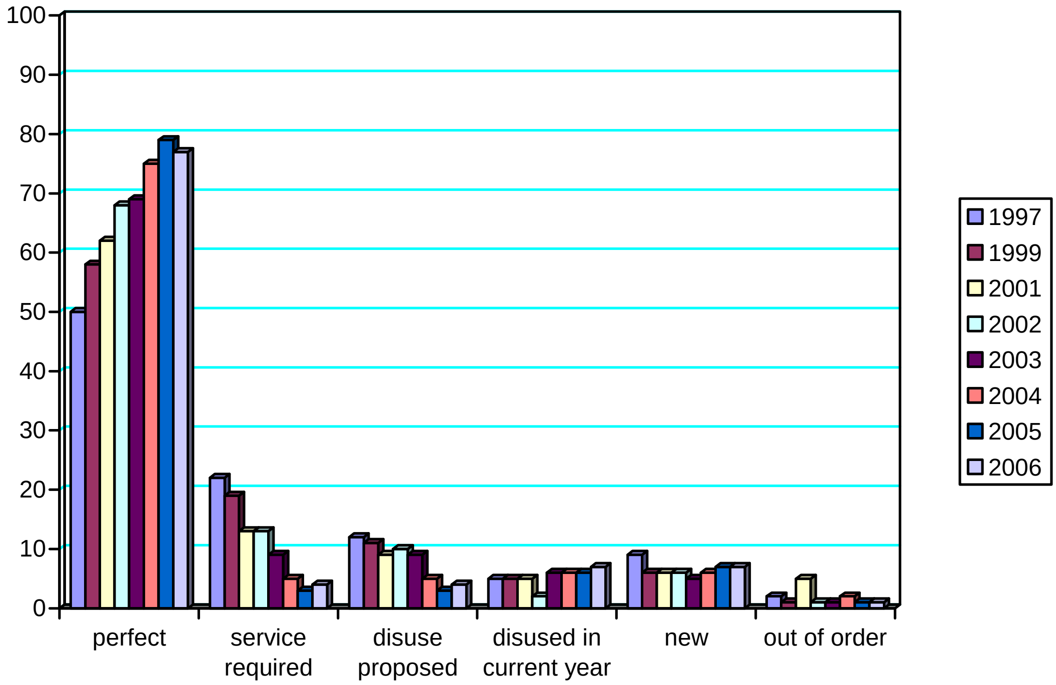
From the total of 768 X-ray devices, 359 were used in private dispensaries and 409 in public hospitals and institutions. The average age of devices in the public sector was 9.9 years and in the private sector 7.7 years. A detailed classification of X-ray devices according to their ownership is given in Table 3.

Table 3: Number of X-ray devices in medicine and veterinary medicine by ownership in 2006.

Ownership	Diagnostic		Dental		Therapeutic		Veterinary		Total	
	No. (%)	Age (y)	No. (%)	Age (y)	No. (%)	Age (y)	No. (%)	Age (y)	No. (%)	Age (y)
Public	281 (82%)	10,0	106 (28%)	9,3	10 (100%)	9,2	12 (39%)	10,3	409 (53%)	9,9
Private	64 (18%)	6.6	276 (72%)	7.9	0		19 (61%)	7.1	359 (47%)	7.7
Total	**345**	**9.4**	**382**	**8.3**	**10**	**9.2**	**31**	**8.3**	**768**	**8.8**

All X-ray devices are examined by approved experts in radiation protection at least once a year. The devices are classified with regard to their quality to one of the following 6 groups: "perfect", "service required", "disuse proposed", "disused in current year", "new" or "out of order". The analysis of data for the period from 1997 to 2006 shows an increased number of perfect devices and a noticeably reduced number of devices that need repair or are proposed for disuse (figure 19).

Figure 19: Percentage of diagnostic X-ray devices according to their quality for the period 1997-2006



In 2006 ten (10) inspections of radiation practices in mammography and use of X-ray mammography devices were performed. In all cases provisions requiring implementation of legally prescribed conditions for radiation practices and the use of ionizing radiation sources were issued. In addition, two inspections of the use of diagnostic X-ray devices were performed.

2.2.2.2 Unsealed and sealed sources in medicine

Seven hospitals and clinics in Slovenia use unsealed sources (radiopharmaceuticals) for diagnostics and therapy in nuclear medicine departments: the Medical Centre Ljubljana - the Department of Nuclear Medicine, the Institute of Oncology, and general hospitals in Maribor, Celje, Izola, Slovenj Gradec and Šempeter near Gorica. In 2006, nuclear medicine departments applied 5,349 GBq of isotope ^{99m}Tc, 1,168 GBq of isotope ^{131}I, 222 GBq of isotope ^{133}Xe and minor activities of isotopes ^{67}Ga, ^{111}In, ^{18}F, ^{90}Y, ^{186}Re, ^{51}Cr, and ^{123}I for diagnostics and therapy. Nuclear medicine departments, the Veterinary faculty and the Medical Centre Ljubljana – the Clinical institute for clinical chemistry and biochemistry used minor activities of isotopes ^{125}I, ^{14}C and ^{51}Cr for in-vitro studies.

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

In 2006 five (5) permits to carry out a radiation practice, 4 permits to use radiation sources in medicine, 2 confirmations of evaluation of protection of exposed workers against radiation and 2 confirmations of the programme of radiological procedures were granted with reference to use of open and sealed sources in medicine. 6 inspections of radiation practices and 2 inspections of companies transporting open sources were performed.

Due to carelessness of a worker who did not close the pipe over the wash-hand basin, the radioactive sewage container at the Institute of Oncology was filled up, but there was no radioactive contamination. Two additional containers were installed underground. A decree was issued to monitor the level of sewage in the container and levels of radiation and to disconnect the wash-hand basin from the sewage container.

The evaluation of the protection of exposed workers against radiation was revised in the General Hospital in Šempeter near Gorica according to the inspection findings. Additional conditions were imposed in the permit to carry out a radiation practice and the permit to use a radiation source.

A decree based on inspection findings in 2005 was issued to the General Hospital Celje to elaborate the programme of radiological procedures and to establish a record of applied activities.

No emergency events (except for the full radioactive sewage container at the Institute of Oncology) were reported to the SRPA in 2006. Medicine departments with radiation sources were surveyed (once or twice per year depending on the types of sources) by the authorized organizations, the Institute of Occupational Safety and the Jožef Stefan Institute. No major deficiencies were found.

3 RADIOACTIVITY IN THE ENVIRONMENT

3.1 Monitoring of environmental radioactivity

Monitoring of the global radioactive contamination due to the former atmospheric nuclear bomb tests (1951-1980) and the Chernobyl accident (1986) has been carried out in Slovenia for four decades and a half. Above all, two long-lived fission radionuclides ^{137}Cs and ^{90}Sr have been followed in the atmosphere, water, soil and in drinking water, foodstuffs and feeding stuffs. A part of the monitoring programme comprises also river water contamination with ^{131}I due to medical use of this radionuclide. In all samples, other natural gamma emitters are measured too, and additionally tritium ^{3}H in drinking water and precipitation.

The results for 2006 showed that concentrations of both long-lived fission products in samples of air, precipitation, soil, milk and foodstuffs of vegetal and animal origin, as well as in feeding stuffs continued slowly to decrease and were mostly lower than before the Chernobyl accident. Exceptionally a specific surface activity of ^{137}Cs in the upper layer of uncultivated soil is still enhanced. On average, at the time of the Chernobyl accident approximately five times higher contamination (20–25 kBq/m^2) was measured in Slovenia if compared to the contribution of all nuclear bomb tests in the past. The highest contamination of the ground was measured in the Alpine and forest regions. This feature indirectly contributes to the enhancement of contents of ^{137}Cs in forest fruits, mushrooms and game, and in Alpine milk and cheese. In 2006 no radioactive contamination of the environment was detected related to any nuclear or radiation event.

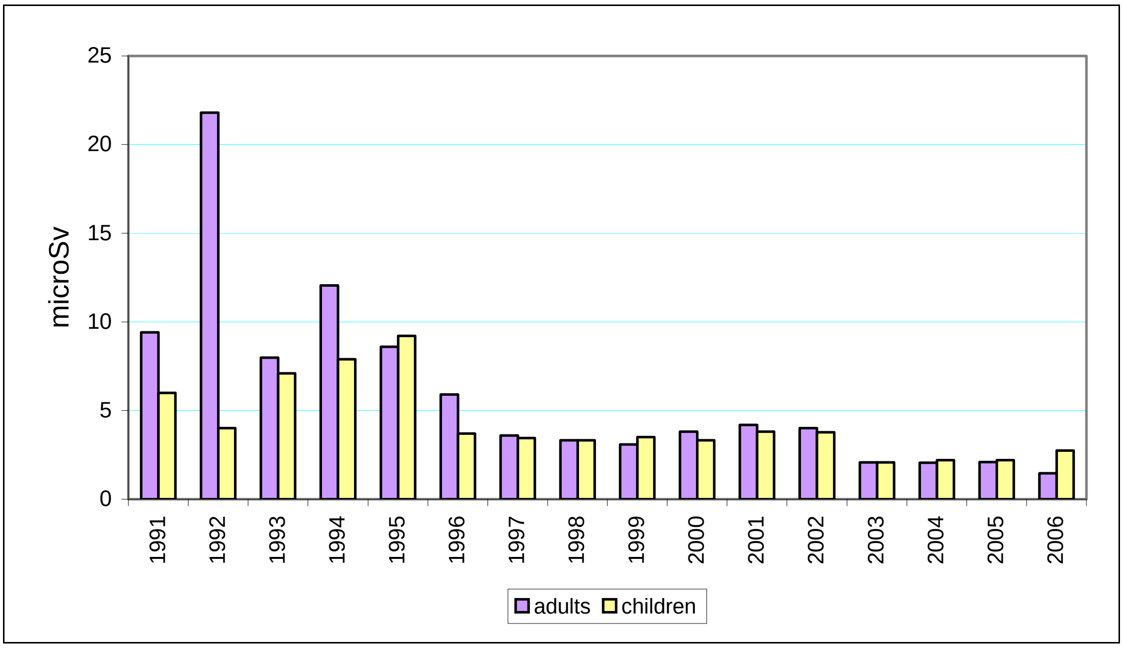
The biggest contribution to radiation exposure of the public comes from external radiation and from food ingestion, while the inhalation dose due to aerosols with fission radionuclides is negligible. In 2006 the effective dose for an adult from external radiation of ^{137}Cs (mainly from the Chernobyl accident) was estimated at about 1.45 μSv, which is 0.06% of the dose received by an average Slovenian from natural background radiation. This value is smaller than the one measured and calculated for the previous year (4.8 μSv) not because of a decrease in radioactivity but because of the inconsistency of soil sampling on different pedologic basements: before 2006 'Ljubljansko barje', after that 'Ljubljansko polje'. Before 2005 the sampling site was at Cesta dveh cesarjev, but in 2006 a new location at the Reactor Centre Brinje was chosen, where soil permeability for radioactive contaminants is higher.

The annual dose from the ingestion pathway (food and drinking water consumption) was 1.49 μSv, which is the same as in previous years; radionuclide ^{90}Sr accounts for two thirds of the dose, while ^{137}Cs contributed the remaining third. The annual contribution due to inhalation of both radionuclides is only about 0.001 μSv, which is negligible if compared with radiation exposure from other transfer pathways. In 2006, the total effective dose to an adult individual of Slovenia arising from the global contamination of the environment with fission products was estimated at 2.94 μSv, as shown in Table 4. This is approximately a thousand times lower dose compared to the annual exposure from natural radiation in the environment (2500–2800 μSv). The effective dose for drinking water, taking into account natural and artificial radionuclides, was also estimated. It was shown that the limit value of 0.1 mSv per year due to water ingestion from local water supplies was not exceeded in any examined case.

Table 4: Radiation exposure of population in Slovenia due to global contamination of the environment in 2006

Transfer pathway	Effective dose [μSv/year]	
	Adults	Children (up to 12 years)
Inhalation (^{137}Cs, ^{90}Sr)	0.001	0.001
Ingestion: - drinking water (^{137}Cs, ^{90}Sr) - food (^{137}Cs, ^{90}Sr)	 0.03 1.46	 0.06 2.74
External radiation	1.45	1.51
Total in 2006 (rounded)	**2.94**	**4.31**

Figure 20: Annual exposure of members of the public in Slovenia to global radioactive contamination of the environment, taking into account radionuclides ^{137}Cs and ^{90}Sr



The high value in 1992 is due to the calculated dose estimation, which takes into account also the game used as foodstuff. Not taking into account these samples, the effective dose for this year is lower than 10 μSv.

3.2 Operational monitoring in nuclear and radiation facilities

Each installation or facility that discharges radioactive substances into the environment is required to be the subject of control. Radioactivity measurements in the environment must be performed in the pre-operational period, during operation and a certain period after ceasing the operation. The goal of operational monitoring is to find out if the discharged activities are within the authorized limits, if environmental specific activities are inside the derived limits and also if the population exposures are lower than the prescribed dose constraints or limits.

3.2.1 The Krško Nuclear Power Plant

The radiological situation in the surroundings of the nuclear power plant is monitored by means of continuous measurements of gaseous and liquid radioactive discharges and by carrying out radioactivity measurements of environmental samples. The measured values of analyzed radionuclides in environmental samples (in air, soil, surface and underground water, precipitation, drinking water, agriculture products, and feeding stuffs) during normal operation of the plant are low, mostly even considerably lower than the detection limits of analytic procedures. The impacts of the nuclear power plant are therefore evaluated on the basis of data on gaseous and liquid discharges. The data are used as input data for the modeling of dispersion of radionuclides to the environment. The results of environmental measurements during normal operation are used as a confirmation that radioactive discharges into the atmosphere and in aquifer were low. In case of emergency, the established monitoring network enables immediate sampling and analysis of contaminated samples.

Radioactive discharges

In 2006 the total released activity of noble gases to the atmosphere was 1.6 TBq or 1.45% of the limit, which is approximately two times more than the year before. The released activities of iodine isotopes were 0.28% of the limit and were higher compared to the previous year due to increased releases of iodine isotopes from three damaged fuel elements (6 fuel rods) which were rejected from the reactor core. Activity of the dust particles was 0.015% of the limit. Discharges of tritium into the atmosphere were within expected values, and 30% less than the year before. The ^{14}C discharges were approximately the same as in the year 2004, when the annual outage took place, but 10 times higher than in 2005, when there was no annual outage.

In 2006, in liquid discharges from the plant to the Sava river the activity of tritium (^{3}H) in the form of water prevailed with 12.7 TBq. This represents 63.4% of the limit, which is less than the year before (2005: 90% of the limit). Liquid discharges were higher at the beginning of the year due to the preparations for the annual outage; the Krško NPP thus exceeded the quarterly limit for tritium. The SNSA later increased the annual limit for this radionuclide to 45 TBq (from 20 TBq) and cancelled the quarterly limit (8 TBq).

The total discharged activity of fission and activation products was higher than in the year before (2005: 0.058 GBq) and was 0.198 GBq, which represents 0.1% of the operational limit value, while the activity of alpha emitters was under the detection limit.

Environmental radioactivity

The monitoring programme of environmental radioactivity due to gaseous and liquid discharges comprised 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), water captures and underground water,
- in food of agricultural and animal origin (including milk),
- in soil on cultivated and uncultivated areas, and
- measurements of ambient dose equivalent of external radiation at several locations.

No environmental measurement showed presence of radionuclides that could be attributed to atmospheric discharges from the nuclear power plant. The measured radioactivity of radionuclides ^{137}Cs and ^{90}Sr is a consequence of global contamination and not a result of the nuclear power plant operation. On the contrary, a direct impact of liquid discharges was indicated as higher concentrations of tritium ^{3}H in the Sava river downstream the plant. The annual average of the concentration of tritium of 1.4 kBq/m^{3}

was measured at Krško, upstream the plant, while at Brežice, downstream the plant, the value of 5.9 kBq/m^3 was obtained. The limit value prescribed with a government decree is 7400 kBq/m^3 (as the derived concentration for drinking water). Concentrations of other artificial radionuclides discharged to the river Sava (^{58}Co, ^{60}Co, and others) were measured below the detection limits in all samples. The concentrations of radioisotope ^{131}I in the Sava river were caused by discharges from the clinics of nuclear medicine in Ljubljana and Celje, not by the operation of the nuclear power plant. The concentrations of this radionuclide at Krško and in Brežice do not differ (Krško: 6.9 Bq/m^3, Brežice: 6.4 Bq/m^3). In tap waters and water captures on the territory of Slovenia neither higher concentrations of ^{3}H nor any other impacts due to the nuclear power plant were detected.

The dose assessment of the public was based on a model calculation. The calculated dispersion factors for atmospheric discharges, based on real meteorological data, showed three most important pathways for public exposure that have to be taken into account, namely external radiation from clouds and deposition, inhalation of air particles with tritium and ^{14}C, and ingestion of food with ^{14}C. The highest dose (less than 1 μSv) was received by adult individuals due to ^{14}C intake with vegetable food ingestion and a lower dose was received also due to inhalation of tritium. The dose assessment due to liquid discharges in 2006 showed their very low contribution to the population exposure: it was less than 0.01 μSv per year. The levels of external radiation in the vicinity of the structures (on-site) are higher than in the natural surroundings, but they are not measurable as far as the plant fence. It was estimated that the plant-related external exposure was of the order of magnitude of less than 0.1 μSv per year. This estimation is much lower than in recent years and it is now based on less conservative data.

