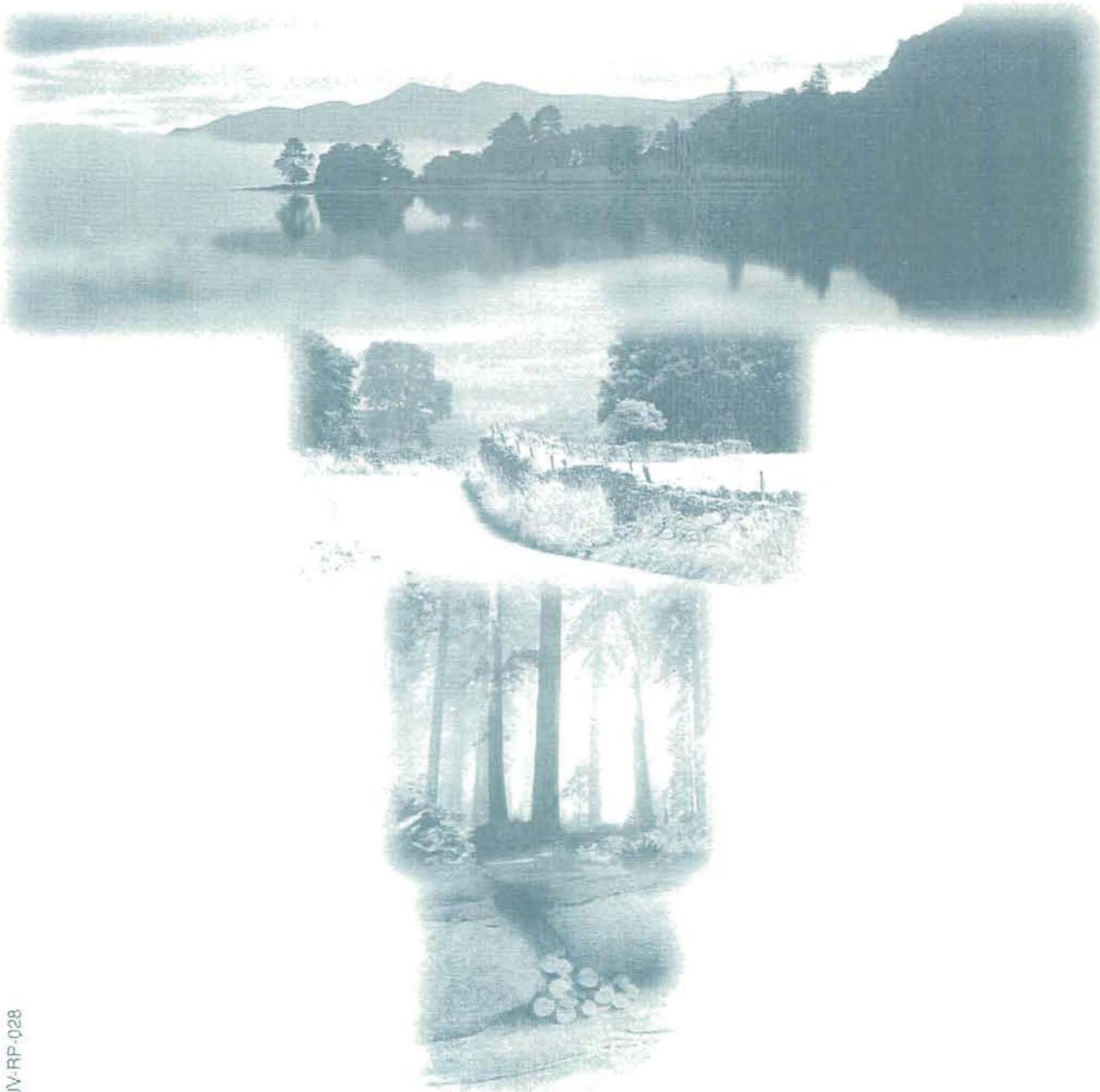
NUCLEAR AND RADIATION SAFETY IN SLOVENIA

ANNUAL REPORT 1997



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REPUBLIC OF SLOVENIA, MINISTRY OF ENVIRONMENT AND PHYSICAL PLANNING
SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

URSJV-RP-032

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Republic of Slovenia

Ministry of Environment and Physical Planning
SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

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Slovenian Nuclear Safety Administration

SUMMARY

The Slovenian Nuclear Safety Administration (SNSA), in co-operation with the Health Inspectorate of the Republic of Slovenia, the Administration for Civil Protection and Disaster Relief and the Ministry of the Interior, has prepared a Report on Nuclear and Radiation safety in the Republic of Slovenia for 1997. This is one of the regular forms of reporting on the work of the Administration to the Government and National Assembly of the Republic of Slovenia. Contributions to the report were furthermore prepared by competent authorities in the field of nuclear safety: the Agency for Radwaste Management (ARAO), the Milan Čopič Nuclear Training Centre, etc. The report contains 17 chapters, which are briefly summarised below.

Chapter 1: INTRODUCTION

Chapter 2: STRUCTURE OF THE SNSA AND ITS SCOPE OF COMPETENCE

The structure or organisational scheme of the SNSA was not substantially changed in 1997. The Administration still consists of 5 divisions, some of which have acquired new departments. The number of staff increased from 30 to 32, which is still below the recommendation of the European Union mission RAMG. It is worth noting that as many as 26 of the staff have professional examination qualification. Three workers have successfully concluded a seven-week Power Reactor Technology course. Six workers are supported by the SNSA in their post-graduate in-training. The SNSA staff have also received fairly intensive training on other expert courses at home and abroad.

Chapter 3: LEGISLATION IN THE FIELD OF NUCLEAR SAFETY

In the field of legislation and international agreements the year 1997 introduced a favourable trend in stipulating the agreements in the area of technical exchange in the field of nuclear and radiation safety with countries such as the Czech Republic, Slovak Republic, France, South Africa and South Korea.
The National Assembly also ratified the Agreement on Safeguards in connection with the Non-Proliferation Treaty between the Republic of Slovenia and the International Atomic Energy Agency (IAEA).
Additional Protocol to the Agreement has not yet been passed by Government procedure, due to some unresolved differences in the co-ordination process with the Ministry of Finance.
The Comprehensive Nuclear-Test-Ban Treaty (CTBT) was signed by 146 states, yet ratified by only 7 states by the end of 1997. In Slovenia the procedure of ratification initiated by the SNSA is taking place. The text has been translated and is ready for

proof-reading. It is expected to be submitted to the National Assembly in the mid-1998. The contribution of Slovenia for the realisation of provisions of the treaty was roughly USD 20.000 in 1997.
On 18 February 1997, the Vienna Convention on Nuclear Safety came into force for Slovenia. In April 1997, there was held a preparatory meeting of the Contracting Parties to the Convention on Nuclear Safety, at which the Rules of Procedure on Nuclear Safety and Financial Rules, guidelines on the form and structure of reports, the procedure of report reviewing etc. were approved.
In September 1997, Slovenia signed the Final Act relating to the Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage and the Convention on Supplementary Funding for Nuclear Damage. In considering the report after the diplomatic conference, the Government of the Republic of Slovenia entrusted the SNSA in co-operation with the Ministry of Foreign Affairs to take all the necessary actions for accession to the Paris Convention and the Brussels Additional Protocol.
In October 1997 Slovenia signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The first activities to ratify the Convention are already in progress.

Chapter 4: INTERNATIONAL CO-OPERATION

At the end of September 1997 the General Conference of the IAEA was held. At the first session of the Board of Governors after the General Conference, Slovenia for the first time participated as a member state, elected in the Eastern European regional group. Slovenia is represented in the Board of Governors by Miroslav Gregorič, M.Sc., Director of the SNSA.
Co-operation between our state and IAEA has been most intensive in the area of technical assistance and co-operation and in participation at meetings, of which dozens were held in 1997. In addition to the representatives of SNSA, many experts from organisations working for the SNSA also attended the meetings.
Within the scope of co-operation between the SNSA and IAEA, Slovenia has hosted a number of fellowships and scientific visits.
In 1997 the SNSA submitted to IAEA 13 research contract proposals, of which 5 were new. The majority of proposals was prepared by the Jožef Stefan Institute.
Slovenia proposed to IAEA 6 projects for technical assistance which are usually the most demanding form of co-operation. Activities were continued on the existent projects, including: Licensing of steam generators replacement in the Krško NPP and for increasing the thermal power (SNSA), Beam Transport System at the Van de Graaff accelerator (JSI) etc.
The IAEA missions were organised by the SNSA in co-operation with relevant organisations and administrations; these included: International Physical Protection Advisory Service (IPPAS) Mission, and IPERS Mission (International Peer Review Service). The final report of the former has already been forwarded to our country, however the final report of the latter on Probabilistic Safety Analyses (PSA) level 2 has not yet been sent.
The IAEA informational system - the International Nuclear Event Scale (INES) has received 45 reports from 21 countries. Among them are 2 reports on events of the third

degree, 16 on events of the second degree and 15 on events of the first degree, while the others are of 0 degree on a seven degree scale. Slovenia reported on two events at the Krško NPP. Both were graded below the scale - degree 0 - with no impact on safety.
The second year of RAMG (Regulatory Assistance Management Group) - PHARE assistance programme consisted of eight areas or items of assistance. In 1997 some programmes representing approximately 70% of the second year assistance budget, were concluded.
The SNSA is also active in the CONCERT Group; it participated at both meetings in 1997, and will host a meeting in 1998.
Slovenia endeavours to attain full membership of the OECD/NEA. Representatives of the SNSA took part in some of the meetings organised by NEA. Bilateral co-operation is often the most effective and useful form of co-operation. In 1997, intensive co-operation activities were carried out with the competent authorities of Finland, France, Spain, Belgium, Germany, Sweden and the USA.

Chapter 5: PROVIDING PUBLIC INFORMATION

Provision of open and authentic information presented to the public is a fundamental policy of the SNSA. The Report on Nuclear and Radiation safety in 1996 was published in **Poročevalec** (Reporter), the publication of the National Assembly, and is available in public libraries throughout Slovenia and on the Internet in Slovene and English.
Reports on the SNSA activities are also published in the bulletin **Okolje in prostor** (Environment and Physical Planning). In 1997, 57 articles were published.
For several years the SNSA has been endeavouring to maintain continuity in translating some of the basic IAEA publications. In 1997 the SNSA prepared a Slovene translation of a publication from the Radiation Safety Series and distributed it free of charge to the institutions concerned.

Chapter 6: BUDGET OF THE SNSA AND ITS REALISATION

The funds assigned from the national budget to the SNSA were in reality lower than in the previous years, especially for some important economic purposes. Particularly worrying is the fact that the implementation of some programme activities in the area of nuclear and radiation safety is being made difficult.

Chapter 7: EXPERT COMMISSIONS AND OTHER SNSA ACTIVITIES

The Nuclear Safety Expert Commission (NSEC), which has an advisory role to the SNSA, met four times in 1997. It consists of 22 members, 10 officials from ministries and 12 experts on nuclear and radiation safety. Within the SNSA there is also an Expert Commission for Operators Exams, which holds exams to asses the professional competence of the staff (operators) of Krško NPP.

Chapter 8: THE STATE OF NUCLEAR SAFETY IN SLOVENIA

Inspectors of the SNSA carried out surveillance of operation of nuclear facilities in accordance with their competencies and the approved yearly programme of inspection in 1997.

Based on findings of the inspections and the earlier experience it was concluded that:

* the Nuclear Safety Inspection Division for surveillance of the facilities successfully co-operated with other administration and inspection bodies;
* also after the 1997 annual outage, the outage works, functional and start-up tests on systems and components of the Krško NPP complied with the technical specifications and acceptance criteria, defined in the approved procedures. This can be seen also from the reports and expert opinions of the technical support organisations, which the Krško NPP and the technical support organisations considered during non-routine inspections;
* non-routine or routine inspections were carried out after each unplanned shutdown of the Krško NPP. After each unplanned shutdown the Krško NPP proposed short-term and long-term measures for permanent elimination of causes;
* in 1997, there was one automatic shutdown of the reactor with actuation of safety injection, caused by broken stem of the isolation valve cylinder on the main steam line no. 2;
* all unusual events reported by the Krško NPP were discussed during inspections in order to clarify the reasons;
* the SNSA Nuclear Safety Inspection Division performed the inspection of the compliance with the decisions, issued to the Krško NPP by the SNSA and did not find any irregularities;
* the SNSA Nuclear Safety Inspection Division reviewed monthly reports on radioactive emissions, however, no deviations from acceptable values were observed.

All safety systems for a safe shutdown of the power plant operated in compliance with the anticipated design parameters; in 1997, nuclear safety was not jeopardised.

In 1997, operation of the research reactor TRIGA Mark II (RR Triga Mark II) at Jožef Stefan Institute Reactor Centre at Podgorica complied with technical specifications. Admission into the cellar and the reactor hall was controlled and the register of entrances of experimentators, maintenance stuff and visitors was consistently kept. The reactor operated through all year without deviations, also during the summer leave; the operation of the reactor was abandoned only for maintenance reasons.

The radioactive waste in the temporary storage of low and intermediate level radioactive waste at the Krško NPP and in the interim storage of radioactive waste of the Reactor Centre at Podgorica is stored in compliance with the legislation and the records are correctly and consistently kept. However, in 1997, the interim storage did not accept radioactive waste from external users due to unsolved status in connection with the transfer of competence for the interim storage management from Jožef Stefan Institute to the public agency ARAO.

At the Žirovski Vrh Mine, the final remedial works on the ore processing site and determining the remedial method at both hydrometallurgic tailings piles at Boršt and

Jazbec have been proceeding very slowly and their completion is difficult to project owing to extremely low funds available.
After repacking of radioactive waste at the temporary storage of low and intermediate level radioactive waste at Zavratec in 1996, there was no change in 1997 and the status of the temporary storage of low and intermediate level radioactive waste still remains unsolved.

In 1997, the Krško NPP generated 5,019,437 MWh (5.0 TWh) of electrical energy at the output of the generator, or 4,793,976 MWh (4.8 TWh) net. The generator was connected to the electrical grid for 7838.52 hours or 89.48% of the total number of hours in the year. The electrical production was 7.01% higher than planned.
The generation of thermal energy in the Krško NPP reactor was 14,463,491 MWh. The whole production of the electrical energy in Slovenia was 11,989 GWh, the share of the nuclear energy production being 39.9%.
In addition to record production and load factor, the operational reliability of the Krško NPP was also at a very high level. In 1997, there were only two abnormal events i.e. the automatic shutdown at the beginning of the year and a short loss of residual heat removal system during the 1997 refuelling outage, which is bellow the average. A planned manual shutdown took place during the 1997 annual outage.
In 1997, the production of electrical energy of the Krško NPP was 7% higher than planned due to the shortest outage duration ever and reliable plant operation.
The only forced shut-down of the Krško NPP occurred on 1 January 1997. Before the event, the power plant operated steadily at full power. At 8.33 a sudden closure of the main steam isolation valve MSIV 20142 occurred on the main steam line no. 2. In consequence to the sudden closure of MSIV and reduced power of the turbine there was a loss of pressure in the steam line no. 1. The safety injection signal was activated, which in turn activated immediate turbine and reactor trip and isolation of the main steam lines (closure of the second MSIV).
The Nuclear Safety Inspection Division of the SNSA was notified on the automatic outage immediately; in the following days it carried out several non-routine and routine inspections.
The event had no impact on the environment. According to the International Nuclear Event Scale (INES) the event was graded as an event "not relevant for the nuclear safety", degree 0.

The period between two refuelling outages is called the reactor fuel cycle. In 1997, the 13th and the 14th fuel cycles were taking place. The 13th fuel cycle started on 21 July 1996, continued into 1997 and was completed on 10 May 1997, as planned. The 14th cycle started on 10 June 1997 and is to be completed in May 1998.

The comparison of the basic indicators of fuel reliability for 1996 and 1997 showed that the integrity of the nuclear fuel degraded by 30% at the beginning of 1997, i.e. at the end of the 13th fuel cycle. During the 14th fuel cycle the Krško NPP for the first time used modified fuel with a new bottom nozzle of the fuel element called "Debris Filter Bottom Nozzle (DFBN)" which proved effective in other power plants. The advantage of the new nozzle is a higher density grid that intercepts any foreign particles. By the end of 1997 the indicators of fuel damage showed that in the 14th fuel cycle there were no damages on the fuel rods and that the introduction of modified fuel elements was justified.

In 1997, the activities on the steam generators of the Krško NPP were twofold:
* inspection and remediation of the existing steam generators,
* replacement of steam generators.

In order to define the level of failure in both steam generators a 100% inspection of tubes was necessary during the 1997 annual outage. For inspection of tubes the eddy current technique (ECT) was used.

The inspection was carried out on 3833 tubes in operation in the steam generator No. 1 (SG1). In the steam generator No. 2 (SG2), 4123 tubes in operation were examined. In each steam generator there are 4568 tubes (SG1) or 4575 tubes (SG2), respectively.

The average share of plugged tubes in both steam generators, considering the impact of inserted sleeves, is 16.51%. The asymmetry of plugging between SG1 (18.06 %) and SG2 (14.97 %) is 3.09% and is inside limits according to the conclusions of the Westinghouse study "NPP Krško 18% Steam Generator Tube Plugging Analysis Review", so that the Krško NPP may operate at 100% power.

During 1997 outage, the sleeves insertion campaign in degraded tubes of steam generators was not carried out; the damaged tubes were only plugged.

In 1997, the Krško NPP started the project of steam generators replacement and power up-rate. On call for tenders in December 1996, Consortium Siemens - Framatone was chosen as the supplier of the new steam generators. The production of components of steam generators is in full swing and according to the plan. The steam generators are to be produced and delivered to the Krško NPP by May 1999. In 1997, preparation of safety analyses for operation of the plant with new steam generators at by 6.3% power up-rate started within the scope of the project for steam generators replacement. Westinghouse has been chosen as the contractor for safety analyses preparation. The replacement of the steam generators will take place in spring 2000.

The SNSA gives special attention to nuclear safety, especially to high safety level of the Krško NPP. This concern includes improvements in the power plant itself based on the best international practices and the latest findings in the nuclear field. The Krško NPP prepares and evaluates technical modifications in accordance with domestic legislation or legislation of the supplying country using its own procedure. The Krško NPP is liable to inform the SNSA on modifications of safety evaluations. For the modifications which are essential for the Krško NPP nuclear safety, it initiates an administrative procedure with the SNSA to acquire the licence. In certain cases, based on safety evaluations of modifications review, the SNSA requires from the Krško NPP to initiate an administrative procedure for granting the licence.

The Krško NPP evaluated the received tenders on full scope simulators from an international invitation for tenders and on 7 August 1997 submitted the final report on tender evaluation to the Ministry of Economic Affairs. To comply with the decision issued by the SNSA the contract should have been signed in August 1997. Due to the founders' failure to decide on the tender evaluation, the contract was not awarded and the Krško NPP sent a letter of intent to the selected supplier CAE Electronics Ltd., Canada, in order to keep the necessary time dynamics to comply with the administrative

decision. CAE confirmed the letter of intent on 25 August 1997. All the details of the contract are agreed and the contract has been submitted to approval to the founders.
The spent nuclear fuel is kept in the spent fuel pool. The grids with 828 positions for storing the nuclear fuel occupy approximately two thirds of the pool. By the end of 1997, 498 fuel elements were stored in the pool (approximately 194.6 tons of heavy metal). In reality, there are 202 positions available for storage of fuel elements, which is sufficient for maximum 6 years of operation of the Krško NPP.

During operation of the NPP various radioactive waste materials in gaseous, liquid and solid state are generated, which are disposed of through the radioactive waste processing system. The processed wastes are categorised as low and intermediate level radioactive waste and are kept in 200 litre drums as follows:
* low level compressible radioactive wastes are packed without additional protection,
* the remaining wastes are stored in drums with the concrete protection from the inside.

In 1997, 330 drums were filled with low and intermediate level radioactive wastes with total radioactivity 300.4 GBq. The accumulated quantity of drums is 3943 with total radioactivity 26,228.2 GBq.

The competent administrative authorities were regularly informed about the releases of radioactive waste into the environment by the Krško NPP on daily, weekly, monthly, quarterly and yearly basis in 1997.
The liquid releases into the Sava river are registered for the main water supply, discharging into the Sava river in front of the dam. The major contribution to the dose is done by the radionuclides caesium and cobalt. In liquid releases, the dominating radionuclide was tritium (H-3). In 1997, the annual released activity of this radionuclide was 7.8 TBq, which was approximately 39% of the annual limit value 20 TBq. The annual activity of other radionuclides in liquid releases was about a thousand times lower.
Radioactive gases from the Krško NPP were released to the atmosphere mainly from the reactor building stack and through the vent of the condenser in the secondary coolant loop. In 1997, the released radioactivity of noble gases was 2.5 TBq, which is 2.3% of the acceptable annual value. A considerable increase of radioiodine in gaseous releases was observed in May, which was due to refuelling and not to regular operating of the Krško NPP.

The Radiological Protection Unit at the Krško NPP is organised for the task of measuring, calculating and regular recording of received effective doses for all workers, who have access to the controlled area of the power plant, regardless if they are members of the NPP staff or external contractors.
In 1997, the average effective dose to workers was 1.28 mSv, which is approximately 2.6% of dose limit to workers who are professionally exposed to ionizing radiation (the Regulation on Dose Limits to Population and Radiation Workers, Off. Gaz. SFRY, No. 31/89) or 6.4% of it in accordance with the latest recommendations ICRP (1991) and BSS (1996). The average effective dose to workers from the NPP was 0.69 mSv and to external workers 1.55 mSv. Workers received the major part of the dose during the

annual outage of the power plant. It was established that the received effective doses in the NPP in 1997 were lower in comparison with the world average, which is 2.5 mSv (UNSCEAR 1993). In 1997, no radiological event at the Krško NPP occurred to cause unplanned exposure of workers either from external radiation or from internal or external contamination. The legal and operational dose limits to an individual were not exceeded.

In the framework of negotiations on the scheduled return of spent fuel from the reactor TRIGA at Podgorica, the delegation of seven representatives of US government organisations visited Slovenia on 18 - 19 September 1997. During discussions it was decided that 218 spent fuel elements would be returned to the USA in the first half of 1999, including twenty-six by 70% enriched fuel elements. The contract will enable Slovenia to return to USA all the remaining spent fuel, i.e. in total 95 fuel elements from the Research Reactor TRIGA, by 2006.

In 1997, the activities of the Žirovski vrh Mine in implementing the Programme of permament cessation of uranium ore exploitation and preventing the negative impact of the mine (the Programme) were reduced due to reprogramming of the operational plan of activities for programme implementation in 1997 (the Reprogramming). The Reprogramming of the Programme was necessary because of the reduced funds assigned to it in the proposal of the national budget for 1997 and the undertaking of the Ministry of Environment and Physical Planning to finance the implementation of the Programme in such a reduced amount.
From the viewpoint of rational use of the reduced budget for the Programme implementation, the implementation of the Programme in 1997 can be estimated as successful.

Similarly, also the implementation of the Programme after realisation of the operational plan for: remediation of landsliding; providing conditions for cessation of concentrate production to enable intensive implementation and realisation of the project; maintainance of the present state; and environment protection, can be estimated as succesful.
The operational costs financing by Ministry of Environment and Physical Planning was satisfactory.
Considering the reduced implementation of the Programme in 1997 and, therefore, higher implementation costs; the probability of unusual events; and the possibility that the implementation of permanent cessation of uranium ore exploitation and the implementation of the Programme could be jeopardized even eight years after shut-down and five years after adoption of the relevant law, the situation can not be estimated as satisfatory at all.
In the scope of decommissioning, the Radiological Protection Unit of the Žirovski vrh Mine carried out regular monitoring of the working site for uranium ore extraction and for uranium concentrate production, and measured contamination of the waste material and the facility surfaces.

Chapter 9: RADIATION SAFETY IN THE LIVING ENVIRONMENT

For years now the SNSA as the competent authority for providing radiological monitoring has been concerned with the establishment and constant improvement of Radiation Early Warning System for immediate detection of a potential contamination in case of nuclear or radiological accident at home or abroad. There are approximately 40 probes for dose rate measurement of external gamma radiation throughout Slovenia; real time data retrieval is possible from 28 of the probes.
Towards the end of 1997 a connection was established between the SNSA and the European centre JRD in Ispra (Italy) which collects data from European national networks for early warning. Therefore, from December on the SNSA has been sending data from CROSS to the European system EURDEP every week. By joining the European network the SNSA gained the possibility of insight into data from other European countries.

In 1997, the radioactivity monitoring programme in the living environment in the Republic of Slovenia was the same as in previous years. The exception was the measurement of radioactivity in solid precipitation (on sticky plates) which are of accidental meaning only, and which, due to shortage of funds the support organisations discontinued. The basic scope of the programme was determined by the Regulation on the locations, methods and time periods for the radioactive contamination control (Off. Gaz. SFRY, No. 40/86), and in addition, certain modifications were taken into account based on the technical bases for amendment to this regulation. Considering the results of measurements of radioactivity in the living environment in the Republic of Slovenia in 1997 the technical support organisations claimed that the annual intake of artificial radionuclides was well within the limits prescribed by the Regulation on the maximum contamination of the human environment and on decontamination (Off. Gaz. SFRY, No. 8/87). The total annual effective dose caused by artificial radionuclides from inhalation and ingesting and from exposure to external gamma radiation due to global radioactive contamination was estimated to be 58 microSv, which was within the range of average world values.

The radioactivity monitoring programme in the living environment of the Krško NPP was approved by the SNSA by Decision No. 391-01/96-8-13582/MK. Regular radiological monitoring of the Krško NPP consists of the control of its liquid and gaseous radioactive releases into the environment and of the independent control of release of radionuclides into the environment. The area under most thorough surveillance is the 12 km circle around the facility, where the highest impact of emissions is expected and the potential changes can be detected first; the surveillance of the area along the Sava river and of the underground water is extended to the territory of Republic of Croatia from Jesenice na Dolenjskem to Podsused (at 30 km distance from the facility).
Measurement results of the radioactivity of artificial and natural radionuclides in various controlled media and along transfer pathways are given by effective dose value. A conservative estimation of the annual effective dose to an individual member of the public due to emissions from the nuclear power plant gives a "committed effective

dose" value of 8.2 microSv/year for 1997. This value represents less than 1% of the average annual effective dose from natural and artificial radiation sources to which individuals are normally exposed. By measurement of selected samples, it was possible to estimate the annual doses due to natural radioactivity, general pollution (contribution of Chernobyl, atmospheric nuclear tests), from industry and hospitals where radioactive substances are used.

Radioactivity monitoring in the vicinity of the Reactor Centre at Podgorica in 1997 was carried out in accordance with the same programme as in the past. In reactor operation and other related activities in 1997 there were no special events found and the total produced thermal power was similar as in the previous years. Releases of ^{41}Ar into the air (approx. 1.0 TBq in 1997) were directly correlated to reactor operation and were also similar. There was no change in the release of liquid effluents (12 MBq in 1997) resulting from the research work at the Department for environmental chemistry. The activity of effluents was similar to that of the previous years. For this reason the estimated annual effective doses on the population were low. The estimate of external immersion dose due to ^{41}Ar release into the air is up to 0.25 microSv/year, which represents only 0.025% of the annual dose limit for the population. A conservative estimate of the ingestion dose due to release of effluents into the Sava river was 0.4 microSv and represented 0.04% of the annual limit value to the population.

The radioactivity measurements showed that the cessation of uranium ore exploitation only partly reduced the impact of the Žirovski vrh Mine to the environment even seven years after its closure. Radionuclides in liquid effluents and the annual emission of radon from a pit and tailings pile at Boršt were significantly reduced in 1997. The most important source of radiation contamination in the vicinity of the Žirovski vrh Mine remains radon ^{222}Rn and its short-lived progeny, which contribute more than 4/5 of the additional exposure. The liquid effluents from the mine and tailings piles at Jazbec and Boršt increased the concentration of radioactive substances in surface waters in the vicinity of the mine (Todarščica and Brebovčica). The local population do not use water from surface waters and underground water in the vicinity of the Žirovski vrh Mine for drinking, irrigation or watering the cattle, so the contamination with radionuclides has no additional impact on the radiation exposure to the local population.

The effective dose to adults due to radiation in the environment caused by uranium ore mining activities is about one third of the dose limit of 1 mSv per year, as prescribed by the Regulation on Dose Limits to the Population and Radiation Workers (Off. Gaz. SFRY, No. 31/89) and the latest international recommendations of the ICRP 60 (1991) and BSS(1996) respectively. In comparison to the total amount of exposure, the Žirovski Vrh Mine represents around 6% of the average background radiation exposure in this area (around 5.5 mSv per year).

Chapter 10: RADIOLOGICAL PROTECTION IN THE WORKING ENVIRONMENT

The Health Inspectorate of the Republic of Slovenia (HIRS) is responsible for inspections at the Krško NPP and at Jožef Stefan Institute (JSI) with TRIGA reactor, and at the Interim Storage for Low and Intermediate Level Radioactive Wastes of the Republic of Slovenia at Podgorica near Ljubljana.
In 1997, the Inspectorate carried out eleven inspections in the Krško NPP, one jointly with inspectors of the SNSA, and participated in the survey of the future sampling site by the Sava river at Brežice. The inspectors observed no major irregularities or problems related to radiological protection in the Krško NPP. During the annual outage works, when some workers were exposed to doses of up to 20mSv, the inspections were more frequent.

At JSI, the HIRS carried out 6 inspections, four in the Reactor Center at Podgorica (three of them jointly with the inspectors of the SNSA). Most of the workers went through the mandatory annual medical examinations required for persons working with sources of ionizing radiation. Some deficiences were observed.
From the viewpoint of radiological protection the inspection of the Research Reactor revealed no major deficiencies. An incident occurred in October 1997, when it was found that the rail transport of an empty radioactive container for Iridium-192 from the Reactor Centre through Austria to Budapest has been carried out without any license and other necessary documentation.

The inspection of the Interim Storage for Low and Intermediate Level Radioactive Wastes in the Reactor Center at Podgorica revealed once again that the waste is not sorted systematically
according to the category of isotopes and their activities. JSI produced a new inventory list of the stored material, which was sent to the Health Inspectorate of the Republic of Slovenia in spring 1997. It should be noted, as from summer 1997, JSI has stopped accepting the wastes because of unsolved management status on the side of ARAO.
The HIRS is responsible for the control of the seven clinics and hospitals in Slovenia where open radiation sources are used (radiopharmaceutics) for diagnostics and therapy (University Medical Centre of Ljubljana - the Department of Nuclear Medicine, the Institute of Oncology and hospitals in Maribor, Slovenj Gradec, Celje, Nova Gorica and Izola). The Inspectorate carried out nine inspections in these facilities.

The Inspectorate observed that in most of the departments for nuclear medicine the state of radiological protection was approximately the same as in the previous years. The requirements of the valid regulations on radiological protection were not complied with in the Hospital of Celje and in the University Medical Centre Ljubljana. Certain deficiencies were also observed in all the other departments for nuclear medicine, either by technical support organizations or by the Health Inspectorate.

HIRS carried out 29 inspections in medical organizations to establish the state of X-Ray departments and in particular, X-Ray equipment and how it was operated in 1997.

Regulatory decrees were issued to nine users. Thirteen X-Rays were forbidden to be used by regulatory decrees and thirteen orders to remedy the deficiencies in the area intended for X-Ray diagnostics were issued.
The inventory of old and unused sealed radiation sources was surveyed in detail in 1997. The inventory list is longer than it was in the report for 1996, as some of the ex-users have not yet delivered the sources into the interim radwaste storage at Podgorica. The list contains 93 commercial and non-commercial organisations currently storing altogether 420 sealed ionizing sources.
HIRS carried out an inspection of the temporary storage of radwaste (originating from the Institute of Oncology) in an abandoned barracks near the village of Zavratec. The situation was unchanged in comparison to the findings of the inspection in 1996. No negative impact of the stored radioactive material on the population was found.
Altogether 4365 workers in Slovenia, working in the area of ionizing radiation, were under regular dosimetric control in 1997: 2203 in medicine, 639 in industry (without the Krško NPP and the Žirovski vrh Mine), 821 at the Krško NPP, 70 at the Žirovski Vrh Mine, and the remaining 632 persons in administration, research and other institutions (Ministry of the Interior, Ministry of Finance - Customs Administration, the SNSA, the Institute for Occupational Safety of the Republic of Slovenia, JSI, HIRS, etc.). No one exceeded the limit of annual effective dose of 50 mSv as prescribed by the Slovene regulations; however in 1997, nine persons received doses exceeding 20 mSv, which is derived limit value according to the latest international standards (IAEA BSS, 1996) and EU Directive (1996).

Chapter 11: STORAGE, TRANSPORT, PROTECTION AND IMPORT OF RADIOACTIVE AND NUCLEAR MATERIAL IN SLOVENIA

The technical support organisation for control of the use of sources of ionizing radiation in medicine and industry, for monitoring of radioactive contamination in working, living and natural environment in Slovenia and for expert training for safe work with ionizing radiation is the Section for Radiological protection at the Centre for Ecology, Toxicology and Radiological Protection in the scope of the Institute for occupational safety.

In the scope of the national radioactivity monitoring programme, established by the Ministry of Health, the radioactivity monitoring was performed in the surroundings of the Krško NPP and Žirovski vrh Uranium Mine, presently in the phase of decommissioning, the monitoring of radon and radon pregeny concentrations in the living environment, the monitoring of radon and radon progeny concentrations in thermal baths of Slovenia and by determining specific activities of natural radionuclides in thermal water and in bottled mineral drinking water.

The inspectors of the Institute for occupational safety inspected 682 radiation sources in medicine and 2313 sources in industry. At present 212 sources are out of use, of which 70 are stored at the Reactor Centre at Podgorica, the rest are written-off or out of use sources, suitably stored in organisations under the surveillance of the Health Inspectorate of the Republic of Slovenia (HIRS).

In 1997, the dosimetric control of radiation doses received by patients during diagnostic procedures in medicine was not carried out because the Ministry of Health did not succeed in providing the necessary funding. Therefore, the UNSCEAR questionnaire for 1997, periodically sent by the World Health Organisation (WHO), will not be filled in. In 1997 the Institute for occupational safety carried out control of dosimeters in 601 organizations. All together 23,622 radiation dosimeters were inspected, 16,260 were thermoluminiscent dosimeters and 7,373 film dosimeters. Some of the organisations concerned are not regular users of ionizing sources or do not use radiation dosimetry regularly. Altogether 2607 persons were under dosimetric control in 1997. The statistics show that the majority of workers were exposed to radiation in the range of annual doses < 0,5 mSv.

The storage, transport, protection and import of radioactive and nuclear material in Slovenia is governed by the Act on Radiological protection and the Safe Use of Nuclear Energy (Off. Gaz. SFRY, 62/84) and by its relevant regulations.
In recent years there has been a substantial increase in quantity of sealed radiation sources in the Interim Radwaste storage at Brinje. The sources are confined in special waste containers (only one source per container). The containers are distributed over the floor of the storage room occupying major part of the ground. In order to optimise the storage capacity the sources need to be rearranged. The refurbishment of storage is undoubtedly the first priority. The present capacity of the storage is insufficient to receive all the quantity of drums stored e.g. at Zavratec. The total volume of accumulated wastes in drums is 31,5 m^3 (drums by volume) and the special wastes volume is estimated to be several m^3. The volume of the active parts of the sealed sources is insignificant, but they take up substantially more place because of the protective containers in which they are kept.

The SNSA issued a licence to the Krško NPP for the purchase of 24 nuclear fuel elements.

On 6 October 1997, during the inspection of goods at the warehouse of railroad station in Salzburg an empty transport container, labelled "Radioactive", was found that was not tightly sealed. The container was sent from Ljubljana to Budapest, Hungary. The finding of the further investigation states that the shipment of radioactive material should be declared either as a dangerous substance falling under Category 7 of RID or it should be dispatched as "expected package - empty container" (IAEA SS No. ST-1/515, 520) corresponding to the Category 7 (radioactive substances), page 4 (empty packing - RID).

The reason for the excessive radiation of the container was not contamination but the technological design and construction of the container itself. Only sealed sources of radiation which are not able to cause contamination are allowed to be transported in containers. A container is made of isotopic depleted uranium alloy, with a wall of stainless steel on the outer and the inner side. A low level of radiation can always be detected on the surface of an empty container as the depleted uranium retains some of

its radioactivity. After a year the radioactivity of the uranium shield increases slightly due to the decay of U-238, and this radioactivity is detectable on the surface of the stainless steel coat of the container.
Up to now it has not been possible to determine what material (depleted uranium or lead) the container shield was made of on previous shipments of the same category of isotopes.
The SNSA will control similar shipments more strictly in the future and will require that all concerned strictly comply with the laws and regulations in force and provide additional technical data on the category and nature of transport containers when applying for an import licence.
The Inspectorate of the SNSA will carry out more frequent inspections on isotopes and transport container handling at JSI.

In 1997, Slovenia concluded the "Agreement between Republic of Slovenia and International Atomic Energy Agency on Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons" (Off. Gaz. RS, No. 11/97). The agreement replaced the Agreement between the former SFRY and the Agency and succeeded by Slovenia. Pursuant to Article 39 of the agreement, which entered into force on 1 August 1997 the Contracting Parties should conclude the Additional Arrangements for implementation of the Agreement within ninety days after its entry into force. The SNSA received the harmonised text of the general part of the additional agreement (Part a.) from IAEA.
Routine IAEA safeguard inspections were carried out until 1 August 1997. There were three routine inspections in the Krško NPP by that date. From 1 August 1997 on, pending adoption of the Additional Arrangements, the control was carried out by so-called ad-hoc inspections. There were two such inspections in the Krško NPP in 1997. No anomalies were reported. In the JSI Research Reactor TRIGA, Brinje, there were no inspections by IAEA in 1997.

Due to the ageing of spent fuel elements with low burnup, the Krško NPP has difficulties in verifying the identity of spent fuel elements. The verification of these fuel elements by optical methods (Cerenkov Viewing Device-CVD) is problematic, and IAEA is making an effort to implement so called Spent Fuel Attribute Tester (SFAT). Consultations on the introduction of SFAT in the Krško NPP are in progress.
In November 1997 the SNSA carried out an inspection of physical protection at the RR TRIGA, Brinje. Some minor deficiencies were observed, which are now being remedied. The inspection of the physical protection system in the Krško NPP was carried out in the course of routine inspection by the SNSA. Modernisation of certain components of the physical protection system was observed.
Within the scope of the Ministry of the Interior, a Commission for implementation of technical tasks in the field of nuclear facilities and installations protection was appointed in 1997. The Commission met in November 1997 to discuss the report of the IAEA IPPAS Mission to asses the present threat to nuclear facilities in Slovenia.
According to the Regulation on Export and Import of Scientific Goods (Off. Gaz. RS, No. 75/95), which entered into force on 1 January 1995, the SNSA issued 190 licenses, 149 of them for single import, 35 licences for multiple import (Karanta, Krka, Genos)

and 6 licenses for export of certain goods (Steklarna Rogaška, Sanolabor, Radeče papir and Institute of Oncology) in 1997. Among regular importers of radionuclides are Krka, Karanta, Genos and Iris; the others import them only occasionally.

Chapter 12: EMERGENCY PREPAREDNESS

In most cases, quick emergency response depends on immediate and comprehensive notification of an emergency event. For the purposes of this report only the nuclear and ionizing radiation risks are included.

The emergency plan (EP) regulates the notification procedures and the activities of the SNSA in order to fulfil its function in the event of emergency in a nuclear facility. The purpose of the emergency plan is: to provide suitably trained staff; means for operative measures in the event of emergency; and to ensure countermeasures to protect the population and the environment from radiological impact in the event of emergency. In 1997 the second revision of the emergency response plan, consisting of a set of 31 procedures, was carried out.

The activities related to the Krško NPP emergency plan for 1997 were aimed, in particular, at the following:

- maintenance of the present preparedness in the event of nuclear emergency at the Krško NPP,
- co-ordination of activities in emergency preparedness planning between the Krško NPP and the off-site organisations,
- further development and improvement of the present emergency preparedness of the Krško NPP.

In April 1997, the Krško NPP participated in an international exercise INEX-2-FIN. In November 1997, the Krško NPP organised a desk-top exercise NEK-97 at its premises. In the exercise NEK-97, those taking part included members of the Civil Protection Headquarters of the Republic of Slovenia, regional Civil protection Headquarters, the local-community Civil protection Headquarters of Krško and Brežice, and the SNSA.

In its extensive annual reports on nuclear and radiation safety in the Republic of Slovenia for 1995 and 1996 the SNSA reported on the state of preparedness of communities and of the government. The systematic and organized preparations for emergency response also continued in 1997.

In the meantime the new role of the Notification Centre (regional centres and the Notification centre of RS) at the Administration for Rescue and Disaster Relief was established, and the rescue and disaster relief plans of the competent planning bodies of the Krško NPP, communities of Posavje and the Posavje region were harmonized.

The European Commission project for improvement of preparedness in case of nuclear emergency in Central and Eastern Europe continued; and, in 1997, a new project was started in the framework of technical assistance from IAEA, entitled "Harmonization of Nuclear Emergency Preparedness in Countries of Central and Eastern Europe".

The Inspectorate of the Administration for Civil Protection and Disaster Relief of the Republic of Slovenia carried out an inspection at the Krško NPP. The observed nonconformances were partly eliminated in 1997.

An Ecological Laboratory with Mobile Unit (ELMU) was established between 1980 and 1982 as an UNDP project. Its organisation and equipment are aimed at: immediate detection and determination of pollution with dangerous substances (radioactive, chemical and biological substances); expert recommendations for protective measures to mitigate the effect of environment pollution in case of emergency; training in and improvement of ecological awareness.

The Ecological Laboratory with Mobile Unit is a specialized emergency unit to carry out certain tasks in the field of protection, rescue and assistance in case of natural and other disaster and is organized to allow for immediate mobilisation.

In the field of radiological activities the Ecological Laboratory with Mobile Unit is directly involved in the regular radioactivity monitoring programme in the vicinity of the Krško NPP; it also performs other radiological measurements and control (underground water, construction material analysis, analysis of food for import or export, etc.) and gives expert recommendations and expertise.

In 1997 ELME carried out three regular monitorings in the Krško NPP and in its vicinity. During every monitoring, carefully planned in advance, the ELMU measures the activity of certain liquid and gaseous samples in the Krško NPP and subsequently carries out special laboratory measurements (determination of H-3, C-14, Sr-89/90). The monitoring also involves the checking of permanent monitoring points in the surroundings of the Krško NPP (air and iodine pumps), measurement of basic radiological parameters (dose rate, surface contamination by beta and gamma radiation, gamma spectrum of unprotected Ge-detector, in-situ gamma measurements) and examination of 1/3 of potential monitoring points on the radiological monitoring map. After each inspection, the monitoring report is prepared.

On 17 April, 1997, Slovenia participated in an international exercise in the series "INEX-2" exercise designed to test the communications and national emergency response plan in the event of nuclear emergency abroad. The exercise scenario details were not known in advance, except for the basic assumption that the nuclear accident was to happen in the Finnish nuclear power plant Loviisa. The whole cycle of exercises "INEX-2" was organised by the Nuclear Energy Agency at the Organisation for Economic Cooperation and Development (OECD/NEA).

In the exercise, the personnel from the Krško NPP participated as official observers and in the group for "media pressure", together with external experts to the expert groups of the SNSA from the Hydrometeorological Institute (HMZ), EIMV, JSI, University of Maribor - Faculty of Mechanical Engineering (FS), Elektrogospodarstvo Slovenije and the RS Institute for Occupational Health.

The purpose of the exercise was to test: the response of IAEA in the event of nuclear emergency; communication between various authorities in Slovenia; decision making; public relations and preparation of public statements; dose calculation; situation assessment in a foreign nuclear power plant; notifications in accordance with the bilateral agreements.

Between 24 to 26 June 1997, the exercise "Lage Krško" was carried out in Celovec (Klagenfurt), organized by experts from the Austrian Ministry of the Interior, the

Chancellor's Office - Department for Radiological protection and from the Seibersdorf Research Centre near Vienna. The purpose of the exercise was to test decision making in the affected federal state (i.e. Carinthia) in the event of a nuclear accident at the Krško NPP.
On 26 November 1997, the desk-top exercise NEK-97 was held with participants from the Krško NPP, national Civil Protection Headquarters, regional Civil Protection Headquarters, communal Civil Protection Headquarters of Krško and Brežice, and the SNSA.
The exercise NEK-97 was designed as a staff exercise in two parts, with discussion by the participants following each part. It was intended to enable senior staff to test the management and control in the event of emergency, and the participants were required to act out and simulate certain situations and responses. The exercise proceeded in a shorter time-frame than it would in reality, i.e. both parts of the exercise proceeded, as a rough estimate, 1.5 times faster than they would in reality, and it was, therefore, extremely demanding for the participants. The participants also brought with them all the necessary material for the exercise (plans, documentation, official forms).

Chapter 13: TECHNICAL SUPPORT ORGANIZATIONS

According to Article 14 of the Act on Implementing Protection against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off. Gaz. SRS, No. 28/80) technical and research organizations were authorized by the Republic Committee for Energy, Industry and Construction, or by SNSA as its legal successor, with a decree to perform specific tasks within their activities and qualifications in the field of nuclear and radiation safety in the Republic of Slovenia.
Technical support organizations represent a vital part in monitoring operations, backfitting, introducing improvements and monitoring maintenance work on nuclear facilities. The work of technical support organisations is supplemental to the work of the Nuclear Safety Inspection Division which has insufficient manpower to cover all the activities in the nuclear facilities related to nuclear safety.
The report by the technical support organisations shows that the major part of their engagement involves surveillance of annual outage and refuellings. With the replacement of steam generators the duration of annual outage will be shorter, and the Inspectorate and the technical support organisations should be prepared accordingly. The shorter outage will require better planning of surveillance activities and even better coordination and co-operation between the Krško NPP, the Inspectorate and the technical support organizations.
The report also shows that technical support organizations take care of the regular training of their personnel in the fields within their responsibility. One vital part is the organisation of quality assurance, verified also by the SNSA. Some of technical support organizations are taking steps to acquire an ISO certificate or accreditation for their laboratories.

Chapter 14: RESEARCH PROJECTS AND STUDIES

In the budget year 1997, the SNSA financed and co-financed 15 research projects and analyses to support safety decision making, and other development projects. The exception is the expert report on the review of the probabilistic safety assessment study, which was fully financed by the Krško NPP.

Chapter 15: AGENCY FOR RADWASTE MANAGEMENT (ARAO)

Two documents, crucial for long-term radwaste management, were adopted in 1996; these documents guided the work of ARAO in 1997. They were: The Strategy for Spent Nuclear Fuel Management and The Decommissioning Plan for the Krško NPP. Both documents are to be reviewed and supplemented every three years.

The most important operational task of ARAO is to construct the repository for low and intermediate level (LILW) radioactive waste. According to the present scenario, the site for the repository should be selected by the year 2002, and the repository constructed by the year 2005.

Additionally, according to the new Rules of Procedure adopted in 1997, one of the tasks of ARAO is to provide public service in radioactive waste management, storing (except for radioactive waste from the Krško NPP and the Žirovski vrh Mine) and disposal (except for the Žirovski vrh Mine) in the Republic of Slovenia.

The working programme for 1997 was adapted to the objectives and tasks from the above memtioned documents, however, due to insufficient funds from the national budget it was not fully realised. Because of the prolonged temporary funding and late adoption of the 1997 national budget, the contracts with technical support organisations were concluded relatively late. Consequently, a number of projects in the programme have not yet been finished, and will be completed only in 1998.

For objective reasons the planned reconstruction of radwaste storage at Zavratec (phase 2) was not carried out. There were, however, certain parallel activities, e.g. public relations activities. Special attention was given to the local communities at Zavratec and Dol-pri-Ljubljani.

The cooperation with local community representatives and local community members of Dol-pri-Ljubljani was multilevel. Among other things, ARAO demonstrated to the Community Council members the progress of remedial action on the temporary radioactive waste storage at Zavratec.

In the scope of LILW siting, the ARAO also took responsibility for management of the interim LILW storage at Podgorica. However, certain circumstances have entailed that transfer of the management function from JSI to ARAO has not yet been carried out. In the preparation framework for management function transfer a study has been prepared entitled: The interim LILW storage of RS - the legal aspects of transfer and the future relationship between JSI and ARAO. The call for tenders for the reorganisation (modernisation) project of the storage has so far been unsuccessful, therefore, the call for tender is to be issued again in 1998. The achievement of the said objectives is to be facilitated by two decisions, at present in preparation at the SNSA. One of the decisions is on modernisation of the repository at Podgorica, and the second one on the removal of radwaste from Zavratec to repositary at Podgorica.

Chapter 16: THE MILAN ČOPIČ NUCLEAR TRAINING CENTRE

The primary concern of the Milan Čopič Nuclear Training Centre (ICJT) is the training of personnel in nuclear technologies and ionizing radiation and providing public information on these activities. The four main areas of activity of the Centre are: the training of the Krško NPP personnel, training activity in the field of radiological protection, organisation of international courses and meetings in the field, and public information.

In 1997 they organised two shorter courses entitled Basics of Nuclear Reactor Technology for the Krško NPP technical personnel. One of them was also offered to other institutions working for the Krško NPP. They also organised four operator retraining courses.

In the field of radiological protection in 1997 they carried out altogether 5 courses for medical personnel, for workers on the industrial application of ionizing radiation, and for JSI personnel.

The year 1997 brought important developments in the organisation of international courses. IAEA organised eight courses at the Centre. The majority were one-week courses; one course lasted two weeks, and the major course three months. In addition, the European Commission organised its first course at the Centre.

In the field of public information they continued to invite elementary and high schools; the students came regularly and in great numbers to hear lectures on nuclear technology and radioactive waste and to visit the permament exhibition. In the school year 1996/97 they had altogether 6717 visiting students.

A feasibility study was carried out on the nuclear technology information centre at the Milan Čopič Nuclear Training Centre, commissioned by ARAO.

Chapter 17: INSURANCE AND REINSURANCE OF LIABILITY FOR NUCLEAR DAMAGE - POOL

The pool for insurance and reinsurance of nuclear damage risk GIZ (Nuclear pool GIZ) is the special legal form of an insurance company for insurance and reinsurance against nuclear damage risk. After the declaration of independence in Slovenia and Croatia the Nuclear pool GIZ and the Croatian nuclear pool agreed to co-insure the Krško NPP in equal shares of 50% in order to retain a good business relationship. For the period from 6 May 1997 to 5 May 1998, both pools issued insurance policies covering nuclear, fire and other risks to the property of the Krško NPP, with a total annual limit of 800 million USD. By the Act on Insurance of Liability for Nuclear Damage (Off.Gaz. SRS, 2/88, 6/89, 6/90 and Off.Gaz. RS, 43/90 and 22/91) a limit of 5 million USD in SIT (Slovenian tolars) countervalue has been established. The liability amount is based on the 1963 Vienna Convention on Civil Liability for Nuclear Damage; however, it is expected that the liability amount will increase significantly in the coming years, but this fact should not cause any insurance problem.

It is noteworthy that, up to the end of 1997, the Krško NPP did not report any damage to the Nuclear pool GIZ.

Chapter 18: POOL FOR DECOMMISSIONING OF THE KRŠKO NPP AND FOR RADWASTE DISPOSAL FROM THE KRŠKO NPP

The Pool was established in conformity with the "Act on Pool for Decommissioning of the Krško NPP and for Radwaste Disposal from the Krško NPP" (Off. Gaz. RS, No. 75/94; in force from 17 December 1994; hereinafter called "the Act") with the purpose of raising funds for the decommissioning of the Krško NPP, and for storage and permanent disposal of low and intermediate level radioactive waste and spent fuel from the Krško NPP.

Due to outstanding payments of the Krško NPP to the Pool on 31 December 1996, the Pool instituted proceedings against the Krško NPP before the Krško district court. The proceedings ended on 12 May 1997 with an out-of-court arrangement in which the Krško NPP committed itself to paying, as of 1 January 1997, on the outstanding 1996 liabilities to the Pool the amount of 0.61 SIT/kWh until the outstanding amount of 6,581,943 SIT was settled. The rough estimate for settlement of the liabilities is 12 years.

In the following months of 1997, the Krško NPP paid to the Pool the amounts from the produced electrical energy supplied to the ELES on the respective maturity dates. The statement of account was prepared also for the Croatian co-owner; however, Croatia does not acknowledge the abovementioned methodology of raising funds from the per kWh price and, consequently, does not pay its share. Furthermore, Croatia has not yet given any guarantees to ensure its share of costs for decommissioning and radwaste disposal.

On 31 December 1997, the active assets of the Pool amounted to 898,778,210 SIT; the long-term receivables totalled 8,645,093,587 SIT, of which the Slovenian debt was 3,796,438,124 SIT and the respective Croatian debt 4,848,655,463 SIT.

The free resources of the Pool will mainly be invested in first-class securities and deposits. The aim of this investment policy is to maintain the real value of investments and profitability. Of the three financial principles directing the Pool operation - the principles of safety, liquidity and profitability - the principle of safety has top priority.

Chapter 19: OPERATION OF NUCLEAR FACILITIES WORLD-WIDE

According to the information provided by the International Atomic Energy Agency, at the end of 1997, there were 437 nuclear power plants in operation in 31 countries and in Taiwan. The number decreased by five in comparison with 1996; however, the overall nuclear capacity slightly increased, from 350,964 MW to 351,795 MW. Some older and smaller nuclear power plants were shut down. In 1997, there were three new nuclear power plants connected to the grid with a total power of 3555 MW, two in France and one in the Republic of Korea. At present, 36 nuclear power plants are under construction in 14 countries.

In 1997, the share of electrical energy supplied from nuclear power plants was still considerably high in ten countries: Lithuania 81.5%, France 78.2%, Belgium 60.1%, Ukraine 46.8%, Sweden 46.2%, Bulgaria 45.4%, Slovak Republic 44%, Switzerland 40.6%, and in Hungary and Slovenia a little below 40%. Slovenia with 39.9% share of produced electrical energy ranks in 9th place. In general, there are 17 countries world-wide and Taiwan, which rely 25% or more of their needs upon electrical energy produced from nuclear power plants. In 1997, the share of electricity supplied by nuclear reactors world-wide was about 17%.

1 INTRODUCTION

The present report is one of the regular forms of informing the Government and the National Assembly of the Republic of Slovenia on the state of nuclear safety in our country. The report is likewise intended for both the professional and the general public as it summarizes the state of affairs as well as activities in the widest possible segment of this domain.

Therefore the report is not only a general survey of the work of the Slovenian Nuclear Safety Administration, but also endeavours to include the activities of other administrative authorities, agencies, institutes and organizations whose field of work is more or less involved with the issues of nuclear or radiation safety.

The copious volume of the report is the result of the fact, that on one hand, it pursues the ambition to provide as far as possible complete and thereby correct information on the present conditions in the field of nuclear and radiation safety, while on the other hand the pursuit of this very aim may create the danger that we would be unable to include all of the data and that the report would, in spite of its copiousness, prove to be inadequate.

For anyone who might wish to get acquainted with the report in a more concise form, there is a summary covering the most important data acquired and the descriptions of the present conditions.

And finally, a word about our expectations. The elaboration of such a report is a demanding and responsible task. We look forward to receiving your opinion and an assessment of its quality. Any remarks and proposals received in the period before we draw up the 1998 report will be considered and reflected in our future work.

2 STRUCTURE OF THE SNSA AND ITS SCOPE OF COMPETENCE

2.1 INTRODUCTION

In Article 11 paragraph 6 of the Act on Organization and Competencies of Ministries (Off. Gaz. RS, No. 71/94 and 47/97), the scope of competence of the SNSA is defined as follows:

"The Slovenian Nuclear Safety Administration performs administrative and technical tasks related to nuclear and radiation safety of nuclear facilities; to trade, transport and handling of nuclear and radioactive materials; to safeguards and inventory of radioactive materials; to physical protection of nuclear materials and nuclear facilities; to liability for nuclear damage; to professional qualifications of operators of nuclear facilities and their training; to quality assurance in this field; to provision of radiation monitoring; to provision of radiation early warning system in case of nuclear or radiation accidents; to international co-operation in the field of administration and to other tasks specified by regulations; supervision of laws and other rules and regulations governing the domain of nuclear safety."

In addition to the above Act, the legal basis for the administrative and professional tasks in the field of nuclear and radiation safety as well as inspection control of nuclear facilities is also provided by the Government of the Republic of Slovenia Act (Off. Gaz. RS, No. 4/93, 23/96 and 47/97), the Administration Act (Off. Gaz. RS, No. 67/94 and 20/95), Act on Ionizing Radiation Protection and Special Safety Measures in Use of Nuclear Energy (Off. Gaz. SFRY, No. 62/84), Article 4 of the Constitutional Act for Implementation of the Basic Constitutional Charter on the Independence and Sovereignty of the Republic of Slovenia (Off. Gaz. RS, No. 1/91-I), Act on Ionizing Radiation Protection and on Nuclear Facilities and Equipment Safety Measures (Off. Gaz. SRS, No. 82/80) as well as by-laws and rules and regulations based on the above acts and the ratified and published international agreements in the field of nuclear energy and nuclear and radiation safety.

2.2 STRUCTURE OF THE SNSA AND ITS COMPETENCIES

The SNSA is one of the authorities within the Ministry of Environment and Physical Planning. According to the Rules of Internal Organization and Job Systematization, the SNSA consists of five divisions:

Nuclear Safety Inspection Division

The Nuclear Safety Inspection Division is responsible for control of nuclear and radiation safety in the Krško NPP, the Reactor Centre at Podgorica (Research Reactor TRIGA Mark II and the interim radwaste storage for small users), the Žirovski vrh Mine and the temporary radwaste storage at Zavratec.

The Nuclear Safety Inspection Division performs routine (planned) and non-routine (unplanned) inspections in the above facilities. In the last year, over 120 inspections were performed in the Krško NPP itself.

Areas of inspection in the Krško NPP:

- operation;
- radiation monitoring;
- maintenance and control testing;
- emergency preparedness;
- physical protection;
- engineering and training;
- quality assurance and safety assessment;
- other activities.

The employees also participate in the IAEA programme International Nuclear Event System (INES) and, within the framework of the OECD/NEA, in organization and execution of exercises for the case of a nuclear accident (INEX).

Nuclear Safety Division

Its responsibilities are as follows:

- conducting of administration procedures and issue of approvals related to modifications of the facilities;
- safety analyses (deterministic and probabilistic);
- analyses of events and operating experience;
- assessment and decision-making on nuclear safety issues;
- reporting on the state of nuclear safety;
- in case of an nuclear accident event, activation of an expert team for nuclear accident analysis.

Priorities:

- in modernization of the Krško NPP (replacement of steam generators, power up-rate, the NPP simulator, and other modifications), particular emphasis is laid on nuclear safety;
- development and maintenance of the professional base for nuclear safety in Slovenia.

Nuclear and Radioactive Materials Division:

Its responsibilities are as follows:

- control of the inventory of nuclear materials;
- trade, transport and handling of nuclear and radioactive materials (issue of export and import licences);

- physical protection of nuclear materials and nuclear facilities (Krško NPP, the Jožef Stefan Institute, the Žirovski vrh Mine, Zavratec);
- storage and disposal of radioactive waste;
- return of spent nuclear fuel from the TRIGA Research Reactor to the USA;
- decommissioning of nuclear facilities and remediation of the site.

This division also participates in:
- monitoring of seismic safety of nuclear facilities;
- planning of measures in case of an accident event in the nuclear facility; and
- serves as a contact point in the IAEA programme against illegal trade in nuclear and radioactive materials.

