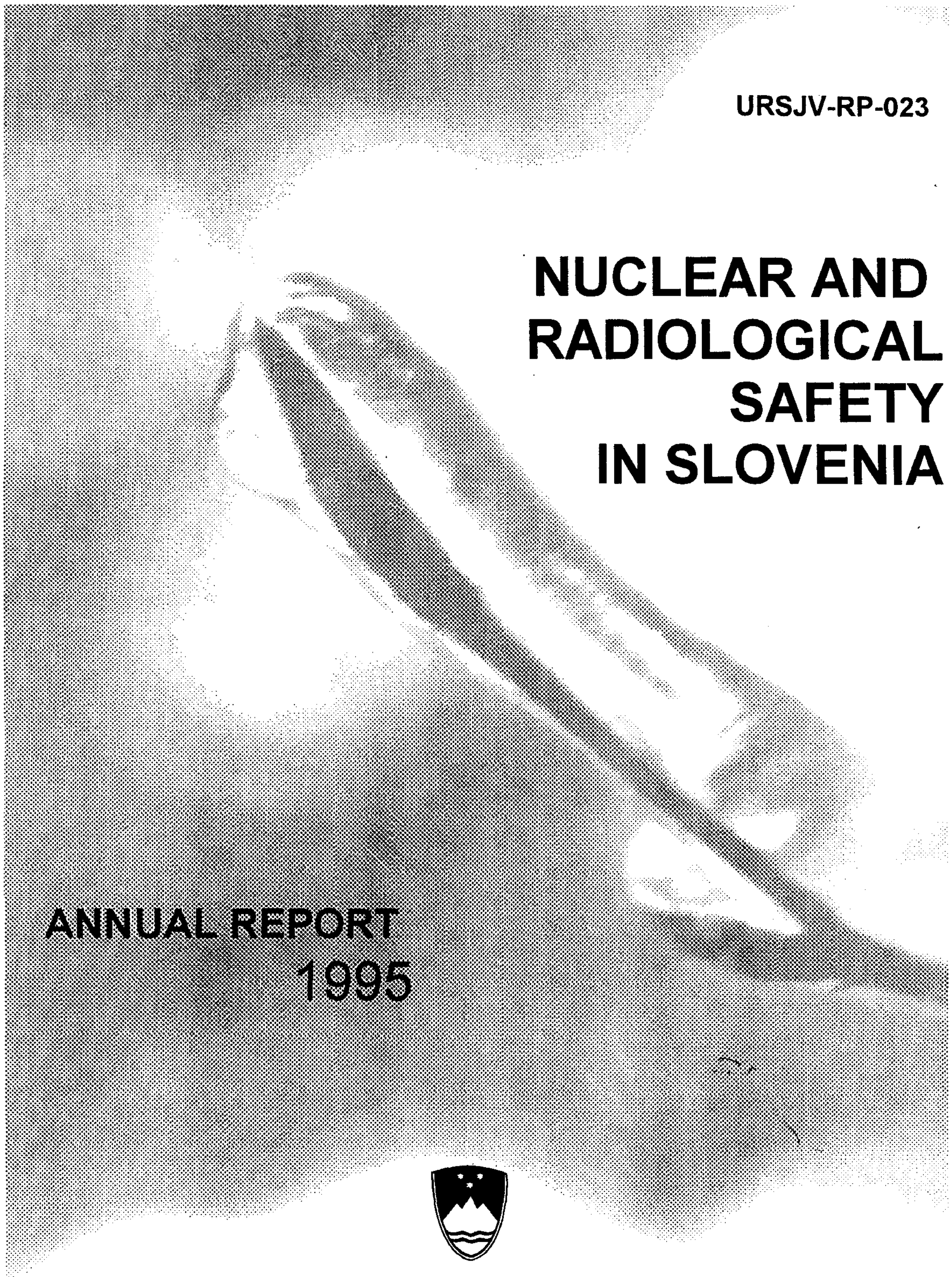
URSJV-RP-023

NUCLEAR AND RADIOLOGICAL SAFETY IN SLOVENIA



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Republic of Slovenia
Ministry of Environment and Physical Planning

SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

URSJV-RP-023

NUCLEAR AND RADIOLOGICAL SAFETY IN SLOVENIA IN 1995

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SUMMARY

The Slovenian Nuclear Safety Administration (SNSA), in cooperation with the Health Inspectorate of the Republic of Slovenia and the Administration for Rescue and Disaster Relief (URSZR) has prepared a Report on Nuclear and Radiological Safety in the Republic of Slovenia for 1995. The report is presenting: the activities of the SNSA; the operation of nuclear facilities; monitoring of radioactivity; control of ionizing radiation and nuclear electricity generation.

In the field of legislation, the Administration continued with the preparation of the new Slovenian legislation (the new law on nuclear and radiological safety, and the new law on liability for nuclear damage). At the international level a great number of activities were carried out, which will certainly influence the further preparation of Slovenian legislation.

In the year 1995, the SNSA significantly expanded its international activities. It participated in negotiations with the neighboring countries on the agreement between the Republic of Slovenia, the Republic of Austria and the Republic of Hungary for the early exchange of information in the event of a radiological emergency. In 1995 the Governments of the Republic of Slovenia and Canada signed an agreement on the peaceful uses of nuclear energy. The ratification is in progress.

The cooperation between the SNSA and the International Atomic Energy Agency was very intensive. The SNSA staff and other Slovenian experts participated in a number of meetings and in the preparation of IAEA documents.The cooperation between the SNSA and the IAEA was also active in the technical assistance and cooperation programme and in the safeguards.

In the scope of its regulatory function, the SNSA issued 21 administrative decisions applying to the Krško Nuclear Power Plant.

In 1995, the inspectors of the SNSA carried out 81 regular inspections, five extraordinary inspections and 11 joint inspections of the Krško NPP. In addition, there were three inspections of the TRIGA research reactor and one regular inspection of the Žirovski Vrh Mine.

The wastes generated in the Podgorica Reactor Center, industry and hospitals are stored in a provisional radioactive waste storage in accordance with the legislation. The records are correctly and consistently kept.

The safeguarding of nuclear materials, pursuant to the NPT was carried out on the basis of the existing legislation and international agreements. No anomalies have been recorded.

The training of the SNSA personnel is a very important activity. Particular attention is given to training in the rapidly developing information technology. The SNSA has obtained possibility to receive and to process the data needed in real time, and has modern computer programmes for safety assessments, which are available to all workers. Training and education in the field of nuclear and radiological safety are substantially supported by the SNSA.

Provision of open and authentic information forwarded 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 the citizens through press conferences, public statements, media discussions and active participation in domestic and international meetings, symposia and congresses.

While the consumption of electricity increased in Slovenia in 1995, the domestic electric power generation was lower than in 1994.The share of electric energy produced in the nuclear power plant increased by approximately 2.5%. The availability factor of NPP Krško was approximately 87%. The number of forced shutdowns slightly exceeded the average of the recent years. The number of unusual events also increased. Faults and equipment damages which caused shutdowns and other events, occurred because of external reasons (total loss of grid power) and human errors (containment spray activation, radioactive emissions).

In recent years the reliability of the nuclear fuel used in NPP Krško has been decreasing. The indicators of fuel damage show that on

completion of the 11th fuel cycle, during the '95 outage, not all damaged fuel elements were removed. The increased number of fuel damages was noticed also in the 12th fuel cycle causing increase in primary coolant contamination. Unless this problem is solved, fuel damages could limit the production of the plant.

Due to longer fuel cycles, the capacity of the spent fuel pool is utilized more slowly than foreseen in the design of the NPP. According to analysis, the capacity of the spent fuel pool will be sufficient for the storage of used fuel elements until the year 2004.

In 1995, 881 drums were filled with low and medium radioactive wastes. Since the beginning of the NPP operation, 10541 drums or 2108 m^3 of radioactive waste had been accumulated. The supercompaction of drums enables more efficient storage of waste. During the last compaction, the volume of waste was reduced to less than 1900 m^3. In addition, NPP Krško is introducing a system for volume decrease of fluid radioactive wastes, which cannot be supercompacted.

In 1995 the average individual effective annual dose of ionizing radiation for the 850 workers at NPP Krško was 1.65 mSv. This is approximately 3% of the prescribed limit rate for radiation workers and approximately 8% of the dose limit recommended in new documents of the International Commission for Radiation Protection (ICRP).

The degradation of steam generators requires, plugging of failed tubes. The plugging is approaching the limit of 18%, which, according to safety analysis, is the limit above which reduction of power is necessary.

In 1995, about thirty modifications in equipment and systems were made in the power plant.

Environmental impact monitoring of NPP Krško was performed in accordance with to the established programme. On the basis of measurements of emissions and environmental radioactivity concentrations, the contribution of NPP Krško, in 1995, to the effective reference-man dose in the surrounding of the power plant was assessed at less than 20 microSieverts. The additional dose represents less than 10% of the prescribed limit and less than 1% of the dose received by an individual from natural or other artificial sources of radiation.

The monitoring of non-radioactive NPP impacts on the quality of the Sava river and ground water has shown no negative effect from the operation of NPP Krško.

In 1995, the 250-kW thermal power research reactor TRIGA produced 337 MWh of heat. Seven unplanned shutdowns occurred - two because of a voltage cutout and five because of a defect in a control system.

In spite of permanent storing of additional radioactive waste in 1995, the total activity of the waste in the Podgorica temporary storage of radioactive waste decreased because of the decay of short-lived radio nuclides. Neither the research reactor nor storage represents a perceptible additional radiological impact on the environment. Radioactive releases from the Podgorica research reactor in 1995 were approximately equal to those in the years of 1991, 1992, 1993, and 1994, when they reached their lowest value in the entire period of operation. The effective dose to the individual living in the surroundings of the reactor center in 1995 was estimated on the basis of the measured emissions to be one microsievert. Therefore, the radio-ecological impact from the Podgorica reactor center is negligible.

The funds assigned, from the national budget for financing the programme of closure of the uranium mine were not sufficient to carry out the majority of activities in the 1995 programme. Only urgent activities were performed. Radioactive measurements at the Žirovski Vrh Mine and its surroundings show that the cessation of the uranium ore exploitation just partly reduced the impact of the mine to the environment even five years after the shutdown. No essential changes are expected until the whole uranium complex site is remediated. The emission of radionuclides with liquid effluents and the annual discharge of radon from the pit and tailing at Boršt were significantly reduced in 1995. The radiation exposure of 0.37 milisievert by people living in the monitored region is similar to the values measured during the last years of the Žirovski Vrh Mine operation. The effective dose to an adult is about one third of the primary limit dose (one milisievert per year), prescribed by Act (Off. Gaz. SFRY, No. 31/87) and the latest international recommendations (ICRP 60, 1991). Compared with the total exposure of an individual in the region due to natural radiation (around 5.5 milisieverts per year) the contribution from the Žirovski Vrh Mine represents 7% of additional exposure. At the invitation of the SNSA in 1995, an IAEA expert mission reviewed the decommissioning documentation and studies on closure of the uranium mine. The mission's report provided useful recommendations to the Government of Slovenia.

The radioactive waste originating from the accident at the Oncological institute in 1961, with a spill of 10 mg of Ra-226, is temporarily stored near the village Zavratec in an old caserne. Due to limited financial funds, the Agency for Radwaste Management in 1995 performed only repacking and classification of the waste at Zavratec.

The Agency for Radwaste Management is intensively working on the siting of a L/ILW repository. After the first campaign, all identified possible locations for a surface repository were rejected due to lack of public acceptance. A study entitled "Recommendations to Find the Most Appropriate Locations for the Repository" is being prepared. The study will provide recommendations for a new programme for finding technically, economically and socially acceptable locations for all types of repositories.

In 1995, three international nuclear safety expert missions visited Slovenia. Although they unanimously concluded that nuclear safety in Slovenia is ensured, they provided reports with 252 recommendations and suggestions. By the end of 1995, 90% of their recommendations and suggestions were implemented.

The URSZR has the authority to assess the situation in the case of a nuclear accident in Slovenia, to elaborate the national plan for protection and rescue and to take measures in the case of an emergency on national level, offsite the NPP. The SNSA emergency plan regulates the manner of alarming procedures and the organizing of operative measures in the event of an emergency, as well as prevention procedures against possible radiological consequences on the environment and population. NPP Krško is responsible for the preparation of its own plan for measures in the event of an emergency and for the technical and organizational execution of the plan. In 1995, the NEK-95 exercise was held as part of training for the case of emergency situations. It was confirmed that the majority of procedures were applicable, but that all the procedures should be reviewed.

The results of radioactivity monitoring (a general national monitoring programme) in air, soil, precipitations, surface waters, food and drinking water show no essential changes in the concentration of artificial radionuclides compared to the years 1992, 1993 and 1994. The assessed mean doses of an individual due to intake of radionuclides (originating from general contamination and the contamination from the Chernobyl accident) are far below the prescribed limits. The annual doses due to inhalation and ingestion of natural radionuclides, as well as the annual doses from external gama radiation are not significantly different from the average values worldwide. The regular radioactivity monitoring in the environment of NPP Krško, the Podgorica research reactor and the former Žirovski Vrh Uranium Mine are currently in progress. The review of radiation exposure in Slovenia is supplemented by other investigations. Potential radiological impacts were studied in some environments. In Velenje, the ash dump site has a relatively small and manageable impact on the environment. The measurements of radioactive elements and some other pollutants in the sea do not show any significant changes in concentrations of individual radionuclides and metals in the sea water and organisms. Iodine in surface waters, originating from hospitals, was still found in high concentrations,higher in fact than to the contribution from the Krško NPP. The measurements of drinking and mineral waters do not show any enhanced concentrations of radio nuclides. The high concentrations of radon were found in some primary schools in the area around Škofja Loka. One of these schools is proposed to be urgently remediated. Unusually high concentrations of radon were detected in the open air in the town of Kočevje. The measured concentrations were twice as high as certain concentrations in the area of the former uranium mining site at Žirovski Vrh. The mean value of the assessed doses received by miners at the Mežica lead and zinc mine shows that they are the most exposed radiation workers in Slovenia. After the completion of the first phase of mine closure, the doses were lowered by half compared to those in 1994. This is attributed to the flooding of the lowest part of the mine. The monitoring of environment in Slovenia is supplemented by maps of some natural radio nuclides and a map showing the Chernobyl Cesium distribution in Slovenia. The maps were produced in 1995.

The Slovenian Health Inspectorate is responsible for the control of sources of ionizing radiation and for safety at work, including: control of clinics, hospitals, institutes, and laboratories using x-ray devices, accelerators and radioisotopes for diagnostics and therapy. The control also encompasses the nuclear installations, mines, tourist caves and about 100 companies, research and training institutions. Two other tasks of the inspectorate are training in the field of radiation protection, and control of radon in dwellings and working environments. Jointly with the Ministry of Internal Affairs, they control transport of radioactive materials in Slovenia and across the state borders.