Table 5: Assessment of partial exposures of the adult member of the public due to atmospheric and liquid radioactive discharges from the Krško NPP in 2006

Type of exposure	Transfer pathway	Most important radionuclides	Effective dose [μSv/year]
External radiation	Cloud immersion Deposition	(^{41}Ar, ^{133}Xe, ^{131m}Xe) Particulates: (^{58}Co, ^{60}Co, ^{137}Cs...)	0.1 < 0.1
Inhalation	Cloud	^{3}H, ^{14}C	0.22
Ingestion (atmospheric discharges)	Vegetable food	^{14}C	< 1
Ingestion (liquid discharges)	Drinking water (the Sava river)	^{137}Cs, ^{89}Sr, ^{90}Sr, ^{131}I	< 0.01
Total Krško NPP in 2006			**< 1***

*Single dose contributions from particular exposures are not additive, because different groups of public were taken into consideration.

From Table 5 it is clear that the total effective dose for an individual who lives in the surroundings of the Krško nuclear power plant is less than 1 μSv per year. This value represents about 2% of the authorized dose limit (50 μSv) or less than a thousandth of the dose received by an average Slovenian from natural background radiation (2500–2800 μSv per year).

3.2.2 The Research Reactor TRIGA and the Central Storage of Radioactive Waste at Brinje

The research reactor TRIGA and the Central storage of radioactive waste are both located at Brinje near Ljubljana. The samples irradiated in the reactor are analyzed in the laboratories of the Department of Environmental Science of the Jožef Stefan Institute, which are located along the reactor. Potential radioactive discharges at this location arise from the reactor, from the waste storage and from the laboratories.

Environmental monitoring of the research reactor TRIGA comprises measurements of atmospheric and liquid discharges and measurements of radioactivity levels in the environment. The latter are performed to find out the environmental impact of the installation and comprise measurements of radioactivity in air, underground water, measurements of external radiation, radioactive contamination of the soil and of radioactivity of the Sava river sediments.

Measurements of radioactive aerosol discharges into the atmosphere showed results below the detection limit. A single discharge of isotope ^{131}I with total discharged activity of 0.22 MBq per year was released from the laboratory of the Jožef Stefan Institute. No radioactive contamination due to reactor operation was detected by environmental measurements. Taking into account the average continuous power of the reactor operation and the annual decreasing trends of radioactive discharges from the waste tank used by the laboratories of the Jožef Stefan Institute, the exposure of population in 2006 was estimated to be similar to the previous year. The external immersion dose due to ^{41}Ar discharges to the atmosphere in 2006 (0.76 TBq) was estimated by a model calculation at approximately 0.19 μSv per year. A conservative assumption was used for dose assessment to individuals of the population for liquid discharges: if river water is ingested directly from the recipient river (Sava), the annual exposure is less than 0.0084 μSv per year. The total annual dose (0.20 μSv) to an individual from the public equals to previous levels and thus reaches only 0.020% of the general dose limit for the public (1000 μSv) or one ten thousandth of the natural background radiation in Slovenia (about 2500–2800 μSv per year).

The monitoring programme of environmental radioactivity of the storage at Brinje comprised control measurements of radioactive atmospheric discharges (radon and its short-lived progeny from the storage as the consequence of the stored ^{226}Ra sources), radioactive waste water (from the newly built drainage collector) and direct external radiation (on outside walls of the storage). Environmental concentrations of radionuclides were measured in the same scope as in previous years (in underground water from the two wells, in soil near the storage, external radiation at several distances from the storage, and dry deposition).

After the reconstruction of the storage in 2004, radon releases to the environment decreased from the annual average value of 75 Bq/s to 52 Bq/s in 2005 and 35 Bq/s in 2006, or 1.1 GBq per year. Enhancement of radon ^{222}Rn concentrations in the vicinity of the storage was estimated by a model for average weather conditions, and equal to 7.0 Bq/m^3 at the distance of 30 m and to about 2.5 Bq/m^3 at the distance at 50 m, i.e. at the fence of the reactor centre. In the waste water from the new drainage collector artificial radionuclides ^{241}Am, ^{134}Cs and ^{60}Co were measured as a consequence of cleaning the storage after the reconstruction. The measured activities were approximately two orders of magnitude lower than in the previous year. These radionuclides originated from keeping and handling radioactive waste in the storage in the past. No radionuclides due to storage operation were detected in underground water.

For the dose assessment of the most exposed members of the public only 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 are potentially under the impact of radon releases from the storage. According to the calculation they received an effective dose of 4.9 μSv in 2006. The security officer receives about 2.3 μSv per year due to his regular rounds, while the annual dose to the farmer at the fence of the controlled reactor area was estimated to be only about

0.1 μSv. These values are lower than in previous years, mostly due to lower radon releases, lower dose conversion coefficients in accordance with the new regulations, and mostly taking into account the actual prevailing wind directions. The annual effective dose collected by an individual from the public from natural background in the country is 2500-2800 μSv.

3.2.3 The Former Žirovski Vrh Uranium Mine

In 2006, the contents and scope of the radioactivity control programme was changed and adapted to the decommissioning phase of the uranium mine. Some analyses from the programme, confirmed in 1992, were abandoned, because they produced similar (equal) results due to weak transfer pathways. These values were frequently at the detection limit of the measuring method. The main emphasis remained on two major transfer routes, which will be important also in the long-term future: atmospheric (mainly radon) and aquatic (mainly dissolved radionuclides and stream sediments) transfer route. The programme change is described in the Safety reports (approved by the SNSA) for the Jazbec and Boršt disposal sites.

Monitoring of environmental radioactivity of the former uranium mine at Žirovski Vrh – the mine is currently in the post-operational phase – consists of measurements of radon releases and liquid radioactive discharges, and environmental measurements of radionuclide specific activities of the uranium-radium decay chain, concentration measurements of radon and its decay products in the air, and external radiation. Measurement locations are set mainly at the settled areas in the valley, up to 3 km from the existing mine radiation sources; that is from the village of Gorenja vas to Todraž. Because of measurements of radionuclides of natural origin, the reference measurements for the evaluation of impact of uranium mining (i.e. for assessment of the enhancement of radioactivity in the environment) have to be carried out at relevant points, outside the influence of mine discharges. The natural background of particular radionuclides has to be subtracted from the measured values to obtain the real contribution of radioactive contamination due to the sources of the former uranium mine.

Concentrations of radionuclides in some environmental media have partially decreased after cessation of mine operation. The differences are most evident in lower values of long-lived radionuclides in air and surface water radioactivity, and they have been observed also for outdoor radon concentrations. Radioactivity of the surface waters in both streams in the last years has been slowly but steadily decreasing, especially ^{226}Ra concentrations in the Brebovščica, the main recipient stream: they are close to the natural background level. Only uranium ^{238}U concentrations in the Brebovščica stream (234 Bq/m^3) are still increased, because all liquid discharges from the mine and from disposal sites flow into it; these concentrations are even higher due to arranging works at the disposal sites and bigger rinsing in the environment as compared with the year before. Radioactivity of sediments (^{238}U, ^{226}Ra) in the Brebovščica and Todraščica streams is not more than 50% higher than in the recipient river Sora before the outflow of the Brebovščica stream. The average concentrations of radon ^{222}Rn in the surroundings of the mine (at Gorenja Dobrava) were still higher than a long-term average value concentration at the reference point, outside the mine influence (about 20 Bq/m^3). In the last years the mine's contribution of radon to natural concentrations in the environment was estimated to have decreased to a little more than 5 Bq/m^3 (2006: 8.0 Bq/m^3, 2005: 5.0 Bq/m^3, 2004: 5.8 Bq/m^3, 2003: 8.4 Bq/m^3, 2002: 5.4 Bq/m^3, 2001 5.1 Bq/m^3).

Calculation of the effective dose for population takes into account the following exposure pathways: inhalation of long-lived radionuclides, radon and its short-lived progeny, ingestion (intake of food and water) and external gamma radiation. Radiation exposure of the population living in the vicinity of the mine was estimated to be 0.26 mSv in 2006. This value is a little higher than in 2004 and 2005 and is somewhat lower than the one calculated in the last decade. The decreasing trend is noticeable and expected, because of the decreasing radon releases due to the decommissioning works. The most important radioactive contaminant in the mine environment still remains radon ^{222}Rn with its short-lived progeny, which contribute almost three quarters of additional exposure (Table 6).

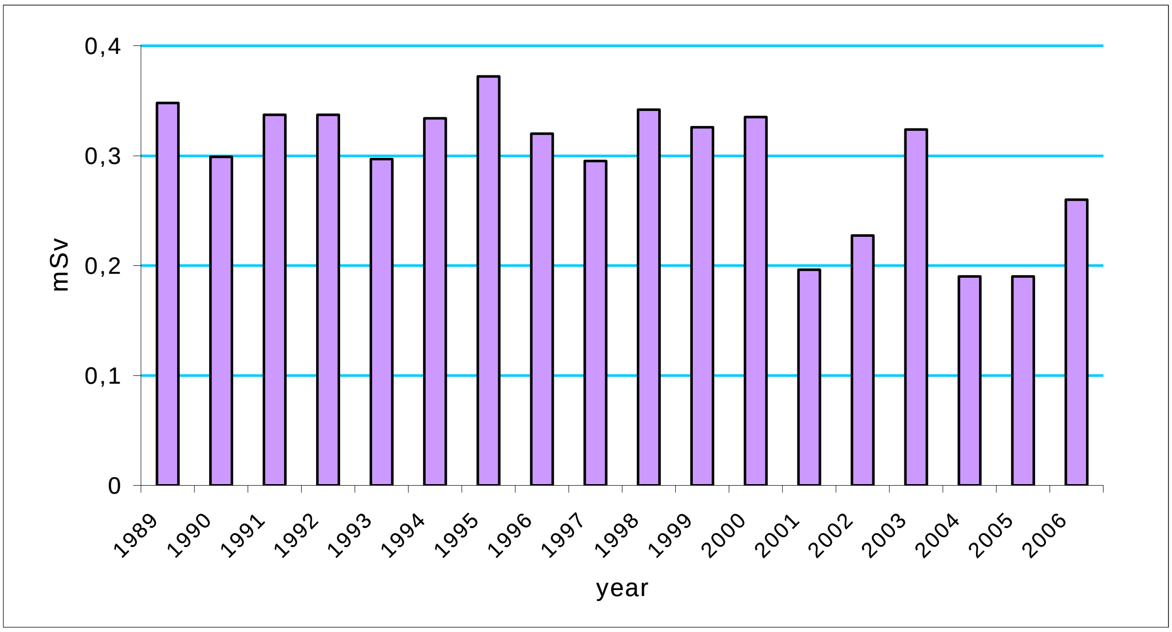
Table 6: Effective dose of population in the surroundings of the former uranium mine at Žirovski Vrh in 2006

Transfer pathway	Important radionuclides	Effective dose [mSv/year]
Inhalation	- aerosols with long-lived radionuclides (U, ^{226}Ra, ^{210}Pb)	0.001
	- only ^{222}Rn	0.006
	- Rn – short-lived progeny	0.208
Ingestion	- drinking water (U, ^{226}Ra, ^{210}Pb, ^{230}Th)	(0.025)*
	- fish (^{226}Ra, ^{210}Pb)	0.003
	- foodstuff (^{226}Ra in ^{210}Pb)	< 0.042
External radiation	- immersion and deposition of radon progeny	0.002
	- deposition of long-lived radionuclides	-
	- direct gamma radiation from disposal sites	0.002
Total effective dose for 2006 (rounded): 0.26 mSv		

* Water from the Brebovščica stream is not included in the dose assessment because it is not used for drinking, watering of animals and irrigation

The total effective dose in 2006 due to contribution of the former uranium mine reached one quarter of the general limit value for the population (1 mSv per year). This figure represents about 10% of the annual dose due to natural radiation background in Slovenia (2500–2800 μSv) and less than 5% of the natural background dose in the Žirovski Vrh environment (5500 μSv). Annual changes of effective doses due to the mine contribution are shown in Figure 21.

Figure 21: Annual contributions to the effective dose of population due to the Žirovski Vrh Mine



Measurements and dose estimations for the period of the last several years clearly show that cessation of uranium mining and the restoration works carried out till now have decreased the environmental impacts and exposure to population. The south-east bank restructuring on the Jazbec disposal site started in June 2006. The existing cover layer was temporarily removed and a new one was built. The surface remodelling of the upper layer of the depositary was achieved by shifting of the tailings. All these activities brought additional contribution of radon to the environment, which is the most probable reason for the higher assessment of the dose contribution in 2006 as compared to the previous year, but it is still below the authorized limit value, which is 300 μSv.

3.3 Early warning system for radiation in the environment

The Slovenian on-line early warning system for radiation in the environment was established at the beginning of the last decade. The system is designed for immediate detection of raised levels of radiation and is one of the key elements of the alarming and reacting procedures in case of emergency. When radioactive releases into the environment occur, the levels of external radiation and concentrations of radioactive particles in the air are higher, since the air, ground, drinking water and food are contaminated by the fallout. They are managed by the SNSA, the Krško NPP, the EARS and each of the Slovenian thermal power plants. The SNSA collects, analyzes and archives data which are also presented on-line on the SNSA web pages. The corresponding alarm would trigger in case of higher detected values.

In the year 2006 there were no events which would have triggered the alarms due to elevated values of radioactivity in the environment.

Since 1997 the SNSA has been sending data to the European system EURDEP with its centre in the Joint Research Centre in Ispra, Italy, where the data from most European national early warning networks are collected. Slovenia has thus gained access to the on-line data of external radiation measurements from other participating countries. Additionally, Slovenian data are daily exchanged with the Austrian centre in Vienna, the Croatian in Zagreb and the Hungarian in Budapest.

In 2004 the SNSA and the EARS started a common project of upgrading and modernization of the early warning system. The project was approved by the European Commission and is co-financed from the PHARE programme. 35 stations for gamma dose rate measurements were added to the existing network in 2006. These new stations are equipped with precipitation meters, and some of them are capable of even more complex meteorological measurements. The data transfer is essentially improved as well as the visualization, analysis of the incoming data, and alarming in case of elevated dose rate values. The whole network now consists of 77 measuring stations.

3.4 Radiation exposures of 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, and only a small part of population is occupationally exposed due to work in a radiation field or with radiation sources. External radiation means that the source is located outside the body. Internal radiation occurs if radiation material enters the body by means of inhalation, ingestion of food and drink or through the skin. The data on population exposure are presented in the following subchapters, while the occupational exposures (to artificial and natural sources) and medical exposures are presented in Chapter 4.

3.4.1 Exposure to natural radiation

According to the data of the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR) the average annual effective dose from natural sources to a single individual is 2.4 mSv, varying according to different locations from only 1 mSv up to 10 mSv. The average annual dose from natural radiation sources for an average member of the public in Slovenia is somewhat higher than the world average, about 2.5 to 2.8 mSv per year. From the existing data on external radiation and radon concentrations in dwellings and outdoors it can be estimated that about 50% of this value is due to internal exposure as a consequence of inhalation of indoor radon and its progeny (1.2–1.5 mSv per year). The dose amount due to intake of food and water is about 0.4 mSv. The annual effective dose of external radiation originating from soil radioactivity, building material in dwellings and from cosmic radiation together was estimated at 0.8 to 1.1 mSv. The Slovenian Radiation Protection Administration (SRPA) has continued the implementation of the governmental programme in the area of radon exposure. This programme comprises monitoring of the working and dwelling environment as well as public informing about the measures for decrease of exposure due to the presence of natural radioactive sources. In the scope of this programme, measurements in altogether 44 objects were performed and the accumulated effective doses were assessed for the employees; in schools and kindergartens also for children.