Radiation Safety Division

The Radiation Safety Division is responsible for the tasks related to radiation safety of workers in nuclear facilities and safety of the population in the vicinity of nuclear facilities. Due to the professional qualifications of its personnel this Division is also active, within the framework of its activities, in a more extensive area of radiation safety together with the Slovenian Health Inspectorate.

The responsibilities of the Division are as follows:
- collection of data on exposure of workers and maintenance of dosimetric records for workers in nuclear facilities (Krško NPP, TRIGA Research Reactor);
- development and approval of the radiation monitoring programme in the vicinity of nuclear facilities and monitoring of data on exposure of the population in the natural environment as well as collection of data on radiation exposure of the population in environments with increased radioactivity;
- establishment and maintenance of Radiation Early Warning System in case of an nuclear accident or radiological event in Slovenia and across the national borders;
- real-time monitoring of gamma radiation level in the environment, both in the entire territory of Slovenia and in the close vicinity of nuclear facilities, and real-time transfer of data to the Internet;
- in case of an unusual event, formation of an expert team for estimation of doses received by the affected population, and to plan and propose the safety measures;
- co-operation with the IAEA, the EU Commission and the OECD/NEA in exchange of information in the field of radiation safety.

Legal and International Co-operation Division

Its duties and responsibilities comprised:

- personnel issues;
- budgetary control;
- co-operation with the ministries, the Government and the National Assembly;

- participation in the process of publishing of administrative acts;
- organization and conduct of meetings of the Expert Commission for Operators Exams and the Nuclear Safety Technical Commission;
- provision of information to the public;
- co-operation with the IAEA, the OECD/NEA, the EU, participation and coordination in elaboration and implementation of multilateral and bilateral agreements;
- co-operation with foreign administrative authorities in the field of nuclear and radiation safety;
- following of international recommendations in the administrative area (the EU directives, the IAEA regulations, ICRP...).

Priorities:
- preparation of the new Slovenian legislation in the field of nuclear and radiation safety;
- preparation of the relevant regulations (Rules of Procedure);
- harmonisation of the domestic legislation with the EU legislation.

2.3 ORGANIZATION SCHEME OF THE SNSA AND EMPLOYMENT POLICY

On 1 January 1997, the SNSA had 30 employees; over the year, five more were employed, of which four as temporarily employed trainees and one as a permanently employed advisor. In 1997, three employees left the SNSA.

As a consequence, on 31 December 1997 there were 32 employees at our Administration. The applicable Rules of Organization and Systematization envisages 48 permanent jobs and 6 trainee workposts.

The 32 employees had the following professional qualifications: there were 12 Masters of Science, 17 Bachelors of Science, 1 employee with a college degree and 2 employees with secondary education.

The structure of employees on the last day of the year was as follows: the director, 19 senior civil servants, 5 civil servants, 3 members of technical staff and 4 trainees for civil servants.

As earlier, the SNSA endeavoured to secure, in accordance with the budgetary funds, as many experts as possible; financing new employment, however, represents a problem since each expert requires special training and regular participation in courses, workshops and seminars.

With the purpose of preventing additional employment, the governmental decision issued in July considerably limited the growth of the number of employees.

We are fully aware that the number of experts employed at our Administration is far from adequate, since international recommendations are much more demanding (80 to

100 experts): In 1993, the EU RAMG mission recommended to the Government and the National Assembly that 40 experts should be employed.

In addition to the fact that all the employees at the SNSA have passed the civil service examination, several of them (among others, naturally, all the inspectors) have participated in special courses and passed corresponding examinations within the scope of basic and advanced training programme of the U.S. Nuclear Regulatory Commission as well as the courses and examinations on the corresponding U.S. simulators (a copy of a nuclear power plant control room); all the junior and senior civil servants have a working knowledge of a foreign language (English).

2.4 EDUCATION AND TRAINING

Just as before, so too in this year the SNSA paid particular attention to the professional training of its employees.

The Rules of Internal Organization and Job Systematization of the SNSA require that the employees pass the state examination which is a prerequisite for civil service. Out of 32 senior and junior civil servants and technical personnel, 26 have already passed the examination, while out of the remaining six employees two will pass it in the beginning of 1998, and the four trainees will have it after completion of their traineeship.

In 1997, special emphasis was given to computer training and language courses; nevertheless, the major part of the training was focused on nuclear safety and radiation protection.

Three of the employees completed a six-weeks' course in "Basic of Nuclear Technology" at the Milan Čopič Training Centre; seven employees successfully completed a course in "Radiation Protection III" and one of them in "Radiation Safety for Open Sources of Ionizing Radiation". In March, one of the employees participated in a week's course in "Professional Management of Library Materials".

Three employees completed an English course, one a German course and two of them a computer course.

Six employees pursue off-the-job post-graduate studies in the following institutions:

University of Ljubljana:

- Faculty of Mathematics and Physics, Department of Physics: reactor engineering;
- Faculty of Mathematics and Physics, Department of Physics: nuclear technology; course: radioecology and radiation safety;
- Faculty of Mathematics and Physics, Department of Physics: reactor engineering; course: reactor and its core;

- Faculty of Civil Engineering and Geodesy: interdisciplinary study of environmental protection, topical course: geotechnology and environment (in co-operation with the Faculty of Natural Sciences, Department of Geology);
- Faculty of Mechanical Engineering: structural mechanics, course: operating strength of machine parts, fracture mechanics and friction processes.

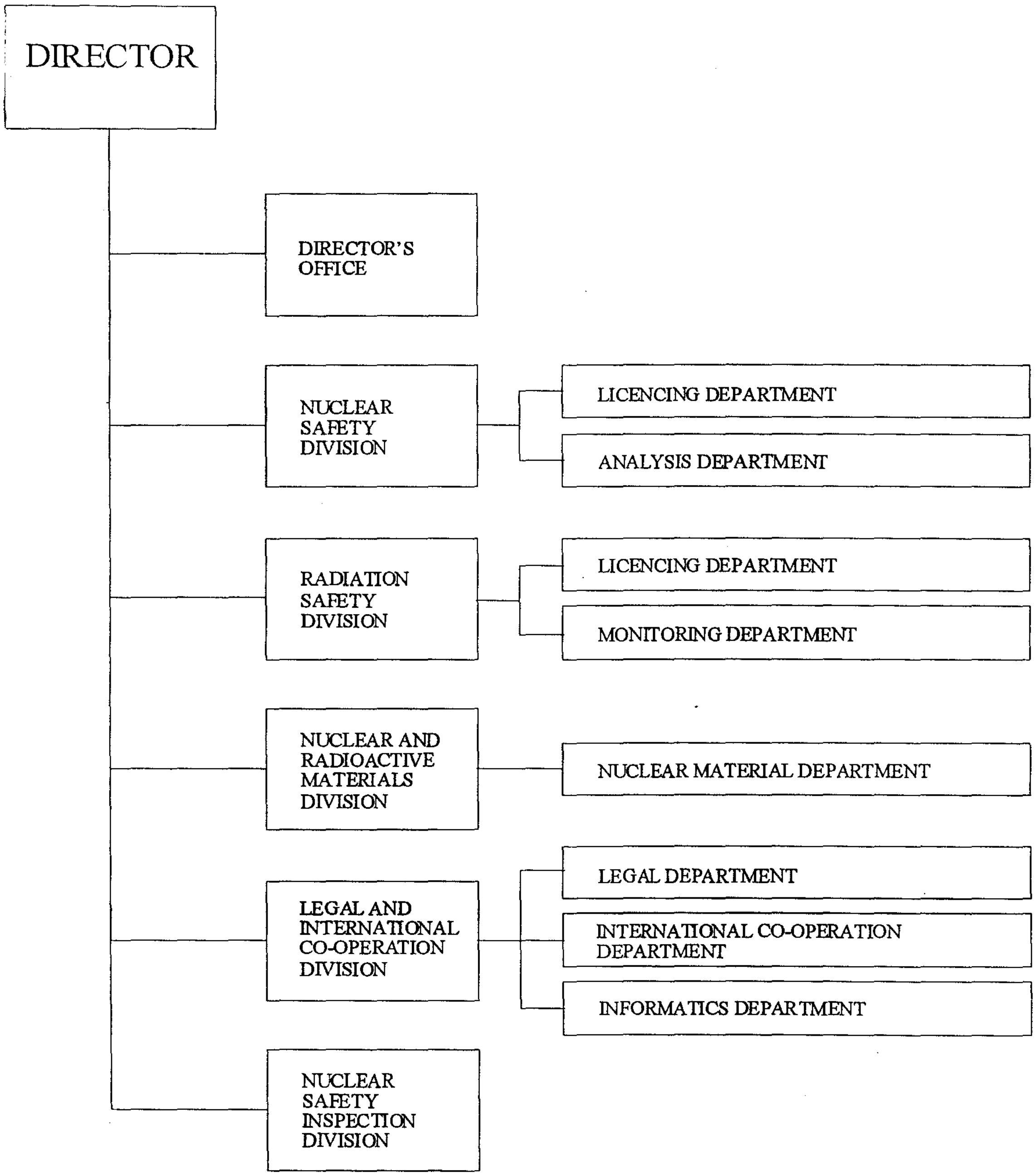
University of Maribor:
- Faculty of Civil Engineering: nuclear energy.

Since the scope of work of the SNSA is in the process of continuous development, much of the training and education was carried out abroad (see item 4.1.4.1 of the present report).

Table 2.1: Total number of employees at the SNSA (December 1997)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Number of employees	5	7	9	11	16	18	20	26	30	32

Figure 2.1: ORGANIZATION CHART OF SNSA



3 LEGISLATION IN THE FIELD OF NUCLEAR SAFETY

3.1 LEGISLATION

Nuclear and radiation safety and the measures for their assurance are defined in the Act on Radiation Protection and the Safe Use of Nuclear Energy (Off. Gaz. SFRY, No. 62/84) and in the Act on Implementing Protection against Ionizing Radiation and on the Measures for the Safety of Nuclear Facilities (Off. Gaz. SRS, No. 28/80). The liability for nuclear damage and its insurance are governed by the Act on Liability for Nuclear Damage (Off. Gaz. SFRY, No. 22/78 and 34/79) and the Act on Insurance of Liability for Nuclear Damage (Off. Gaz. SRS, No. 12/80) as well as by the relevant decisions on determination of the liability amount and on insurance of the amount . Work on preparation of the new Slovene legislation in this field is largely conditioned by international agreements; the status of the international agreements in 1997 was as follows:

- within the framework of the International Atomic Energy Agency, the Standing Committee on Liability for Nuclear Damage drew up the Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage as well as the Convention on Supplementary Funding for Nuclear Damage. Both documents were adopted at the Diplomatic Conference held in Vienna in September 1997 (see Item 3.2 of the present report);

- the translation of the Basic International Safety Standards for Ionizing Radiation Protection and Radiation Sources Safety (BSS), which were internally adopted by all the participating international organizations in the process of their formulation, was revised in 1997; however, certain inadequacies in the text were subsequently eliminated. Due to lack of funds also in 1997 the publication of the Slovenian translation was not yet feasible. The BSS is the reference material to be used in the elaboration and revision of the relevant rules in the field of radiation safety;

- in September, the Joint Convention on Safety of Spent Fuel Management and on Safety of Radioactive Waste Management was adopted by the Vienna Diplomatic Conference in which the Slovenian delegation took part as well (see Item 3.2 of the present report);

- in 1996, the National Assembly ratified the Convention on Nuclear Safety (Off. Gaz. RS, MP, No. 16/96), whose binding provisions likewise serve as the basis for legislation elaboration; the Convention came into force for Slovenia in February 1997 (see Item 3.2 of the present report).

3.2 INTERNATIONAL AGREEMENTS

3.2.1 BILATERAL AGREEMENTS

- **The Agreement between the Republic of Slovenia and the Republic of Austria for the Early Exchange of Information in the Event of Radiological Emergency and for the Questions Referring to the Field of Nuclear Safety and Radiation Protection**

The Agreement was ratified by the National Assembly on 1 October 1996 and published in the Off. Gaz. RS, MP No. 15/96. By the end of 1997, Austria had not yet ratified the Agreement.

Within the framework of preparations for the conclusion of a bilateral agreement with Croatia, significant progress was achieved. **The Agreement between the Republic of Croatia and the Republic of Slovenia for the Early Exchange of Information in the Event of Radiological Emergency** was initiated by both heads of delegations at the second round of negotiations in Zagreb in November 1997.

The text of the Agreement was proofread by the Commission for Translations and Editing within the Slovenian Foreign Ministry. At its December session, the Government of Slovenia considered the report on the completed negotiations for conclusion of the said Agreement and issued a decision in which Dr. Pavle Gantar, Minister of Environment and Physical Planning, was authorized to sign the Agreement.

The Agreement serves to upgrade the warning regulative system by way of conventions in the event of radiological emergency, and to put in concrete terms the bilateral exchange of information, with emphasis on the fact that two neighbouring countries are involved. The Agreement establishes focal points available 24 hours a day, which are, together with the competent authorities, responsible for receiving and forwarding information in the event of radiological emergency.

- In the field of early warning in case of radiological emergency between **Italy** and Slovenia, no significant progress was noted in 1997; the first informal relevant activities, however, were initiated or continued between Slovenia and the **Czech Republic, Slovak Republic, France, South Africa and South Korea** (concerning the exchange of information and co-operation in the field of nuclear safety).

In connection with these informal contacts, the SNSA plans to introduce formal initiatives for conclusion of agreements in the governmental proceedings and to initiate the procedure for acquisition of a power of attorney for negotiations.

The Agreement between the Republic of Slovenia and the IAEA on the Safeguards in connection with the Non-Proliferation Treaty, signed on 29 September 1995 in Ljubljana, was ratified by the National Assembly at its session on 26 June 1997 and published in the Off. Gaz. RS, MP No. 11/97.

- **Additional Protocol to the Agreement on the Safeguards in connection with the Non-Proliferation Treaty**

In order to prevent further uncontrolled proliferation of nuclear technology and its abuse for the purpose of manufacture of nuclear weapons, the Board of Governers of the IAEA established a special committee with the task of developing a model protocol to the Safeguards Agreement . On this basis, the IAEA drew up the Additional Protocol to the Agreement on the Safeguards in connection with the Non-Proliferation Treaty and appealed to the countries which have concluded agreements on the safeguarding of nuclear materials to inform them whether they were willing to adopt the text of the Additional Protocol. The initiative for adoption of the Additional Protocol was subjected to governmental procedure. Due to some diversities in the process of co-ordination with the Ministry of Finance, the Additional Protocol has not yet been taken under consideration by the Government.

Since the Republic of Slovenia concluded all of the said bilateral agreements with other countries or authorities as a sovereign state, they do not represent the inheritance of the former SFRY.

The Comprehensive Nuclear-Test-Ban Treaty (CTBT)

At the initiative of the international community, The Comprehensive Nuclear-Test-Ban Treaty was drawn up and, by the end of 1997, signed by 146 states, among them Slovenia (in September 1996). The Treaty was ratified by only a small number of states (7). The CTBT will come into force as a legal instrument only after it has been ratified by 44 states, among others by all the states in possession of nuclear weapons. In Slovenia the procedure of ratification with the Foreign Ministry, initiated by the SNSA, is under way. A working translation has been made and is ready for proof-reading. It is expected to be submitted for consideration to the National Assembly in mid-1998.

With the purpose of implementing the provisions of the Treaty, a Preparatory Commission for establishment of the international Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) was established at the seat of international organizations in Vienna. The work of the Commission is financed from contributions by the states-signatories of the CTBT. Slovenia pays its contributions regularly. The 1997 contribution amounted to approx. USD 20,000 .

3.2.2 MULTILATERAL AGREEMENTS

- **Convention on Nuclear Safety**

The Convention came into force as an international legal instrument on 24 October 1996 and was ratified by the National Assembly on 1 October 1996. Since Slovenia deposited the instrument of ratification with the general director of the IAEA on 20 November 1996, it came into force for Slovenia -in accordance with the provisions of the Convention - on 18 February 1997.

In accordance with Article 21 of the Convention, a preparatory meeting of the Contracting Parties to the Convention on Nuclear Safety was held in Vienna in April 1997. At this meeting, the delegations of the member states:

- approved the Rules of Procedure and the Financial Rules;
- adopted the Guidelines on the form and structure of the reports to be submitted according to Article 5 of the Convention;
- determined the procedure of reviewing of the reports; and
- set the date of the first review meeting (12 April 1998) and the date for submission of reports (29 September 1999) when the so-called organizatorial meeting of the Contracting Parties for preparation of the review meeting is to take place.

- Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage
and
Convention on Supplementary Funding for Nuclear Damage

At the diplomatic conference held from 8 to 12 September 1997 in Vienna, the representatives of Slovenia signed the "Final Act" relating to the above Protocol and Convention.

In considering the report on progress of the diplomatic conference on adoption of the Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage and the Convention on Supplementary Funding for Nuclear Damage, the Government of Slovenia, at its session on 20 November 1997 passed a resolution to entrust the Ministry of Environment and Physical Planning (the SNSA) in co-operation with the Ministry of Foreign Affairs to take all the necessary actions for accession to the Paris Convention and the Brussels Additional Protocol.

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

The Joint Convention was adopted at a diplomatic conference within the IAEA, held from 1 to 5 September 1997. Slovenia signed this document during the 41st session of the General Conference of the IAEA in October 1997.

At its session on 20 November 1997, the Government of Slovenia considered the report on the progress of the diplomatic conference and approved it. In that way the first activities to ratify the Joint Convention (such as proof-reading of the adopted text of the Joint Convention) were launched in 1997.

4 INTERNATIONAL CO-OPERATION

4.1 COOPERATION WITH IAEA

4.1.1 GENERAL

The IAEA is an independent international organisation, established in 1957 by decision of the General Assembly of the United Nations Organisation. Among the functions of the IAEA, defined in the IAEA Statute, the following are included: to broaden and increase the contribution of nuclear energy to peace, health and progress in the world; and, in particular, to promote research and development in the field of the peaceful use of nuclear energy; to exchange scientific and technical information; to establish and maintain control over nuclear materials; and to prepare and adopt health and safety standards for the use of nuclear energy.

4.1.2 GENERAL CONFERENCE

The General Conference is the supreme body of the IAEA. It meets once a year - usually in September. At its 41st session, held in Vienna between 29 September and 3 October 1997, Slovenia was represented by a delegation including representatives of the SNSA, the Slovenian Embassy in Vienna, the Ministry of Economic Affairs and the Jozef Stefan Institute.

The strong endeavours of Slovenia to become a member of the Board of Governors were accomplished at the 41st session of the General Conference, when Slovenia was elected to the Board of Governors for the period 1997 - 1999. At the same session the General Conference adopted 24 resolutions covering the following issues:

- measures to strengthen international co-operation in nuclear, radiation and waste safety;
- promotion of further research and use of nuclear waste control systems, and establishemt of wider regional areas without nuclear weapons;
- use of nuclear energy for peaceful purposes in the fields of health, agriculture and industry;
- IAEA activities in the Near East and Iraq (on adoption of this resolution Iraq required voting) and also in the PDR Korea, when voting was required by China;
- ban on trade in nuclear material.

Several items on the agenda traditionally refer to the financial operations of the IAEA. Within their scope the following documents were approved:

- Agency's Accounts for 1996;
- Agency's Budget for 1998 (USD 222 million);
- Financing of Technical Co-operation Fund (USD 71.5 million).

The financial contribution of the Republic of Slovenia to the IAEA budget for 1998 is as follows:

- contribution to Regular Budget: USD 20,036 and ATS 1,695,601;

voluntary contribution to the Technical Co-operation Fund: USD 50,050 (payable in Slovenian Tolars).

The integral report of the Slovenian delegation at the 41st session of the General Conference was approved by the Slovenian Government at its 32nd session on 11 November 1997.

4.1.3 BOARD OF GOVERNORS

The Board of Governors meets four times a year at three regular sessions and at an extraordinary session before the session of the General Conference. Until the last session of the General Conference Slovenia participated as an observer at the sessions of the Board of Governors. At the first session of the Board of Governors after the General Conference in a new composition on 6 October 1997 and at the next session held on 8 December 1997, Slovenia for the first time participated as a member state, elected in the Eastern European regional group. Slovenia is represented in the Board of Governors by Miroslav Gregorič, M.Sc., Director of the SNSA, and there are also three deputies appointed.

4.1.4 TECHNICAL ASSISTANCE AND COOPERATION

Also in 1997, the cooperation between our country and the IAEA was most intensive in the area of technical assistance and cooperation.

4.1.4.1 Seminars, Courses and Workshops, organised by the IAEA

The SNSA personnel sucessfully participated in various forms of cooperation and training, i.e. seminars, courses and workshops, organised by the IAEA itself, or jointly with other similar organisations. These included:

- IC "Low Doses of Ionizing Radiation", Sevilla, Spain, 17 November - 21 November 1997;
- International Training Course (ITC) on Technical and Administrative Preparations Required for Shipment of RR Fuel to its Country of Origin, Argonne, USA, 11 January - 14 January 1997;
- IC on Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operations, Vienna, 10 November - 14 November 1997;
- ITC on Physical Protection of Nuclear Facilities and Materials, Albuquerque, New Mexico, 13 April - 1 May 1997;
- RTC on Decontamination and Decommissioning of RRs and Other Small Nuclear Facilities, Bucharest, Romania, 9 June - 20 June 1997;
- Symposium on International Safeguards, Vienna, 13 October - 17 October 1997;
- OSART Mission to Qinshan NPP in China, Qinshan, China, 13 January - 31 January 1997;
- Public Information Seminar on Nuclear Energy, Zagreb, 25 March - 27 March 1997;
- TCM - Annual Meeting of the IRS National Co-ordinators, Vienna, 26 May - 30 May 1997;
- Regional Regulatory Workshop on Periodic Safety Review of NPPs, Budapest, 23 June - 27 June 1997;
- Ministerial Level Meeting, Vienna, 23 October - 24 October 1997;
- TCM on Advances in Safety Related Maintenance, Vienna, 15 September - 19 September 1997;

- Annual Meeting of the INES National Officers, Vienna, 22 October - 24 October 1997;
- Workshop on Outage Management, Pecs, Hungary, 6 October - 10 October 1997;
- Regional Workshop on Nuclear Safety Regulatory and Legislative Infrastructure, Review of Incidents, Prague, Czech Republic, 20 October - 24 October 1997;
- RTC on Safety Analysis of NPPs during Low Power and Shutdown Conditions, Vienna, 1 December - 5 December 1997;
- Regional Workshop for Utilities on Periodic Safety Review of NPPs, Dukovany, Czech Republic, 13 October - 16 October 1997;
- A Meeting for the Country Co-ordinators for the Projects RER/9/046, RER/9/047, RER/9/052, Vienna, 16 December - 17 December 1997.

In some of the above-mentioned courses and seminars, and also in many others organised by the IAEA, experts from the following organisations participated: the JSI, the Krško NPP, the University Medical Center, the Žirovski vrh Mine, the ARAO, the Institute of Occupational Safety, etc. The IAEA organised altogether 118 courses, seminars, workshops, symposia and conferences. The SNSA kept the interested institutions and organisations from Slovenia informed on these meetings, and forwarded registration forms for the meetings to the IAEA.

Experts from the SNSA and also from other organisations attended the following ten meetings, organised by the IAEA in cooperation with our country, i.e. with the JSI - the Milan Čopič Training Center, and the University Medical Center - the Institute of Nuclear Medicine:

- ITC on Nuclear Instrument Maintenance, with JSI, Milan Čopič Training Center, Ljubljana, 7 April - 27 June 1997;
- TCM on International Task Force on NPP Diagnostics, with JSI, Milan Čopič Training Center, Portorož, 23 June 1997;
- Regulatory Assessment of the Safety Report for SG Replacement at the Krško NPP, with JSI, Milan Čopič Training Center, Ljubljana, 23 June - 24 June 1997;
- Training Course on Inspection Technique, with JSI, Milan Čopič Training Center, Ljubljana, 16 June - 20 June 1997;
- Regional Training Workshop on IAEA Guidance on Developing an Effective Emergency Capability and Plan for Nuclear or Radiation Accidents, with JSI, Milan Čopič Training Center, Ljubljana, 30 June - 11 July 1997;
- PC-Gamma Camera Interfacing Systems and Clinical Software, with University Medical Center, Institute of Nuclear Medicine, 1 September - 12 December 1997;
- Safety Analysis of Plant Modifications, with JSI, Milan Čopič Training Center, Ljubljana, 15 September - 19 September 1997;
- Workshop on Review of Accident Analysis for Emergency Operating Procedures and Accident Management Guidelines for All Types of NPPs, Ljubljana, with JSI, Milan Čopič Training Center, 27 October - 30 October 1997;
- ITC on Risk Based Optimization of Operational Tasks in NPP Operation (SLO/9/004), with JSI, Milan Čopič Training Center, Ljubljana, 6 October - 10 October 1997;
- Consultants' Meeting on Final State of the WIMS-D Library Update Project, organised with JSI, Ljubljana, 3 December - 5 December 1997.

A successful joint organisation of an increasing number of international meetings is a proof of close cooperation between the IAEA and the SNSA.

4.1.4.2 Fellowships and Scientific Visits

Another area of the SNSA-IAEA collaboration within the scope of technical assistance and cooperation covers fellowships and scientific visits. In 1997, we received 39 applications for the training of foreign experts in Slovenia. Two applications out of 39 were implemented in 1997. The following countries sent their applications for the following fields of training:

- Brasil, for a two-week scientific visit in the field of nutritional and health-related environmental studies;
- Bosnia and Herzegovina, for a one-month fellowship in the field of medical physics.

The following fellowships, for which the applications were received in 1996, were completed in 1997:

- Ivory Coast, a one-month fellowship in the field of analytical nuclear physics;
- Bangladesh, a three-month fellowship in the field of nuclear instrumentation, electronics and reactor control;
- Bangladesh, a one-week scientific visit in the field of nuclear instrumentation, electronics and reactor control;
- Pakistan, a one-month scientific visit in the field of analytical nuclear physics.

Also a fellowship, for which the appplication was received already in 1995, was completed:

- Vietnam, a three-month fellowship in the field of nuclear instrumentation, electronics and reactor control.

The applications were addressed to the Jozef Stefan Institute, the Faculty of Mathematics and Physics and to the University Medical Center Ljubljana - the Institute of Nuclear Medicine and the Institute of Oncology.

Training through fellowships and scientific visits is in most cases connected to a certain project of technical assistance. The activities of Slovenia in this field are summarised below.

4.1.4.3 Research Contracts

The framework of technical assistance and cooperation between the SNSA and IAEA covers also the field of reasearch contracts and the financing of major (national) projects.

In 1997, the SNSA submitted to the IAEA 13 research contract proposals with a typical value of approximately USD 5000, of which seven were renewals and five new ones. The majority of research contract renewals or new contract proposals was prepared by the Jozef Stefan Institute, two by the University Medical Center Ljubljana - the Institute of Nuclear Medicine, and one by the Institute of Surface Technology and Optoelectronics.

A new research contract proposal, not yet approved by the IAEA:

- JSI, Department of Reactor Engineering, Review, Analysis and Development of Methodologies for Incident Analysis.

New research contract proposals, already approved by the IAEA:

- University Medical Center, Institute of Nuclear Medicine, Relationship between Viscoureteral Reflux, Pyelonephritis, and Renal Scarring in Children with Urinary Tract Infection in Slovenia, contract amount USD 5000;
- University Medical Center, Institute of Nuclear Medicine, Evaluation of Functional (Bone Spect) and Morphological (CT) Diagnostic Modalities in Patients with Unexplained Back Pain, contract amount USD 5000;
- JSI, Department of Low and Medium Energy Physics, Depth Profiling of Semiconductor Materials by ERDA and RBS£ contract amount USD 5000;
- JSI, Department of Environmental Chemistry, Sources and Flexus of Dissolved Inorganic Carbon at the Sediment Water Interface in the Gulf of Trieste, contract amount USD 4000;
- JSI, Department of Low and Medium Energy Physics, Depth Profiling of Semiconductor Materials by ERDA and RBS, contract amount USD 5000.

Proposals for research contracts renewal, already approved by IAEA:

- JSI, Department of Reactor Engineering, "Allowed Duration of Out-Service Testing and Maintenance - Optimisation of Safety, contract amount USD 5000;
- JSI, Department of Low and Medium Energy Physics, Calculation of Response of Detector Photons from Space Sources, contract amount USD 5000;
- JSI, Department of Environmental Chemistry, Monitoring in Working Environment and Study of Impacts to the Health of Workers at the Šoštanj Thermal Power Station, contract amount USD 5000;
- University Medical Center, Institute of Nuclear Medicine, Evaluation of Acquisition Module for Gamma Camera and Clinical Software", contract amount USD 3000;
- Institute of Surface Technology and Optoelectronics, Experimental and Theoretical Research of Atom Movement in Thin Surfaces, contract amount USD 5000;
- JSI, Department of Reactor Engineering, Collection and Classification of Data on Human Reliability, contract amount USD 1000;
- University Medical Center, Institute of Nuclear Medicine, PC- Gamma Camera Interface and Clinical Software Development, contract amount: USD 5000 on renewal and USD 5000 USD after conclusion of the project.

The following proposal was sent to IAEA already in 1996; however, it has not yet been approved:

- JSI, Department of Thin Films and Surfaces, Improvement of Surfaces with PVD Hard Protective Coatings, Deposited at High and Low Temperature.

Successfully concluded research contracts in 1997:

- Faculty of Medicine, Institute of Biomedical Informatics, Comparative Assessment of Phosphor-32 and Strontium-89 Efficiency and Toxicity in Relieving Pain Induced by Bone Metastases;
- JSI, Laboratory of Radiochemistry, Multielement Analysis of Reference Materials by Neutron Activation Analysis;
- JSI, Trace Element Air Pollution Monitoring in Slovenia Using Nuclear Analytical Techniques;
- JSI, Department of Low and Medium Energy Physics, Photon Production at Radiation Capture of Energy Nuclei with Direct-Semi-Direct (DSD) and Pre-Equilibrium Model (PEQ);
- JSI, Department of Reactor Engineering, WIMS Library Update Project - Scientific Coordination and Test Library Preparation.

4.1.4.4 Projects of Technical Assistance

Technical assistance projects are the most extensive and the most demanding form of cooperation between the Republic of Slovenia and the IAEA. This is due to the large amount of resources, engagement of experts and also to the fact that projects of this type usually last for several years.

In 1997 (for the 1999-2000 budgetary year) Slovenia applied for six projects, of which three were the so called "footnote A" projects, prepared by experts from the Jozef Stefan Institute:

- Irradiation Facility;
- Laboratory of Nuclear Spectroscopy;
- Center for Public Information on Nuclear Technologies;
- Improvements of Facilities for Dosimetric Calibration;
- Fast Pneumatic Transport System for Transport of Irradiated Samples from the TRIGA Mark II Reactor;
- Comparative Impact Assessment of Power Generation in the Šoštanj TPP and the Krško NPP on Human Health and the Environment.

In 1997, activities within the project: Licensing of Steam Generators Replacement in the Krško NPP and for Thermal Power Up-Rate (SNSA) were continued; namely, at the end of June, a one-week workshop was held at the Milan Čopič Training Center entitled "The Administration Authority Assessment for Safety Report on Steam Generators Replacement in the Krško NPP", and at the end of August, there was the second scientific visit of two representatives of the SNSA in Sweden in order to get acquainted with the Swedish licensing practice for steam generator replacement and power up-rate of the nuclear plant.

Within the Žirovski vrh Mine project, approved in 1996, the TC mission visited the Žirovski vrh Mine three times in 1997. The first mission visit was in February, the second in March and the third in July 1997.

The missions referred to the implementation of mining and ore processing site decommissioning at the Žirovski vrh Mine, with particular attention given to long-term remediation of the Boršt tailings pile. Also, the list of equipment was planned to be delivered within this project by IAEA in 1998.

In 1997, activites continued on the JSI project (Beam Transport System at the Van de Graaff Accelerator). Within this project a tandem accelerator was successfully installed at the Microanalytical Center (MIC) at the JSI. The beam tube was set up - selected among five variant tubes - and the first measurements started. The installed beam tube is intended for ambient measurements and is adapted to analyses of samples which for various reasons cannot be put into the accelerator vacuum system. It is primarily intended for archeometric measurements required by the National Museum and the Research Institute of the Faculty of Arts.

The Institute of Nuclear Medicine project was concluded in 1997 by a fourteen-day visit by Mr. Andrasi, an IAEA expert. With his help the whole-body counter was successfully put into operation and the personnel trained for its regular routine use.

In 1997, the programme for Phases 1 and 2 of the two-year SNSA project (Early Warning System in Case of a Nuclear or Radiological Event) was prepared, of which Phase 1 was fully supported and realised by the IAEA: the SNSA received a portable gamma spectrometer in December 1997, and in April 1998 an automatic radiometer for measurement of ambient radioactivity is to be delivered. Moreover, in autumn 1997 the SNSA was visited by the IAEA expert mission, which reviewed the programme for 1998; the mission approved the set aims and guidelines for new equipment delivery in 1998.

The project "Improved Operation Safety of the Krško NPP", in implementation by the JSI, the Milan Čopič Training Center from 1995/96, was successfully concluded in 1997.

4.1.5 IAEA MISSIONS

4.1.5.1 IPPAS Mission

The International Physical Protection Advisory Service Mission (IPPAS) visited Slovenia (the SNSA, the Ministry of the Interior, the Krško NPP and the Reactor Center at Podgorica) at the end of 1996.

In April 1997, the IAEA sent to Slovenia the draft report on the IPPAS mission, and the participating organisations were invited to send their observations, in particular intended for additional clarification of our legislative framework. The observations were forwarded to the IAEA in June, and the IAEA sent the final report to Slovenia in September 1997.

4.1.5.2 IPERS Mission

In the framework of the IPERS Mission (International Peer Review Service) a group of experts from the USA, UK, South Korea and Spain reviewed the Probabilistic Safety Assessment of the Krško NPP (level 2), referring to the analysis of the containment integrity in case of core damage, in the period 10 - 14 November 1997. At the SNSA initiative the review was organised by the IAEA in the framework of Technical Co-operation Assistance. A group of experts from the Krško NPP also participated in the review with the task of presenting the study and answering any questions that the reviewers might have had. The final report on the Probabilistic Safety Analysis (PSA) - Level 2 will be sent to the SNSA in 1998.

4.1.6 INES - INTERNATIONAL NUCLEAR EVENT SCALE

The IAEA information system - the International Nuclear Event Scale (INES) received 45 reports from 21 countries in 1997, of which 34 were reports on events in nuclear power plants and 11 on events in research reactors and during use or processing of radioactive substances. Among them, 2 reports were on events of the third degree, 16 on events of the second degree and 15 on events of the first degree - on a seven degree scale. Eleven reports were on events which were of no safety significance (below scale - degree 0), and one event was outside the scale.

No events of the third degree - which means a serious accident -occurred in nuclear power plants. However, one did occur in a plant for processing of radioactive wastes in Tokai, Japan, and another during work with an ionizing source in Treviso, Italy. In the second case one worker was exposed to a very high dose of radiation (an equivalent dose of 0.89 Sievert to the whole body), while the doses to other personnel and to the environment were below regulatory limits.

Slovenia reported on two events at the Krško NPP. According to the international scale of events (INES), both events were graded as an event not relevant for nuclear safety, degree 0 (Below Scale - No Safety Significance).

4.2 COOPERATION WITH EU

4.2.1 PHARE PROGRAMME

The activites of the PHARE RAMG (Regulatory Assistance Management Group) mission also continued in 1997. The RAMG programme for Slovenia consisted of eight areas or items of assistance:

1. assistance in preparation of new nuclear legislation;
2. transfer of western experiences in the decomissioning of nuclear facilities;
3. development of public information methods;
4. development of inspection programmes and training of nuclear safety inspectors;
5. training the SNSA for implementation of integrated system analyses;
6. assistance to the SNSA for elaboration of an approach and for use of experiences in radioactive waste management;
7. development of emergency planning at the SNSA and enabling the assessment of the environmental impact of radioactive releases;
8. training the SNSA for serious accidents analyses and response.

The activities under paragraphs 2, 3, 6 and 8 were already concluded in 1997, while the others are still in progress. In total, approximately 68% of the programme was realised in 1997. The second year of assistance to the competent administrative authority for nuclear and radiological safety is to be concluded in February 1998.

The funding for continuation of the project for geotectonic research to enable operation safety assessment of the Krško NPP in case of an earthquake was approved by the PHARE programme - Nuclear Safety. The foreign firm - selected under the PHARE call for tenders - in cooperation with the Slovenian IGGG carried out 40 km of geophysical measurements in the vicinity of the Krško NPP in the scope of the above project.

In 1997, another project was approved in the framework of the Phare programme, i.e. "Study Management Schemes for Slovenia", or the so called Cassiopee mission. The purpose of the project is to assess the situation in the field of radioactive waste management in Slovenia and to prepare guidelines for the further solution of this problem. The project started in September 1997 and is to be concluded in July 1998 with a report, drawn up in English. The data for the report will be collected through expert missions, and the chief coordinator of the DBE project (Deutsche Gesellschaft zum Bau und Betrieb von Endlagern fur Abfallstoffe mbH), Germany, will send the results to Slovenia. For this purpose Mr. Wolfgang Fibert of DBE visited Slovenia in September. In the first half of 1998, visits are expected by a number of experts from various European organisations involved in radioactive wastes.

On the Slovenian side, the following organisations are participating in the project: the SNSA, as the main project user, the ARAO, the JSI, the Krško NPP and the Žirovski vrh Mine.

4.2.2 THE CONCERT GROUP

The former EC working group IA and the Council of Regulatory Bodies from countries, operating VVERS, established the so called CONCERT Group in 1992. The aims were to improve cooperation among regulators for nuclear and radiation safety in the field of legislative bases and procedures, administrative approaches to technical and operative problems and coordination of assistance programmes, and, in general, to promote the safety culture. The Group proposes to the European Commission the assistance programmes in the field of nuclear safety and general cooperation with the Central and Eastern European countries.

The CONCERT Group was therefore established as the technical framework of implementation of the European Commission assistance in the field of nuclear safety. The current structure of CONCERT is simple. The competent regulatory authorities for nuclear (and radiation) safety from the EU countries appoint one representative each: one representative is appointed by each competent authority from the Central and Eastern European countries (CEEC) and from the NIS countries. By contrast, the CONCERT Group consists of the members of the European Commission, DGXI and DG IA. The competent authorities from the West European countries appoint the chairman of the Group, while the vice-chairman is appointed by the competent authorities from the Eastern Europan countries.

The CONCERT Group representatives meet twice a year - in Brussels and in one of the CEEC or NIS countries; the meeting is held for two days. When the meeting also involves a technical visit it is extended to three days.

The 11th meeting of the CONCERT Group, which was the first meeting in 1997, was held in St. Petersburg on 11 - 12 June. The most important item on the agenda was preparation and first reports on "Nuclear regulatory Authority Improvement Plans".

The second meeting in 1997 was held in Brussels on 11 - 12 December. The meeting continued with reports on NRA Improvement Plans.

4.3 COOPERATION WITH OECD/NEA

Slovenia is endeavouring to attain full membership of the OECD/NEA, since full membership would enable the cooperation of the Slovenian research groups in the field of nuclear technology, giving them power to impact the projects scope and aims, and direct access to information on equal terms with other members. Representatives of the SNSA have already participated in some of the meetings organised by the NEA.

On 17 April 1997 the SNSA actively participated in an international exercise INEX-2-FIN; an expert of the SNSA also attended the final meeting of the exercise which was held in Paris between 25 and 29 June 1997.

A representative of the SNSA attended the meeting of the CSNI experts on "Power Plant Simulators and Analysers" in Espoo, Finland, between 29 September and 2 October 1997; he also delivered a report at the meeting. The meeting was jointly organised by the OECD/NEA, the Technical Research Center of Finland and the Finnish Ministry of Trade and Industry.

A seminar on "Nuclear Law" was held on 25 - 30 August 1997 in Dubrovnik, which was attended also by a representative of the SNSA. The seminar was organised by OECD/NEA, IAEA and EU.

4.4 BILATERAL COOPERATION

Bilateral cooperation is realised through existent agreements or informally, at the level of representatives of competent administrative authorities for nuclear and/or radiation safety. In 1997, intensive cooperation activities were carried out with the competent authorities of Finland, France, Spain, Belgium, Germany, Sweden and the USA. The cooperation involved exchange of expert reports on nuclear safety and related concrete solutions, implementation of the proposed solutions on licensing, exchange of legal and regulatory acts and standards, inspection practices, etc.

"Lage Krško"

The Austrian Ministry of the Interior including the Civil Protection Service and the Austrian Armed Forces organised an exercise in the event of a nuclear accident and a seminar in two parts with the joint title "Lage Krško". The first part of the seminar was held on 3 April 1997 in Celovec (Klagenfurt) and covered:

- basics in nuclear power plant operation and technical characteristics of the Krško NPP; the lecture was given by Miroslav Gregorič, M.Sc. from the SNSA as an invited lecturer;
- structure and tasks in case of an unusual event of the following civil protection organisations: police units, the Red Cross, army units (sanitation service and the ABK protection) and fire brigades.

The second part of the seminar in connection with the above-mentioned exercise on a potential accident in the Krško NPP was held at Keutschach, Carinthia, on 13 - 14 May 1997.

This part of the seminar was entitled "Protective Measures in Case of Extensive Contamination". The two-day seminar was attended by approximately one hundred participants, mainly from Austrian Carinthia, and also from other federal states. Also at this seminar an invited lecturer from Slovenia participated with a lecture on "Radiation Early Warning System and Radioactivity Monitoring in Slovenia"; this gave a description of warning systems that transmit data to the Centeral Radiation Early Warning Systems of Slovenia at the SNSA and their characteristics. The second part of the lecture included radioactivity monitoring and sampling in the vicinity of the Krško NPP in case of an unusual event. In the third part, radioactivity measurements in the environment were presented: measurements of Cs-137 distribution, radiological map, measurements of indoor radon concentrations and radiation monitoring in the living environment in Slovenia.

Between 24 and 26 June 1997, the exercise "Lage Krško" was carried out in Celovec (Klagenfurt), organized by experts from the Austrian Ministry of the Interior, the Chancellor's Office - Department for Radiological Protection, from the Seibersdorf Research Center near Vienna and from the Military High School of Atomic, Biological and Chemical Protection. The purpose of the exercise was to test decision making in the affected federal state (i.e. Carinthia) in the event of a nuclear accident at the Krško NPP.

5 PROVIDING PUBLIC INFORMATION

Good safety culture is strongly related to transparent and timely information. Experience has shown that radiation and nuclear safety are under continuous surveillance by the public.

The provision of open and authentic information to the public is a fundamental policy of the SNSA. The SNSA endeavours to provide substantial and reliable information to the interested institutions, mass media and to the citizens through press conferences, public statements, media discussions, and active participation in domestic and international meetings, symposia and congresses, through publications, the Internet and direct contacts with the interested public.

The SNSA regularly provides information on nuclear safety to the Government, the National Assembly and the citizens of the Republic of Slovenia.

The Annual Report on Nuclear and Radiation Safety in 1996 was published in Poročevalec No. 40 (Reporter) - the publication of the National Assembly - on 6 August 1997, and is available in public libraries throughout Slovenia.

Both reports are available also on the Internet (http://www.sigov.si/ursjv/uvod.html) in Slovene and English. Access to data of the Central Radiation Early Warning System of Slovenia (CROSS), recording the real time (at half-hour intervals) gamma dose rate levels, is also available through Internet.

The report in English was sent to Slovenian embassies world-wide, to certain foreign embassies in Slovenia and to other organisations participating in the activities in the nuclear and radiological field.

Reports on the SNSA activities were also published in the bulletin Okolje in prostor (Environment and Physical Planning), published by the Ministry of Environment and Physical Planning. The SNSA regularly contributes articles on courses, seminars and symposia attended at home and abroad.

In 1997, 53 articles were published (Table 5.1).

The articles are intended to give basic information on training and the names of contact persons to provide additional information on certain topics to those interested. More than half of these activities were organised by the IAEA.

For several years the SNSA has been endeavouring to maintain continuity in translating some of the basic IAEA publications. In 1997 the SNSA prepared a Slovene translation of a publication from the Radiation Safety Series - Radiological Protection and Safety of Radiation Sources. As usual, this publication was distributed free of charge to the institutions concerned.

In 1997, the SNSA continued sending data to the international network in the field of nuclear and radiation safety NucNet and distributed the NucNet data to the interested media in Slovenia. The NucNet - a global reporting agency for atomic energy - was established in 1991 as an information source to all interested in information on the most recent activities in the field of atomic energy.

It receives data from more than 40 countries: from nuclear facilities, competent regulatory authorities for their surveillance, ministries, and research centers. The information is collected in Bern, and from there distributed world-wide.

Every year the SNSA, the distributor for Slovenia, investigates the interest of media and others in this kind of information and updates the list of the receivers.

All research work and studies being financed by the SNSA are public and available at the SNSA, and the international missions' reports are available from the National and University Library, the Central Technical Library, Ljubljana and the University Library, Maribor.

Table 5.1: Titles of the SNSA articles in the bulletin Okolje in prostor

Month of Publication	**Title**
January 97	IAEA IPPAS Mission to Slovenia
	Annual Report on Nuclear Safety in 1995 on Internet
	Physical Protection of Nuclear Facilities
	Ageing of Nuclear Power Plants
February 97	Technical and Administrative Preparations Required for Shipment of RR Fuel to its Country of Origin
	Inspection of Krško NPP Operators Training on the Simulator
March 97	Liability for Nuclear Damage
	PIME 97
	Westinghouse Power Plants Systems
April 97	PHARE RAMG Programme
	Training at the Belgian Regulatory Authority AVN for Replacement of Steam Generators in the Krško NPP
	Seminar on Public Information on Nuclear Safety

Month of Publication	Title
	Central Radiation Early Warning System of Slovenia
May 97	PHARE Programme; CSN - Nuclear Safety
	Conference Top Fuel 97
	Training in the Field of Nuclear Safety for Nuclear Safety Inspectors in USA
May 97	Exercise INEX-2-FIN - Nuclear Accident in a Foreign Country
	1st Regional Workshop on Radon in South-Eastern European Countries
June 97	Austrian Exercise in the Event of a Nuclear Accident in the Krško NPP
	Physical Protection of Nuclear Material
	10th CAMP Meeting in Budapest
July 97	Replacement of Steam Generators in Krško NPP
	Preliminary Safety Reports on Nuclear Power Plants
	Working Meeting of Experts for Nuclear Power Plants Safety Systems and Diagnosis
September 97	Eddy Current Technique - New Practical Experiences
	Emergency Planning and Response in Case of Nuclear Accident in Bavaria
	Internet - Annual Report on Nuclear and Radiation Safety in 1996
	Visit of SNSA Representatives to SKI
October 97	Topical - 4th Anniversary of IAEA
	Emergency Planning and Response in Case of Nuclear Accident
	4th International Conference of Nuclear Experts at Bled
	Simulators and Analysers of Nuclear Power Plants Transients
	Radiation Safety in Central Europe
	Establishment of Czech Agency for Radwaste Management

Month of Publication	Title
	Radioactive Waste - Workshop
November 97	Emergency Preparedness in Case of an Unusual Event in Germany
	IAEA Expert Mission to Armenia
	Periodic Safety Review (PSR)
	Basics of Radiological Protection
	Progress in Maintenance of Nuclear Power Plant Safety Equipment
	French Nuclear Safety Administration and Public Relations
	Application of Probabilistic Safety Analyses
December 97	Workshop - Risk Assessment - Chemicals
	Workshop - Determination of National Priorities for Chemical Safety
	Visit to a Nuclear Center in France
	Quality Assessment of Steam Generators Production
	Annual Conference on Water Reactor Monitoring Systems (WRMS)
	Fire Safety in Nuclear Power Plants
	Quality Assurance of Radioactive Waste Packing

6 BUDGET OF THE SNSA AND ITS REALISATION

The table below presents the funds assigned to the SNSA for 1997 (with modifications) and its realisation according to the purpose.

Although the financial situation seems quite satisfactory, the funds assigned from the national budget to the SNSA were in reality lower than in the previous years, especially for some important economic purposes (services, investment). Particularly worrying is the fact that the implementation of certain aims and programme activities in the area of nuclear and radiation safety is being made difficult.

Table 6.1 The SNSA budget for 1997

Purpose	**Budget**	**Budget after Modification**	**Realisation in %**
Wages	101,447,000.00	111,879,510.00	99.67
Material Expenses	38,500,000.00	33,815,862.00	97.89
Services	30,400,000.00	34,684,138.00	98.20
Investment	8,600,000.00	9,000,000.00	96.97
Total	178,947,000.00	189,379,510.00	98.96

7 EXPERT COMMISSIONS AND OTHER SNSA ACTIVITIES

7.1 NUCLEAR SAFETY EXPERT COMMISSION (NSEC)

The Nuclear Safety Expert Commission (NSEC), which has an advisory role to the SNSA, met four times in 1997. It is composed of 22 members, of whom 10 are officials from ministries and 12 experts on nuclear and radiation safety. Its scope of work is defined in the Act on Implementing Protection against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off. Gaz. SRS, 28/80) and in its Rules of Procedure, adopted at its 45th meeting on 22 March 1991.

In addition to the standard issue, i.e. "safety of nuclear facilities operation in the period after the last meeting", the NSEC also discussed the following issues in 1997:

- preparations for the 1997 outage in the Krško NPP and the outage report;
- health care in case of a nuclear accident in Slovenia;
- report on planned replacement of steam generators;
- applications for the operator license in the field of nuclear safety;
- annual report on nuclear and radiation safety in the Republic of Slovenia in 1996;
- radiological monitoring in Slovenia;
- status of the Krško NPP in negotiations between Slovenia and Croatia;
- preparation of criteria to assess competence of the technical support organisations in the field of nuclear safety;
- report on progress of the diplomatic conference for adoption of:
  Protocol to amend the Vienna Convention on Civil Liability for Nuclear Damage and to prepare Draft Convention on Supplementary Funding;
  Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management;
- report of the RS delegation at the 41st session of the IAEA General Conference;
- Preliminary report on implementation of the OSART mission (Operational Safety Review Team) and the ICISA mission (International Commission for Independent Safety Analysis of the Krško NPP) recommendations.

7.2 EXPERT COMMISSION FOR OPERATORS EXAMS

In 1997, the Commission for Testing the Qualifications of the Krško operators organised two exams for 20 candidates, of which 15 candidates for the post of senior operators took the exam to renew their licenses and 5 candidates for operators took the exam for the first time.

All candidates successfully passed the exam, and on the proposal of the Commission, the SNSA granted the licences for four years, or for one year, respectively (to candidates who took their exam for the first time).

7.3 QUALITY ASSURANCE IN THE FIELD OF NUCLEAR SAFETY

The SNSA performs external assessment of quality systems in technical support organisations in compliance with the Act on Radiation Protection and the Safe Use of Nuclear Energy, the E-1 Statute and the Internal Instructions URSVJ-QA-002, Rev. 1 "Assessment of Competence of Technical support Organisations in the Field of Nuclear Safety". In 1997, it carried out assessments of quality systems in five organisations. They included: the JSI - Department of Reactor Physics, the Milan Vidmar Electrical Institute, the Institute of Metals and Technologies, the Institute of Metal Constructions, and the Welding Institute. The head of the assessment group was a representative of the SNSA, and among the members there was also an expert from the Krško NPP. The assessments proved that the overall quality assurance situation was satisfactory; however, the assessment group also identified the fields, where improvements are necessary to obtain high quality standards.

The SNSA also considered the application of SIAP d.o.o., Pesnica, to acquire the status of an technical support organisation. After quality assessment, the SNSA refused the application.

The increased interest of various companies to acquire the status of an technical support organisation induced the SNSA to establish an ad-hoc working group to prepare criteria which an organisation should fulfil to acquire the status of an technical support organisation.

As part of the administrative procedure for the replacement of steam generators in the Krško NPP, the SNSA participated also in quality assessments of steam generator suppliers. In November, a representative of the SNSA participated in an assessment group for quality assessment of the company ENSA, Spain - the main producer of the steam generators.

The SNSA is active also in the field of standardisation of quality programmes according to the ISO system. The representative of the SNSA is a member of a Technical Committee "Management and Quality Assurance" within the Ministry of Science and Technology, Office for Standardisation and Metrology.

8 THE STATE OF NUCLEAR SAFETY IN SLOVENIA

8.1 INSPECTIONS BY THE SNSA

The Nuclear Safety Inspection Section of the SNSA carried out surveillance of the operations of nuclear facilities in accordance with its competencies and in compliance with the relevant legislation, standards and other regulations governing nuclear and radiological safety measures for siting, design, construction and installation of facilities, functional and start-up tests, test operation, regular operation, quality assurance of services provided and of material built-in, radiological monitoring, physical protection, emergency planning, training of operative personnel, maintenance, surveillance testing, revisions, outages and safety equipment modifications, nuclear material balance and liability for nuclear damage.

The Nuclear Safety Inspection Section carried out inspections according to the approved Annual Programme of Inspections for Nuclear and Radiological Safety in 1997. Routine inspections were mainly focused on surveillance of the Krško NPP operation with particular attention being given to issues important for nuclear safety, while the non-routine inspections were performed in case of an unusual event.

According to the organisational chart of the Nuclear Safety Inspection Section there are 5 posts, of which all were occupied in 1997.

In 1997, the Nuclear Safety Inspection Section prepared and sent to the IAEA the preliminary and final report on "Incident Reporting System", dealing with the incident involving the broken stem of the isolation valve on the main steam line no. 2, which occurred on 1 January 1997.

In 1997, the Nuclear Safety Inspection Section continued with preparation of the "Inspection Manual" and formulated draft inspection procedures:

- for steam generator replacements;
- for inspection of electrical components, systems and cables.

Implementation of Recommendations of the International Missions to the Krško NPP

During 19 inspections the implementation of recommendations of the OSART 93 and the ICISA international missions were considered.

1. The OSART mission, organised by the IAEA
The mission examined the following fields: management and organisation, training and qualifications, operation, maintenance, technical assistance, radiation safety, chemistry and emergency planning.

It was found that out of 175 recommendations and proposals of the OSART 93 mission altogether 138 were already implemented, 28 noted satisfactory progress, with 7 recommendations there was no progress, and 2 recommendations have a special status (one cannot be realised short-term, and one was withdrawn). Out of 7 recommendations with no progress, 2 recommendations refer to Chapter "Management, Organisation and Administration", one to Chapter "Operation" and 4 recommendations to Chapter "Maintenance". The Nuclear Safety Inspection Section carried out 10 inspections at the Krško NPP relating to recommendations of the OSART mission. The inspections established that about 79% of recommendations had already been implemented, and 16% were in implementation.

2. The ICISA mission, established by the Government of the RS
The mission dealt with the following: the ICISA safety assessment of the Krško NPP, the public company Krško NPP and the Slovenian Nuclear Safety Administration, the ICISA findings on the Krško NPP, the ICISA conclusions and recommendations, abbreviations, references and appendices list.

The ICISA mission issued 77 recommendations, of which 41 were already implemented, important progress was observed with 19 recommendations, with 2 recommendations there was no progress (one is for the Krško NPP emergency plan, and one refers to solving the low and intermediate level waste storage problem); 9 recommendations do not directly refer to the Krško NPP, and 6 recommendations have not yet been reviewed.

The Nuclear Safety Inspection Section carried out 9 inspections at the Krško NPP in connection with the ICISA mission recommendations. It was found that of all recommendations pertaining to the Krško NPP, 60% had already been implemented and 28% were in implementation.

The most important recommendations refer to construction of the full scope simulator of the Krško NPP, required by the SNSA decision - (the expected delivery date is November 1999, and the decision requires full operation by 31 December 1999) - and to the steam generators replacement (expected for April 2000).

Unimplemented remained the recommendations which were no longer relevant or which had been adequately implemented in other ways through modifications applicable.

After the 1998 outage and refuelling, additional inspections will be carried out by the Nuclear Safety Inspection Section to establish the status of recommendations of both international missions, which have not yet been fully implemented.

8.1.1 INSPECTIONS AT THE KRŠKO NPP

In 1997, the inspectors of the SNSA carried out altogether 113 inspections at the Krško NPP, of which 103 were routine inspections, 5 non-routine inspections and 5 joint inspections with the technical support organisations in order to prepare the joint expert report after the 1997 outage.

Routine inspections at the Krško NPP were performed twice a week (1.98 times a week) on average in 1997 and involved the following areas:

Operation:

- implementation of corrective measures for fast transfer at the 400 kV switchyard in case of in-station blackout;
- inspection of documentation for the control rods management system;
- inspection of regular work in the chemical laboratory of the secondary systems;
- information on corrective measures for steam generators and components of isolation valves of the main steam header during the 1997 outage;
- survey of results of the fuel sipping;
- pre-outage meeting between the Krško NPP, the technical support organisations and the SNSA;
- inspection on implementation of the decision in an administrative issue "Modification of Technical Specifications of the Krško NPP - Fire Protection";
- survey of data on nuclear fuel status (leakage, fuel burnup at the end of the 13th fuel cycle, project for a new core in the 14th fuel cycle) and activity of the primary coolant;
- inspection of documentation relating to the presence of foreign particles in the primary system;
- keeping of daily records on operative personnel;
- corrective action on valves of the system for containment atmosphere release;
- inspection of outage activities on compressors of the instrumentation and compressed air system;
- inspection of corrective measures in connection with the event "Actuation of Containment Spraying on 19 June 1995";
- preparations for the 1997 outage;
- status of the last revision of emergency operating procedures;
- inspection of documentation for the fuel leakage detection system;
- modifications of abnormal operating procedures;
- determining the causes for the occurrence of a temporary switchover of the main feedwater pump no. 2 to no. 3;
- activities of the Krško NPP in the field of a safe reactor shutdown and maintaining the safe shutdown status in case of fire;
- activities of the Krško NPP in the field of early failure detection;
- status of the TMI programme (Three Mile Island) implementation;
- inspection of batteries for emergency power supply;
- inspection walkdown of technical safety systems;
- modifications relating to the fire protection programme;
- status of the OSART and ICISA mission recommendations;
- measures for improvement of housekeeping in the technological part of the NPP;
- preparation of the power plant for operation in winter time.

Radiological control:
- received doses by personnel in 1996;
- inspection of monitoring of gaseous and liquid radioactive releases (emissions);
- inspection of procedures and methods for surface decontamination;
- inspection of quarterly reports on monitoring of radioactivity in the environment;
- inspection of a new drum design for prepacking of drums with LILW;
- calibration of dosimeters;
- received doses by personnel during the 1997 outage;
- inspection of records and the LILW storage;
- training in the field of radiation safety;

- inspection of the ALARA programme;
- inspection of licenses for working in the area of radiation;
- decontamination unit performance.

Maintenance and control testing:
- presence during regular monthly testing of diesel generators for emergency power supply (DG 1 and DG 2);
- inspection of results and the RTD calibration method (resistant temperature detectors for temperature measurements in the primary loop);
- inspection of results of the testing of safety injection pumps;
- inspection in connection with certain problems during testing of the diesel fire protection pump in the period 30 December 1996 - 6 January 1997;
- inspection of results of the auxiliary feedwater system turbine pumps control testing;
- inspection of results of the residual heat removal pumps testing;
- inspection of results of the main service water supply pumps control testing;
- inspection of pressure vessels;
- inspection of data on surveillance testing of safety-related equipment in March 1997;
- examination of procedures for testing the post-accident sampling system;
- inspection of procedures for testing the AMSAC system (ATWS Mitigation System Actuation Circuit);
- calibration of instrumentation;
- inspection of the instrumentation calibration stickers;
- implementation of the 10 CFR 50.65 Maintenance Programme Rule;
- inspection of electro-workshops at the Krško NPP;
- activities in the field of testing the motor-driven valves;
- organisation and activities of the electrical maintenance unit.