In 1995, there were 3490 radiation workers and no one was overexposed. The dose limits (50 milisieverts according to the Slovenian legislation and 20 milisieverts according to new international recommendations)were not exceeded. Three percent of workers received doses in the range from 1 to 20 milisieverts. A study on patients exposures due to diagnostic use of x-rays showed that the mean values of input surface doses received by a selected number of patients did not exceed the mean values recommended by the Basic Safety Standards. The only exception were patients with spine x-ray examination. Basic data on the total number of performed x-ray examinations of patients are still inaccessible or incomplete. For this reason, the study lacks relevant data on medical exposure of the population and its contribution to the total radiation load.

In 1995, the Slovenian Health Inspectorate issued 61 permissions for the purchase and usage of sealed and open ionizing sources, and 52 permissions for the usage of x-ray devices or new x-ray tubes. The data of the Customs Administration show that the number of imported x-ray devices increased in 1995. Three permissions were issued for the purchase and use of 3000 ionization smoke detectors. Sixteen x-ray machines were put out of operation. Eight provisions were issued for work with radioactive materials and 12 provisions for work with x-ray devices on which some former deficiencies had been removed. The general status in the field of fire protection improved in 1995 compared to the year 1994.

The production of nuclear installations in the Republic of Slovenia met all the requirements for nuclear safety assurance and the elementary limits of environmental radioactive pollution, as well as those concerning radiation exposure of population and radiation workers.

ABBREVIATIONS

AMS	Automatic Meteorological Stations
ARAO	Agency for Radwaste Management
EIS	Ecological Information System
HLW	High Level Radioactive Waste
IAEA	International Atomic Energy Agency
ICISA	International Commission for Independent Safety Analysis
ICRP	International Commission on Radialogical Protection
IJS	Jožef Stefan Institute
INES	International Nuclear Event Scale (IAEA)
INIS	International Nuclear Information System (IAEA)
LILW	Low and Intermediate Level Radioactive Waste
MOP	Ministry of Environment and Physical Planning
NNSR	Non Nuclear Safety Related
NPA	Nuclear Plant Analyzer
NPP	Nuclear Power Plant
NSR	Nuclear Safety Related
NSRAO	Medium and Low Level Radioactive Waste
OECD	Organization for Economic Co-operation and Development
OSART	Operational Safety Review Team (IAEA)
PHARE	European Community Programmes for Economic Assistance to Central and Eastern European States
RAMG	Regulatory Assistance Management Group (of EU)
RAMS	Radiological Alarm Measuring System
ROS	Radiation Early Warning System
RS	Republic of Slovenia
RŽV	The Žirovski Vrh Mine
SEP	SNSA Emergency Plan
SKJV	Nuclear Safety Expert Commission
SNSA	Slovenian Nuclear Safety Administration
TLD	Thermoluminescent Dosimetry
TSO	Technical Support Organizations
TTC	Tube Type Container
URSZR	Ministry of Defence, Administration for Rescue and Disaster Relief
US NRC	US Nuclear Regulatory Commission
WMS	Weather Monitoring System
ZVD	Institution for Occupational Safety of the Republic of Slovenia

INTRODUCTION

3.1. SLOVENIA

Slovenia is a central European country, located along the foothills of the eastern end of the Alps, at the very tip of the most northerly Mediterranean bay, open towards Hungary.

It is a natural hub of European routes from the North to the South and from the West to the East. Besides Hungary to the East it borders with Austria to the North, Italy to the West and Croatia to the South.

Basic data on Slovenia
Area: 20,256 km^2
Population (according to the Central Register of Inhabitants, 31.12.1995): 1,983,000
Number of households (1991): 640,200
Population density: 97 inhab./km^2
Constitutional order: a parliamentary republic
Capital: Ljubljana
Ethnic composition (census 1991): Slovens 87,9%, Hungarians 0.43, Italians 0,16%. Others 11,6%
Official language: Slovene, in nationally mixed regions also Hungarian and Italian
Currency: Slovene tolar (1 SIT=100 stotin)
Annual population growth (1994): 1,1 per thousand
Birthrate (1993): 9,8 per thousand
Life expectancy (1992/1993): men 69,40, women 77,29
Urban population (1994): 50,1%
Major towns (1994): Ljubljana (270,000), Maribor (103,100), Celje (39,800), Kranj (36,800), Velenje (27,100), Koper (24,600), Novo mesto (22,600)
Gross domestic product (1994, current prices): 1839,61 billion SIT (14,28 billion USD)
Per capita gross domestic product (1994): 7179 USD
Main agricultural products (1994): potato (4,609t), corn (54,554t), wheat (54,944t), hops (2,215t), apples (32,968t), wine (807,000hl), meat (164,000t), milk (559,1 mil.l)
Main industrial branches (by share of added value in industry, 1994): food industry 15.2%, textile industry 10.8%, metal industry 11.8%, electrotechnical and optics industry 10.0%, wood and furniture industry 9.9%, chemical industry 9.8%, machinery industry 7.3%, paper and graphics industry 7.5%
Exports (1995, temporary data): 8286.0 mil. USD
Imports (1995, temporary data): 9451.4 mil. USD
Number of tourists (1995): 1,577,000, overnight accommodation 5,883,000
Number of schools (1994/95): primary 821, secondary 152, universities 2
Number of primary and secondary school pupils and students (1994/95): primary 213,000; secondary 102,700; tertiary 48,000;
Number of books published (1994): 2906, of which 1981 original works
Number of magazines and newspapers (1994): 953, of which 6 daily and 41 weekly
Number of television subscribers (1994): 456,000
Number of telephone subscribers (1994): 577,200
Number of motor vehicles registered (1995): 833,000, of which 698,000 private cars

Ref: Statistical yearbook 1995

3.2. SLOVENIAN NUCLEAR LEGISLATION

Legislation in force

The Constitutional Law on Enforcement of the Basic Constitutional Charter on the Autonomy and Independence of the Republic of Slovenia, adopted on 23 June 1991, (Off.Gaz. RS1/91) provides that all the laws adopted by SFR of Yugoslavia remain in force in the Republic of Slovenia pending the adoption of appropriate legislation by the Slovenian Parliament.

Accordingly, legislation on nuclear energy (and safety) in Slovenia is made up of the following laws and regulation:

Liability

- Act on Third Party Liability for Nuclear Damage (Off.Gaz. SFRY, 22/78 and 34/79),
- Act on Insurance of Liability for Nuclear Damage (Off.Gaz. SRS, 18/80),
- Decree to Amend Decree on the Insurance Amount for Liability (Off.Gaz. RS, 22/91-1),
- Decree to Amend Decree on the Limitation for the Liability (Off.Gaz. RS, 22/91-1),

Nuclear and Radiological Safety

- Act on Radiation Protection and the Safe Use of Nuclear Energy (Off.Gaz. SFRY, 62/84),
- Act on Implementing Protection against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off.Gaz. SRS, 28/80).

For the implementation of the act first mentioned in this section several regulations were adopted:

- On Siting, Construction and Operation of Nuclear Facilities (Off.Gaz. SFRY, 52/88),
- On Safety Analysis Reports (Off.Gaz. SFRY, 68/88),
- On Operator Licensing (Off.Gaz. SFRY, 86/87),
- On Safeguards (Off.Gaz. SFRY, 9/88),
- On Radioactivity Monitoring in whole country (Off.Gaz.SFRY, 40/86),
- On Radioactivity Monitoring in the Vicinity of Nuclear Facilities (Off.Gaz. SFRY, 51/86),
- On Radioactive Wastes (Off.Gaz. SFRY, 40/86),
- On Trade of Radioactive Materials or Sources (Off.Gaz. SFRY, 40/86, 45/89),
- On Conditions for Radiation Workers (Off.Gaz. SFRY, 40/86),
- On Dose Limits to Population and Radiation Workers (Off.Gaz. SFRY, 31/89, 63/89),
- On Use of Sources in Medicine (Off. Gaz. SFRY, 40/86, 10/87),
- On trade of Foodstuffs (Off. Gaz. SFRY, 23/86),
- On limits of Radioactivity of the Environmental and for Decontamination (Off.Gaz. SFRY, 8/87, 27/90),
- On Register of Sources and Doses to Population and Radiation Workers (Off.Gaz. SFRY, 40/86),
- On Trade of Fodder (Off.Gaz. SFRY, 6/88).

Radwaste

- Act on Decommissioning Fund (Off.Gaz.RS, 75/94),
- Act on Termination of Exploration of the Uranium Mine (Off.Gaz.RS, 36/92),
- Decree on Setting Up the Radwaste Agency (Off.Gaz. RS, 5/91),

Administrative

- Act on Organization and Competencies of Ministries (Off.Gaz. RS, 71/94),
- Act on Administration (Off.Gaz.RS,67/94),
- Act on Administrative Procedures (Off.Gaz.SFRY,47/86),

Energy

- Act on Energy Economy (Off.Gaz.RS,71/94),
- Act on Construction Postponement of Nuclear Power Plant until Year 2000 (Off.Gaz. SRS,45/87),

General

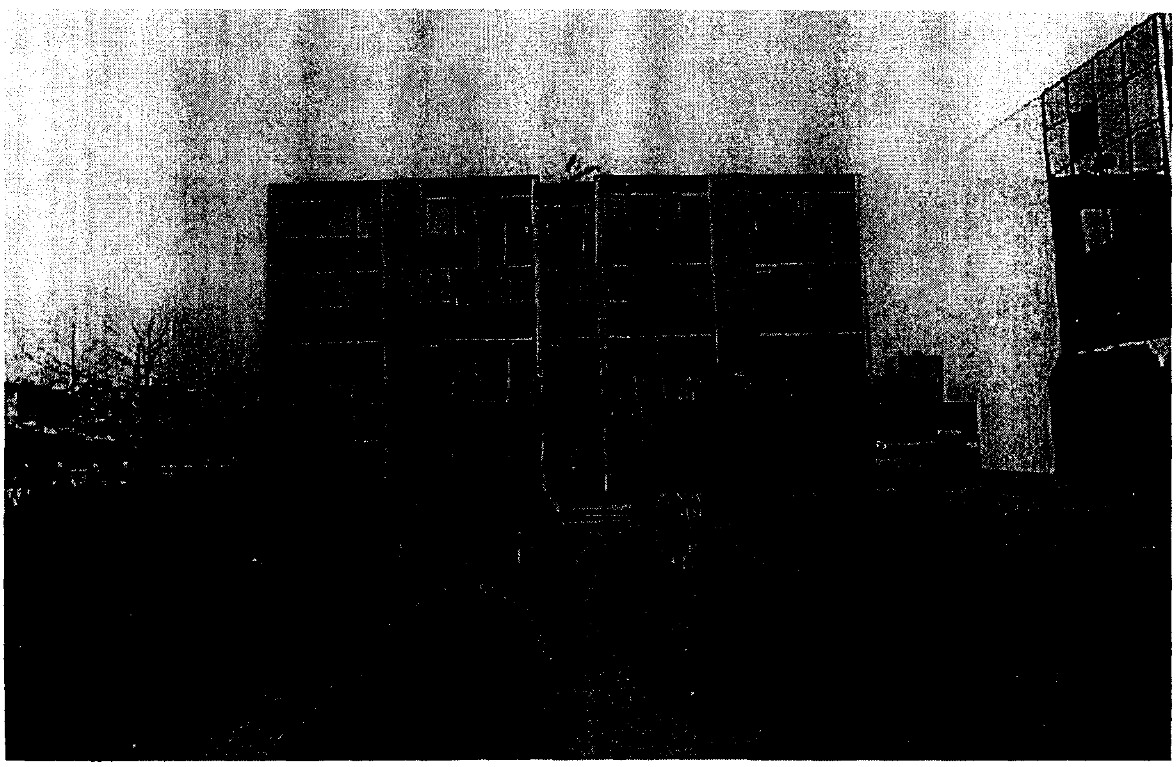
- Act on Environmental Protection (Off.Gaz.RS, 32/93,1/96),
- Act on Defense and Civil Protection (Off.Gaz.RS, 46/94),
- Criminal Act (Off.Gaz.RS,63/94),
- Act on Minor Offences (Off.Gaz.RS,66/93, last version),
- Act on Transport of Dengerous Substances (Off.Gaz.SFRJ, 27/90),

Furthermore, based on the Slovenian Constitution, all announced and ratified international treaties also constitute an integral part of our legislation and can be applied directly, so the following international treaties, to which former Yugoslavia was party and were later succeeded by Slovenia should be mentioned:

- Agreement between SFR of Yugoslavia and IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (Off.Gaz.SFRJ, 67/73),
- Vienna Convention on Civil Liability for Nuclear Damage,
- Convention on the Physical Protection of Nuclear Material,
- Convention on Early Notification of a Nuclear Accident,
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency,
- Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water,
- Treaty on the Non-Proliferation of Nuclear Weapons,
- Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction in the Sea-Bed and the Ocean Floor and in the Subsoil.

Slovenia also became a party to Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention; in 1994 Slovenia also signed the Convention on Nuclear Safety which was in 1995 in the final stage of ratification in the Slovenian Parliament.

SLOVENIAN NUCLEAR SAFETY ADMINISTRATION



4.1. LEGAL BASIS

The Slovenian Nuclear Safety Administration (SNSA) was established in 1987. Activities in this field before 1987 had been carried out by different committees and secretariats (now transformed into ministries). From 1987 to 1991 the SNSA was an independent, functionally autonomous body dealing with all matters concerning nuclear safety. It had two organizational divisions, the Safety Analysis and Legislative Division and the Division of Inspection. The SNSA was directly responsible to the Government and to the Parliament of the Republic of Slovenia. In 1991 the Parliament of Slovenia adopted a new Act on Organization and the Working Field of State Administration, by which the SNSA came under the Ministry of the Environment and Physical Planning and lost some of its independence and autonomy. It is also no longer responsible directly to the Government and to the Parliament but to the Ministry of the Environment and Physical Planning.

The director of the SNSA represents the SNSA and conducts its activities. On the Governmental and Parliamentary level the SNSA is represented by the minister. The director is responsible to the minister for his work and for the work carried out by the SNSA. He is appointed and discharged by the Government on the motion of the minister.

Senior civil servants are also appointed by the Government on the motion of the director while others are appointed by the director.

The scope of competences of the Slovenian Nuclear Safety Administration - SNSA (which is a national regulatory body in Slovenia) is defined in the Act on the Organization and Competences of Ministries. The SNSA deals with regulatory, inspection and technical tasks, related to:

- nuclear and radiological safety in nuclear installations;
- handling, trade and transport of nuclear and radioactive materials;
- safeguards for nuclear installations and materials;
- physical protection of nuclear installations and materials;
- liability for nuclear damage;
- licensing of operators of nuclear installations;
- quality assurance;
- radiological monitoring;
- early notification in the case of a nuclear or a radiological accident;
- international cooperation in the field of the SNSA work;
- other tasks defined in "nuclear" and other legislation.

Off-site emergency preparedness is the responsibility of the Ministry of Defense - Administration for Rescue and Disaster Relief. For the physical protection of nuclear material the responsibilities are divided between the SNSA and the Ministry of Internal Affairs.

In view of the markedly interdisciplinary nature of the SNSA fields of activities, cooperation with other administrative bodies in 1995 was very intensive, especially with the Ministry of Economic Affairs, the Ministry of Labor, Family and Social Affairs, the Ministry of Health, the Ministry of Foreign Affairs, the Ministry of Internal Affairs, the Ministry of Defense and the Ministry of Science and Technology. This cooperation is manifested in issuing administrative decisions, inspections and supervisions, the preparation of answers to the questions and initiatives of the members of the Parliament, the preparation of materials for sessions of the Government and its working bodies, and in the work of interdisciplinary expert commissions.