3.4.2 Population dose due to global contamination

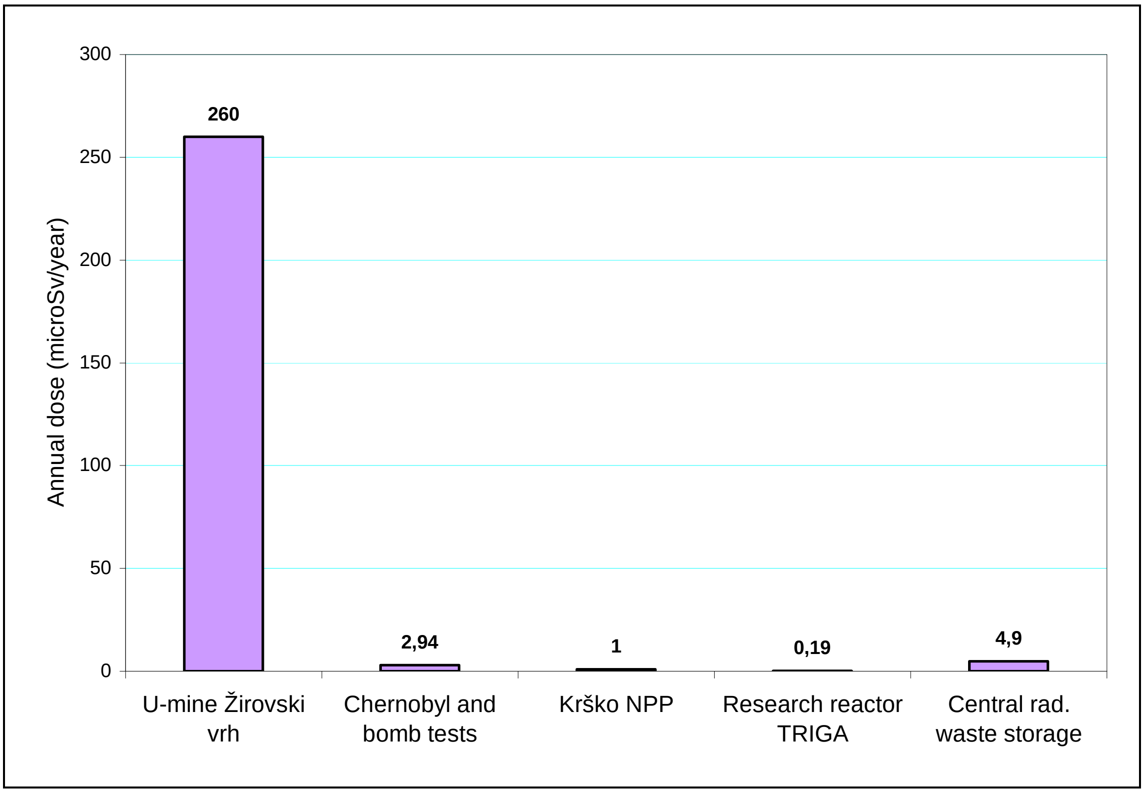
Particularly people from the Northern Hemisphere are still exposed to ionizing radiation from global contamination of the environment as the consequence of past atmospheric nuclear bomb tests and the nuclear accident in Chernobyl. The last estimation of this exposure showed that in 2006 the average individual dose to the population from long-term radionuclides ^{137}Cs and ^{90}Sr in our country was near 3 μSv. External radiation contributed with 1.45 μSv, while the exposure due to intake of food and water was estimated at 1,49 μSv. Due to lower contamination of the ground with ^{137}Cs the population in urban areas is less exposed than the one in rural environment. This estimation is 50% lower than in 2005.

3.4.3 Radiation exposure of population due to human activities

Radiation exposures due to the regular operation of nuclear and radiation facilities are usually attributed only to local population. Exposures of particular groups of population as a consequence of radioactive discharges from these objects are described in the chapters on operational monitoring. In Figure 19 the annual individual doses are given for the adults of the reference groups of population living in the vicinity of particular nuclear and radiation installations in Slovenia. For comparison, also an average annual dose for individuals related to global radioactive contamination of the environment (nuclear tests and the Chernobyl accident) is shown. The highest exposures of the population are recorded for the individuals living in the surroundings of the former uranium mine at Žirovski Vrh, and are slightly below one tenth of the exposure due to natural sources.

The population is exposed to radiation also due to some other human activities. These exposures come from deposited materials with enhanced natural radioactivity and originates from past industrial or mine activities, related mostly to mining and processing of raw materials containing uranium or thorium (in Slovenia: mining and processing of mercury ore, processing of bauxite, phosphates, coal combustion). Only certain data are available on various types of materials, on their amounts, and their higher contents of natural radionuclides. The dose assessment has not been systematically carried out due to the lack of data needed. The exception is the operation of the Šoštanj thermal plant: environmental radioactivity monitoring of the coal ash disposal provided the information that in the year 2006 individuals from the surrounding population received doses not higher than about 6.8 μSv.

Figure 22: Population exposures due to the installations discharging radioactivity to the environment, and due to global contamination in 2006 (the annual dose limit for the population is 1000 μSv, natural background radiation is 2500-2800 μSv)



4 RADIATION PROTECTION OF WORKERS AND MEDICAL EXPOSURES

4.1 Occupational exposure to ionizing radiation

Due to occupational exposure, individuals can receive a substantial dose of radiation. Therefore, organizations that carry out radiation practice should optimize working activities in a manner to decrease the dose of ionizing radiation to a level as low as reasonably achievable (ALARA). The exposed workers are subject to a regular medical surveillance programme and suitable training. The employer has to assure that the dose of ionizing radiation is assessed for every worker performing specific activities.

4.1.1 Individual exposures

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

The approved dosimetry services in 2006 were the Institute of Occupational Safety (IOS) and the Jožef Stefan Institute (JSI). Limited approvals were granted to the Krško Nuclear Power Plant (for thermo-luminescent dosimetry) and to the Žirovski Vrh Mine (internal dosimetry for workplaces in mines). Currently 7,500 persons have their records in the central register, including those who ceased using sources of ionizing radiation in previous years. In 2006, the dosimetric service at the IOS performed measurements of individual exposures for 3,100 workers employed at around 700 enterprises. The JSI monitored the exposures of approximately 500 radiation workers. The Krško Nuclear Power Plant (Krško NPP) performed individual dosimetry for 902 plant personnel and outside workers, who received an average dose[1] of ionizing radiation of 1.14 mSv. In other working sectors the average annual effective dose due to external radiation was the highest for workers in industrial radiography, namely 0.93 mSv, while the employees in medicine received on average 0.34 mSv. The highest average value of these, 0.75 mSv, was recorded for brachytherapy workers.

The highest collective dose due to external radiation was received by radiation workers in the Krško NPP (855.13 man mSv) and in the medical sector (381 man mSv). Exposures in industry and in education, research and other activities were 73 man mSv and 15 mSv, respectively.

The highest doses are received by workers exposed to radon and its progeny.

At the Žirovski Vrh Mine the highest annual individual dose was 0.77 mSv, and the average for a group of 64 workers was 0.35 mSv. The collective dose was 22.4 man mSv.

In the other two mines (the Mežica Lead and Zinc Mine in closure and the Idrija Mercury Mine in closure) a total of 61 workers were exposed in 2006. On average they received 0.27 mSv and the collective dose was 15.8 man mSv.

Out of 124 tourist workers in the Karst caves 36 received an effective dose above 5 mSv. The collective dose was 341 man mSv, with an average dose of 2.96 mSv.

As previously, the doses due to radon and its progeny are assessed according to the International Commission on Radiological Protection (ICRP) 65 recommendations. In 2005 the SRPA carried out a study related to the exposure of individuals in the Karst caves. The findings show that doses assessed according to ICRP 65 are underestimated

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

for tourist workers in Karst caves. Due to a high unattached fraction of radon progeny, an approximately two times higher dose factor should be taken into account. According to the study, the ICRP 32 model would be more appropriate to assess the individual doses of tourist workers in caves. The collective dose for workers in Karst caves according to ICRP 32 would be 682 man mSv and the highest individual dose 19.3 mSv.

The distribution of workers by dose intervals in different work sectors is shown in Table 7.

Table 7: Number of workers in different work sectors distributed according to dose intervals

	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	150	509	202	39	2	0	0	0	902
industry	273	89	16	3	0	0	0	0	381
medicine and veterinary	1687	1038	83	2	0	0	0	0	2810
radon	11	158	44	36	0	0	0	0	249
education, research and other activities	285	153	4	0	0	0	0	0	442
TOTAL	**2406**	**1947**	**349**	**80**	**2**	**0**	**0**	**0**	**4784**

MDL - minimum detection level
E- effective dose in mSv received by an exposed worker

4.1.2 Training

Education of workers using sources of radiation is in accordance with regulations. Minor deficiencies have been found regarding timely refreshment of knowledge and skills. Training, refreshment courses and tests are carried out by the approved technical support organizations, namely the IOS and the JSI. In 2006 a total of 1227 participants attended courses on ionizing radiation protection.

The training of exposed workers is inspected by the SRPA. One inspection related to training in radiation protection of persons carrying out radiological procedures was performed in 2006.

4.1.3 Medical surveillance

In 2006, medical surveillance of radiation workers was performed by five approved occupational health institutions:

- Clinical Institute of Occupational, Traffic and Sports Medicine, Ljubljana,
- IOS, Ljubljana,
- Aristotel Llc., Krško,
- Health Centre Krško,
- Health Centre Škofja Loka.

Altogether 2284 medical examinations were carried out.

4.2 Diagnostic reference levels for X-ray examinations

Medical applications of ionizing radiation are by far the largest man-made source of radiation exposure for the population in most developed countries. Good practice in diagnostic radiology should produce an image containing all necessary information needed for accurate diagnosis and should result in a minimum dose to the patient. After introduction of the diagnostic reference level by the International Commission on Radiological Protection in 1996 the process of patient exposure optimization has been enhanced. Local performance in patient exposure for a particular type of X-ray examination in a radiological department can be assessed by comparison of the mean patient dose to the diagnostic reference level derived from relevant regional or national data. The results of the extensive five-year national patient dose survey in Slovenia are being reviewed. The proposed Slovenian diagnostic reference levels for fifteen different X-ray examinations are presented, commented and compared with international and national levels of other countries in Table 8.The introduction of national diagnostic reference levels will increase the awareness of patient doses in Slovenia. Their proper use should promote good radiological practice by reducing doses where current practice is not optimized.

Table 8: Diagnostic reference levels for standard X-ray examinations in Slovenia and comparison with international and other national values

	Entrance Surface Dose (mGy)				
X-ray examination	**IAEA 1994**	**EC 1999**	**Germany 2002**	**United Kingdom 2002**	**Slovenia 2005**
skull AP/PA	5	5	5	3	2.5
skull LAT	3	3		1.6	2
cervical spine AP					1.8
cervical spine LAT					1.9
chest PA	0.4	0.3	0.3	0.2	0.4
chest LAT	1.5	1.5	1.5	1	1.2
chest AP					0.3
thoracic spine AP	7		7	3,5	8
thoracic spine LAT	20		12	10	10
lumbar spine AP	10	10	10	6	8
lumbar spine LAT	30	30	30	14	20
lumbo sacral joint LAT	40	40		26	30
pelvis AP	10	10	10	4	6
hip AP					5
abdomen AP	10	10	10	6	6

In parallel an analysis of digital radiological systems in healthcare was performed in 2006, aiming to optimize the quality system of procedures, where such systems are in use. In cooperation with the IAEA, the SRPA also started a technical project aiming to optimize patient exposures in interventional radiology procedures with an emphasis on interventional cardiac procedures.

5 RADIOACTIVE WASTE MANAGEMENT AND MANAGEMENT OF NUCLEAR AND RADIOACTIVE MATERIALS

In Slovenia the high level radioactive waste (HLW) consists of the spent nuclear fuel (SNF) at the Krško NPP and at the research reactor TRIGA. The greatest amount of low and intermediate level radioactive waste (over 95%) is generated due to the operation of the Krško NPP. The rest is produced in medicine, industry and research activities. A special category of waste are spent sealed radioactive sources, which are in the possession of small holders or are stored in the Central Interim Storage for Radioactive Waste at Brinje.

5.1 Implementation of the National Programme on Radioactive Waste and Spent Nuclear Fuel Management

On the 1st February 2006 the National Parliament of the Republic of Slovenia adopted the Resolution on the National Programme on Radioactive Waste and Spent Nuclear Fuel Management for the period 2006–2015 (ReNPROJG), which was published in the Official Gazette RS No. 15/06 and is part of the National Environment Protection Programme (NPVO). ReNPROJG is an extensive and detailed document setting goals and tasks in the field of radioactive waste and spent nuclear fuel management.

The basic scenario for the preparation of the long-term national programme of radioactive waste and spent nuclear fuel management foresees the construction of repositories for low and intermediate level radioactive waste and spent nuclear fuel, respectively. The national programme foresees the construction of a repository for LILW with half capacity, to satisfy the needs of the Slovenian part of LILW generated through the operation and decommissioning of the Krško NPP and for the disposal of all other Slovenian waste generators. In parallel the programme enables technical foundations and construction of a repository with full capacity for all waste from the Krško NPP if an appropriate agreement is reached with the Republic of Croatia about a joint solution of this problem.

5.1.1 Operational Programmes of the National Programme on Radioactive Waste and Spent Nuclear Fuel Management

On the basis of ReNPROJG the ARAO in 2006 prepared Operational Programmes of the National Programme on Radioactive Waste and Spent Nuclear Fuel Management that cover the entire field of RAW and SNF management for a period from 2006 to including 2009 and treat transaction of the public service of management of RAW from small generators, management of RAW in medicine, management of LILW in the Krško NPP, site selection of the LILW repository, closure of the Žirovski Vrh uranium mine, management of SNF and HLW, revision of the Decommissioning programme for the Krško NPP and disposal of LILW and SNF, preparation of the decommissioning programme for the TRIGA research rector and preparation of new operational programmes. For each specific programme its goals are presented with a short explanation regarding the current state and future plans, provisions to achieve goals with their deadlines and evaluated costs by years and by sources of financing. Additionally the holders of specific measures, supporting measures and criteria to achieve the goals are defined. In the composition of the operational programmes all holders of specific programmes took part.

5.2 Radioactive waste and irradiated fuel at the Krško NPP

5.2.1 Management of low and intermediate level waste

In the past years, volume reduction of LILW radioactive waste was achieved by means of compression, super-compaction, drying, incineration, and melting, so that the total volume of waste accumulated at the end of 2006 amounted to 2258 m^3. The total gamma and alpha activity stored were $1.79 \cdot 10^{13}$ Bq and $1.93 \cdot 10^{10}$ Bq, respectively. In 2006, 117 standard drums containing solid waste were stored with total gamma and alpha activity on 31.12.2006 $1.02 \cdot 10^{12}$ Bq and $7.57 \cdot 10^{8}$ Bq, respectively.

Figure 23 shows the accumulation of low and intermediate level radioactive waste in the storage at the Krško NPP. Periodical volume reductions with compression, super-compaction, incineration, and melting are denoted. The lower waste volume accumulation rate after 1995 results from a new in-drum drying system (IDDS) for drying of evaporators concentrate and spent ion exchange resins.

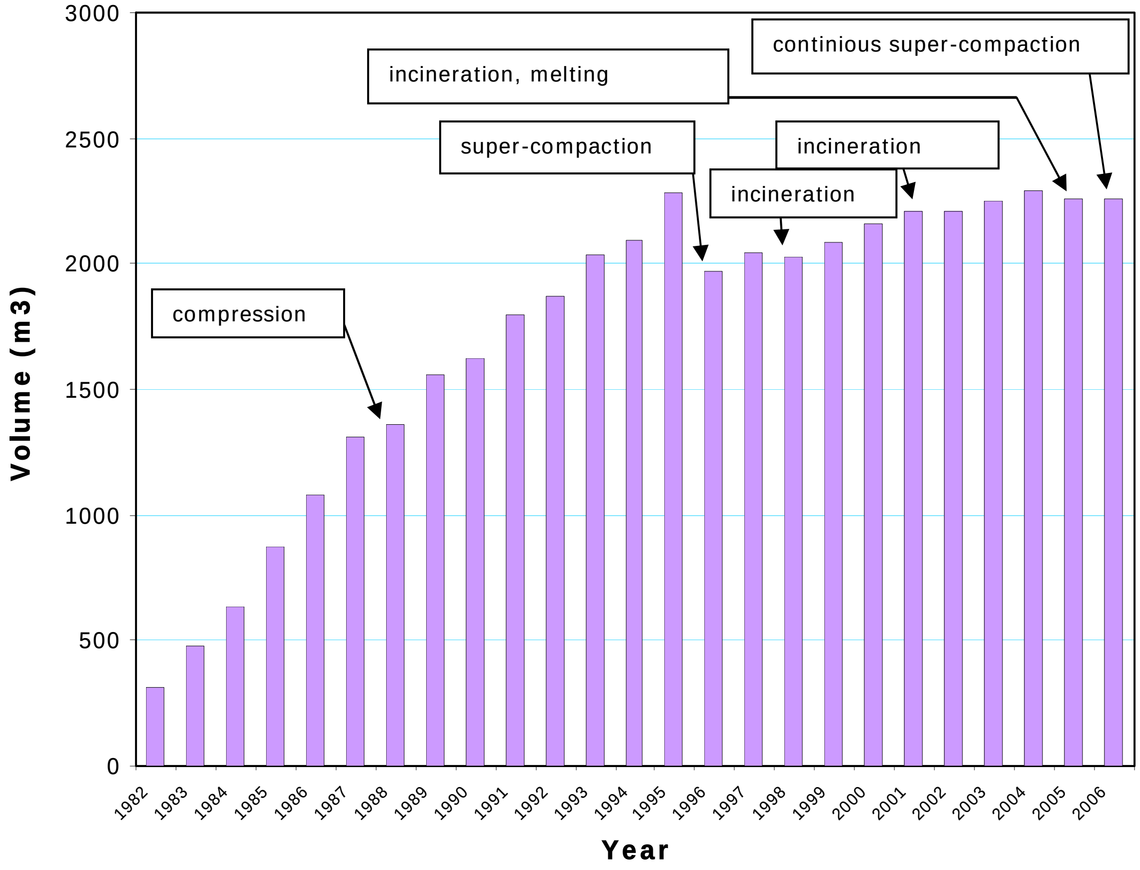
Because the working capacity of the existing IDDS is insufficient for drying backlog sludges and sediments, the Krško NPP hired an external service GNS Gesellschaft für Nuclear-Service mbH from Germany, which until the end of 2006 performed the drying of 92 drums of sludges and sediments using a mobile IDDS unit.