Emergency preparedness:
- inspection of training in emergency response planning in 1996;
- inspection of progress of the "Emergency plan" preparation;
- sampling in the environment in case of emergency and inspection of sampling sites within the exclusion area;
- inspection of exercises of the Krško NPP Mobile Unit;
- inspection of the training programme for the technical support center and the operation support center personnel;
- evaluation of the NEK-97 exercise;
- inspection at the technical support center and the operation support center.

Physical protection:
- inspection of the procedure for control testing of the technical protection equipment;
- inspection tour of the safety fence;
- planned and implemented modifications.

Engineering and training:
- inspection of planned modifications for the 1997 outage;
- status of procedures/instructions for preparation for accident management;

- inspection of the safety analyses results at reactor shut-down;
- status of the project for steam generators replacement;
- inspection of planned modifications for the 1998 outage;
- activities for construction of a storage place for out-of-use steam generators;
- status of modifications for reconstruction of the hanging ceiling in the command room;
- activities in the field of probabilistic safety assessments in 1997;
- list of licenses to personnel working at the reactor operation control;
- construction of the full scope simulator of the Krško NPP;
- labelling of components and systems;
- status of the process information system;
- training of refuelling personnel.

Quality assurance:
- documentation filing for individual power plant systems;
- status of spare parts for diesel generators DG 1 and DG 2;
- inspection of the work orders list (base);
- inspection of preparations for quality assurance during the 1997 outage;
- quality assurance of the steam generators production;
- quality assurance system for the qualified subcontractors of the Krško NPP.

Other activities:
- establishing the consequences of the fire in room no. 41;
- nuclear damage insurance;
- inspection of concrete facilities in the Krško NPP for concrete fatigue.

On 11 April 1997 at 16.00, the consignment of 24 fuel elements for the Krško NPP was inspected at the truck terminal at Šentilj for entrance into the country. The consignment was accompanied by the required documentation, and after customs survey the transport continued towards Krško, where it finally arrived at 22:00.

In addition to the police escort and the Krško NPP personnel, an inspector of the SNSA also accompanied the transport all the way from the border-crossing Šentilj to the Krško NPP.

All five non-routine inspections carried out in 1997 were entailed by actuation of the safety injection, caused by closure of the isolation valve on the main pipeline. On 1 January 1997 at 8:33 the breakage of the isolation valve stem on the pipeline no. 2 occurred. The stem was broken at the point where it is set into the stop cylinder; consequently, the stop cylinder fell down from the open position, thus closing the steam flow in pipeline no. 2. Due to decreased pressure in pipeline no. 2, and the consequent increased flow of steam through pipeline no. 1, the reactor safety system detected the event as a steam line no. 2 break. The reactor safety system actuated the automatic reactor trip and safety injection. The remediation of the damage (replacement of the broken stem of the valve) was supervised by the authorised serviceman of the valve supplier Atwood&Morril (USA) and was concluded on 6 January 1997 when the valve was assembled again and the cold functional test of the valve was carried out.

Five joint inspections with the technical support organisations included inspection of the "Joint Expert Report on the 1997 Outage and Refuelling at the Krško NPP".

8.1.1.1 Reports on Unusual Events (by the Krško NPP)

In 1997, the Krško NPP sent to the SNSA five reports on unusual events in conformity with the Rules on Reporting (Off. Gaz. SRS, No. 12/81):

- broken stem of the isolation valve on the main pipeline no. 2;
- short-term loss of the residual heat removal system during the 1997 refuelling;
- automatic trip of diesel generators for emergency power supply, caused by high temperature of the cooling water;
- non-opening of switches for reactor trip in channel A during testing of reactor safety system;
- exceeding the deadline for weekly control tests of the 125V batteries.

All the above-mentioned unusual events were thoroughly discussed during routine and non-routine inspections.

8.1.1.2 The 1997 Outage and Refuelling at the Krško NPP (at the end of the 13th fuel cycle)

The 1997 outage of the Krško NPP took place from 9 May to 11 June 1997 (the second synchronisation to the grid), which was one of the shortest outages ever. Also during this outage the critical path was determined by inspection of the steam generator pipes and the corrective action on them. During the outage 19 routine inspections were carried out at the Krško NPP.

In addition to republic inspectors for nuclear and radiation safety, other SNSA personnel also took part in inspections during the 1997 outage and refuelling. Compared to previous annual outages at the Krško NPP the SNSA was more intensively involved in surveillance of the outage activities, which was enabled by the improved personnel structure.

The major outage activities inspected were the following:

- safety at shutdown;
- testing of safety systems;
- refuelling;
- ultrasonic inspection of fuel;
- ISI and the corrective action on steam generators; remediation of inspection openings;
- overhaul of the turbine and regulation valves;
- overhaul of the power generator;
- overhaul of diesel generators;
- overhaul of the reactor coolant pump motors;
- sludge lancing in the steam generators;
- overhaul of isolation valves on the main pipelines (MSIV);
- regular maintenance service of mechanical, electrical and instrumentation equipment;
- modifications.

The critical outage path:

- was determined by the power plant shutdown and cooling, opening of the primary system, refuelling, the ISI survey of the steam generator pipes and by corrective action on the steam generators, by start-up and functional tests and by heating of the power plant. In comparison with the previous annual outages, the share of activities that approached the critical path during the 1997 outage increased.

Modifications: during the 1997 outage the following major modifications - discussed during inspections at the Krško NPP - were implemented:

- remote manipulation of polar cranes;
- MCB (Main Control Board) indication for "seal leakoff" on the Reactor Coolant Pump);
- electromagnetic valve on the suction ventilation line of the CS pump (the chemistry and volume control system);
- video camera for fuel inspection in the containment;
- acquisition of PIS signals (Process Information System) from the SSPS (Solid State Protection System);
- monitoring of the main generator;
- monitoring of chemical parameters;
- replacement of fuel filters on diesel generators;
- changed process logic of "generator stator cooling" water pumps;
- cooling of the 7300 instrumentation racks;
- PIS (Process Information System) - Phase 2;
- "Auto Shunt Trip";
- replacement of the FIS (Flow Indicator Switch) on the CW (Circulating Water) system;
- level indicator in the condenser (MCB-Wide Range);
- DG (Diesel Generator) "Low Water Level" alarm;
- shifting of the 56600 and 56601 valves;
- shifting of the 6" pipeline to DG;
- shifting of DG instrumentation (Phase II);
- Volume Control Tank "Purge Line";
- Turbine Generator vibration monitoring (Phase I);
- reconstruction of the hydraulic gate system on the Sava river;
- blockade of the refuelling machine when the camera telescope is pulled out;
- installation of a mechanical seal on the HD103PMP-001 and 002.

Among other activities in connection with the 1997 outage the following were inspected:

- control testing;
- calibration of instrumentation;
- in-service testing programme;
- overhaul of mechanical equipment;
- regular maintenance service of electrical equipment;
- reactor shut-down and analysis of events accompanying the reactor shut-down;
- survey of results of the fresh fuel inspection;
- ALARA plan during the 1997 outage;

- inspection of procedures for maintenance and modifications of high voltage and low voltage motors;
- Krško NPP measures relating to the presence of foreign particles in the primary system;
- programme for corrosion and erosion control in the secondary loop;
- inspection of reactor core loading;
- maintenance of the switchyard and transformers;
- feasibility study for start-up of a generator at the Brestanica gas power station;
- containment leak rate test.

The inspection of the 1997 outage activities was reinforced by the staff of the technical support organisations. In the 1997 outage 8 technical support organisations were involved, 6 from the Republic of Slovenia and 2 from the Republic of Croatia (EIMV, IE, JSI, IMK, FME, IMT, WI and SNSA), coordinated by the EIMV.

Prior to commencement of the outage the SNSA concluded a contract with the coordinator of the technical support organisations (Contractor) to prepare the project "Joint Expert Report on Tasks, Corrective Measures and Tests during the Krško NPP Outage and Refuelling at the End of the 13th Fuel Cycle", which was to be compiled from individual reports by the technical support organisations. An additional requirement of the contract was that the contractor should forward to the Contracting Party the "Joint Statement for Re-establishment of Reactor Criticality" by the end of the outage, and after successful start-up test the "Joint Statement for Full Power Operation". The scope of surveillance by the technical support organisations was determined at the meeting of representatives of the SNSA, the EIMV and the Krško NPP on 19 November 1996. It included: activities related to requirements of technical specifications for the Krško NPP and for the following major components: turbine and generator with protection, power transformers, reactor coolant pumps (RCP), main feedwater pumps (FW), cooling water pumps (CW), condensate system pumps (CY), component programme of the secondary systems (CEMS and pressure vessels) and 400 kV switches.

During the 1997 outage regular weekly meetings with representatives of all technical support organisations took place, at which the technical support organisations reported in writing and verbally on the outage works they supervised, on their findings and recommendations, and suggested the working plan for the following week. Besides weekly meetings, nuclear and radiation safety inspectors held discussions on current problems with representatives of the individual technical support organisations concerned.

After the outage the technical support organisations issued a positive opinion for re-establishment of criticality of the Krško NPP reactor, and on 9 June 1997 the EIMV - the coordinator of technical support organisations - issued document No. 3937/97, the "Joint Statement for Re-establishment of the Krško NPP Criticality after the 1997 Outage and Refuelling at the End of the 13th Fuel Cycle". After successful completion of the start-up tests, the statements for full power operation were issued, which were compiled into the "Joint Statement for Full Power Operation of the Krško NPP after the 1997 Outage and Refuelling at the End of the 13th Fuel Cycle", issued on 28 July 1997.

On 31 July 1997, the coordinator of the technical support organisations involved submitted to the SNSA and the Krško NPP the report "Joint Expert Report on the 1997 Outage and Refuelling in the Krško NPP"; expert reports by the technical support organisations compiled in the joint report confirmed that the outage and refuelling activities were carried out in conformity with the regulations, approved procedures and good engineering practices, and that the parameters and conditions defined in technical specifications for the Krško NPP were not changed, which, from the viewpoint of nuclear safety, is the prerequisite for safe full power operation. The joint report remains valid until the next shutdown of the power plant due to refuelling or annual outage.

The Nuclear Safety Inspection Section carried out inspections with representatives of all technical support organisations and the Krško NPP on the "Joint Expert Report on the 1997 Outage", with particular attention given to recommendations and eliminated non-conformances.

8.1.2 INSPECTIONS AT THE TRIGA RESEARCH REACTOR

In 1997, three inspections were carried out at the TRIGA Mark II Research Reactor.

The routine joint inspection with the Health Inspectorate on 29 January 1997 included the following:

- implementation of decision No. 31-22/94-9209/SA on an administrative issue "Radiological Monitoring in the Vicinity of the Reactor Center at Podgorica for 1995", issued by the SNSA on 13 July 1995;
- inspection of the reactor hall and basement.

On 17 October 1997, the second routine joint inspection with inspectors of the Health Inspectorate was carried out, covering the following areas: neutron dosimetry, examination of instructions for transport and replacement of radioactive sources Ir-192, review of Chapter 7 of the safety report on the TRIGA Mark II reactor, experimental work in the reactor and training of the reactor personnel.

On 17 November 1997, the third joint inspection with two inspectors of the Health Inspectorate was performed. It included:

- survey of the training programme on radiation safety at the Milan Čopič Training Center;
- inspection of laboratories at the Department of Environmental Chemistry;
- nuclear damage insurance;
- inspection of procedures for radioactivity monitoring;
- inspection of physical protection at the Reactor Center at Podgorica.

8.1.3 INSPECTIONS AT THE INTERIM STORAGE OF LILW FOR SMALL USERS AT PODGORICA

In 1997, two inspections at the Interim Storage of LILW for small users at Podgorica were carried out. During joint inspection with the Health Inspectorate on 29 January 1997 it was found that:

- the number of sealed ionizing sources in the storage considerably increased in 1997 (twice the average of the last eight years);
- sealed ionizing sources were not sorted systematically according to the category of isotopes and their activities;
- the Agency for Radwaste (ARAO) had not yet taken responsibility for management of the Interim Storage;
- the Interim Storage of LILW should be reorganised, which - according to the JSI, the present manager of the storage - could be expected only when the storage was under the responsibility of the ARAO.

During the joint inspection with the Health Inspectorate at Interim Storage of LILW on 17 October 1997 it was established that the public institution ARAO had not yet taken over the management of the Interim Storage of LILW and that it had not yet carried out activities under the code no. DF/23.30 - Management of the Interim Storage of Low and Intermediate Level Radwaste at Podgorica, as foreseen in Article 5 of the Decision on Transformation of a Public Organisation ARAO into a Public Establishment (Off.Gaz. RS, No. 45/96).

8.1.4 INSPECTIONS AT THE ŽIROVSKI VRH MINE

In 1997, two routine inspections were carried out at the Žirovski vrh Mine.

The inspection of 25 April 1997 included the following:
- operational plan of activities for implementation of the 1996 programme within the scope of the "Programme of Permanent Cessation of Uranium Ore Exploitation and Prevention of Negative Impact of the Žirovski vrh Mine";
- report on survey point measurements at the Boršt hydrometallurgical tailings pile, where the speed of landslide is measured;
- inspection of the Boršt hydrometallurgical tailings pile and the testing ground for tailings cover, situated at the tailings pile;
- report on permeability of the cover for Rn-222.

During inspection on 23 July 1997 the following was inspected:
- progress of the operational plan for 1997;
- the uranium ore exploitation plant, the Boršt hydrometallurgical tailings pile, solids trap for meteoric waters from the Boršt tailings pile and temporary mine and tailings dumps P-1 and P-9.

8.1.5 TEMPORARY LILW STORAGE AT ZAVRATEC

On 24 September 1997, an inspection of the temporary storage of low and intermediate level radwaste at Zavratec was carried out. After the repacking of radioactive waste in 1996, there was no change in 1997: low and intermediate level radioactive wastes were walled up in the first room by the entrance, the other rooms in the facility were cleaned up and there was no trace of their use.

8.1.6 CO-OPERATION WITH OTHER INSPECTIONS

The SNSA endeavours to intensify co-operation with other inspections in the field of nuclear safety. In 1997, four joint inspections with other inspections were carried out:

- three joint inspections at the TRIGA Mark II reactor with the Health Inspectorate;
- two joint inspection at the Krško NPP:
  a) with inspectors of the Ministry of the Interior in order to inspect physical protection at the Krško NPP;
  b) with inspectors of the Administration for Rescue and Disaster Relief in order to inspect conditions in the field of fire protection and rescue and disaster relief.

8.1.7 CONCLUSIONS

Based on earlier experiences and facts it can be concluded that:

- the Nuclear Safety Inspection Division for surveillance of the facilities successfully co-operated with other administrative and inspection bodies;
- also after the 1997 annual outage, the outage works, functional and start-up tests on systems and components of the Krško NPP complied with the technical specifications and acceptance criteria, defined in the approved procedures. This can be seen also from the reports and expert reports of the technical support organisations and from the reports, which the Krško NPP and the technical support organisations considered during non-routine inspections;
- non-routine or routine inspections were carried out after each unplanned shutdown of the Krško NPP. After each unplanned shutdown the Krško NPP proposed short-term and long-term corrective actions for permanent elimination of causes;
- in 1997 there was one automatic shutdown of the reactor with the actuation of safety injecting, caused by the broken stem of the isolation valve cylinder on the main steam line no. 2;
- all abnormal events reported by the Krško NPP were discussed during inspections in order to clarify the reasons;
- the SNSA Nuclear Safety Inspection Section performed the inspection of compliance with the decisions, issued to the Krško NPP by the SNSA and did not find any non-conformances;
- the SNSA Nuclear Safety Inspection Section reviewed monthly reports on radioactive emissions, however, no departures from standard values were observed.

All safety systems for a safe shutdown of the power plant operated in compliance with the anticipated design parameters; in 1997, nuclear safety was not jeopardised.

In 1997, operation of the research reactor TRIGA Mark II at the Jožef Stefan Institute Reactor Center at Podgorica complied with the technical specifications. Admission into the basement and the reactor hall was controlled, and the register of entrances of experimentators, maintenance staff and visitors was consistently kept. The reactor operated throughout the year without deviations, also during the summer leave; the operation of the reactor was suspended only for maintenance reasons.

The radioactive waste in the temporary storage of low and intermediate level radioactive waste (LILW) at the Krško NPP and in the interim storage of radioactive waste of the Reactor Center at Podgorica is stored in compliance with the legislation and the records are correctly and consistently kept. However, in 1997, the interim storage did not accept radioactive waste from external users due to the unsolved status in connection with the transfer of competence for the interim storage management from Jožef Stefan Institute to the public agency ARAO.

At the Žirovski vrh Mine, the final remedial works on the ore processing site and determining the remedial method at both tailings piles at Boršt and Jazbec have been proceeding very slowly and their completion is difficult to predict owing to low funds available.

After repacking of radioactive waste at the temporarary storage of low and intermediate level radioactive waste at Zavratec in 1996, there was no change in 1997 and the status of this temporary storage of low and intermediate level radioactive waste still remains unresolved.

8.2 THE KRŠKO NUCLEAR POWER PLANT

8.2.1 OPERATIONAL SAFETY

8.2.1.1 Operational and Safety Indicators

In 1997, the Krško NPP generated 5,019,437 MWh (5.0 TWh) of electrical energy at the output of the generator, or 4,793,976 MWh (4.8 TWh) net. The generator was connected to the electrical grid for 7838.52 hours or 89.48% of the total number of hours in the year. The electrical production was 7.01% higher than planned. The generation of thermal energy in the Krško NPP reactor was 14,463,491 MWh.

The whole production of the electrical energy in Slovenia was 11,989 GWh, the share of the nuclear energy production being 39.9%.

The most important safety and operational indicators are shown in Table 8.1, while their changes over several years are presented further below in the report.

Table 8.1 Safety and operational indicators of the Krško NPP

Safety and Operational Indicators	Year 1997	Average
Availability factor (%)	89.48	81.56
Load factor (%)	88.27	77.35
Forced outage factor	1.87	1.68
Net electrical energy production (GWh)	4793.9	4192.6
Reactor shut-down - manual (Number)	1	2.4
Reactor shut-down - automatic (Number)	1	4.3
Incident reports (Number)	2	4.2
Outages duration (Days)	31	64.63
Fuel reliability indicator (FRI) (GBq/m^3)	0.08	0.15

Figures 8.1 to 8.3 present charts showing the number of reactor shut-downs per year, the forced outage factor and the number of incidents per year. The data in Figure 8.3 differ from those before 1991, since the Krško NPP introduced a new system of labelling the incident reports (i.e. some reports were registered under the same number, ref. a letter from the Krško NPP No. SRT-356/4150 of 8.4.1991).

In addition to record production and load factor, the operational reliability of the Krško NPP was also at a very high level. In 1997, there were only two abnormal events i.e. the automatic shut-down at the beginning of the year and a short loss by the residual heat removal (RHR) system during the 1997 refuelling outage, which is below the average. A planned manual shut-down took place during the 1997 annual outage.

Figure 8.1: Reactor shut-downs

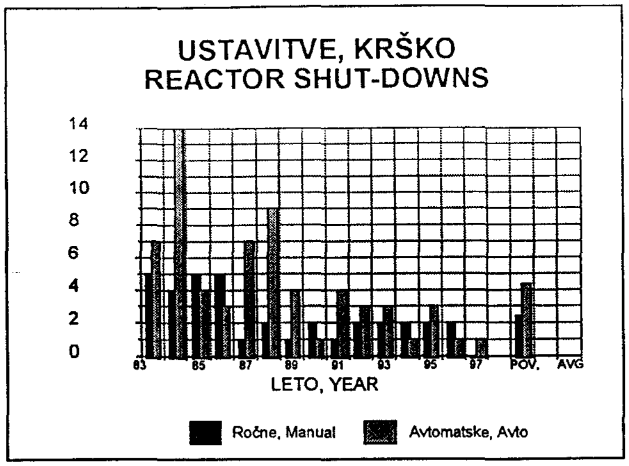


Figure 8.2: Forced outage factor

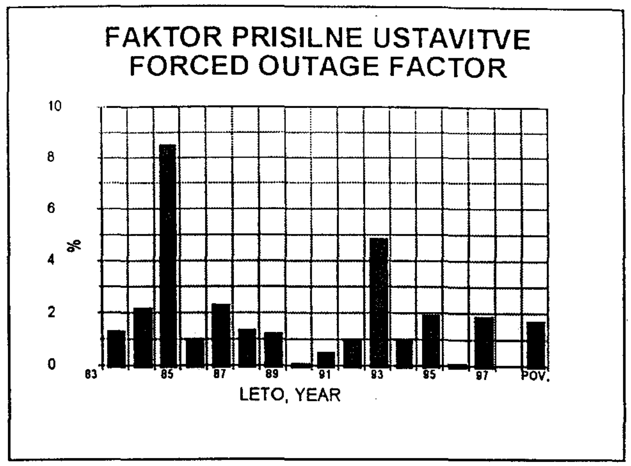


Figure 8.3: Incident reports

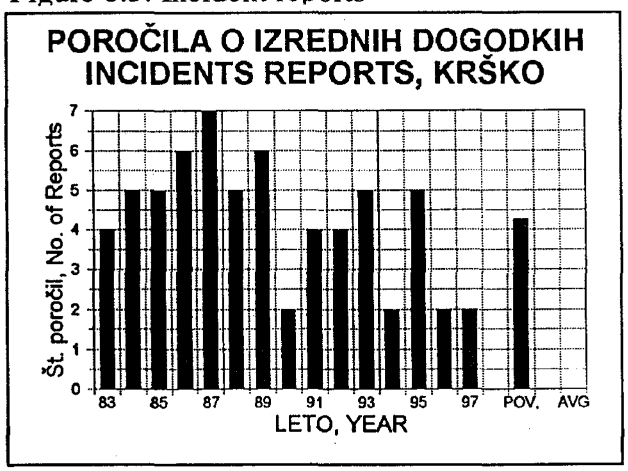


Figure 8.4: Time diagram of energy production in the Krško NPP for 1997

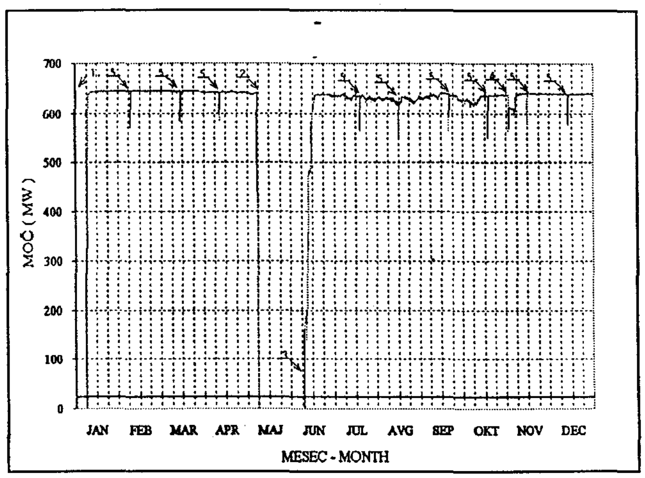


Table 8.2: Schedule of planned and realized production in the Krško NPP in 1997.

Month	Planned Production (GWh)	Actual Production (GWh)	Difference (%)
January	430	355.848	-17.24
February	400	423.536	5.88
March	430	468.164	8.88
April	410	448.540	9.40
May	100	132.128	32.13
June	200	254.072	27.04
July	410	456.360	11.31

Month	Planned Production (GWh)	Actual Production (GWh)	Difference (%)
August	410	451.748	10.18
September	420	441.876	5.21
October	430	453.920	5.56
November	420	444.096	5.74
December	420	463.688	10.40
Total	4480	4,793.976	7.01

Table 8.3: Analysis of operation of the Krško NPP in 1997.

Analysis of operation	Hours	Percentage (%)
Number of hours in a year	8760	100
Operation of the NPP (in the grid)	7838.5	89.48
Duration of shut-downs	921.5	10.52
Duration of annual outage	758.1	8.65
Duration of planned shut-downs	0	0
Duration of unplanned shut-downs	163.4	1.87

Figure 8.4 presents the time diagram of energy production in the Krško NPP in 1997, and Figure 8.5 the monthly diagrams of operation of the power plant. Due to the shortest annual outage ever, and to the operational reliability, the production of the electrical energy of the Krško NPP was by 7% higher than planned.

The availability of the nuclear power plant is the ratio between the number of hours of generator operation (synchronized with the grid regardless of the power of the reactor) and the total number of hours in the given period. This shows the percentage of time of the NPP being connected to the grid.

The load factor is the ratio between the electrical energy produced and the electrical energy which could have been theoretically produced at the maximum capacity in the same time period.

In calculations of the availability factor, load factor and forced outage factor, the total production of electrical energy from 1 January 1983, when the start-up tests were finished, was taken into account.

The charts in Figures 8.6 to 8.9 present the main operational data for the entire period of regular operation of the Krško NPP and enable a comparison to be made between the 1997 results and the previous period. The load factor (Figure 8.6) is used world-wide as the main indicator of operational reliability of the power plant; in 1997, it was the highest ever in the entire operation period of the Krško NPP. The availability factor (Figure 8.7) is another important factor, since in a number of power plants the power is intentionally reduced because of fluctuations in the demand for electrical energy and, therefore, a better load factor cannot be achieved. In Figure 8.8 the total electrical energy production for all years of the nuclear power plant operation is presented; in 1997, there was a record production of 4793 GWh. Figure 8.9 offers a comparison between nuclear, hydro and thermal electrical energy production in Slovenia over several years. Figure 8.10 presents the outage duration, which has been getting shorter in recent years.

Figure 8.11 demonstrates the unplanned capability loss factor. This factor is calculated as a ratio of the unplanned energy losses to the reference energy generation (maximum production of energy).

Figure 8.12 indicates the number of unplanned automatic scrams per 7000 hours critical, which represents the annual amount of critical hours in the plant in most countries.

Collective radiation exposure (Figure 8.13) shows a further decrease in personnel exposure at the plant.

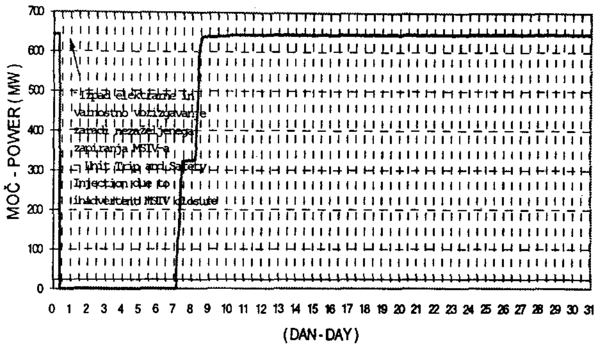
Figure 8.14 presents the volume of low-level solid radioactive waste. The absolute volume of wastes was slightly reduced in 1995 due to a new, more efficient method of supercompressing the wastes. In recent years, a general progress can be observed toward reducing the volume of wastes.

The industrial safety rate (Figure 8.15) presents the ratio between the number of lost working hours resulting from occupational injuries and the total of working hours. In 1997, there were 9 injuries, involving one or more working days out of work.

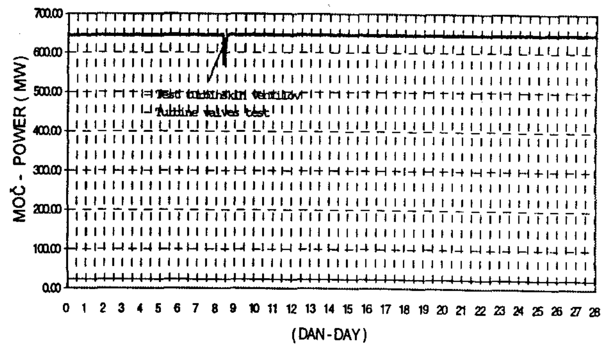
Figure 8.16 presents the number of unplanned actuations of the safety injection system.

Further below, a presentation is given of the operational reliability factors and the time analysis of the Krško NPP operation in 1997.

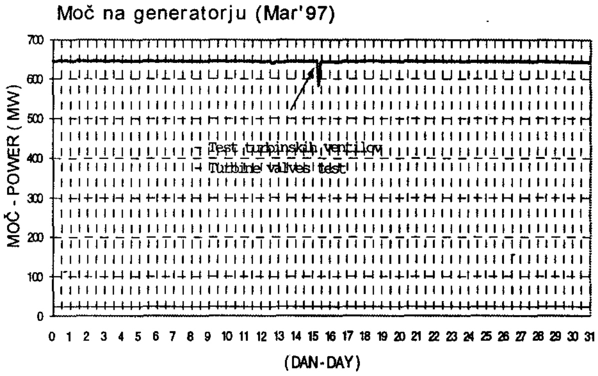
Moč na generatorju (Jan'97)



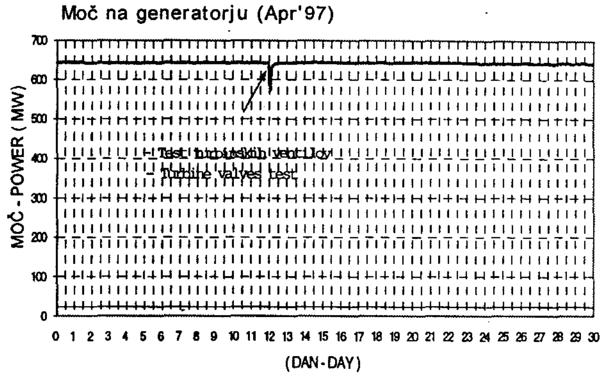
Moč na generatorju (Feb'97)



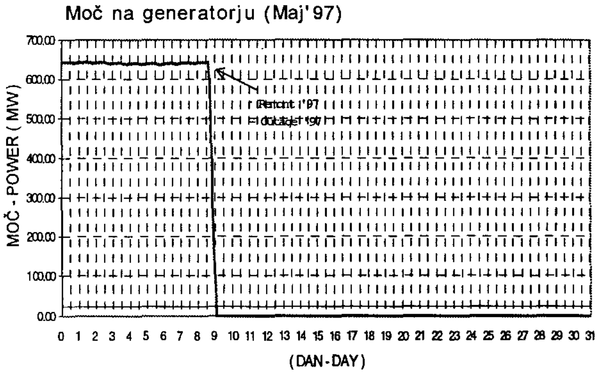
Moč na generatorju (Mar'97)



Moč na generatorju (Apr'97)



Moč na generatorju (Maj'97)



Moč na generatorju (Jun'97)

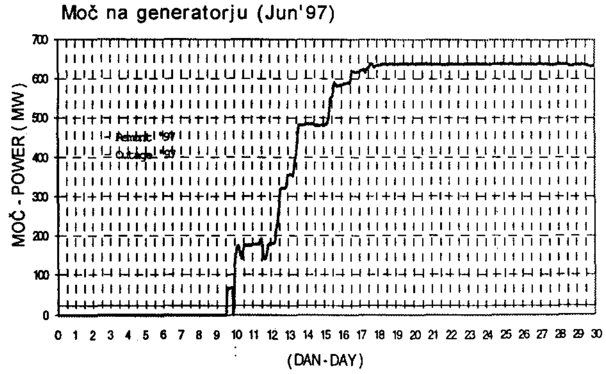
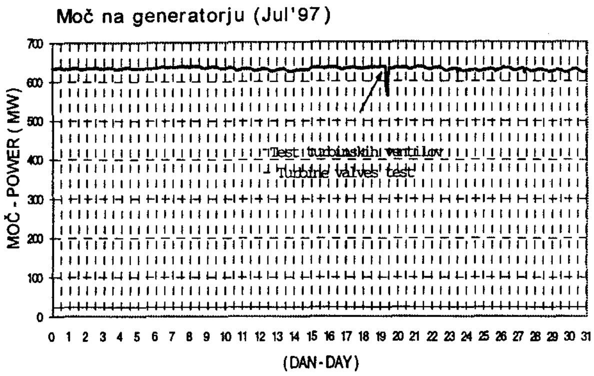
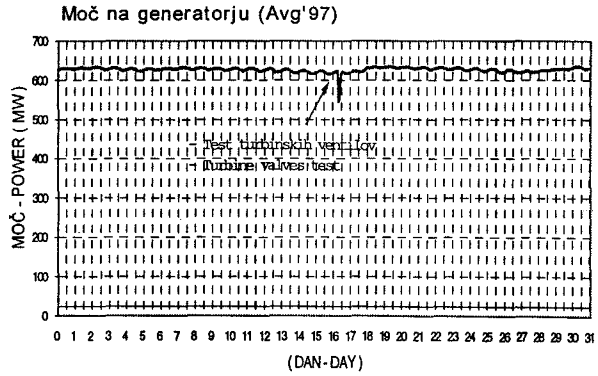
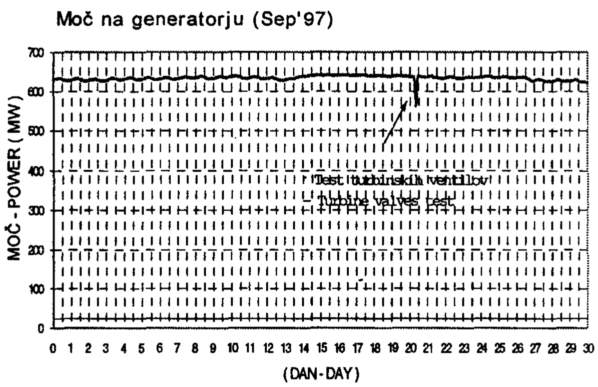
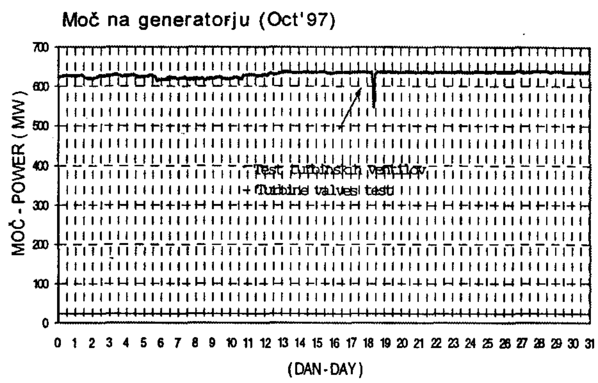


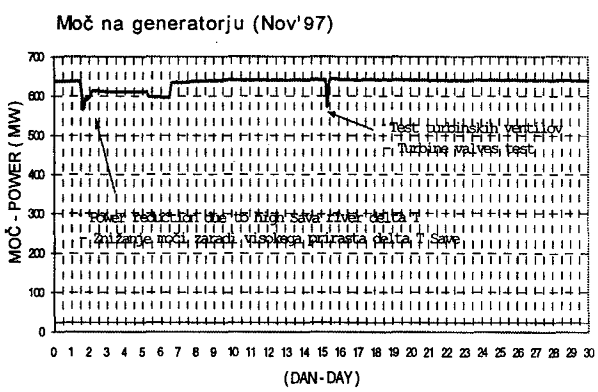
Figure 8.5: Monthly diagrams of operation of the Krško NPP











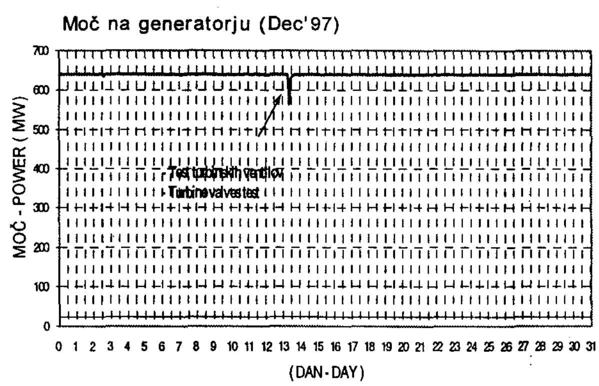


Figure 8.5: Monthly diagrams of operation of the Krško NPP

Figure 8.6: Load factor

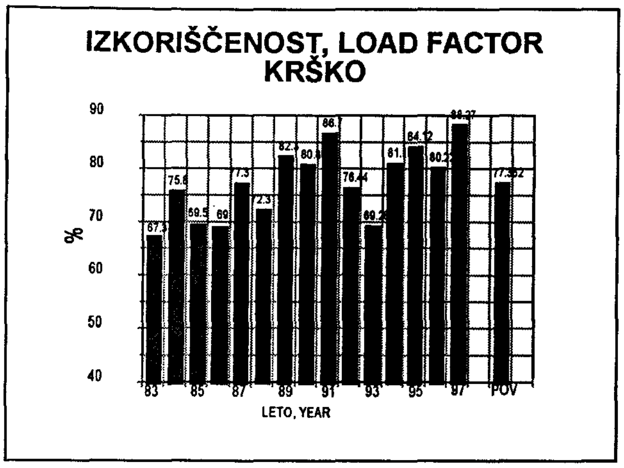


Figure 8.7: Availability factor

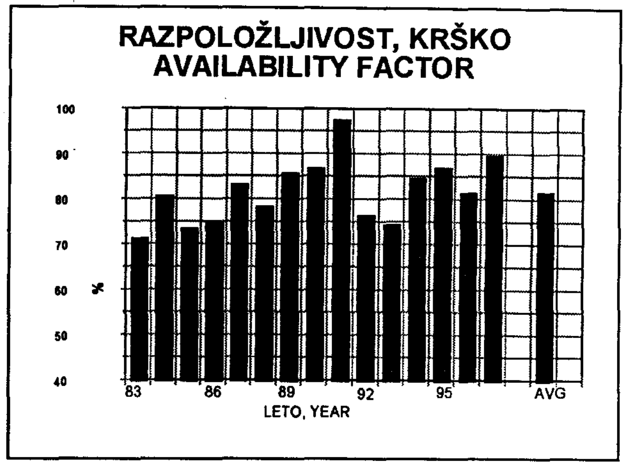


Figure 8.8: Actual electrical energy production

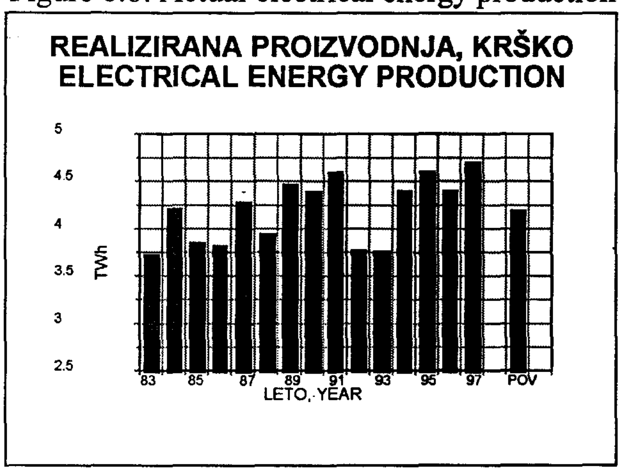


Figure 8.9: Electrical energy production

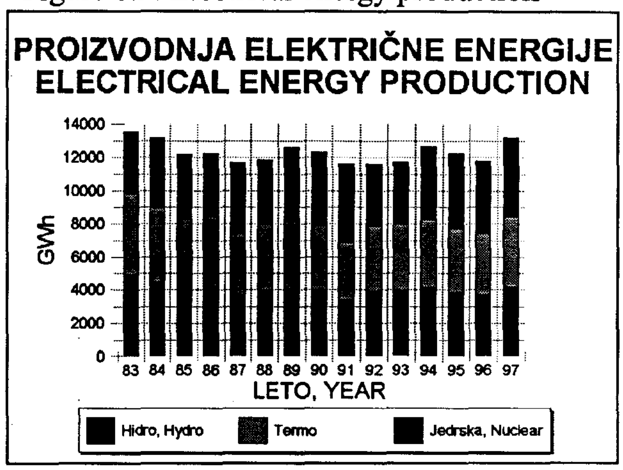


Figure 8.10: Annual outages duration

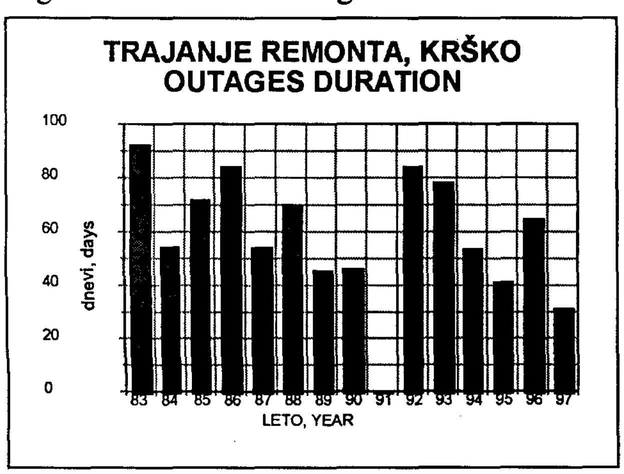


Figure 8.11: Unplanned capability loss factor

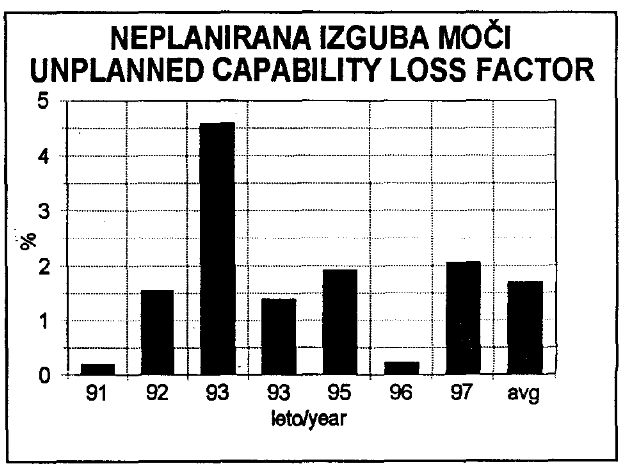


Figure 8.12: Unplanned auto scrams per 7000 hours critical

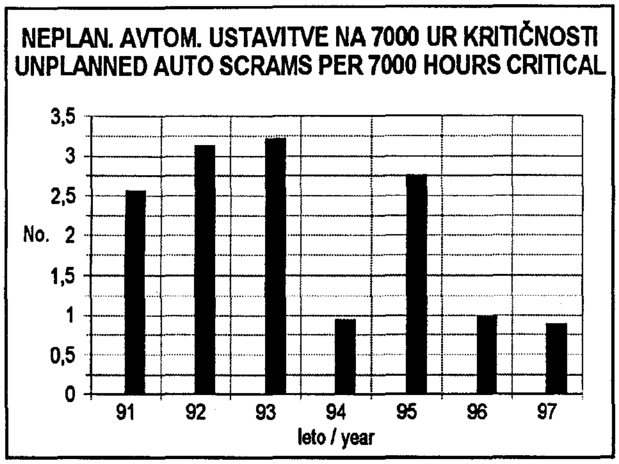


Figure 8.13: Collective radioactive exposure

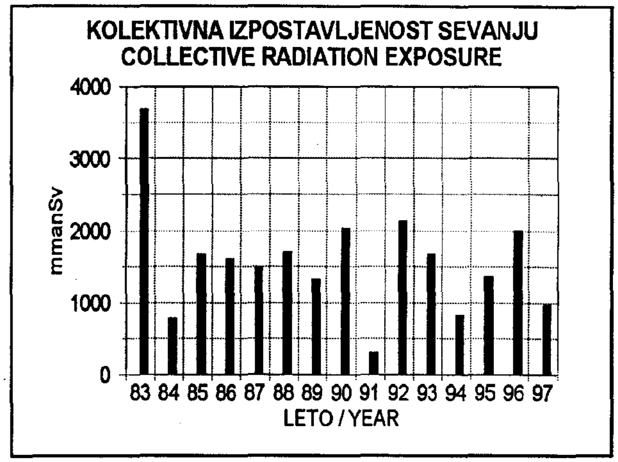


Figure 8.14: Volume of low level solid radioactive vaste

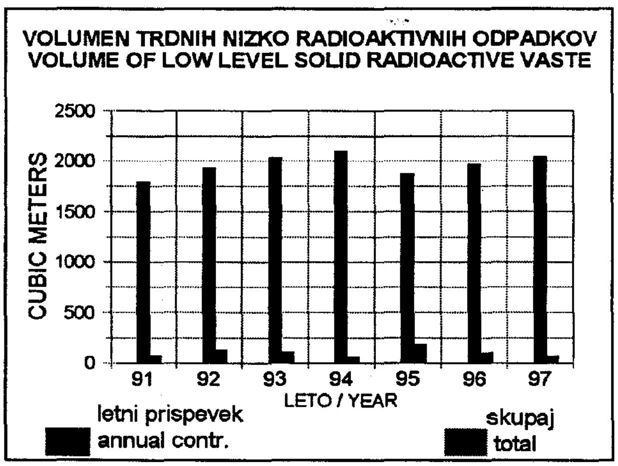


Figure 8.15: Industrial safety rate

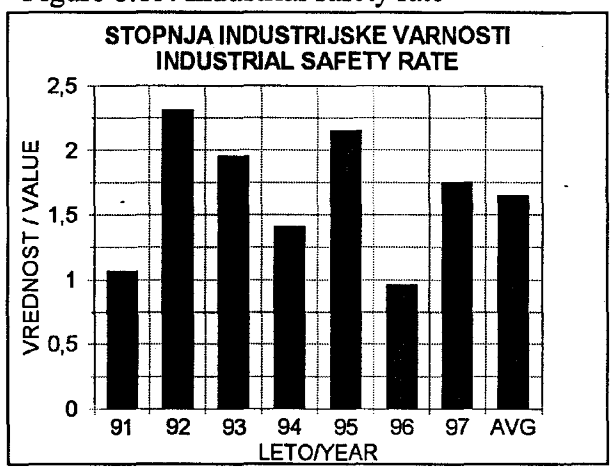


Figure 8.16: Unplanned safety injection system actuations

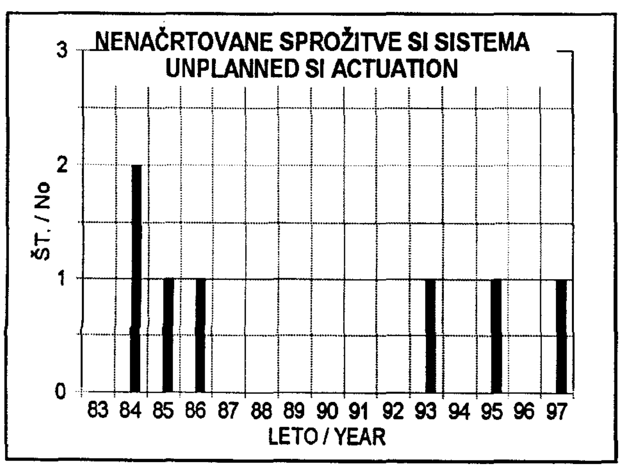


Figure 8.17: Emergency AC power system unavailability factor

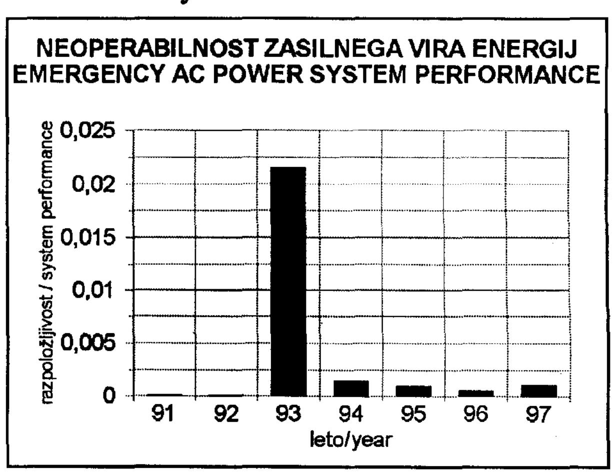


Figure 8.18: Auxiliary feedwater system unavailability factor

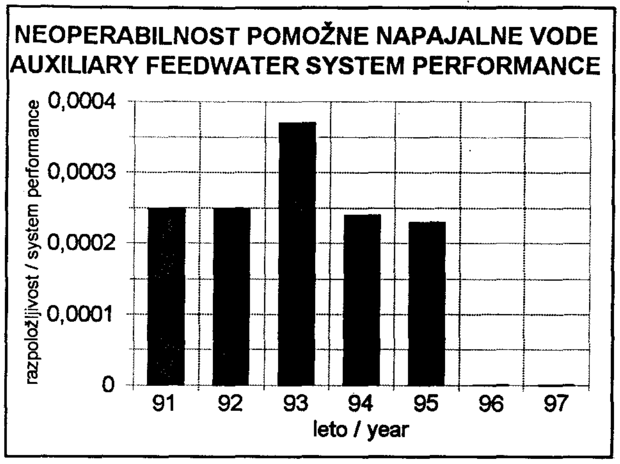


Figure 8.19: High pressure safety injection unavailability factor

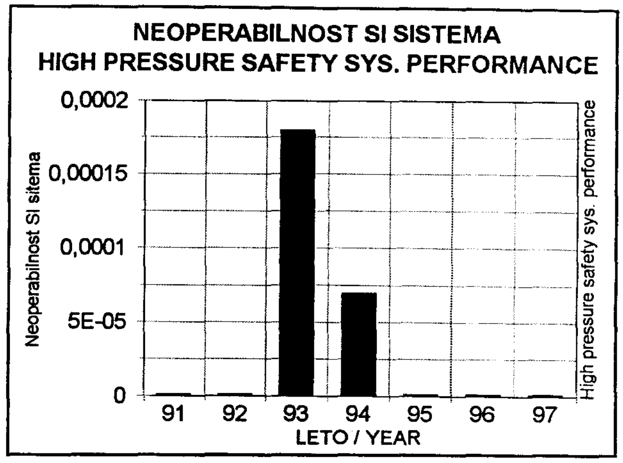
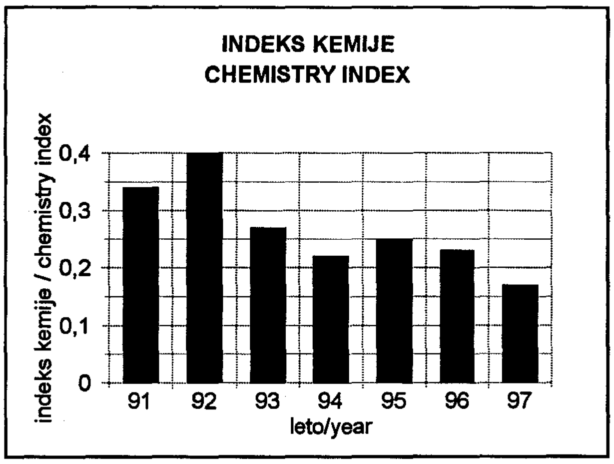


Figure 8.20: Chemistry index



Note: Data on outages, actual production, load factor and abnormal events have been rechecked, and, consequently, there are some slight differences in comparison with previous reports.

The purpose of the indicators in Figures 17, 18 and 19 is to present the system performance, i.e. reliability of important safety systems to respond to abnormal events or incidents. The indicators show the impact of effective operational and maintenance practices on the availability of safety systems components.

Figure 8.17 presents the auxiliary AC power system unavailability factor, i.e. the electrical power system performance in case of on-site or off-site loss of AC power.

Figure 8.18 presents the auxiliary feedwater system unavailability factor, i.e. the performance of the auxiliary system for supplying the feedwater into the steam generators of the pressurized water NPP, when the main feedwater system is unavailable.

Figure 8.19 presents the high pressure safety injection system unoperability factor, i.e. the performance of the system for supplying additional coolant in case of pressure drop or loss of coolant in the primary system and, therefore, in the core.

Figure 8.20 indicates the chemistry index for water, comparing concentrations of chosen impurity samples with their limit values. The average of such daily measurements for each impurity sample is divided by its limit value, and the sum of ratios normalized to 1.0.

Sources:

1. 1997 Annual Report of the Krško NPP, February 1998.
2. Performance Indicators for the Year 1997, Krško NPP, January 1998.

8.2.1.2 Shut-downs and Reductions of Power

Data on shut-downs and reductions of power of the Krško NPP are presented in tabular form (Table 8.4). Below is given a short description of the only automatic forced outage of the NPP in 1997.

Table 8.4: Planned and unplanned shut-downs of the Krško NPP and reductions of reactor power by more than 5% of the installed power.

Date	Duration (h)	Type	Mode	Cause
01.01.	163.4	Forced	Automatic	**Automatic outage** of the NPP and safety injection system actuation due to closure of the isolation valve on the main steam line no. 2 (MSIV).
09.02.	4	Planned	Manual	**Operating at reduced power (90%)** due to testing of the turbine valves.
16.03.	4	Planned	Manual	**Operating at reduced power (92%)** due to testing of the turbine valves.
13.04.	4	Planned	Manual	**Operating at reduced power (90%)** due to testing of the turbine valves.
10.05.	758.1	Planned	Manual	**1997 annual outage** (10.05.97 - 10.06.97).
20.07.	4	Planned	Manual	**Operating at reduced power (90%)** due to testing of the turbine valves.
17.08.	4	Planned	Manual	**Operating at reduced power (89%)** due to testing of the turbine valves.
21.09.	4	Planned	Manual	**Operating at reduced power (89%)** due to testing of the turbine valves.
19.10.	4	Planned	Manual	**Operating at reduced power (89%)** due to testing of the turbine valves.
02.11.	122	Forced	Manual	**Operating at reduced power (94%)** due to low water level of the Sava river.

16.11.	4	Planned	Manual	**Operating at reduced power (90%)** due to testing of the turbine valves.
14.12.	3.5	Planned	Manual	**Operating at reduced power (90%)** due to testing of the turbine valves.

A short description of the forced outage in 1997:

On 1 January 1997, before the event, the power plant operated steadily at full power. At 8.33 a sudden closure of the main steam isolation valve MSIV 20142 occurred on the main steam line no. 2. As a consequence of the sudden closure of MSIV and unreduced power of the turbine there was a loss of pressure in steam pipe no. 1. The safety injection (SI) signal was activated, which in turn activated an immediate turbine trip and reactor trip and isolation of the main steam lines (closure of the second MSIV).

The Nuclear Safety Inspectorate Section of the SNSA was immediately notified of the automatic shut-down; in the following days it carried out several non-routine and routine inspections.

The event had no impact on the environment. According to the international scale of events (INES) the event was graded as an event not relevant for nuclear safety, degree 0 (Below Scale - No Safety Significance).

The Krško NPP personnel immediately started actions to establish the cause of the sudden closure. At first it was suspected that the closure was caused by failure of one of the components of the valve control system; however, on 2 January 1997 it was established that the stem of the valve was broken and, consequently, the valve remained closed in spite of the opening action.

The valve was completely dismantled in the following days, and it was found that the breakage occurred at the junction point where the valve stem is set into the stop cylinder. The stem and other vital mechanical parts were replaced. The repair was supervised by a serviceman of the valve supplier (Atwood&Morrill, USA).

After successful maintenance works and post-maintenance tests the power plant was resynchronized to the electrical grid at 3:57 on 8 January 1997.

The Inspectorate of the SNSA surveyed all the repair works and the operability tests.

At the request of the Inspectorate Section of the SNSA the technical support organization IMT, Ljubljana, made a detailed analysis of the mechanical integrity of the broken valve stem. The analysis established that the damage had occurred because of fatigue fractures at the narrow part of the valve stem, where it is set into the stop cylinder.

During the 1997 annual outage the stem of the isolation valve of the steam pipe loop A was also examined, and the presence of the initial fatigue cracks was established. The stem of the valve was replaced by a new one, and all mechanical parts were checked.

The SNSA carried out a detailed analysis of the event and reported on the event to the international incident data base (Incident Reporting System, IAEA). The survey of available reports on similar events shows that the event can be considered as unique, since up to now such valve damage has not been described. The SNSA also reported on the event to the US NRC (US Nuclear Regulatory Commission).

The experience gained from this event has shown that the effects of material fatigue and ageing should be taken into account in maintenance of components important for safety of the NPP, a point which has already been taken into account by the maintenance staff of the Krško NPP.

8.2.1.3 Fuel Reliability and Activity of the Primary Coolant

The period between two refuelling outages is called the reactor fuel cycle. In 1997, the 13th and the 14th fuel cycles took place. The 13th fuel cycle started on 21 July 1996, continued in 1997 and was completed on 10 May 1997, as planned. The 14th cycle started on 10 June 1997 and is to be completed in May 1998. The core of the reactor consists of standard type fuel elements 16x16 with VANTAGE 5 properties and with 4.3% enriched U-235, produced by Westinghouse. During the 14th fuel cycle modified fuel (16 elements), which included a new bottom nozzle of the fuel element (Debris Filter Bottom Nozzle), was used for the first time.

The condition of the fuel elements in the reactor (fuel integrity) is controlled indirectly through the activity of the reactor coolant (See the SNSA 1996 Annual Report).

The comparison of the basic indicators of fuel reliability for 1996 and 1997 showed that the integrity of the nuclear fuel was degraded by 30% at the beginning of 1997, i.e. at the end of the 13th fuel cycle. During the 14th fuel cycle for the first time the Krško NPP used modified fuel with a new bottom nozzle of the fuel element "Debris Filter Bottom Nozzle (DFBN)"; which has proved effective in other power plants. The advantage of the new nozzle is the higher density grid which intercepts any foreign particles. By the end of 1997 the indicators of fuel damage showed that in the 14th fuel cycle there was no damage to the fuel rods and that the introduction of modified fuel elements was justified.

Information on the activity of the primary coolant is presented in Table 8.6, while the contamination values for individual fuel cycles are given in Figure 8.21.

The Fuel Reliability Indicator (FRI) is a criterion of fuel reliability and is also used for comparison with other reactors world-wide. This factor represents the specific activity of iodine 131, corrected by the contribution of iodine 134 from dispersion uranium in the primary system and normalized to a constant value of the purification rate. The FRI values for the 12th, the 13th and the 14th cycle in 1997 are presented in Table 8.5. The Krško NPP was within the target value for the last time in 1991.