4.2. ORGANIZATION

The SNSA is divided into five divisions:

- Nuclear Safety Inspectorate,
- Nuclear Safety Division,
- Radiation Safety Division,
- Nuclear and Radiological Materials Division,
- Legal and International Cooperation Division.

According to the organizational chart there are 40 posts; at the end of 1995 more than half were occupied.

The main task of the Nuclear Safety Inspectorate is to perform the inspection in compliance with the regulations and to determine the scope and depth of the inspection. The inspections can be organized as a single or as a planned series of inspections in order to determine whether the licensee's actions meet regulatory requirements. The inspections can be (a) planned or (b) unplanned (e.g. inspections which cover reactor trips, abnormal events). Planned inspections can be announced or unannounced.

The Nuclear Safety Division has to run two main functions: the subdivision for licensing is responsible for tasks which are directly related to licensing, such as: issuing decisions, integrated safety evaluations, cooperation with the inspectorate, quality assurance, etc. The subdivision for analysis supports the licensing division in performing the analyses which are allocated to it and other, mostly continuous analyses; the priority is given to PSA application, severe accident analysis and emergency preparedness tool development. Since the manpower of the SNSA as well as this division are limited, many analyses are performed by the Technical Support Organizations (TSO).

The main technical and regulatory responsibilities of the Radiation Safety Division are in connection with radiological safety (of nuclear installations only), radiological monitoring, early notification in the case of a nuclear or radiological accident, etc. In some other areas, as for example dose exposure of workers (and population), strict division of responsibilities between different authorities has not been defined yet; therefore, the SNSA closely cooperates with the Ministry of Health (Health Inspectorate), which is responsible for all questions concerning radiation protection (apart from nuclear facilities radiation).

Nuclear and Radioactive Materials Division has duties and responsibilities regarding the trade, transport and handling of nuclear and radioactive materials; it accounts for and controls nuclear facilities and materials (safeguards); provides physical protection of nuclear facilities and materials; etc. This division deals also with questions relating to the treatment (conditioning), intermediate storage and final disposal of radioactive waste. It also deals with siting of nuclear installations.

The Legal and International Cooperation Division has duties and responsibilities which are not necessarily always related to nuclear safety but which are in close connection with organizational matters, as for example: links with other ministries, the Government and the Parliament; the budget; the employment policy, etc. This division is also engaged in the licensing process and the preparation of new legislation in the field of nuclear and radiological safety. Its responsibility is also the licensing of NPP's shift personnel. Regarding international cooperation the SNSA fosters and implements international relations for the purpose of gathering information on the state-of-the-art in nuclear technology worldwide and of exchanging experience. The SNSA was appointed as a liaison office for contacts with the IAEA (for technical questions); good relations have been established with the OECD/NEA and with the European Commission regarding the PHARE programme (RAMG assistance).

There are also expert Commissions attached to the SNSA:

- The Nuclear Safety Experts Commission, which has an advisory role (for different questions, as for example: yearly report of the SNSA; important licences, issued to the nuclear facilities; drafts of laws and regulations; measures for physical protection of nuclear materials and facilities, etc.),
- Expert Commission for Operators Exams, which gives exams and proposes the SNSA to grant or extend licenses to shift personnel.

4.3. LICENSING

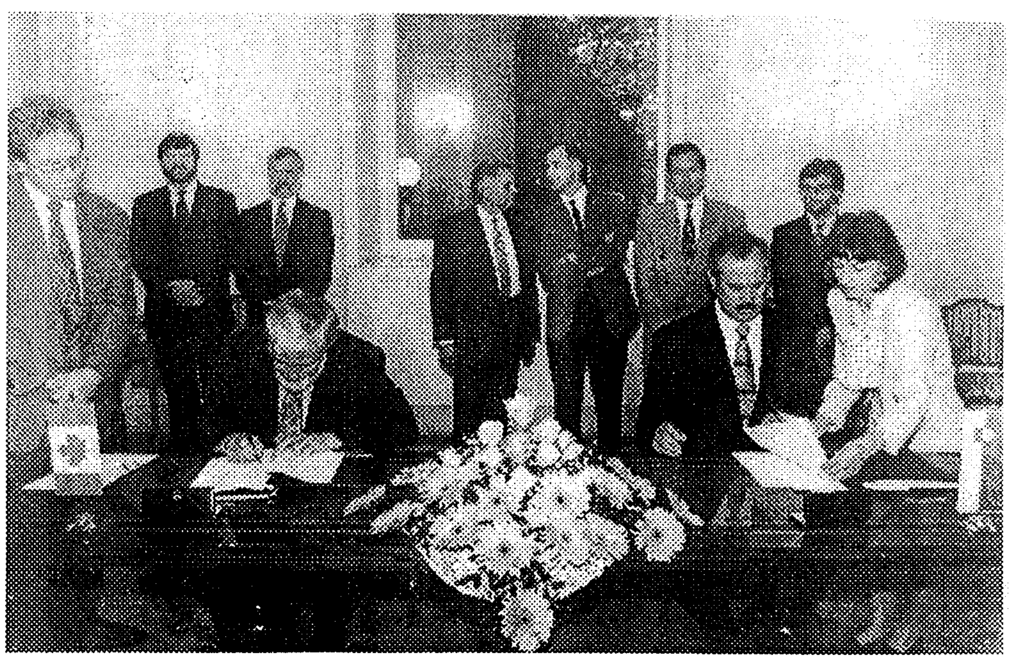
In the licensing procedure, the SNSA has an overall control over nuclear safety in all stages. This task is, however, implemented in two main forms:

1. The form of a previous consensus: the site licence and the construction licence are granted by other ministries; in these two stages the SNSA reviews and evaluates only questions related to nuclear safety; accordingly, it issues a previous consensus to the licence.

2. The form of a licence: the licences for commissioning, operation and decommissioning are granted by the SNSA.

All safety-related modifications in a nuclear facility under construction or operation require a new procedure and licence of the SNSA. The operator may file a complaint against a licence issued by the SNSA; in this case the Ministry of the Environment and Physical Planning makes the decision based on an outside expert opinion. This decision can be challenged at the Supreme Court by the operator or by the attorney general.

The SNSA has a nuclear safety inspectorate which is responsible for inspecting nuclear facilities during construction and operation. In discharging their responsibilities, the SNSA inspectors may require to halt the operation of a nuclear facility if all prescribed conditions from the licence have not been met and if there is an eminent threat to nuclear safety. The SNSA can at any time suspend or revoke a licence.



Agreement between the Government of the Republic of Slovenia and the Government of Canada for Cooperation in the Peaceful Uses of Nuclear Energy was signed in Ljubljana on May 31, 1995.

4.4. INSPECTION AND ENFORCEMENT

The Nuclear safety within the SNSA consists of the section head and four inspectors for nuclear safety. The entry qualifications of the inspectors are university degree in engineering or science and eight years of relevant experience. Additionally, inspectors are trained in Slovenian legislature and administrative procedures, nuclear technology, nuclear and radiological safety, simulator training, and on-the-job training with a foreign inspector.

The main task of a nuclear safety inspector is to perform inspections in compliance with the regulations and to determine the scope and depth of the inspection. The legislation gives the inspectors full power to perform inspections. He can stop the operation of the plant in case safety is jeopardized. There are no resident inspectors having an office on-site, but continuous monitoring of the nuclear power plant performance is performed through planned inspections of two inspectors once or twice a week. The inspection report is written on the spot and a copy of this report is handed over to the plant staff.

The inspections are planned in accordance with the general annual programme of inspections, which is divided into four three-month periods. More detailed plans are prepared at the beginning of each three-month period and, after the end of each three-month period, the inspection reports are reviewed and the compliance of the objectives and the scope of the inspections with the general annual program is established. The new three-month plan is then amended according to the findings given in the review of the inspection reports.

In 1995, 92 planned and 5 unplanned inspections were performed during the operation of **NPP Krško.** During refueling and longer outages, the frequency of planned inspections was increased to three (sometimes four) a week. The inspection for this purpose was reinforced with the staff of authorized organizations (TSO). No irregularities on the safety systems or violations of licensing limits and conditions were found.

The TRIGA Mark II Research Reactor was inspected three times. The inspections were performed in cooperation with the Slovenian Health Inspectorate and covered the reactor, the interim storage of low- and intermediate-level waste and monitoring of the environment. The operation of the reactor was found to comply with the operating limits and conditions. Access to the reactor hall was readily controlled. The operation of the interim storage of low- and intermediate-level waste was in accordance with the license.

One regular inspection was performed of the **Žirovski Vrh Mine**, a uranium mine and milling facility in decommissioning. The implementation of the yearly plan of decommissioning and remedial actions on the waste disposal sites of mine waste, ore waste, red mud and mill tailings were checked. An unplanned inspection was also performed to assess possible damage to the disposal sites after heavy rains. The inspection concluded that the measures taken to stop the sliding of the Boršt waste disposal were successful. However, progress on the implementation of the programme of decommissioning was not satisfactory.

4.5 THE SAFEGUARDS

Succeeding to the Treaty of the Non-Proliferation of Nuclear Weapons, the Republic of Slovenia continues to meet the commitments pertinent to safeguarding of nuclear materials. The preparation of the Slovenian legislation in this field is under way.

The Agreement between the Republic of Slovenia and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons was signed on 29. 9. 1995 and still has to be ratified by the Parliament of the Republic of Slovenia. Until then, the Agreement between the former SFR of Yugoslavia and the International Atomic Energy Agency is being used. In the preparation of related Slovenian legislation,also the IAEA programme 93+2 on strengthening the effectiveness and the efficiency of the safeguard system, is being considered.

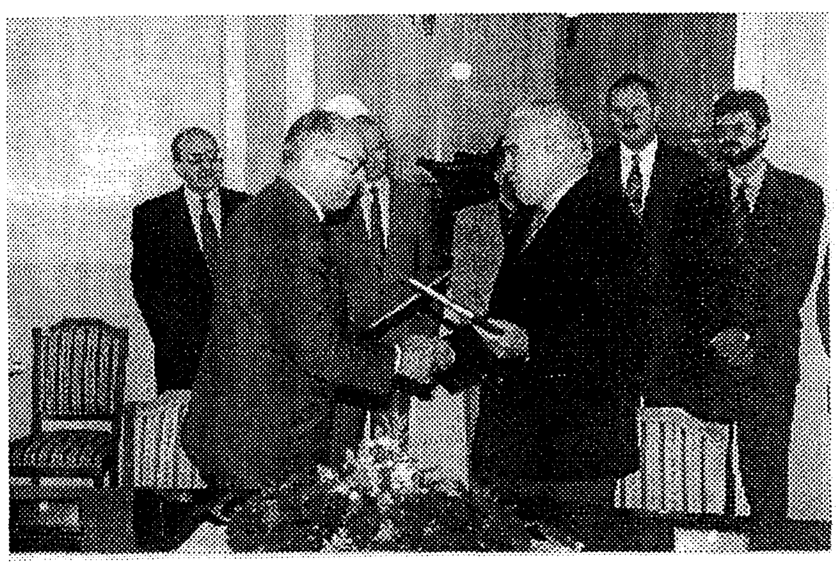
The adoption of the 93+2 project will also require the establishment of control over transfers of nuclear-related dual-use equipment, material and related technology, as adopted by the Nuclear Suppliers Group countries. The related act is in preparation at the SNSA.

In 1995 Slovenia adopted the simplified procedures for the designation of the IAEA safeguards inspectors. Under these simplified procedures, Slovenia accepts the designation of an inspector unless rejection is proposed by Slovenia to the IAEA within two months from receipt of the designation. The inspectors with valid United States Laissez-Passer (UNLP) do not need the entry or exit visa to Slovenia.

The current cooperation between Slovenia and the IAEA is good. All procedures regarding the technical and administrative procedures pertinent to safeguarding activities are adequate and in compliance with the present legislation in Slovenia.

In Slovenia there are only two facilities which are subject to safeguards, i. e. NPP Krško and the RR TRIGA MARK II near Ljubljana. In 1995 there were six regular safeguards' inspections in NPP Krško. No anomalies were reported. In the RR TRIGA there was no inspection in 1995. Additional measures for the physical protection of the nuclear material have been introduced by the operator of the Research Reactor.

Dr. Hans Blix and Mr. Ignac Golob signing the Safeguards Agreement



4.6. EXPERTISE AND RESEARCH

During 1995, the SNSA ordered and financed the following studies:

- Stress mechanical analysis of pump casing - Report of Laboratory for modeling and numerical simulation in mechanics, University of Ljubljana.
- Safety analysis of spent fuel pit criticality for TRIGA reactor - Report of the Jožef Stefan Institute (IJS-DP-7301).
- Analysis of severe accident with MELCOR - Report of the Faculty of engineering, Maribor.
- Reliability of the Krško NPP operation in different operation states of ESS. Report of the Milan Vidmar Electro Institute, Ljubljana.
- Measurement of neutrons in NEK with passive dosimeters of neutrons - Report of the Jožef Stefan Institute Ljubljana. (IJS-DP-7300).
- Measurement of neutrons inside NEK's fence - Report of the Jožef Stefan Institute Ljubljana. (IJS-DP-7300).
- Measurement of Water quality of the river Sava in the vicinity of NEK - Report of the Jožef Stefan Institute Ljubljana. (IJS-DP-7398).
- Measurement of radio nuclides content in rivers, lakes, and drinking water - Report of the Institute of RS for Occupational Health, ZVD-DP 1003/96.
- Performance of physically oriented data base of neotectonics and seismic researches at the Krško area - Report of the Institute for geology, geotechnics and geophysics., Ljubljana.
- Preparation of data for the first level selection for LLRAW for work with code package ARC/INFO - Report of the Engineering Bureau "Elektroprojekt" ,Ljubljana.
- Neotectonic researches of the Krško NPP site - First phase report, Institute for geology, geotechnics and geophysics., Ljubljana.
- Measurements of radioactive elements and some other pollutants in the Slovenian sea - Report of the Jožef Stefan Institute Ljubljana. (IJS-DP-7398).
- Map of natural radioactivity in Slovenia (Geological Institute of Ljubljana).

4.7. INTERNATIONAL COOPERATION

Conclusion of new agreements

4.7.1 Bilateral agreements

- Agreement between the Government of the Republic of Slovenia and the Government of Canada for Cooperation in the Peaceful Uses of Nuclear Energy (together with the administrative arrangement) was signed in Ljubljana on 31 May 1995, after which a process of ratification was launched.

- Agreement between the Republic of Slovenia and the International Atomic Energy Agency for the Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons was signed in Ljubljana on 29 September 1995, after which a procedure of ratification was initiated.

- Agreement between the Republic of Slovenia and the Republic of Hungary for the Early Exchange of Information in the Event of a Radiological Emergency was signed in Budapest on 11 July 1995, after which a procedure of ratification was initiated.