In 2006 the Krško NPP started continuous compression of radioactive waste with their own super-compactor installed in the storage facility.

Secondary waste sent for incineration and melting in October 2005 to Studsvik in Sweden was returned to the Krško NPP in December 2006. Due to installation works for two-level storing of drums in the solid radwaste storage facility (SRSF) the waste is temporarily kept in the multipurpose building (decontamination facility). After the completion of the works the waste will be transferred to the SRSF. Also new drums with waste pending incineration and melting in Sweden are temporarily kept in the decontamination facility.

For the reasons stated above, the total volume of low and intermediate level waste at the Krško NPP at the end of 2006 was only 3 m^3 larger compared to the volume at the end of 2005, and the total activity also remained the same.

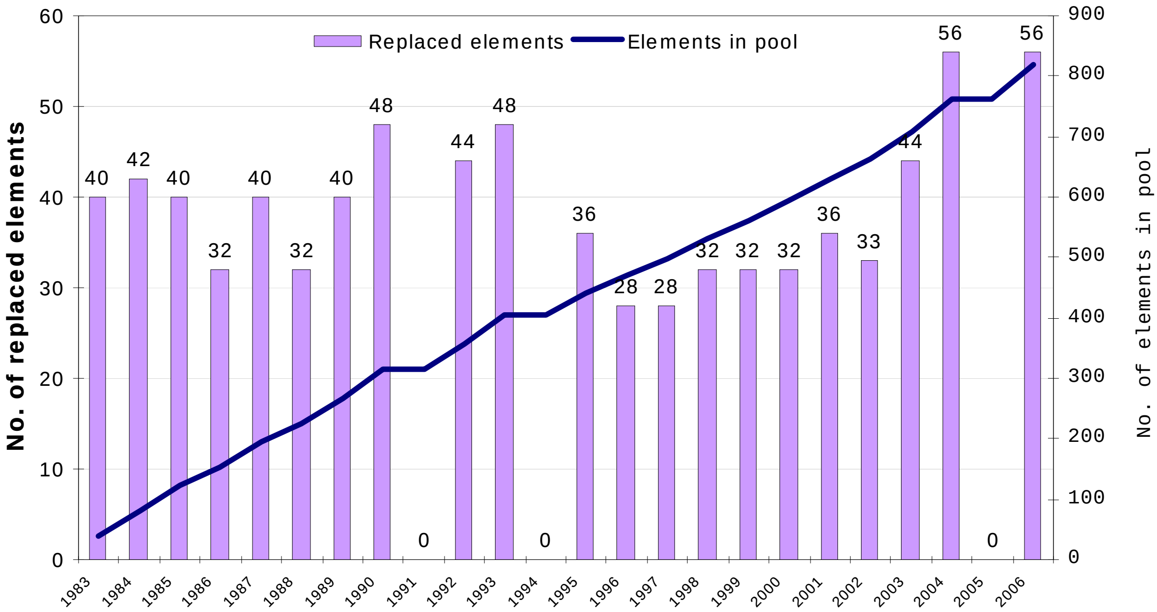
Figure 23: Accumulation of low and intermediate level radioactive waste at the storage in the Krško NPP



5.2.2 Management of spent nuclear fuel

In 2004 the Krško NPP started with a longer fuel cycle, according to which outages take place every 18 months. In 2006, 56 fuel elements were replaced during the regular outage. At the end of 2006 there were 819 fuel elements stored in the spent fuel pool. Figure 24 shows accumulation of spent fuel at the Krško NPP.

Figure 24: The annual discharges of spent fuel assemblies and accumulation of spent fuel assemblies in the Krško NPP spent fuel pool



5.3 Radioactive waste at the Jožef Stefan Institute

During the operation of the reactor in 2006, approximately 0.05 m^3 of solid low and intermediate level waste was produced that was handed over to the institute's Service for protection against ionizing radiation, which removed it from the reactors premises and handed it over to the Central Interim Storage Facility at Brinje.

5.4 Radioactive waste in medicine

The Oncological Institute Ljubljana, as the biggest user of radioactive iodine ^{131}I, has appropriate hold-up tanks to facilitate decrease of the activity of waste liquids through decay. The tanks are emptied every four or more months. Before the discharge, measurements of specific activity are performed by the authorized organizations. Discharge is carried out if the limit values are not exceeded. The Clinic for Nuclear Medicine of the Clinical Centre of Ljubljana has not built the system for holding up of liquid waste yet. The Clinic for Nuclear Medicine intends to build new premises that will have an appropriate system for holding up of liquid waste. The construction will be performed in the course of renovation of the Clinical centre.

5.5 Activities of the Agency for Radwaste Management

The ARAO is responsible as a transactor of the public service of radioactive waste management. Among other things, it also covers the operation of the Central Interim Storage for Radioactive Waste at Brinje, receipt of radioactive waste from small producers. It has obtained the required licenses and regularly performs the public service of radioactive waste management.

5.5.1 The process of site selection for the disposal of low and intermediate level radioactive waste

The ARAO is also responsible for the site selection and construction of the repository for low and intermediate level radioactive waste.

Siting of the repository for radioactive waste is extremely complex and entangled legislation-wise. It is regulated by several acts, among which the most important are the Act on Environmental Protection and the Act on Spatial Planning (in relation with the 2002 Act), and the subsidiary legislation issued on its basis.

For the construction of a nuclear facility the 2002 Act provisions three decision phases and documentation preparation:

- Siting of a nuclear facility shall be carried out through a Detailed Plan of National Importance. Site selection shall be among other performed on the basis of a Special Safety Analysis (SSA).
- To obtain an environmental consent, an Environment Impact Assessment (EIA) shall be submitted.
- To obtain a construction license a consent from the SNSA shall be obtained. The key document to estimate safety of the construction, operation and closure of the facility is a Safety Analysis Report (SAR).

On 31st January 2006, the SNSA determined the contents and scope of SSA for siting of the LILW repository. The content prescribes parameters that have to be evaluated in SSA for the decision-making process on selection of the most appropriate alternative on each available site for the LILW repository and to exclude the sites inappropriate for any alternative.

Within the framework of »Siting of the LILW repository«, at the beginning of 2006 the ARAO prepared everything necessary to start field investigations, preparation of the project and other study documentation for the sites Čagoš (Sevnica municipality), Vrbina (Krško municipality) and Globoko (Brežice municipality), but continued works only at Vrbina (Krško) due to the withdrawal of Čagoš and Globoko.

For the Vrbina site (Krško) the annual plan has been fulfilled and the elaborates required for the continuation of the process were prepared (i.e. the Comparative Study of Alternatives, Environmental Report, a part of which is the SSA). The elaborates have been submitted to the Ministry of the Environment and Spatial Planning – Directorate for Spatial Planning. The Study of Alternatives for a repository at the potential Vrbina site (Krško) proposed as an optimal alternative the underground silos. At the beginning of 2007 the procedure of examination and confirmation of the proposed alternative was at the interdepartmental stage, where the public debate is continued, led by the Directorate for Spatial Planning.

Field investigations at the Globoko site, which withdrew from the process in August 2006, have been performed only partially (biosphere, radionuclide content in some crops, state of the nearby mine Globoko). In December 2006, Brežice municipality offered a new area, for which the municipal council determined a site at the beginning of 2007. Therefore, preparatory works have already been carried out to continue works at the new site.

Within the framework of investigations at the Vrbina site (Krško) geosphere investigations (geological, hydrogeological and geotechnical conditions) were performed, as well as hydrosphere (hydrological and meteorological conditions) and biosphere investigations (fauna and flora), radiological zero state measurements, paedological investigations and monitoring. The key difficulty in performing these investigations was the fact that they were carried out offsite instead of onsite, due to the specific ownership structure. This unfortunately increases the uncertainties of repository design, requires additional investigations and raises the costs of investigations. The ARAO has created a database of field investigations and has set up a consultant council (the »geo- and hydro-technical board«) to control the scientific accuracy of the investigations, as well as the geotechnical and hydrotechnical design solutions. The board consists of top scientists.

As part of a holistic estimation of environmental impacts, an Environmental Report was produced for the Vrbina site, and its revision was performed by the Directorate for Spatial Planning.

5.6 Remediation of the Žirovski Vrh Uranium Mine

The remediation of the Žirovski Vrh uranium mine has been in progress since the foundation of the public enterprise Rudnik Žirovski Vrh (RŽV) in 1992. Since then, the uranium processing plant, together with the accompanying objects, has been successfully decommissioned and deconstructed. In 2006 activities were mainly performed in the mineshaft and consisted of removal of the temporary mill tailings depository, preparation of project documentation and regular maintenance of facilities and both depositories, Jazbec and Boršt respectively. In autumn the first works of final remediation of the Jazbec depository started.

In spring 2006 works on smaller shaft facilities were finalized when improving the pile landslide above sap P-11 with mine tailings and piling mine tailings on the plateau below the Jazbec depository. The piled mine tailings and the contaminated material were transported through a radiometric portal to the Jazbec depository.

Final arrangements of specific mine facilities were terminated in the first half of 2006. 19,204 tons of mine tailings and contaminated soil were transported to and deposited at the Jazbec depository.

The plateau of the former facility for uranium concentrate production was entirely handed over to Gorenja vas – Poljane municipality in autumn 2006. An economic zone is being constructed there.

Regular maintenance of the facilities and surface at the Boršt depository for hydrometallurgical tailings took place in 2006.

In November 2006 the RŽV applied for consent to the mining works for the closure of the Boršt depository for hydrometallurgical tailings and attached the required project documentation, which was later adequately supplemented. Analyses of potential emergencies (earthquake; lasting heavy rain; storm; landslide; lasting drought; combination of earthquake, lasting heavy rain and storm; occurrence of liquefaction of hydrometallurgical tailings; reduction in functioning of drainage systems; airplane crash; unauthorized human intrusion and loss of institutional control) showed that the consequences of such events would be limited, affecting only a few percent of the cover and the piles, respectively. According to the Supplemental Detailed Plan issued in May 2003 by the Ministry of the Environment and Spatial Planning, doses to the members of the public shall not exceed 0.3 mSv/year. As after finalization of works Boršt shall become part of the national infrastructure, long-term institutional control and remediation of consequences resulting from emergencies shall be guaranteed.

After finalization of mining works for improvement of the Boršt depository for hydrometallurgical tailings, the license for closure will have to be obtained from the SNSA. The license is a prerequisite to obtain a final provision on cessation of rights and obligations according to mining regulations and for the conveyance of the facility to the national infrastructure.

The funds for performing the planned activities, for ensuring safe working conditions of the staff and external workers and for limiting the effects of the mine to the environment were assured in full and in time.

In 2006 the SNSA Inspection took part in a commission for technical inspection of the facilities in which works had been performed.

5.7 Import, Export, Transport and Transit of Radioactive and Nuclear Materials

The SNSA issues permits for import and export of radioactive and nuclear materials, with the exception of medical appliances, which are regulated by the Ministry of Health – the Slovenian Radiation Protection Administration (SRPA). In 2006 both regulatory authorities validated 44 declarations of consignees in accordance with Council Directive (EURATOM) No. 1493/93 of 8 June 1993. Each isotope at the same consignee from one holder is counted separately. This standard document of declaration shall be valid for a period of not more than three years

Besides imports and exports from Member States, in 2006 the SNSA and the SRPA issued 27 permits for import, 2 permits for export, and 1 permit for multiple input/output. The biggest importers were Biomedis Llc., Karanta Ljubljana Llc., Genos Llc., the Krško NPP, Temat Llc., Kemofarmacija Inc., IMP Promont kontrolor NDT Črnuče, Premogovnik Velenje Jsc., Nafta-Geoterm Llc., Editrade Llc., the Institute for occupational health Jsc., and Sava Tires Llc. Other companies only have occasional imports of radiation sources.

In accordance with the permit of the SNSA, issued in 2005, the Krško NPP imported 56 fresh fuel assemblies in February 2006.

In 2006 no transit permits were issued.

5.8 The Programme of Decommissioning of the Krško NPP

Obligations relating to the decommissioning of the Krško NPP are defined by the treaty between the Slovenian and Croatian Governments on solving statutory and other legal relations related to investment into the Krško NPP, its exploitation and decommissioning. The treaty determines, *inter alia*, that the decommissioning of the Krško NPP and the disposal of radioactive waste are joint responsibilities of both contractors. A Programme of Decommissioning was prepared, which is to be revised at least every five years. The purpose of the programme was to estimate the costs of decommissioning and to determine the corresponding amount of regular levy liable for payment for every kWh of electric power delivered from the NPP. The programme was confirmed in March 2005 by the Interstate Commission.

For the purpose of a new revision that has to be prepared in 2009 a task project »Development of inventory for a new revision of Decommissioning and LILW and SF management program of the NPP Krško« was made to prepare the time consuming and content extensive parts that follow recommendations of the IAEA expert mission in 2005. The task project, whose counterparts will be the Krško NPP, SCK-CEN, APO and ARAO, shall comprise the creation and recalculation of a new inventory of radioactive waste from decommissioning, which represents the biggest source of uncertainty in the project, and a database of all necessary information.

According to the interstate treaty, Croatia should start collecting financial resources for the decommissioning of the Krško NPP in its own fund, which has not yet been established.

5.9 The Fund for Decommissioning of the Krško NPP

The Fund for Decommissioning of the Krško NPP is collecting financial resources from the Slovenian owner of the plant, GEN Energija, Llc. In 2006 the Krško NPP delivered one half of electric power to Slovenian and one to the Croatian utility. GEN Energija, Llc. was liable for the payment of the regular levy to the Fund in 2006, in the amount of 0.003 € for every kWh of electric power received from the NPP. By the end of the year GEN Energija, Llc. contributed in due time the total amount of 1875 million SIT, which is 5.2% more than in 2005.

In 2006 the Fund invested in accordance with the long term strategy and the investment policy. For the sake of safety of investments, the Fund has at least 30% of financial investments in securities issued or warranted by the EU or OECD member states.

On 31 December 2006, the Fund managed 31,500 million SIT of financial investments, 18% of which was invested in banks in the form of deposits and CDs, 44% in state securities, 28% in other bonds and 10% in mutual funds, investment funds and stock of Slovenian companies. The Fund's portfolio is formed in accordance with the strategy and the investment policy for 2006 and guarantees stable long-term incomes. The value of the financial portfolio in 2006 amounted to 31,500 million SIT or 131.5 million €, which is 8% more than the previous year.

Considering the stock market exchange rates of the Fund's portfolio on 31 December 2006, the selling of all securities would have resulted in 1,695 million SIT or 7 million € of capital profit. The yield of the entire portfolio of the Fund for 2006 amounted to 6.16%. The entire income of 3355 million SIT or 14 million € from the funding in 2006 exceeded the income of 2005 by 4%. The expenses in 2006 were 33% lower than planned and amounted to 1153 million SIT or 4.8 million €. Income from financing in 2006 amounted 1500 million SIT or 6.3 million €.

The fund is facing a period of bigger investment costs, thus planning of solvency and rational use of finances shall be put forward.

Construction of the LILW repository is expected to take place between 2007 and 2013. It is foreseen that the site for the repository shall be known by 2008 and the construction shall be finished in 2010 (the legislative requirement is 2013). Because of the high costs related to the construction of the repository, an estimation of the costs and a solvency plan for that period was prepared by the Fund. It is estimated that around 85.45 million € will be earmarked for projects of the ARAO. According to that the Fund will have to adapt the time schedule of investments, which can result in lower profit for individual investments.

5.10 The Nuclear Pool GIZ

The pool for the insurance and reinsurance of nuclear risks GIZ (in short: Nuclear Pool GIZ) is a special type of insurance company dealing with insurance and reinsurance of nuclear risks. The Nuclear Pool GIZ has been operating since 1994 and at the moment includes seven members.

The Insurance Company Triglav, Ltd., the Reinsurance Company Sava, Ltd. and the Adriatic Slovenica, Ltd. have the biggest shares in the Pool. The Nuclear Pool GIZ has its headquarters at the premises of the Insurance Company Triglav, Ltd., Miklošičeva street 19, Ljubljana.

The Krško NPP third party liability cover is insured by the Nuclear Pool GIZ in the amount of SDR 150 million, which is in accordance with the Decree on Establishment of the Amount of the Operator's Limited Liability and the Corresponding Amount of Insurance for Nuclear Damage. At the beginning of 2006 the Nuclear Pool GIZ also issued an insurance policy for the NPP Krško under the head of the transport of nuclear fuel, limited at the amount of SDR 20 million.