Table 8.5: FRI values for the 12th, the 13th and the 14th cycle and 1997 only

	Fuel Reliability Indicator FRI			
	12th cycle	13th cycle	14th cycle	1997
Beginning	0.0041	0.00407	0.00172	0.00493
End	0.0123	0.00643	/	0.00269
Average (all measurements)	0.0199	0.00555	in 1997 0.00224	0.00361

Source: Krško NPP Annual Report

Figure 8.21: Contamination of the primary coolant in the 14th cycle - only in 1997

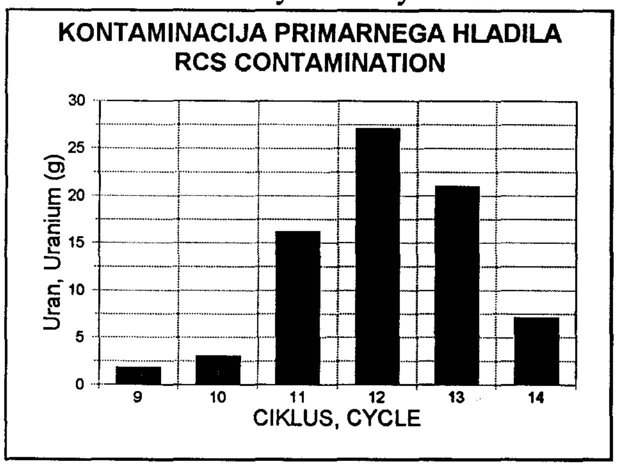


Figure 8.22: Fuel reliability factor

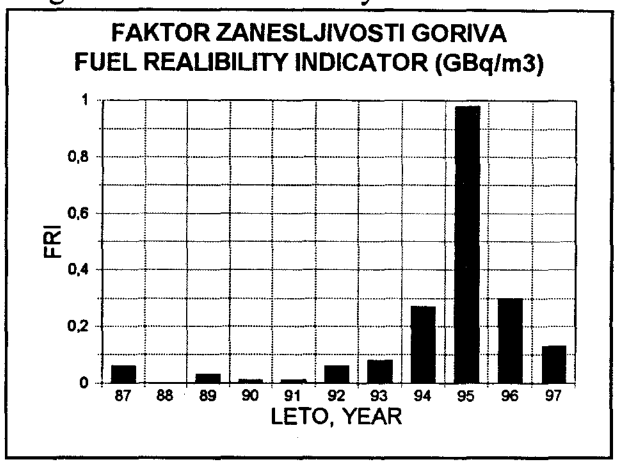


Table 8.6: Average activity of primary coolant in the 7th, 8th, 9th, 10th, 11th, 12th, 13th and 14th cycle

Radionuclide (λ/2 in hours h or days d)	AVERAGE ACTIVITY (GBq/ m3)											
	7th cycle	8th cycle	9th cycle	10th cycle	11th cycle		12th cycle		13th cycle		14th cycle 10.6.97 – 31.12.97	
					1*	2*	1*	2*	1*	2*	1*	2*
I-131 (8.1 d)	0.08	0.03	0.1	0.11	0.78	744	0.44	0.66	0.183	0.306	8	7
I-133 (20.8 d)	0.55	0.34	0.25	1.09	3.99	914	2.22	2.12	2.217	1.8	115	103
I-134 (0.87 h)	2.22	1.22	0.68	0.62	5.4	540	5.81	6.03	9.288	0.72	430	4.11
Xe -133 (5.24 d)	23.3	7.4	16.83	6.1	19.72	2035	12.62	18.61	5.04	4.32	178	167

Radionuclide (λ/2 in hours h or days d)	AVERAGE ACTIVITY (GBq/ m3)											
Xe-135 (9.1 d)	2.96	0.89	5.81	3.2	16.24	1668	13.65	17.39	5.4	4.82	289	273
Xe-138 (14.2 m)	0.93	0.52	0.91	0.41	3.09	363	5.92	7.03	7.308	6.55	374	370
Kr-85m (4.5 h)	1.11	0.26	1.54	0.73	2..33	239	2.11	2.623	0.705	0.6372	35	34
Kr-87 (1.3 h)	0.48	0.19	0.93	0.47	2.69	282	3.53	2.85	1.28	1.1844	64	62
Kr-88 (2.84 h)	1.11	0.32	2.36	1.12	6.88	633	4.92	5.51	1.746	1.692	91	88
Duration of the fuel cycle	308 days	396 days	485 days	513 days	469 days		351		293		204	
Duration of EFPD days	275.5	365.5	437.9	394.5	406.5		336.7		274.2		200	
Maximum burnup of an element (MWD/TU)	37402	40009	46606	46785	48094		48333		44215		42679	

1* stable conditions
2* all measurements

8.2.1.4 Condition of Barriers - Steam Generators

The steam generators in the Krško NPP are designed as vertical heat exchangers, where the reactor coolant transmits the heat from the primary system to the water of the secondary system, thus turning it into steam. The construction of the steam generator enables the generation of superheated steam, which is used to run the turbine. The Krško NPP has two Westinghouse Type D-4 steam generators with vertical U-tubes, which together with the tubesheet for in-built and in-rolled U-tubes, form the barrier between the primary and secondary coolant/system. Due to the fairly large surface of the U-tubes, the steam generator represents more than half of the barrier surface of the primary coolant, which is exposed to high differential pressure (92 bars) and thermal loads (191 kW/m^2). Breakage or strong leakage of one or more U-tubes would cause increased radioactivity from the secondary coolant and the risk of a limited release of radioactivity into the environment.

The extreme importance of the safety barrier by U-tubes between the primary and secondary system requires regular and efficient monitoring of tube integrity or tube failure, respectively. The basic criteria for assessment of the failed tubes level in a steam generator were laid down early in 1970. The criteria are based on the prerequisite that more than a 50% degradation of the tube wall is unacceptable, and that a tube with such an indication should be plugged and taken out of operation. The most frequent cause of U-tubes failure is stress corrosion.

In 1997, the activities on the steam generators of the Krško NPP were twofold:
* inspection and remediaton of the existing steam generators,
* replacement of steam generators.

Inspection and Remediation of the Existing Steam Generators

In order to define the level of failure in both steam generators a 100% inspection of tubes was necessary during the 1997 annual outage. For inspection of the tubes, the eddy current technique (ECT) was used.

The inspection was carried out on 3833 tubes in operation in the steam generator No. 1 (SG1). In the steam generator No. 2 (SG2) 4123 tubes in operation were examined. In each steam generator there are 4568 tubes (SG1) or 4575 tubes (SG2), respectively.

The analysis of measurement results by the eddy current technique (ETC) showed the following:

Steam generator No. 1:
- 82 tubes in operation indicated damages which exceeded the criteria for plugging,
- during the 1997 outage altogether 82 tubes were plugged,
- after the 1997 outage there were 3751 tubes in operation, of which 298 with inserted sleeves; altogether 817 tubes or 17.89% are plugged. By taking into account the equivalent of the hydrodynamic resistance of the inserted sleeves the relative level of plugged tubes is 18.06%.

Steam generator No. 2:
- 225 tubes in operation indicated damages which exceeded the criteria for plugging,
- during the 1997 outage altogether 225 tubes were plugged,
- after the 1997 outage there were 3898 tubes in operation, of which 291 with inserted sleeves; altogether 677 are plugged. The absolute level of plugging is 14.80%. The relative level of plugged tubes (if the sleeves are taken into account) is 14.97%.

The average proportion of plugged tubes in both steam generators, taking into account the impact of inserted sleeves, is 16.51%.

Figure 8.23: Plugged steam generators tubes in the Krško NPP in the period 1981-1997

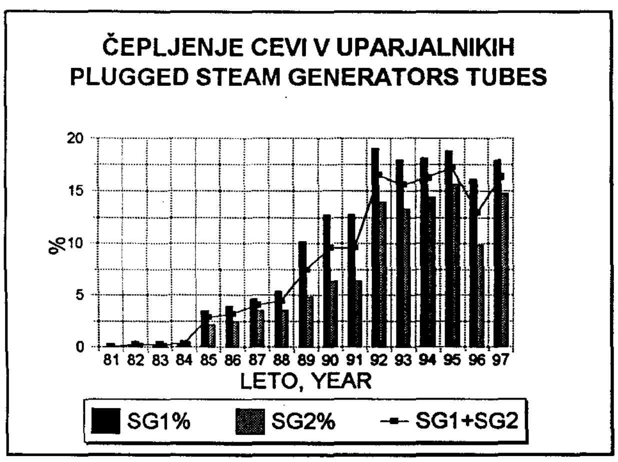
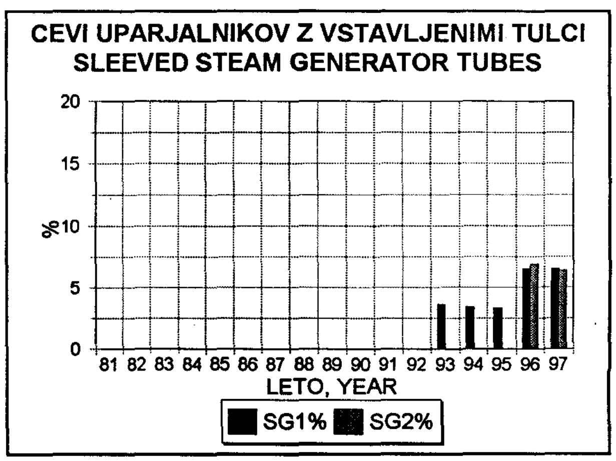


Figure 8.24: Sleeved steam generator tubes in the Krško NPP in the period 1981-1997



The asymmetry of plugging between SG1 (18.06%) and SG2 (14.97%) is 3.09% and is within the limits according to the conclusions of the Westinghouse study "NPP Krško 18% Steam Generator Tube Plugging Analysis Review", so that the Krško NPP may operate at 100% power.

During the 1997 outage, the sleeves insertion campaign in degraded tubes of steam generators was not carried out; the damaged tubes were only plugged.

Figures 8.23 and 8.24 present the corrective measures of plugging and insertion of sleeves to the steam generators in the period 1981 - 1997.

Table 8.7 presents a survey of corrective activities status on SG1 and SG2 for the period from the 1993 outage to the 1997 outage.

Table 8.7: Status of steam generators after the corrective activities on U-tubes.
Steam generator No. 1 (SG#1)

Status of U-tubes in the steam generator	Outage '93		Outage '94		Outage '95		Outage '96		Outage 97	
Total without sleeves	3582		3582		3558		3534		3453	
-in normal operation		3559		3511		3558		3525		3453
-reactivated, plugged before		23		71		0		9		0
Total with sleeves	166		158		152		299		298	
Total in operation	3748		3740		3710		3833		3751	
INSERTION OF SLEEVES										
With sleeves	166		0		0		147		0	
-in operationovanju		27		0		0		15		0
-reactivated. plugged before		139		0		0		132		0
PLUGGING										
Unplugged	245		156		64		197		0	
-replugged, according to plugging criteria		37		85		0		45		0
-replugged, unsuccessfull insertion of sleeves		46		0		0		11		0
-replugged, other reasons (e.g. * exchange of plugs)		0		0		64*		0		0
-reactivated, without sleeves		23		71		0		9		0
-reactivated, with sleeves		139		0		0		132		0
Total replugged	83		85		64		56		0	
Plugged for the first time, in operation before	110		79		30		18		82	
-plugged, without sleeves (corresponding to the plugging criteria)		93		71		24		15		81
-plugged, with sleeves (unsuccessful insertion of sleeves, criteria for plugging fulfilled)		17		8		6		3		1
Total plugged during the outage (plugged for the first time and replugged)	193		164		94		74		82	

Status of U-tubes in the steam generator	Outage '93		Outage '94		Outage '95		Outage '96		Outage 97	
Not plugged	623		672		764		661		735	
Total plugged	**820**		**828**		**858**		**735**		**817**	
Absolute plugging in %	17.95		18.13		18.78		16.09		17.9	
Relative plugging (with sleeves) in %	18.05		18.21		18.87		16.24		18.1	
Total number of U-tubes	**4568**									

Steam generator No. 2 (SG#2)

Status of U-tubes in the steam generator	Outage '93		Outage '94		Outage '95		Outage '96		Outage 97	
Total without sleeves	3966		3916		3858		3809		3607	
-in normal operation		3849		3916		3858		3778		3607
-reactivated, plugged before		117		0		0		31		0
Total with sleeves	0		0		0		314		291	
Total in operation	**3966**		**3916**		**3858**		**4123**		**3898**	
INSERTION OF SLEEVES										
With sleeves	0		0		0		314		0	
-in operationovanju		0		0		0		47		0
-reactivated. plugged before		0		0		0		267		0
PLUGGING										
Unplugged	179		6		81		423		0	
-replugged, according to plugging criteria		62		0		0		88		0
-replugged, unsuccessfull insertion of sleeves		0		0		0		37		0
-replugged, other reasons (e.g. * exchange of plugs)		0		6*		81*		0		0
-reactivated, without sleeves		117		0		0		31		0
-reactivated, with sleeves		0		0		0		267		0
Total replugged	62		6		81		125		0	
Plugged for the first time, in operation before	87		51		58		33		225	
-plugged, without sleeves (corresponding to the plugging criteria)		87		51		58		21		202
-plugged, with sleeves (unsuccessful insertion of sleeves, criteria for plugging fulfilled)		0		0		0		12		23
Total plugged during the outage (plugged for the first time and replugged)	149		57		139		158		225	
Not plugged	460		602		578		294		452	
Total plugged	**609**		**659**		**717**		**452**		**677**	
Absolute plugging in %	13.31		14.40		15.67		9.89		14.8	
Relative plugging (with sleeves) in %							10.06		15.0	
Total number of U-tubes	**4575**									

Replacement of Steam Generators at the Krško NPP

In 1997, the Krško NPP started the project of steam generators replacement and power up-rate. After the call for tenders in December 1996, the Consortium Siemens-Framatome was chosen as the supplier of the new steam generators. The production of components of steam generators is in now full swing and proceeding according to plan. The steam generators are to be produced and delivered to the Krško NPP by August 1999. In 1997, the preparation of safety analyses for operation of the plant with new steam generators at a 6.3% power up-rate was started as part of the project for steam generators replacement. Westinghouse was selected as the contractor for all safety analyses. The replacement of the steam generators will take place in spring 2000 (See paragraph 8.2.3 of this report).

8.2.2 SAFETY ASSESSMENTS AND LICENSING

8.2.2.1 Technical Improvements and Modifications to the Krško NPP

The SNSA gives special attention to nuclear safety, especially to high safety level of the Krško NPP. This concern includes improvements in the power plant itself based on the best international practices and the latest findings in the nuclear field. The Krško NPP has its own procedure for preparation and evaluation of technical modifications in accordance with domestic legislation or legislation of the supplying country (USA). The Krško NPP is required to inform the SNSA on modifications and its own safety evaluations. For modifications which are important for the nuclear safety the Krško NPP initiates licensing process with the SNSA in order to acquire the licence. In certain cases, based on safety evaluations of the proposed modifications review, the SNSA requires that the Krško NPP initiates an licensing process for granting the licence.

Modifications in 1997, for which a decision was issued by the SNSA:

Modification 219-CH-S "PIS Data Transmission to Ljubljana (ERDS&EOF)". By the end of the 1997 outage a data server for PIS Level 3 was set up, and software for modem transmission through the public telephone network to Ljubljana was installed.

Modification 102-VP-L. "Project In Drum Drying System - IDDS" comprises the change in the processing technology of concentrates from the evaporator and of spent resins with drying. The concentrates from the evaporator are dried directly in drums on two drying stations, while the drying of spent resins takes place in a drying tank.

- Modification 192-MW-L "Connection of the IDDS System with the MW System." The reactor make-up water is used for washing out the IDDS system.

- Modification 193-IA-L "Connection of the IDDS System with the IA System". The instrumentation air is used to drive pneumatic valves, actuators, seals and the vibrator.

- Modification 194-CA-L "Connection of the IDDS System with the CA System". Compressed air is used to clean sieves inside the SRST.

- Modification 195-FD-L "Connection of the IDDS System with the FD System". The washing-out system is conducted into the floor drains system.

- Modification 196-VA-L "Connection of the IDDS System with the VA System". Gaseous products from IDDS are conducted into the ventilation and air conditioning system.

- Modification 200-WD-S "Modification of the Tube Type Container Seal for Storage of Drums with Radioactive Wastes". Remote manipulation of drums for storage of IDDS products in TTCs.

- Modification 201-WD-S "Modification of a Protective Container for Transport of Drums with Radioactive Wastes". Modification of the protective container for use with the new remotely manipulated conveyer car for drums with the IDDS products.

- Modification 129-WP-L "Cutting-off of the Protection Wall in the Drumming Room." A part of the protection wall had to be removed to enable manipulation of the conveyer car for transport of drums with the IDDS products.

Other modifications:

- Modification 090-CH-L "Acquisition of Process Signals for Process Instrumentation System (PIS)" - Phase 2. This modification enables organised acquisition of signals from the process information system and facilitates better monitoring of technological process.

- Modification 125-DG-S "Emergency Diesel Generators Instrumentation Improvement". For easier access for calibration and repair, a modification was introduced into a part of the coolant system piping and the diesel generator ventilation system.

- Modification 132-CS-L "SV Valves on the Suction Ventilation Line of CS Pumps". Enclosure of two valves on the suction ventilation line of the chemical and volume control system to separate the charging pump from the volume control tank (VCT).

- Modification 144-ES-S "Automatic Reactor Shut-down by Shunt Trip Coil". A system for additional activation of the actuation switch for quick shut-down (Rx trip) in case of actuation of the safety injection signal for automatic reactor trip.

- Modification 210-XI-S "Cooling of CB103RCKK201 and CB103CKK401 Racks". Increased flow of the cooling air past electronic cards, installed in the control panel system racks.

- Modification 218-HE-S "HE910CRN001 Elevator Speed Regulation". Improved regulation of the polar crane speed.

- Modification 143-FH-L "Video Camera for Fuel Inspection". A new video camera on a moving telescopic pole installed in a spare slot on the conveyer car.

- Modification 147-FP-S "Rerouting of Tubes to the H15 Hydrant". The hydrant tubes were replaced and more conveniently routed.

- Modification 156-HD-S "Insertion of Mechanical Seals on HD Pumps". The seal failure frequency decreased on all three pumps of the heater drain system.

- Modification 214-FP-S "Electrical Fire Pump Shaft Shortening". The shaft was shortened in order to ensure better suction and to reduce impurities on the start-up of the pump.

- Modification 060-DG-S "Low water Level Alarm in the Diesel Generator". By separating the alarm circuits, an error of actuation in the general alarm signal was corrected at low coolant water level in the diesel generator system.

- Modification 080-CS-S "New Flow Meters for Reactor Coolant Pumps Seal No. 2". New flow meters for measuring wider range of seal leakoff flow in the reactor coolant system pumps.

- Modification 209-GN-S "Stator Coolant Water Pumps". The logic of start-up of the coolant water pump in the stator of the main generator was changed.

- Modification 183-CP-S "Carrying Construction for MG SET 1A, 1B". A suitable carrying construction with a manual elevator for manipulations during maintenance works of the generator motor was installed.

- Modification 191-NA-S "Protection Tubes around Rx Pool". Installation of protection tubes around the reactor pool for protection of maintenance staff during outage.

- Modification 137-DG-L "Replacement of Fuel Filters in Diesel Motors". Replacement of fuel filtering units of the housing with filter cartridges on motor driven pumps of diesel generators.

- Modification 072-CS-L "Drainage of the VCT Purge Line". To allow for easier drainage of gas decay tanks.

- Modification 142-NA-L "Adaptation of the Technical Support Centre". Refurbishment of floors, ceiling, furniture, communication equipment and documentation updating.

- Modification 228-FH-S "Insertion of Interlock onto Refuelling Machine FHSCMC01". A barrier relating to the telescopic video camera in the refuelling machine has been built in.

- Modification 063-CW-S "Lube Water Flow Initiation Alarm for the CW102PMP001, CW102PMP002 and CW102PMP003 Pumps". Replacement of instruments for measuring the flow rate.

- Modification 148-HE-S "Modification of the Crane in the Drumming Room". The crane in the drumming room was modified as required for manipulation of the IDDS products.

- Modification 101-HE-S "Remote Manipulation of Polar Crane". Replacement of the control panel on the crane by remote control system.

- Modification 088-VA-S "Shifting of Test Valves of the VA System". In order to decrease the exposure to high doses during the measurements, the valves in the ventilation and air conditioning system were shifted.

- Modification 082-DG-L "Relocation of Instrumentation of Diesel Generator System". The modification covered the relocation of instrumentation of the diesel generator system to enable easier access to locations during calibration and repair.

- Modification 050-RD-L "Reconstruction of the Hydraulic System on the Dam". Reconstruction of the hydraulic gate system - degraded by use and ageing - on the Sava river.

- Modification 116-PW-S "Installation of Additional Instrumentation on the PW System". Improved pH, conductibility and water opacity monitoring in the pretreatment water system.

8.2.2.2 Decisions Issued by the SNSA

In 1997, the SNSA issued the following decisions in field of nuclear and radiation safety:

1. Decision no. 390-01/96-7-1322/DL (13.12.1996): "Hydrogen monitors". With the proposed replacement of the hydrogen monitor the Krško NPP fulfils the requirement for extended measurements by continuous sampling (NUREG-0737/3.1, R.G. 1.97) and for an improved procedure for determination of hydrogen concentrations in the atmosphere of the reactor containment. This replacement represents a contribution towards the better safety of the power plant.

2. Decision no. 391-01/96-8-13582/MK (31.12.1996): The SNSA confirmed the Programme of radiological monitoring of the Krško NPP for 1997.

3. Decision no. 390-01/97-1-13679/DV (21.01.1997): The revision no. 50 of the Standard Technical Specifications (NEK-STS) for the Krško NPP is to be applied, namely, by changes in Chapter 4 "Design Features", Subchapter 4.1 "Site", Paragraphs 4.1.1 "Exclusion Area", 4.1.2 "Low population Zone", 4.1.3 "Map Defining Unrestricted Area and Site Boundary for Radioactive Gaseous and Liquid Effluents" coming into force.

4. Partial decision no. 390-01/97-2-14148/MP (28.02.1997):

- the Krško NPP is to supplement the "Programme of Measures for Fire Safety - the Krško NPP Fire Protection Plan" with an implementation deadline for each item and submit it to the SNSA for approval;
- the Krško NPP is to finish the applicable modifications to remedy the deficiencies from Table 2: the Krško NPP Fire Hazard Analysis, BPT APCsb 9.5-1, Appendix A, Compliance Matrix;
- the Krško NPP is to finish reconstruction of the entire outside hydrant network laid down in the Krško NPP document "Fire Hazards Analysis Assessment for Conformance to UNSRC Fire Protection Criteria", rev.1, point E.2;
- the Krško NPP is to replace all fire doors for fire areas protection in accordance with Chapter II, point 1.j of the NUS study. The new door should comply with the requirements of Standard NFPA 803.

5. Decision no. 391-01/97-2-14476/IO (28.03.1997): the Krško NPP is not permitted to proceed with any works on the modification no. 102-WP-L, "Drying of Wastes in EB and SR Type Drums", until a legally valid decision is obtained.

6. Decision no. 390-01/96-3-14580/DV (18.04.1997):

- the Krško NPP is allowed to change section 9.3.5 of the Final Safety Analysis Report (FSAR) and add the subsection 9.3.5.6 Temporary Fuel Sipping. The subsection reads as follows: "The other methods and equipment for the inspection of fuel elements may be used when demonstrated through safety evaluation process that applicable analyses and its results remain valid.";
- the Krško NPP should at least 20 days prior to application of the methods for testing the leak-tightness of fuel elements - different from those described in subsections 9.3.5.1 to 9.3.5.5 of the FSAR - submit for approval by the SNSA the following relevant procedures, previously reviewed and approved by the SNSA, and a special report together with the safety assessment in attachment;
- by this decision the temporary decision no. 390-01/96-3-11815/ AM issued by the SNSA on 12.06.1996 is repealed.

7. Decision no. 390-01/97-3-14548/DL (25.04.1997):

- the Krško NPP is allowed to use fuel elements with debries filter bottom nozzle (DFBN) in the Krško NPP reactor;
- the modification of FSAR proposed in the application ING.ANDO-260.97/BF/5014 of 27.03.1997 by the Krško NPP for use of DFBN filters is hereby approved;

8. Decision no. 390-01/97-4-15158/RD (06.06.1997): The SNSA applied the revision no. 53 of the Standard Technical Specifications (NEK-STS) defining the new closing times for valves in Chapter 3.6.4 "Containment Isolation Valves" and in section 6.2 "Containment Systems";

9. Partial decision no. 391-01/97-2-15179/IO (27.06.1997): the Krško NPP is allowed to install equipment for drying of the concentrate from the evaporator and of spent resin

using the methodology described in Modification no. 102-WP-L, under condition, that the present system for processing of such kinds of wastes remains in operation;
By this partial decision, the following actions are prohibited until further decision: packing into modified 200 l drums, transport of the drums to the storage area, filling of TTC-s in the storage area and storing;
An additional decision will regulate the remaining issues of the project and the FSAR modifications for the entire project of reducing the volume of concentrated wastes from the evaporator and spent resins;

10. Decision no. 391-01/96-2-15609/MK (18.07.1997): in the scope of meteorological measurements in 1997, the Krško NPP should provide for the following:
- performance of meteorological monitoring in 1997;
- sending meteorological data to the SNSA on a daily basis;
- regular updating of the basic meteorological data base and assurance of reliable computer data transmission to the SNSA and the Hydrometeorological Institute;
- regular and reliable transmission of meteorological and radiation data from all automatic measuring stations to the meteorological data base;
- processing of these data and their graphic presentation in the control room, in the technical support centre and in the operational support centre of the Krško NPP;
- prior notification of the SNSA on all planned extraordinary releases of radioactive materials into the air;
- formulation of the aggregate annual meteorological report and its delivery to the SNSA in two copies by 28.02.1998;
- delivery of the annual report on the establishment of operational procedures for meteorological service operations in case of emergency releases and their improvements to the SNSA;
- annual report on the project progress and its delivery to the SNSA;
- submission of the proposal of the programme for meteorological monitoring in 1998 to the SNSA;

11. Decision no. 318-53/90-16286/AM (14.10.1997): the Krško NPP is allowed to decrease the concentration of boric acid in the BIT tank from 20,000 – 22,500 ppm to 2,450 – 2,550 ppm, thus giving approval to amendment of the STS on pages 3.5-10, 3.5-11 and B3.5-2 and the FSAR in chapters 6.3, 15.1 and 15.5.

12. Partial decision no. 390-01/97-4-16827/RD (03.12.1997): the Krško NPP is allowed to use the ZIRLO material for fuel rods cladding, plugs and instrumentation channels.

13. Decision no. 390-01/96-11-16373/MP (19.12.1997): the SNSA has issued a decision to the Krško NPP on the administrative issue "Amendment of Standard Technical Specifications of the Krško NPP; Fire Safety" by official duty. The revision no. 55 of Standard Technical Specifications (NEK-STS) in the field of fire safety should be applied by the Krško NPP. The new specifications read as follows:

Chapter 3.3	Instrumentation
Subchapter 3.3.3	Monitoring Instrumentation
Chapter 3.7	Plant Systems
Subchapter 3.7.11	Fire Suppression Systems
Subchapter 3.7.12	Fire Rated Assemblies
Chapter B 3.3.	Instrumentation
Chapter B 3.7	Plant Systems
Subchapter B 3.7.11	Fire Suppression Systems
Subchapter B 3.7.12	Fire Rated Assemblies

14. Partial decision no. 318-42/95-17130/ DV (23.12.1997): the new revision no. 56 of Standard Technical Specifications (NEK-STS) is applied for the Krško NPP by the amendment of specifications in Chapter 5 "Administrative Controls", page 5-5, of the NEK-STS.
    The Krško NPP should set up the ISEG group in due time and change its internal organization so as to enable the ISEG to undertake its functions and fulfil its mission productively and efficiently in compliance with the provisions of the NEK-STS in the period after the 1998 outage.

8.2.3 PROJECT FOR MODERNIZATION OF THE KRŠKO NPP

8.2.3.1 Power Up-rate and Replacement of Steam Generators

The project of steam generators replacement started for the SNSA, when in September 1995 the Krško NPP presented its project for modernization of the Krško NPP, i.e. steam generators replacement and by a 6.3% power up-rate.

In 1996, communication between the Krško NPP and the SNSA intensified; this involved: presentation of evaluations of tenders for the supply of new steam generators and offers for analyses; the SNSA then prepared its comments and proposals on the scope and substance of analyses from these bids.

The co-operation continued in 1997, when the Krško NPP submitted its comments and additional explanations to the questions of the SNSA from 1996. Upon the initiative by the Krško NPP the SNSA clearly expressed its views as to the scope and substance of safety analyses in connection with the replacement of steam generators and the power up-rate. In February 1997, the Krško NPP presented to the SNSA the plan of quality assurance (QA) activities for production of the steam generators (materials, production of individual parts, installation/assembly of steam generators) and transport.

After selection of the supplier of new steam generators (Consortium Siemens-Framatome) and the contractor for safety assessment (Westinghouse) in 1997 - and considering the planned scope and dynamics of works for modernization of the power plant - the Krško

NPP, according to the previously determined scope of applications for initiation of licensing process, sent to the SNSA:

- an application to initiate the licensing procedure for steam generators replacement and safety analysis of the simultaneous power up-rate. Analyses for power up-rate and replacement of the steam generators, including the following:

⇒ determination of new operational conditions,
⇒ verification of new operational conditions,
⇒ other safety analyses,
⇒ review and verification of further operation (operability of the power plant, analysis of mechanical properties of components and system analysis);

- an application to initiate the licensing process for the design and production of steam generators for the Krško NPP. The new steam generators should provide for the following:

⇒ stabilized operation till the end of the anticipated lifetime of the Krško NPP;
⇒ increased availability of the power plant to 85%, and annual outages shortened to approximately 35 days;
⇒ increased operational safety and reduced risk of radioactive releases into the environment and reduced number of unplanned shut-downs to less than 2 per year.

With the above-mentioned applications the Krško NPP also formally initiated the licesing process for replacement of steam generators and power up-rate. The SNSA is considering the requests of the Krško NPP in accordance with its authority and the procedural and substantive law.

In conformity with domestic legislation, expert opinions on the proposed modifications relating to the steam generators replacement should be provided by the technical support organizations. Judging by the professional qualifications of individual technical support organizations, the Krško NPP opted for several professional organizations to provide expert opinions. Construction and production of the steam generators is to be covered by the following organizations:

- Faculty of Mechanical Engineering (FS);
- Institute of Metals and Technologies (IMT);
- Institute of Metal Constructions (IMK);
- Welding Institute (IV).

The evaluations and analyses of the planned power up-rate at the steam generators replacement are to be provided by the following organizations:

- Jožef Stefan Institute;
- Faculty of Civil Engineering and Geodesy (FAGG);
- Faculty of Electrical Engineering and Computer Science (FER).

From the SNSA viewpoint, the present stage of the project for modernization consists of seven subprojects subject to a licensing process - review, evaluation, analysis and inspections of the following:

- scope of the safety analyses;
- design/production of steam generators;

- safety assessment of the modification: replacement of the steam generators;
- replacement of the steam generators;
- disposal of out-of-use steam generators;
- other modifications and related safety assessments;
- functional and start-up tests.

Other necessary modifications related to the modernization of the Krško NPP should be subject to the separate licensing procedures. The SNSA expects to finish all the ongoing licensing procedures by the year preceding the year in which the actual replacement of the steam generators is planned.

According to the project for the steam generators replacement the Krško NPP also started preparations for the transport of new steam generators to Krško.

The steam generators, which will be produced by Siemens in Spain, are to arrive by ship at the port of Koper by the end of August 1999. From there they are to be transported by road, one by one, to the Krško NPP. The choice of the transport route and transport means has been importantly influenced by the extreme weight of the steam generator (343 tons). The transport is to start in Koper, continue to Kozina and further by highway to Ljubljana and Višnja Gora, from there on by main road through Čatež, Brežice and Spodnja Pohanca to Krško. For safety reasons the travelling speed is to be limited to 5 km/h; therefore, the transport of each steam generator is expected to take ten days. The time estimate for delivery of both steam generators to the Krško NPP is about one month.

The SNSA actively follows the production of the new steam generators. In 1997, there were two QA verifications with the producers of the steam generators: i.e. one at ENSA, Spain, and one at Sandvik, Sweden.

In 1997, modernization of the Krško NPP also included intensive training of the SNSA personnel with technical assistance from IAEA and the RAMG-PHARE programme.

8.2.3.2 Full Scope Simulator of the Krško NPP

The construction of the Krško NPP full scope simulator has been considerably delayed even though the first activities began already in 1984, when the Milan Čopič Training Center, Ljubljana, for the training of operators was built and its construction design foresaw the place for a full scope simulator.

On 20 April 1995 - in compliance with the national regulations, recommendations of international organizations, international practice and situation in Slovenia - the SNSA issued decision no. 318-30/94-8259/ML requiring the Krško NPP to purchase, install, test and bring into operation a full scope simulator of the Krško NPP by 31 December 1999. The construction of a simulator takes at least two years, and any delay would threaten meeting of the administratively determined deadline.

The Krško NPP evaluated the received tenders on full scope simulators from an international call for tenders, and on 7 August 1997 submitted the final report on tender evaluation to the Ministry of Economic Affairs. To comply with the decision of the SNSA the contract should have been signed in August 1997. However, due to the founders' failure to decide on the tender evaluation, the contract was not awarded and the Krško NPP sent a letter of intent to the selected supplier CAE Electronics, Ltd., Canada, in order to sustain the necessary time dynamics to comply with the administrative decision. CAE confirmed the letter of intent on 25 August 1997. All the details of the contract are agreed, and the contract has been submitted for approval to the founders.

The letter of intent means the following:

- delivery of the major part of documentation; and
- agreement and definition of the scope of simulation in accordance with the Technical Specifications.

The following activities were performed:

- delivery of additionally registered documentation;
- on the spot verification of data from the documentation by the contractor;
- preparation of project documentation by the contractor;
- verification of project documentation by the Krško NPP.

8.2.4 SPENT NUCLEAR FUEL

During each annual outage in the Krško NPP, the spent fuel elements are removed from the reactor core and replaced with fresh fuel. The spent nuclear fuel quantity depends primarily on the level of fuel burnup and on the strategy of reactor core utilization. In the past, when the level of burnup was lower - i.e. aprox. 33 GWdays/ton - about one third of the fuel elements had to be replaced from core during each refuelling outage. However, due to better fuel quality, an average burnup of up to 44 GWdays per ton has recently been reached. Consequently, the fuel elements are left in the core for about four years, and only one quarter of fuel elements need to be replaced at a specific time. Details on annual refuelling are given in Table 8.8.

Table 8.8: Records on fuel elements in the spent fuel pool

Year	Number of spent fuel elements in the spent fuel pool, cumulative per year	Annual increase
1983	40	40
1984	82	42
1985	122	40
1986	154	32

Year	Number of spent fuel elements in the spent fuel pool, cumulative per year	Annual increase
1987	194	40
1988	226	32
1989	266	40
1990	314	48
1991	314	0*
1992	358	44
1933	406	48
1994	404	0**
1995	442	36
1996	470	28
1997	498	28

* No refuelling in 1991
**In 1994, the annual outage started in December 1994, but the refuelling was carried out only in January 1995; in the reactor vessel are altogether 121 fuel elements containing 49 tons of enriched uranium

The spent nuclear fuel is kept in the spent fuel pool. The grids with 828 positions for storing the nuclear fuel occupy approximately two thirds of the pool. By the end of 1997, altogether 498 fuel elements were stored in the pool (approximately 194.6 tons of heavy metal). Altogether 7 positions are occupied by fuel inserts and containers, while 12 positions are reserved (closed with seals) for disposal of damaged fuel elements. The remaining 323 positions are reserved for storage of fuel elements, of which 121 are reserved for storage of the whole reactor core in case of emergency. In reality, there are only 202 positions available for storage of fuel elements, which is sufficient for a maximum of 6 years of operation of the Krško NPP.

8.2.5 RADIOACTIVE WASTE

During the operation of the nuclear power plant various radioactive waste materials are generated in gaseous, liquid and solid state, and are disposed of through the radioactive waste processing system. This system is constructed so as to collect, process, store and suitably pack the waste, and to minimize the radioactive releases into the vicinity of the NPP and the power plant area itself.

Three basic systems of radioactive waste management are used: for liquid, solid and gaseous radioactive waste.

The processed wastes are categorized as low and intermediate level radioactive waste (LILW), and are kept in 200 litre drums as follows:

- low level compressible radioactive wastes are packed without additional protection,
- the remaining wastes are stored in drums with concrete protection from the inside.

Table 8.9: Categories of LILW, stored in 1997

Category of waste	Number of drums	Activity (GBq)
EB	139	100
CW	142	19.4
O	49	6.4
SR	0	0
F	0	0
Total	330	125.8

Table 8.10 presents the status of the storage area on 31 December 1997 as to the category, quantity, activity, volume and specific activity of the wastes and the dose rate on the surface of the drums.

Table 8.10: Status in the storage area of the Krško NPP on 31 December 1997

Category of waste	Number of drums	Activity (GBq)	Volume (m^3)	Specific activity (GBq/m^3)	Dose rate microSv/h from	to
SR	689	16130	144.7	111.5	5	100000
CW	384	470.4	80.64	5.8	5	40000
EB	284	274.3	59.64	4.6	50	3000
F	98	1966	20.58	95.4	20	50000
O	118	72.5	24.78	2.9	5	10000
SC	617	531	197.4	2.7	10	25000
ST	1753	6784	1514.6	4.5	0.9	70000
Total	3943	26228.2	2042.34	12.8	0.9	100000

Category of waste:
SR - spent resins
CW - compressible waste
EB - concentrates from the evaporator
F - filters
O - other wastes
SC - compressed wastes from 1988 and 1989
ST - compressed wastes from 1994 and 1995

8.2.6 RADIOACTIVE RELEASES FROM KRŠKO NPP IN THE ENVIRONMENT

The limits of radioactive releases into the environment are stipulated by the licence for operation of the NPP Krško No. 31-04/83-5, issued on 6 February 1984 by the Energy Inspection Authority of the Republic of Slovenia.

The competent authorities were regularly informed about the releases of radioactive materials in the environment by the Krško NPP on a daily, weekly, monthly, quarterly and yearly basis.

8.2.6.1 Liquid Releases

The liquid radioactive releases are discharged into the Sava river through the main water supply in front of the dam. The activity of liquid releases indicates that the dominating radionuclides are: Xe-133, Xe-135, Xe-131m, Xe-133m, Kr-85, Co-60, Fe-59. The activity of Cs-134, Cs-137, Co-58 and Sb-125 decreased for two to three orders of magnitude. The main contribution to the dose is made by the radionuclides caesium and cobalt. The concentrations of each radionuclide in the liquid releases are measured and controlled by reactivity meters. These automatically close the local valves, once the prescribed limit concentration is reached, and thus prevent further releases into the environment. In liquid releases, the dominating radionuclide was tritium (H-3). In 1997, the annual released activity of this radionuclide was 7.8 TBq, which was approximately 39% of the annual limit value of 20 TBq. Figure 8.25 presents the changes of the aggregate activity of tritium in releases over several years. The annual activity of other radionuclides in liquid releases was about a thousand times lower, and is shown in Figures 8.26 to 8.29 for the entire period of the Krško NPP operation.

Figure 8.25: Activity of tritium in liquid releases (annual administrative technological limit is 20 TBq)

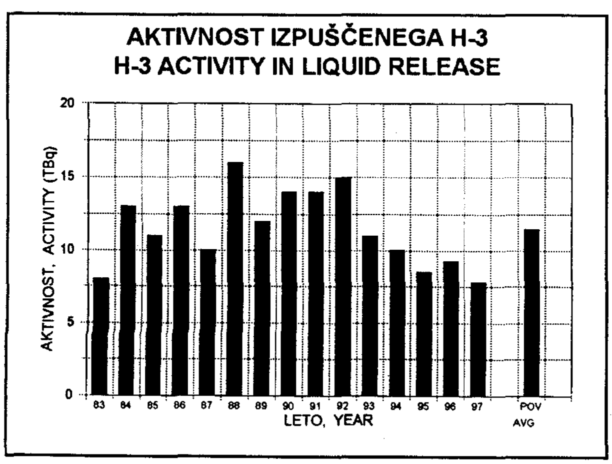


Figure 8.26: Activity of fission and activation products without tritium in liquid releases (annual administrative technological limit is 200 GBq)

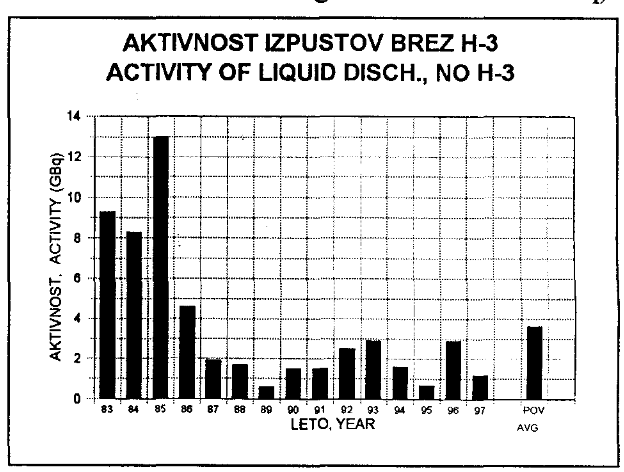


Figure 8.27: Co-60 activity in liquid releases

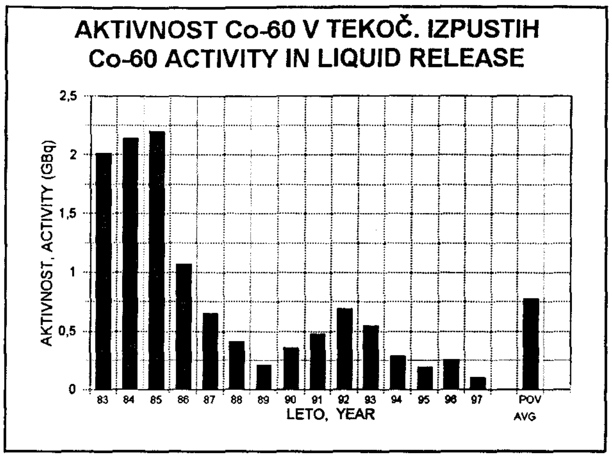


Figure 8.28: Cs-137 activity in liquid releases

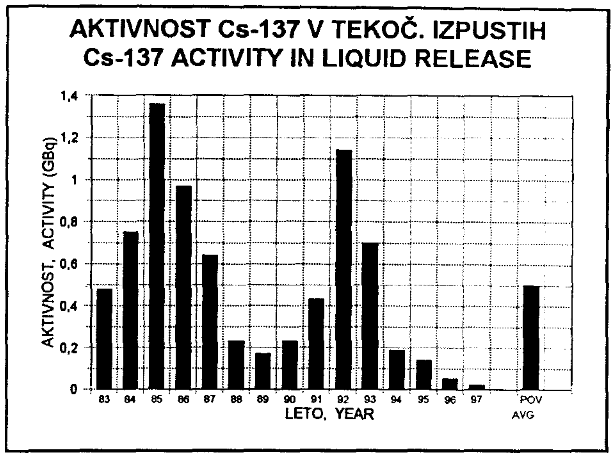


Figure 8.29: I-131 activity in liquid releases

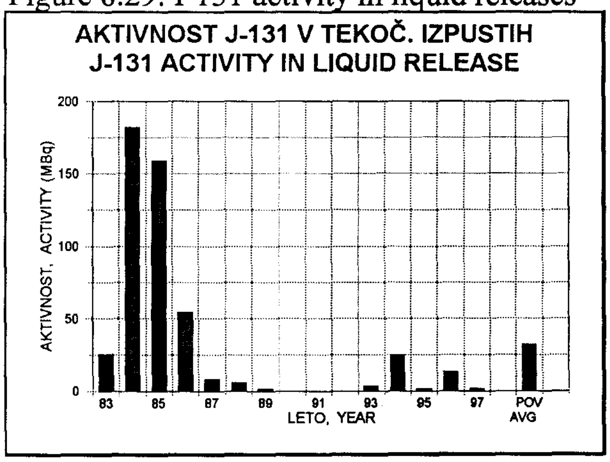
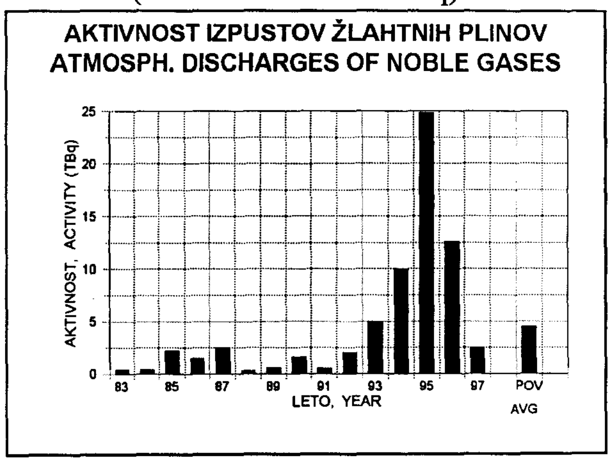


Figure 8.30: Activity of noble gases in gaseous releases (annual limit is 110 TBq)



8.2.6.2 Gaseous Releases

Radioactive gases from the Krško NPP were released into the atmosphere mainly from the reactor building stack and through the vent of the condenser in the secondary coolant loop. The radiation monitoring system continuously measures and controls concentrations of individual radioactive elements at both discharge points.

The released activities and limit values for all important gaseous emissions in 1997 are given in Table 8.11. In gaseous releases the activity of noble gases prevails. In 1997, the radioactivity of noble gases was 2.5 TBq, which represents 2.3% of the annual limit value. Figure 8.30 presents changes of the total activity of noble gases in discharges,

Figure 8.31 the activity of C-14 in atmospheric discharges and Figure 8.32 the activity of H-3 in atmospheric discharges for each year.

Figure 8.33 shows an increase of the noble gases released during the outage, when the ventilation of the containment is normally carried out. A considerable increase of radioiodine in gaseous releases was observed in May, which was due to refuelling and not to the regular operation of the Krško NPP (Figure 8.34). The concentration of iodine in releases increases during opening of the primary system (reactor vessel, steam generators); this is normal and expected. The activity of other radionuclides in aerosol releases is lower by several orders of magnitude. Figure 8.35 presents the released activity of tritium, and Figure 8.36 the activity of C-14 for each month in 1997.

According to the technical specifications for the Krško NPP the annual limits for releases are as follows:

- limit value for activity of released noble gases is 110 TBq, equivalent to Xe-133 per year,
- limit value for activity of radioiodine in gaseous releases is 18.5 GBq, equivalent to I-131 per year;
- limit value for aerosols in gaseous releases with a decay time of more than 8 days is 18.5 GBq per year,
- there are no explicitly specified limit values for tritium and C-14 in gaseous releases.

The activity of gaseous releases is indirectly restricted by dose/ concentration limits at the Krško NPP fence.

Table 8.11: Activities of gaseous releases in 1997

Gaseous Emissions	**Released Activity in 1997 (Bq)**	**Limit Values of Emission (Bq/year)**	**Limit Value Percentage (%)**
Noble gases	2.50E + 12	110 E + 12 (Xe-133 eq.)	2.3
Iodines	14.50 E + 08	18.5 E + 9 (I-131 eq.)	7.8
Aerosols	364.20 E + 04	18.5 E + 9	under 0.1
Tritium	1.05 E + 12	no restriction in TS*	-
C-14	13.70 E + 10	no restriction in TS*	-

*TS - technical specifications

Figure 8.31: Atmospheric discharges of C-14 in 1997

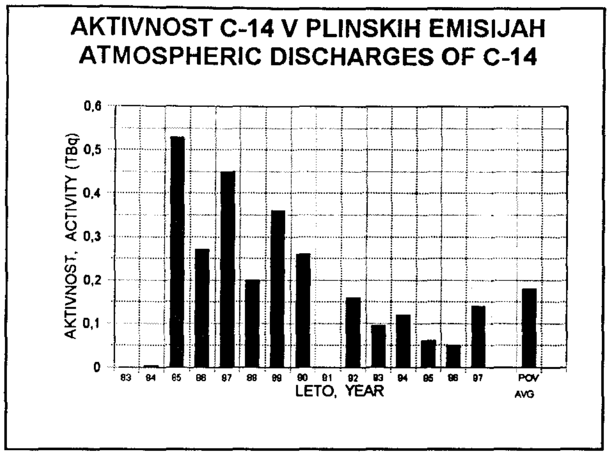


Figure 8.32: Atmospheric discharges of tritium in 1997

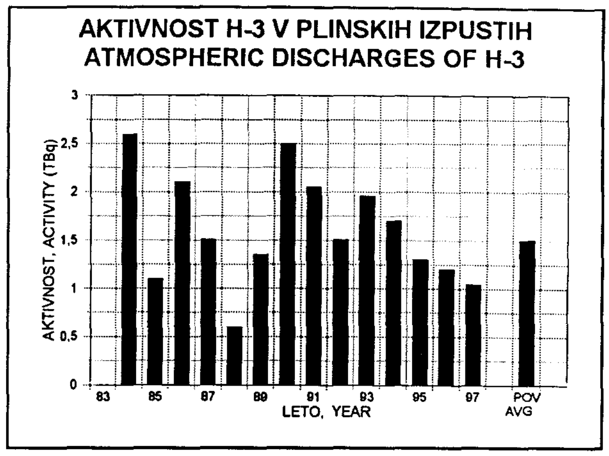


Figure 8.33: Atmospheric discharges of noble gases in 1997

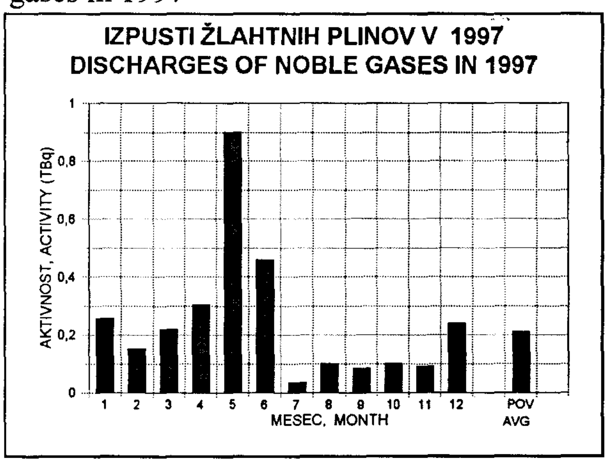


Figure 8.34: Iodine activity in 1997

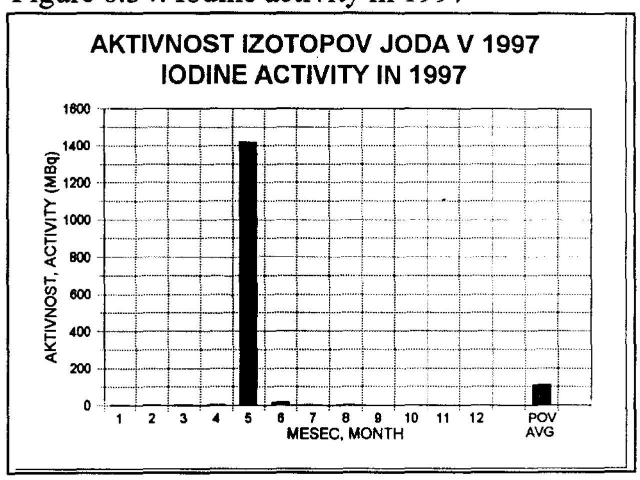


Figure 8.35: Discharges of tritium in 1997

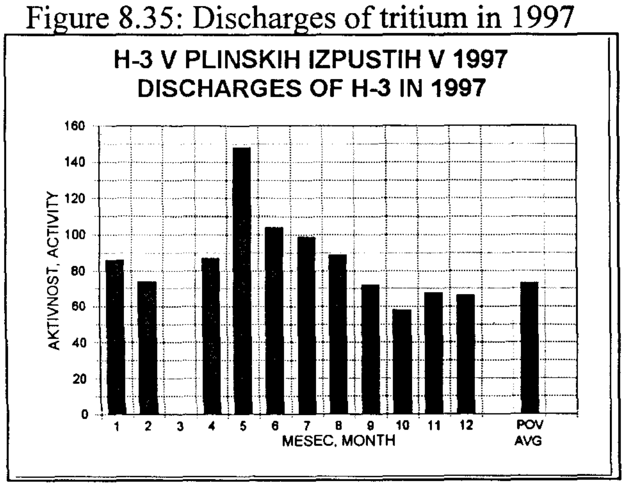
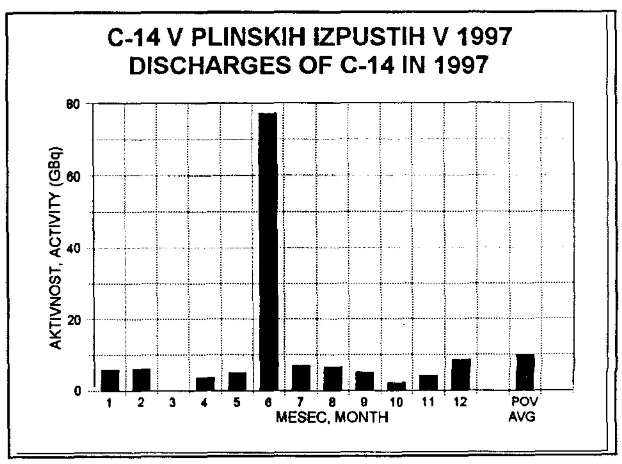


Figure 8.36: Discharges of C-14 in 1997



Note: In Figures 8.31 and 8.32 the estimate for the Krško NPP is given for the period 1983-1990, based on periodical measurements of concentrations and flows, and - as from 1991 - on the estimate by the Jožef Stefan Institute, derived from results of continuous measurements.

Note: No data for March 1997 are available in the periodical report of the Krško NPP.

Source: Periodical reports of the Krško NPP to the SNSA

8.2.7 THE KRŠKO NPP PERSONNEL EXPOSURE TO RADIATION

The Radiological Protection Unit at the Krško NPP was organized for the task of measuring, calculation and regular recording of received effective doses for all workers who have access to the controlled area of the power plant, regardless of whether they are members of the NPP staff or external contractors.

From the viewpoint of radiological protection, the power plant area comprises the area under constant radiological surveillance and the area where the radiological surveillance is carried out either periodically or according to needs. The area under constant radiological surveillance (controlled area) consists of: the reactor building, the fuel handling building, the auxiliary building, a part of the intermediate building, the primary laboratory, hot machine shops, the decontamination area and areas for processing and storing of radioactive wastes.

In the area under radiological surveillance - where irradiation and contamination is highly probable - the Krško NPP staff or external contractors must carry with them personal dosimeters in addition to regular protection equipment. Personal dosimeters are designed for surveillance of exposure to external radiation, and measure the total received dose in a given period. Internal radiation - or the so called internal contamination in the Krško NPP - is measured by the whole-body counter (WBC) and also by radiological analyses of biological samples. Measurements of internal contamination are carried out for all workers working in the radiologically controlled areas where there is a risk of irradiation and contamination (annual outages or major maintenance) before and after work. For daily recording and control of received doses during work at the Krško NPP, digital alarm personal dosimeters and/or reading dosimeters are used. However, for monthly recording of official doses thermoluminescent personal dosimeters (TLD) are used.

The average exposure of workers to ionizing radiation in the NPP is low. In 1997, the average effective dose to workers was 1.28 mSv, which is approximately 2.6% of the dose limit to workers who are professionally exposed to ionizing radiation (the Regulation on Dose Limits to Population and Radiation Workers, Off. Gaz. SFRY, No. 31/89) or 6.4%, in accordance with the latest recommendations ICRP (1991) and BSS (1996).

The average effective dose to the NPP personnel was 0.69 mSv and to external workers 1.55 mSv. Workers received the major part of the dose during the annual outage of the power plant. It was established that the received effective doses in the NPP in 1997 were lower in comparison with the world average for the PWR reactors, which is 2.5 mSv (UNSCEAR 1993).

In Table 8.12 the distribution of effective doses to workers in the Krško NPP for the entire period of its operation is shown. Altogether 6 workers received annual effective doses of more than 5 mSv, of which the highest effective dose of 8.1 mSv was received by one maintenance worker. Of the external contractors, 46 received effective doses above 5 mSv, of which 5 contractors received an effective dose above 10 mSv. The highest effective dose in the Krško NPP, received by an external worker (from Djuro Djaković), was 11.66 mSv.

The dose values stated in Table 8.13 refer to regular maintenance works, regular operation of the reactor, extraordinary maintenance, processing of radioactive wastes and refuelling of the reactor.

Table 8.13 shows that in 1997 the collective effective dose to workers at the Krško NPP was 0.99 manSv, which is less than in 1996 (2.01 manSv) and in 1995 (1.4 manSv). The collective effective dose in 1997 was within the range of average values for the whole period of commercial operation of the Krško NPP from 1983 to 1997 (1.58 manSv) (Figure 8.37). The low effective doses can be attributed mainly to systematic prevention work to minimize the workers' exposure (education, training for specific tasks in the radiation area and suitable planning of operations in compliance with the ALARA principle). In 1997, the collective dose to the Krško NPP staff was only 0.24 manSv, and to the external contractors and the main supplier workers 0.75 manSv.

In 1997, the collective effective dose per unit of net electrical energy produced was 1.81 manSv/GWyear, which is the lowest dose in the last three years (in 1995, 2.69 manSv/GWyear and in 1996, 4.00 manSv/GWyear) (Figure 8.38). Compared to the average value of 4.3 manSv/GWyear for PWR reactors in the world (the same type of reactor as in the Krško NPP), the collective exposure of workers is lower than average (UNSCEAR 1993). Also, the collective effective dose per unit of electrical energy produced in the Krško NPP is lower than the average for the United States of America (6.02 manSv/GWyear). The distribution of the received effective doses in the Krško NPP from 1983 to 1997 is presented in Figure 8.37. The effective dose was the lowest in 1991. In 1991, there was no refuelling and, therefore, the annual outage was shorter.

In 1997, no radiological event at the Krško NPP occurred to cause unplanned exposure of the workers, either from external radiation or from internal or external contamination. The legal and operational dose limits for an individual exposure were not exceeded.
Krško NPP regularly submits annual reports on radiological events and doses received by its workers to the international organisation OECD/NEA International System on Occupational Exposure (ISOE). The members of the organisation have at their disposal:

* an extensive and updated data base on occupational exposure in nuclear power plants and on methods for the best possible radiological protection of workers,
* mechanism for analysis and evaluation of collected data to help anticipate trends and identify critical areas by use of the principle for optimised protection (ALARA),
* access to organizations and experts with expertise on protection of occupationally exposed workers and on reducing their doses.

Slovenia has two representatives in the ISOE organization - one from the Krško NPP, and one from the SNSA.

Table 8.13: Collective and average effective dose to workers in 1997

	Collective Effective Dose	**Number of Workers**	**Average Dose (mSv)**
The Krško NPP	0.24	338	0.69
Contractors	0.75	483	1.55
Total	0.99	821	1.20

Table 8.12: Distribution of effective doses for all workers at the Krško NPP in the years noted

Year	Range of Received Annual Effective Doses (mSv/year)							Total Number of workers
	0-1	1-5	5-10	10-15	15-20	20-25	above 25	
1981	475	45	0	0	0	0	0	520
1982	275	313	9	13	10	1	1	622
1983	462	206	53	45	34	27	4	831
1984	375	205	15	3	2	0	0	600
1985	517	277	79	17	2	0	0	892
1986	524	301	79	3	4	1	0	912
1987	486	242	65	16	6	1	0	816
1988	506	298	60	21	3	1	0	889
1989	443	200	66	19	3	0	0	731
1990	390	265	92	38	5	2	0	792
1991	257	89	8	0	0	0	0	354
1992	448	219	0	127	22	1	0	817
1993	401	183	87	26	9	1	0	707
1994	536	187	32	2	0	0	0	757
1995	521	248	62	16	3	0	0	850
1996	489	258	114	25	3	0	0	889
1997	559	211	46	5	0	0	0	821

Figure 8.37: Received collective effective doses by all workers at the Krško NPP per year

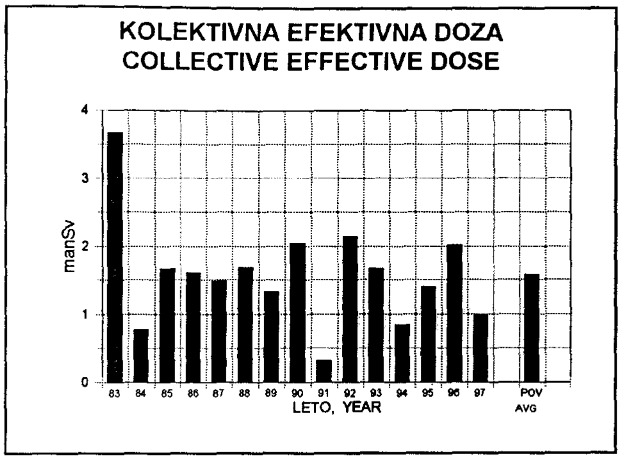
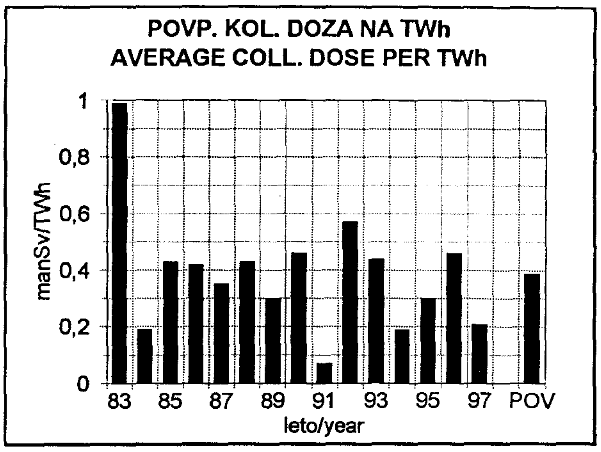


Figure 8.38: Collective effective dose per unit of produced electrical energy



8.3 TRIGA MARK II RESEARCH REACTOR AT PODGORICA

8.3.1 OPERATION

Purpose

The purpose of the reactor is experimental work, training of the Krško NPP personnel and preparation of radioactive isotopes for medicine, industry and nuclear chemistry. In 1997, it operated for 1088 hours at full power. Altogether 1876 samples were irradiated in the reactor, of which 1418 in the pneumatic transfer system. On 26 March - 27 March 1997, the reactor was in the pulse mode operation: 12 pulses were provided in this period. For experimental purposes 3 refuellings/reshiftings of fuel elements in the reactor core were carried out. Construction of the experimental facility in channel no. 1 for the Boron Neutron Capture Therapy (BNCT) experiment was also finished.