Bilateral agreements under preparation

- Agreements on the early exchange of information in the event of a radiological emergency

Already in 1994, the SNSA gained authorization for signing bilateral agreements with the neighboring countries (Austria, Croatia, Hungary, Italy) from the Goverment and the Parliament. The basis for these agreements are:
- Convention on Early Notification of a Nuclear Accident, and
- Council Decision on Community Arrangements for the Early Exchange of Information in the Event of a Radiological Emergency (87/600/Euratom).

The negotiations on the early exchange of information between Slovenia and Austria continued in 1995, while formal negotiations between Slovenia and Croatia and Slovenia and Italy have not started yet.

- Agreements on the Exchange of Information and Cooperation in the Field of Nuclear Safety

In 1995, the SNSA made some connections with competent administrative bodies of the Slovak Republic, the Czech Republic and France, for defining a draft version of the agreement; however, these initiatives have not yet been submitted to the governmental procedure.

4.7.2. Multilateral agreements

- Convention on Nuclear Safety; The Republic of Slovenia signed the convention already in 1994, but the procedure of ratification has not been completed yet.

- Within the framework of cooperation with the Agency, the work of the Standing Committee on Liability for Nuclear Damage to accept the Protocol to Amend the Vienna Convention on Liability for Nuclear Damage and the Convention on Supplementary Funding continued. The Slovenian delegation was involved in work of the SCLND.

- The preparations for the Convention on the Safety of Radioactive Waste Management began at the headquarters of the IAEA. The preparations are a logical follow-up to the Convention on Nuclear Safety. Experts from the Republic of Slovenia also cooperate within the framework of this expert group.

4.7.3. Cooperation with the International Atomic Energy Agency

A. Seminars, Courses and Workshops Organized by the IAEA

In 1995, the SNSA staff successfully participated in more than 15 various seminars, courses and workshops organized by the Agency or in cooperation with other organizations, institutes and associations.

Other Slovenian experts from institutions such as: the Jožef Stefan Institute, the Krško Nuclear Power Plant, the University Medical Center, the Slovenian Health Inspectorate, IBE Elektroprojekt, the "Milan Vidmar" Electroinstitute, the Faculty of Natural Sciences and Technology, the Žirovski Vrh Mine, etc. also attended training courses, and technical committees meetings organized by the IAEA.

B. Fellowships and Scientific Visits

Another area of the SNSA-IAEA collaboration within the sphere of technical assistance and cooperation covers fellowships and scientific visits. In 1995, Slovenian institutes received 23 applications for training in Slovenia. Applicants come from various countries such as: Pakistan, Iran, Vietnam, Algeria, Nigeria, Morroco, Columbia, Myanmar and Ghana.Three applications out of 23 were implemented in 1995. The others will be considered in 1996 or later. Four applications for training that had been received already in previous years were also implemented in 1995. It is also worth mentioning that four applications were rejected due to the lack of possibilities to arrange suitable programmes of training.

C. Research Contracts and Projects of Technical Assistance

In 1995, the IAEA approved six research contracts (new ones or renewals) prepared by Slovenian institutions. The approximate amount for a single project is 4000 USD.

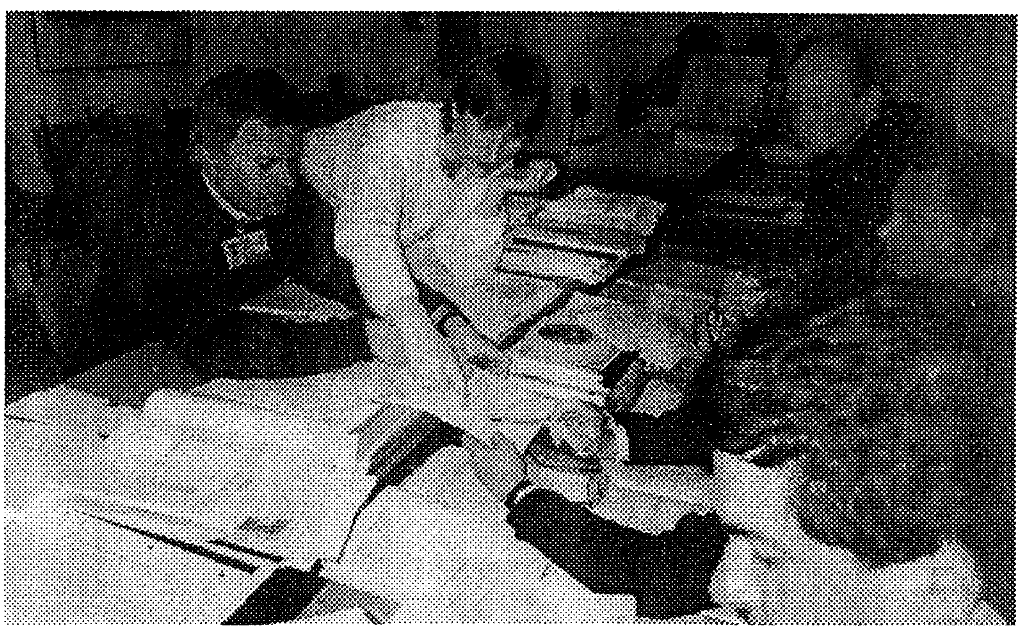
Through the IAEA technical co-operation programe six projects were going on in Slovenia (from the period 1993/94 and 1995/96). At the end of 1995, the Republic of Slovenia submitted a request for assistance to be provided under the regular programme of technical cooperation for 1997/98 for three new projects.

Cooperation with Other International Organizations and Administrative Agencies

The Slovenian Nuclear Safety Administration also cooperates with international organizations and agencies other than the IAEA, particularly with the EU Commission, the OECD/NEA and the US Nuclear Regulatory Commission. Professional and personal contacts with these organizations are very tight, which helps the SNSA to receive updated information and learn from experiences of foreign administrative bodies. The Republic of Slovenia has not yet become a member of the OECD. Its experts, at the invitation of the OECDE/Nuclear Energy Agency, have attended several seminars and specialists' meetings which have become very open to non-member countries and countries of the former Soviet Union, as well as other East European countries. As far as cooperation between the SNSA and the US NRC is concerned, attention was paid to mutual exchange of nuclear safety inspectors; a SNSA inspector visited the US NRC offices and stayed in the USA for six weeks, while an NRC inspector stayed in Slovenia for two weeks. The Slovenian side welcomes such exchanges, since the Krško Nuclear Power Plant and the TRIGA Research Reactor were built by USA technology; even USA standards and technical requirements are used where appropriate and when Slovenian ones are not available. The SNSA is also very well acquainted with the American practice, which is the result of very strong contacts.

4.8. TRAINING AND COMPETENCE

The Slovenian Nuclear Safety Administration paid full attention to professional training of its personnel. Employment in government administration is conditioned by a special exam which one has to pass before getting a job. Employment at the SNSA is also conditioned by the Regulation on Internal Organization and Systematization of Vacant Posts at the SNSA. Many workers attend language courses, PC courses and courses in the field of nuclear safety and radiation protection. Two workers began Master's degree studies, one worker successfully completed the training course entitled "Bases of Technology in NPP's", and three workers completed the training course on quality assurance of nuclear safety. Education and training were also very intensive at courses abroad.



The SNSA staff, Mrs Alenka Beličič Kolšek and Mr. Igor Grlicarev at the Regional training course on practical tools for accident assessment and consequence projection during a radiological accident, which was held from March 28 to April 15, 1995 in Ljubljana, Slovenia

4.9. EXPERT COMMISSIONS

4.9.1. Nuclear Safety Expert Commission (SKJV)

This expert commission held two meetings in 1995. The Commission has 22 members, ten of them are selected from ministries, while 12 are experts in individual fields of nuclear safety and radiological protection. The work of the SKJV is defined in the Act on Ionizing Radiation Protection and the Safe Use of Nuclear Energy (SRS Official Gazette, NO.28/80) and in the Rules of Procedure (as amended at 45th session of the SKJV on 22 March 1991).

In addition to the standard item, i.e., operational safety of nuclear facilities in the period since the last meeting, the SKJV in 1995 also dealt with:

- the report on the outage of the Krško NPP
- the report on planned exchange of steam generators
- the proposal on the establishment of an ad-hoc working group for a new authorized organization (technical support Organisation)
- the report on work of the Agency for Radwaste Management and its programme for 1995
- the report on activities of the Agency for Special Wastes of the Republic of Croatia and the working plan for 1995
- the report on 39th regular session of the IAEA General Conference.

4.9.2. Expert Commission for Operators Exam

In 1995, the Commission for Testing the Qualifications of the Krško Operators organized two examination periods for 24 candidates. 14 candidates for senior operators took the exam to renew their licenses, 10 candidates for reactor operators also took the exam, four of them took the exam for renewal, while six candidates took the exam for the first time to become reactor operators.

All the candidates successfully passed the exam and on the proposal of the Commission, the SNSA granted the licence for one or four years or extended their licences for four years.

4.10. INFORMATION MANAGEMENT

Good safety culture is strongly connected with information. It can be said from experience that radiation and nuclear safety are under public control. The open and authentic nature of information forwarded to the public is a fundamental characteristic of the SNSA. The SNSA tries to forward substantial and convincing information to all interested institutions, mass media and citizens through press conferences, press statements, media discussions, active cooperation in domestic and international meetings, symposia and congresses, through publication of booklets, and through the Internet. The SNSA prepares reports for a bulletin entitled "Environment and Space", published by the Ministry of the Environment and Physical Planning. The SNSA regularly reports on nuclear safety to the Government, the National Assembly and Slovenian citizens. The Annual Report for 1994 (nuclear and radiological safety in Slovenia) is available in public libraries, in some professional libraries and can also be found on the Internet

(http://www.sigov.si/ursj/uvod.html).

All research projects and studies financially supported by the SNSA are public domain and available at the SNSA, while the reports of international missions are available at the National and University Library, the Central Technical Library of Ljubljana and the University Library of Maribor.

Within the framework of the IAEA Safety Series, the SNSA in cooperation with the Nuclear Society of Slovenia, in 1995 prepared bilingual (the English text and the Slovene translation) publications:

- Code on the Safety of Nuclear Power Plants:
  - Governmental Organization
  - Siting
  - Quality Assurance
  - Operation
  - Design

- Safety Fundamentals: Installations.

These booklets were published in order to represent and make available international standards to all people interested in nuclear energy and nuclear safety in the Republic of Slovenia. The booklets are issued in the form of parallel Slovene and English texts. On the left side of each booklet there is a copy of the original text (in English), on the right is the Slovene translation. These booklets are available in all public libraries and in more than 30 professional ones.

4.11. EMERGENCY PREPAREDNESS

On the national level, all vital decisions and supervision in emergency situations are the responsibility of the Civil Defense Headquarters of the Republic of Slovenia (URSZR). The URSZR has the authority to assess the situation in the case of a nuclear accident in Slovenia, to elaborate the national plan for protection and rescue and to take measures in the event of an emergency on national level and offsite the NPP. The "SNSA Emergency Plan" (SEP) describes the organization of the SNSA, which is capable to meet the necessary requirements in the case of an emergency. The SEP includes notification of the SNSA emergency staff, training and the equipment needed during an emergency and prevention of radiological consequences for the population and the environment. In 1995 the SEP draft was revised. The SEP draft comprises 32 procedures, which are grouped into six sections:

- internal organization and responsibilities,
- notification of the emergency staff,
- assessment of accident progression, and assessment of the consequences,
- public information (domestic and foreign),
- instructions for the equipment (communication, computer codes),
- maintaining emergency preparedness.

The SNSA is only one of the organizations, taking part during a nuclear or radiological emergency, therefore part of the SEP procedures concern communication between the SNSA and other subjects of the emergency preparedness.

In the case of an emergency, the SNSA employees and experts from other organizations and institutions, who have been determined in advance, meet on the SNSA premises. They split into three groups:

- expert group for accident analysis,
- expert group for dose assessment,
- expert group for public information.

Expert groups receive the information directly from the spot of the accident and from the environmental monitoring systems (described in the chapter on Information Management). The groups analyze the event and recommend countermeasures to the SNSA director. The SNSA director is authorized to pass the recommended countermeasures to the Civil Protection Headquarters. He also coordinates the information to the public and to the IAEA. His work is supported by the expert groups. Each group has its leading expert and predetermined group members who have to implement specific tasks required by the SEP.

The task of the expert group for accident analysis is to determine the event progression at NPP Krško and the potential source term. The work of the accident analysis group is an essential support to the dose assessment group and to the SNSA director. The expert group for accident analysis has three shifts. Each shift comprises the leading expert and four members.

The activities of the expert group for dose assessment are related to the accident analysis group. The dose assessment is made on the basis of the source term (potential or actual), radiological data (if any), and meteorological data. NPP Krško provides its own dose assessment to the dose assessment group for comparison only. The recommended countermeasures are based on the calculated doses and passed to the SNSA director. The dose assessment group includes, besides the group leading expert, four members in each of the three shifts.

The task of the expert group for public information is to prepare the information for the Government, ministries and the media. It notifies the IAEA in accordance with the Convention on Early Notification of a Nuclear Accident, the governments of foreign countries and the consular representatives in Slovenia. The group also receives the public information releases from NPP Krško and tries to clarify the issues which may be unclear. The information between the SNSA expert groups, and the information which is to be passed to other expert organizations, is written in a prescribed format.

4.12. INTERNATIONAL MISSIONS

PHARE Programme, RAMG Assistance to the Slovenian Nuclear Safety Administration

Within the framework of the PHARE programme, the European Union established RAMG (Regulatory Assistance Management Group) to offer assistance related to the organization, capability and performance of regulatory bodies. The Republic of Slovenia is a recipient of a three-year programme of assistance to improve the work of regulatory bodies on the basis of experience of similar authorities in Western Europe. In 1995, phase I of the programme, with six of the following seven tasks, was implemented:

1. Technical review of the proposed text for the new regulations on nuclear and radiological safety - postponed for the 2nd phase of assistance.

2. Establishing the SNSA internal organizational and administrative procedures.

3. Assistance in the development of techniques for public and media information.

4. Development of inspection guidelines, an inspection programme and provision of training on working practice for site inspectors.

5. Development of capability for integrated systems analysis and use of PSA for regulatory purposes.

6. Assistance to the SNSA in developing a regulatory approach and practice for Radwaste management.

7. Development of the SNSA internal emergency plan and capability to assess the progress of environmental impact after a radioactive release.