In 2006 the NPP Krško did not report any damage to the Nuclear Pool GIZ.

Also the Jožef Stefan Institute's TRIGA type Research Reactor third party liability cover is insured by the Nuclear Pool GIZ, in the amount of SDR 5 million.

6 NUCLEAR AND RADIATION EMERGENCY PREPAREDNESS

The emergency response, which would be activated in the case of a substantial release of radioactivity to the environment, is a very important part of the national comprehensive system of nuclear and radiation safety. Therefore, in order to ensure the national nuclear and radiation safety it is essential to work constantly on nuclear and radiation emergency preparedness.

6.1 The Administration for Civil Protection and Disaster Relief

During 2006 the Administration of RS for Civil Protection and Disaster Relief (ACPDR) continuously ensured the national emergency preparedness in the area of nuclear and radiation emergencies. The main activities were focused on writing and updating of Annexes and Appendices of the National Nuclear Emergency Response Plan.

The emergency planning authorities co-ordinated and reconciled the emergency plans at the regional and local level. All except two regional emergency plans were produced. The latter two are in the process of reconciliation at the Administration of RS for Civil Protection and Disaster Relief. Also some additional municipal (local) emergency plans were written and harmonized with other plans.

In the Training Centre for Protection and Rescue at Ig, 291 members of Civil Protection,

capable of intervening in radiation and nuclear emergencies, were trained.

Under the provisions of the Agreement between the Governments of Croatia and

Slovenia on Co-operation in the Protection against Natural and Civilization Disasters an emergency plans harmonization subcommittee meeting was held. The meeting agenda comprised the exchange of information between both parties in case of a nuclear emergency. The Slovenian side handed over to the Croatian representatives the National Nuclear Emergency Plan in force, with the request to start resolving open issues as soon as possible.

6.2 The Slovenian Nuclear Safety Administration

By continuous activity on emergency preparedness, the SNSA has maintained an efficient emergency response system which would be activated in case of a nuclear and/or radiation emergency and release of radioactivity to the environment. During an emergency the SNSA completely transforms its operation structure, follows its own emergency plan and provides professional support to the National Civil Protection Headquarters (Administration for Civil Protection and Disaster Relief - ACPDR, the leading agency for decision making during an emergency in Slovenia). During nuclear or radiological emergencies the SNSA prepares expert and competent suggestions for the civil protection administration in the form of recommendations about protective actions, response and counter-measures (especially in early and intermediate phases of the accident). The emergency plan contains specific procedures for the maintenance of the SNSA preparedness for emergency and for staff activation. Some new procedures were prepared in 2006 on the basis of domestic exercises, international experience and new knowledge, and they were included in the SNSA emergency plan. The SNSA emergency plan is regularly revised, verified and updated by new procedures.

The SNSA regularly trains its staff for the response in case of a nuclear and/or radiological emergency. The emergency personnel had general and also more specific regular drills during the whole year. The SNSA also actively worked with other institutions (in particular with the Jožef Stefan Institute) in preparing drills and exercises for its staff.

The SNSA actively co-operates with domestic and international organizations and emergency agencies on maintaining and updating the national emergency plan. It was also actively involved in the Krško NPP emergency plan examination.

In 2006 the "NEK-2006" exercise took place. Besides the Krško NPP, also the SNSA emergency team actively participated in this exercise.

6.3 The Krško NPP

The activities of the Krško NPP in 2006 concerning emergency planning were directed to the maintenance of the existing preparedness, especially to increasing the training and skills of the Krško NPP emergency personnel and to implementing the tasks and recommendations assigned within the frame of the annual emergency preparedness action plan. In this context, priority was given to the staff's professional training and evaluation of the emergency plan, and to the tasks of preparation and implementation of the Krško NPP exercises.

Throughout the year, the Krško NPP maintained the operability of emergency centers and equipment, updated emergency documentation and performed systematic monthly communication testing and checking of emergency personnel response. In 2006 six Krško NPP emergency implementation procedures were revised. In December 2006 a new, 24th revision of emergency documentation was completed.

In March 2000, the Krško NPP emergency preparedness organization was presented to the Slovenian Minister of Defense during his visit to the plant. Six groups visited the plant throughout the year 2006 and informatively examined the Krško NPP's emergency preparedness and response system.

In February 2006 the regular independent internal emergency system checking was performed. The resolutions will be implemented through the Krško NPP corrective programme.

The modification of the Technical Support Centre (TSC) ventilation and reorganization of the Operative Support Centre (OSC) continued successfully in 2006. As a consequence of past trainings the radio system ZARE+ was installed in the Krško NPP TSC in 2006. The regular updating of computer equipment in all emergency centers was performed.

Throughout the year, the Krško NPP actively co-operated with the ACPDR, the SNSA and other local and national domestic organizations and emergency agencies. The SNSA performed three inspections of the Krško NPP emergency organization.

6.3.1 The "NEK-2006" Exercise

The announced annual internal exercise, called "NEK-2006", took place on 29 November 2006 between 16:30 and 22:50. Besides the plant's personnel, the Krško professional fire unit, the IOS environment radiological monitoring unit and the SNSA participated. The National Notification Centre and the Regional Krško Notification Centre were also involved.

The essential purposes of the exercise were the usual annual test and the maintenance of integrity of the Krško NPP emergency preparedness system.

The exercise has shown that all participants are well prepared. The Krško NPP procedures and emergency plan are reconciled with and follow the latest international recommendations and practice. The need for some specific equipment, the revision of some procedures and of specifying some measures was established. All deficiencies will be corrected through the Krško NPP corrective programme.

6.4 The Reactor Infrastructure Centre of the Jožef Stefan Institute

In January 2006, the Reactor Infrastructure Centre of the Jožef Stefan Institute (RIC) published the document: The RIC guidelines for emergency response. On 26 October 2006 an exercise for all RIC's employees was performed on the basis of these guidelines.

6.5 The Ecological Laboratory with the Mobile Unit

Intervention teams of the Ecological Laboratory with the Mobile Unit (ELMU) have their training during the practical in-the-field measurements in the Krško NPP and its surroundings. In 2006 the Krško NPP chose another contractor (i.e. the Institute of Occupational Health) for the above activity, which is performed in the framework of radioactivity monitoring in the vicinity of the Krško NPP. Thus, the training of one intervention team of ELMU was performed as part of the Reference Control Measurements of the ELMU in the vicinity of the Krško NPP. The training of ELMU was substantially reduced compared to the previous years, in terms of both the scope of training and the number of participants.

Due to reduced funding, the programme of ELMU emergency preparedness maintenance had a limited scope. For the measuring equipment and also for other equipment all testing, maintenance and calibration procedures were carried out. The existing procedures were upgraded and some new ones were developed based on the lessons learned during the exercises and inter-comparison measurements.

After the accident of a gondola cableway in April 2006 the cableway inspector required inspection of the two radioactive sources in the towing wire of the Velika planina cableway. On April 14, 2006, the ELMU member inspected both sources and it was concluded that they were at the appropriate position in the towing wire. The cause of the incident was a too low limit of detection of the sensor in the upper cableway station.

6.6 International Activities in the Area of Emergency Preparedness

In February 2006 two Slovenian representatives took part in the National Representatives Meeting of the Competent Authorities, who are reporting in the system ECURIE. These meetings are organized every two years. Slovenia participated in the response to the ECURIE Level 1 exercises and its response was adequate. The SNSA representative was active in the EURDEP-ECURIE Working Group, which had meetings in May and September 2006 in Luxembourg.

In December 2006 a SNSA employee took part in the IAEA Technical Meeting in Vienna, where the draft »Code of Conduct on Emergency Management System« was reviewed and harmonized among the Member States. The document was based on the two Conventions (on Early Notification and on the Assistance) and it shall co-ordinate response of the Member States in case of a nuclear or radiation emergency at the national, as well as the international level.

7 CONTROL OVER RADIATION AND NUCLEAR SAFETY

7.1 Legislation

The most important legal instrument in the area of nuclear and radiation safety in the Republic of Slovenia is the Act on Protection against Ionizing Radiation and Nuclear Safety (ZVISJV, Off. Gaz. RS, 102/04 – official consolidated text).

The ZVISJV, which was adopted in 2002 and then amended for the fist time in 2003 and for the second time in 2004, provides in its final clauses that a number of governmental and ministerial implementing regulations should be adopted. Until such regulations are adopted, the regulations based on the acts which were valid in the year 2002 are still in force (Act on Radiation Protection and the Safe Use of Nuclear Energy, Off. Gaz. SFRY, 62/1984; Act on Implementing Protection against Ionizing Radiation and Measures on the Safety of Nuclear Facilities, Off. Gaz. SRS, 82/1980).

Based on the ZVISJV, eighteen implementing regulations were adopted by the end of 2005, namely four governmental decrees, three regulations issued by the Minister of the Environment, nine issued by the Minister of Health and two regulations issued by the Minister of the Interior.

In 2006 the adoption of implementing regulations expedited and the following regulations were issued:

- Programme on systematic monitoring of working and residential environment and raising awareness about measures to reduce public exposure due to the presence of natural radiation sources (Off. Gat. RS, 17/06),
- Regulation on the use of radiation sources and on radiation practice (Off. Gaz. RS, 27/06),
- Regulation on radioactive waste and spent fuel management (Off. Gaz. RS, 49/06),
- Regulation on approved experts for radiation and nuclear safety (Off. Gaz. RS, 51/06).

Furthermore, amendments on two governmental decrees were adopted in 2006, namely:

- Amendments of the decree on radiation practices (Off. Gaz. RS, 9/06) and
- Amendments of the decree on the areas of limited use of space due to a nuclear facility and the conditions of facility construction in these areas (Off. Gaz. RS, 103/06).

Several other decrees and regulations were in the process of preparation and reconciliation in 2006. A more detailed list of already adopted implementing regulations and those under preparation can be found at the SNSA's web page http://www.ursjv.gov.si, but unfortunately this is only partially available in English translation.

In 2006 also the draft Act on third party liability for nuclear damage was prepared. The new act should replace the legal frame in this field, which is valid for the time being and harmonizes it with two Protocols – the Paris Convention and the Brussels Supplementary Convention (both from 2004).

7.2 Slovenian Nuclear Safety Administration

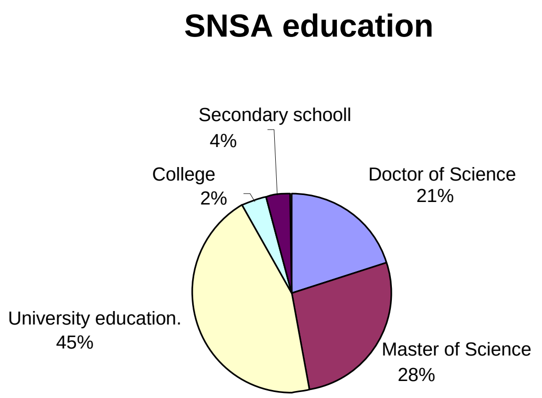
7.2.1 Slovenian Nuclear Safety Administration

The Regulation on Organizations within the Ministries (Off. Gaz. RS,58/03, 45/04, 86/04, 138/04, 52/05 and 82/05)) provides that the Slovenian Nuclear Safety Administration (SNSA) performs specialized technical and developmental administrative tasks and tasks of inspection in the areas of: radiation and nuclear safety; carrying out of practices involving radiation and use of radiation sources, except in medicine and veterinary medicine; protection of 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.

The web pages of the Slovenian Nuclear Safety Administration (http://www.ursjv.gov.si) offer general information about the SNSA, information to the public, legislation, agreements and standards in this field, annual and other reports, information on meetings, workshops, projects and invitations for tenders co-financed by the International Atomic Energy Agency, data on radiation monitoring, INES events and links to the web pages of other regulatory authorities, organizations and research centers. On these web pages all relevant information required by the Act on Access to Information of Public Nature is also available. Unfortunately the English version is less comprehensive and informative.

The structure of the SNSA's employees was at the end of 2006 as follows:

	No.	%
All employees	47	100
Women	14	29.8
Men	33	70.2
Doctors of Science	10	21.3
Masters of Science	13	27.7
University education	21	44.7
College	1	2.1
Secondary school	2	4.2



The average age of employees was 42.7 years, while the average employment period at the SNSA was 8 years.

At the conference »Good Practices in Slovene Public Administration 2006« the SNSA was awarded a prize for a comprehensive solution for efficient work (»The InfoURSJV Intranet Portal«) by the Minister of Public Administration.

7.2.2 The Expert Council for Radiation and Nuclear Safety

The Expert Council for Radiation and Nuclear Safety provides expert assistance to the Ministry of the Environment and Spatial Planning and to the SNSA 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.

The Expert Council met four times in 2006. In addition to the regular report of the SNSA Director to the Council on the situation in the field of radiation and nuclear safety between the meetings, the Council considered the following issues: monitoring of operation of nuclear facilities regarding nuclear and radiation safety, follow-up of the

SNSA activities, draft nuclear regulations, strategic questions with regard to ensuring nuclear and radiation safety, general questions of nuclear and radiation safety. In 2006, the Expert Council also considered and adopted the Annual Report on Radiation and Nuclear Safety in Slovenia for 2005, the Krško NPP Outage Report in 2006, the Report on the OSART Follow-up Mission and the Report of the Expert Commission for Examinations of Operators.

7.2.3 Expert Commission for the Examination of the Krško NPP Operators Qualifications

In March 2006, the SNSA appointed a new Expert Commission for the verification of professional competence and fulfillment of other requirements in respect of workers performing duties and tasks in nuclear and radiation facilities (the Commission).

The Commission held five examining sessions in the year 2006. Four examining sessions were dedicated to licensing of seven workers of the Krško NPP and one to four workers of the Jožef Stefan Institute. Regarding the licensing of the candidates from the Krško NPP two of them successfully acquired extension of the Senior Reactor Operator license, one candidate acquired the extension of the Reactor Operator license and four candidates acquired the extension of the Shift Engineer license. Four candidates from the research reactor TRIGA successfully acquired extension of the Shift Supervisor license. The SNSA granted all candidates extension of the licenses for operator's work in the nuclear facilities.

7.2.4 Commission for verification of fulfillment of the conditions for an authorized expert

On June 2006 the Minister of the Environment and Spatial Planning appointed by a decree a three-member commission for verification of fulfillment of the conditions for carrying out the job of an authorized expert for radiation and nuclear safety. Since the authorizations based on the old Act ceased to apply in December 2006, the SNSA received by the end of 2006 one application for acquiring the authorization for an expert for radiation and nuclear safety from a physical person and five applications from legal persons. In 2006 none of the legal proceedings of granting the authorization was concluded.

7.3 The Slovenian Radiation Protection Administration

The Slovenian Radiation Protection Administration (SRPA), an agency within the Ministry of Health, performs specialized technical and developmental administrative tasks and tasks of inspection related to carrying out practices involving radiation and use of radiation sources in medicine and veterinary medicine, protection of people against ionizing radiation, systematic survey of exposure of both living and working environments to natural radiation sources, monitoring of radioactive contamination of foodstuffs and drinking water, restriction, reduction and prevention of health detriment resulting from non-ionizing radiation, and auditing and authorization of radiation protection experts.

An expert council for radiation protection was nominated by the Minister of Health on 19.9.2005. The expert council advises the Ministry of Health and the SRPA on topics related to radiation protection of people, radiological procedures and use of radiation sources in medicine and veterinary medicine.

As a special operational unit within the SRPA, the Inspectorate for radiation protection is responsible for surveillance of sources of ionizing radiation used in medicine and veterinary medicine and for the execution of regulations in the field of protection of workers and general population against ionizing radiation. In 2006, the SRPA had five employees, four of them holding the Ph.D. degree in science.

The activities of the administration focused on establishing an integral institutionalized system required for performing duties in the field of radiation protection. Within this framework, the activities of the SRPA comprised issuing of permits and certificates as prescribed by the Act, issuing of approval to radiation protection experts and to medical physics experts, transfer of EU legislation, performing of inspections, informing and bringing awareness to the public about procedures of health protection against effects of radiation, and co-operation with international institutions involved in radiation protection.

In 2006 the SRPA continued with monitoring of foodstuff and drinking water and launched a project of analysis of digital radiological systems in healthcare aiming to optimize the quality system of procedures, and a technical project aiming to optimize patient exposures in interventional radiology procedures with emphasis on interventional cardiac procedures.

The SRPA surveyed radiation practices in medicine and veterinary medicine and use of radiation sources in these activities. 67 permits to carry out a radiation practice, 140 permits to use radiation sources and 59 confirmations of programmes of radiological procedures were granted. 20 inspections were performed in medicine and veterinary medicine. In 12 cases decrees requiring correction of established deficiencies were issued.

The SRPA also supervised the radiation protection of exposed workers in the Krško NPP, where 5 inspections were carried out. No major deficiencies were found.

With regard to radon, in 2006 the SRPA supervised the Žirovski Vrh Uranium mine, the Mežica Lead and Zinc Mine in closure, the Idrija Mercury Mine in closure, the Postojna Cave, the Škocjan Caves and primary schools, kindergartens, hospitals and other public buildings with increased radon concentrations.