Shutdowns

In 1997, there were 197 shutdowns, of which 4 were unplanned, 1 occurred due to the burnt coil of the driving motor of the reactor control rod and 3 due to loss of offsite power.

Fuel

There were altogether 313 fuel elements in the reactor building by the end of 1997. They were distributed at the following locations:

- reactor core	53
- racks in the reactor pool	86
- spent fuel pool	130
- experimental facility in the hall	2
- fresh fuel storage	42
Total	313

On 22 January 1997, a visual inspection of all 67 spent fuel elements with Al cladding, stored in the spent fuel pool, was carried out.

Personnel

The responsibility for reactor operation is shared by the head of the Reactor Center, head operator, three operators and the Radiation Protection Unit.

8.3.2 RECEIVED DOSES BY WORKERS AT THE JSI REACTOR CENTER AT PODGORICA

The workers operating and using the reactor or the interim storage for radwaste are classified under the following three categories: reactor operators, the Radiation

Protection Unit personnel and researchers working at the reactor or handling the irradiated material. Table 8.14 presents received doses of external radiation (without neutrons) by workers, and collective doses for individual groups in 1997.

Table 8.14: Collective and average annual effective doses to reactor operators, the Radiation Protection Unit personnel and researchers in 1997

	Collective Effective Dose (manmSv)	Number of Workers	Average Dose (mSv/year)
Reactor	0.39	4	0.10
Radiation Protection Unit (laboratories, storage)	0.70	3	0.23
JSI researchers (R-1, 0-2)	n.d.a.*	n.d.a.*	n.d.a.*
Total RC JSI	1.09	7	0.16

* n.d.a. - no data available

8.3.3 SCHEDULED RETURN OF SPENT FUEL FROM TRIGA REACTOR TO USA

In May 1996, the US-DOE (United States - Department of Energy) decided to accept back to the USA the spent fuel from research reactors, produced in the USA from enriched uranium. By this decision Slovenia was given the possibility to send the spent fuel from the TRIGA Research Reactor to the USA by the years 2006 or 2009, respectively.

In the framework of negotiations on the scheduled return of spent fuel from the reactor TRIGA at Podgorica, a delegation of seven representatives of US government organisations visited Slovenia on 18 - 19 September 1997. The visit was aimed at surveying the research reactor and spent fuel storage and at negotiations on return of the spent nuclear fuel from the research reactor TRIGA, in operation at the JSI. The costs incurred by return, storage and disposal of fuel in the USA for the low budget countries - Slovenia included - are to be fully covered by the USA. Certain expenses for the organisation of transport, license approval, preparation of documentation and modifications of local infrastructure are likely to be incurred also in Slovenia. They are to be funded by the Ministry of Science and Technology and the Agency for Radioactive Waste (ARAO).

During discussions it was decided that 218 spent fuel elements would be returned to the USA in the first half of 1999, including twenty-six 70% - enriched fuel elements. The contract will enable Slovenia to return to the USA all the remaining spent fuel, i.e. in total 95 fuel elements from the Research Reactor TRIGA, by 2006. During discussions, the Slovenian interests were represented by the SNSA, the Ministry of Science and Technology, the Ministry of External Affairs, the JSI and the ARAO.

8.4. THE ŽIROVSKI VRH MINE

8.4.1. ACTIVITIES OF PERMANENT CESSATION OF URANIUM ORE EXPLOITATION IN 1997

8.4.1.1 Introduction

In 1997, the activities of the Žirovski vrh Mine in implementing the Programme of Permanent Cessation of Uranium Ore Exploitation and Prevention of Negative Impact of the Mine (the Programme) were reduced due to reprogramming of the operational plan of activities for Programme implementation in 1997 (the Reprogramming). The Reprogramming of the Programme was necessary because of the reduction in funds allocated to it in the 1997 national budget proposal, whereupon the Ministry of Environment and Physical Planning undertook to finance the implementation of the Programme up to such a reduced amount.

The prerequisites for Reprogramming were provided in July 1997, following its approval by the Slovenian Government. On passing of the budget for 1997 in December the implementation was also formally ensured.

Two sources of financing the implementation of the planned works and activities have been foreseen: the 1997 budget as specified by law, and the Mine's own turnover. The turnover includes funds acquired by sales of unnecessary equipment and materials as well as funds acquired through subcontracting of temporarily redundant labour by other enterprises.

Due to the fact that the budgetary funds assigned for this purpose and the turnover together totalled no more than 40% of the amount foreseen in the Programme, the Reprogramming cut the Programme to urgent actions in the following fields:

- provision of supporting documents for acquisition of approvals for implementation of the basic projects of the Programme and revision of the Programme;

- maintenance of buildings, equipment and machinery required for implementation of the Programme in order to keep them available and to prevent damage;

- monitoring the environmental impact of the mine.

The Act on Permanent Cessation of Uranium Ore Exploitation and Prevention of the Negative Impact of the Žirovski vrh Uranium Mine (the Act) commits the mine to introduce the programmes of alternative activities for reallocation of labour after the final cessation of uranium ore exploitation and liquidation of the company. In line with the relevant provisions of the Act, some activities of this kind were included in the Reprogramming, although they were not originally envisaged by the Programme.

Of the funds available for Reprogramming, the share of budgetary funds amounted to 78% and the share of proceeds from turnover to 22%. The scope and time-schedule of funding were determined in the relevant annexes concluded between the Žirovski vrh Mine and the Ministry of Environment and Physical Planning.

Regular financing of the mine operations, provided by the Ministry in this scope, enabled smooth progress of the Reprogramming in spite of the fact that the national budget for 1997 was passed as late as in December of the same year.

8.4.1.2 Implementation of the Programme

The assessment of the Programme implementation is based on comparison of planned and realized costs of material and services, which are proportional to the planned and realized scope of implementation of the basic projects under the Programme. The accuracy of this method is satisfactory, although the presented costs also include the costs of preliminary works and partly also the costs of maintenance of the present state, which are not directly dependent on the scope of works. When the execution of the basic projects is limited to a smaller scale, it is particularly the costs of maintenance of the present state which considerably increase the implementation costs.

In 1997, the realized costs of the basic projects under the Programme amounted to 20% of the planned costs, while their respective share in the Programme as a whole totalled 27% of the planned costs. Such a striking discrepancy in the planned and realized costs indicates that the progress of the Programme has been inadequate, both in 1997 or over the entire period of its duration.

Cessation of the uranium ore exploitation was to be carried out on a small scale. The projected works were carried out in full. The part of the P-10 tunnel which ensures smooth discharge of mine water was finally shut down. The share of the relevant costs in the Costs Projection is approx. 10%. The share of works carried out under this item amounts to 15% of the planned costs, since it also includes the preliminary and maintenance works.

No other works were projected or carried out under this project. In the underground workings the prescribed working conditions were not maintained; all the mine gates were kept locked.

The presented scope of projected and realized works for cessation of the concentrate production applies to the preliminary and maintenance works under this project. Dismantling and decontamination of structures and equipment as well as demolition of facilities were neither planned nor effected.

The extent of works envisaged under the project of cessation of operation of the tailings piles, which amounts to 7% of works projected under the Programme, indicates that covering of the tailings piles as foreseen in the Programme has not been carried out. Nevertheless, the remediation of landsliding on the Boršt tailings pile, planned under this item, was fully completed. With the exception of the drilling of two drainage wells which was postponed by 1998, the works fully completed under this item were the second phase of the landslide drainage installation and construction of a permanent concrete steel reinforcement of the drainage tunnel in the part where the temporary concrete steel reinforcement had been damaged.

The scope of the priority preliminary works exceeded those planned under the Programme. All the activities relating to the requirements of the SNSA with respect to rechecking of various versions for the final remediation of the tailings piles and the revision of the Programme were carried out.

In this period, all the projected studies and surveys, intended for verification of project solutions, were made. The foreseen project documentation was elaborated in full. All the approvals required for execution of the basic projects, which would allow for intensive implementation and completion of cessation of the exploitation were acquired.

Revision of the Programme which will serve to eliminate the discrepancies between the projected and realized scope of the Programme and provide the foundation for appropriate monitoring of the Programme was elaborated up to the last phase. Co-ordination and checking of parameters of physical extent and value have been postponed till 1998.

Due to the protracted acquisition of opinions, reviews and assessments concerning the supplementary requirements of the SNSA, not all the conditions for the procedure of acquisition of the outline building permit for cessation of the tailings piles operation have been entirely fulfilled. The postponement of these activities till 1998, however, will not affect the intensity of Programme implementation in the following years.

The project of monitoring the environmental impact of the mine was fully completed. Since the projected scope also includes safety at work for a considerably larger extent of works, the indices do not reflect the actual conditions. The extent of maintenance of the present state and availability of the required machinery and equipment do not fully depend on the extent of works. The costs of this component of activities have a particularly negative effect upon the total costs of Programme implementation, if the execution of the projects is kept down to a smaller scale.

Maintenance of the present state considerably exceeded the extent planned for 1997 as well as its respective share in the entire Programme.

Due to the ageing of facilities and plants, as well as machinery and equipment required for implementation of the Programme, the maintenance costs will rise, and the consequences of slowing down of the execution of the projects will be even more unfavourable.

8.4.1.3 Conclusion

From the viewpoint of rational usage of the limited budget available, the implementation of the Programme in 1997 can be assessed as satisfactory.

Equally satisfactory were also the implementation of the Programme after completion of the operating plan for remediation of landsliding; provision of conditions for cessation of concentrate production to enable intensive implementation and completion of the project; maintenance of the present state; and environment protection.

Financing of operational costs by the Ministry of Environment and Physical Planning was likewise satisfactory.

Considering the reduced implementation of the Programme in 1997 and the resulting higher implementation costs, the probability of unusual events, and the possibility that the implementation of permanent cessation of uranium ore exploitation as well as the implementation of the Programme could be jeopardized even as late as eight years after shut-down and five years after adoption of the relevant law, the situation cannot be estimated as satisfactory at all.

Despite the fact that non-performance of the preliminary works in 1997 does not directly hinder the Programme, it has prolonged the process and increased the overall costs; the implementation of the Programme as seen from the viewpoint of completion of preliminary works has been inadequate as well.

The Programme Progress Report for 1997 was passed by the Managing Board of the Žirovski vrh Mine at its 56th regular session on 27 March 1998.

8.4.2 EXPOSURE OF WORKERS TO IONIZING RADIATION

Within the scope of decommissioning, the Radiological Protection Unit of the Žirovski vrh Mine regularly monitored the working site for uranium ore extraction and for uranium concentrate production, and measured contamination of the waste material and the facility surfaces.

Exposure of workers to ionizing radiation was assessed by the RPU based on measurements of radon progeny concentrations and gamma radiation dose (Thermoluminescent Dosimetry), whereby the exposure time of workers at individual workposts was considered. The calculation of an annual effective dose received by workers during underground work was made in accordance with the generally applicable methodology. Due to low concentrations of short-lived radon progeny and low dose rates the values were as low as expected. The dosimeters were replaced quarterly.

The calculation of annual effective doses was made for 95 workers of the Žirovski vrh Mine, of whom 48 worked in the uranium ore exploitation plant and 47 in the uranium concentration production plant. Some of the workers occasionally worked in both plants; altogether 70 workers were recorded as working with radiation sources.

The working sites for remediation of the P-10 tunnel and the drainage tunnel in the uranium ore exploitation plant were outside the area with increased radioactivity - except for implementation and cleansing of the meteoric waters drainage system from the Boršt tailings pile as well as corresponding sampling and measurements. The maximum calculated effective dose for 1997 was 3.4 mSv, and the average of all annual effective doses 0.8 mSv. The highest annual effective dose was received by a worker responsible for regular sampling of water in the drainage tunnel.

In the area of uranium concentrate production plant, the major contribution to the cumulative dose was done by concentration of short-lived radon progeny on the premises of the electrical and mechanical maintenance workshop and the locker rooms at the facility No. 322 and the laboratory. The contribution from works on the plant plateau and from gamma radiation on the contaminated surfaces is lower. Since the main sources of gamma radiation (uranium ore, hydrometallurgical tailings, uranium concentrate) were removed from the plant after cessation of regular operation, the contribution from these sources is negligible. The maximum effective dose for 1997 was 3 mSv or 6% of the still valid dose limit 50 mSv, while the average value of all calculated annual effective doses was 1.1 mSv. The highest dose was received by a worker in the workshop of facility No. 322.

Table 8.15: Exposure of workers to ionizing radiation

Year	Number of Workers	Average (mSv)	Maximum Dose (mSv)	Collective dose (manSv)
1989 (during operation)	350	5	18	1.75
1996	55	0.91	2.64	0.050
1997	70	1.3	3.4	0.09

8.4.3 IMPACT ON THE LIVING ENVIRONMENT

The monitoring of the impact of the Žirovski vrh Mine on the environment was performed according to the programme for emission monitoring and the programme for radioactivity monitoring in the vicinity of the Žirovski vrh Mine. The monitoring of emissions was carried out by the Safety-at-Work Service of the Mine, and the analyses of radionuclides in liquid effluents were made by the Mine laboratory and the Jožef Stefan Institute, while the monitoring of radioactivity in the Žirovski vrh Mine environment was provided by the technical support organization, the Institute of Occupational Safety, in co-operation with the Jožef Stefan Institute.

8.4.3.1 Liquid Emissions

The schedule of the monitoring of liquid effluents in the releases from the Žirovski vrh Mine remained unchanged as compared to previous years. It involved measurements of uranium and radium-226 in the samples of all liquid releases from the Žirovski vrh Mine, including meteoric waters from the mine pits and all the releases which contributed to contamination of surface waters. Monthly samples were analysed for U_3O_8 concentration (Žirovski vrh Mine laboratory), while the monthly composite samples were analysed for content of chemical substances as well as U_3O_8 (Žirovski vrh Mine) and 226-Ra (Jožef Stefan Institute).

Waste waters from treatment and decontamination by wet process in the area of the uranium ore production plant were collected in the collecting sump at the treatment and decontamination site. Periodically and when necessary, water was pumped into the trap where solid particles gradually precipitated; currently diluted clear water containing dissolved radioactive substances was periodically (at high water level) released under supervision into the Brebovščica. U_3O_8 concentrations in water at the outlet did not exceed the value of 350 mg/m^3 at a flow of 0.45L/s. In total, 1187m^3 of water containing 0.4 kg of U_3O_8 was released, which amounts to less than 0.1% of the total U_3O_8 release from the Žirovski vrh Mine in 1997. Monitoring of liquid effluents in the releases from the Žirovski vrh Mine is shown in Table 8.16.

Table 8.16: Monitoring of liquid effluents from the Žirovski vrh Mine and water courses

Sampling site	**Annual flow (1000 m^3)**	**Average conc. of dissolved U_3O_8 (mg/m^3)**	**Average conc. of dissolved ^{226}Ra (Bq/m^3)**
Monitoring of liquid releases			
Mine water treatment plant	645	288	43
The Jazbec stream under the mine waste (Jazbec)	233	419	30
Joint drainage of the Boršt tailings pile	6.7	716	178
Overflow of the solids trap at Boršt	17	841	2423
Drainage of the solids trap at Boršt	0.87	721	304
Drainage tunnel at the Boršt tailings pile	37.59	2	18
Results of measurements in water courses			
The Boršt stream	216	5	35

Table 8.17: Cumulative annual emissions of U_3O_8 and ^{226}Ra in individual facilities of the Žirovski vrh Mine in 1997

	U_3O_8 (kg)	**%Share**	**^{226}Ra (MBq)**	**%Share**
Mine	185	61	28	33
Jazbec mine waste	97	32	7	8
Boršt tailings pile	20	7	51	59
Total ŽVM 1997	302	100	86	100

The emissions of uranium and ^{226}Ra were lower than those in 1996, most probably due to lighter precipitation in the past year.

Table 8.18: Annual flows and average annual concentrations of uranium and Ra-226 in monthly composite samples of the Todraščica stream (before it flows into Brebovščica) and the Brebovščica stream at Gorenja Dobrava

Sampling site	**Flow** (m^3/s)	**Average concentration of U-238 (Bq/m^3)**	**Average concentration of ^{226}Ra (Bq/m^3)**
Measurements in water courses			
Todraščica	0.09	58	29
Brebovščica (1.5 km under Todraž)	0.85	219	16.1

8.4.3.2 Gaseous Emissions

Mine ventilation stations and ventilation shafts as well as tailings piles surfaces (hydrometallurgic tailings at Boršt, mine waste at Jazbec) and temporary dumps (mine waste at P-1 and P-9) are the main sources of gaseous emissions of ^{222}Rn from the former Žirovski vrh Mine. Other surface sources are filled-in unpaved surfaces in the area of mine facilities, some road surfaces, filled in with mine waste, and the drainage outlet from the Jazbec mine waste. By the impact of radon concentrations on the environment, the sources are divided into low and high altitude sources. The former are situated below the limit of average temperature inversion (at an altitude below 500 m) and include the P-10 and P-11 tunnels (when the mine is ventilated naturally) and the Jazbec mine waste.

Estimates of annual emissions from each particular source showed that in 1997 the order of magnitude of radon-222 emissions from all the sources totalled approx. 12 TBq, of which the mine facilities (the mine itself, the mine waste deposit, the drainage by-pass of the Jazbec mine waste) contributed 5.2 TBq and the processing plant (the hydrometallurgic tailings pile) 7.07 TBq. Table 8.19 gives maximum and minimum values at each mine outlet and the Jazbec mine tailings pile by-pass.

Table 8.19: Maximum and minimum ^{222}Rn and short-lived radon progeny (PAEC) concentrations in emissions (1WL = 3700 Bq/m^3)

Source/Concentration	**Rn-222 (Bq/m^3)**		**PAEC(WL)**	
	Max.	Min.	Max.	Min.
P-11 tunnel	10960	5680	2.31	1.21
P-10 tunnel	13800	9700	2.96	2.14
Ventilation shaft 6/2	9450	732	2.09	0.09
Jazbec drainage by-pass	25920	263	1.23	0.02

8.4.4 FINAL ASSESSMENT OF ENVIRONMENTAL IMPACT

The radioactivity measurements showed that the cessation of uranium ore exploitation only partially reduced the impact of the Žirovski vrh Mine on the environment, although the mine was closed seven years ago. Major changes are not to be expected until a full remediation of all the present tailings piles has been completed.

Over the past year, emission of radionuclides from liquid discharges has considerably decreased; the same applies to the yearly releases of radon from the mine and the Boršt tailings pile.

Source:

1. 1997 Annual Report on Implementation of Radiological Protection and Environmental Impact of the Žirovski vrh Mine, the Žirovski vrh Mine, March 1998.

2. 1996 Report on Radioactivity Measurements in the vicinity of the Žirovski vrh Mine Environment and Environmental Impact Assessment, Institute for Occupational Safety, Ljubljana, March 1998.

9 RADIATION PROTECTION IN THE LIVING ENVIRONMENT

The present chapter contains a summary of reports on the radioactivity monitoring in the environment. First it gives a presentation of the Radiation Early Warning System which enables immediate detection of increased radiation on the territory of Slovenia; it is followed by summaries of reports of technical support organizations which monitored the environmental impact of global contamination and operation of nuclear plants.

9.1 RADIATION EARLY WARNING SYSTEM

For years now the SNSA, as the competent authority for providing radiological monitoring, has been concerned with the establishment and permanent improvement of the Radiation Early Warning System for immediate detection of potential contamination in case of a nuclear or radiological accident in the country or abroad.

There are about 40 probes for dose rate measurement of external gamma radiation throughout Slovenia; real-time data retrieval is possible from 28 probes. Since 1996, when the fully computer-supported Central Radiation Early Warning System of Slovenia (CROSS) was established within the SNSA, the real-time measurement data from all the existing systems of this type in Slovenia have been collected at one site. These network systems are managed by the following organizations:

- the Krško NPP;
- the Hydrometeorological Institute;
- the SNSA; and
- the Milan Vidmar Electrical Institute.

The SNSA has an agreement with the measurement network operators for transfer of the collected and archived data in half-hour intervals. The communication and computer infrastructure required for data transfer, archiving, analysing and representation as well as for alerting the CROSS operator has been provided. The data are transmitted along the national communication backbone to the communication server located at the SNSA (Figure 9.1).

Figure 9.1: Communication network for data transfer to the CROSS. Special application software provides displaying of collected data in numerical or graphic form

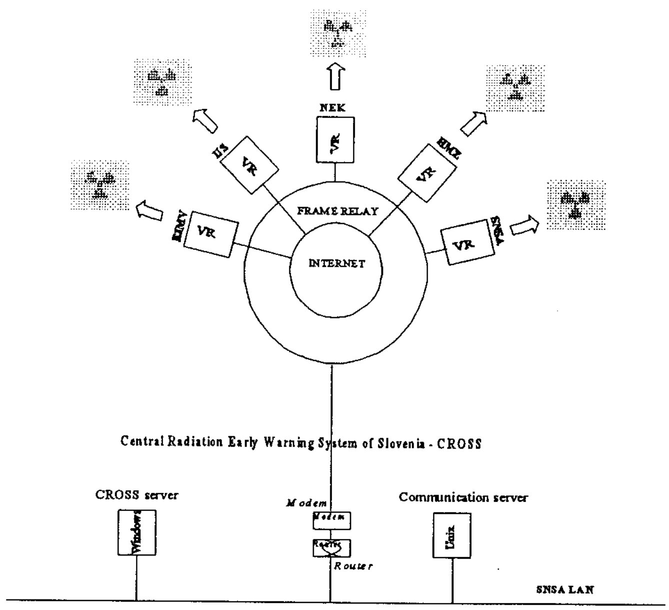
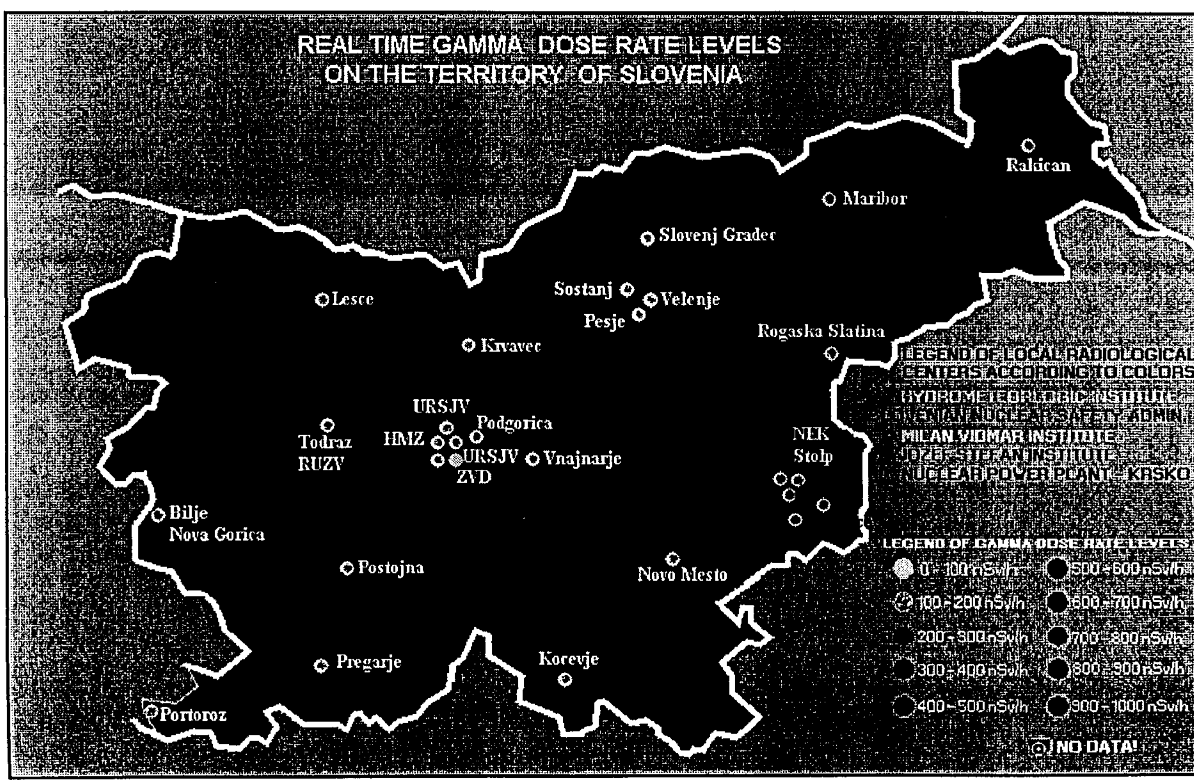


Figure 9.2: Geographical locations of radiological measuring points; coloured circles indicate real-time dose rate levels at each site.



The principal innovations introduced into the CROSS system in 1997 were as follows:

- inclusion of 8 new probes into the real-time data EWS network;
- inclusion of graphic representation of ten-days data (Figure 9.3);
- written procedures for work with the CROSS system;
- transmission of data into the EURDEP system.

The data collected from all 28 probes (Figure 9.2, Table 9.1) are available on Internet at the following address:
http://www.sigov.si/cgi.bin/spl/ursjv/rad_mon.html?language=winee.

Table 9.1: Part of a summary table which shows codes of the measuring point, 10-days average dose rate levels, 24-hours average dose rate level, the last half-an-hour dose rate level, the name and co-ordinates of the geographical location for each probe.

REAL TIME GAMMA DOSE RATE LEVELS ON THE TERRITORY OF SLOVENIA

Governmental Institution: Slovenian Nuclear Safety Administration
Updated: 140598 1051 (Time is given in UTC time)
Warning: The data are automatically updated and are not guaranteed without error!
The data are for information only

		Date: 130598			Date: 140598					
STATION	BACKGR. 10 DAYS nSv/h	MEAN VALUE nSv/h	MAX VALUE nSv/h	AT Hr	MEAN VALUE nSv/h	MAX VALUE nS/h	AT Hr	LAST VALUE nSv/h	AT Hr	REMARKS
RAD M23	120	121	129	09	120	125	02	120	10	15°31',45°56' Krško-NEK
RAD M21	113	115	120	07	112	116	03	115	10	15°29',45°57' Krško-Videm
RAD M18	126	125	132	01	122	130	02	125	10	15°31',45°53' Cerklje
RAD M15	136	137	144	05	133	138	03	135	10	15°36',45°54' Brežice
RAD M01	128	127	134	22	130	137	07	128	09	15°38',46°32' Maribor
RAD M03	117	117	125	23	116	120	02	111	10	15°10',45°48' Novo Mesto
RAD M40	119	119	126	02	117	120	07	119	08	15°38',46°14' Rogaška Slatina
RAD M05	106	107	113	05	104	106	09	106	09	13°38',45°53' Nova Gorica
RAD M04	121	121	130	07	122	127	07	122	09	14°29',46°02' Ljubljana-IJS

Figure 9.3: An example of graphic representation of data for the last ten days

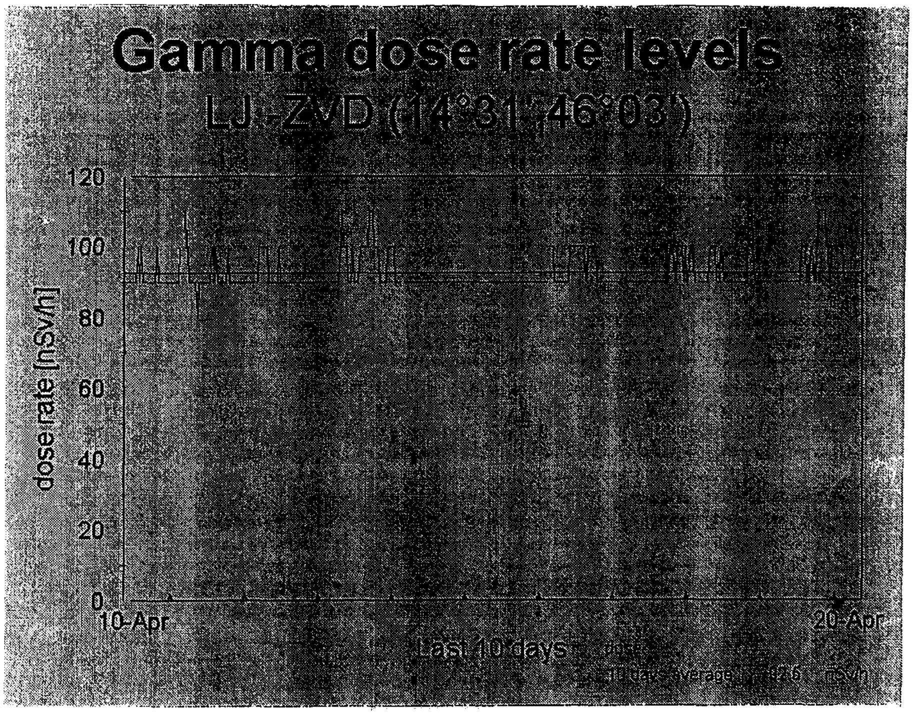
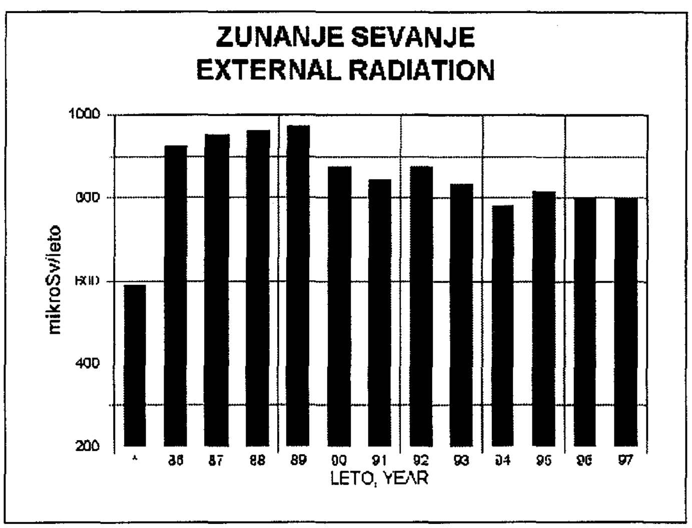


Figure 9.4: External radiation in the vicinity of the Krško NPP after the Chernobyl



accident, annual dose (thermoluminescent dosimeters IJS-TLD-05)

* - Pre-Chernobyl average dose (data from the previous reports by the Jožef Stefan Institute)

Table 9.2: Summary of statistically processed data from radiation monitoring by the SNSA (ALNOR radiation meters) for 1997

Location	Average (nSv/h)	Standard deviation (nSv/h)	Min. (nSv/h)	Max. (nSv/h)
Ljubljana - SNSA	100	10	70	180
Krško - NPP	98	7	80	140
Podgorica - TRIGA	99	10	70	220
Todraž - ŽVM	122	12	70	260
Ljubljana - Inst. of Occup. Safety	90	6	80	140
Pregarje (Brkini)	110	6	70	170

Table 9.3: Distribution of the obtained data by ranges of dose rate levels from the Radiation Early Warning System of the SNSA (the ALNOR radiation meters)

	Number of Measured Values per Range					
Range of Dose Rate Levels (n Sv/h)	LOCATION					
	SNSA	NPP [1]	Triga	ŽVM	Inst.of Occup. Safety	Pregarje [2]
less than 70	8	0	305	3	0	1
71 - 80	1245	5	1450	18	2564	0
81 - 90	5044	1924	4142	855	16272	0
91 - 100	13283	3721	16341	845	2253	1708
101 - 110	2788	386	2992	2372	223	7424
111 - 120	936	49	356	13317	82	934
121 - 130	480	26	190	6932	31	140
131 - 140	189	24	80	993	5	22
141 - 150	53	0	61	196	0	18
151 - 160	24	0	24	115	0	6
161 - 170	0	0	34	62	0	1
171 - 180	2	0	23	31	0	0
181 - 190	0	0	2	29	0	0
191 - 200	0	0	7	10	0	0
more than 201	0	0	5	18	0	0
Number of data	24052	6135	26012	25796	21430	10254

1) Data for the period September - December 1997

2) Data for the period July - December 1997

The data collected in 1997 from the Radiation Early Warning Center at the SNSA center were processed and statistically evaluated by the Slovenian Nuclear Safety Administration staff. The measuring equipment consists of 6 probes RD-02L for measuring external radiation ALNOR by the Finnish manufacturer RADOS. In the second half of 1997, the SNSA put into operation two new measuring points, one of them at Krško at the nuclear power plant site and the other one at Brkini (Pregarje near Ilirska Bistrica).

The summary table of results (Table 9.2) shows average values, standard deviations and extreme values. The highest natural background was measured in the vicinity of the former Žirovski vrh Mine (122 nSv/h) and at Brkini (110 nSv/h), while the lowest was found in the urban environment (Institute of Occupational Safety: 90 nSv/h). As a rule, the minimum levels were obtained in winter, when the ground was covered with snow (70 nSv/h), and the maximum dose rate levels were likewise of natural origin; they were generally recorded when it started to rain and persisted for a few hours. Namely, a heavier precipitation causes washing out of aerosols with the short-lived radon progeny from the air to the ground; the increased gamma radiation from the ground surface is detected by the probes. As illustrated in the table with statistical data, the external gamma dose rate levels may, for a short period, grow by considerably more than 100% (up to 260 nSv/h at the Žirovski vrh Mine and up to 220 nSv/h at Podgorica); however, the threshold level has been set sufficiently high to prevent false alarm triggering due to natural phenomena.

Towards the end of 1997 a relationship was established between the SNSA and the European center JRD in Ispra (Italy) where data from European national networks for early warning are collected. Therefore, from December on, the SNSA has been regularly sending data from CROSS to the European system EURDEP every week. By joining the European network, the SNSA gained the possibility of insight into data from other European countries.

9.2 GLOBAL RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT IN SLOVENIA IN 1997

In 1997, the general radioactivity monitoring programme in the living environment in Slovenia was the same as in the preceding years. The exception was the measurement of radioactivity in solid precipitation (on sticky plates) which is of accidental significance only, and which the supporting organizations discontinued due to shortage of funds. The basic scope of the programme was determined by the Regulation on the Sites, Methods and Time Periods for the Radioactive Contamination Control (Off. Gaz. SFRY, No. 40/86); in addition, certain modifications based on technical bases for amendment to this Regulation were taken into account as well.

The Contracting Party for the annual environmental radioactivity monitoring programme is the Ministry of Health. However, in 1997, the part of the programme applying to measurements of the radionuclide Sr-90 in water and measurements of external radiation with TL dosimeters was financed by the SNSA. The Contractors are the Institute of Occupational Safety, Ljubljana, Bohoričeva 22a, and the Jožef Stefan Institute, Ljubljana, Jamova 39.

9.2.1 MONITORING PROGRAMME

The programme of global radioactive contamination monitoring in the environment covered the following environmental elements: surface waters, air, ground, precipitation, drinking water, food and fodder.

1. Surface waters:

A single semi-annual sampling of the Sava river near Ljubljana (Laze-Jevnica), the Drava river near Maribor, the Savinja river near Celje and the Soča river near Anhovo. Specific activity of gamma emitters and H-3 was determined.

2. Air:

Continuous pumping of air through air filters at the sites in Ljubljana, Jezersko and Predmeja. The air monitoring consisted of measurements the concentrations of gamma emitters in the monthly composite samples of daily filters.

3. Ground:

3.1. Soil:

The content of gamma emitters and Sr-90 in three layers of soil (0-5 cm, 5-10 cm and 10-15 cm) was measured twice a year in samples of the undisturbed grassland taken in Ljubljana, Kobarid and Murska Sobota.

3.2. External gamma radiation:

Continuous measurements of dose rate levels were performed in Ljubljana, Maribor, Novo mesto, Celje, Nova Gorica, Portorož, Murska Sobota, Kredarica and Lesce. In addition, TL dosemeters were installed at 50 outdoor sites throughout Slovenia, forming a 20 km x 20 km network, for the purpose of determination of semi-annual doses received from external gamma radiation.

4. Precipitation:

Continuous sampling of liquid and solid precipitations in Ljubljana, Novo mesto, Bovec and Murska Sobota. Specific activities of gamma emitters were measured on a monthly basis, while those of Sr-90 were monitored quarterly. In 1997, measurements of radioactivity of solid precipitation collected on sticky plates were discontinued.

5. Drinking water:

Sampling of drinking water from water mains twice a year in Ljubljana, Celje, Maribor, Kranj, Škofja Loka and Koper. The specific activity of gamma emitters, Sr-90 and H-3 was determined.

6. **Food:**

Seasonal sampling of the food of animal and plant origin in Ljubljana, Novo mesto, Koper, Celje, Murska Sobota, Maribor and Slovenj Gradec or at other locations when required. Samples of milk taken in Ljubljana, Kobarid, Bohinjska Bistrica and Murska Sobota were collected and analysed monthly. The content of gamma emitters and Sr-90 was determined in all food samples.

7. **Fodder, grass:**

Sampling of grass at sites in Ljubljana, Kobarid and Murska Sobota twice a year. The content of gamma emitters and Sr-90 was determined.

9.2.2 CONTRACTORS

The Contractors for the radiological monitoring measurements in the living environment of Slovenia were the Institute of Occupational Safety and the Jožef Stefan Institute. In addition to measurements foreseen in the programme, parallel measurements of air and precipitation samples were performed by both institutes as well. Both Contractors participated in international inter-comparison measurements within the IAEA with the purpose of assuring and controlling the quality of measurements. Additional comparative measurements of samples were carried out within the framework of the radioactivity monitoring programme of the Krško NPP.

9.2.3 MONITORING RESULTS

The results of measurements of artificial radionuclides in all four largest **rivers** in Slovenia showed that Cs-137 concentrations could only be found in traces up to a maximum of 0.7 Bq/m^3, while the concentrations of the radionuclide I-131 released from centers of nuclear medicine in Ljubljana, Maribor and Celje, varied from 1 Bq/m^3 in the Drava and Savinja rivers to 50 Bq/m^3 in the Sava river.

No major changes occurred in the specific activity of radionuclides in the **air and in precipitation** as compared to 1996.

The results of measurements of artificial radionuclides in **soil** layers indicated that distribution by depth was very similar to that established in 1996. The average specific activities of Cs-137 were somewhat lower than the previous year, while there was a slight decline in activity of Sr-90 in the upper layer from 0 cm to 5 cm at all three sampling sites.

The measurements of the **external gamma radiation** showed the same dose levels as in the previous years. The contribution of the Chernobyl contamination persisted still between 15 and 20%, considering the level of the natural background. In 1997, the average dose rate level from external radiation in Slovenia amounted to 97.3 nSv/h; a comparison with 97.5 nSv/h in 1996 indicated that no noteworthy changes occurred.

The trend of decline in the specific activity of radionuclides Sr-90 and Cs-137 in food continued throughout 1997. The mean value of Cs-137 in vegetables, fruit and cereals was lower than that determined in the previous years. A substantial decrease of Sr-90 was detected in cereals only, while the mean value of this radionuclide in vegetables remained equal to the value from 1996. The food of animal origin showed a similar decrease: the Cs-137 content in meat and milk from Ljubljana and Kobarid were as much as halved as compared to the results obtained a year earlier; much the same applied to specific activities of Sr-90 in meat. High relative decreases occurred as a consequence of extremely low absolute values, both in the case of Cs-137 and of Sr-90, where even minor variations of results, e.g. due to a statistical error in measurement, resulted in high relative variations. The reasons for higher deviations of concentrations of artificial radionuclides in food samples as compared to 1996 were principally the inadequate number of samples and the exceptionally low concentrations of both fission radionuclides.

The long-term concentration trends illustrated in Tables A, B, and C show that the level of radioactive contamination in the environment has already reached the pre-Chernobyl level. The only exceptions are the Cs-137 and Sr-90 content in the ground and increased external gamma radiation caused by the presence of the long-lived Cs-137 in the surface soil samples.

On the basis of average specific activities of the long-lived fission radionuclides in the air, water and food for 1997 and the average annual intake, taking into account the dose conversion coefficients according to IAEA Basic Safety Standards (1996), the cumulative committed effective dose E_{50} was estimated. The contribution of both radionuclides to the dose due to inhalation was estimated to be actually negligible in comparison with the doses received along other transfer pathways. This contribution was estimated to be a few nSv in the case of Cs-137 and a few tens of nSv in the case of Sr-90. The ingestion dose amounted to 3.6 microSv per year, of which Sr-90 accounted for two thirds of the dose and Cs-137 for one third. The external radiation caused by the soil contamination with Cs-137 represents the largest contribution to the global contamination of the environment. On the assumption that every inhabitant spends 30% of the available time outdoors, the measuring data from the measuring point in Ljubljana have been used in estimation of the annual dose due to external radiation. In 1997, the effective dose due to external radiation (mostly from the Chernobyl accident) was estimated to 54 microSv. The cumulative dose to an adult, caused by the global contamination of the environment with fission radionuclides, was estimated to be 58 microSv, as shown in the table below (Table 9.4).

Table 9.4: Radiation dose to the population in 1997 caused by contamination of the environment with long-lived fission radionuclides

Transfer pathway	**Effective dose (in microSv/year)**
Inhalation (Cs-137, Sr-90)	0.02
Ingestion (Cs-137, Sr-90)	3.6
External radiation (Cs-137, Cs-134)	54
Total in 1997	58 microSv

9.2.4 CONCLUSION

Considering the results of the radioactivity monitoring in the living environment in the Republic of Slovenia in 1997 the technical support organizations claimed that the annual intake of artificial radionuclides was well within the limits prescribed by the Regulation on the Radioactive Contamination Limits of the Human Environment and on Decontamination (Off. Gaz. SFRY, No. 8/87).

The total annual effective doses caused by artificial radionuclides from ingestion and from exposure to external gamma radiation due to the Chernobyl contamination were within the average world values.

Table 9.5: Mean annual activities of Sr-90 and Cs-137 (Bq.m^{-2}) in the soil layer at a depth of 0-5 cm (grassland) for the period 1982 – 1997

	Ljubljana		**Kobarid**		**Murska Sobota**	
year	Sr-90 (Bq.m^{-2})	Cs-137 (Bq.m^{-2})	Sr-90 (Bq.m^{-2})	Cs-137 (Bq.m^{-2})	Sr-90 (Bq.m^{-2})	Cs-137 (Bq.m^{-2})
1982	126		222		69	
1983	157*		161		43	
1984	102		161		48	
1985	107		154		56	
1986	123		680		115	
1987	115	25500	465	32250	90	4850
1988	120	8600	395	5950	84	2750
1989	129	6800	384	15000	89	3200
1990	130	12500	335	8350	81	6200
1991	80	11000	240*	7750	73	4350

1992	82	9350	255	14000	71	5050
1993	94	10500	280	16500	54	4650
1994	77	7400	230	10100	70	4550
1995	71	8000	210	10500	79	3950
1996	43	6200	145	9700	59	4000
1997	27	5750	67	6500	40	4400

*changed sampling site

Table 9.6: Mean annual activities of Sr-90 and Cs-137 (Bq/kg) in milk in the period 1984 - 1997

	Content of Sr-90 ($Bq.m^{-2}$)		**Content of Cs-137** ($Bq.m^{-2}$)		
year	Ljubljana	Kobarid	Ljubljana	Kobarid	Murska S.
1984	0.17	0.33	0.13	0.27	1.02
1985	0.19	0.33	0.10	0.27	0.95
1986	0.28	0.81	21.5	65.7	168.6
1987	0.40	0.87	0.40	0.87	2.70
1988	0.22	0.53	1.49	7.32	17.20
1989	0.17	0.38	0.68	6.00	7.48
1990	0.19	0.43	1.10	4.90	5.60
1991	0.16	0.36	0.58	3.50	4.30
1992	0.22	0.32	0.41	4.00	4.10
1993	0.15	0.30	0.47	2.90	3.20
1994	0.14	0.22	0.48	2.00	2.30
1995	0.12	0.22	0.45	1.70	2.50
1996	0.13	0.29	0.36	1.20	2.00
1997	0.10	0.15	0.12	0.55	1.00

Table 9.7: Annual dose from external gamma radiation in Ljubljana

YEAR	Cumulative Dose from External Radiation (microSv)	Contribution of Chernobyl (microSv)
1988	1080	360
1989	1131	280
1990	994	220
1991	966	190
1992	975	190
1993	904	180
1994	876	146
1995	872	150
1996	844	145
1997	851	146

9.3 RADIOACTIVITY MONITORING IN THE ENVIRONMENT OF THE KRŠKO NPP

The results of the radioactivity monitoring of artificial and natural radionuclides in various controlled media and along transfer pathways are given by the effective dose value. A conservative estimation of the annual effective dose to each individual inhabitant due to emissions from the nuclear power plant gives a "committed effective dose" value of 8.2 microSv/year for 1997. This value represents less than 1% of the average annual effective dose from natural and artificial radiation sources to which individuals are normally exposed. By measurement of selected samples, it was possible to estimate the annual doses due to natural radioactivity, general pollution (contribution of Chernobyl, atmospheric nuclear tests), from industry and hospitals where radioactive substances are used.

9.3.1 SCOPE OF MONITORING

The radioactivity monitoring programme in the living environment of the Krško NPP was approved by the SNSA Decision No. 391-01/96-8-13582/MK. The regular radiological monitoring of the Krško NPP consists of monitoring of its liquid and gaseous releases into the environment and of an independent control of radioactivity into the environment (environmental samples). The area under the most thorough surveillance is the 12 km circle around the facility, where the highest impact of releases is anticipated and the potential changes can be detected first; the surveillance of the area along the Sava river and of the underground water is extended to the territory of Croatia (from Jesenice to Podsused, up to a distance of 30 km downstream from the facility).

The regular monitoring of releases is provided by the Radiological Protection Unit of the Krško NPP. The periodic monitoring of releases and control measurements of emissions is performed by the technical support organizations: the Jožef Stefan Institute, and the Institute of Occupational Safety from Ljubljana, the Institute "Rudjer Bošković" - the Center of Maritime Research (IRB) and the Institute of Medical Research and Occupational Medicine from Zagreb.

9.3.2 MONITORING RESULTS

The average contribution of the global Chernobyl contamination to the environmental pollution have been declining over the first seven years after the accident; in the case of field crops, the average values dropped almost to the pre-Chernobyl level. In 1995, this process was halted and even a slight increase in level of the caesium isotopes was observed. It remained unchanged until 1997, when again a slight decline was observed. Although in the second part of 1997 there were also certain indications of an increased external radiation dose (radiation in the environment), the latter, unlike in 1997, nevertheless failed to prevail in the annual total, and the average annual dose remained at approximately the 1996 level, as in other regions of Slovenia (the national programme). Considering the recurrent pattern of these semi-annual variations, which more or less applied to the entire Slovenia, it was presumed that climatic effects in combination with general pollution were the factors responsible.

A decline in the contribution of liquid effluents from the Videm paper mill to the radiation load of the Sava water by means of artificial (by factor 0.5) and natural radionuclides (by factor 0.25), caused by a drop in production in 1992 and 1993, was followed by a repeated increase in natural radionuclides (by factor 2) which was retained at roughly the same level both in the case of natural and in the case of artificial radionuclides in 1995, 1996 and 1997. In particular, discharges of ashes from the paper mill heating power plant into the Sava river served to boost the presence of natural radionuclides from coal; no increase in the number of artificial radionuclides (Sr-90, Cs-137) was observed. Due to lower concentrations of caesium radionuclides, the "pre-Chernobyl" strontium gained importance over the long-lived artificial radionuclides. The prevailing share of the dose from artificial radionuclides, however, has been contributed by short-lived iodine-131 from hospitals, particularly since 1989.

A comparison of results in the various Sava media indicates that less than a half of average annual concentrations of caesium isotopes determined in the Sava water at Brežice can be attributed to the Krško NPP, while the rest can be attributed to the global, mainly Chernobyl contamination of the environment. Taking into account the increased tritium concentrations contributed by the Krško NPP releases, as well as I-131 and strontium, it can be estimated that the contribution of the Krško NPP to annual exposure of a reference individual due to potential drinking of the Sava water at Brežice in 1997 was about 0.4 microSv/year (for a reference child about 1.5 microSv/year), which amounted to approx. 85% of the committed dose from natural and artificial radionuclides and to 7% of the cumulative dose from natural and artificial radionuclides. This estimate for the Sava river at Brežice is comparable to the estimate for 1996. A somewhat lower dose due to the Krško NPP (0.2 microSv/year for a reference individual and less than 1 microSv/year for a reference child) can be observed for the Sava at Jesenice (Dolenjska). These data are considerably affected by the unreliable estimations of the short-lived I-131 share, which was largely contributed by hospital releases, as in previous years. A rough estimate of the I-131 contribution from hospitals to the dose to a reference child at Brežice (1.9 microSv/year) shows that it is comparable to the contribution of the Krško NPP. It is noteworthy that a similar estimate, excluding the contribution of the Krško NPP, indicates a dose of 1.7 microSv/year to Krško, and that the estimated potential doses are on an increase upstream of the Sava river in the direction of Ljubljana.

For an estimate of the increase of the effective dose to a reference individual due to ingestion of fish from the Sava (36 kg/year) - assuming the most unfavourable circumstances (max. obtained values of artificial radionuclides regardless of origin, the whole fish) - a value of less than 1.8 microSv/year (for a reference child at 60% of the adult's ingestion, less than 5.5 microSv/year) was obtained. On average, the fish which, by 1996, represented the critical transfer pathway of the Krško NPP effluents through the food chain, also did not considerably differ in the content of (mainly Chernobyl) caesium from the rest of the protein food in 1997. The major periodic dose increases were caused by the short-lived I-131, which is the result of contamination of the whole Sava water body upstream and downstream from the Krško NPP.

An independent model estimation of the effective dose to a potentially maximally exposed individual from the reference group of inhabitants of Brežice for the anticipated transfer pathways of liquid effluents over the Sava, based on the estimated dilution factor in the Sava and on the inventory of the releases from the Krško NPP (amended monthly reports of the Krško NPP for 1997), gives an effective dose of 0.8 microSv/year to adults and 0.6 to children. Although this effective dose is approximately by factor 2 lower than in 1996 due to differences in the dilution factor in the Sava estimate and due to decreased liquid releases, its order of magnitude is comparable to the doses from the past five years.

Over all the years of operation of the Krško NPP (since 1982), the concentration of tritium in the Brežice water main has been twice as high as in the wells at the Brežice-Krško plain and in the Krško water main. A study and analyses made in 1985 confirmed the assumption that this increase might be attributed to the Krško NPP contributions through the Sava water. In the second half of 1990, the Brežice main began to utilize, to a large extent (70% of consumption), a new deep well distinguished by water with exceptionally low tritium content (old water) so that this problem was practically solved. The measured contribution of all the artificial radionuclides from the Brežice water mains to the annual dose to an adult due to drinking of this water, dropped to a few per cent of a microSv/year (in 1997, about 0.024 microSv/year for adults and children), whereby the contribution of the Krško NPP through tritium from the old well became negligible. The cumulative dose due to the content of natural and artificial radionuclides was estimated at 7.64 microSv/year to adults and 19 microSv/year to children (aged 1 to 2 years). Also the control wells in the alluvial deposits in the area of Samobor (Croatia) in 1997 detected neither a noticeable impact of global contamination nor any impact of the Krško NPP (tritium).

The measurements of aerosols showed no effects of particulate emissions from the Krško NPP. The estimates based on the inventory of gaseous emissions (monthly reports of the Krško NPP for 1997, and the JSI estimate of the gaseous emissions of tritium and carbon-14) and emissions of particulates (monthly reports of the Krško NPP for 1997, and the JSI additional estimates of emissions) and monthly dilution factors (meteorological reports by the Hydrometeorological Institute) showed a dose value of 0.5 microSv/year at Spodnji Stari grad (direction ENE, distance 0.8 km) as the maximum dose due to inhalation (0.24 microSv/year) and due to external radiation from a travelling "cloud" (a plume) (0.21 microSv/year). In comparison with 1996 the estimated dose decreased by factor 2. The major contribution to the dose was made by increased emissions of inert gases in the first half of the year before the annual outage of the Krško NPP. The continuous control measurements of I-131 at 6 sites in the vicinity of the Krško NPP did not detect concentrations of I-131 over the control limit, which corresponded to the conditional annual thyroid dose of 0.4 microSv.

The average dose value due to external radiation, measured at 57 sites in the vicinity of the Krško NPP by thermoluminescent dosimeters throughout the year was 800 microSv/year, which is equal to the value in the preceding year, and 36% higher than the pre-Chernobyl dose. Measurements at other places throughout Slovenia (50 places included in the national monitoring programme) gave similar unchanged annual dose values, although the average annual doses were higher than the average dose in the Krško-Brežice area. The automatic continuous dose rate level meters (13 permanent measuring points with autonomous recording and with real-time radio and telephone connection to the central computer at the Krško NPP) mainly intended for emergency warning gave similar, but rather less extreme results than TL dosimeters, in particular the results concerning annual dose levels characteristic for individual places (which correspond to the different detection characteristics of both meters). Nevertheless, the instruments also detected periodical excursions of dose rate levels (up to 160% over the monthly average) in the duration of a few hours, which could be attributed to wash-out of natural radionuclides - radon progeny from the air with rain as well as to their initial presence in the top wetted layer of soil. These phenomena have been also regularly observed in other remote areas of Slovenia where the instruments are installed and are, as a rule, correlated with precipitation and not with gaseous emissions.

Based on the results of external radiation measurements using thermoluminescent meters, a map of external radiation in the wider area of the Krško plain was made. The map proves that the lowest values are in the close vicinity of the Krško NPP (concrete surfaces, the Sava river, the river sand). The measurements of deposition from the air at the Vrbina location did not show any contribution from releases during regular operation of the Krško NPP or from the activity of stored radioactive waste or the Krško reactor itself in 1997.

The inter-comparison measurements of liquid samples and filters showed that the obtained values of doubly detected radioisotopes were well matched. The parallel measurements of the proportionate representative samples of liquid effluents at the Krško NPP from the parallel measurement of the cumulative aerosol filters did not indicate any divergence which would critically change the estimation of annual doses due to gaseous and liquid releases. In all cases of divergence, less favourable values were used for estimation.

9.3.3 EXPOSURE OF THE POPULATION

All the determinable and quantitatively estimated doses to the environment from the Krško NPP releases were found to be below the regulatory limit values(**). In 1997, the estimated dose to an individual from the reference (critical) group of inhabitants, based both on the directly estimated values of the environmental radiation and on the calculation models from actual data on annual releases from the Krško NPP, was lower than 20 microSv/year, i.e. lower than 1% of the annual dose received by an individual from natural and artificial sources in a normally contaminated environment.

Figure 9.4: External radiation in the vicinity of the Krško NPP after the Chernobyl accident, annual dose (thermoluminescent dosimeters IJS-TLD-05)

* - Pre-Chernobyl average dose (data from the previous reports by the Jožef Stefan Institute)

Table 9.8: Estimation of partial exposure of individual members of the population through all transfer pathways from the Krško NPP releases in 1997

Transfer path	**Annual Effective Dose (microSv)**	
	Adults	**Children**
Internal exposure through inhalation - tritium, carbon-14, iodine-131, particulates	0.24	0.14
Internal exposure through ingestion - food - water	 < 1.8 < 0.4	 <5.5 <1.5
External exposure through submersion and deposition	6	6
Estimation of the cumulative dose due to the Krško NPP emissions in 1997	8.2	13

* The quoted annual dose values in microSv/year apply in all relevant cases (with the exception of the external radiation) up to the value defined as the "50-year committed effective dose".

** For dose estimation, for the first time "new" dose conversion coefficients from 1996 were used in the Report. These coefficients generally (as compared to the "old" ones from 1982) show slightly lower doses to adults, with an increase in the case of children. For this reason the reference (critical) population group also included children, aged 1 to 2 years.

*** The regulatory annual dose limit to an individual who is not professionally exposed to radiation is 1000 microSv/year (1000 microSv/year = 1 miliSv/year) of the effective dose. The limit value applies to the cumulative contributions from all the artificial radiation sources with the exception of medicine, and to the contributions from modified natural radiation sources with the exception of the indoor radon. Besides the quoted basic general limitation there are also administrative limitations which apply to the normal operation of individual nuclear facilities - the so-called authorized limit doses which are, as a rule, lower than the basic dose. According to the provisional planning permission of the RS Secretariat of Physical Planning (No. 350/F-15/69 from 8 August 1974), the limit dose value to a member of public living at the border of the exclusion zone (a circle with a radius of 500 m around the reactor) is 50 microSv/year. According to the Decree by the Committee for Environmental Protection and Physical Planning (No. 350/F-6/88-DF/JV from 2 August 1988), however, the annual dose limit at the facility fence, including contributions from the reactor and the temporary radioactive waste storage, amounts to 200 microSv. According to the Decree by the Inspectorate of Energy (31-04/83-5 of 6 February 1984), there are several other limitations as well (e.g. annual activity of liquid effluents and gaseous emissions).

The doses (*1) were estimated for an adult and a child from the reference group who received the highest doses and lived on locally produced food only. The data classified by sources are set out in the relevant table and graphically represented on a chart.

(*1) The estimations were made using the dose conversion coefficients adopted by the European Community in 1996 (EU Council Directive 96/29/EUROATOM from 13 May 1996; OJ No. - 159, 29 June 1996, p.1)

(*2) The dose from artificial radionuclides (the Krško NPP, general contamination) is defined as the "50-year committed effective dose", while the dose from natural radionuclides is defined as the "annual effective dose".

(*3) For dwellings with an average equilibrium radon concentration of 15 Bq/m^3 (or a concentration of Rn-222 of 38 Bq/m^3 at an equilibrium factor of 0.4) and an indoor occupancy factor of 0.8 and an outdoor occupancy factor of 0.2. According to the proposal of the ICRP Publication 65 from 1993, an inhabitant living in the environment with an average equilibrium radon concentration of 22 Bq/m^3 and spending 80% of his time at home and 20% at work, would receive the same annual dose. The latter concentration values are closer to those measured in Slovenia (M. Križman et al., Proceedings, Symposium on Radiation Protection in Neighbouring Countries in Central Europe - 1995, Portorož, Slovenia, p. 66, January 1996).

(*4) Consumption determined on the basis of data of the Statistical Office of Slovenia on *Consumption by the Population from 1993 to 1996* (Statistical Yearbook of Slovenia). The data from the publication UNSCEAR 1988 Report (p. 95), United Nations, New York 1988 were used for the average dose from natural radionuclides.

(*5) Data obtained from the German government report for 1989 (Bericht der Bundesregierung über Umweltradioaktivität und Strahlenbelastung für das Jahr 1987, Drucksache 11/6142, 20 December 1989). A very approximate estimate for the Slovenian population suggests roughly the same or a higher exposure, due to inferior equipment at a lower number of examinations. Due to the unreliability of the estimation, the relatively lowest estimation of 300 microSv/year, set out in the British NRBP (Radiation Exposure of the UK Population - 1988 Review, NRBP-R227) is quoted here as well.