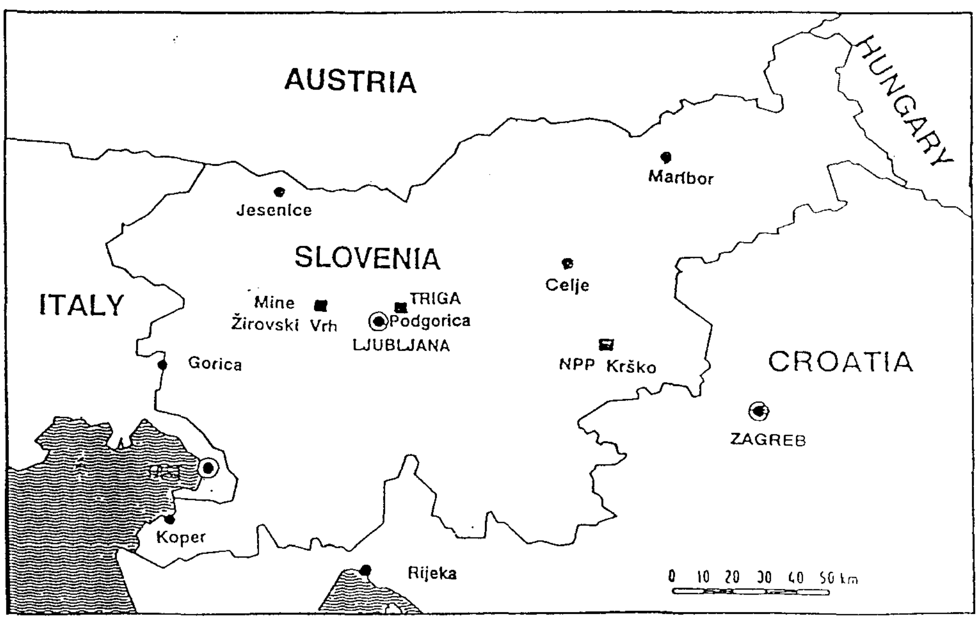
The programme is being coordinated by the National Agency for Environmental Protection of Italy (ANPA) with the participation of regulatory bodies for nuclear and radiological protection of Belgium, Spain, Germany, France and Great Britain.

The tasks above included:

- visits of the SNSA staff at regulatory bodies of the above-mentioned countries
- visits of experts from Western European countries at the SNSA
- organization of workshops in Ljubljana for the SNSA staff and other Slovenian experts.
- training of the SNSA staff in countries participating in the programme.

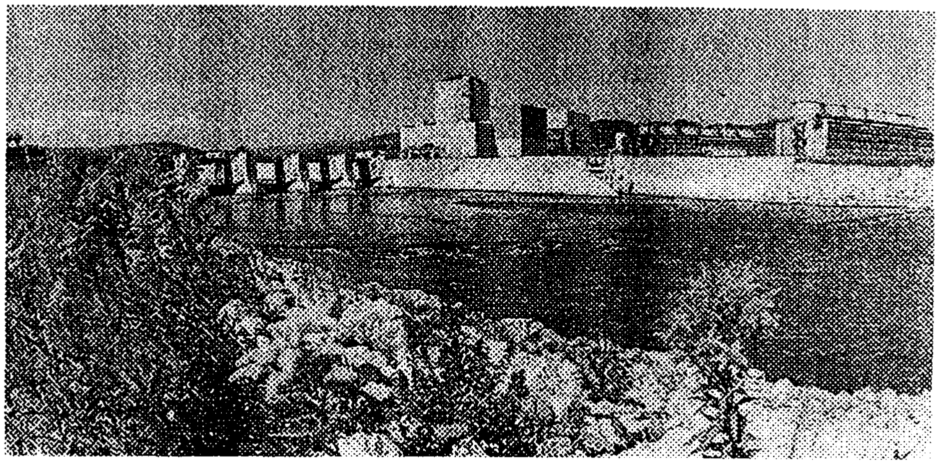
The RAMG programme proved to be very useful to the SNSA and other professional organizations dealing with issues of nuclear and radioactive safety, because it offers practical experience of similar Western European regulatory bodies existing for a long period of time.

OPERATION OF NUCLEAR FACILITIES



■ Nuclear Facilities in Slovenia

5.1. KRŠKO NUCLEAR POWER PLANT



5.1.1. Main Operational Data

In 1995 the Krško NPP generated 4,779,337 MWh of electrical energy at the output of the generator, or 4,568,500 MWh net.

The generator was connected to the electrical grid for 7605.1 hours or 86.82 % of the total number of hours in the year. The electrical production was 6.49 % higher than planned. Table 1 shows the energy output compared to the planned one.

Table 1: NPP Krško net electrical energy generation in 1995

Month	Planned Output (GWh)	Actual Output (GWh)	Difference (%)**
JAN	420	461.6	9.90
FEB	380	416.6	9.62
MAR	420	442.0	5.24
APR	350	304.7	-12.93
MAY	0	0	0
JUN	350	356.7	1.92
JUL	360	447.3	24.24
AUG	360	387.3	7.58
SEP	400	392.2	- 1.95
OCT	420	456.7	8.73
NOV	410	443.4	8.15
DEC	420	460.1	9.54
Total	4290	4568.5	6.49

** (Actual Output - Planned Output)/(Actual Output) (%)

In 1995, the generation of thermal energy amounted to 13,843,003 MWh. The whole production of the electrical energy in Slovenia was 11,550 GWh, the share of the nuclear energy production being 39.5 %. Slovenia used 9,903 GWh of produced electrical energy and the nuclear share was 23%, as half the production of NPP Krško was transmitted to Croatia.

Important performance indicators of the power plant are availability, the capacity factor and the number of forced shutdowns.

The availability factor shows how long the plant has been connected to the network in a certain period of time. This factor is determined by the quotient between the number of hours in which the electrical generator is synchronized with the network (regardless of reactor power) and the whole number of hours in the same period of time.

The load factor represents the amount of electrical energy produced by the plant in comparison to the whole amount of electrical energy which could theoretically be produced in a certain period, i.e., it is the quotient between the yielded electrical energy and the electrical energy which could be produced theoretically (the product of power on el. generator terminals and the number of hours) in that period of time.

The forced outage factor in a certain period of time is determined by the quotient of forced outage duration (in hours) and duration of plant operation (in hours) in that period of time.

Tables 2 and 3 show the performance indicators and the time consumption of NPP Krško in 1995.

Table 2: Performance indicators of operation of the NPP Krško in 1995

	Year 1995 (%)	Average (%) 1983 - 1995
Availability factor	86.82	80.97
Load factor	84.12	75.74
Forced outage factor	1.9	1.78

Table 3: NPP Krško electicity production time periods in 1995

Time analysis of electricity production	Hours	Percentage (%)
total available time	8,760	100
plant operating time	7,605.1	86.82
total outage time	1,154.9	13.18
maintenance	988.1	11.28
planned shutdowns	0	0
unplanned shutdowns	166.8	1.90

Figure 1: DIAGRAM OBRATOVANJA NE KRSKO ZA LETO 1995

NE KRSKO OPERATING DIAGRAM FOR 1995

Proizvedena energija na generatorju: 4, 779, 337.5 MWh

Proizvedena energija na pragu: 4, 568, 500 MWh

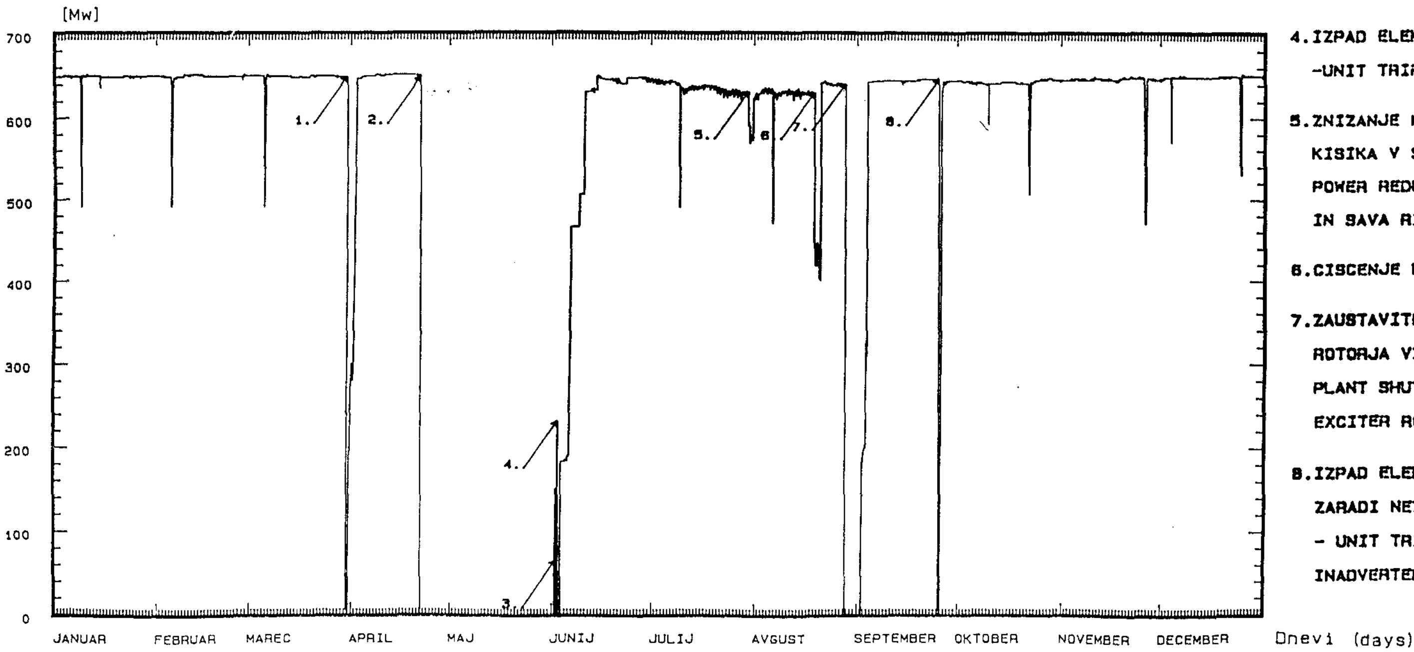
Gross produced energy: 4, 779, 337.5 MWh

Net produced energy: 4, 568, 500 MWh

Razpolozljivost (Availability Factor): 86.82%

Izkoristek (Capacitiy Factor): 84.12%

MOC (POWER)



1.IZPAD ELEKTRARNE ZARADI
IZGUBE 400 kV ZUNANJEGA NAPAJANJA
-UNIT TRIP BECAUSE OF
LOSS OF 400 kV OFF SITE POWER

2.MENJAVA GORIVA - REFUELING

3.TEST TURBINSKEGA TRIPA - TURBINE TRIP

4.IZPAD ELEKTRARNE ZARADI PADCA TLAKA HP
-UNIT TRIP CAUSED BY HP OIL PRESSURE DR

5.ZNIZANJE MOCI ZARADI NIZKE KONCENTRACI
KISIKA V SAVI
POWER REDUCTION BECAUSE OF LOW OXYGEN C
IN SAVA RIVER

6.CISCENJE KONDENZATORJA - CONDENSER CLEA

7.ZAUSTAVITEV ELEK. ZARADI POSKODBE BANDA
ROTORJA VZBUJEVALNIKA GLAVNOG GENERATOR
PLANT SHUTDOWN BECAUSE OF MAIN GENERATO
EXCITER ROTOR BANDAGE FAILURE

8.IZPAD ELEKTRARNE IN VARNOSTNO VBRIZGAVA
ZARADI NEZAZELJENEGA ZAPRTJA MSIV-A
- UNIT TRIP AND SAFETY INJECTION BECAUS
INADVERTENT MSIV CLOSURE

Figure 1 shows the NPP Krško operating diagram for 1995. Figure 2 shows the total electrical energy production in Slovenia for the past 12 years. Figures 3 to 8 show the main operational data for the whole period of the NPP Krško operation (1983 - 1995). The Load factor (Figure 3) is frequently used for the estimation of the efficiency of the NPP operation. An important factor is also the plant availability (Figure 4), because some plants intentionally decrease the power due to changes in electrical energy consumption which causes decrease in the load factor. Figure 5 shows the electrical energy production along the whole period of the NPP Krško operation. Figures 6 - 8 show the number of plant shutdowns, forced outage factors and the number of incident reports per year and throughout the commercial operation of the plant. The availability of NPP Krško in 1995 was 86.82 %.

Figure 2: Electrical energy production in Slovenia

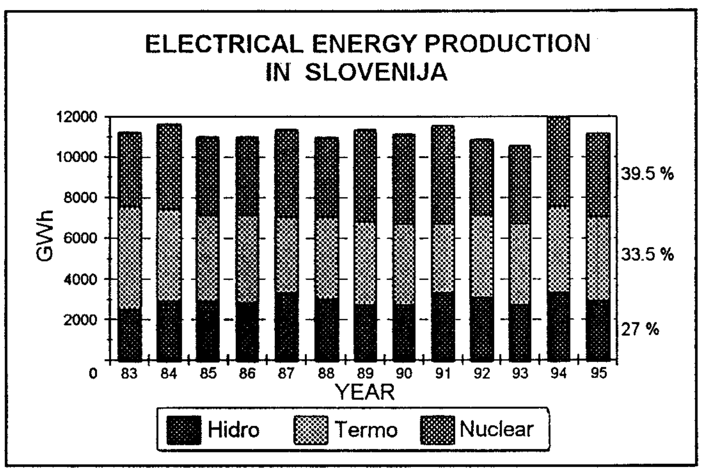
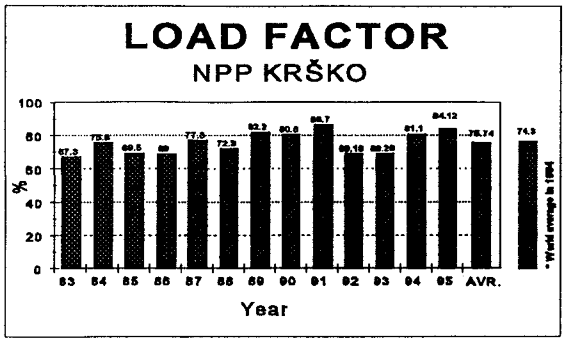
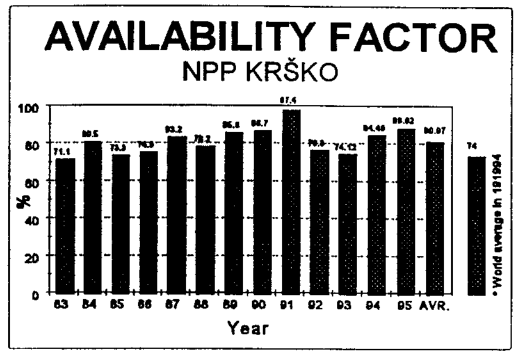


Figure 3: NPP Krško load factor



* source: Nuclear Engineering International, May1996

Figure 4: NPP Krško availability factor



* source: Operating experience with nuclear power stations in Member States in 1994, IAEA, Vienna 1995