In 2006 the SRPA issued 120 confirmations of evaluation of the protection of exposed workers against radiation (62 with regard to use of x-ray devices in medicine, 2 with regard to use of open and sealed sources in medicine, 12 for carrying out radiation practices in nuclear and radiation facilities, 2 with regard to radon exposure and 42 for radiation practices in industry, research and other activities).

Inspection surveillance was increased by 40% compared to 2005 (115 inspection procedures in 2006) and the number of granted permits and confirmations increased by 20%. Appropriate protection was assured in carrying out radiation practices and the use of sources of radiation in medicine and veterinary medicine. The SRPA carried out supervision together with the professional organizations that regularly check the state of affairs in this field. Records of radiation sources used in medicine and veterinary medicine were kept. Development of and input into the Central Records of Personal Doses of exposed workers were also performed.

7.4 Authorized Experts

The Act on protection against ionizing radiation and nuclear safety of 2002 stipulates the functioning of several types of authorized organizations and experts.

At the beginning of 2004 the Regulation on authorization of performers of expert activities in the area of ionizing radiation within the competence of the Slovenian Radiation Protection Administration (SRPA) (Off. Gaz. RS,18/04) was passed. The Regulation sets the conditions for acquiring authorization. A new condition in this area is the requirement for accreditation of participating laboratories in accordance with SIST EN ISO/IEC 17025 or SIST EN 45004 standards. The Regulation sets the deadline for acquiring authorization in the areas of radiation protection, dosimetry and medical physics based on this Regulation, which is defined as three years from the enforcement of this Regulation, which means 13 March, 2007. Until this date the authorizations issued in accordance with the legislation from the 1980s are valid.

In 2006 the SRPA performed three inspections in two institutions, the Institute of Occupational Health (ZVD) and the Jožef Stefan Institute (IJS), in the area of conduct of inspections of X-ray equipment used in medicine and veterinary medicine. Based on the findings of the inspections a proposal was given to the regulatory part of the SRPA to verify the qualification of the IJS for the performance of inspections of x-ray equipment used in medicine and veterinary medicine. Based on the declaratory proceeding the regulatory part of the SRPA issued a decision determining that IJS is not qualified for conducting inspections of x-ray equipment used in medicine and veterinary medicine.

7.4.1 Authorized radiation protection experts

cooperate with the employers in drawing up assessment of the radiation protection of exposed workers. They give advice on the working conditions of exposed workers, the extent of implementation of radiation protection measures in supervised and controlled areas, examination of the effectiveness thereof, the regular calibration of measuring equipment, the control of operability of measuring instruments and protective equipment, and perform training of the exposed workers in radiation protection. Authorized radiation protection experts regularly monitor the levels of ionizing radiation, contamination of the working environment and working conditions in supervised and controlled areas. In 2006 the authorizations for radiation protection experts were held as a legal persons by IJS and ZVD, which acquired the authorizations in accordance with the legislation of 1980. On 29 September 2005 the Minister of Health appointed a Commission for verification of fulfillment of the conditions for carrying out the work of authorized radiation protection experts, which started its work in 2006. Based on the opinions of the Commission, the SRPA issued in 2006 authorizations for radiation protection experts to 8 physical persons.

7.4.2 Authorized dosimetric service

performs tasks related to monitoring of the exposure of persons to ionizing radiation. In 2006 the authorizations for measuring of the personal doses with the thermoluminiscent dosimeters were held by ZVD, IJS and the Nuclear Power Plant Krško (for its own and for the contractor's workers). All the above mentioned institutions either acquired an accreditation according to the SIST EN ISO/IEC 17025 standard or the proceeding was in its final stage.

Authorizations for monitoring of the exposure to radon and its progeny were held in 2006 by IJS, ZVD and the Žirovski Vrh mine. Of the above mentioned institutions ZVD has already acquired an accreditation for measurement of radon and its progeny according to the SIST EN ISO/IEC 17025 standard.

On 21 November 2005 the Minister of Health appointed a Commission for verification of fulfillment of the conditions for carrying out the work of authorized dosimetric service. The Commission started its work in 2006. Based on the opinions of the Commission, the SRPA will issue authorizations at the beginning of 2007.

7.4.3 Authorized medical physics experts

give advice relating to the optimization, measurement and evaluation of irradiation of patients, to the development, planning and use of radiological procedures and equipment, and to ensuring and verifying the quality of radiological procedures in medicine. The institution of authorized medical physics experts is a novelty in our legislation. On 29 September 2005 the Minister of Health appointed a Commission for verification of fulfillment of the conditions for carrying out the work of authorized medical physics expert. Based on the opinions of the Commission, the SRPA issued in 2006 authorizations for medical physics experts to five physical persons.

7.4.4 Authorized providers of the health surveillance of exposed workers

carry out the health surveillance of exposed workers. In 2006 five organizations were authorized: the Clinical Institute for Medicine of Work, Traffic and Sport, ZVD, the Community Health Centre Krško (for the Krško NPP employees), the Community Health Centre Škofja Loka (for the Žirovski Vrh mine employees) and Aristotel Plc. from Krško. The extent of medical surveillance, the functioning of the authorized institutions and the conditions which must be fulfilled for acquiring the authorization are set in the Regulation on Medical Surveillance of Exposed Workers (Off. Gaz. RS, 2/2004). The regulation sets the requirement that the authorized specialists of occupational medicine have to re-qualify themselves in the area of the health surveillance of exposed workers at least every three years. In 2006 the SRPA, in cooperation with the Clinical Institute for Medicine of Work, Traffic and Sport, carried out training of physicians - specialists in medicine of work, traffic and sport.

7.4.5 Authorized experts for radiation and nuclear safety

On the basis of Article 14 of the Act on Implementing Protection Against Ionizing Radiation and Measures for the Safety of Nuclear Facilities of 1980 (ZIVIS) expert and research organizations were authorized for performing certain tasks in the fields of nuclear safety and radiation protection within the territory of the Republic of Slovenia.

In 2006 the following 13 organizations held the authorization:

- Milan Vidmar Electric Institute (EIMV), Ljubljana,
- ENCONET Consulting, Vienna, Austria,
- Faculty of Electrical Engineering and Computing, University of Zagreb, Croatia,
- Faculty of Mechanical Engineering, University of Ljubljana,
- IBE Consulting Engineers (IBE), Ljubljana,
- Jožef Stefan Institute (IJS), Ljubljana,
- Energy Institute (IE), Zagreb, Croatia,
- Institute for Energy and Environment Protection (EKONERG), Zagreb, Croatia,
- Institute of Metals and Technologies (IMT), Ljubljana,
- Institute of Metal Constructions (IMK), Ljubljana,
- Welding Institute (ZAVAR), Ljubljana,
- Izolirka, Fire Engineering, Radovljica,
- Slovenian National Building and Civil Engineering Institute (ZAG), Ljubljana.

Based on the yearly reports of the authorized organizations, the main conclusion was that there were no major changes in their performance in comparison with previous years. In the field of staffing the authorized organizations maintain their competence; however, there is no noticeable recruitment of new young engineers. The equipment used in their professional work has been well maintained and updated. The organizations have established the Quality Management Programmes, and some of them even obtained or renewed the Quality Certificate in compliance with ISO 9001:2000. In 2006 EIMV coordinated the surveillance of the activities during the refueling outage of the Krško NPP, with the participation of other authorized organizations, and issued the "Joint expert assessment report on the outage works, interventions and tests during the shutdown of the Krško NPP during the refueling at the end of the 21st fuel cycle (No. 2072/06). The authorized organizations kept providing professional support to the Krško NPP by preparation of expertise, safety analyses and project documentation; they also trained the plant's personnel in various professional areas. An important part of their work focused on an independent review and assessment of plant modifications. They also offered professional support to remediation of the mining waste sites of the Žirovski Vrh mine and to the activities of the Agency for Radwaste Management.

An important part of their activities consisted of research and development activities. Some organizations participated very successfully in the 6th framework research programme of the EU.

Worthwhile mentioning is also cooperation of the authorized organizations with the international organizations – the International Atomic Energy Agency and the OECD Nuclear Energy Agency.

The Act on ionizing radiation protection and nuclear safety of 2002, in Articles 58 and 59, regulates the functioning of the authorized experts for radiation and nuclear safety. According to the Act the authorized organizations shall acquire new authorizations for authorized experts.

In 2006, the Regulations on authorized experts for radiation and nuclear safety (Off.Gaz. RS, 51/06), within the competences of the SNSA, were promulgated. The Regulations set forth, in relation with the procedure for acquisition of authorization for an expert for radiation and nuclear safety, hereinafter referred to as "authorized expert", a programme of verification of the fulfillment of the conditions for carrying out the job of an authorized expert, appointment of a special commission for the verification of the fulfillment of the conditions, keeping records of the authorized experts, the format and extent of regular and exceptional reporting and other conditions which authorized experts must fulfill in relation to assessing radiation and nuclear safety.

In accordance with Article 21 of the Regulations on authorized experts for radiation and nuclear safety, the organizations that were authorized on the basis of Article 14 of the ZIVIS, the validity of these authorizations shall cease to apply six months after these Regulations enter into force, which in this case was on 2 December 2006. An exception to this is ZAVAR, whose authorization expired on 15 March 2006.

The three-member commission for verification of fulfillment of the conditions for an authorized expert for radiation and nuclear safety was established on 22 June 2006, with a five-year mandate.

In the last three months of 2006, the SNSA received 6 applications for an authorized expert.

8 NUCLEAR NON-PROLIFERATION AND SECURITY OF RADIOACTIVE MATERIALS

Nuclear non-proliferation is an activity preventing the development and production of nuclear weapons in countries which are formally non-nuclear-weapon states. Nuclear-weapon states are the USA, the Russian Federation, the United Kingdom, France and China. Since the Gulf crisis, the discovery of clandestine activities in North Korea, nuclear weapon tests in India and Pakistan and the terrorist attacks on 11 September 2001, the international community has been devoting a lot of attention to this issue. Slovenia completely fulfils its obligations which derive from the adopted international agreements and treaties.

Due to potential misuse of radioactive sources, the international community has increased the control of these sources with significant activity. The International Atomic Energy Agency (IAEA) has issued a Code of Conduct on the Safety and Security of Radioactive Sources, and has adopted guidelines for the protection of high-activity sources, which might be misused with terrorist intentions. With a similar goal in 2003, the Council of the European Union issued Council Directive 2003/122/EURATOM on the control of high-activity sealed radioactive sources and orphan sources. Slovenia transposed the provisions of the Code and the Directive with the adoption of Regulation on the use of radiation sources and on practices involving radiation and changes of the Decree on practices involving radiation.

8.1 Nuclear Safeguards

Due EU membership Slovenia had to freeze the bilateral Safeguards agreement and the Additional protocol, inferred with the IAEA, and had to adopt the multilateral acts that cover these issues. With the exchange of diplomatic notes on 1 September 2006, the Agreement between the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of the Netherlands, the European Atomic Energy Community and the International Atomic Energy Agency in implementation of Article III (1) and (4) of the Treaty on the non-proliferation of nuclear weapons and the Additional protocol to the Agreement between the Kingdom of Belgium, the Kingdom of Denmark, the Federal Republic of Germany, Ireland, the Italian Republic, the Grand Duchy of Luxembourg, the Kingdom of the Netherlands, the European Atomic Energy Community and the International Atomic Energy Agency in implementation of Article III (1) and (4) of the Treaty on the non-proliferation of nuclear weapons entered into force. Slovenia decided to apply the Additional protocol directly with the IAEA.

In Slovenia, all nuclear material (fresh and spent fuel) at the Krško NPP and at the Jožef Stefan Institute, which operates the research reactor TRIGA, is under the supervision of international inspection. Since the beginning of EU membership, the Krško NPP and the Institute report in accordance with the EU Council Directive. In autumn 2006 the SNSA temporarily took over the responsibility of reporting for small holders. Due to harmonization of reporting in accordance with the EU Council Directive, the SNSA organized a workshop for small holders of nuclear material and elaborated them on the responsibilities and way of reporting to EURATOM.

In 2006, IAEA inspections started to be performed in accordance with the integrated safeguards. There were five IAEA inspections in 2006, one of them unannounced. According to the Additional Protocol there were three inspections, with one short-notice inspection performed at the Žirovski Vrh uranium mine. EURATOM inspectors took part in four inspections in 2006. No anomalies were found. The SNSA reported to the IAEA in due time and in accordance with the Safeguards agreement. Since the validity of multilateral agreement on safeguards entered into force on 1 September 2006, reporting to the IAEA is no longer performed.

Due to direct application of the Additional Protocol, the SNSA shall according to the Protocol continue to report to the IAEA directly. The focus of the 2006 annual report was mainly on the description of facilities modifications on the sites of the Krško NPP and the TRIGA Mark II research reactor.

8.2 The Comprehensive Nuclear Test-Ban Treaty

One of the international legally binding instruments for combating proliferation of weapons of mass destruction is the Comprehensive nuclear test-ban treaty (CTBT). Slovenia signed the treaty on 24 September, 1996 and ratified it on August 31, 1999.

Several meetings of workgroups in the framework of the CTBT Organization took place in 2006. Among these was the North Korean notification on nuclear weapon testing on 9 October 2006. The SNSA, together with the Ministry of Foreign Affairs, is following the events in this area and is informing the interested local organizations.

8.3 Export Controls of Dual-Use Goods

In the scope of international activities in this area Slovenia participates in the work of the Nuclear Suppliers Group (NSG) and the Zangger Committee. In accordance with the established rules and procedures, the SNSA reported regularly to both organizations also in 2006.

On the basis of the Act on Export Controls of Dual-Use Goods a special Commission for Export Controls of Dual-Use Goods operates at the Ministry of Economy. Representatives of the Ministry of Economy, the Ministry of Foreign Affairs, the Ministry of Defense, the Ministry of the Interior, the Customs Administration, the SNSA, the Slovenian Intelligence and Security Agency and the National Chemicals Bureau constitute the Commission. An exporter of dual-use goods must obtain a permit from the Ministry of Economy, which is issued upon expert findings of the Commission. In 2006 the Commission had 6 regular and 42 correspondence sessions.

8.4 Physical Protection of Nuclear Material and Facilities

Physical protection of nuclear facilities and material at the Krško NPP, at the research reactor TRIGA, and at the Central Interim Storage for Low and Intermediate Waste at Brinje is supervised by the Ministry of the Interior and the SNSA. In July 2006 the application of provisions of two regulations in the area of physical protection of nuclear material and facilities, issued on the basis of the 2002 Act, started. State administrative bodies and nuclear facility operators coordinated their activities with the provisions of both regulations.

In 2006, the Ministry of the Interior issued a consent to the Programmes of initial and permanent professional training of workers performing physical protection of nuclear material at nuclear or radiation facilities. The Ministry also issued a consent to the Plan of physical protection of nuclear facilities.

The Inspectorate of the Republic of Slovenia for Internal Affairs performed an inspection of physical protection at the Krško NPP and established that it was being performed according to the valid plan.

In 2006 also the physical protection of fresh fuel transportation for the Krško NPP was performed.

8.5 Illicit Trafficking of Nuclear and Radioactive Materials

In order to prevent illicit trafficking of nuclear and radioactive material, the SNSA has been for years coordinating activities of state departments, mostly the Customs Administration, the Police and the SNSA, and when necessary also other state departments (the Slovenian Radiation Protection Administration, the Ministry of Transport) and organizations (the ARAO, the Slovenian Railways, authorized expert organizations, recyclers and smelters of scrap metal).

The customs and police officers at border crossings are equipped with detectors of radiation. Through bilateral cooperation with the USA, the border crossing Obrežje and the Port of Koper were equipped also with portal monitors. The procedures for actions in case of finding a radioactive shipment and systems for mutual notification and consultation were established.

To enable assistance and consultation, the SNSA gave other state offices and private organizations (scrap recyclers, melting facilities) the phone number of a 24-hour on-duty officer. There were 9 calls in 2006, most of them by the customs and the Slovenian railways.

The Customs Administration informed the SNSA about two rejections of truck shipments of scrap metal due to elevated levels of radioactivity. Both shipments were returned to the senders to Croatia. The shipment returned from Italy had its radioactive waste removed and handed over to the Central Interim Storage Facility.

In order to find a permanent solution for preventing illicit trafficking of radioactive material, the Slovenian Government in September 2005 appointed a Joint working group for prevention of unauthorized shipments and transit of nuclear and other radioactive materials in Slovenia. Its members are representatives from the Ministry of the Interior, the Ministry of Finance – the Customs Administration, the Ministry of Economy, the Ministry of Transport, the Ministry of Health – the Slovenian Radiation Protection Administration and the SNSA. In the beginning of 2006 the Government of the Republic of Slovenia adopted a report of the Joint working group and imposed on the Ministry of the Environment and Spatial Planning to prepare subsidiary legislation, according to which importers of scrap metals will have to have their shipments radiologically measured. By the end of the year a draft of the Decree on inspection of radioactivity for scrap metal shipments was prepared.