(*6) Data obtained from the report by U. Miklavžič et al., Annual Doses of External Radiation in Slovenia, IJS DP-6696, March 1993.

(*7) A longer outdoor stay, with an outdoor occupancy factor of 0.3 and an indoor stay factor of 0.7, was assumed.

Source: Radioactivity Measurements in the Vicinity of the Krško NPP - Report, IJS DP-7869

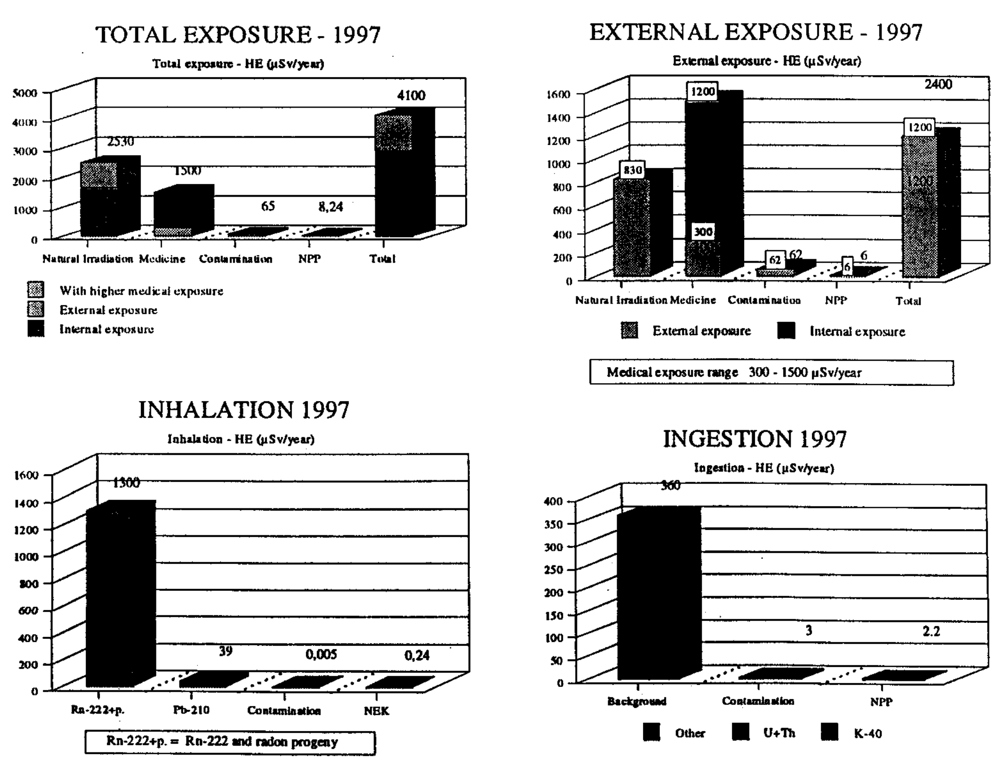
Table 9.9: Survey of sources and dose values to the population in the vicinity of the Krško NPP in 1997

1 INTERNAL EXPOSURE (as a result of intake and the presence of radionuclides in the body and their radiation effects on the body)	**Effective dose in 1997 (*2)** **(microSv/year)** **Adults**	 **Children**
1.1 due to intake by breathing (inhalation) from the following sources:		
1.1.1 natural radioactivity - radon-222 and its short-lived progeny in the air (*3)	1300	
1.1.2 general contamination with dust particles (aerosols) - accumulated lead-210 (from industrial and natural sources) - resuspended artificial radionuclides	 39 0.005	 20 0.0002
1.1.3 gaseous emissions from the Krško NPP - tritium, carbon-14, iodine-131, particulates	0.24	0.14
total for inhalation	1339	
1.2 due to intake with food and water (ingestion) from the following sources(*4):		
1.2.1 natural radioactivity - potassium-40 - uranium and thorium chain - other	 180 140 40	

total	360	
1.2.2 general contamination (Chernobyl, nuclear explosions, industrial accumulation of artificial radionuclides) - food - water total	 3 0.02 3	 4 0.024
1.2.3 liquid effluents (the Sava river) and gaseous (deposition) emissions from the Krško NPP - food - water total	 < 1.8 < 0.4 2	 <5.5 <1.5 < 7
total for ingestion	365	
rounded total for internal exposure	1700	
2 EXTERNAL EXPOSURE (as a result of radiation sources outside the body in the environment and their radiation effects on the body)		
2.1 due to medical diagnostics (*5)	1500 (300)	
2.2 due to natural radiation (cosmic and terrestrial) (*6) - cosmic neutronic component - cosmic and terrestrial radiation (U, Th chain, K-40, cosmic radiation)	 60 770	
2.3 due to Chernobyl deposition in the environment (*7)	62	-
2.4 due to gaseous emissions from the Krško NPP (inert gases and deposition) (*7)	6	6
rounded total for external exposure grand total for internal and external exposure (rounded) with major medical contribution (1500 microSv/year) with minor medical contribution (300 microSv/year)	2400 4100 2900	
grand total for exposure due to releases from the Krško NPP	8.24	13

Note: (*) see explanations in the text

Figure 9.5: Doses to adult members of the reference group in the vicinity of the Krško



9.4 RADIOACTIVITY MONITORING IN THE ENVIRONMENT OF THE TRIGA RESEARCH REACTOR CENTER

The radioactivity monitoring in the vicinity of the Research Reactor Center at Podgorica in 1997 was carried out according to the same programme as in the past. The monitoring programme, approved by the SNSA Decision No. 318-22/94-9209/SA on 13 July 1995, in accordance with the Z2 Regulation (Regulation on Radioactivity Monitoring in the Vicinity of Nuclear Facilities (Off. Gaz. SFRY, No. 51/86) was implemented as follows:

9.4.1 SCOPE OF MONITORING

1. Measurements of releases at the source in order to enable impact assessment of the facilities:
   - gaseous releases (aerosols and gases released from the exhaust from the reactor hall, radon progeny in the radioactive waste storage);
   - releases of liquid effluents (radioactive isotopes in the discharge water from the Department of Environmental Chemistry, monitoring of some other liquids).

2. Measurements of radioactivity in the environment in order to assess the impact of the facility or to identify the impact from the external polluters:
   - liquids: radioactivity of precipitation and well water;
   - external radiation: monitoring of dose rate levels at the control point.

3. Other measurements:
   - radioactive isotopes in soil;
   - radioactive isotopes in the Sava river deposit.

In accordance with the requirements of the Decision referred to above, the Jožef Stefan Institute launched the activities for construction of the on-site meteorological station.

9.4.2 MONITORING RESULTS

In reactor operation and other related activities in 1997 there were no special events found, and the total produced thermal power was comparable to previous years. Releases of ^{41}Ar into the air (approx. 1.0 TBq in 1997) were directly correlated to reactor operation and were also similar. There was no change in the release of liquid effluents either (12 MBq in 1997) resulting from the research work at the Department of Environmental Chemistry. The activity of liquid effluents was similar to that in the previous years.

9.4.3 EXPOSURE OF THE POPULATION

For this reason the estimated annual effective doses to the population were exceptionally low. The same methodology was used as in the past.

The external immersion dose due to releases of ^{41}Ar into the air was estimated to 0.25 microSv per year which amounted to no more than 0.025% of the annual dose limit to the population.

A conservative estimate of the ingestion dose due to release of effluents into the Sava river was 0.4 microSv per year representing 0.04% of the annual dose limit to the population.

9.5 RADIOACTIVITY MONITORING IN THE ENVIRONMENT OF THE ŽIROVSKI VRH MINE

9.5.1 SCOPE OF MONITORING

The Žirovski vrh Mine was in operation from December 1984 to 1 January 1990, when all mining operations and ore processing were discontinued. The Act on Permanent Cessation of Exploitation of Uranium Ore, adopted two years later (Off. Gaz. RS, No. 36/92) prescribed the radiological monitoring of the environment in the period of closing down of the mine as well as in the period after its closure. The monitoring programme covers measurements of radon and its short-lived progeny concentrations in the air, measurements of the specific activity of the long-lived natural radionuclides of the uranium-radium decay chain in the air, in the surface waters, the deposits, the water biota, the food and the fodder and in the soil, as well as measurements of the external gamma radiation in the living environment. The monitoring is focused in particular on the valleys and other inhabited areas in the vicinity of the Žirovski vrh Mine, mostly up to a distance of 3 km from the central mine facilities. The comparative measurements are also performed at remote sites outside the mine impact area; from the data obtained the mine contribution to the radioactive contamination of the environment is estimated.

In 1997, the monitoring was carried out by the technical support organization for radiation protection, the Institute of Occupational Safety in co-operation with the Jožef Stefan Institute.

9.5.2 MONITORING RESULTS

In the present phase of mine closure, a decline in the total emissions of radon and liquid effluents into the environment was observed, which brought about a partial decrease of radionuclide concentrations in individual media.

The difference was best noticeable in concentrations of long-lived radionuclides in the solid particles in the air, which were determined by quarterly composite samples obtained by continuous sampling. Immediately after the cessation of ore exploitation these concentrations dropped almost to the normal environmental values. The results for 1997 show that the estimated increase in radon concentrations in the vicinity of the Mine amounted to an average of 7.0 Bq/m^3 and was therefore similar to those in the preceding years (in 1989 the estimated contribution of the mine was 8.2 Bq/m^3, in 1990 6.7 Bq/m^3, in 1991 and 1992 7.9 Bq/m^3, in 1993 6.6 Bq/m^3, in 1994 7.8 Bq/m^3, in 1995 9.1 Bq/m^3, and in 1996 7.8 Bq/m^3). Concentrations of outdoor radon in the inhabited Brebovščica valley are affected by emission from the low-altitude sources only, in particular those from the Jazbec mine waste, the covered surfaces near the surface mine facilities and from the outlet channel under the Jazbec tailings pile. The continuous measurements of radon progeny proved that also in 1997 the factor of equilibrium between the radon of mine origin and its progeny was low, which was also taken into account in the calculation of the dose value estimate. Since the dispersion of radon into the environment (from the low-altitude sources) is limited due to the specific topographical and meteorological characteristics of the Žirovski vrh Mine site, there is a possibility that relatively high radon concentrations may be found along a narrow strip down the valley, even as far as 3-4 km.

In 1997, there was a general decline in the radioactivity of surface waters. The average annual concentration of ^{238}U in the Brebovščica, calculated on the basis of results in the monthly composite samples, was 219 Bq/m^3 (170 Bq/m^3 in 1996), while in the Todraščica it was 58 Bq/m^3 (128 Bq/m^3 in 1996). The average annual concentration of ^{226}Ra in the Brebovščica was 16.1 Bq/m^3 (19.8 Bq/m^3 in 1996), while in the Todraščica it was 29.1 Bq/m^3 (38 Bq/m^3 in 1996). The principal remaining sources of water pollution after the cessation of ore exploitation are the mine water, the Jazbec mine waste and the Boršt tailings pile. The discharge water from the Boršt tailings pile flows directly into the environment. This is the main reason why radium concentrations in the Todraščica, in particular in the dry season, are significantly higher than those in the Brebovščica. The same applies to sediments in both streams.

Concentrations of ^{226}Ra and ^{210}Pb found in food and fish were low, and may vary considerably. Even with the same type of samples, variations may exceed the difference of concentrations between the samples taken in the vicinity of the mine and those taken at reference sites. As aerosols contain few long-lived radionuclides, there is less deposition of radioactive particles onto grass and soil. As a result, the dose received through the food chain is low.

After the cessation of ore exploitation, the external gamma radiation in the vicinity of the piles has varied according to the character of remedial works such as formation and consolidation of pile surfaces, taking materials from other sites to a common pile, partial covering of surfaces etc. In 1997, the external gamma radiation in the vicinity of the tailings pile at Boršt did not differ from the 1996 values. However, in the vicinity of the

P-1 and P-9 mine wastes, the P-36 and the Jazbec waste rock pile, the situation has not changed since 1992; it was at that time that all the activities at these facilities were discontinued. Here and there it is still possible to locate places outside the tailings piles, where radiation is significantly increased due to remains of ore from the past period.

9.5.3 EXPOSURE OF THE POPULATION

The area exposed to the rather even impact of the mine has 250-300 inhabitants. Most of the adult population are either farmers or work elsewhere, at more remote places. In estimation of the effective dose to an individual inhabitant received from the former Žirovski vrh Mine sources, the following transfer pathways have been considered:

- inhalation of long-lived radionuclides;
- inhalation of ^{222}Rn and its short-lived progeny;
- ingestion (intake with food and water) through the water and soil food chain;
- external gamma radiation.

The dose conversion coefficients for the effective dose value estimation were taken from the Basic Safety Standards (1996), whereby the contractors retained the method of the effective equivalent dose calculation from inhalation of radon and its short-lived progeny according to ICRP 50 Publication (1988). The dose due to potential intake of water from the surface waters was also calculated, but it was not taken into account in the grand total, since the local population do not use this water for drinking, watering or irrigation.

The cumulative annual effective dose caused by the Žirovski vrh Mine in 1997 (rounded): **0.30 mSv/year.**
The estimate was made for those adults inside a wider population group who received the highest additional annual doses. Inhalation of radon and its progeny from the mine is the main factor of contribution to the exposure. The most exposed population are the inhabitants of Gorenja Dobrava, situated 1.3 km to the north of the former surface mine facilities. Based on the radon concentration measurements, and considering the meteorological parameters, it was established that this was the place with the highest equilibrium equivalent concentrations of radon from the mine. In 1997, the exposure of the population in the surroundings of the former Žirovski vrh Mine due to its impact was close to the values obtained in the previous years as well as to the values during operation of the mine.

Source: Report of the Institute of Occupational Safety on Radioactivity Monitoring in the Vicinity of the Žirovski vrh Mine for 1997 No. 1001/98, March 1998

Table 9.10: Annual effective dose to the population in the vicinity of the Žirovski vrh Mine in 1997

Transfer Pathway	Detailed Description, Major Radionuclides	Annual Effective Dose (mSv)
Inhalation	- aerosols with long-lived radionuclides U, ^{226}Ra, ^{210}Pb - ^{222}Rn alone - short-lived radon progeny	0.011 0.005 0.225
Ingestion	- U, ^{226}Ra, ^{210}Pb, ^{230}Th in drinking water (surface waters, underground water) - fish (^{226}Rn, ^{210}Pb) - agricultural products and food (^{226}Ra and ^{210}Pb)	(0.018) 0.0003 <0.050
External radiation	- gamma radiation of ^{222}Rn and its progeny (deposition, immersion) - gamma radiation of long-lived radionuclides (aerosols) - direct gamma radiation (vicinity of tailings piles)	0.002 - 0.002

10 RADIOLOGICAL PROTECTION IN THE WORKING ENVIRONMENT

This chapter contains the report on surveillance of the safeguards in the field of ionizing radiation sources (HIRS) and the report by technical support organisations (Institute for Occupational Safety of the Republic of Slovenia, JSI) on implementation of various measures for radiological protection in Slovenia, based on authorisation by the Republic Committee for Health and Social care from 1981. The report by the Jožef Stefan Institute on this activity is not included in the present chapter.

10.1 THE REPORT BY THE HEALTH INSPECTORATE OF THE REPUBLIC OF SLOVENIA

10.1.1 INSPECTION OF NUCLEAR FACILITIES

The Health Inspectorate of the Republic of Slovenia (HIRS) is responsible for inspections at the Krško NPP and at Jozef Stefan Institute (JSI) with the TRIGA reactor, and at the Interim Storage for Low and Intermediate Level Radioactive Wastes of the Republic of Slovenia at Podgorica near Ljubljana.

In 1997, the Inspectorate carried out eleven inspections in the Krško NPP, one jointly with inspectors of the SNSA, and participated in the survey of the future sampling site by the Sava river at Brežice. The inspectors observed no major irregularities or problems related to radiological protection in the Krško NPP. During the annual outage works, when some workers were exposed to doses of up to 20 mSv, the inspections were more frequent.

At the Reactor Center at Podgorica, the HIRS carried out four inspections, three of them jointly with the inspectors of the SNSA. From the viewpoint of radiological protection the inspection of the Research Reactor revealed no major deficiencies. Most of the workers went through the mandatory annual medical examinations required for persons working with sources of ionizing radiation. During the inspection in October 1997 it was agreed that the JSI internal instructions on transport and replacement of radioactive sources Ir-192 for industrial radiography should be amended and supplemented by instructions on labelling and transport of empty containers and on the documentation required for the purpose by the end of January 1998. One incident did occur, in October 1997, when it was found that the rail transport of an empty radioactive container for Iridium-192 from the Reactor Centre through Austria to Budapest had been carried out without any license and other necessary documentation.

During inspection of the new accelerator TANDETRON it was found out that the Jozef Stefan Institute had not acquired the licence for usage from the Health Inspectorate.

The inspection of the Interim Storage for Low and Intermediate Level Radioactive Wastes in the Reactor Center at Podgorica revealed once again that the waste was not sorted systematically according to the category of isotopes and their activities and that the radiation sources data did not fully comply with the regulations, primarily due to incomplete documentation handed over by users (mainly from industry) on the delivery of sources. The JSI produced a new inventory list of the stored material, which was sent to the Health Inspectorate of the Republic of Slovenia in spring 1997. It should be noted that, as from summer 1997, JSI has stopped accepting the wastes because of unsolved management status on the side of ARAO.

10.1.2 INSPECTIONS IN MEDICINE

10.1.2.1 Departments and Laboratories for Nuclear Medicine

The HIRS is responsible for the inspection of seven clinics and hospitals in Slovenia where unsealed radiation sources are used (radiopharmaceutics) for diagnostics and therapy (the University Medical Centre of Ljubljana - the Department of Nuclear Medicine, the Institute of Oncology and hospitals in Maribor, Slovenj Gradec, Celje, Nova Gorica and Izola). The Inspectorate carried out nine inspections in these facilities.

The Inspectorate also carried out four inspections at the Institute of Oncology, where the situation seemed to be the most problematic due to the low safety culture (lack of discipline as regards medical examinations), relatively high doses and unsuitable working premises. For the new premises of the Institute of Oncology that are now under construction, the project documentation was prepared in summer 1997, and as regards radiological protection the prior approval for the construction permit was also issued.

Compared to the previous year the situation at the hospital of Celje even worsened, and an order for proper storage of radioactive wastes was given. Further, the reorganisation of management at the Department of Nuclear Medicine was carried out. The inspector carried out 3 inspections at the General hospital of Celje.

At the Clinic of Nuclear Medicine in Ljubljana two inspections were carried out. The term for compliance with the order for the required remedial action at the Clinic of Nuclear Medicine in Ljubljana was extended again for one year, till 10 September 1998, since the difficulties in providing the funds continued.

In autumn 1997, the RS Institute for Occupational Safety found that contamination in the working environment of the Department of Nuclear Medicine at the hospital of Maribor exceeded the limit value. Since this had occurred repeatedly also in the previous years, a complaint was filed against the responsible person for contamination of the working environment above the regulatory limit.

In Izola and Slovenj Gradec no inspection was carried out, as there were no major changes in comparison to 1996. After minor adaptations at the laboratories in Izola the work with Technetium was again temporarily permitted in autumn 1997. The construction of a new department for nuclar medicine is still in progress, but it is not yet equipped.

The Inspectorate observed that in most departments of nuclear medicine the state of radiological protection was approximately the same as in the previous years. The requirements of the regulations on radiological protection were not complied with in the Hospital of Celje and in the University Medical Centre Ljubljana. Certain deficiencies were also observed, either by technical support organizations or by the Health Inspectorate, in all the other departments of nuclear medicine.

In addition to the unsealed sources, the Institute of Oncology also uses sealed sources (two Cobalt-60 sources, one Iridium-192, one Cesium-137 and one Ruthenium-106) and three electron accelerators. The state of radiological protection in the teleradiotherapeutic and in the brahiradiotherapeutic departments was not questionable, except for irregular medical examinations. In spring as many as 63 persons did not have a valid medical certificate. The Institute of Oncology management issued a decision to several workers prohibiting them from working in the area of radiation sources, and suspended the related allowances.

10.1.2.2 X-Ray Devices in Medicine and Veterinary Medicine

According to the records of the HIRS, in 1997 there were 658 X-Ray devices in medicine and in veterinary medicine in Slovenia with an operation licence. The HIRS carried out 29 inspections in medical organizations to establish the state of X-Ray departments and X-Ray equipment in particular, and to determine how the equipment was used. Orders for remedy of the deficiencies were issued to nine users.

The operation of thirteen X-Rays was forbidden by regulatory decrees, and thirteen orders to remedy the deficiencies in the premises for X-Ray diagnostics were issued.

Table 10.1: Radiation sources in medicine and veterinary medicine

Purpose of X-Ray	Status in 1996	Number of new permits	Registered write-offs	Status in 1997
Dental	289	38	5	322
Mammographs	15	10	2	23
CT	12	2	0	14
Therapeutic	5	0	2	3
Diagnostic	279	18	13	284
Veterinary	8	4	0	12
Total	608	72	22	658

Table 10.2: Regulatory decree by HIRS:

No.	Medical organisation	Number of forbidden X-Rays	Number of orders to remedy deficiencies
1.	ZD Ljubljana Bežigrad	5	1
2.	ZD Ljubljana Center	0	3
3.	SB Jesenice	0	2
4.	SB Nova Gorica	3	0
5.	SB Celje	1	2
6.	ZD đalec	2	2
7.	ZD Velenje	1	1
8.	ZD Postojna	0	2
9.	KC - IDIR*	1	0
	TOTAL	13	13

*IDIR - The Institute for Radiology

10.1.3 INSPECTIONS IN INDUSTRY

10.1.3.1 Sealed Radiation Sources with Radioactive Isotopes

The inventory of old and unused sealed radiation sources was surveyed in detail in 1997. The inventory list is longer than it was in the report for 1996, as some of the ex-users have not yet delivered the sources into the interim radwaste storage at Podgorica. The list contains 93 commercial and non-commercial organisations currently storing altogether 420 sealed ionizing sources for:

- radiography with Iridium-192, Cobalt-60 and Caesium-137: 41 sources in 11 organisations (IMK Ljubljana - 4, IMP Maribor - 2, IMP Črnuče - 7, Welding Institute Ljubljana - 9, Litostroj Ljubljana - 2, Mascom Maribor - 3, STO Ravne - 6, Metalna Maribor - 4, M&K Laboratory Dornava - 1, Montavar Miklavž -2, the Krško NPP -1);
- lightning conductors with Europium-152 or Cobalt-60: 22 sources in 14 organisations (Aerodrom Maribor - 2, Cestno podjetje Novo Mesto (Drnovo) - 1, Helios Domžale - 5, Industrija usnja Vrhnika -1, Inkop Kočevje - 1, Komunalna Plinarna Celje - 1, Koto Ljubljana - 1, Motel Grosuplje - 1, Orthaus Kočevje - 2, Smola Kočevje - 1, Svilanit Kamnik - 1, Telekom Dragomer - 1, Titan Kamnik - 2, Tovarna vzmeti Ptuj -2);

- thickness gauges/density gauges in manufacture: 193 sources in 26 organisations (Acroni Jesenice - 87, Aero Copy Celje - 2, Filc Mengeš - 2, Goričane Medvode - 2, ICEC Krško - 4, Impol Folije Slovenska Bistrica - 5, Impol Valjarna Slovenska Bistrica - 13, Intec Kranj - 3, Juteks Žalec - 6, Konus Slovenske Konjice - 2, KSE Novo mesto - 2, Paloma Sladki vrh - 1, Papirnica Vevče - 6, Plama Podgrad-1, Pohorska vzpenjača Maribor - 2, Radeče Papir - 8, Sarrio Slovenija Količevo - 5, Sava VIST Kranj - 4, Termoelektrarna toplarna Ljubljana - 3, Termoelektrarne Šoštanj - 4, TKI Hrastnik - 3, Tobačna Ljubljana - 15, Tokis Ilirska Bistrica - 1, Tovarna sladkorja Ormož - 10, Velika planina Kamnik - 1, Žičnice Vogel - 1);
- moisture/densitometers in field work: 76 sources in 21 organisations (Aktim Ljubljana - 1, Apros Maribor - 4, B&A&M Maribor - 1, Cestno podjetje Celje (Pirešica) - 3, Cestno podjetje Koper - 1, Cestno podjetje Kranj - 1, Cestno podjetje Ljubljana - 2, Cestno podjetje Maribor - 1, Cestno podjetje Nova Gorica - 2, Cestno podjetje Novo Mesto - 1, Gradbeni inštitut ZRMK Ljubljana - 4, Gradis Ljubjana - 3, Gradis Maribor - 3, IGGG Geofizika Ljubljana - 3, IGGG Geotehnika Ljubljana - 3, IGMAT Ljubljana - 12, Pontello Ločica ob Savinji - 1, Primorje Ajdovščina - 7, PUV Žalec - 1, SGP Kraški zidar Sežana - 1, ZAG ZRMK Ljubljana - 21);
- level gauges for liquids and road metal: 88 sources in 23 organisations (Cementarna Trbovlje - 2, Cinkarna Celje - 8, Coca cola Žalec - 4, Gasilska brigada Koper - 1, ICEC Krško - 8, Kemiplas Dekani - 5, Ladjedelnica Izola - 1, Lesonit Ilirska Bistrica - 9, Metal Ravne - 1, Metal Ravne/Štore - 4, M.P.P. Livarna Maribor - 4, Novoles Novo mesto - 1, Pivovarna Laško - 7, Pivovarna Union - 3, Radenska Radenci - 4, Sava TAP Kranj - 8, Slovenijavino Ljubljana - 1, Steklarna Rogaška Slatina - 1, Termo Škofja Loka - 6, Treibacher Ruše - 1, Termoelektrarne Šoštanj - 3, Tovarna sladkorja Ormož - 3, Yulon Ljubljana - 3);
- and ionizing fire detectors are preserved in Iskra Sistemi Ljubljana, Iskra Servis Ljubljana, Ultimate Tržič and Zarja Kamnik.

The technical support organisation the Institute for Occupational Safety of the Republic of Slovenia is responsible for inspections of these sources once a year. However, the situation did not change substantially in comparison to the previous year. Due to various reasons (in most cases, due to ownership and organisational changes, and delayed payments for inspections) in as many as 27 organisations the inspections were not carried out in 1997. These included: Aerodrom Maribor, Cestno podjetje Koper, IGGG Geotehnika Ljubljana, Inkop Kočevje, Industrija usnja Vrhnika, Konus Netex Slovenske Konjice, Koto Ljubljana, KSE Novo mesto, Lesonit Ilirska Bistrica, Litostroj Ljubljana, Mascom Maribor, Metal Ravne, Metal Ravne/Štore, Metalna Maribor, M.P.P. Livarna Maribor, Novoles Novo mesto, Orthaus Kočevje, Plama Podgrad, Smola Kočevje, STO Ravne, Telekom Dragomer, Termoelektrarna toplarna Ljubljana, Titan Kamnik, TKI Hrastnik, Tokis Ilirska Bistrica, Velika Planina Kamnik, Yulon Ljubljana, in 14 of which inspection had not been performed in the last three years (Aerodrom MB, Cestno podjetje Koper, Industrija usnja, Konus, Koto, KSE, Novoles, Orthaus, Plama, Pohorska vzpenjača, Smola, TKI, Tokis, Velika Planina). Some of the above-mentioned organisations have gone bunkrupt or changed their names.

In February 1997, the regional health inspectors carried out inspections in most of the above-mentioned organisations, altogether 52. The inspector from the Office of the Chief inspector of the HIRS personally carried out inspections in 5 organisations (Metalna, Inkop, Smola, Orthaus, Acroni) and 2 hearings (Litostroj, Cestno podjetje Ljubljana), of which in 6 cases he found irregularities and issued 4 orders for remedy (Litostroj, Smola, Orthaus, Inkop). Based on the findings of the inspectors and other documentation the list of radiation sources not yet delivered to the Interim Storage at Podgorica was supplemented.

10.1.3.2 X-Ray Devices in Industry and in Other Facilities

By 31 December 1997, the HIRS kept in its records altogether 88 X-Rays under regular survey by technical support organisations (RS Institute for Occupational Safety and Jozef Stefan Institute), used by:

- industry	44
- the Ministry of the Interior and the Government	28
- Customs and Post offices	3
- Aerodrom Brnik	6
- Jozef Stefan Institute	7

In 1997, licences for usage were issued for 5 X-Rays, and no X-Rays were written-off; in two cases the change in the user's address was registered.

10.1.3.3 Ionizing Fire Detectors

The HIRS did not issue any license for the purchase and use of ionizing fire detectors in 1997. The records of the fire detectors is kept and routine annual inspections are carried out by technical support organisations: the Institute for Occupational Safety Ljubljana and the Institute for Occupational Safety Maribor. In 1997, there were altogether 16,523 ionizing fire detectors inspected in Slovenia (See Table 10.3).

Table 10.3. Inspected ionizing fire detectors in Slovenia in 1997.

No.	Technical support organisation	Number of ionizing fire detectors	Number of locations
1.	The Institute of Occupational Safety Ljubljana	11095	138
2	The Institute of Occupational Safety Maribor	2727	20
3.	Varnost, Maribor	2701	36

10.1.3.4 Radiochemical and Other Laboratories

The HIRS is also responsible for inspections in other laboratories with unsealed ionizing radiation sources, yet these have an activity about one thousand times lower than in hospital departments, and the potential danger is not great. They include: The Faculty of Medicine - The Institutes of Pharmacology, Anatomy, Microbiology, Pathophysiology, Patology, Biochemistry; the University Medical Centre in Ljubljana - The Institute of Clinical Chemistry and Clinical Biochemistry, The Institute of Blood Transfusion of the Republic of Slovenia, the National Institute of Chemistry, the Jozef Stefan Institute - the Department of Biochemistry and the Department of Environmental Chemistry, Lek, the University of Ljubljana - the Faculties of Agronomy, Forestry, Veterinary Faculty, the Institute of Biology Piran. The HIRS did not carry out any inspection in these laboratories in 1997.

During inspections at the Jozef Stefan Institute some irregularities were observed. From the records on medical examinations it was not clear whether the workers were under dosimetric control or not. The records on medical examinations of undergraduates preparing diploma works or persons otherwise temporarily employed in the area of ionizing radiation were not kept separately. In addition, the consignment of radiological material, containing a calibrated source Ra-226, was inspected at the Department of Environmental Chemistry, as it was not sent for inspection to the Border Unit of the Health Inspectorate in conformity with the customs procedure. During the period from July to August 1997 one worker (a student) from the Laboratory of Nuclear Chemistry received a dose of 26 mSv on her hand. The HIRS required an explanation; however, the Head of the Radiological Protection Unit of the Jozef Stefan Institute failed to send it. The HIRS is of the opinion that the Radiological Protection Unit at the Jozef Stefan Institute is evidently understaffed.

Sealed ionizing radiation sources are used also in the regular education process at the Faculty of Physics and at the Faculty of Medicine - the Institute of Biophysics; and for calibaration of measuring devices at the Institute for Occupational Safety, Jozef Stefan Institute, the Krško NPP and at the Slovenian Nuclear Safety Administration. The Ministry of Defence uses low activity Tritium in guns for night firing. In 1997, the HIRS did not carry out any inspections of these sources.

10.1.4 INSPECTIONS IN MINES AND IN OTHER FACILITIES WITH THE RADON PROBLEM

The HIRS and the technical support organisations regularly survey the radiological protection at the Žirovski vrh Mine, and periodically also at the Mežica Lead and Zinc Mine, at the Cave of Postojna and in other facilities.

At the Žirovski vrh Mine six inspections and one technical survey were carried out. Major attention was given to surveying the project documentation for the decomissioning and pulling down of facilities in connection with the final remedial works on the ore processing site of the Žirovski vrh Mine and with the intercalibration measurements. Two projects on radiological protection and on decontamination were surveyed in detail. Apart from radon releases from the tailing piles there are no major radilogical problems at the Žirovski vrh Mine. In connection with the complaint of one worker against the management of the Žirovski vrh Mine on radiation safety at work in the period between 1986 and 1996 and in the autumn 1997 an extensive official record (10 pages) was signed, and additional information was required from the Žirovski vrh Mine. The administrative procedure has not yet been finished.

At the Mežica Lead and Zinc Mine the radiation safety tasks, as specified in the order by the Health insepctorate from 1995, continued. In 1997, the inspector did not carry out any inspection, as it was evident from the report for 1996 that the workers in the Mine received annual doses of radon only from 5 mSv to maximum 15 mSv on avarage.

By the order of the Inspectorate, issued in autumn 1995, similar safety measures were required also from the Cave of Postojna concerning the doses from the radon progeny in the air, to which the guides and other workers in the cave are exposed. The repeated changes in management of the Cave delayed the beginning of implementation of measures until summer 1996. The radiological measurements are carried out by Jozef Stefan Institute, and the medical examinations by the Institute for Occupational Safety of the Republic of Slovenia. The semi-annual doses to workers were lower than before (lower than 11 mSv). The life dose to a worker was estimated to be approximately 1000 mSv. In 1997, two inspections were carried out.

In 1997, the HIRS also carried out one inspection of the temporary storage of radwaste (originating from the Institute of Oncology) in an abandoned barracks near the village of Zavratec. The situation remained unchanged in comparison to the findings of the inspection in 1996. No negative impact of the stored radioactive material was found on the population.

In connection with the problem of indoor radon concentrations in schools and kindergartens in spring 1997 the HIRS organized a lecture on radon at the Ministry of Health for the most critical locations. The Health Inspectorate of the Republic of Slovenia provided funds for the programme of radon concentration measurements in 24 schools and in 6 kindergartens, in which the radon level exceeded 1000 Bq/m^3 a couple of years ago. The measurements were carried out by the Jozef Stefan Institute during winter 1996/97.

In connection with the indoor radon concentrations problem, four additional inspections were carried out by the Inspectorate: in the kindergarten at Iga vas near Lož, in the elementary school at Dolenja vas near Ribnica (2x), and at the Museum of the Slovenian Railways in Ljubljana.

Based on the findings of these inspections and on measurements by the Jozef Stefan Institute, 10 regulatory decrees were issued (ES Ribnica, ES Nove Fužine, ES Žužemberk, ES I. Grohar Škofja Loka, KG Iga vas, Slovenske Železnice, ES Janče, ES Semič, ES Sežana, KG Ivančna Gorica). The elementary school "Dr. France Prešeren" at Ribnica was given the order to remedy the conditions in school rooms with increased indoor radon concentrations at Dolenja vas, and for the technical support organisation to continue the measurement of radon concentrations and establish the doses to pupils and teachers; furthermore, the teachers and the pupils were required to pass precautionary medical examinations at an authorised medical organisation. Similar measures were imposed also on the Slovenian Railways. Other parties received orders to perform regular measurements and ventilation. In December 1997, the second inspection was carried out at the ES Ribnica-Dolenja vas, and it was concluded that the situation was partly remedied; medical examinations of the adults were carried out, but not of the pupils.

10.1.5 SURVEILLANCE OF TRANSPORT OF RADIOACTIVE MATERIALS

The main road transporters of radioactive material fulfilling the prescribed conditions and holding the licence in 1997 were: Janis Maribor, Intertrans Ljubljana (1st half of the year), Jozef Stefan Institute, IMP Montaža Maribor, IMP Promont Črnuče, M&K Laboratory Dornava, IMK Ljubljana, the Welding Institute Ljubljana, Montaver Miklavž, the Institute of Geology, Geotechnics and Geophysics and Zarja Kamnik. The TROXLER or Cambell probes with radioactive materials were being transported by all road transporters from Chapter 10.1.3.1, point (d).

The transboundary transport of radioactive material is organized by many import/export companies, of which the most important in the field of radiopharmacy are Iris, Karanta, Krka and Genos, each of which was given more than 20 licenses for single import. The others (JSI, Lek, Sanolabor, etc.) imported radioactive material only occasionally, i.e. fewer than 20 single imports were carried out in the last year. An important transit transporter is Biovit from Varaždin, transporting pharmaceutics for Croatian hospitals from the Sežana border-crossing every week, and from Brnik Airport every fortnight.

In 1997, the Inspectorate carried out 5 inspections associated with the transport (Janis/IO): Ljubljana, Intereuropa/NPP Krško: Šentilj + Krško + Jesenice, Tramsal/IZOTOP: Sežana), of which two jointly with the SNSA (Janis and Intereuropa-Šentilj). During the inspection no irregularities were observed; only for the transit of radioactive material from Spain to Hungary the instruction for emergency action had to be translated from English into Slovene.

The inspector issued an order to the importer Meditrade for the transport of old radioactive material from Brnik to the University Medical Centre for destruction. This consignment had been in the warehouse at Brnik for more than a year. IMP PROMONT Črnuče was reported to the minor offences judge for a worker without valid medical certification being involved in the transportation and use of Iridium-192. The problem with the transport of a radioactive container from Jozef Stefan Institute in October 1997 was already mentioned at the beginning of this report.

In 1997, in agreement with the Ministry of the Interior, we issued altogether 257 import, 32 transit and 7 export licences and 40 licenses for internal transport in Slovenia, with validity terms of up to 6 months. The transporters required are to announce each shipment at least 24 hours before its commencement to the Health Inspectorate of the Republic of Slovenia and the Ministry of the Interior or the Police. The records of notification show that there were registered altogether 310 single oneway transportations to border-crossings, and 415 twoway inland transportations (from companies to working sites and back) in 1997. The statistical data do not include transport by road construction companies since the probe users only rarely report transportation to the working sites to the Health Inspectorate.

Transport of radioactive materials by rail is still not permitted, pending the fulfillment of all prescribed conditions (measuring devices, qualifications, medical examinations). Shipment by air was limited according to the international requirements concerning air transport of dangerous goods. Brnik Airport fulfills all the prescribed conditions, and in 1997 there were no related problems.

10.1.6 TRAINING AND EDUCATION IN RADIOLOGICAL PROTECTION

The professional qualifications of workers involved with the radioactive materials are under control and in accordance with the regulations. The training and professional examination is carried out by two technical support organisations: the Jozef Stefan Institute and the Institute for Occupational Safety. Since the regulations on training in radiological protection are out-of-date and incomplete, a special working group - appointed already in 1995 by the Ministry of Health - has drawn up new radiological protection programmes. However, in spite of repeated requests, the chairman of the commission has not yet sent the programmes to the Ministry of Health for approval.

10.1.7 REGULAR ANNUAL MEDICAL EXAMINATIONS

The HIRS also found irregularities regarding the regular annual medical examinations of workers. As in the previous years the Institute of Oncology was again the most problematic of all.

Regular annual medical examinations of personnel working with the ionizing radiation sources are carried out by two technical support organisations: The Institute for Occupational Safety of the Republic of Slovenia (HIRS) and the Institute of Occupational, Traffic and Sports Medicine. The technical support organisations responsible for regular medical examinations of workers of the Krško NPP and the Žirovski vrh Mine are, respectively, the Medical Centre Krško - Department of Occupational Medicine or the Medical Centre Škofja Loka - Department of Occupational Medicine.

In 1997, approximately 1200 workers were examined at the Institute of Occupational Safety and 104 workers at the Institute of Occupational, Traffic and Sports Medicine. At the Krško NPP 403 workers and 230 subcontractors working in the controlled area of the Krško NPP were examined at the Medical Centre Krško. According to the information from the Medical Centre Škofja Loka they examined 82 workers from the Žirovski vrh Mine. Altogether about 1800 persons working in the area of ionizing radiation were medically examined (or approximately 40% workers under dosimetric control). The records of the technical support organisations show that there were no examples of occupational disease caused by ionizing radiation.

10.1.8 RECEIVED DOSES BY PERSONS WORKING WITH THE IONIZING RADIOATION SOURCES

Altogether 4365 workers in Slovenia, working in the area of ionizing radiation, were under regular dosimetric control in 1997: 2203 in medicine, 639 in industry (without the Krško NPP and the Žirovski vrh Mine), 821 at the Krško NPP, 70 at the Žirovski Vrh Mine, and the remaining 632 persons in administration, research and other institutions (Ministry of the Interior, Ministry of Finance - Customs Administration, the SNSA, the Institute for Occupational Safety of the Republic of Slovenia, JSI, HIRS, etc.). The central register of received doses by all workers, working with the ionizing radiation sources has not yet been established in Slovenia, however, partial computer data processing in institutions carrying out personal dosimetry is possible (HIRS, JSI, NPP, ŽVM, etc.).

The dosimetric control involves received doses of external and internal radiation. In most cases external radiation is measured by thermoluminescent dosemeters (TLM), and the film dosimetry is used only for about 600 workers. The external dose is usually increased by the dose caused by neutron radiation (in 1997, the control was performed by the Krško NPP). The major proportion of registered internal doses is caused by inhalation of radon progeny, and a minor part of the dose caused by the input of radionuclides, of which the activity is determined by the whole body counter. Some workers were using thermoluminescent dosemeters on their hands during their work.

The technical support organisations for dosimetric control of received doses in Slovenia are Jožef Stefan Institute and the Institute for Occupational Safety. The Žirovski vrh Mine is authorised for dosimetry of radon short-lived progeny in mines.

In 1997, two workers received doses exceeding 40 mSv, three workers doses exceeding 30 mSv and nine workers doses of more than 20 mSv. 3418 workers (78.3%) received doses under 1 mSv, 820 workers (18.8%) doses exceeding or equal to 1 mSv, but less than 5 mSv. 82 workers (1.9%) received doses exceeding or equal to 5 mSv, but less than 15 mSv. According to these data no one exceeded the limit of annual effective dose of 50 mSv as prescribed by the Slovene regulations (Off. Gaz. SFRY, No. 31/89). In accordance with the international Basic Standards for Radiation Protection from 1996 (IAEA standards and EU Directive) workers should not receive an annual dose exceeding 20 mSv (more precisely: 100 mSv in 5 successive years). Out of the nine persons who exceeded this dose, 8 were from industry and 1 from medical diagnostics.

The detailed distribution of effective doses (D) for workers by users and by range of annual doses is given in the table below (Table 10.4). In the second column the technical support organisation for dosimetric control is given. The abbreviations used in the table stand for: ZVD for the Institute for Occupational Safety of the Republic of

Slovenia, JSI for Jozef Stefan Institute, NEK for the Krško NPP, OI for the Institute of Oncology, PJ for the Cave of Postojna, RŽV for the Žirovski vrh Mine and RSCM for the Mežica Lead and Zinc Mine.

Table 10.4: Distribution of effective doses for workers working with ionizing radiation sources by users and by range of annual doses

Users	Tech. support organ.	Total number of workers	D 0-0.9 (mSv)	D 1-4.9 (mSv)	D 5-9.9 (mSv)	D 10-14.9 (mSv)	D 15-19.9 (mSv)	D 20-29.9 (mSv)	D >30 (mSv)
Medicine, industry, other	Ins. of Occ. afety	2667	2139	504	14	7	2	1	0
Medicine, industry, other	JSI	258	258	0	0	0	0	0	0
NPP	NPP	821	559	211	46	5	0	0	0
JSI	JSI	189	187	2	0	0	0	0	0
IO	JSI	185	166	14	3	2	0	0	0
PJ 1)	JSI	54	23	24	3	4	0	0	0
ŽVM	ŽVM	70	41	29	0	0	0	0	0
Other mines 2)	ŽVM	121	45	36	16	13	3	5	3
TOTAL	All tech. support organ.	4365	3418	820	82	31	5	6	3

1) The Krško NPP is performing the dosimetric control of its own workers and subcontractors
2) Data available for the first half of 1997 only.
3) Data available for RSCM only, data from the Idrija Mercurium Mine for 1997 not yet available.

10.2 REPORT BY THE INSTITUTE OF OCCUPATIONAL SAFETY, LJUBLJANA

The Institute of Occupational Safety, the Centre of Ecology, Toxicology and Radiation Protection, Ljubljana is authorized for the following activities in the field of radiological protection:
- by the Slovenian Ministry of Health to implement measures for radiation protection prescribed by the Act on Protection against Ionizing Radiation (Off. Gaz. SRS, No. 9/91), Decision No. 180-1/80-81 of 9 March 1981;
- by a decree from the Federal Ministry for Work, Health and Social Care (SFRY) to perform systematic research of radioactive contamination (Off. Gaz. SFRY, No. 40/86);

- by a decree from the Slovenian Ministry for Health and Social Care it was appointed as an technical support organisation to perform radiological contamination control of food of animal and vegetable origin (Off. Gaz. SRS, No. 25/89);
- in the field of ecology and toxicology for expert tasks in the field of occupational safety (Off.Gaz. SRS, No. 22/87).

In 1997, the Institute for Occupational Safety functioned as an technical support organisation and a research unit for the monitoring and control of radioactive contamination in the living and working environment in Slovenia, and helped the Krško NPP in performing radiation protection services during maintenance outage.

10.2.1 INTRODUCTION

The Section for Radiation Protection at the Centre for Ecology, Toxicology and Radiological Protection within the Institute of Occupational Safety is an technical support organisation for supervision of the use of ionizing radiation sources in medicine and industry, for monitoring of radioactive contamination in the working, living and natural environment in Slovenia and for expert training for safety at work with ionizing radiation sources.

Monitoring of working places involves first of all inspection of radiation sources as regards their technical performance, doses received by patients and personnel, certificates of medical examinations and qualifications of personnel for safe work with radiation sources.

Control and monitoring of radioactive contamination in the living environment in Slovenia was performed within the scope of the national radioactivity monitoring programme, established by the Ministry of Health, with monitoring of radioactivity in the vicinity of the Krško NPP and the Žirovski vrh Uranium Mine, presently in the phase of decommissioning, measurements of radon and radon progeny concentrations in dwellings, measurements of radon and radon progeny concentrations in the spas of Slovenia, and by determining specific activities of natural radionuclides in thermal water and in bottled mineral drinking water.

10.2.2 INSPECTIONS OF IONIZING RADIATION SOURCES IN MEDICINE

The technical staff of the Institute for Occupational Safety inspected altogether 682 sources in medicine:

EQUIPMENT	ABBREVIATION	NUMBER
Diagnostic radiography	(DR)	115
conventional units	(DR/CT)	14
mobile units	(DR/MO)	37
Fluoroscopy		
using fluorescent screen	(DR/DE)	7
using Odelca cameras	(DR/OD)	11

EQUIPMENT	ABBREVIATION	NUMBER
using image intensifiers	(DR/TV)	105
Mammography	(DR/MA)	25
Computer tomography	(DR/CT)	14
Bone densitometry	(DR/DI)	7
Dental radiography		
conventional	(ZR)	252
using digital detectors	(ZR/TV)	31
dental tomography	(ZR/TO)	41
Therapy		
Therapy simulation	(DR/SI)	2
Therapeutic x-ray	(TR)	3
Isotopic laboratory	(NM)	19
TOTAL MEDICINE		682

10.2.3 CONTROL OF IONIZING RADIATION SOURCES IN INDUSTRY

Altogether 231 radiation sources were examined in industry. At present 212 sources are out of use, of which 70 are stored at the Reactor Centre at Podgorica, the rest are written-off or out of use sources, suitably stored in organisations and under the surveillance of the Health Inspectorate of the Republic of Slovenia (HIRS). The following sources were inspected:

Industrial X-Rays	(IR)	56
Industrial X-Rays with TV chain	(IR/TV)	1
Defectoscope	(DEF)	11
Static electricity eliminator	(ELM)	2
Quantometer	(RKVA)	12
Thickness gauges	(RMD)	12
Density gauges	(RMG)	34
Level gauges	(RN)	50
Lightning rods	(RS)	9
Probes	(RSO)	44
TOTAL INDUSTRY		231
TOTAL MEDICINE + INDUSTRY		913

In a quality control procedure of conventional X-Rays the following parameters are estimated: tube housing leakage, congruence, exposure time, TV, mechanical stability, reproducibility, exposure times and anode voltage.

The X-Ray devices are classified into the following categories according to acceptability of individual parameters following the methodology described in the NCRP Report No. 99, Quality Assurance for Diagnostics Imaging Equipment: in operation without defects, service needed, proposal for write-off, written off in the current year, new X-Ray devices and out of operation.

The status of diagnostic X-Ray devices, inspected in 1997:

in operation, without defects	169	50%)
service needed	74	22%)
proposed for write-off	40	12%)
written-off in the current year	16	5%)
new X-Ray devices	31	9%)
out of operation	6	2%)
Total:	336	

Dental X-ray units are inspected separately and the following parameters are controlled: positive beam limitations, mechanical stability, repeatability, exposure times and anode voltage.

According to the methodology from NCRP 99 the statistical statement was prepared also for dental radiographs in 1997, in the same way as for conventional X-Rays:

in operation, without defects	209	65%)
service needed	25	(8%)
proposal for write-off	21	(6%)
written-off in the current year	11	(3%)
new X-Ray devices	38	(12%)
out of operation	20	(6%)
Total:	324	

10.2.4 DOSES TO POPULATION FROM IONIZING RADIATION SOURCES USED IN MEDICINE

In 1997, the dosimetric control of radiation doses received by patients during diagnostic procedures in medicine was not carried out due to lack of the necessary funding. Therefore, the UNSCEAR questionnaire for 1997, periodically sent by the World Health Organisation (WHO), cannot be filled in.

10.2.5 RECEIVED DOSES IN THE WORKING ENVIRONMENT

In 1997, the Institute of Occupational Safety carried out dosimetric control of 2667 persons in 601 organizations (altogether 23,622 dose measurements, of which 16,260 by thermoluminescent dosemeters and 7,373 by film dosemeters). Some of the organisations concerned are not regular users of ionizing sources or do not use radiation dosimetry regularly.

The statistics show that the majority of workers were exposed to radiation in the range of annual doses 0,5 mSv-0,99 mSv.

In 1998, the Institute for Occupational Safety plans to replace the remaining film dosemeters by more precise thermoluminescent dosemeters. In 1997, in addition to regular monthly personal dosimetry the Institute for Occupational Safety also carried out control of received doses on extremities, eyes and other parts of body for 20 persons in hospitals and at the Institute of Oncology. The cumulative doses to individual organs in 1997 were in the range of 1 mSv to 71 mSv, which is lower than the dose limit.

Table 10.5.: Received doses (the abbreviations for ionizing radiation sources are explained in 10.2.2. and 10.2.3).

Source	Number of workers	Collective dose (manmSv)	Average dose (mSv)
DR	1575	1400.8	0.89
ZR	291	166.8	0.57
NM/LAB	148	124.0	0.84
I	288	190.8	0.66
IR	145	118.7	0.82
VET	34	21.2	0.62
INSP	23	10.7	0.46
OTHER	55	24.6	0.45
Stopped working with	108	48.4	0.45
Total	2667	2105.9	0.79

Table 10.6.: Total number of workers in annual dose range (the abbreviations for ionizing radiation sources are explained in chapters10.2.2. and 10.2.3.)

Total number of workers in annual dose range							
Source	<0.49 mSv	0.5-0.99 mSv	1.0-4.99 mSv	5.0-9.99 mSv	10.0-14.99 mSv	15.0-19.99 mSv	20-30 mSv
DR	482	708	363	14	5	2	1
ZR	122	136	33	0	0	0	0
NM/LAB	35	77	35	0	1	0	0
I	91	162	35	0	0	0	0

Total number of workers in annual dose range							
Source	<0.49 mSv	0.5-0.99 mSv	1.0-4.99 mSv	5.0-9.99 mSv	10.0-14.99 mSv	15.0-19.99 mSv	20-30 mSv
IR	42	77	25	0	1	0	0
OTHER	140	67	13	0	0	0	0

Table 10.7. The collective dose by annual dose range of individual doses (the abbreviations for ionizing radiation sources are explained in chapters10.2.2. and 10.2.3).

Collective dose by annual dose range of individual doses (manmSv)							
Source	<0.49 mSv	0.5-0.99 mSv	1.00-4.99 mSv	5.0-9.99 mSv	10.0-14.99 mSv	15.0-19.99 mSv	20-30 mSv
DR	161.0	497.2	535.2	95.0	56.4	31.2	24.7
ZR	38.2	88.0	40.8	0	0	0	0
NM/LAB	10.5	51.1	52.1	0	10.3	0	0
I	27.9	112.8	50.2	0	0	0	0
IR	8.6	56.9	39.5	0	13.6	0	0
OTHER	38.1	45.9	20.9	0	0	0	0

10.2.6 TRAINING

In the previous year the Institute for Occupational Safety organised 4 seminars on protection against ionizing radiation, of which 3 were general 5-day seminars and one specific for nurses from the general hospital of Murska Sobota. Altogether 240 persons successfully passed the test: 31 physicians working with X-Ray equipment, 58 stomatologists, 15 physicians working with unsealed ionizing radiation sources, 56 persons working with industrial X-Ray equipment and 40 persons working with radioactive probes, used in industry.

In addition to these seminars, the Institute for Occupational Safety also organised two 27-hour seminars on radiation protection for the Training centre of the Ministry of the Interior.

In 1997, the Institute for Occupational Safety carried out two 14-hour seminars for the Faculty of Biology, as part of the training of biologists and microbiologists for safe work in laboratories, where unsealed ionizing radiation sources are used.

10.2.7 OTHER PROFESSIONAL TASKS

In the previous year, the Institute for Occupational Safety prepared 20 study reports on projecting the protection of premises, intended for usage or storage of ionizing radiation sources and 100 prior opinions for procurement and usage licences, issued by the Health Inspectorate of the RS.

11 STORAGE, TRANSPORT, PROTECTION AND IMPORT OF RADIOACTIVE AND NUCLEAR MATERIAL IN SLOVENIA

The storage, transport, protection and import of radioactive and nuclear material in Slovenia is governed by the Act on Radiological Protection and the Safe Use of Nuclear Energy (Off. Gaz. SFRY, No. 62/84) and by its relevant rules and regulations.

The transport of nuclear material in governed also by the Act on Transport of Hazardous Substances (Off. Gaz. SFRY, No. 27/90) and by the IAEA recommendations (IAEA Safety Series No.6). By the end of 1996, the IAEA Board of Governors adopted a new revision of rules (ST-1, Rev. 1996) for safe transport of radioactive material which is to replace the SS No.6 and is to be incorporated into the domestic legislation of the IAEA member states in the next five years. Only organisations fulfilling the prescribed conditions are allowed to engage in the transport of nuclear material.

In 1991, the Act on Organisation and Competencies of Ministries (Off. Gaz. RS, No. 71/94) was adopted, and its Article 18, paragraph 3 contains a detailed definition of the responsibility for the transport of nuclear and radioactive materials. The SNSA is the competent authority for granting licenses for trade in nuclear materials (e.g. licenses to the Krško NPP for purchase, import and transport of nuclear fuel elements); licenses for transboundary transport of nuclear materials; for domestic transport (import, export, transit); and certificates on conformity for containers for nuclear fuel transport.

In accordance with the Regulation on Export and Import of Specific Goods (Off. Gaz. RS, No. 75/95, 7/96, 73/96), the SNSA issued import licenses for the import of 24 fuel elements confined in 12 USA/9239/AF containers, and licenses for import of radioactive sources for hospitals (diagnostics, therapy), research institutions and industry.

In the licenses issued the SNSA prescribes special safeguards to be applied in conformity with the above-mentioned laws and regulations; the SNSA is also responsible for surveillance of implementation of the laws and regulations.

11.1 RADIOACTIVE WASTE STORAGE

11.1.1 TEMPORARY RADWASTE STORAGE AT ZAVRATEC

For objective reasons the planned reconstruction of the radwaste storage at Zavratec (Phase 2) was not carried out (see Annual Report for 1996 for Phase 1). There were, however, certain parallel activities, e.g. public relations activities (see Chapter 15 of the *present* report). The remediation project will be finished when all wastes are stored with the required licenses issued in conformity with the valid regulations.

11.1.2 INTERIM STORAGE FOR LOW AND INTERMEDIATE LEVEL WASTE AT PODGORICA

In recent years there has been a substantial increase in the quantity of sealed radiation sources, confined in special waste containers (only one source per container). The containers are distributed over the floor of the storage room occupying the major part of the ground, although they represent only 5% of the actual capacity of the storage. In order to optimise the storage capacity the sources need to be rearranged. The refurbishment of storage is undoubtedly the first priority. The present capacity of the storage is insufficient to receive the entire quantity of drums stored e.g. at Zavratec. Further, a separate room should be available for emergency storage if an accident involving radioactive substances happened in the territory of Slovenia. With rearrangement of the wastes a detailed records on their location in the storage should be introduced. Within the project of the storage modernisation it would be necessary to envisage a partial prepacking from small containers into large ones.

The implementation of both projects - i.e. from Chapter 11.1.1. and from Chapter 11.1.2. - is too slow. Therefore, the SNSA has prepared two decisions: the first one for modernisation of the storage at Podgorica and the second one for the removal of radwaste from Zavratec to repository at Podgorica.

There are three categories of radioactive waste in the storage:

- drums with contaminated items (paper, plastics, glassware, etc.) and materials with induced radioactivity due to irradiation in the TRIGA reactor;
- special waste - contaminated or radioactive items which, due to their big size, could not be stored in drums and were therefore stored separately;
- sealed sources out-of-use, stored in the original protected containers.

The table below shows the stored radioactive wastes by category (the situation at the end of 1997) and the number of sources, received in the last year.

The total volume of accumulated wastes in drums is 31,5 m3 (drums by volume) and the special wastes volume is estimated to be several m3. The volume of the active parts of the sealed sources is insignificant, but they take up substantially more space because of the protective containers in which they are kept.

Table 11.1: Radioactive waste stored in the interim storage at the Reactor Center at Podgorica at the end of 1997

Category	Total (1997)	Isotopes	Activity (GBq)
Drums	150 (0)	Co-60, Cs-137, Eu-152, Ra-226	3-20
Special waste	116 (7)	Co-60	4000
Sealed sources	337 (9)	Co-60, Cs-137, Kr-85, Sr-90	551

11.2 TRANSPORT

The experiences gained with the transport of radioactive materials in Slovenia are connected with the Krško NPP operation, the TRIGA Reactor operation, production of isotopes at the JSI and the use of radioactive substances in industry, medicine and research. Certain experiences stem from the period of the Žirovski vrh Mine operation.

The SNSA issued a licence to the Krško NPP for purchase of 24 nuclear fuel elements by 4.35% enriched uranium at maximum, and with a total activity of 1,012.32 GBq.

The transport was carried out on 8 April. The fuel elements were transported by two trucks, loaded with one standard container (containing 12 fuel elements) each, by the route Šentilj - Ljubljana - Krško. The import documentation was examined by the SNSA, the Krško NPP and the HIRS. No difficulties occurred during the transport.

The transport of radioactive material includes transport of radionuclides for hospitals (diagnostics, therapy), research institutes and industry. In addition to the above-mentioned regulations the following should also be complied with: The European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) (Off. Gaz. SFRY, MP No. 59/72 - Protocol, No. 16/70 - Annexes A and B; No. 8/77, 1/76, 6/78, 11/80); European Agreement concerning the International Carriage of Dangerous Goods by Rail (RID) (Off.Gaz. SFRY, MP No. 8/84 - Convention COTIF, Rules; 9/86 - Protocol); the Regulation on Road Transport of Hazardous Substances (Off. Gaz. SFRY, No. 82/90); the Decision on Roads allowed for Transport of Hazardous Substances by Motor Vehicles and Parking Places where Stopping and Parking are permitted (Off. Gaz. RS, No. 8/94); the Act on Implementing Protection against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off. Gaz. SRS, No. 28/80); the Basel Convention (Off. Gaz. RS, MP No. 15/93); the IAEA Resolution on Transboundary Transport (Transit) of Radioactive Waste (IAEA INFCIRC/386 1990) and the Regulation on Special Transport in the Republic of Slovenia (Off. Gaz. SRS, No. 17/82).