Figure 5: NPP Krško net electrical energy production per year

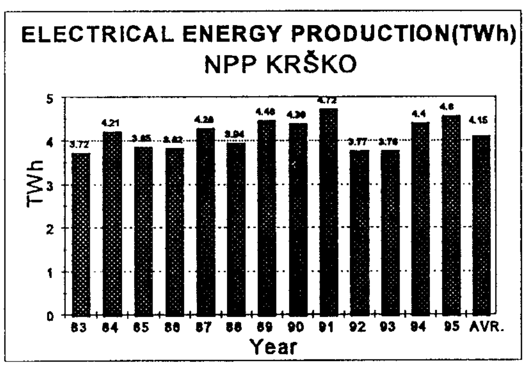


Figure 6: NPP Krško reactor shutdowns

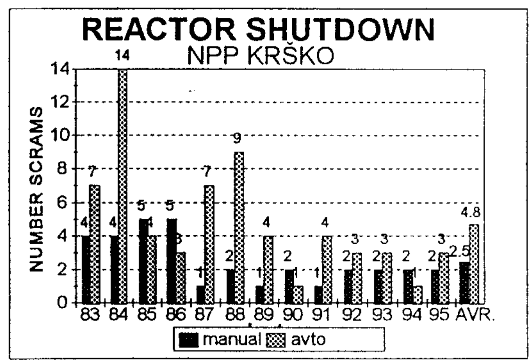


Figure 7: NPP Krško forced outage factor number

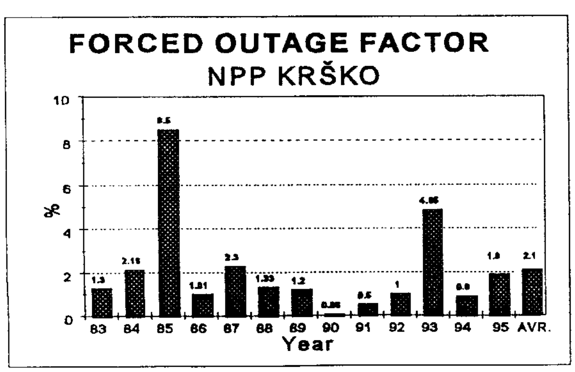
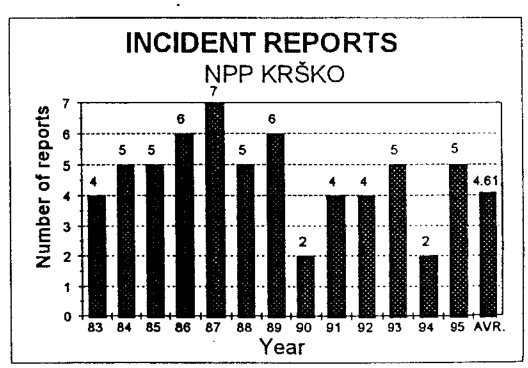


Figure 8: NPP Krško incident report



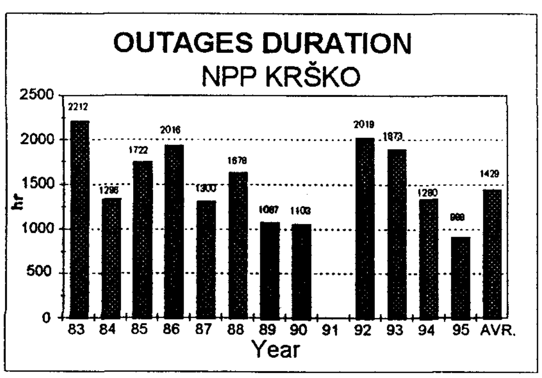
Shutdowns and Load Reduction

Table 4 shows the data and durations of the events for which NPP Krško was shut down or during which the power was reduced by more than 10% and for more than four hours. Short descriptions of the events are given below:

Tab. 4: Shutdowns and reductions of power in 1995

Date	Hours of duration	Outages type	Short description
8.1.	16	Planned, Manual	Operating at reduced power (76%) due to testing of the turbine valves.
5.2.	16	Planned, Manual	Operating at reduced power (75%) due to testing of the turbine valves..
5.3.	16	Planned, Manual	Operating at reduced power (75%) due to testing of the turbine valves.
30.3.	15.6	Unplanned Automatic	**Shutdown** due to loss of AC power on 400 kV electricity network
22.4. — 20.6.	988	Planned, Manual	**OUTAGE 95**
2.6.	20.5	Unplanned Automatic	**Shutdown** becausedue to pressure decrease in high turbine pressure oil system.
9.7.	5.4	Planned, Manual	Operating at reduced power (77%) due to testing of the turbine valves.
30.7.	41	Unplanned Manual	Operating at reduced power (90%) due to low oxygen concentration in the Sava. river
6.8.	8.3	Planned, Manual	Operating at reduced power (70%) due to testing of the turbine valves.
19.8.	52	Planned, Manual	Operating at reduced power (70%) due to maintenance works on condenser, regular monthly testing.
28.8.	116.5	Planned, Manual	Shutdown due to the main generator exciter banding degrdation
25.9.	14.2	Unplanned Automatic	Safety injection actuation and plant shutdown
22.10	17	Planned, Manual	Operating at reduced power (75%) due to testing of the turbine valves.
26.11	22	Planned, Manual	Operating at reduced power (75%) due to testing of the turbine valves.
28.8.	116.5	Planned, Manual	Operating at reduced power (80%) due to testing of the turbine valves.

Figure 9: NPP Krško outage duration



5.1.2. Integrity of Barriers

5.1.2.1. Nuclear Fuel Performance

Nuclear fuel integrity depends on the reactor operation history during the electricity generation process. 1995 was the year of the 11th and 12th fuel cycles. The 12th cycle started on June 1 1995. The core consists of 121 fuel assemblies. Each fuel assembly contains 16 x 16 rod arrays composed of 235 fuel rods Vantage 5 type with enrichment 4.3 % of U 235. The fuel is made by Westinghouse.

The integrity of the fuel in the reactor is monitored indirectly by the reactor coolant activity. The specific activities of a greater number of isotopes are measured at stable operations as well as during transient phenomena. The following isotopes are analyzed in the Krško NPP: Xenon 133, 135 and 138, Krypton 85m, 87 and 88, Iodine 131, 133, 134 and 135, Cesium 134 and 137. The measurements are done daily, during the transients at least every four hours.

The characteristic values for isotopes (the average values of the concentrations at full power) for the 11th and 12th cycle, including a comparison with other cycles are shown in Table 5. In 1995, from iodine specific activity, we can conclude, that in the reactor there are some open type damages. Control results show a continued decrease of fuel integrity.

After performance of UT measurements, fuel defects were discovered from the 11th cycle. Four fuel elements planned for the 12th cycle were removed from the core with refueling in 1995.

Table 5: Average activity of the primary coolant for 7th, 8th, 9th, 10th, 11th and 12th cycles.

ISOTOPE	AVERAGE ACTIVITY (GBq/m^3)							
	cycle 7	cycle 8	cycle 9	cycle 10	cycle 11		cycle 12	
					stable conditions	all measures	stable condition	all measures
J - 131	0.08	0.03	0.10	0.11	0.78	7.44	0.44	0.68
J - 133	0.55	0.34	0.25	1.09	3.99	9.14	2.22	2.12
J - 134	2.22	1.22	0.68	0.62	5.40	5.40	5.81	6.03
Xe - 133	23.3	7.40	16.83	6.10	19.72	20.35	12.62	18.61
Xe - 135	2.96	0.89	5.81	3.20	16.24	16.68	13.65	17.3
Xe - 138	0.93	0.52	0.91	0.41	3.09	3.63	5.92	7.03
Kr - 85m	1.11	0.26	1.54	0.73	2.33	2.39	2.11	2.62
Kr - 87	0.48	0.19	0.93	0.47	2.69	2.82	3.53	3.85
Kr - 88	1.11	0.32	2.36	1.12	6.88	6.33	4.92	5.51

5.1.2.2. Steam Generators

NPP Krško has two steam generators with vertical U-tubes (Inconel 600). The SG tubes are exposed to thermal chemical and mechanical influences, mainly during plant transients. The effects are cumulative and over years might necessitate repair (sleeving) or even elimination of the tubes from operation. There are the same problems with corrosion, as with many similar steam generators used elsewhere in the world.

The main SG data of NPP Krško

Overall height	20.6 m
Total weight of empty SG	322 t
Number of U-tubes	4572
U-tube outer diameter	19.05 mm
Tube wall thickness, nominal	1.09 mm
U-tube material	Inconel 600
Total heat transfer surface area	4460 m^2
Flow on primary side	4479 kg/s
Pressure, reactor coolant side	155 bar
SG inlet temperature	324 °C
SG outlet temperature	287 °C
Feedwater temperature	221 °C
Pressure steam	63 bar
Total steam flow	515 kg/s
Maximum moisture carryover, wt percent	0.25 %

During the 95 outage, 100% U-tubes checkout was performed with "Gimbaled Plus Point" (GPP) and I-COIl sounds. The following operations were performed in steam generator no.1:

- 94 tubes were plugged, 6 of which had already been sleeved and 64 were plugged with Westinghouse plugs made of Inconnel 600 (24 for the first time) and had to be replaced according to new NRC regulations with ABB plugs.
- The plugging in steam generator No.1 increased after the 95 outage from 18.13% to 18.78%, or to 18.87% if sleeving effect is taken into account.

The following operations were performed in steam generator No.2:

- 139 tubes were plugged, 81 of which were plugged with Westinghouse plugs made of Inconnel 600 (58 for the first time) and had to be replaced according the NRC regulations with ABB plugs.

The plugging in steam generator No.2 increased after the 95 outage from 14.40 % to 15.67 %.

Table 6: Steam Generators tube plugging

Steam generators characteristics	SG 1	SG 2
Plugged tubes	858 (18,78%)	717 (15.67%)
Plugging considering sleeving	832 (18,87%)	0
average plugging	17.22%	
sleeved tubes in operation	152	0

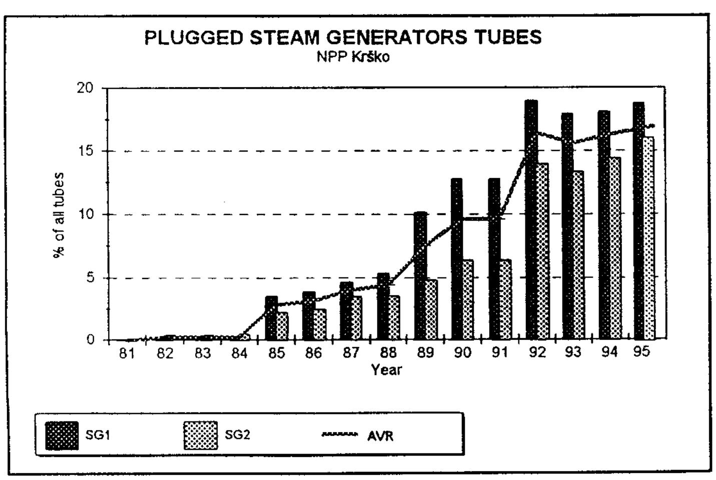
The average plugging of both steam generators is 17.22%

The data about the region of U-tubes, where indications were found that plugging was required, give evidence about processes in the steam generators. Until 1987, the prevailing process was stress corrosion in the tube sheet region and in the transition region. After 1987, the degradation process was caused by intergranular corrosion in the tube support plate region. It was expected that after 1992, when the new condenser was installed, the conditions would improve due to changed secondary chemistry. The previous condenser was manufactured of a bronze alloy that allowed the pH up to 8.8. The new condenser is made of stainless steel and can operate at a higher pH value, which substantially reduces the corrosion rate.

Table 7: Number and percentage of plugged tubes in steam generators along exploitation period

Year	Steam Generator 1		Steam Generator 2	
	Tubes plugged	%	Tubes plugged	%
1982	4	0.088	17	0.370
1983	4	0.088	17	0.370
1984	6	0.130	21	0.460
1985	161	3.520	100	2.190
1986	179	3.920	112	2.450
1987	212	4.640	159	3.480
1988	246	5.390	162	3.540
1989	465	10.180	220	4.810
1990	584	12.780	293	6.400
1992	868	19.02	639	13.97
1993	820	17.95	608	13.31
1994	828	18.13	659	14.40
1995	858	18.78	717	15.67

Figure 10: Percentage of plugged steam generator tubes



5.1.3. Doses Received by Personnel

The exposure data in 1995 indicate that the doses received by workers remained at the very low levels achieved over recent years. The average individual dose was 1.65 mSv and the total collective dose was 1.403 manSv. The reduction of exposure compared to the previous years is the result of improving personnel training and practice during refueling and maintenance.

Table 8 shows the distribution of effective doses for workers of NPP Krško for the period 1981 - 1995. Besides the power plant personnel exposure, the doses of subcontractors are also included in the table. The table shows that no employee received an annual dose exceeding 20 mSv and only 81 persons received the annual dose above 5 mSv in 1995. Workers are mostly exposed during the outage period due to refueling and maintenance.

Table 9 shows the collective and average doses in 1995. The annual collective effective dose per unit of electric power generated in 1995 was 1.65 manSv/GWyear. It increased by two thirds compared to the previous year.

Table 8: Distribution of effective doses for all workers at the Krško NPP during the operational period from 1981 to 1995.

Year	Range of annual doses mSv							Total number of workers
	0 - 1	1 - 5	5 - 10	10-15	15-20	20-25	over 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

Figure 11 shows the collective dose for all workers at NPP Krško for the past 15 years. In 1995, the collective dose was assessed at 1.4 manSv.

Figure 11: Collective effective doses for all workers at (NPP Krško)

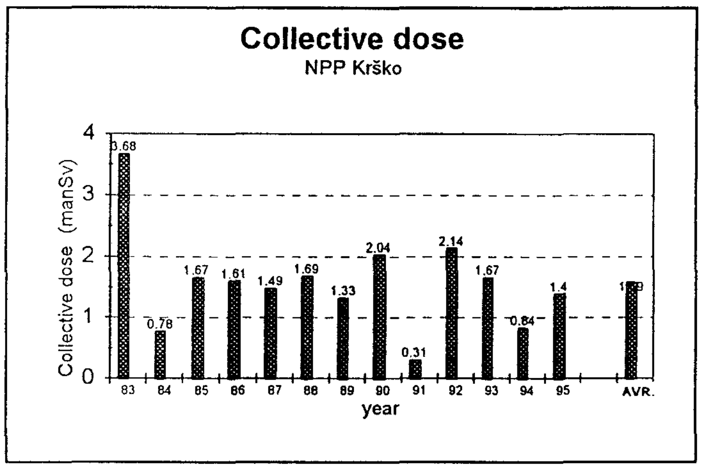


Table 9: Collective and average effective doses for all workers at NPP Krško in 1995

	Collective dose (man Sv)	No. of workers	Average dose (mSv)
Krško NPP Personel Subcontractors	0.306 1.097	347 503	0.9 2.2
Total	1.403 man Sv	850	1.65

5.1.4. Environmental Impact

5.1.4.1. Radioactive Discharges to the Environment

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

Competent administrative authorities are regularly informed about the releases in regular and special reports by NPP Krško. Regular reports are made on a weekly, monthly and yearly basis. In daily reports, NPP Krško informs competent administrative bodies in regular operation reports about the type and activity of releases into the atmosphere and the Sava river. Special reports are mostly relevant to planned gas releases from the gas storage tanks and for the containment before its venting.

In liquid discharges into the Sava river, the dominating radionuclide is tritium. The annual released activity of this radionuclide was 8.5 TBq, which is approximately 43 % of the limiting value 20 TBq stated in the licence. The activity of all other radionuclides is about 10,000 times lower and is currently at the level of a few percent of the limiting values of the licence.

Radioactive gas discharges to the atmosphere are released mainly from the reactor building stack. Noble gases represent the majority of radioactivity in atmospheric discharges, i.e., about 95% of all released activity. In 1995 total discharged activity was 24.8 TBq, which is approximately 23% of the limiting value 110 TBq. This value increased considerably compared to previous year, due to the decreasing fuel cladding integrity.