In 2005, an agreement was signed between the Slovenian Ministry of Finance and the US Department of Energy, on co-operation in the area of combating illicit trafficking of nuclear and other radioactive materials. Based on this agreement, in the second half of 2006, fixed portal monitors were installed at the Port of Koper and the international border crossing Obrežje (road). These portal monitors – single columned for pedestrians and double columned for vehicles – can detect gamma radiation and neutrons. The customs officers passed short two- and three-day trainings organized by American experts.

In 2006, Slovenia did not report to the IAEA Illicit Trafficking Database. From 1993 to the end of 2006, the IAEA received almost 1000 reports of incidents throughout the world. They were characterized as theft, loss, discovery, unauthorized transfer of radioactive sources, etc.

9 RESEARCH ACTIVITIES

The SNSA tries to maintain and improve the expertise needed to assure radiation and nuclear safety with thematically oriented research projects. This chapter summarizes the projects that were funded or organized by the SNSA.

9.1 Radon potential in soils in Slovenia

So far investigations on radon in Slovenia have covered radon concentrations in dwellings, in kindergartens and schools, and outdoors. Almost in all cases where high concentrations were found they were the consequence of high radon concentrations in soil pores, i.e. of a high radon potential in the ground. The expertise of radon critical areas is important when planning residential structures, in order to assure minimization of indoor radon concentrations. Slovenia is one of the few countries where these surveys had not been done in the past.

The aim of the research work, assigned by the SNSA and carried out by the Jožef Stefan Institute, was to measure radon in soil in areas of at least 20 km x 20 km on the territory of the whole country, to elaborate the map of radon potential in soil and to characterize the associated radon risk.

The study showed that radon concentrations in soil in Slovenia ranged from 1 to 201 kBqm-3, with the arithmetic mean value of 18.6 kBqm-3 and the geometric mean 9.5 kBqm-3. The highest values were measured on the carbonates, covering more than 50% of the territory of Slovenia, with the arithmetic mean of 33 kBqm-3. Compared with other European countries the measured values are at least for a factor of two lower.

According to the Swedish risk categorization of the ground at least one half of the measurements should be classified as low radon risk areas (< 10 kBqm-3), and only in 7% of cases the level of 50 kBqm-3 was exceeded, which is the level of high risk areas of increased indoor radon concentrations. The levels of radon potential in soil are surprisingly low in the Karst region, but in spite of that the highest radon indoor concentrations have been found in these areas. Anyhow, the regional distribution of radon potential in soil shows, with the exception of the Karst region, the expected increased levels from the Northern part of the Inner Carniola, via the Ribnica-Kočevje region to Bela Krajina.

9.2 Measurements of C-14 content in plant samples in the nearby surroundings of the KRŠKO NPP

The main part of radiation exposure of the public living in the surroundings of the Krško NPP comes due to the intake of the radionuclide ^{14}C via the food chain. The radionuclide ^{14}C is mostly of natural origin (it is generated in the upper atmosphere through the nuclear reactions caused by cosmic radiation) but it is permanently present also in near-ground air in the vicinity of nuclear power plants. This radionuclide enters the life cycle of plants in the chemical form of CO_2 and plants therefore steadily contain a certain level of it. The equilibrium concentration of ^{14}C in plants equals 227 Bq ^{14}C/kg-C.

The aim of the research study conducted by the Rudjer Bošković Institute from Zagreb on behalf of the Krško NPP was to obtain data on the content and concentration of the radionuclide ^{14}C in certain plants grown in the nearby vicinity of the NPP and compare them with the values obtained at locations out of the influence of gaseous effluents from the NPP.

The results of the research comprised the measurements of ^{14}C contents in apples, grains (wheat, corn), grass and leaves, and showed that the average value at the 12 km distant place Dobova (a reference location for the NPP) is about 235 Bq ^{14}C/kg-C. Around the

NPP, 1 km far from the plant vent and in the direction of prevailing winds, the values are enhanced by about 7-9 Bq ^{14}C/kg-C compared to the reference value, and they are mostly in the range of 245-250 Bq ^{14}C/kg-C. At shorter distances, namely 0.3-0.5 km, the ^{14}C contents in plants increase up to 295 Bq ^{14}C/kg-C, i.e. 25% more than at reference locations. This provides a very clear picture about the ^{14}C space distribution in the surroundings of the NPP. The results show very well the environmental influence of the NPP via the atmospheric pathway and form the foundation for a realistic dose assessment for members of the reference group.

9.3 Target research programme »Slovenian competitiveness 2006-2013«

In September 2005 the Government of the Republic of Slovenia issued its standpoints for a long-term assurance of supporting activities in the area of nuclear and radiation safety and appointed a working group. The working group prepared a long-term plan for the assurance of supporting activities in the area of nuclear and radiation safety based on the performed analysis of the conditions among educational, research and application oriented organizations in the field of radiation and nuclear safety. Within the public call for the target research program "Slovenian competitiveness 2006-2013" [20], as part of the priority area no. 5 (Connecting measures to achieve sustainable growth), a thematic complex no. 5.6 (Assuring radiation and nuclear safety) was based on this plan, with the following topics: Safety questions of nuclear and radiation buildings technologies, Safe disposal of radioactive waste and Surveillance of radioactivity in the environment.

Following a public call for tenders, five two-year projects financed by the SNSA and the Slovenian Research Agency, and performed by the Jožef Stefan Institute, the Institue of Metals and Technologies and the Slovenian National Building and Civil Engineering Institute were accepted.

10 INTERNATIONAL CO-OPERATION

10.1 The International Atomic Energy Agency

The successful co-operation with the International Atomic Energy Agency continued. From September 2005 to September 2007 Slovenia has been a member of the Board of Governors, the main policymaking body in the period of two regular sessions of the IAEA's General Conference. Traditionally the Slovenian delegation attended the regular session of the General Conference.

Slovenia and the International Atomic Energy Agency closely cooperated in the following fields:

- Within the programme of technical co-operation in 2006 Slovenia received 13 applications for training of foreign experts in our country. 2 applications out of 13 were implemented in the same year as well as 13 applications from the year 2005. All other applications approved by our country will be implemented in 2007.
- Within the technical co-operation Slovenia submitted 4 new proposals for research contracts in 2006. 2 research contracts out of 4 were approved, 1 proposal is still pending, while one proposal was rejected by the IAEA. There were 5 research contracts going on. These research contracts had been signed between the IAEA and Slovenian organizations already in the previous years.
- In November 2006, the IAEA approved 3 new technical assistance projects for the cycle 2007-2008, which had been submitted to the IAEA already in 2005. The extension of a technical assistance project, which had been going on since the 2005-2006 cycle, was approved as well. In 2006, activities within the framework of three national projects approved by the IAEA for the 2005-2006 cycle continued, while the activities of the three projects of the 2003-2004 cycle were in the closing stage.
- Slovenia continues with its activities as a host of activities organized by the IAEA. In 2006, Slovenia hosted 5 regional workshops, training courses and seminars.
- In 2006, three Slovenian experts, appointed to the Nuclear Standards Committee, the Waste Standards Committee and the Radiation Standards Committee, actively participated in activities of their respective three committees.

During the first meeting of the Board of Governors following the 50th General Conference in September 2006, the Board elected Dr. Ernest Petrič, the Ambassador of the Republic of Slovenia to Austria, as the chairman until the next General Conference in September 2007. Slovenia took over a very demanding and responsible position which brings with it the task of reconciliation of viewpoints and searching for consensus among the members of the Board of Governosrs. In the period of ambassador Petrič's chairmanship, Dr. Andrej Stritar, the Director of the Slovenian Nuclear Safety Administration, will lead the Slovenian delegation in the Board of Governors. The November session of the Board of Governors was the first meeting chaired by Dr. Petrič. He chaired the Technical Assistance Coordination Committee being in session as the Board of Governors, harmonizing a Technical Cooperation Programme for the 2007-2008 cycle in order to submit it to the Board of Governors for approval. The Technical Cooperation Programme included, among other projects, 7 technical assistance projects of Iran. The EU, the USA, Japan and Canada opposed the 7 Iranian technical assistance projects. On the other hand, the non-aligned countries supported the approval and acceptance of the Iranian projects. The chairman tried his best to avoid the politicization of the technical assistance programme. After the long lasting discussions and numerous consultations the chairman succeeded in finding a solution acceptable to all involved Member States.

10.2 Organization for Economic Co-operation and Development – Nuclear Energy Agency (OECD / NEA)

The Nuclear Energy Agency (NEA) is a specialized agency within the Organization for Economic Co-operation and Development (OECD), based in Paris, France. 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 NEA works closely with the International Atomic Energy Agency (IAEA) in Vienna and with the European Commission in Brussels. The NEA Secretariat serves seven specialized standing technical committees under the leadership of the Steering Committee for Nuclear Energy - the governing body of the NEA - which reports directly to the OECD Council. The standing technical committees are comprised of member country experts.

Due to the fact that Slovenia is not a full member of OECD, Slovenian experts have an observer status, which enables Slovenia access to almost all information.

10.3 Co-operation with the European Commission

10.3.1 Working Party on Atomic Questions (ATO)

In the first half of 2006, when Austria took over the EU Presidency and of the ATO, a new revision of the Co-operation Agreement between Euratom and Japan was presented and later on signed in February 2006, the work continued on the draft Directive on Shipment and Control of Radioactive Waste and Spent Fuel, and the document entitled "Instrument for Nuclear Assistance" (later "Instrument for Nuclear Safety Co-operation") was reviewed. The aim of this document was to provide rules in rendering assistance in nuclear safety to the third countries. The review of the document had already started under the Presidency of the UK.

In the second half of 2006 Finland took over the Presidency of the European Union as well as the presidency of the ATO. The most important achievements during their Presidency were:

- The agreement between Euratom and Ukraine was put into force and the Euratom - Kazakhstan agreement was signed,
- The Instrument for Nuclear Safety Cooperation was reconciled and sent to COREPER for approval,
- The Council Directive on shipment of radioactive waste and spent fuel was adopted,
- The »Guidelines on cooperation between the Euratom and the Member States in the framework of international conventions to which the Euratom and its Member States are parties« were prepared and agreed on,
- The first draft Nuclear Illustrative Program was presented (PINC – Programme Indicatif Nucléaire Communautaire). The last similar program was published in 1997.

In 2006, ATO also considered accession to the amended Paris Convention, the issues regarding the KEDO organization, which had constructed the nuclear power plant in the Democratic People's Republic of Korea and the Council Decision regarding accession to the Convention on the Physical Protection of Nuclear Material (CPPNM).

Slovenia has also been preparing for the EU Presidency in 2008 in the field of radiological and nuclear safety. The persons who will be working for the EU Presidency were appointed and their training began.

10.3.2 Ad-hoc Working Party on Nuclear Safety (WPNS)

The ad-hoc WPNS started its work in 2005 and in 2006 it was still active. The main task of the WPNS was to deliver a report on harmonized safety approaches in the member states. The WPNS reviewed the WENRA reports and the reports were deemed appropriate to be considered in the preparation of the report. The IAEA and OECD/NEA documents were also reviewed and the recommendations from the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste were taken into account. Slovenia actively participated in the process of report preparation. A report on adequate financial arrangements in Member States, which are needed to cover the decommissioning costs, was also included in the WPNS report. At the December 2006 ATO Meeting, the WPNS Summary Report was presented. At the end of 2006 the WPNS finished its term of office and ceased to exist.

10.3.3 Phare Projects in 2006

The contract for the implementation of the project "Support to the SNSA in Upgrading and Modernization of the National Early Warning System" was successfully finalized in the first half of 2006. The contractor installed 43 gamma dose rate monitors, 2 automatic meteorological stations, 29 rain gauges, 2 wind gauges, 2 barometers, 2 insulation gauges, 5 thermometers and 5 hygrometers. Provisional acceptance was signed on 7 April 2006, the final acceptance will be made in two years.

In 2006 writing and harmonization of the final report for the project "Characterization of Low and Intermediate Level Radioactive Waste Currently Stored in the Central Facility Brinje" were carried out.

By the end of 2005 all equipment was supplied for the project "Hot-Cells Facility Renovation and Modernization" except the manipulators, which were delivered in 2006 when all the equipment was paid for.

For the project "Assistance in Development of the Conceptual Design of a Low and Intermediate Radioactive Waste Repository in Slovenia" the final report was presented in November 2006 by the consortium Quintessa. The report analyzes the production of radioactive waste in Slovenia and the advantages and disadvantages of three types of nuclear waste storage: surface, silos and underground (tunnel).

In 2006 the tender documentation was prepared in the first selection procedure (i.e. short-list) for the project in the framework of a transition facility, namely "Improvement of Institutional Radwaste Management with the Establishment of a Data Management System" and "Improvement of Institutional Radwaste Management in Slovenia". For both projects the Agency for Radwaste Management is an assistance recipient.

10.3.4 Verification According To Art. 35 Of The EURATOM Treaty

The EURATOM Treaty binds the Member states to establish the system for environmental monitoring of radioactivity on their territories and report on the monitoring results to the Commission. The Commission may verify if the system has been established and if it is in accordance with the requirements. After the enlargement of the EU, the intensive verification programme has been dedicated primarily to the new member states.

The verification visit to Slovenia took place in the period of 12-15 June 2006 and comprised a review of monitoring of radioactive discharges at the Krško NPP together with an operational monitoring of environmental radioactivity and a review of general environmental radioactivity monitoring on the territory of Slovenia. The verification Commission consisted of five experts acting in two groups. The SNSA was in the role of the national coordinator between the partners on the Slovenian side and the coordinator with the Commission.

The Commission reported on its preliminary findings at the end of the verification visit. First of all the Commission found out that regular monitoring of discharges from nuclear installations has to be done in parallel with an independent monitoring programme provided by the competent authority. The second important finding of the Commission was that all laboratories involved in analytical measurements should be accredited for the methods they perform. Expressing some minor remarks, the verification commission found out that Slovenia fulfils the requirements from Art. 35 of the EURATOM Treaty.

10.4 Co-operation with other Associations

10.4.1 West European Nuclear Regulators Association (WENRA)

WENRA is an informal association consisting of representatives of Nuclear Regulatory Authorities of European countries with nuclear power plants. The main objectives of WENRA are to develop a common approach to nuclear safety and to exchange experience between the chief nuclear safety regulators in Europe. Since 2003 WENRA comprises 17 member countries. In order to harmonize approaches to nuclear safety, a committee for nuclear safety and a committee for decommissioning of nuclear objects and safety of radioactive waste were established.

At the end of 2006 WENRA finalized activities with regard to reference levels, i.e. it harmonized the requirements for the nuclear power plants' safety. All WENRA members committed themselves to harmonize their legislation with these reference levels by 2010. This process should lead to harmonization of nuclear safety, which has not been regulated within the EU so far. Slovenia will transpose the missing requirements to the Slovenian legislation by 2008.

10.4.2 Network of Regulators of Countries with Small Nuclear Programs (NERS)

NERS is an international network of nuclear regulators and inspectors providing means of communication between regulators of countries with small nuclear programs. These countries have a small number of nuclear power plants and their nuclear regulators have much smaller resources to develop administrative systems and practices to the level of detail which bigger countries can afford.

In the period 2005/2006 Slovenia chaired the NERS group, and the NERS regular annual meeting in June 2006 was held at Bled in Slovenia. At the meeting the conclusions of the NERS meeting in 2005 were reviewed and the new web page (www.ners.info) of the NERS network was presented. The main topics considered during the meeting were ageing and lifetime management, regulatory control of radioactive sources, regulatory control of radioactive waste management and regulatory control of transport of radioactive materials.

10.5 Co-operation 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.

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

From 15 to 24 May 2006, at the headquarters of the International Agency for Atomic Energy in Vienna, the Second Review Meeting took place, where 41 delegations of contracting parties of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management were present.

The National report was prepared by the Slovenian Nuclear Safety Administration with contributions by the Slovenian Protection Administration, the Krško NPP, the Jožef Stefan Institute, the Agency for Radwaste Management, the Žirovski Vrh Mine Llc, the Institute of Oncology, the Ljubljana University Medical Centre - the Department for Nuclear Medicine. The national report and its presentation were well accepted.

After the presentation of the Slovenian report the rapporteur of the review meeting, following a short debate, concluded that Slovenia presented a comprehensive national report that satisfactorily addresses all relevant issues of safety of spent fuel management and radioactive waste management, and that the situation in the country in this regard is well controlled.

The closing plenary session offered a general finding that despite a positive trend the conditions in some countries and in some areas could still be improved.

Slovenia is obliged to report at the Third Review Meeting scheduled for May 2009 on the implementation of provisions from the Interstate Treaty with Croatia on decommissioning and radioactive waste management, on siting, design and licensing of the LILW repository and on continuation of solution finding for high level waste.

10.5.2 Bilateral Co-operation

In 2006 the SNSA participated in regular annual meetings with related regulatory bodies in the framework of bilateral agreements.

The quadrilateral meeting with the Czech Republic, the Slovak Republic and Hungary was organized in June in Hungary. The meeting agenda focused on recent developments in the regulatory bodies, discussion on events of interest at nuclear power plants, coordination of European matters, discussion on the co-operation in IAEA issues and discussion on the use of indicators of regulatory efficiency and effectiveness.