11.2.1 TRANSPORT OF A B(U) TYPE CONTAINER THROUGH AUSTRIA TO HUNGARY

The Embassy of Austria notified the Slovenian authorities that on 6 October 1997, during the inspection of goods at the warehouse of railroad station in Salzburg an empty transport container, labelled "Radioactive", was found that was not tightly sealed. During further investigation it was found that the consignment should be declared as a hazardous substance falling under Category 7 of RID, however, this was not evident from the accompanying documentation.

The examination of the documentation (application for import license by the JSI, certificate for container) revealed that the container was of the B(U) type, intended for transport of certain high activity radioactive substances (artificial isotopes).

The certificate no. CZ/012/B(U)-85(Rev.0) for the container - manufactured by Škoda-UJP, Prague - was issued on 16 December 1996 by the Czech Nuclear Safety Administration; and the container was also included in the IAEA Tecdoc 956 Aug. 97 catalogue (the owner of the container is a Hungarian company Institute of Isotopes, Budapest).

The importer of isotopes (sealed sources) was the JSI, which received the required import license from the SNSA on 11 September 1997.

The Ministry of the Interior issued the transport permit for transport of this radioactive substance on 5 September 1997.

In the above-mentioned container three sealed sources of Ir-192 with a total activity of 4.89 TBq intended for industrial radiography arrived in Slovenia from Hungary (Budapest, Institute of Isotopes) on 18 September 1997 by road transport - the driver and the vehicle, equipped in conformity with the ADR requirements, were from the JSI. The summary customs procedure was carried out in the customs warehouse of INTEREUROPA in Ljubljana - Moste on the same day; there were no irregularities noted.

The JSI prepacked the sources into industrial defectoscopes (Gammamate) of the end users at the premises of the Reactor Center at Podgorica (in the hot laboratory) and handed them over to the end users. It is noteworthy, that the JSI Reactor Center at Podgorica is the only entity in Slovenia with qualified personnel and premises equipped for this kind of work.

The empty container of the B(U) type was returned to the Hungarian supplier of the sources.

The JSI engaged the forwarding company FERŠPED d.d., Ljubljana to return the empty container; FERŠPED dispatched the container as a non-hazardous packing based on a written statement from the JSI Purchasing Department that the container was not contaminated and had been thoroughly cleaned. This assurance was given to the JSI Purchasing Department verbally by the Radiation Protection Unit upon measurement of the surface contamination (spectroscopy of the surface smear). However, in spite of the specific requirement in the certificate, the dose rate measurement on the surface of the empty container was not carried out.

The consignment should have been dispatched as "expected package - empty container" (IAEA SS No. ST-1/515, 520) corresponding to Category 7 (radioactive substances), page 4 (empty packing - RID). The regulatory limit dose for this kind of goods is the surface dose below 5 microSv/h. However, the Austrian Federal Railways in Salzburg established an actual dose value of 11 microSv/h. For such a dose the container should be additionally protected by a light packing, i.e. by a wooden case; which was afterwards actually done for further transport from Salzburg to Budapest. The contact dose rate on the surface of the case amounted to 3 microSv/h.

The SNSA has not experienced a case like this before in spite of the fact that it issues a couple of hundred licenses for import and export of radioactive materials every year and keeps records on shipments. Therefore, we are of the opinion that this inconvenience must be attributed to an unfavourable combination of factors rather than to violation of the regulations, or to lack of experience of the Slovenian import-export companies engaging in the transport of radioactive materials.

The reason for the excessive radiation of the container was not contamination but the technological design and construction of the container itself. Only sealed sources of radiation which are not able to cause contamination are allowed to be transported in containers. A container is made of isotopic depleted uranium alloy, with a wall of stainless steel on the outer and the inner side. A low level of radiation can always be detected on the surface of an empty container as the depleted uranium retains some of its radioactivity. After a year the radioactivity of the uranium shield increases slightly due to the decay of U-238, and this radioactivity is detectable on the surface of the stainless steel coat of the container.

Up to now it has not been possible to determine what material (depleted uranium or lead) the container shield was made of on previous shipments of the same category of isotopes.

It was found that neither the Hungarian owner nor the supplier gave sufficient attention to this fact. It is presumed that the manufacturer or the owner of the container in particular should know that the surface dose rate was to increase gradually and should permanently label the container accordingly. They should also control the condition of the containers in use for a certain length of time and give the users proper instructions.

The SNSA will control similar shipments more strictly in the future and will require that all concerned strictly comply with the laws and regulations in force and provide additional technical data on the category and nature of transport containers when applying for an import licence.

The Inspectorate of the SNSA will carry out more frequent inspections on isotopes and transport container handling at the JSI.

11.3 SAFEGUARDS

Agreement between the Republic of Slovenia and the International Atomic Energy Agency on Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons

When Slovenia became an independent state, it succeeded to the Treaty on the Non-Proliferation of Nuclear Weapons (Off. Gaz. SFRY, No. 10/70) concluded between the former SFRY and the Agency, and in 1997, concluded the "Agreement between Republic of Slovenia and the International Atomic Energy Agency on Application of

Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons" (Off. Gaz. RS, No. 11/97). Pursuant to Article 39 of the agreement, which entered into force on 1 August 1997, the Contracting Parties should conclude the Additional Arrangements for implementation of the Agreement within ninety days after its entry into force. The SNSA received from IAEA the harmonised text of the general part of the Additional Agreement (Part a.).

The Additional Arrangements to the Agreement are practically identical to the Additional Arrangements applied in Slovenia when the Agreement between the former SFRY and the IAEA on Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (Off. Gaz. SFRY, No. 67/73) was in force.

In the general part the Additional Arrangements (Part a.) regulates communication between Slovenia and the IAEA. It also includes: a short description of the Slovenian system of nuclear material safeguards and records keeping; a specification of information to be sent regularly to the IAEA by Slovenia; a specification of information to be published by the IAEA; and other guidelines referring to methods and frequency of reporting and communication between the IAEA and Slovenia.

The Additional Arrangements in its second part (Part b.) contain special annexes with technical specifications of the Krško NPP and the TRIGA Research Reactor, Brinje. In 1997, only the general part of the Additional Arrangements (Part a.) was sent to Slovenia for approval. After approval of the general part of the Additional Arrangements, and based on the data already sent the IAEA is to prepare the corresponding annexes for the Krško NPP and for the TRIGA Research Reactor, Brinje (Part b.). The annexes will contain technical specifications of the nuclear facilities and installations in Slovenia, the zones of material balances and the safeguards.

At the end of 1997, the general part of the Additional Arrangements was sent for approval to the Government.

IAEA Safeguard Inspections

Routine IAEA safeguard inspections were carried out until 1 August 1997. There were three routine inspections in the Krško NPP by that date. From 1 August 1997 on, pending adoption of the Additional Arrangements, the control was carried out by so-called ad-hoc inspections. There were two such inspections in the Krško NPP in 1997. No anomalies were reported. In the JSI Research Reactor TRIGA, Brinje, there were no inspections by IAEA in 1997.

Verification of Fuel Elements

Due to ageing of the spent fuel elements with low burnup, the Krško NPP has difficulties in verifying the identity of spent fuel elements. The verification of these fuel elements by optical methods (Cerenkov Viewing Device-CVD) is problematic, and IAEA is making an effort to implement the so called Spent Fuel Attribute Tester

(SFAT). The introduction of this method is somewhat problematic; problems were encountered regarding the safety analysis and QA SFAT. Consultations on the introduction of SFAT in the Krško NPP are in progress, and in November 1997, two representatives of the IAEA, M. Zendel and R.D.Arit, visited Slovenia on this issue. The purpose of their visit was to clarify the remaining questions on the SFAT use in the spent fuel pit in the Krško NPP. At the meeting the Krško NPP promised assistance in the implementation of SFAT under condition that the process proceeded according to the "Design Modification Process" and the costs were not debited to the Krško NPP. The working plan for introduction of SFAT into the Krško NPP was prepared.

The physical protection of the Krško NPP and the TRIGA RR at Podgorica and of nuclear materials is carried out in accordance with the regulations. In November 1997, the SNSA carried out an inspection of physical protection at the RR TRIGA, Brinje. Some minor deficiencies were observed, which are now being remedied. The inspection of the physical protection system in the Krško NPP was carried out in the course of routine inspection by the SNSA. Modernisation of certain components of the physical protection system was observed.

Within the scope of the Ministry of the Interior, a Commission for the implementation of technical tasks in the field of nuclear facilities and installations protection was appointed in 1997. The Commission met in November 1997 to discuss the report of the IAEA IPPAS Mission and to assess the present threat to nuclear facilities in Slovenia. It was agreed to prepare a formal evaluation of the threat to nuclear facilities in Slovenia in 1998 based on data collected by the UNZ Krško, the Krško NPP, the SOVA, the VOMO and the UKS.

11.5 IMPORT

According to the Regulation on Export and Import of Specific Goods (Off. Gaz. RS, No. 75/95), which entered into force on 1 January 1996, the SNSA issued 190 licenses in 1997, 149 of them for single import, 35 licences for multiple import (Karanta, Krka, Genos) and 6 licenses for export of certain goods (Steklarna Rogaška, Sanolabor, Radeče papir and Institute of Oncology) in 1997.

Among regular importers of radionuclides are Krka, Karanta, Genos and Iris; the others import them only occasionally. The most frequently imported radionuclides include: Xe-133, I-133, Ti-201, Ga-67, Tc99m, I-125, In-111, etc.

The import of radionuclides by users in 1997 is given in Table 11.2. There were for approximately 81,453 MBq activity of exported radionuclides (Co-60, Kr-85, Cs-137 and Ir-192).

Table 11.2: Import of radionuclides by users (values in MBq) and a comparison of import in 1996 and 1997 by radionuclides

User/isotope	Y-90	Sr-90	In-111	Am-241	I-125	Cr-51	Co-57/58	Tc-99m	Rb-86	Ga-67	C-14	Sr-89	I-131	Tl-201	U-238	Mixture	Xe-133	Fe-59	H-3	S-35	P-32	Cd-109	Ir-192	Kr-85	U-235	Hg-203	Co-60	Pb-210	Fe-55
KC KNM. LJ	9990		2730		566.899	1332	4.17	687500					488252	510.1		0.2	162814	3.7											
BolnCelje			370		71	1.21	0.37	659486																					
Onkinštitut.LJ			4786		7			667030	37	11070		1628	414025						148				40250		1.2				
BolnMaribor			122		63	5476	0.1	803950					51097	27195															
BolnIzola					14																								
MFInšt/mikrobiol					25														185										
BolnPDržaja											9																		
ZZV.LJ		0.003		0.004											0.01	0.0003													
KCIKKKB					51														0.6										
BolnSlGradec					81			52500					22940																
Fakzaveterino					11																								
BolnFDerganc								180000																					
MFInšt/gatologijo																				74									
MFInšt/gatofiz																			10		37								
MFInšt/biokemijo																			56	490	185								
MFInšt/anatomijo																				74									
ZZTK.LJ						37													74										
JSI		3.7		0.032	148															385	83	18.5				37		0.1	0.04
Industry																13							21350000						
Lek						11544												111											
Inštzabiologijo											185								37										
Radečepapir																								9259					
Radenska3srca				1700																									
JuteksŽalec		5550																						10500					
SteklRogaška																											1850		
Total 1997	9990	5554	8008	1704	1038	18390	5	3050466	37	11070	194	1628	976314	27705	0.01	13	162814	115	516	1023	305	18.5	21390250	19759	1.2	37	1850	0.1	0.04
Total 1996	7770	0	4497	0	3809	7807	3715.6	2828555	111	17060	218.2	777	892847	55 870	0	0	192400	0	1.13 E8	740	1156	1.8	16941000	0	0	0	370	0.02	3700

12 EMERGENCY PREPAREDNESS

For the most part, quick emergency response depends on immediate and comprehensive notification on an emergency event. For the purpose of this report only nuclear and ionizing radiation emergencies have been included. The international legislation framework for such notification is embodied in the Convention on Early Notification of Nuclear Accidents (Off. Gaz. SFRY, MP No. 15/89) succeeded by Slovenia and incorporated in its legal system by the Act on Notification of Inheritance (Off. Gaz. RS, MP No. 9/92). Related provisions on reporting obligations are also contained in the European Union legislation (Council Decision 87/600/EURATOM), while Slovenia has already regulated this area by way of bilateral agreements with Austria and Hungary.

12.1 SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

Four sets of regulations in the field of nuclear protection and ten in the field of radiation safety were issued on the basis of fundamental legislation governing the nuclear field in Slovenia (the Act on Implementing Protection against Ionizing Radiation and on the Special Safety Measures in the Use of Nuclear Energy). The National Emergency Plan for rescue and disaster relief in the Krško NPP has been designed on the same basis. According to this Plan, each participating organization (SNSA, Krško NPP, Ministry of Defence - Administration for Rescue and Disaster Relief) is required to elaborate its own special internal plan. For this purpose, some of the measures anticipated at the SNSA are designed for communication between these organizations (alerting and activation of the staff, notifications). Since the experience from the previous exercises shows that the area of communications is particularly delicate, a part of the SNSA Emergency Plan deals with preparedness maintenance (testing of communications, training of the SNSA employees and expert groups). The SNSA serves, in fact, as a liaison group, since Article 26 of the basic law governing the nuclear field in Slovenia, commits the nuclear facility operator to immediately inform the SNSA in case of a radiation emergency, whereas the SNSA is not responsible for the field implementation of safety measures.

The Emergency Plan (EP) regulates the notification procedures and the special organisation of the SNSA in order to fulfil its function in the event of emergency. The purpose of the Emergency Plan is to provide suitably trained staff; means for operative measures in the event of emergency; and to protect the population and the environment from radiological impact in the event of emergency. In 1997, the emergency response plan consisting of a set of 31 procedures underwent the second review.

The procedures are divided into six groups according to the areas of activities they cover:

- internal organization and responsibilities;
- alerting and activating the staff (in particular the expert groups and other participating organizations);
- assessment of the accident (instructions for work of expert groups);

- information (to the public at home and abroad);
- various instructions for use of strictly specified means (communication, computer and other equipment);
- maintenance of the state of preparedness.

In the event of an emergency the SNSA employees and the previously appointed external experts gather at the headquarters of the SNSA. They are divided into three groups:
- expert group for accident assessment;
- expert group for dose assessment;
- expert group for public information.

Within the RAMG Programme (Subject 7b), an international review of the SNSA emergency response procedures was held on 18 - 20 November 1997. The review was conducted by two experts from Germany and Italy, respectively. It was established that the recommendations from the previous review (1996) had been to a large extent observed. The procedures were prepared in accordance with international recommendations on elaboration of emergency plans.

The expert groups collect the data from the site of occurrence of an accident and from various monitoring activities. Each group analyses the event according to its expertise and submits its proposals for action to the SNSA director. He in turn proposes the line of action to the National Civil Defence Headquarters and draws up notifications to the IAEA and the neighbouring countries, and also co-ordinates the drawing up the information to the public. In this task he is supported by the relevant expert groups.

12.2 KRŠKO NPP

The activities related to the Krško NPP emergency planning for 1997 were focused in particular on:
- maintenance of the existing preparedness in the event of a nuclear emergency at the Krško NPP;
- co-ordination of activities in emergency planning between the Krško NPP and the off-site organizations;
- upgrading and improvement of the existing emergency preparedness of the Krško NPP.

Updating of the Emergency Plan and other documentation:

In 1997, in the field of emergency planning, the Krško NPP staff:

a) prepared a new revision of
    - the EIP.5.001 Emergency Class Determination Procedure; and three revisions of the Krško NPP Notification List;

b) drew up the following new documents:

- an "Assessment of Threat to the Krško NPP", required for elaboration of communal, regional and national rescue and disaster relief plans;
- assessment of evacuation time for the area of preparedness around the Krško NPP, made on the basis of the methodology specified by the NUREG-0654.

Premises, equipment and systems required for control of an emergency:

In the area of premises and systems for emergency control, the following measures were taken at the Krško NPP:

- setting up of an evacuation check point at the Brestanica Power Plant and on the Brežice football stadium;
- completion of the first phase of setting up the Krško NPP technical support centre;
- securing the premises for the external support centre at Kardeljeva pl. 21 in Ljubljana;
- approval of the proposal for a new organizational structure of the Krško NPP in the event of emergency.

In 1997, the following equipment was procured:

- TLD and alarm dosimeters for the technical support centre and the operative support centre;
- first aid equipment;
- equipment for the Krško NPP ambulance;
- mobile and portable radio stations for the ZARE radio system.

Training, drills and exercises:

In 1997, the following training courses were held at the Krško NPP:

- in August, an advanced emergency training course for new personnel, organized by the Krško NPP;
- in March and November, training courses for the reactor control personnel;
- in March, a general training course for the Krško NPP and the Krško town professional fire brigade;
- in August, an 80-hour first-aid course
- in September, a training course for the protection personnel;
- an informative course for the new employees;
- in November, a course in communications using the ZARE radio system.

Drills in the following skills were carried out:

- radiation monitoring in the power plant - 4 drills;
- radiation monitoring in the environment - 5 drills;
- radiation monitoring in the environment together with the ELMU - 1 drill;
- first aid - 1 drill and participation in the regional competition of first-aid teams in September 1997;
- fire-fighting - 11 drills according to the fire-protection programme.

In April 1997, the Krško NPP participated in the international INEX-2-FIN exercise. In November 1997, the Krško NPP organized the desk-top NEK-97 exercise at its premises. The participants in the NEK-97 exercise were members of the National Civil Protection Headquarters, the regional Civil Protection Headquarters, the communal Civil Protection Headquarters of Krško and Brežice, and the SNSA.

The requirements of the administrative authorities:

In connection with the decisions by the SNSA and the Inspectorate of the Administration for Civil Protection and Disaster Relief of the Republic of Slovenia the Krško NPP fulfilled:

- seven requirements concerning rescue and disaster relief, contained in the Decision of the Administration for Rescue and Disaster Relief No.40-s-370-04/58-96/MD,MP of 16 December 1996;
- the requirement of the SNSA Decision No. 318-48/92-11585/IG of 24 May 1996 concerning the setting-up of the system for the transfer of parameters to the SNSA in the event of an emergency at the Krško NPP (Emergency Response Data System).

12.3 SLOVENIAN ADMINISTRATION FOR RESCUE AND DISASTER RELIEF

In its extensive 1995 and 1996 annual reports on nuclear and radiation safety in the Republic of Slovenia, the SNSA reported on the state of preparedness of communities and of the government. The systematic and organized preparations for emergency response also continued in 1997. In this period, the following changes took place:

- the Notification Centres (both regional ones and the Slovenian Notification Centre) assumed a new role;
- deficiencies in the ZARE radio communication system were eliminated and a radio link with the Krško NPP established;
- rescue and disaster relief plans among the competent planning bodies in the power plant, the communities of Posavje and the Posavje region were harmonized;
- a preliminary and basic training programme for members of radiation, chemical and biological protection units was drawn up;
- radiation, chemical and biological protection units were formed, equipped and trained;
- work continued on the European Commission project "Nuclear Off-Site Emergency Preparedness Needs Assessment Study in Central and Eastern Europe";
- a new project was launched within the framework of the IAEA technical assistance, entitled "Harmonization of Nuclear Emergency Preparedness";
- two international exercises (INEX-2-FIN and INTEX 97) and a staff training exercise (Krško NPP 97) were carried out.

The Inspectorate of the RS Administration for Rescue and Disaster Relief carried out an inspection at the Krško NPP. The observed non-conformances were partly eliminated in 1997.

12.4 ECOLOGICAL LABORATORY WITH MOBILE UNIT (ELMU)

The Ecological Laboratory with Mobile Unit (ELMU) was established between 1980 and 1982 as an United Nations Development Programme (UNDP) project. It was designed and equipped for immediate detection of dangerous substances (radioactive, chemical and biological substances), expert recommendations for protective measures to mitigate the effect of environment pollution in case of emergency, as well as training in and improvement of ecological awareness.

The ELMU is composed of a mobile unit (intervention team) which is ready for intervention all the time, and of the stationary laboratories of our research institutes which use the most comprehensive expertise and the best equipment available in Slovenia and are capable of providing a thorough analysis of the event. The operative headquarters is at the Jožef Stefan Institute.

The ELMU is a specialized emergency unit intended for performance of specific tasks of protection, rescue and disaster relief in case of natural and other disasters and is organized to allow for immediate mobilization.

In the field of radiological activities the ELMU is directly involved in the Programme of Routine Radioactivity Monitoring in the Vicinity of the Krško NPP; it also performs other radiological measurements and control (underground water and construction materials analyses, analyses of food for import or export, etc.) and provides expert recommendations and expertise.

In 1997, the ELMU carried out three regular inspection walkdowns of the Krško NPP and its vicinity. During each inspection, carefully planned in advance, the ELMU measured the activity of certain liquid and gaseous samples in the Krško NPP and subsequently subjected them to special laboratory measurements (determination of H-3, C-14, Sr-89/90). The walkdowns also involved the checking of permanent monitoring points in the surroundings of the Krško NPP (air and iodine pumps), measurement of basic radiological parameters (dose rate level, surface contamination by beta and gamma radiation, gamma spectrum of unprotected Ge-detector, in-situ gamma measurements) and examination of 1/3 of the potential monitoring points on the radiological monitoring map. Each walkdown was followed by a special report.

On one hand, these inspection walkdowns offer an opportunity to compare the ELMU measurement results with those of the Krško NPP services, and on the other hand this is the best way of directing on-the-spot checking of operation of the entire mobile radiological laboratory. This is why the inspection walkdowns are of utmost importance for immediate and effective action in case of an emergency event.

Every year, the ELMU team takes part in the international inter-comparison measurements of the European mobile units. In October 1997, the inter-comparison measurements in the environment were organized by the Swiss Radiological Laboratories of Public Health in the Swiss Federal Nuclear Safety Inspectorate in Gordola, Switzerland. This time, 17 teams from 8 countries participated in the measurements.

12.5 DOMESTIC AND INTERNATIONAL EXERCISES

INEX-2-FIN exercise

On 17 April 1997, Slovenia participated in an international exercise in the series "INEX-2" exercises designed to test the communications and national emergency response plan in the event of a nuclear emergency abroad. The details of the exercise scenario were not known in advance, except for the basic assumption that a nuclear accident was to occur in the Finnish nuclear power plant Loviisa. The whole cycle of the "INEX-2" exercises was organized by the Nuclear Energy Agency with the Organization for Economic Co-operation and Development (OECD/NEA).

The exercise began on Thursday, 17 April 1997 at 7 a.m. (Central-European time). The initial event was triggered by an aeroplane cutting a power line which was, at the time, the only source of external power supply to the Loviisa NPP. In the exercise scenario, the Loviisa NPP was supposed to be in outage at that moment. Since its diesel generators were not capable of taking over the load, the Loviisa nuclear power plant was left without any AC power supply at all. Core damage occurred, and at the same time the failure at the containment caused some releases of radioactive substances into the environment, because the valve on the primary system remained open, the release path through reactor containment bypass existed as well. In Slovenia, the participants in the exercise were:

- the National Civil Protection Headquarters;
- the SNSA;
- the Administration for Rescue and Disaster Relief,
- the UVI;
- the Ministry of Foreign Affairs.

The Krško NPP personnel participated in the exercise both as official observers and as members of the group for "media pressure". The external experts to the SNSA expert groups from the Hydrometeorological Institute (HMZ), the Milan Vidmar Electrical Institute, the Jožef Stefan Institute, the University of Maribor - Faculty of Mechanical Engineering, the Electric Power Company of Slovenia and the Institute of Occupational Safety.

Information on the nuclear accident abroad arrived over the IAEA (EMERCON System) as specified in the Convention on Early Notification of Nuclear Accidents to both contact points (SNSA and the National Notification Centre). A simulated press agency established in Finland was forwarding its communications to the Government Information Office by fax and to the SNSA by E-mail. Certain information concerning the exercise were available on Internet on the home page of the Finnish Ministry of Internal Affairs.

The purpose of the exercise was to test: the response of the IAEA in the event of nuclear emergency; communication between various authorities in Slovenia; decision making; public relations and preparation of public statements; dose calculation; situation assessment in a foreign nuclear power plant; and notifications in accordance with the bilateral agreements.

The "Lage Krško" exercise

Between 24 and 26 June 1997, the "Lage Krško" exercise was carried out in Celovec (Klagenfurt); it was organized by experts from the Austrian Ministry of Internal Affairs, the Chancellor's Office - Department for Radiological Protection and from the Seibersdorf Research Centre near Vienna. The purpose of the exercise was to test decision-making in the affected Federal Land (i.e. Carinthia) in the event of a nuclear accident at the Krško NPP. The exercise headquarters were located in the Land Fire Service Training Centre in Celovec (Klagenfurt) together with the crisis action staff ("Civil Defence Staff") for Carinthia. Other participants were two regional Notification Centres (Beljak/Villach and Wolfsberg) and two communal Notification Centres (Lavamünd and Sv. Jakob v Rožu/St. Jakob im Rosental).

The preparatory arrangements included the following two seminars:

- the first was held in Celovec (Klagenfurt); the lectures comprised the bilateral and multilateral agreements which Austria has concluded with other countries in the field of emergency measures, and the tasks of the state - the Federal Lands, the Red Cross, the municipal police, the meteorological service and fire brigades - in the event of a nuclear accident. Two of the lectures dealt with the radiation early warning systems in Austria, while the SNSA director gave the introductory lecture entitled "Krško NPP - Basics of Nuclear Technology and Possible Consequences in the Event of a Nuclear Accident";

- the second seminar, which was prepared by experts from the Seibersdorf Research Centre, was held on 13 and 14 May 1997 in Keutschah in Austrian Carinthia. It dealt with: radiation protection (protective measures, legislation); basics on radiation and decontamination; dose measurement; contamination mapping and consequences of nuclear accidents. Here the representative of Slovenia held a lecture entitled "Radiation Early Warning System and Radioactivity Monitoring in Slovenia".

The exercise commenced at noon on 24 June 1997. This day was intended for simulation of the development of an event prior to release of radioactive substances (the so-called pre-release phase). The next day the participants replayed the release phase (proclamation of protective measures, environmental measurements, recording of forces and means required for evacuation, contamination monitoring at the border, public information). On 26 June 1997, the scenario was set in the so-called recovery phase, i.e.

seven days after the event, and was intended for testing the measures related to the food chain. The measures recommended for that day covered, among others, a ban on fresh fodder for cattle, a warning against the use of tank water, a restriction on sales of vegetables, and an enforcement of the foodstuffs sampling schedule.

NEK-97 exercise

The desk-top exercise NEK-97 was held on 26 November 1997; its participants were the Krško NPP staff, the National Civil Protection Headquarters, regional Civil Protection Headquarters, communal Civil Protection Headquarters of Krško and Brežice, and the SNSA.

The scenario was to entail a rather significant release of radioactive substances in order to enable the participants of the exercise to test issuing recommendations of protective measures including evacuation. The scenario began with a steam generator leakage followed by a multiple steam generator tube rupture. Since the safety valve on the steam generator remained open and could not be closed, a loss of primary coolant occurred as a result of its leakage through the ruptured steam generator U-tubes and through the open safety valve into the environment. Due to loss of the primary coolant, core uncovery occurred and later on also core melting. The weather was determined in advance and remained unchanged for the duration of the exercise.

The NEK-97 exercise was designed as a staff training exercise in two parts, with discussion among the participants following each part. It was intended to enable senior staff to test the management and control in the event of emergency, and the participants were required to simulate certain situations and responses. The exercise proceeded in an accelerated time-frame; as a rough estimate, both parts of the exercise proceeded roughly 1.5 times faster than they would in reality, therefore it placed the participants under extreme strain. Each participant brought all the materials required for the exercise (plans, documentation, official forms).

The participants expressed their commendation of the exercise; they also found it very valuable as a chance for officials from different levels (government and communal authorities, the power plant) to meet and get acquainted. Their observations may be summed up as follows:

- some of the participants were not adequately acquainted with the emergency plans; the plans themselves should be amended, and further training should be provided for the relevant personnel;
- procedures employed in work of the SNSA expert groups should be revised;
- since the participants in the exercise are not used to working outside their own environment and have no experience in desk-top exercises, such exercises should be organized more frequently;
- the exercise proceeded too rapidly;
- the use of two modes of communication (fax and E-mail) confused the participants;
- there were certain technical problems with which the participants could not cope;

- more time and effort should be invested in coaching the participants about the course and the targets of the exercise prior to its beginning.

13 TECHNICAL SUPPORT ORGANISATIONS

According to Article 14 of the Act on Implementing Protection against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off. Gaz. SRS, No. 28/80), technical and research organisations were authorised by a decision of the Republic Committee for Energy, Industry and Construction, or by the SNSA as its legal successor, to perform specific tasks within the scope of its activities and qualifications in the field of nuclear and radiation safety in the Republic of Slovenia.

The conditions and the time-schedule for performing their tasks is laid down in the "Rules on Methods and Terms for Records Keeping and Reporting on Nuclear Safety to the Republic Inspectorate of Energy by Organisations in the Field of Nuclear Safety and by Organisations Operating Nuclear Facilities and Installations, and on Exchange of Information" (Off. Gaz. SRS, No. 12/81).

13.1 INSTITUTE OF METAL CONSTRUCTIONS

By the decision of the Republic Committee for Energy, Industry and Construction No. 31.10-034/80 of 8 December 1980 the Institute of Metal Constructions (IMK), Ljubljana is authorised for:

- quality assurance activities;
- measurements, quality control and functioning, including non-destructive testing and quality assurance for bearing metal constructions and metal parts of equipment, pressure piping and vessels during construction, trial operation and operation of nuclear facilities and installations;
- training of technical staff for the above-mentioned tasks.

The IMK participated in welding control on steel bearing constructions of the containment, lifting devices of the primary and the secondary loop, hydromechanical equipment, and the primary and secondary pipelines from the start of the Krško NPP construction. As a technical support organisation it has been participating in welding control and other maintenance works on the reactor vessel, steam generators, the primary and secondary pipelines, heat exchangers, hydromechanical equipment, lifting devices and hangs right from the start of operation of the Krško NPP.

In 1997, the IMK carried out the following works contracted or ordered directly by the Krško NPP or through the EIMV:

- Activities in the area of expertise of the Institute in the scope of the 1997 annual outage as described in the IMK Report No. P-23042 "Expert Report on Tasks, Corrective Action and Tests during the Krško NPP Annual Outage and Refuelling";
- Inspection of torque wrenches and dynamometers:
  - for the Krško NPP:
    reports P-22959 to P-22959/45 (46 pcs)
  - for Elmont company:

reports P-23030 to P-23030/3 (4 wrenches)
  * for Medivak company:
    reports P-22983 to P-22983/2 (3 wrenches);
- Inspection of measuring instrumentation for the Krško NPP:
  reports P-22959/46 to P-22959/111 (66 pcs);
- Verification of welders qualifications and evaluation of welding procedures for the Krško NPP:
  report on weld testing, welded by W-03-05, W-03-24, W-03-08, W-03-10 and W-03-12 techniques; P-22986;
- Certificates on conformity of the welding techniques P-22986.2 to P-22986.7 (6 certificates);
- Report on testing for verification of welding techniques and welders qualifications P-23986.8;
- Certificates on welders qualification P-22986 - P-22986.32 (24 certificates);
- Report on exams for welders qualification and verification of the welding technique W-03-50; P-22936.1;
- Report on weld testing, welded by W-030-05 and W-03-24 techniques; P-22936.2;
- Report on weld testing, welded by W-03-08, W-03-10 and W-03-12; P-22936.3;
- Report on weld testing, welded by W-03-53, W-03-54, W-03-55 and W-03-56; P-22936.4.

Training of technical personnel:
- Course for use of the eddy current technique and Remote field; October 1997; power plants Termini Immerese and Torrevaldiga Sud, Italy; practical work, 120 hours;
- Course "Quality Control System Implementation", SIQ, Ljubljana;
- Course "Operation Optimisation based on the Nuclear Power Plant Risk Analysis", 6 - 10 October 1997, Training Center, Ljubljana;
- Course "Regulatory Authority Approach to the Safety Report at Steam Generators Replacement in the Krško NPP"; 23 - 27 June 1997, Training Center, Ljubljana;
- Course "Welding of Installations and Pressure Vessels", 19- 21 February 1997, Muenchen, 20 hours, organised by SLV Muenchen GmbH (Schweisstechnische Lehr- und Versuchsanstalt);
- Seminar and exam "Internal Assessment", 27 - 28 November and 9 December 1997, Preddvor;
- One-day course "Nuclear Power Plant at Construction of Replacement Steam Generators for the Krško NPP"; at the IMK for the Krško NPP controllers and the IMK personnel.

Participation in expert meetings:
- 4th Regional Meeting "Nuclear Energy in Central Europe", 7 - 10 September 1997, Bled.

Implementation of the IMK QA programme in 1997:
- revision of administrative procedures A6 and A8;

- internal assessment in the test room, 20 March 1997;
- preparation of working procedures in the test room;
- training of technical personnel and participation in expert meetings.

Following new developments in the field of nuclear engineering through subscriptions to the following publications:
- News on European Nuclear Society;
- Material Evaluation;
- Material Pruefung;
- Nuclear News,
- Varilna tehnika.

13.2 WELDING INSTITUTE

According to the decision of the Republic Committee for Energy, Industry and Construction (Off. Gaz. SRS, No. 6/82) the Welding Institute, Ljubljana is authorised for the following tasks related to nuclear safety:

- quality assurance activities related to welding;
- quality control of welding;
- verification of welders qualifications, suitability of welding equipment and instrumentation;
- verification of welding-engineering concepts for welded constructions, design and statistics;
- inspection of welds, including non-destructive testing;
- consulting in the use of welding technology in new installations and in maintenance.

During the 1997 annual outage the Welding Institute controlled welding in the following areas:
- modifications;
- replacements of worn valves and other armatures;
- reparative welding of damaged elements;
- replacement of worn pipe elements and vessels;
- repair works on the turbine.

In general, the Institute did not have any remarks on performance of the works; however, whenever it did have any comments, they were mainly given as advice or recommendations. Nevertheless, all these suggestions were taken into account by the Krško NPP, as was proved at the final outage meeting.

The observations at welding control are collected in the Expert Evaluation of the Institute No. 234/E-97.

In November 1997, the representative of the Institute participated in the QA assessment of the company Equipos Nucleares S.A., Maliano, Spain, the manufacturer of the new steam generators for the Krško NPP. The assessment group was composed of two representatives of the Krško NPP (one a senior assessor), one representative of the SNSA and one representative of the Institute. The QA assessment took three and a half days.

The Institute focused on the field of assessment of production and special processes, control and training, and on certification.

Most of the activities and documents were related to the assessment of the FW11 subsystem fabrication.

The findings within the area of assessment of the Institute are positive. The work is well-organised, the personnel is suitably qualified, and the working procedures are verified. The control tasks are in accordance with the requirements.

The assessment gives full assurance of good performance of the project undertaken.

13.3 INSTITUTE OF METALS AND TECHNOLOGIES

The Institute of Metals and Technologies (IMT), Ljubljana, following the decision of the SNSA No. 318-13/94-6906/AS of 18 November 1994, is authorised for the following expert activities relating to the construction, trial operation, start-up and operation of nuclear facilities and installations:

- quality assurance and control of metals based on investigations of their chemical, mechanical, microstructural and corrosion properties;
- assurance of quality and adequacy of metals used for metal constructions, piping and pressure vessels.

In 1997, the activities of the IMT were the following:

- Participation in regular maintenance works during shut-down of the Krško NPP due to refuelling. The control included the ECT measurements on steam generators, control of the ISI programme, control of cleaning and examination of reactor and pressurizer screws, monitoring and control of erosion-corrosion processes and periodical inspection of pressure vessels;
- Expert reports and evaluations (Contracting Party the Krško NPP);
- The expert report on the broken stem of the isolation valve on the main steam line in the Krško NPP comprises results of chemical, mechanical and microstructural analyses and gives the reasons for the nucleation of cracks on the stem;
- The expert report on testing the modified TTCIIs includes results of the static, dynamic and free-drop tests of the tube containers intended for the storage of heavy drums with radioactive waste (Report No. NCRI-30/97);
- The expert report on testing of heavy drums for radioactive waste without lead liner of the "TBO" type comprises the results of pressure, static, dynamic, penetration and free-drop tests of the heavy drums without a lead liner (Report No. NCRI-52/97);

- Expert report on testing of heavy drums for radioactive waste with the lead liner of the "TBO-PB30" type includes results of the pressure, static, dynamic, penetration and free-drop tests of the heavy drums with a lead liner (Report No. NCRI-54/97);
- Project preparation (commissioned by the SNSA);
- Expert report on the programme "In-service Testing, Rev. 2 for the Second Ten-year Inspection Interval". The first part includes the review of valid issues of ASME XI section standards, including the relevant references from the recent issues and annexes and "Code Cases" (Report No. NCRI-55/97);
- Participation in seminars:
  * 4th Regional Meeting "Nuclear Energy in Central Europe", 7 - 10 September 1997, Bled;
  * EUROMAT '97, Proceedings of the 5th European Conference on Advanced Materials and Processes and Applications, 21 - 23 April 1997, Maastricht-NL;
  * IAEA Workshop on Regulatory Assessment of the Safety Report for SG Replacement at the Krško NPP, 23 - 27 June 1997, JSI - Milan Čopič Training Center;
  * Conference on Non-destructive Systems and Installations, 22 October 1997, IEVT.
- Additional training in non-destructive testing (UT, PT, MT).

13.4 MILAN VIDMAR ELECTRICAL INSTITUTE

According to the decision of the Republic Committee for Energy, Industry and Construction No. 31.10-034/80 of 8 December 1980, the Milan Vidmar Electrical Institute (EIMV) is authorised for the following tasks relating to construction, trial operation, start-up and operation of nuclear facilities and installations:

- quality assurance, performance of measurements of electrical equipment, low and high voltage electric circuits and installation during construction, trial operation and operation of nuclear facilities;
- verification of operability, reliability and quality of the systems for control and automation of nuclear facilities and installations;
- training of technical staff in the above-mentioned areas;
- performance of acceptance tests on the electrical equipment.

In 1997, the activities of the EIMV relating to the nuclear safety were as follows:

- during the annual outage and refuelling, the EIMV carried out all the required measurements and controls on electrical components and systems; co-ordinated technical support organisations, and on the basis of individual expert reports compiled the "Joint Expert Report on Tasks, Corrective Action and Tests during the Krško NPP Outage and Refuelling at the End of the 13th Fuel Cycle".

Activities in the field of quality assurance and participation in the seminars:

- Participation in the exercise INEX-2-FIN (17 April 1997) intended to test communications and use of the national emergency plan in case of a nuclear accident in a foreign country. The exercise was led from Finland where an accident occurred in the Loviisa NPP;

- Participation in the workshop "Equipment Qualification Training", 22 - 24 October 1997, Krško NPP;
- Participation in the 4th Regional Meeting "Nuclear Energy in Central Europe", 7 - 10 October 1997, Bled;
- Participation in the meetings of the quality assurance working group in the scope of the FORATOM (Forum Atomique Europeen) and preparation of a seminar on quality assurance in European countries with a nuclear programme in joint organisation with the IAEA.

Research projects:

- The "Programme for Electrical Equipment Qualification according to the Requirements of the Working Environment in the Krško NPP - Phase III" includes all safety-related electrical equipment; non-safety-related electrical equipment, the failure of which can prevent safety function; and monitoring equipment related to the post-accident period;
- The "Automatic Transfer of External 110 kV Power Supply of the Krško NPP" analyses the possibilities and requirements for introduction of additional logical conditions for implementation of the fast transfer function in case of a loss of the 400 kV system, or a switch-off of the 400 kV switch in the transformer field of the Krško NPP;
- The "Feasibility Study of Power, System and Ecological Aspects of Decommissioning of the Krško NPP" deals with development alternatives of the Slovenian power supply system in case of premature shutdown of the Krško NPP;
- The "Programme for Development Processes for Spare Parts Procurement according to the QA programme of the Krško NPP"
- The "Participation in Modernisation of the Krško NPP", i.e. steam generator replacement and construction of the simulator;
- Participation in periodical testing of the qualifications and competence of the Krško NPP operators in the field of electrical systems and components.

13.5 FACULTY OF MECHANICAL ENGINEERING

The Faculty of Mechanical Engineering, University of Ljubljana, is authorised by the decision of the Republic Committee for Energy, Industry and Construction No. 31.10-034/80 of 8 December 1980 for the following:

- quality assurance and control of mechanical equipment in nuclear facilities and installations during production, installation, pre-operational tests, trial operation and operation of a nuclear facility;
- testing, measurements and operability control of measuring systems, regulation and mechanical equipment operation in a nuclear facility;
- measurements, quality control and operability control of ventilation and heating systems, cooling systems and air-conditioning in a nuclear facility;
- measurements, testing and operability control of mechanical installations and emergency power supply systems;
- acceptance testing of mechanical equipment;
- training of technical staff in the above-mentioned areas.

In the period 9 May - 11 June 1997, the Faculty of Mechanical Engineering participated in the annual outage works in the Krško NPP in the scope of the EIMV. Its scope of activities included the steam turbine with subsystems and the auxiliary steam driven pump. At the conclusion of its works the Faculty of Mechanical Engineering prepared the expert report No. 03-34/3-97/MT for the "Joint Expert Report on the 1997 Outage and Refuelling in the Krško NPP", prepared by the EIMV on 28 July 1997.

13.6 IBE CONSULTING ENGINEERS

The IBE Consulting Engineers (IBE), Ljubljana is authorised for the following (decision of the Republic Committee for Energy, Industry and Construction of 8 December 1980, Off. Gaz. SRS, No. 32/1980):

- preparation of investment and technical documentation for nuclear facilities;
- organisation of construction of nuclear facilities and installations and surveillance during construction, pre-operational tests and trial operation, including organisation of quality assurance in nuclear facilities and installations during construction;
- control of investment and technical documentation for nuclear facilities and installations;
- preparation of physical plans and siting documentation.

In 1997, the following tasks were carried out for the Krško NPP:
Mechanical-technological:

- In-Drum Drying System (IDDS) for liquid radioactive wastes and spent resins. In 1997, the IBE coordinated implementation engineering for the purchasing, installation, testing and start-up of the system. The start-up of the system with non-radioactive materials was sucessfully carried out by the end of the year;
- Cooling of diesel generators. A new revision of the modification programme was implemented for the cooling feedwater piping into the diesel generators;
- Modification 137-DG-L - Fuel filters for DG. The fuel filters on the feed lines from the DC pumps were replaced, and the documentation - AS BUILT prepared and delivered;
- Modification 067-SX-L/1. Modification of the condenser sampling system. The mechanical part of the modification package 067-SX-L/1 - condenser sampling - was finished.

Construction part:

- Technical-geodetic observation of facilities. The technical-geodetic observation of the key facilities was carried out - geodetic examination for sinks and damages - cracks; and the cadaster of observations prepared;
- Projects of construction modifications;
- Preparation of modification projects - DMP - for:

* refurbishment of the radiological protection premises in the ORZ building at the elevation 100.30 and in the command building at the elevation 100.30;
* IDDS - shielding projects;
* Completing of the "Turn-over" projects for:
  - landing of "MID-LOOP" connectors;
  - reconstruction of lids on the ESW building roof;
  - reorganisation of the TK room in TB at the elevation 115.55;

Electrical:

- In-Drum Drying System (IDDS) (Mod. 102-WP-L). Work was concluded on the project for implementation of the (electrical and I&C part in the Krško NPP) reduction of the boric acid (Evaporator Bottom) and spent resins volume by evaporation of the liquid part of the substance by Siemens technology. The software for PLC for system control was developed (with the help of the manufacturer). Also the installation of the equipment and non-radioactivity test were carried out in 1997. However, the radioactivity test and acceptance will be carried out in 1998;
- Acqusition of PIS Phase II Signals Scope 2 (Mod. 090-CH-L). Within the DMP project, 105 signals were processed which will be connected to the process-information system in Phase II;
- Wireless communication (123-PC-L). Due to the specific tasks of the individual services the research project requires preparation of documentation for 5 separate wireless networks;
- Replacement of Inverters ESELIV03&04 and EE100XFRJ005&006 (Mod. 206-ES-L). The research project for replacement of the existent old SR inverters #3, #4, #5 and #6;
- Control Point (Mod. 171-AB-L). The project was prepared for reorganisation of the control point for admittance and exit from the controlled area;
- Safety systems of the Krško NPP. The PGD was completed for a new admittance control point for the Turbine building or GPO. In addition to the control point an auxiliary command center is forseen in the building, up to now situated at the entrance into the Krško NPP.

Tasks for the Žirovski vrh Mine, carried out in 1997:

- Project documentation was prepared (PGD, PZR, PZI) for the final remediation of the ore processing site at the Žirovski vrh Mine. This included: dismantling of equipment, foundations, and mechanical and electrical installations; pulling down and remediation of facilities; decontamination; radiation protection and decontamination; remediation and recultivation of the area. The documentation - construction, mechanical and electrical - refers to:
  * closure of the surface facilities of the uranium ore processing site (8 facilities);
  * facilities to be pulled down (22 facilities);
  * facilities to be remedied (19 facilities).

In addition to the above, a new version of the programme is being prepared for permanent cessation of uranium ore processing and for preventing the impact on the Žirovski vrh Mine to the environment.

The projects for the ARAO in 1997:

- Preparation of the Procedure for Siting of the LILW Repository (commissioned by the ARAO);
  The elements of an integral process for siting are given. The procedure is based on valid principles for the site compliance assurance, the special feature of the procedure being the methodology for definition of a potential site. A site is to be defined in two steps. First, by cabinet research, the areas in the territory of Slovenia suitable for LILW repository will be defined; in the second step, potential sites within these areas will be defined with the participation of the local communities. It is expected that the entire procedure will be socially verified and supported by the appropriate political and strategical decisions of the national authorities;
- Use of Non-Geologic Recommendations in the Process of Siting the LILW Repository (Contracting Party: IGGG-GZL);
  The proposal for use of non-geological recommendations in the process for siting of the LILW repository has been prepared. The non-geological recommendations include: environment protection; population density; land use; land management; expences; transport, and the problem of social acceptability.

In 1996, the IBE Consulting Engineers established a system of quality assurance in accordance with the ISO 9001 standard. Following acquisition of the ISO 9001 certificate, the design and engineering works are being carried out in compliance with the quality rules and other procedures of the quality assurance system. Twice a year, the quality assurance system is reviewed by the certification body BVQI, which is competent to extend the validity of ISO 9001 certificates.

The modification projects for the Krško NPP are carried out in accordance with the Krško NPP's own procedures. The Krško NPP has its own quality assurance system which - due to specific requirements in certain elements - differs from the IBE quality assurance system. Within its programme of quality assurance the IBE has issued an instruction for performance of services for the Krško NPP in a special organisational regulation.

The Quality and Standardisation Unit carries out inspections of the quality assurance system in the IBE according to the annual programme. In conformity with the relevant procedures the quality control is also carried out for each project.

13.7 INSTITUTE FOR ENERGY AND ENVIRONMENT PROTECTION - EKONERG

EKONERG (Institut za energetiku i zaštitu okoliša d.o.o. - Zagreb), within the area of its expertise authorised by the decision No. 318-36/92-2933/AS, is issued by the SNSA of 18 June 1992, for the following:

- quality control and quality assurance of mechanical equipment in nuclear facilities and installations during production, installation, pre-operational tests, trial operation and operation;
- performance of acceptance and functional tests of mechanical equipment;
- verification of the base line condition and periodical in-service inspection of mechanical safety-related equipment.

Activities of the EKONERG in the Krško NPP:
Quality control of the outage works in the Krško NPP in the field of mechanical equipment and preparation of the expert report on the quality of outage works performed during the 1997 outage and refuelling at the end of the 13th fuel cycle:

- quality control of overhaul works on rotational mechanical equipment, valves, and ventilation and air conditioning equipment (HVAC) in line with the inspection report no. 68/95 of 20 September 1995 and according to the technical specifications: motors of diesel generators; diesel motor of the fire pump; air compressors for instrumentation and regulation; pumps of the primary loop and partly pumps of the secondary loop; valves of the primary loop and partly valves of the secondary loop; part of the air conditioning and ventilation equipment (HVAC); fire protection equipment; and control over the following components: turbine of the turbine generator, pumps of the main feedwater system, pumps of the cooling water system for condenser and main condenser pumps;
- inspection and independent evaluation of three modification packages: replacement of a fuel filter in the system for conducting fuel into diesel motors of the DG107DSL-001/-002 generators; shifting of two valves of the ventilation system from the area with high radiation into the intermediate building (IB) and installation of additional electromagnetic valves into the stack of suction lines on both pumps of the chemical and volume control system (CVCS);
- expert report, based on a survey of working orders, on direct visual inspection and the presence in activities of the contractors, on personal contacts with contractors and on co-operation with the maintenance and quality control services of the Krško NPP.

In addition to the above-mentioned activities carried out within preparatory works for the outage and during outage itself, the EKONERG personnel regularly participates in further training in the field of nuclear safety or in related areas through:

- additional training and specialisation;
- participation in symposia, seminars and lectures in the field of nuclear safety and quality assurance;
- participation in the IAEA missions related to projects in the Republic of Croatia;

- following domestic and foreign technical literature on nuclear safety and quality control;
- quality control and assurance in conventional power facilities.

13.8 JOŽEF STEFAN INSTITUTE

By the decision No. 31.10-034/80, issued by the Republic Committee for Energy, Industry and Construction on 8 December 1980, the Jožef Stefan Institute, Ljubljana is authorised to carry out the following activities in the territory of the Republic of Slovenia:

- analysis of events in nuclear facilities;
- reviewing the results of siting investigations for nuclear facilities;
- analysis of unusual events in nuclear facilities;
- verification of the operational status of the safety systems in a nuclear facility and of physical security;
- testing, measurements and verification of operability of nuclear, in-core and radiological instrumentation, and of the reactor control system;
- nostrification and review of the safety report;
- verification of test results of the safety systems during trial operation;
- preparation and execution of emergency measures during an accident related to radiation protection, labelling of radioactive contamination and decontamination and risk assessment to the environment;
- training of workers in the basics of reactor technology, description of nuclear power plant systems, and radiation protection.

13.8.1 DEPARTMENT OF REACTOR ENGINEERING (R-4)

In 1997, the activities of the JSI-Department of Reactor Engineering (R-4) were as follows:

Research Projects

Contracting Party: Ministry of Science and Technology

In the field of THERMAL-HYDRODYNAMIC SAFETY ANALYSES the research concerning the experimental facility BETSY in Grenoble (France) was carried out. Improvements were made to the simulation model for the test 6.9c: "Midloop Operation" (OECD ISP-38) at low pressure and reduced level of coolant in the reactor coolant system during loss of the residual heat removal system. These improvements were focused on the analysis of phenomena of stratified two-phase critical flow in the hot leg of the primary system to which the surge line of the pressurizer was connected. The 9.1b test (OECD ISP-27) - representing a two-inch cold leg break without high pressure safety injection and with delayed operator action - was used to investigate the application of experimental results to actual plants. Based on similarity criteria, the experimental facility geometry and initial and boundary conditions were evaluated for a real nuclear power plant. A methodology was developed for evaluation of similarity between the simulated and real heat structures and their impact on the quality of results. The 6.2 TC test represents a medium cold leg break without safety injection system, leading to a distinctive core uncovery and heating. The improved quantifying of the similarity between simulation transients was achieved with the critical flow-rate setpoint. In addition, an investigation was made into the physical phenomena in the reactor vessel head which have an impact on emptying of the reactor vessel. The international standard experiment (IAEA-SPE-4) was re-analysed, and significantly better correspondence to the experimental results at the PMK-2 facility was achieved. The experiment represents a small-break loss of coolant accident (LOCA) at the VVER-440 system when the safety injection is not available. In the scope of extrapolating the uncertainty of the calculated course of an accident and transients, the uncertainty of a small LOCA was calculated for a two-loop nuclear power plant. A second-order accurate numerical scheme, developed for the two-fluid two-phase flow model of fast transients, was upgraded to a scheme suitable for all kinds of transients. Development was continued on a Langrangian simulation of a saturated nuclear boiling in a vertical channel.

In the field of PROBABILISTIC SAFETY ASSESSMENT the research comprised analyses of testing and maintenance of safety systems of the nuclear power plant. The quantitative results of risk assessment showed that the plant safety and availability may be improved by optimisation of the surveillance test frequency and by optimisation of the allowed outage time. An important innovation is research into the acceptability of the substitution of traditional safety analyses techniques with safety-related computer-based systems, where the probabilistic analysis of reliability of the included software is of special importance. For increased reliability of the software the analyses were focused on the early phases of life-cycle of the computer-based systems, in particular the analysis of requirements. In 1997, a research project of modelling of the components condition by means of a combination of the probabilistic theory, and the fuzzy logic has now been started. The probabilistic safety assessments are uncertain due to random processes, inaccurate measurements and unclear description data. Compared to the known mathematical approaches for uncertainty assessment - such as sensitivity analysis, the mathematics of intervals and probabilistic theory - a more integral mathematical model for description of uncertainty can be constructed by the theory of fuzzy sets.

The field of STRUCTURAL SAFETY ANALYSES includes improved computer simulations of initiation and growth of different kinds of defects in the steam generator tubes. These simulations are based on probabilistic considerations and also account for the non-destructive examination and repair of damaged tubes. The main result is e.g. the probability of complete failure of a given number of steam generator tubes, meaning a failure by excessive leakages of the coolant through damaged tubes or tube breakage.

In the field of MAN-MACHINE INTERFACE, the project of elaborating an algorithm for the determination and prediction of the form of an NPP emergency state has continued. Determining the forms of transients is based on observance of the equilibrium systems in a NPP and on establishing the dynamic interdependence of a predefined set of physical parameters. With the Krško NPP analyser, based on the RELAP5/MOD3.2 computer code, the scenarios of failure for different components in the primary and the secondary system of the nuclear power plant were simulated. The scenarios were divided into two groups: referential and test. In comparison with the referential scenarios, the algorithm ranked the test scenarios into appropriate groups, described them, and determined the position of a failure within the system. The algorithm was also verified with real data obtained by measurements in the Krško NPP. For the test the events from 1995 and 1997 were used, when a separate isolation of the main steam line on the steam generators no. 1 and 2 occurred. The algorithm correctly described their dynamics and correctly determined the kind of transient and the location of the failure in the system.

In the field of ANALYSES OF CONSEQUENCES OF SEVERE ACCIDENTS the phenomena in the containment of the Krško NPP in the initial phase of the large-break loss of coolant accident have been analysed using the CONTAIN computer code. The impact of heat transfer on the structures and dispersion of the liquid in the containment atmosphere in relation to loss of pressure was investigated. By using the graphic interface NPA (Nuclear Plant Analyser), the graphic presentation and animation of the simulation results was developed by the MELCOR program, which serves for event analysis during severe nuclear accidents. At modelling, the basic phenomena of the processes at steam explosions, and an improved computer program for predicting the distribution of the melted fuel in the first phase of steam explosions, are investigated in detail. The program is based on the probabilistic equations of the multiphase flow, and each phase (melt, water, vapour and air) is separately processed by its equation system.

Contracting Party: the Krško NPP

The research results in the field of STRUCTURAL SAFETY ANALYSES and real-time monitoring of the state of steam generators damage in the Krško NPP are combined to support decision-making during their maintenance. The basic idea is simple: the best maintenance is that which minimises the probability of a tube failure.

In the field of ANALYSES OF CONSEQUENCES OF SEVERE ACCIDENTS the research was focused on analyses of severe accidents with the PC COSYMA code. The potential consequences of a severe nuclear accident from release into the air of fission products - indicated in the assessment of the nuclear power plant NEK-IPE level 2 - to the vicinity of the Krško NPP, in the area within a radius of approx. 25 km, were investigated. Taking into account the capacity of the computer code PC COSYMA, long-term releases were replaced by a series of one-hour releases. In analyses of expected consequences for various scenarios the most recent data available on population were used, the meteorological file for 1995 and the plan of emergency countermeasures: sheltering, use of stable iodine and evacuation. The contribution of post-accident nourishment to the consequences was estimated. In addition to the statistical approach, the deterministic approach was also used. Early consequences were analysed as stohactic effects on individuals and on the population, occurring for decades after the nuclear accident.

Contracting Party: SNSA

In the field of ANALYSES OF CONSEQUENCES OF SEVERE ACCIDENTS an engineering data base was generated for analysis of phenomena in the Krško NPP containment with the CONTRAN computer program. The base is meant as a basis for further modelling of phenomena for various severe accidents.

Expert Evaluations and Reports

In 1997, in compliance with the received authority and many years of professional experience in the field of nuclear safety the researchers of the JSI Department of Reactor Engineering prepared the following expert reports on corrective action and tests in the Krško NPP:

- Independent Expert Evaluation of the "Probabilistic Safety Assessment of the Krško NPP (Level 2)", documents: IJS-DP-7764, Rev. 1 and 2, IJS-DP-7811, Rev. 1. The probabilistic safety analysis of the Krško NPP, level 2, was prepared according to recommendations of the IAEA and the US Nuclear Regulatory Commission;
- Expert Evaluation of Revision of Technical Specifications for the Krško NPP due to prolonged maximum time limit for closure of certain isolation valves of the containment atmosphere (Expert Evaluation JSI No. R4/LF-zv/43 of 14 April 1997). Determination of prolonged time limit for closure of certain isolation valves of the containment, which were not in conformity with the original technical specifications, based on safety analyses of impact on the environment;
- Expert Evaluation of Boric Acid Concentration Decrease in the "Boron Injection Tank" (BIT) - (Expert Evaluation JSI No. R-4/LF/51 of 6 May 1997). The expert evaluation of the Westinghouse analysis of boron concentration decreasing in BIT from 20,000 ppm - 22,500 ppm to the same concentration level as in the water tank for refuelling. The expert evaluation was based on verification of individual parts of the proposed analysis with methods and program tools, developed at the JSI;
- Separate expert evaluation No. R-4/LF/217 of 8 October 1997. The JSI gave its opinion on the status of the isolation valves in BIT and its surge tank after effecting the boron concentration decrease in BIT;
- In conformity with the authorisation for the monitoring of safety and protection systems operation in nuclear facilities the following activities were evaluated during the NEK 97 outage:
  - safety systems testing;
  - corrective action and testing of steam generators;
  - refuelling;
  - measurements of the core power distribution.

International co-operation

In 1997, within the scope of international projects and contracts the Department of Reactor Engineering co-operated with the International Atomic Energy Agency (IAEA), the OECD Agency for Nuclear Energy (OECD/NEA), the US Nuclear Regulatory Commission (US NRC; the CAMP, CSARP and other programmes), Centre d'Etudes

Nucléaires de Grenoble and the European Commission (Commisariat a l'Energie Atomique). The Department also actively co-operated with the Texas A&M University (USA); the University of Pisa (Italy); the University of Newcastle (Great Britain, in the scope of a COPERNICUS project); Forschungszentrum Karlsruhe (Germany); AIB-Vincotte Nucléaire (Brussels, Belgium); and the KFKI Atomic Energy Research Institute (Hungary). In addition to working visits the co-operation also included joint publication of results.

The workers of the Department participated in 15 international conferences and working meetings, and presented 37 papers. The response to the papers at the international meeting reflected the up-to-date standards and high professional quality of research work in the Department.