The released activity in liquid discharges and the released tritium activity during the past years, are depicted in Figures 12 and 13, respectively.

Figure 12: Activity in liquid discharges (without tritium) at Krško NPP. Annual limit is 200 GBq.

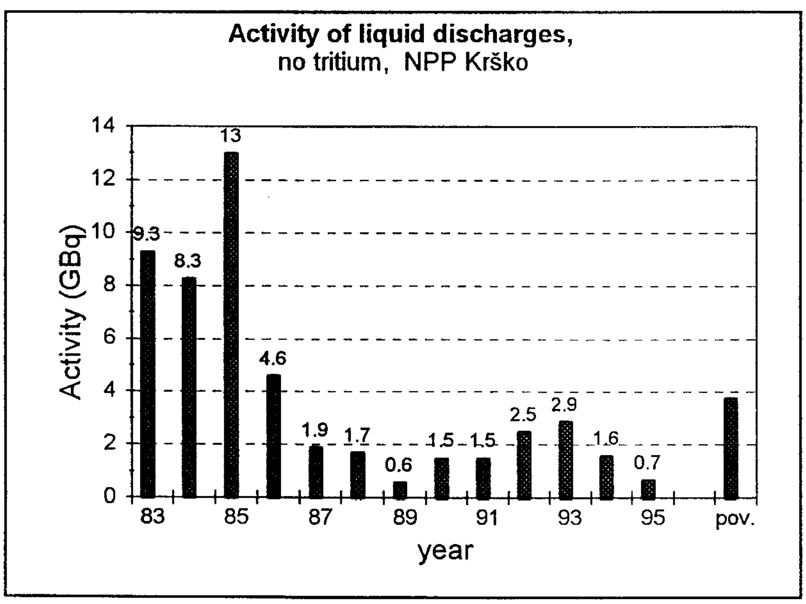


Figure 13. Activity of a tritium in liquid effluents at Krško NPP. Annual limit is 20 TBq.

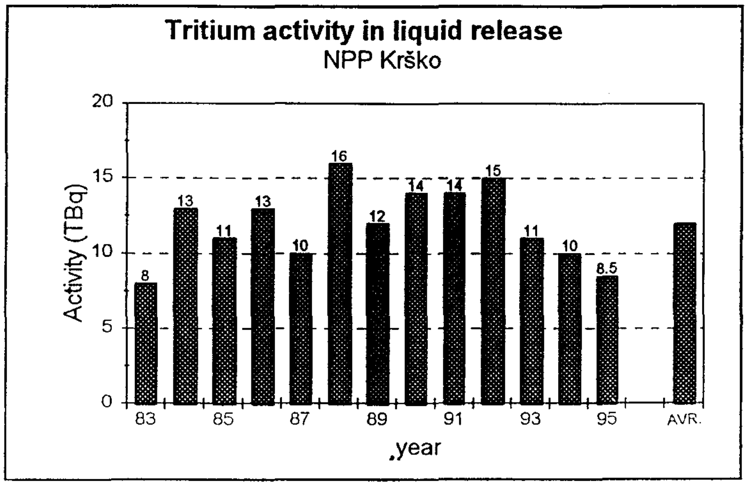
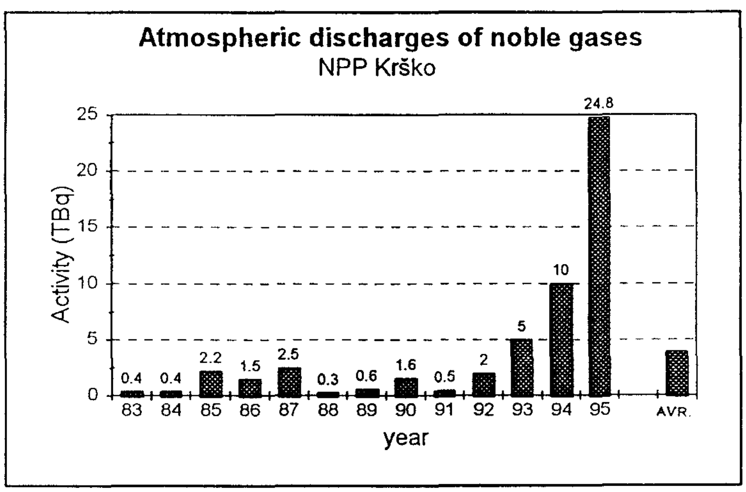


Figure 14 : Atmospheric discharges of noble gases from NPP Krško. Annual limit is 110 TBq.

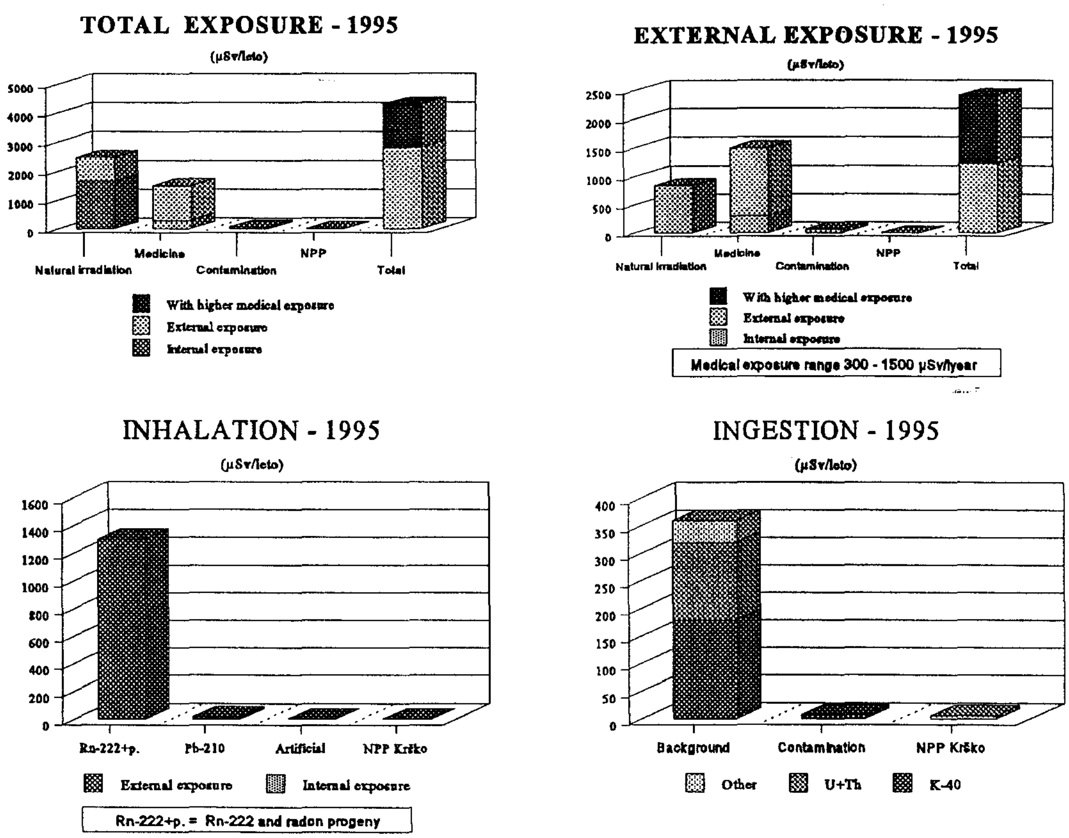


5.1.4.2. Radiological Monitoring

The monitoring programme of radioactivity in the environment of NPP Krško was approved by the SNSA and was regularly performed by the Jožef Stefan Institute and the Institution for Occupational Safety from Ljubljana, and by the Rudjer Bošković Institute and the Institute for Medical Research and Occupational Health from Zagreb. Radionuclide concentrations in different media of the environment were determined, covering all important pathways. The area monitored lies within the radius of 12 km around NPP Krško and reference measurements were taken up to the distance of 45 km.

Members of the public are exposed to radiation originating from liquid and atmospheric discharges from NPP Krško, including direct radiation. The dose evaluation was made on the basis of results of the environmental monitoring programme, including activities of liquid and gaseous releases; meteorological data were also taken into account. In 1995, the additional annual effective dose for the members of the critical group was estimated to be below 20 microSv. The annual individual exposure of population around NPP Krško should not exceed the prescribed limits: 0.25 mSv for total exposure (0.05 mSv due to releases and 0.20 mSv due to direct radiation) so that all doses of members of the public were - as before - well within the regulatory limits.

Figure 15: Radioactivity Monitoring in the Environment of NPP Krško - results of the dose assessment 1995



5.1.5. Radioactive Wastes

During the operation and maintenance of NPP Krško, low and intermediate level radioactive (LIL) wastes are generated. These wastes have to be treated, packed and safely stored at the location of the NPP.
All low and intermediate level radioactive wastes are packed into 200 l drums:

- compressible low radioactive waste without additional protection,
- other drums containing more active waste are enforced with additional protection that consists of a concrete cylindrical liner inside the drums

881 drums of LIL wastes (total activity 7815 GBq) were generated in 1995.

Table 10: Types of storage of low and intermediate level wastes in 1995

Type of waste	No. of drums	Activity (GBq)
EB	400	582
CW	409	296
O	3	0.04
SR	43	6090
F	26	847
Total	881	7815

During the twenty-one years of power plant operations 2281 m^3 (10541 drums) of LIL wastes were accumulated. The average specific activity in a single drums is 29 Gbq/m^3, ranging from 1 to 243 GBq/m^3 (see Table 11).

Table 11: Data on LIL radioactive wastes at NPP Krško (as of 31.12.1995)

Type of wastes	No. of drums	Activity (GBq)	Volume (m^3)	Specif. activity (GBq/m^3)	Radiation level μSv/h from	to
SR	995	50770	209	242.9	1	250000
CW	1525	1250	320.8	3.9	1	30000
EB	7139	9507	1498.6	6.3	0,5	10000
F	151	3344	31.7	105.5	20	90000
O	114	20	23.9	10	1	300
SC	617	531	197.4	2.7	10	25000
Total	10541	65422	2281.4	287	0,5	250000

Source: Data of NPP Krško

Type of waste:
SR - spent resins
CW - compressible waste
EB - evaporator bottom
F - filters
O - other
SC - really compacted waste

In 1993, the Slovenian Nuclear Safety Administration issued a licence to a plant operator for the compaction of drums containing evaporator bottoms. The compaction procedure was used to reduce the volume of evaporator concentrates. The compacted drums were deposited into a special cask (TTC-Tube Type Container). Each TTC has an inside diameter of 640 mm and is 2700 mm high. TTC is 864 liters. The TTC is reinforced with a steel ring, protected against corrosion and tested according to the IAEA recommendations. The TTCs are put into a temporary storage where they are stacked into two levels. These procedures reduce the LIL Waste in the storage.

1635 drums (CW and O) were compacted and stored into 207 TTC (7.89 standard drums into one TTC). The compaction campaign was completed at the end of November. 7135 drums with a less compressible EB were also compacted and stored into 1417 TTC (five standard drums into one TTC). 387 standard drums with SR/F were stored into 129 TTC without compacting. (See table 12)

The status on December 1995 was the following: 1753 TTC, which included 9157 standard drums (200 liters), were stored in a temporary storage of NPP Krško at the end of December 1995.

Table 12: Data on LIL wastes compaction at NPP Krško in 1994 and 1995

Type of waste	Activity (GBq) before compaction	No. of drums	No. of TTC	Volume (m^3)	Specific. Activity. (GBq/m^3)
CW + O	1267	1635	207	178.8	12430
EB	9426	7135	1417	1224.3	7665
SR + F	36550	387	129	111.5	504500
Total	47240	9157	1753	1514.6	44790

Source: Data of NPP Krško from 21.06.96

Modification system treatment liquid LILW

Since the on-site storage capacity is limited, an advanced treatment method should be applied to reduce the waste volume and use the storage capacity available more effectively.

Radwaste treatment installed in NPP Krško consists of the equipment for a solidification system for concentrates and spent resins using cement/vermiculite as the binding materials. The solidified waste is filled and stored in 55 gal. drums.
Solidification increases the waste volume/number of drums.

In 1995, Siemens and IBE (Slovenian Engeneering Company) prepared a study on the "Conceptional Design Packages of a Waste Processing System for the Volume Reduction of Evaporator Bottoms and Spent Resins"

With the new technology, spent resins will be drying in a spent resins drying tank. When the drying process is finished, dry and free flowing bead resins are discharged by the gravity force directly into a 55 gal. drum.
Drying the concentrates will take place directly into 55 gal. drums, under vacuum. Treatment of wastes with the new technology will reduce the volume of SR by approximately 4.5 times, and the volume of EB will be reduced by approximately twenty times.
With the new technology the waste products contain 1% free water and have low residual moisture. There are no solidification agents like cement or vermiculite and waste will be reduced in volume. However, the activity content and the surface dose rate levels will be higher. This system is in operation in five nuclear power plants in Germany and in one in Spain.
The SNSA is carefully considering the modification, but it is not ready for approval yet.

5.1.6. Plant Improvement Programmes

5.1.6.1. Steam Generator Replacement

It is well known that the steam generators (SG) represent a weak point in PWR nuclear power plants. The life time of SG built in the seventies and eighties is approximately 15 years. The same goes for SG of NPP Krško.

SG replacement is a well-known modification which has already been done in many NPPs. The main reasons for modifications are:

- the collective effective dose after the replacement is smaller
- financial assessments support SG replacement
- need for more electricity, with possible upgrading of the plant

In the last few years, the SNSA has been stressing the need for SG replacement because of:

- the number of plugged tubes, which is approaching the limiting value for safe operation at full power;
- maintenance work, which prolongs outages, and increases the cost and the collective effective dose;
- the preparation time for replacement, which is at least three years.

5.1.6.2. Plant Modifications

An extensive programme of upgrading NPP Krško and increasing the safety of the plant is in progress. Modifications in accordance with decrees issued by the SNSA, which were either started or completed in 1995, were the following:

1. Modification 001-ER-S, "Meteorological System Upgrades"
   Status: NNSR, were not completed by the end of 1995.
2. Modification 020-RP-L, "AMSAC NSR, completed.
3. Modification 026-FP-L, "Fire Protection Upgrade"
   Status: NNSR, in progress.
4. Modification 043-PC-S, "Increase of Paging System Channels"
   Status: NNSR, completed.
5. Modification 046-HC-L, "Containment Hydrogen Monitoring"
   Status: NSR, in progress.
6. Modification 047-SI-L, "Containment Wide Range Pressure Monitoring"
   Status: NSR, completed.
7. Modification 051-LS-L, "LS ADD Emerg. Lighting sys"
   Status: Acronyms:

NSR - Nuclear Safety Related
NNSR - Non-Nuclear Safety Related

5.1.6.3. Implementation of the Recommendations of Expert Missions

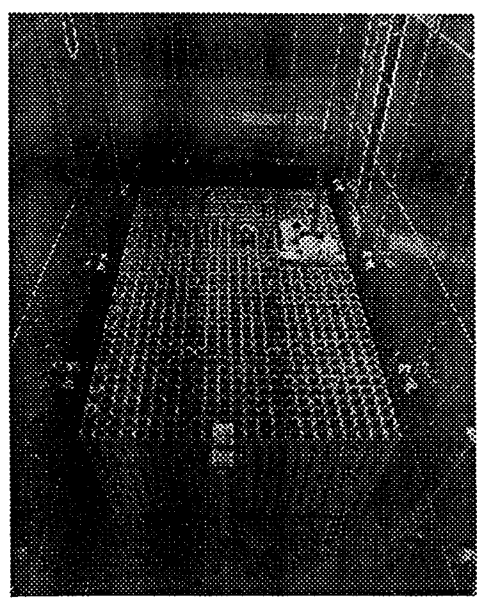
There were three expert missions working on nuclear safety in Slovenia in 1993. Together they made 252 recommendations. However, they assessed that nuclear safety in Slovenia was ensured. By the end of 1995 approximately 90% of recommendations had been carried out. Table 13 shows a review of recommendations with the present and required status of their performance.