During the bilateral meeting with Croatia the Slovenian delegation presented the Slovenian nuclear programme, the experiences with harmonization of European legislation, and gave a short overview of events and experiences at the time before Slovenia entered the EU. The Croatian delegation expressed a request to be directly informed in case of emergency in the Krško NPP, and suggested a different format of exchange of environmental radiation data.

The bilateral meeting with Austria covered the latest developments in the area of legal and administrative framework. The Slovenian delegation made a presentation on emergency preparedness and described the modernization of the Slovenian early warning system. The Austrian delegation presented new developments in the field of nuclear emergency preparedness and explained their compliance with the EU legislation requirements. The Austrian side was also interested in licensing the process of nuclear power plant construction in Slovenia.

10.5.3 Intergovernmental Agreement on Co-ownership of the Nuclear Power Plant Krško

Co-ownership of the NPP Krško is regulated with the Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on Regulating the Status and Other Legal Relations with regard to the Investment in the Krško Nuclear Power Plant, Its Exploitation and Decommissioning (hereinafter referred to as the "Intergovernmental Agreement).

Operation of the NPP Krško in 2006 was in compliance with the adopted economic plan for 2006.

Long-term investments have been approved, the electricity price has been determined by common consent, the personnel policy has been harmonized and payment has been made modally. The supervisory board has been approving the decisions essential for the effective operation of the nuclear installation in due time.

The Intergovernmental Agreement provides in the third paragraph of Article 11 that both contracting parties shall pass, within twelve months after entry into force of the agreement, adequate regulations to ensure the financial means for financing the expenses for decommissioning and for the disposal of radioactive waste and spent fuel. Each party shall regularly pay in the financial means in its own special fund in an amount established by the NPP Krško Decommissioning and Disposal of Radioactive Waste Management and Spent Fuel Programme (hereinafter referred to as the Decommissioning Programme). By the end of 2006 Croatia did not established its special fund for NPP Krško decommissioning. In April 2006, Croatia adopted the Decree on the payment of funds for the decommissioning and for the storage of radioactive waste and spent nuclear fuel of the Krško Nuclear Power Plan (hereinafter referred to as the Decree).

Although the decree is the first step towards establishment of Croatia's fund for decommissioning of the NPP Krško and allocation of the necessary financial means, it does not represent an act which would fully meet the provisions of the Intergovernmental Agreement.

This means that the Croatian side has not established a special decommissioning fund through an appropriate Act defining the return on the collected financial resources, investment policy and the control over the fund. According to the decree, Hrvatska elektroprivreda d.d. is to pay funds into the state budget, which are then managed by the ministry responsible for energy. The decree determines that the funds would be transferred to the fund when established; however, the decree does not set the due date for the establishment, and is thus being put off into the future.

Conversely, the Gen-energija d.o.o. pays in the Decommissioning fund for the NPP Krško on the regular basis for each kWh of supplied electrical energy from the NPP Krško.

10.6 Use of Nuclear Energy World-wide

At the end of 2006 there were 31 countries operating 436 nuclear reactors for electricity production. In 2006 two new nuclear power plants were put in operation, in India and in Taiwan, with the total installed electric power of 1490 MW. Eight nuclear power plants were permanently shut down in 2006, one in the Slovak Republic, two in Bulgaria, four in Great Britain and one in Spain. The total electric power of these nuclear power plants was 2236 MW. The construction of six new nuclear power plants has started, three in the Republic of Korea, one in Russia and two in China.

In the developed countries we can observe a trend of revival of interest in nuclear power plants. Construction of new nuclear power plants has been in preparation in the USA, in France they are about to build new reactor in 2007, the policy regarding nuclear energy is being changed in Great Britain, in Bulgaria a tender to build two new reactors has been published, and in Romania they intend to finish the construction of reactors number 3 and 4 at the Cernavoda site.

Data on the number and installed power of reactors by countries at the end of 2006 are given in Table 9:

Table 9: Number and Installed Power of Reactors by Countries at the end of 2006

Country	Operational		Under construction	
	No.	Power [MW]	No.	Power [MW]
Belgium	7	5,824		
Bulgaria	2	1,906	2	1,906
Czech Republic	6	3,523		
Finland	4	2,696	1	1,600
France	59	63,260		
Lithuania	1	1,185		
Hungary	4	1,755		
Germany	17	20,339		
Netherlands	1	482		
Romania	1	651	1	655
Russia	31	21,743	7	4,585
Slovakia	5	2,034		
Slovenia	1	666		
Spain	8	7,450		
Sweden	10	9,048		
Switzerland	5	3,220		
Ukraine	15	13,107	2	1,900
Great Britain	19	10,982		
Europe total:	196	169,871	13	10,646
Argentina	2	935	1	692
Brazil	2	1,795		
Canada	18	12,584		
Mexico	2	1,360		
USA	103	98,446		
America total:	127	115,120	1	692
Armenia	1	376		
India	17	3,732	6	2,910
Iran			1	915
Japan	55	47,587	1	866
China	10	7,572	5	4.220
Korea, Republic of	20	17,454	1	960
Pakistan	2	425	1	300
Taiwan	6	4,921	2	2,600
Asia total:	111	79,966	17	12,771
South Africa	2	1,800		
World total:	**436**	**373,779**	**31**	**24,109**

10.7 Radiation Protection and Nuclear Safety World-wide

The International Atomic Energy Agency (IAEA) maintains a system for reporting on abnormal radiation and nuclear events in nuclear facilities and in the use of nuclear energy in the IAEA member states. The system is known as the International Nuclear Event Scale (INES).

It is now six years since the Nuclear Events Web Based System (NEWS) went into operation. NEWS is a partially open communication system providing a fast flow of information between regulatory bodies, operators, technical support organizations, media and the public. The system is jointly managed by the IAEA, the OECD Nuclear Energy Agency and the World Association of Nuclear Operators. It enables transfer of information on the INES events that could attract interest of the media. The system has different levels of access, for experts from regulatory bodies and nuclear facilities or other users of nuclear energy, and also for journalists and members of the public. It is available on the Internet site: http://www-news.iaea.org/news/default.asp.

All INES reports are simultaneously translated into the Slovenian language and can be browsed on the Internet address: http://www.ursjv.gov.si/si/info/ines_dogodki/.

The summary of the reports of 2006 shows the level of radiation protection and nuclear safety world-wide.

Thirty-three INES reports were received by the IAEA NEWS in 2005. Eleven reports were on events in nuclear power plants, the remaining 22 on exceeded dose levels due to use of radioactive sources (11 reports), transport of radioactive material (5 reports), research reactors (1 report), irradiation facility (1 report), radwaste management (2 reports) and other (2 reports).

Four events in a nuclear power plant were rated as level 2 – *incident*, two as level 1 – *anomaly*, two as level 0 – *deviation/no safety significance*, one was *out of the scale* and two were not rated. The reports were related to non-operational safety equipment (3 reports), non-operational classical equipment (1 report), problems with the emergency power supply (2 reports), flaw in the design (1 report), fire on a transformer (1 report), flaw on a control system (1 report) and to a breach of the operating limits and conditions (2 reports).

The rest of the events were rated: one as level 4 – *accident without significant off-site risk,* 12 as level 2 – *incident*, six as level 1 – *anomaly*, one as level 0 - *deviation/ no safety significance* and two were not rated.

Slovenia did not report any event to NEWS in 2006 since there were no reports satisfying the criteria for reporting.

It can be concluded from the reports that the management of the radioactive sources which are widely used in industry and the control thereof are deficient in the world, and that often workers using the sources are exposed over the regulatory limits, and often the source is lost during transport or stolen. It is evident that the countries were improving the control over scrap metal, since in contrast to 2005 in 2006 only one event involving a source found in scrap metal was reported.

The events which were reported to NEWS in 2006 did not have any strong impacts on the environment. In eight cases radiation workers received doses higher than the prescribed limit but this did not result in any lasting health effects. In three cases workers were potentially overexposed but there was no possibility to confirm their doses by measurement. A serious accident occurred at the work on the irradiation facility for sterilization Sterigenics in Belgium. The facility was using gamma radiation emitted from the sealed source of cobalt-60. Incorrect use of the facility resulted in one employee receiving a dose of 4 Gy, which caused imediate health effects and hospitalization in a hospital specialized in treatment of radiation exposure was necessary. There were five reports on lost sources during transport and in one case a source was stolen.

The most serious event in a nuclear power plant occurred on 25 June in NPP Forsmark – 1 in Sweden. It was rated as level 2 based on the defense-in-depth criterion. Opening of a circuit breaker in the 400 kV switchyard, to which the unit is connected, caused an arc and a two-phase short circuit. As the voltage on the generator bus bars dropped to about 50% of nominal voltage the unit was disconnected from the grid. The excitation of the generators caused an increase in the voltage level on the generator bus bars to about 120%. This overvoltage caused two out of four UPS DC/AC inverters to trip. About 30 seconds later in the sequence, when the house load mode of operation on both turbo generators was lost, the trip of the UPS DC/AC inverters implicated that two out of four emergency diesel generators did not start as expected. The switchover to off site auxiliary power was successful. Both diesel generators started in manual mode after approximately 20 minutes and all the power supply was thereby operational.

The scram of the reactor was successful, all control rods were inserted as expected. The emergency core cooling system in two out of four trains was, however, more than sufficient and it did not result in a loss of coolant accident (LOCA). The control room staff had difficulties with supervising the plant properly during the event as many indications and readings were lost due to the loss of power in two trains.

Since there was no real LOCA or any other safety problems associated with the reactor and the cooling capability was more than adequate, the event is categorized as a level 1 on the INES scale. An increase to level 2 is justified by the common cause failure in the two out of four trains of the emergency power supply system.

To remedy the problem the inverters will be modified before the unit is allowed to power up again.

11 APPENDIX: LIST OF ORGANIZATIONS AND THEIR INTERNET ADDRESSES

Organization	Internet Address
Agency for Radioactive Waste	http://www.gov.si/arao
Milan Vidmar Electric Institute	http://www.eimv.si
ENCONET Consulting	http://www.enconet.com
Faculty of Electrical Engineering and Computing, University of Zagreb	http://www.fer.hr
Faculty of Mechanical Engineering, University of Ljubljana	http://www.fs.uni-lj.si/
IBE Consulting Engineers	http://www.ibe.si
Jožef Stefan Institute	http://www.ijs.si
Energy Institute	http://www.ie-zagreb.hr
Welding Institute	http://www.i-var.si
Institute of Metals and Technologies	http://www.imt.si
Institute of Metal Constructions	http://www.imk.si
International Atomic Energy Agency	http://www.iaea.org
Ministry of Agriculture, Forestry and Food	http://www.mkgp.gov.si/
Ministry of the Interior	http://www.mnz.gov.si/
Ministry of the Environment and Spatial Planning	http://www.mop.gov.si/
Ministry of Health	http://www.mz.gov.si/
Krško Nuclear Power Plant	http://www.nek.si
OECD Nuclear Energy Agency	http://www.nea.fr
Žirovski Vrh Uranium Mine	http://www.rudnik-zv.si/
United States Nuclear Regulatory Commission	http:/www.nrc.gov/
Slovenian Nuclear Safety Administration	http://www.ursjv.gov.si/
Slovenian Radiation Protection Administration	http://www.mz.gov.si/
Administration of RS for Civil Protection and Disaster Relief	http://www.sos112.si/slo/index.php
Slovenian National Building and Civil Engineering Institute	http://www.zag.si/
Institute for Occupational Safety	http://www.zvd.si/

12 REFERENCES

[1] Razširjeno poročilo o varstvu pred ionizirajočimi sevanji in jedrski varnosti v RS leta 2006, URSJV/DP-094/2007.
[2] Nuklearna elektrarna Krško, Letno poročilo 2006, rev. 1, april 2007.
[3] Krško nuclear power plant, Performance Indicators for the Year 2006, NEK, februar 2007.
[4] Dodatno poročilo o varnostnih in obratovalnih kazalcih za leto 2006, februar 2007.
[5] NEK Poročilo o zaustavitvi reaktorja dne 10.5.2006, št. 3903-3/2005/22.
[6] NEK Posebno poročilo o odstopanju št. 1/2006, št. 39010-5/2006/1.
[7] NEK Posebno poročilo o odstopanju št. 2/2006, št. 39010-5/2006/2.
[8] URSJV Zaključno poročilo št. 39010/5/2006/3.
[9] URSJV inšpektorski zapisnik št. 006/2006.
[10] NEK Posebno poročilo o odstopanju št. 4/2006, št. 39010-5/2006/4.
[11] NEK Obvestilo o izpustih tritija, št. 39010-7/2005/6.
[12] Tekočinski izpusti tritija iz Nuklearne elektrarne Krško, rev. 2, SPIS: 39010-7/2005/25 , URSJV/DP – 095/2006, URSJV, Ljubljana, september 2006.
[13] URSJV odločba št. 39000-5/2006/17.
[14] NEK Posebno poročilo o odstopanju št. 5/2006, št. 39010-5/2006/5.
[15] NEK Posebno poročilo o odstopanju št. 6/2006, št. 39010-5/2006/7.
[16] Analiza remonta NEK 2006, rev. 0, URSJV/DP–096/2006, URSJV, november 2006.
[17] Uredba o državnem lokacijskem načrtu za hidroelektrarno Krško, Ur. list RS št. 103/2006.
[18] Poročilo o delu Reaktorskega infrastrukturnega centra Instituta Jožef Stefan v letu 2006, Institut "Jožef Stefan", Ljubljana, februar 2006.
[19] Javni razpis za izbiro raziskovalnih projektov Ciljnega raziskovalnega programa »Konkurenčnost Slovenije 2006-2013« v letu 2006, Ur.l. RS, št. 60/06, 63/06.
[20] Letno poročilo o izvajanju varstva pred IO sevanji in o vplivu Rudnika Žirovski vrh na okolje za leto 2006, Rudnik Žirovski vrh, Služba varstva pred sevanji, april 2007.
[21] Poročilo URSZR, šifra 843-2/2007, 22. 2. 2007.
[22] Poročilo ELME, radiološki del, IJS Delovno poročilo, IJS-DP-9549, januar 2007.
[23] Poročilo o delu Komisije za preverjanje izpolnjevanja pogojev pooblaščenih izvedencev.
[24] Prispevek Uprave RS za varstvo pred sevanji k letnemu poročilu 2006.
[25] Letna poročila pooblaščenih organizacij za leto 2006.
[26] Komunikacijski sistem NEWS Mednarodne agencije za atomsko energijo.
[27] Poročilo o skladiščenju trdnih radioaktivnih odpadkov v letu 2006 ter kumulativno na dan 31.12.2006, NEK, z dne 29.01.2007.
[28] Poročilo o skladiščenju trdnih radioaktivnih odpadkov v mesecu decembru 2006, NEK, z dne 09.01.2007.
[29] Letno poročilo ARAO za URSJV 2006, Verzija 2, št. ARAO-SP-1017-1, z dne 15.3.2007.
[30] Poročilo o dejavnostih NE Krško v letu 2006 na področju pripravljenosti za primer izrednega dogodka.
[31] Poročilo jedrskega poola za leto 2006.
[32] Radonski potencial v tleh v Sloveniji, J. Vaupotič et al., IJS Delovno poročilo IJS-DP-9457, Ljubljana, oktober 2006.
[33] Mjerenje koncentracije 14C u biološkim uzorcima iz okolice NEK, B. Obelić et al., Izveštaj Institut Ruđer Bošković, IRB-ZEF-2006/56, Zagreb, januar 2007.

[34] "Verification Activities under the Terms of Article 35 of the EURATOM Treaty", Preliminary Information Report, edited by Slovenian Nuclear Safety Administration, Ljubljana, May 2006.

[35] Radioaktivnost v življenjskem okolju Slovenije za leto 2006, LMSAR-20070027PJ, marec 2007.

[36] Poročilo o radioaktivnih emisijah iz NE Krško za leto 2006, marec 2007.

[37] Meritve radioaktivnosti v okolici Nuklearne elektrarne Krško, Poročilo za leto 2006, april 2007, IJS, Ljubljana.

[38] Nadzor radioaktivnosti v okolju Rudnika urana Žirovski vrh med izvajanjem programa trajnega prenehanja izkoriščanja uranove rude in ocena vplivov na okolje, Poročilo za leto 2006, IJS-DP-štev.9552, marec 2007.

[39] Meritve radioaktivnosti v okolici reaktorskega centra IJS, Poročilo za leto 2006, IJS-DP-9582, marec 2007.

[40] Poročilo o izvajanju programa nadzora radioaktivnosti v centralnem skladišču radioaktivnih odpadkov v Brinju in njegovi okolici, Poročilo za leto 2006, ARAO-SP-4606, marec 2007.

[41] Nadzor radioaktivnosti Centralnega skladišča radioaktivnih odpadkov v Brinju, IJS-DP-9553, februar 2007.

[42] Poročilo Sklada za razgradnjo NEK za leto 2006.

[43] Posebno poročilo Jedrskega poola GIZ kot prispevek letnemu poročilu o sevalni in jedrski varnosti, marec 2007.