13.8.2 DEPARTMENT OF REACTOR PHYSICS (F-8)

In 1997, the Department oriented its research mainly into new methods for calculation of power and research reactors. Special attention was given to calibration and benchmarking of nuclear data and computational methods. Specific problems that have been addressed include the transport of neutron, photon and electron with the Monte Carlo method and nuclear data processing for transport calculations, advanced nodal methods, pincell and fuel assembly homogenisation and methods aimed at detailed power distribution reconstruction. The research results were published in a number of scientific papers and proceedings of international conferences. The Department continued the implementation and verification of a new two-dimensional program package for TRIGA reactor burnup calculations. A very precise three-dimensional Monte Carlo model of the entire TRIGA reactor (core, internals, shields, irradiation channels, etc.) has been constructed. Using this model, a series of demanding Monte Carlo benchmark calculations was performed, resulting in excellent agreement between simulation and actual experimental data (criticality, fuel element reactivity and control rod worths). The results of the calculations were published. An extensive safety analysis of fuel criticality in the sarcophagus of the exploded Chernobyl reactor was carried out. The analysis results have already been accepted for publication. As has been done every year since the initial start-up of the Krško NPP, the entire core design calculation for the Krško NPP fuel cycle was performed in 1997 using the CORD/II program package. The start-up physics tests were also performed during refuelling of the Krško NPP, using its own original, and now quite widespread, method for control rod worth measurements. In 1997, the Department started development of an extensive program application for the monitoring of power distribution in the reactor core for the needs of the Krško NPP.

13.8.3 DEPARTMENT OF LOW AND MEDIUM ENERGY PHYSICS (F-2)

The Department of Low and Medium Energy Physics is a research unit at the JSI. Research in the department spans many topics in low energy, i.e. atomic physics, and medium energy, i.e. nuclear physics. Basic research is complemented with applied research into metrology-based nuclear measuring techniques and instrumentation, both as a direct spin-off of the previous fundamental projects and as on-going programmes. The Department also includes the National Laboratory for Secondary Dosimetry Standards; and the Ecological Laboratory with Mobile Unit - the ELMU has its operative headquarters at the department.

The Department is a co-ordinator and a performer for the Programme of Routine Radioactivity Monitoring in the Vicinity of the Krško Nuclear Power Plant and participates in the project Programme of Measurements and Radioactivity Monitoring in the Living Environment in Slovenia. A report on measurement results and dose estimation is prepared every year.

In the field of development and research in 1997, analysis methods for quality assurance and control were improved, and modelling of detector systems with the Monte Carlo code was continued. A new method for determination of the average path length of gamma-rays in the sample, based on differences in absorption of x-rays above and below the absorption edge; and a new method related to measurements of the average path length for determination of attenuation factors for samples of irregular shape were determined. Also, a new method was developed for calculation of the photon path length from the point sources in detectors based on measurements of the total effect.

In the National Laboratory for Secondary Dosimetry Standards preparations for accreditation started in 1997: the trace chain was improved and the rules on quality were prepared. In May, they participated in the international inter-comparison of the TLD system, with the main focus on calibrations at low energies with a new x-ray device. In co-operation with the Rudjer Bosković Institute, Zagreb, a series of CaF and LiF dosimeters was calibrated. The results were presented at the IRPA Symposium on Radiation Protection in Prague as a method for determination of effective energy of X-radiation. Verification of instrument testing and calibration for individual users is already routine by now.

13.9 INSTITUTE OF OCCUPATIONAL SAFETY

The Institute of Occupational Safety, the Center of Ecology, Toxicology and Radiation Protection, Ljubljana is authorized for the following activities in the field of radiological protection:

- by the Ministry of Health to implement measures for radiological protection prescribed by the Act on Protection against Ionizing Radiation (Off. Gaz. SRS, No. 9/91), Decision No. 180-1/80-81 of 9 March 1981;
- by a decree from the Federal Committee for Work, Health and Social Care (SFRY) to perform systematic research of radioactive contamination (Off. Gaz. SFRY, No. 40/86);
- by a decree from the Republic Committee for Health and Social Care it was appointed as an authorised organisation to perform radiological contamination control of food of animal and vegetable origin (Off. Gaz. SRS, No. 25/89);

- in the field of ecology and toxicology for expert tasks in the field of occupational safety (Off.Gaz. SRS, No. 22/87).

In 1997, the Institute of Occupational Safety functioned as a technical support organisation and a research unit for the monitoring and control of radioactive contamination in the living and working environment in the Republic of Slovenia, and helped the Krško NPP in performing radiation protection services at the 1997 maintenance outage.

13.10 ENERGY INSTITUTE LTD.

Energy Institute Ltd. (Institut za elektroprivredu i energetiku d.d., Zagreb - IE) is by decision no. 318-36/4751/AS, issued by the SNSA of 24 August 1993, authorised for the following tasks related to nuclear safety:

- quality assurance and quality control of instrumentation and control systems (I&C) and verification of its operability and reliability during construction, pre-operational tests, trial operation and operation of a nuclear facility.

The activities related to nuclear safety during the 1997 outage and refuelling in the field of instrumentation and control systems (I&C area), control of primary systems according to the technical specifications for the Krško NPP, the nuclear instrumentation system (NIS), and instrumentation and control systems of diesel generators (DG1 and DG2):

- inspections of outage and refuelling activities at the end of the 13th fuel cycle in the Krško NPP in the I&C area;
- inspection of modifications of the I&C equipment and systems;
- on the basis of the activities performed during the outage the IE prepared the following documents:
  - Statement for Re-establishment of Reactor Criticality after the 1997 Outage and Refuelling at the End of the 13th Fuel Cycle in the Krško NPP No. 16-26/97/9.NEK of 9 June 1997;
  - Statement for Full Power Operation after the 1997 Outage and Refuelling at the End of the 13th Fuel Cycle in the Krško NPP No. 16-27/97/9.NEK of 17 June 1997; and
  - Expert Report on Tasks, Corrective Measures and Tests during the Krško NPP Outage and Refuelling at the End of the 13th Fuel Cycle in the I&C domain No. 16-28/97/9.NEK of 7 July 1997;

    for the EIMV to compile the "Joint Expert Report on the 1997 Outage and Refuelling in the Krško NPP" of 28 July 1997;
- activities in the field of quality assurance and participation in seminars on nuclear technology and quality assurance according to the ISO EN standards:
  - survey of the Krško NPP procedures for maintenance and calibration of I&C systems and loops;
  - preparation and initiation of a quality system into the IE in conformity with the HRN EN 9001 and in conformity with the international standard ISO DIN EN 9001;

* quality assurance activities with preparations of revisions of the IE Manual for Quality Assurance and programme and working procedures for the IE activities as a technical support organisation;
* certification of the IE VN experimental laboratory in conformity with HRN EN 45001 (procedure for acquirement of the certificate is in progress at the accreditation organisation BAM, Berlin and at the National Standards and Metrology Institute of RH);
* active participation in the National Standards and Metrology Institute experimental laboratories;
* participation in seminars for ISO 9001 and ISO 54001 internal assessors at TÜV, Essen;
* activities based on the quality assurance programme, quality control during construction of energy facilities and installations in the Republic of Croatia;
* internal assessment based on 50-C-QA and ANSI/ASME NQA-1 in co-operation with the EIMV experts, in accordance with the IE Manual for Quality Assurance for the Nuclear Technology Field and with the programme of internal assessments.

13.11 ENCONET

The company ENCONET Consulting Ges.m.b.H., Auhofstrasse 58, A-1130 Vienna, Austria is by decision no. 318-55/95-14126/ML, issued by the SNSA on 19 March 1997 authorised for the following tasks and services in the field of nuclear safety in the territory of the Republic of Slovenia:

- evaluation and verification of safety reports and other documentation related to nuclear safety;
- preparation of safety analyses to support the regulatory authority for nuclear safety in decision-making in administrative procedures.

13.12 HIGH VOLTAGE AND ENERGETICS DEPARTMENT, FACULTY OF ELECTRICAL ENGINEERING, UNIVERSITY OF ZAGREB

The High Voltage and Energetics Department, Faculty of Electrical Engineering, University of Zagreb is by decision no. 318-38/90-1413/AS issued by the SNSA on 2 April 1991 authorised for the following tasks and services in the field of nuclear safety in the territory of the Republic of Slovenia:

- safety analysis of installations, components and systems of nuclear facilities;
- safety analysis for qualification of safety class electrical equipment.

13.13 CONCLUSION

Technical support organisations represent a vital part in surveillance operations, backfitting, modifications and maintenance work on nuclear facilities. The work of technical support organisations is supplemental to the work of the Nuclear Safety

Inspection Section which has insufficient manpower to cover all the activities in the nuclear facilities related to nuclear safety.

The report by the technical support organisation shows that the major part of their engagement involves surveillance of annual outage and refuelling. With the replacement of steam generators the duration of annual outage will be shorter, and the Inspectorate and the technical support organisations should be prepared accordingly. The shorter outage will require better planning of surveillance activities and even better co-ordination and co-operation between the Krško NPP, the Inspectorate and the technical support organisations.

The report also shows that technical support organisations take care of regular training of their personnel in the fields within their responsibility. One vital part is the organisation of quality assurance, verified also by the SNSA. Some of the technical support organisations are taking steps to acquire an ISO certificate or accreditation for their laboratories.

14 RESEARCH PROJECTS AND STUDIES

In the budget year 1997, the SNSA financed and co-financed research projects and analyses to support decision making during licensing, and other development projects. The exception is the expert evaluation of the probabilistic safety assessment study, which was fully financed by the Krško NPP. The main projects and activities are briefly summarised below.

Safety Improvements for Krško NPP for the Loss of Off-site Power (ENCONET Consulting, Vienna)

The results of the probabilistic safety assessments (PSA) in the Krško NPP have shown that the loss of off-site power is one of the most dominating initiating events in the power plant and significantly contributes to the probability of core damage. Therefore, the SNSA commissioned a study to establish measures necessary to improve the safety of the Krško NPP in case of loss of off-site power.

The study consists of the following parts:
- Survey of improvements in power plants throughout the world (Germany, Sweden). Primarily, it involves improvements of AC power supply (diesel generators, gas turbines and hydrogenerators) and also improvements of DC power supply (additional batteries and/or load shedding).
- Identification of sequences from the PSA in connection with the loss of off-site power. The most important sequences in connection with the loss of off-site power were identified. It was found that improvements to emergency power sources could provide for additional safety and are, therefore, well-grounded.
- Determination and assessment of the feasibility of the suggested improvements at the Krško NPP. As the most feasible solution, the improvement of 125V DC batteries and procurement of an additional emergency diesel generator was suggested.

Independent Expert Evaluation of "Individual Plant Examination of Krško NPP (Level 2)"
(JSI, Department of Reactor Engineering)

The probabilistic safety assessment (PSA) - level 2 for the Krško NPP refers to analysis of the reactor containment integrity in case of core damage, and as a result gives an estimate of the quantity of radioactive substances that might be released in case of an accident. The analysis is used primarily for identification of potential weak points of the nuclear plant, and the potential course of events and their consequences. The probabilistic safety assessment was prepared by Westinghouse.
The purpose of the independent evaluation was verification of the analysis and validation of its results before further use in the licensing decision making. Only a part of the analysis has been evaluated so far, and the work is to continue in 1998. The evaluation performed so far has shown that the assessment complies with the

requirements of the SNSA and US NRC and is a reliable indicator of the power plant condition.

Severe Accidents Analysis by the Programming Package MELCOR - Phase III (University of Maribor, Faculty of Engineering, Maribor)

MELCOR is a code package for severe accidents calculations. It is based on the concept of free volumes, which a user can freely shape and combine into more complex geometrical forms. The connections between final volumes can be equipped with various control and other functions, i.e. with pumps, valves, etc. By use of the programming package decay products are followed and the interaction between the concrete and the melted core is simulated. The project is a follow-up to the 1995 and 1996 projects Severe Accidents Analysis, by the Programming Package MELCOR.

The input model of stable condition parameters of the primary and the secondary system, developed in the previous years, has now been tested. Only from parameters of the stable condition can the scenario of transients and severe accidents be modelled. The actual parameters of the power plant are close to the stable condition parameters. Several input models with different nodalisations (number of control volumes) have been developed, especially on the primary side. By means of different nodalisations the most appropriate nodalisation has been determined. The results of nodalisation with 18 control volumes are comparable to results of MAAP 3.0B (This calculation was performed in the Krško NPP IPE level 2 study). The modelled scenario in this nodalisation is SBO (Station blackout). According to the results the most appropriate nodalisation is with 24 control volumes.

Modelling of the Krsko NPP Containment with the CONTAIN 1.12 Computer Code - Development of Input Deck Data Base (JSI, Department of Reactor Engineering, Ljubljana)

In performing its tasks, the SNSA often encounters problems with understanding of the phenomena of the Krško NPP containment in case of a severe accident. The aim of the SNSA is to obtain some substantial results in the field.
The purpose of the project is to carry out a detailed analysis of the pressurisation of the containment and the individual phenomena (hydrogen generation, behaviour and transport of fission products, etc.) in the containment in the course of one of the potential severe accidents. As a scenario, an accident involving large loss of coolant accident (LOCA) 92 LL02_1 - referred to in NEK PSA Level 2 - was chosen.
Due to insufficient funding in 1997, only a minor part of the project has been finished (engineering data base, upon which the input model is based). The project is to be finished in 1998.

Calculation of Isotopic Inventory and Activity of Irradiated Fuel using the ORIGEN Programme Package
(JSI, Department of Reactor physics)

ORIGEN is a well-known and widely used programme package for calculation of the isotopic composition and activity of the fuel. By the inclusion of a relevant base of fuel elements, it can be used to perform calculations of activity, isotopic composition and residual heat in the core and in the spent fuel pool for any time after reactor shutdown. One of the results is radiotoxicity of individual elements. This information could be extremely important in case of an unusual event. Also, the results of the calculation can be used for the planning of storage and disposal of highly radioactive wastes. A couple of years ago such calculations were performed for the fuel from the Krško NPP and the TRIGA reactor. The above calculations were performed by the programmes ORIGEN and IZAK; the IZAK was used for data base generation, which in turn served as input data for ORIGEN.
The aim of the project is to encourage more extensive use of the programme ORIGEN. It covers also upgrading the data base of fuel elements at the Krško NPP for calculations with the programme ORIGEN and construction of input models for the programme ORIGEN.

Calculation of the Test Case TRIGA Mark II by the Monte Carlo Code
(JSI, Department of Reactor Physics, Ljubljana)

In 1995, the safety analysis of the spent fuel criticality at the reactor TRIGA Mark II in Ljubljana was performed within the scope of the applied research project "Expert Support for Safe Operation of Nuclear Reactors in Slovenia". The analysis showed that the new pool did not provide for subcritical configuration under certain accident conditions. A case of such an accident condition was breakage of the rack caused by an earthquake. The next year, an additional safety analysis was carried out with calculations of additional Cadmium absorption elements in the pool. These elements should provide for the subcritical condition also in the above mentioned accidental condition. In both analyses the Monte Carlo code MCNP4A with associated programme libraries, the exact explicit model of the fuel element for the TRIGA reactor and the exact model of the spent fuel pool were used.
The project is aimed at verification of the calculations, geometric models and section libraries. The project also covers construction of the reactor core model, calculation of properties and comparison between calculation results and actual experimental values, measured at the reactor TRIGA reconstruction in 1992.

Review and Comparison of the Methods for Detection of Nuclear Core Fuel Elements Failures
(JSI, Department of Reactor Physics, Ljubljana)

In the recent years of operation of the Krško NPP, pinholes and open cracks on fuel elements in the reactor core have been detected, thus contributing to the increased activity of the primary loop. In 1995, ultrasonic testing of the fuel for leak tightness was

carried out for the first time. In 1996, in addition to the above method the cladding was also inspected by the fuel sipping method. These two methods are technologically well established throughout the world and are used in the process of monitoring the integrity of fuel elements in nuclear power plants during refuelling.
The purpose of the study is presentation of non-destructive methods used world-wide for monitoring fuel integrity. The study includes a chapter on damage to nuclear fuel, on the ultrasonic method for fuel cladding inspection, on the fuel sipping method, visual methods and on comparison of results between the ultrasonic method and the fuel sipping method.

Evaluation of the Krško NPP "Inservice Inspection Program, rev.2, for the Second Ten-year Inspection Interval"
(IMT, Ljubljana)

The purpose of the project was to establish whether all requirements from ASME Standards, Section XI, and the American regulations 10CFR 50.55a "Inservice Inspection" for Class 1, 2 and 3 components were taken into account in the programme of inservice inspections at the Krško NPP "Inservice Inspection Programme" TD2E, Rev. 2 (ISI) for the second ten-year inspection interval. The project is, inter alia, aimed at surveying and evaluating the following:
- valid issues of ASME section standards, including the relevant references from the recent issues;
- how the Class 1, 2 and 3 components and their various racks and supports are included and taken into account in the ISI programme for the Krško NPP;
- the proportion of welds which the Krško NPP intends to control in accordance with the ISI programme,
- the accuracy and completeness of routine inspections in individual periods during the inspection interval according to ASME;
- the methods of inspection, frequency and acceptance criteria according to ASME;
- any additional controls.

Due to the complexity of the project it will be only finished in April 1998. The expert evaluation of the ISI programme in the Krško NPP is required by the SNSA for decision-making in the administrative procedure "The Programme of Inservice Inspections in the Krško NPP", introduced by official duty.

Nuclear Plant Analyser of the Krško NPP - Phase III
(Belgatom, Belgium)

The basic purpose of the analyser is that of performing as a programming tool for the training of the SNSA employees in the Krško NPP operation in case of an accident and for improved information and training of expert group members and contractors of the SNSA in accident condition assessment in case of emergency. In 1997, phase III of analyser development was carried out, involving upgrading of the existing model and elimination of deficiencies in the transfer of the original model RELAP/MOD2, developed by the Krško NPP, to the model RELAP/MOD3.2. The final stabilisation to verify the compliance of major thermohydraulic parameters of the nuclear power plant by the calculation RELAP5 was performed. The upgraded input model RELAP also includes critical safety functions trees. Default normal conditions from RELAP are compared to actual conditions of the power plant and in case of non-compliance, the input model RELAP is suitably adapted. The present model of the Krško NPP is to be extended by visualisation of the critical safety functions trees. The verification criteria for the power plant condition are based on thermohydraulic and neutron parameters, obtained from the calculation with RELAP. The obtained data are compared to the specific setpoint values of the power plant.

Development of the Experiment Programme on START Device (University of Maribor, Faculty of Engineering, Maribor)

In 1997, the SNSA co-financed the installation of the START device (glass application of the reactor loop) at the Institute of Energetics and Process Engineering, Maribor. START is a glass model of the primary loop of a pressurised water reactor. It is intended for in-depth study and understanding of phenomena in reactor engineering and is used for research, training and educational purposes.
In 1997, the SNSA financed the project "The Implementation of the Programme for Experimentation on START", in the framework of which the programme for experiments was developed and evaluated. The experiments cover the following events:
- small break loss of coolant accident (LOCA);
- medium break LOCA;
- large break LOCA;
- system blowdown;
- steam generator tube rupture (breakage of one tube);
- steam generator tube rupture (breakage of multiple tubes);
- loss of off-site power;
- natural circulation.

Geotectonic Research for Safety Assessment (Institute of Geology, Geotechnics and Geophysics (IGGG), and Tomaž Verbič, Independent Researcher, Ljubljana)

The purpose of the research is to assess the safety of the Krško NPP operation in case of an earthquake. To achieve this purpose, the maximal magnitude (on the Richter scale), position of focal points, actual tectonic joints in the vicinity of the Krško NPP, their length and the level of their activity should be determined. Furthermore, the reevaluation of the project earthquake parameters is projected, as well as a new probabilistic safety assessment of critical components of the Krško NPP and of the total seismic risk.
In 1997, the geological mapping continued, using the methodology of all outcrops on a scale of 1:5000, and improved cartography by trenching. On a particular section (Libna and its vicinity) under research, the geologic reambulation and trenching was carried out. The continuous electrical sounding of Libna by the Schlumberger technique was carried out; and, on the most interesting sections of the geoelectric profile, performed in

1996, the density of geoelectrical sounding was increased, which proved to be a very effective solution for more precise determination of the tectonic structure of Libna.
In 1998 and 1999, the research will be partly co-financed by the PHARE Programme, and to this purpose the programme of preparatory works for implementation of PHARE/NUCLEAR SAFETY/PH 1.08 and PHARE/TSO/SLO/03 projects and a proposal of methodology for construction of a seismotectonic model of the Krško NPP location have already been carried out.

Data base for Neotectonic and Seismic Research of the Krško Basin (IGGG, Ljubljana).

New data and the reambulated geological map of the Libna region and its vicinity (1996) were entered into the spatially oriented data base, generated in the period 1995-1996. Each year new digital data are added into the data base, built in the ARC/INFO and ARCView format. In 1997, vector topographic maps on the scale of 1:25000 and ortho-photo maps, scale 1:5000, of the region to the south of the Krško NPP were entered.
In addition to the spatially oriented data base for the Krško NPP, another two data bases for the location of the Research Centre TRIGA Brinje and for the Žirovski vrh Mine are being generated. For the site of the Žirovski vrh Mine the situation of the main facilities (mine, processing site, roads, location of piezometric wells) was digitised in 1997. The digitalisation is based on a vector topographic map, scale 1:25000. For the TRIGA Reactor, Brinje, vector topographic bases, scale 1:25000 and ortho-photo maps, scale 1:5000 and 1:25000 were provided in 1997.

Control of Internal Contamination of Medical Personnel working with the Radioactive Isotope Iodine I-131
(University Medical Centre, Ljubljana, Department of Nuclear Medicine, Ljubljana).

In medicine the radioactive isotope Iodine I-131 is used for treatment of certain thyroid diseases. The activity of I-131 applied to a patient depends mostly on the kind of thyroid disease, and ranges between 0.5 to 1.0 GBq. About 30% of the applied activity is eliminated from the organism by secretion in the first couple of days after application.

In the course of their work with the patients the medical personnel are exposed to certain amounts of radiation, in particular:
- to external radiation from radioactivity applied to the patients, and
- in certain hospital areas, to internal contamination by inhalation of air contaminated with I-131.

The external contamination of the workers that might be involved in contacts with the patients can be avoided by personal protection equipment; however, the external and internal radiation cannot be avoided completely.

At the University Medical Centre Ljubljana, Department of Nuclear Medicine, a whole body counter of radioactivity was installed in 1997, which enables control of the internal contamination rate of the whole human body.

In the scope of a study, commissioned and financed by the SNSA, the experts of the Department of Nuclear Medicine controlled the internal contamination of the personnel working with I-131. First, the cumulative activity of I-131 was measured by the whole body counter and then the received dose from inhalation of the radionuclide was estimated. It was found that the annual effective doses to the medical personnel due to contamination with I-131 are up to 0.72 mSv/year. In addition, based on measurements of the iodine concentrations in the working environment, the possible intake of iodine by inhalation was calculated and the received internal dose was estimated. According to this estimate the related dose to a person was 0.58 mSv/year. Both estimates are in excellent agreement and show that the contribution of the inhaled I-131 to the total dose to medical personnel is by no means negligible and should be added to the measurement results by personal TLD dosimeters. Considering that the doses received by workers from the external radiation are approx. 2-3 mSv/year, the internal dose accounts for approx. 25-30% of the present officially registered radiation dose. According to our regulations and requirements of the EU Directive (96/29/Euratom of 13 May 1996) the register of cumulative radiation doses to individual workers should be kept in the central register of doses. The results of the study undoubtedly confirm the justification of these requirements and imply that, in Slovenia, all workers involved with unsealed radiation sources should be controlled by the whole body counter in the future. At present this kind of practice holds only for the Krško NPP personnel.

Natural Radioactivity in Thermal Baths and Mineral Waters in Slovenia

Within the scope of the study, co-financed by the SNSA and conducted by the Institute for Occupational Safety of the RS, the measurements of concentrations of natural radionuclides in thermal baths and mineral waters in Slovenia were carried out. The concentrations of radionuclides ^{238}U (^{234}Th), ^{226}Ra, ^{210}Pb, ^{232}Th (^{228}Ra) and ^{40}K in 11 thermal baths, 8 mineral waters and in two bottled natural drinking waters were determined. In the latter the concentrations of ^{7}Be, which emerge in the air under influence of the cosmic rays and come into the water during the technological process by ventilation with the external air, were also determined.

Individual samples of 20-25 l water were steamed out and the activity of radionuclides was determined, using the gammaspectrometric method. The summary of results is given in the table below. In column 2 the derived limit value (IK) for an individual radionuclide is given, and in columns 3 and 4 the respective percentages of IK in samples of thermal waters and in samples of mineral waters.

Table 14.1: Results of the measurement of radionuclide concentrations (in percentage of IK) and related derived concentrations for drinking water (in Bq/m^3)

Radionuclide	Derived concentration (Bq/m^3)	Thermal waters range of values (in % of IK)	Mineral waters range of values (in % of IK)	Effective doses adults (mikroSv)
^{7}Be	40.10^6	-	0.000025-0.00075	do $0.05.10^{-3}$
^{40}K	$0.2.10^6$	0.05-2.5	0.01-0.75	0.03-1.6
^{210}Pb	$0.4.10^3$	1-5	2.5-12	1-6.4
^{226}Ra	$1.0.10^3$	1-60	1.5-13	0.5-7.6
^{232}Th (^{228}Ra)	$0.6.10^3$	2.5-55	0.8-19	0.2-4.7
^{238}U (^{234}Th)	10.10^3	0.05-0.25	0.1	0.09

The range of the values measured in table 14.1 refers only to waters offered to consumers; the results of samples taken directly from wells are left out.
The last column presents the results of the radiation doses received by consumers consuming bottled water on a daily basis. The dose conversion coefficients used for calculation are those from the most recent sources (IAEA Basic Safety Standards, 1996) and the calculation is performed for an adult with a daily consumption of 0.50 l. According to this estimate an individual member of the public receives an annual effective dose of 2 to 20 microsieverts by drinking mineral water. It should be noted, however, that the received dose of an adult citizen of Slovenia from other natural radiation sources is 2 to 3 mSv/year, which means that mineral waters contribute about 1% maximum to the said values.

Radon Concentrations in Thermal Baths in Slovenia

The study on radon and radon progeny concentrations in thermal baths in Slovenia was carried out by the RS Institute for Occupational Safety, Ljubljana. In conformity with the requirements of the most recent international standards in the field of radiological protection, the research was aimed at determining radon concentrations in the working environment, where an actual possibility for high concentrations existed. It is known that geothermal waters contribute as much as one fifth of all atmospheric inventory of radon. Therefore, the SNSA decided to financially support the project to enable estimation of received doses of radon by medical personnel in 12 thermal baths in Slovenia.
The programme involved measurements of radon concentrations in the water and in the air of the thermal baths, especially at places where the medical personnel spent most of their time. According to the international standards IAEA and directives of the European Union (Basic standards for radiation protection) and depending on the level of radon concentrations, such working places should be classified as working with ionizing sources and the workers should be included under regular dosimetric control.

The measurements indicated the state of concentrations in thermal waters in Slovenia, intended for therapy, and the survey of radon and its short-lived progeny concentrations in the air at the places used for medical purposes.

The radon in the water was mostly determined directly by the gammaspectormetric method, and radon and its short-lived progeny concentrations in the air by continuous radon monitors. The integral concentrations of radon were measured by passive detectors, i.e. by detectors of nuclear tracks and by charcoal absorbers.

The results are given in the table below (Table 14-2). In column 2 the cumulative results of radon concentrations in thermal waters are given separately for the collection pool, bathing pool and for various baths. In column 3 the range of values for radon concentrations in the air at the same places is given, and, by analogy, in column 4 also the concentrations of radon progeny are given. Based on these results the received dose by inhalation of radon for the medical personnel spending most of their working time in an area with increased radon concentrations can be estimated. It should be noted that there is no uniform methodology for estimation of doses in the specific environment of thermal baths (high humidity, high proportion of radon short-lived progeny not bound to the particles in the air) and, therefore, only the range of values from the four variant calculations in the study can be given.

The annual effective doses to medical personnel in most thermal baths (in 10 out of 12) is proportionally low, even below the prescribed limit value for an individual member of the public, i.e. 1 milisievert/year. The range of values per person ranges between 0.2 and 0.7 mSv/year. Dosimetric measurements prove that only in two thermal baths can the annual dose to a person reach from 1 to 4 mSv. Therefore, it is reasonable to continue systematical control for another year at least and, during this period, to monitor how long the medical personnel actually stay in the areas with increased radon concentrations; namely, the present estimate of doses is based on 1700-hours presence in these areas. The doses to the patients are at least by one order of magnitude lower than the above mentioned values.

Table 14.2: Radon concentrations in thermal water and in the air at places intended for medical purposes (in Bq/m^3)

Thermal bath area	**Radon in water**	**Radon in air (monthly aver.)**	**Radon progeny in air**	**Note**
Collection pool	4,100-35,000	3,500-4,000	Not controlled	No presence required
Bathing pool	4,000-10,000	10-170	10 maximum	-
Baths	4,500-60,000	15-240	3-110	Constant presence

15 AGENCY FOR RADWASTE MANAGEMENT (ARAO)

Two documents, crucial for long-term radwaste management, were adopted in 1996; these documents guided the work of the ARAO in 1997. They were: The Strategy for Spent Nuclear Fuel Management and The Decommissioning Plan for the Krško NPP. Both documents are to be reviewed and supplemented every three years.

The most important operational task of the ARAO is to construct the repository for low and intermediate level (LILW) radioactive waste. According to the present scenario, the site for the repository should be selected by the year 2002, and the repository constructed by the year 2005.

Additionally, according to the new Rules of Procedure adopted in 1997, one of the tasks of the ARAO is to provide public service in radioactive waste management, storing (except for radioactive waste from the Krško NPP and the Žirovski vrh Mine) and disposal (except for the Žirovski vrh Mine) in the Republic of Slovenia.

The working programme for 1997 followed the objectives and tasks from the above-mentioned documents, however, due to insufficient funding from the national budget its scope was substantially reduced. Because of the prolonged temporary funding and late passing of the 1997 national budget, the contracts with technical support organisations were also concluded relatively late. Consequently, quite a number of projects from the programme have not yet been finished, and will be concluded only in 1998.

For objective reasons the planned reconstruction of radwaste storage at Zavratec (phase 2) has not yet been carried out. There were, however, certain parallel activities, e.g. public relations activities. Special attention was given to the local communities at Zavratec and Dol-pri-Ljubljani. In 1996, the following remedial works were carried out in the temporary storage of radioactive waste at Zavratec: radioactivity measurements, categorisation and inventory of the wastes. The project of remediation will be finished when all wastes are stored with the required licenses issued in conformity with the valid regulation.

With the transformation of the ARAO into a public company, the responsibility for management of the interim LILW storage at Podgorica, situated in the territory of the local community Dol-pri-Ljubljani, will be transferred to the ARAO.

However, owing to certain circumstances, the transfer of the management function from the JSI to the ARAO has not yet been carried out. In the preparation framework for transfer of the management function a study has been prepared entitled: The Interim LILW Storage of RS - Legal Aspects of Transfer and the Future Relationship between JSI and ARAO. The call for tenders for the reorganisation (modernisation) project of the storage has so far been unsuccessful, therefore, the call for tender is to be re-issued in 1998.

The co-operation with local community representatives and local community members of Dol-pri-Ljubljani was multilevel. Among other things, the ARAO demonstrated to the Community Council members the progress of remedial action on the temporary radioactive waste storage at Zavratec.

The number of the ARAO personnel by the end of 1997 was 10, of whom 1 worker with a Ph.D. degree, 1 with an M.Sc. degree, 7 with B.Sc. degrees and 1 with a secondary school certificate.

Since January 1997, the ARAO homepage with an overall presentation of the ARAO has been available on Internet at the address: Http://www.sigov.si/arao/sarao.html.

Table 15.1: Studies and projects

TITLE	CONTRACTOR	BEGINNING	CONCLUSION OR STATUS
Siting of LILW Repository - Preliminary Hydrological Identification of Potentially Suitable Areas for LILW Repository	GZL - IGGG	February 1996	January 1998
Technology of Radwaste Disposal - Geotechnical Aspects of the LILW Repository Construction	IRGO	September 1996	November 1997
Research Programme for Determining the Endogenous Activity (Seismic Activity, Active Faults)	ZAG/GZL-IGGG	June 1996	June 1997
Siting of LILW Repository - Methodology for Implementation of Criteria and Ranking the Areas by Suitability	GZL - IGGG	December 1996	in review
A Comparative Law Survey of the Legislation in other Countries for Siting of LILW Repository by Tendering	Faculty of Law	November 1996	April 1997
Preparation of Procedure for LILW Repository Siting	IBE Ljubljana	December 1996	June 1997
Problem of Long-Lived LILW	IBE Ljubljana	June 1996	March 1997
Information Center Design	JSI-ICJT	December 1996	August 1997
Multimedia Presentation	VPK, d.o.o.	July 1996	January 1998
Folder "Transport of LILW and HLW"	JSI-ICJT	July 1996	October 1997
Book "Radioactive Waste - Through Knowledge Against Fear"	JSI-ICJT	December 1994	May 1997
Book "Radioactive Waste - Most Frequently Asked Questions and Answers"	JSI-ICJT	December 1995	September 1997
Exhibition and Lecture on Radwaste	JSI-ICJT		concluded
Siting of LILW Repository - Preliminary Hydrogeological Identification of Potentially Suitable Areas for LILW Disposal	GZL-IGGG	February 1996	January 1998

TITLE	CONTRACTOR	BEGINNING	CONCLUSION OR STATUS
Videofilm on Remediation of Repository at Zavratec	VPK, d.o.o.	July 1996	July 1997
Model of an Underground LILW Repository	A. Čarman	December 1996	April 1997
Interim LILW Storage of RS at Brinje - Legal Aspects of Transfer and Future Management	Faculty of Law	July 1997	September 1997
Raopis No. 4	ARAO	November 1996	January 1997
Siting of LILW Repository - Evaluation of Potential Geological Suitability for Underground Repository	GZL-IGGG	December 1997	in progress (June 1998)
Continuation of the project Siting of LILW Repository - Methodology of Criteria Implementation and Ranking of Areas	GZL-IGGG	December 1997	in progress (March 1998)
Siting of LILW Repository - Proposal for Inclusion of the Siting Procedure into Physical Planning	Institute of Physical Planning	November 1997	in progress (March 1998)
Analysis of Experience in Provisional Procedure for Siting LILW Repository - General and Geologic Part, Socio-legal Aspects, Economic, Water-engineering Criteria, Endogenous Processes and Terrain Stability, Economic Feasibility and Stability of Concrete Barriers	Institute of Ecology, Faculty of Biotechnics, Institute of Physical Planning, IGGG-GZL, ZAG, IBE Ljubljana	December 1997	in progress (April 1998)
Chemical and Physical Processes in LILW Repository	ZAG	September 1997	in progress (February 1998)
Time-dependence of Spent Fuel and LILW	JSI	October 1997	in progress (February 1998)
Chemical and Physical Processes in LILW Repository - Impact on Radionuclides Migration	JSI	September 1997	in progress (February 1998)
Use of Plasma Sources of Ions and Ion Tracks in the LILW Repository Area; Phase I	JSI	July 1997	January 1998
Workshop "Preparation of Procedure for Siting of LILW Repository"	ARAO	September 1997	October 1997
Folders "LILW and HLW Repositories"	JSI-ICJT	November, December 1997	in progress
Book "Radioactive waste - A Guide for Reporters"	JSI-ICJT	November 1995	in progress
Exhibition and Lecture on Radioactive Waste at the ICJT	JSI-ICJT	5 July	concluded
Raopis No. 5	ARAO	January 1997	April 1997
Raopis No. 6	ARAO	April 1997	November 1997
Public Opinion Research	Pristop, d.o.o.	September 1997	October 1997

In September 1997, the ARAO organised a workshop, in which experts from various environmental and sociological fields participated; the purpose was to determine the most suitable procedure for siting of the radioactive waste repository in our country.

In the majority opinion, the decision-making on the management of LILW and its disposal is not adequately supported by political bodies (Government, National Assembly), although a repository is definitely indispensable in Slovenia. All the same, the participants supported the ARAO proposal to renew the process for the siting of the LILW repository based on a new, integral approach. They also suggested a thorough analysis of reasons for failure of the discontinued LILW siting process in 1993, in order to avoid the same mistakes. At the same time, it is necessary to prepare information on the funds spent, as the public is likely to require such information.

The inter-dependence of different factors (type of repository, public participation in decision-making, compensations and tax relief, safety assessment, funding, etc.) requires an integral approach to the procedure; after decision on the technical component of the procedure, an agreement on the very principle for solving the repository problem at the national level should be reached.

The final document of the workshop is public and the ARAO will send it to the competent ministries, the National Assembly and the National Council.

More information on the ARAO is available in its 1997 Annual Report.

16 THE MILAN ČOPIČ NUCLEAR TRAINING CENTRE

The primary concern of the Milan Čopič Nuclear Training Centre (ICJT) is the training of personnel in nuclear technologies and ionizing radiation and providing public information on these activities. The main areas of activity of the Centre are: training of the Krško NPP personnel, training in the field of radiological protection, organisation of international courses and meetings in the field, and public information.

In 1997, the ICJT continued its work in all main areas of activity.

The primary concern of the ICJT activities is training of the Krško NPP personnel. In 1997, they organised two shorter courses entitled Basis of Nuclear Power Plant (NPP) Technology for the Krško NPP technical personnel. One of them was also offered to other institutions working for the Krško NPP. They also organised four operator refresher courses.

In the field of radiological protection, they carried out altogether 5 courses for medical personnel, for workers on the industrial application of ionizing radiation, and for the JSI personnel in 1997.

The year 1997 brought important developments in the organisation of international courses. The IAEA organised eight courses at the Centre. The majority were one-week courses; one course lasted two weeks, and the major course three months. In addition, the European Commission organised its first course at the Centre. The interest in organising meetings at the Centre confirms its vision and orientation to become an internationally recognised training center.

In the field of public information they continued to invite primary and high schools; the students came regularly and in great numbers to hear lectures on nuclear technology and radioactive waste and to visit the permanent exhibition. In the school year 1996/97 they had altogether 6717 visiting students.

A feasibility study, commissioned by ARAO, was carried out on the nuclear technology information centre at the Milan Čopič Nuclear Training Centre.

Table 16.1: Courses in 1997

Date	TITLE	No. of Participants	No. of Lecturers	No. of Weeks	Participant - weeks
02.12.96-17.01.97	Basis of NPP Technology - Systems	16	14	5	80
13.01.-07.02.97	Basis of NPP Technology - Theory, OTJE 1/97	14	8	4	56

Date	TITLE	No. of Participants	No. of Lecturers	No. of Weeks	Participant - weeks
03.02.- 06.02.97	Nuclear technology, Refresher Course	7	2	1	7
17.03.- 26.03.97	Nuclear Power Plant Technology, Refresher Course	8	3	1	8
01.04.- 28.04.97	Basis of NPP Technology - Systems, OTJE 1/97	12	7	4	48
07.04.- 27.06.97	IAEA Interregional Training Course on Nuclear Instrumentation Maintenance	21	7	12	252
07.05.- 09.05.97	Radiological Protection for Open Sources of Ionizing Radiation	20	6	0.6	12
13.05.- 16.05.97	Exercises in Radiophysics and Radiological Protection for Medical School	36	1	0.8	28.8
20.05.- 22.05.97	Radiological Protection for Industrial Sources of Ionizing Radiation	5	4	0.6	3
16.6.- 20.6.97	IAEA Regional Training Course on Inspection Techniques	19	6	1	19
16.06.- 16.06.97	Radiological Protection for Workers in Postojna cave	47	3	0.2	9.4
23.06.- 26.06.97	IAEA Technical Committee on Safety Related Diagnostics and Early Failure Detection Systems	22		0.8	17.6
23.06.- 26.06.97	IAEA Workshop on Regulatory Assessment of the Safety Report for SG Replacement at the Krško NPP	32	7	0.8	25.6
30.06.- 11.07.97	IAEA Regional Training Workshop on Guidance on Developing an Effective Emergency Capability and Plan for Nuclear or Radiation Accidents	39	8	2	78
01.09.- 19.09.97	Basis of NPP Technology - Theory	16	8	3	48
08.09.- 12.09.97	General Operating Procedures and Emergency Operating Procedures	3	1	1	3
15.09.- 19.09.97	IAEA Regional Workshop on Safety Analysis of Plant Modifications	15	10	1	15
22.09.- 17.10.97	Basis of NPP Technology - Systems	16	7	4	64
29.09.- 03.10.97	EU Training Course on Off-site Emergency Planning and Response for Nuclear Accidents	25	13	1	25
06.10.- 10.10.97	IAEA/USA Training Course on Risk Based Optimization of NPP Operation	20	7	1	20
20.10.- 05.11.97	Word97 in ICJT	10	1	1	10
27.10.-	IAEA Regional Workshop on Review of				

Date	TITLE	No. of Participants	No. of Lecturers	No. of Weeks	Participant - weeks
31.10.97	Accident Analysis for Emergency Operating Procedures and Accident Management Guidelines	17	7	1	17
03.11.-06.11.97	General Operating Procedures and Emergency Operating Procedures	2	1	0.8	1.6
10.11.-14.11.97	Nuclear Power Plant Technology, Refresher Course	5	2	1	5
24.11.-24.11.97	Demonstration of Simulator Capabilities	4	2	0.2	0.8
24.11.-03.12.97	Nuclear Power Plant Technology, Refresher Course	7	3	1.6	11.2
4.12.-4.12.97	Demonstration of Simulator Capabilities	4	2	0.2	0.8
15.12.-19.12.97	General Operating Procedures and Emergency Operating Procedures	3	1	1	3
16:12.-18.12.97	Radiological Protection for Open Sources of Ionizing radiation	23	6	0.6	13.8
	Total	468	86	52.2	882.6

Below is a summary of all courses organised by the ICJT by number of participants and lecturers in years noted.

Table 16.2: Summary of courses

Year	No. of Courses	No. of Participants	No. of Lecturers	No. of Weeks	Participant - weeks
1975	1	15	5	18	270
1976	1	22	5	21	462
1978	1	12	5	23	276
1982	1	16	5	35	560
1983	1	30	5	4	120
1984	1	22	5	2	44
1985	2	32	12	28	404
1986	3	56	32	6	129
1987	3	38	31	14	173

Year	No. of Courses	No. of Participants	No. of Lecturers	No. of Weeks	Participant - weeks
1988	1	19	9	2	38
1989	2	38	29	43	814
1990	8	147	54	26	435
1991	6	89	65	61	921
1992	6	89	32	21	258
1993	5	99	51	42	625
1994	12	210	73	396	531
1995	31	695	173	692	11748
1996	19	306	108	564	9814
1997	28	452	133	472	8026
1998	10	96	54	294	456
Total:	142	2483	886	5878	94748

17 INSURANCE AND REINSURANCE OF LIABILITY FOR NUCLEAR DAMAGE - POOL

Until the declaration of independence by Slovenia and Croatia the Krško NPP was insured at the then Yugoslav Nuclear Pool, Zagreb. After Slovenia and Croatia became independent states, the Slovenian nuclear insurance and reinsurance pool and the Croatian nuclear pool agreed to co-insure the Krško NPP in equal shares of 50% in order to retain a good business relationship. For the period from 6 May 1997 to 5 May 1998, both pools issued insurance policies covering nuclear, fire and other risks to the property of the Krško NPP, with a total annual limit of 800 million USD. Both pools have a 2% joint share in the Krško NPP, the remaining share is reinsured by 22 foreign pools, of which the British, the German, the US and the French pools have major shares. The Krško NPP liability for damage to third persons is insured only by the Slovenian nuclear pool with an annual limit of 5 million USD. Slovenia's own share of the pool is 3%, the remaining share is reinsured by 19 foreign pools, of which the British, the German, the US and the French pool have major shares. By the Act on Insurance of Liability for Nuclear Damage (Off.Gaz. SRS, 2/88, 6/89, 6/90 and Off.Gaz. RS, 43/90 and 22/91) a limit of 5 million USD in SIT (Slovenian tolars) countervalue has been established. The liability amount is based on the 1963 Vienna Convention on Civil Liability for Nuclear Damage; however, it is expected that the liability amount will increase significantly in the coming years, but this fact should not cause any insurance problem.

It is noteworthy that, up to the end of 1997, the Krško NPP did not report any damage to the Nuclear pool GIZ.

18 POOL FOR DECOMMISSIONING OF THE KRŠKO NPP AND FOR RADWASTE DISPOSAL FROM THE KRŠKO NPP

The Pool was established in conformity with the "Act on Pool for Decommissioning of the Krško NPP and for Radwaste Disposal from the Krško NPP" (Off. Gaz. RS, No. 75/94; in force from 17 December 1994; hereinafter called "the Act") with the purpose of raising funds for the decommissioning of the Krško NPP, and for storage and permanent disposal of low and intermediate level radioactive waste and spent fuel from the Krško NPP.

The Act provides that the funds for the Pool are to be secured from a portion of the price per kWh of electrical energy supplied to Slovenia and Croatia. The calculated amount is to be determined by the programme to be adopted by the Government of the Republic of Slovenia; pending the adoption of the programme, the calculated amount is 0.61 SIT/kWh. According to the Act the Government has to prepare the programme for decommissioning of the Krško NPP with variant solutions, including the estimate of the funds required and the time schedule.

On 28 July 1995, the Ministry of Economic Affairs issued an Instruction on Methodology of Calculation and Payments of Contributions to the "Fund", based on a binding interpretation of Article 4 of the Act providing that the Krško NPP is a legally responsible entity for payments into the fund. On 27 June 1996, the National Assembly adopted the binding interpretation of Article 4 of the Act laying down that the funds for the Pool raised on the price per kWh basis were to be set apart as an obligatory contribution, and, from the day on which the Act came into force, brought into account and paid to the Pool by the Krško NPP.

On 12 September 1997, the Government of the Republic of Slovenia approved the Programme for Decommissioning of the Krško NPP, and assessed that the reasonable basis for raising the required financial resources would be the intermediate scenario at 0.462 SIT/kWh. This scenario includes: temporary storage and double repositories, and a revision of the programme for decommissioning every three to five years, taking into account all data necessary to include new knowledges and practices, which all together would represent a basis for a revision of the amount required.

Due to outstanding payments of the Krško NPP to the Pool on 31 December 1996, the Pool instituted proceedings against the Krško NPP before the Krško district court. The proceedings ended on 12 May 1997 with an out-of-court arrangement in which the Krško NPP committed itself to paying, as of 1 January 1997, on the outstanding 1996 liabilities to the Pool the amount of 0.61 SIT/kWh until the outstanding amount of 6,581,943 SIT was settled. The rough estimate for settlement of the liabilities is 12 years.

In the following months of 1997, the Krško NPP paid to the Pool the amounts from the produced electrical energy supplied to the ELES on the respective maturity dates. The statement of account was prepared also for the Croatian co-owner; however, Croatia does not acknowledge the abovementioned methodology of raising funds from the per kWh price and, consequently, does not pay its share. Furthermore, Croatia has not yet given any guarantees to ensure its share of costs for decommissioning and radwaste disposal.

On 31 December 1997, the active assets of the Pool amounted to 898,778,210 SIT; the long-term receivables totalled 8,645,093,587 SIT, of which the Slovenian debt was 3,796,438,124 SIT and the respective Croatian debt 4,848,655,463 SIT.

The free resources of the Pool will mainly be invested in first-class securities and deposits. The aim of this investment policy is to maintain the real value of investments and profitability. Of the three financial principles directing the Pool operation - the principles of safety, liquidity and profitability - the principle of safety has top priority.

19 OPERATION OF NUCLEAR FACILITIES WORLD-WIDE

19.1 REVIEW OF NUCLEAR POWER PLANTS WORLD-WIDE

According to the information provided by the International Atomic Energy Agency, at the end of 1997, there were 437 nuclear power plants in operation in 31 countries and in Taiwan. The number decreased by five in comparison with 1996; however, the overall nuclear capacity slightly increased, from 350,964 MW to 351,795 MW. Some older and smaller nuclear power plants were shut down. In 1997, there were three new nuclear power plants connected to the grid with a total power of 3555 MW, two in France and one in the Republic of Korea. At present, 36 nuclear power plants are under construction in 14 countries.

In 1997, the share of electrical energy supplied from nuclear power plants was still considerably high in ten countries: Lithuania 81.5%, France 78.2%, Belgium 60.1%, Ukraine 46.8%, Sweden 46.2%, Bulgaria 45.4%, Slovak Republic 44%, Switzerland 40.6%, and in Hungary and Slovenia a little below 40%. Slovenia with 39.9% share of produced electrical energy ranks in 9th place. In general, there are 17 countries world-wide and Taiwan, which rely 25% or more of their needs upon electrical energy produced from nuclear power plants. In 1997, the share of electricity supplied by nuclear reactors world-wide was about 17%.

Table 19.1: Country-by-country figure for the number of nuclear power units in operation and under construction and the end of 1997, total nuclear output and nuclear share in total electricity (NucNet News No. 170/98, 8 May 1998).

COUNTRY	REACTORS		OUTPUT	
	Operation	Construction	TWh	% Share
Argentina	2	1	7.45	11.40
Armenia	1		1.43	25.67
Belgium	7		45.10	60.05
Brazil	1	1	3.16	1.09
Bulgaria	6		16.44	45.38
Canada	16		77.86	14.16
China	3	4	11.35	0.79
Czech Rep.	4	2	12.49	19.34
Finland	4		20.00	30.40

France	59	1	376.00	78.17
Germany	20		161.40	31.76
Hungary	4		13.97	39.88
India	10	4	8.72	2.32
Iran		2		
Japan	54	1	318.10	35.22
Kazakhstan	1		0.30	0.58
South Korea	12	6	73.19	34.08
Lithuania	2		10.85	81.47
Mexico	2		10.46	6.48
Netherlands	1		2.30	2.77
Pakistan	1	1	0.37	0.65
Romania	1	1	5.40	9.67
Russia	29	4	99.68	13.63
South Africa	2		12.63	6.51
Slovak Rep.	4	4	10.80	43.99
Slovenia	1		4.79	39.91
Spain	9		53.10	29.34
Sweden	12		67.00	46.24
Switzerland	5		23.97	40.57
UK	35		89.30	27.45
Ukraine	16	4	74.61	46.84
USA	107		629.42	20.14
Total*	**437**	**36**	**2276.49**	

* Total includes Taiwan: six units, nuclear share 26.35%.

19.2 NUCLEAR SAFETY WORLD-WIDE

19.2.1 IAEA Missions

Table 19.2. IAEA international missions - International Peer Review Service (IPERS) on Probabilistic Safety Analysis Reviews in 1997

REVIEW TYPE	COUNTRY	PLANT
Main review	Republic of Korea	Ulchin 3 and 4
Main review	Australia	HIFAR research reactor
Main review	Bulgaria	Kozloduy
Main review	Slovenia	Krško

Table 19.3: Engineering Safety Review Services (ESRS) related to site and external hazards in 1997

COUNTRY	SITE/PLANT	SERVICE
Armenia	Medzamor	(1) Finalization of terms of reference for seismic upgrading (2) Review of seismic capacity and upgrading (3) Review of seismic instrumentation
Bulgaria	Belene WWER-1000	Final review of seismic input
China	Lianyungang WWER-100	Workshop on seismic safety of WWER type nuclear power plants
Cuba	Juragua WWER	Workshop on seismic safety of WWER type nuclear power plants
Egypt	22 MW MPR res. reactor	Seismic safety review (from PSAR)
Indonesia	Muria	(1) Final review of volcanic hazard (2) Review of geological, seismic and geotechnical aspects
Kazakhstan	10 MW Alatau research reactor	Seismic safety reviews
Korea, Rep.of	Ulchin, units 3 and 4 PWR	Review of external event PSA
Morocco	Prototype 10 MW desalination plant Tantan	Site survey reviews
Romania	Cernavoda PHWR	External event PSA workshop

Table 19.4: Operational Safety Review Team (OSART) missions in 1997

TYPE	COUNTRY	LOCATION/NUCLEAR POWER PLANT	PLANT TYPE
O	China	Qinshan-1	PWR 300 MW(e)
O	Mexico	Laguna Verde	BWR 675 MW(e)
O	Rep. of Korea	Yonggwang 1 and 2	PWR 950 MW(e)
O	Argentina	Embalse	PHWR 650 MW(e)
FU	Lithuania	Ignalina	RBMK 1300 MW(e)
TV	Russian Federation	Novovoronezh-5	WWER 1000 MW(e)
T	Kazakhstan	BN-350	FBR 90 MW(e)
T	China	Qinshan; Daya Bay	PWR 300 MW(e); 944 MW(e)

Type O - OSART mission, **Type FU** - OSART follow-up visit, **T** - technical exchange mission, **TV** - technical visit.

Table 19.5: Assessment of Safety Significant Events Team (ASSET) services in 1997

TYPE	COUNTRY	LOCATION/NUCLEAR POWER PLANT
S	Russian Federation	Balakovo
Z	Russian Federation	Smolensk
S	Ukraine	Rovno
S	Bulgaria	Kozloduy
S	Romania	Cernavoda
Z	Russian Federation	Balakovo
Z	Ukraine	Rovno
S	Sweden	Ringhals
S	Kazakhstan	Aktau BN-350
Z	Bulgaria	Kozloduy

Type S - ASSET seminar; **Type Z** - peer review of self-assessment of plant operational event

Table 19.6: Incident Reporting System for Research Reactors (INSARR) in 1997

COUNTRY	SITE/PLANT
Ghana	GHARR-1
Malaysia	Triga Puspati (RTP)
Peru	RP-10
Thailand	TRR-1/M1

Table 19.7: International Regulatory Review Team (IRRT) missions in 1997

MISSION TYPE	COUNTRY
Main review	Bulgaria
Pre-review	Pakistan

Source: The Annual Report for 1997, IAEA, GOV/1988/16, 24 April 1998

19.2.2 PROGRAMMES OF THE INTERNATIONAL AGENCY FOR ATOMIC ENERGY

The programmes of the International Agency for Atomic Energy are focused on the use of nuclear energy for peaceful purposes as indicated in Table 19.8. Most of the funds are allocated to food production in agriculture for disease prevention and health care and for location and protection of water sources.

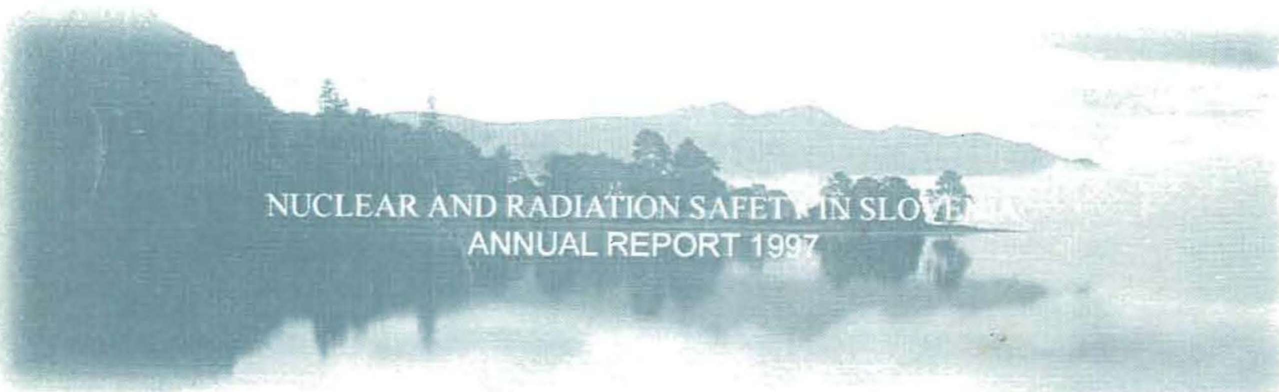
Table 19.8.: TECHNICAL CO-OPERATION DISBURSEMENTS BY AGENCY PROGRAMME IN 1997 (in thousands of dollars)

Programme	**Total**
Nuclear power	33810
Nuclear fuel cycle and waste technology	28637
Comparative assessment of energy sources	512
Food and agriculture	124252
Human health	121697
Marine environment, water resources and industry	80747
Physical and chemical sciences.	73200
Nuclear safety	24061
Radiation safety	68436
Radioactive waste safety	4756
Co-ordination of safety activities	9563
Safeguards	550
Security of material	668
Management of technical co-opèration for development	30456
Policy making, co-ordination and support	6507
Total	**605039**

ABBREVIATIONS

ALARA	As Low As Reasonable Achievable
ARAO	Agency for Radwaste Management
ATWS	Anticipated Transient Without Scram
BNCT	Boron Neutron Capture Therapy
BSS	Basic Safety Standard
CEEC	Central and East European Countries
CONCERT	Concentration on European regulatory Tasks
CROSS	Central Radiation Early Warning System of Slovenia
CTBT	Comprehensive Nuclear-test-ban Treaty
CVCS	Chemical Volume Control System
CVD	Cerenkov Viewing Device
CW	Circulation Water
DBE	Dehtsche Gesellschaft zum Bau und Betreib von Endlagen fuer Abfallstoffe mbH
DFBN	Debris Filter Bottom Nozzle
DG IA	Directorate General IA
DG XI	Directorate General XI
ECT	Eddy Current Testing
ELMU	Ecological Laboratory with Mobile Unit
EP	Emergency Plan
ERDS	Emergency Response Data System
FAGG	Faculty of Civil Engineering and Geodesy
FER	Faculty of Electrical Engineering and Computer Science
FIS	Flow Indicator Switch
FRI	Fuel Reliability Data Indicator
FS	Faculty of Mechanical Engineering
HD	Heater Drain
HIRS	Health Inspectorate of the Republic of Slovenia
HMZ	Hydrometeorological Institute
IAEA	International Atomic Energy Agency
ICISA	International Commission for Independent Safety Assessment
ICJT	Milan Čopič Nuclear Training Centre
IDDS	In-Drum Drying System
IE	Initiating Event
IGGG	Institute of Geology, Geotechnics and Geophysics
IMK	Institute of Metal Constructions
INES	International Nuclear Event Scale
INEX	International Nuclear Exercise
IO	Institute of Oncology
IPERS	International Peer Review Service
IPPAS	International Physical Protection Advisory Service
ISEG	Independent Safety Evaluation Group
ISI	Inservice Inspection
ISO	International Standard Organization
ISOE	International System on Occupational Exposure

IV	Welding Institute
JSI	Jožef Stefan Institute
Krško NPP	Krško Nuclear Power Plant
LILW	Low and Intermediate Level Radwaste
MCB	Main Control Board
MSIV	Main Steam Isolation Valve
MTC	Moderator Temperature Coefficient
NEK-STS	Krško NPP Standard Technical Specifications
NFPA	National Fire Protection Agency
NIS	Newly Independent States
OECD/NEA	Operation for Economic Co-operation and Development/Nuclear Energy Agency
OTJE	Basis of Nuclear Power Plant (NPP) Technology
OSART	Operational Safety Assessment Review Team
PHARE	Central and Eastern European Countries Assistance for Economic Restructuring
PIS	Process Information System
PSR	Periodic Safety Reviw
RAMG	Regulatory Assistance Management Group
RB	Reactor Building
RCP	Reactor Coolant Pump
RS	Republik of Slovenia
RTD	Resistance Thermal Detector
SFAT	Spent Fuel Attribute Tester
SG	Steam Generator
SKI	Swedish Nuclear Power Inspectorate
SNSA	Slovenian Nuclear Safety Administration
SSPS	Solid State Protection System
TLD	Thermoluminescent personal dosimeters
TTC	Tube Type Container
US-DOE	United States Department of Energy
UT	Ultrasonic Testing
WBC	Whole Body Counter
WHO	World Health Organization
ŽVM	Žirovski vrh Mine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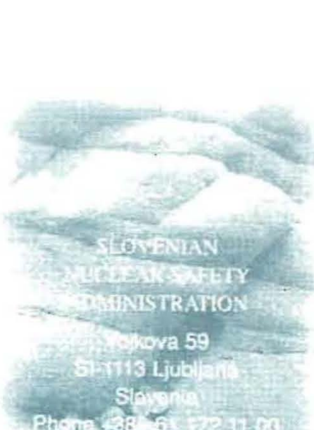
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