Table 13: The overview of Recommendations and their Implementation

1997	Review Area	No. of Recommendations			Implementation Schedule			
		OSART	ICISA	Total	Already Implemented	Not implemented	1996	No Schedule
	Management, Organization and Administration	21	9	30	30	0		
1	Training and Qualification	19	1	20	18	2		1
1	Operations	23	6	29	28	1		
	Maintenance	17	3	20	18	2		2
2	Technical Support	17	3	20	17	3		1
1	Radiation Protection	24	6	30	28 +1 N/A	1		
	Chemistry	27	8	35	30	5		5
	Emergency Planning and Preparedness	19	2	21	20	1	1	
9	Plant Systems	/	9	9	7	2		1
10	Fuel and Wastes	/	3	3	2	1	1	
11	Geology/Seismology	/	8	8	7	1		1
12	Analyses and Studies	/	11	11	8	3	1	2
13	Regulatory Body	/	/	5		0		
TOTAL		167.00	74.00	241.00	213 + 6 (N/A)	22.00	3.00	13.00

5.1.7. Spent Nuclear Fuel

Spent fuel elements are stored at the power plant in the spent fuel pool which has enough space for 17 refuelings and for the entire reactor core (121 fuel assembles) as a permanent available reserve if, for any reason, it will be necessary to empty the reactor core. The capacity of the spent fuel pool is therefore sufficient for the storage of used fuel elements at least until the year 2000. The plant operator is making great efforts to increase the duration of the fuel cycle and to achieve better efficiency by improving the nuclear core design. This would make it possible to use the existing spent fuel pool until 2004. In 1995, additional 36 fuel elements were stored, so that in total, there were 442 spent fuel assembles in the pool by December 31, 1995.



Spent fuel storage pool

5.1.8. Training of Personnel

The plan of training for 1995 was established on the basis of presented needs of individual divisions and departments of NPP Krško and in accordance with the professional programme of personnel as it is described in chapter 13.2. of the FSAR.

The training of licenced personnel, of personnel taking care of nuclear safety and of personnel whose knowledge has to be updated with respect to the Slovenian legislation, was carried out according to plan.

Complementary Training

Complementary training of operating personnel includes training for obtaining operator licences, training of workers for vacancies in a working unit of production and specific training needed for obtaining new knowledge. In 1995, one group (six participants) successfully completed the training for reactor operators and passed the exam for the operating licence.

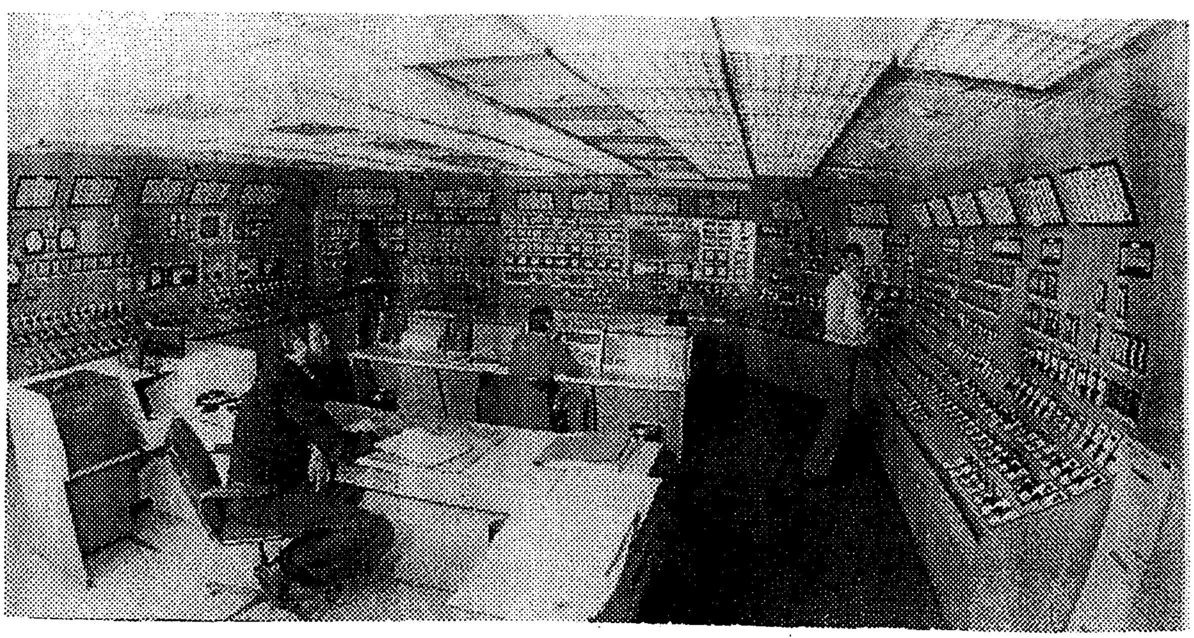
Permanent Training

Permanent training of personnel includes programmes prescribed for licenced personnel and for personnel on local posts.

In 1995, eighteen candidates passed the exam for the Reactor Operator and Senior Reactor Operator licences. All the candidates who had to renew their licences attended a refresher course.

Simulator training is in accordance with the US NRC training and requirements for the renewal of licences.

Training on the engineers' simulator *held in* Brussels was organized for two groups of licenced personnel with Senior Reactor Operator licences. The purpose of this course was to broaden and deepen the knowledge related to accident events and measures in the case of an accident.



5.1.9. Emergency Planning and Preparedness at NEK

Two full-time employees in the Engineering department of the Krško NPP are responsible for the emergency preparedness. Their duty is to maintain the NPP Krško Radiological Emergency Preparedness Plan as the document, to prepare the training plan for the emergency staff, to prepare the draft plan of the nuclear emergency exercise (they are assisted by other NPP personnel), to monitor the availability and operability emergency preparedness equipment, and to resolve minor deviations related to emergency preparedness on the spot or to report them to the superiors if these deviations cannot be resolved immediately. In 1995, the most important activity in the field of emergency preparedness was the annual exercise NEK-95 on November 24.

In the NEK-95 exercise the following organizations took part:

- NPP Krško,
- a regional notification center - Krško
- SNSA,
- a professional firefighting unit of the town Krško.

The purpose of the NEK-95 exercise was to test the NPP Krško Radiological Emergency Preparedness Plan and the corresponding emergency procedures, communications and operability of the equipment, to activate technical and operations support centers, as well as performance testing of contracted organizations (e. g. a firefighting unit of the town Krško), notification of the regional notification centre, testing of the dose assessment, recommendation of countermeasures and notification of the SNSA.

At the SNSA, the expert groups tried to evaluate the information collected about the accident and the plant status, forecast the development of the event and to inform the public. Most of the communication was carried out via telephone, facsimile and computer network.

The exercise scenario was the following: the nuclear power plant is at the end of the fuel cycle (EOL) in cold shutdown just before the annual outage. During the preparation works there is a release of radioactive gases from the gas decay tanks in the auxiliary reactor building. While locating the release of radioactive gases is in progress, an explosion blasts off a gas decay tank which is incidentally filled with hydrogen. A local fire breaks out in the auxiliary reactor building. Primary systems and the reactor building are not jeopardized. The scenario lasts four hours and, in between, there are minor radioactive releases into the environment.

The lessons learned, during the exercise, can be summarized in:

- transmitting only vital and necessary data,
- computer support for fast calculation of different parameters,
- some modifications to the emergency plans (of the nuclear power plant and the SNSA),
- training according to the procedures should be increased.

The final conclusion was that the exercise was necessary and that such activities should be continued; they are also planned for next year.

5.2. TRIGA RESEARCH REACTOR

The TRIGA Mark II research reactor at Podgorica near Ljubljana with power of 250 kW has been operating for more than 25 years. Radioactive isotopes, mostly short-lived ones, are produced for use in medicine, science and industry. The reactor is also used by the Jožef Stefan Institute, which carries out scientific and research work involving neutrons and gamma radiation in the fields of reactor physics, neutron activation analyses, and training of personnel.

No one among the operating personnel exceeded an external annual gamma dose of 0.4 mSv or an effective dose of 1 mSv from neutron radiation.

Radioactive Discharges and Environmental Monitoring

The monitoring of radioactive discharges and environmental radioactivity in 1995 was performed on the basis of the program adopted by the SNSA. The main discharges into the environment were releases of Ar-41 into the atmosphere (ventilation system of reactor confinement) and the discharge of liquid effluents into the Sava river, mainly from the Radiochemical Laboratory.

The conservative assessment of an annual effective dose for a member of the public living close to the reactor site gives the following values: 0.3 microSv due to Ar-41 inhalation and 1 microSv due to hypothetical drinking of water from the Sava river.

Interim Storage of Radioactive Waste in the Reactor Center Podgorica

Interim low and medium storage for solid radioactive waste for users in Slovenia (except for NPP Krško and the Žirovski Vrh Uranium Mine) has been in operation since 1987.

There are three types of radioactive waste in the storage:

- closed barrels with contaminated items (paper, plastics, glassware, etc.) and materials with induced radioactivity due to irradiation in the TRIGA reactor,
- other waste - contaminated or radioactive items which, due to their big size, cannot be stored in barrels and are therefore stored separately,
- sealed sources out of use, which are stored in original protected containers.

The quantities and activities of different types of radioactive waste are given in Table 14.

Table 14: Stored Radioactive Waste in the Interim Storage at the Podgorica Reactor Center in 1995

Type of waste	Total (1995)	Isotopes *	Activity (GBq)
Barrels	145 (3)**	Co-60, Cs-137, Eu-152	3 - 20
Special	97 (7)	Ra-226	5400
Sealed source's	234 (69)	Co-60/Ra-226/Am-241 Co-60, Sr-90	1000

* - only isotopes providing the majority of activity are quoted , ** - barrels stored in 1995

5.3. THE ŽIROVSKI VRH MINE

5.3.1 the Activities on Permanent Closure of the Uranium Ore Exploitation

The Uranium Mine authorities stated that the funds allotted from the Budget of Slovenia were insufficient to carry out the major parts of the program for 1995. Only the most necessary works were carried out. The available funds did not allow to perform any underground activities in connection with the termination of exploitation. No such activities have been not performed during the last two years. The consequence of this will be substantially higher costs of the closure and a higher probability of unpredictable events affecting the safety of the mine closure.

In the facility for the production of uranium concentrate, only sporadic works on cleaning and decontamination of equipment have been carried out. These works included the separation of reusable equipment from wastes and scrap material, the classification of material according to levels of radioactive contamination, temporary storage of contaminated material and equipment and sales of uncontaminated equipment. A wet process was used for the cleaning and decontamination (a high-pressure water beam). 63.1 tones of scrap iron, predominantly parts of the rod mill, were shipped to the iron smelter. On the Jazbec mine waste disposal site, 12.4 tones of contaminated and uncontaminated nonmetallic (construction) material, has been disposed of.

On Boršt, disposal of uranium mill tailings, regular maintenance works, mainly on drainage system into a water treatment pond, and works on sealing the crack caused by the landslide, have been carried out. The construction of the drainage tunnel under Boršt produced a lot of material, which has been deposited on top of milling tailings in order to decrease the gamma exposure rate, emanation of radon into the atmosphere and to protect the surface against erosion. The results of the quarterly geodetic measurements performed by the Faculty for Geodesy from Ljubljana, carried out during the drainage tunnel progress, led to a conclusion that the speed of landslide has gradually decreased. The last three quarterly measurements in 1995 showed that the movement of the slide is no more than a few millimeters. The displacements are noticeable only along the measuring points that are positioned in the general direction of the landslide.

5.3.2 Protection Against Ionizing Radiation

During all works, special attention has been devoted to the measurement of radon emanation and ionizing radiation. In total, 231 radon measurements were performed in 1995. The concentration of radon and radon daughter products reached about 1/3 of the prescribed limits for the working environment. In 1995, at the RŽV, 16,055 measurements of alpha, beta and gamma radioactivity were performed. The RŽV issued 180 certificates on non-contamination of reusable materials and equipment. In addition, fourteen certificates were issued for scrap iron and 21 certificates for the deposition of material on the municipal waste disposal.

5.3.3 Protection of Employees

The average of all calculated effective doses, calculated for 56 employees, was 0.5 Sv per employee in 1995. The highest calculated effective dose for an employee in 1995 was 1.5 mSv or 3% of the prescribed limit (50 mSv). Regular annual medical examinations for all employees and ex-employees were carried out. In 1995, the limited working ability was recognized in six cases.

5.3.4 The Control of Radioactive Pollution

The emissions of radioactive pollutants into the drainage system of the Sora river were regularly monitored (on a daily, weekly and monthly basis). The concentration of uranium and radium are given in Table 15. The total annual quantity of emitted uranium and radium are given in Table 16.

Table 15: The average annual flow and assay of uranium and radium in waters

Sampling station	Annual Flow (1000 m^3)	Average Uranium Assay (mgU_3O_8/m^3)	Average Radium Assay (Bq $^{226}Ra/m^3$)
Station for the treatment of mining water	742	272	61
Creek Jazbec, after mining waste disposal (Jazbec)	539	340	20
Drainage from mill tailings disposal Boršt	23	495	176
Overflow from water treatment pond Boršt	19	1065	4547
Drainage of the water treatment pond Boršt	958	675	589
Drainage tunnel Boršt	39	<10	13
Creek Boršt	441	<10	92

Table 16: Total annual emissions of U3O8 and Ra-226

	U_3O_8 kg	% of emission %	activity ^{226}Ra MBq	% of activity %
Mine	200	51	46	25
Waste disposal Jazbec	162	41	11	6
Waste disposal Boršt	29	8	124	69
Total	391	100	181	100

The radon emissions in 1995 were lower than in 1994 due to the termination of ventilation of underground workings. However, a significant decrease can not be expected before the sanation of the Jazbec mining waste disposal, which is the main contributor to the radon concentration in the valley.

5.3.5. The Environmental Impact of RŽV

The contamination with uranium and radium is regularly measured in the creeks Todraščica and Brebovščica. The results for 1995 are given in Table 17.

Table 17: The average annual concentrations of uranium and Ra-226 calculated from monthly composites for the creeks Todraščica and Brebovščica

Sampling station	Annual flow (1000 m^3)	Average Uranium assay, (mgU_3O_8/m^3)	Average Radium assay ($Bq^{226}Ra/m^3$)
Todraščica	4253	10	33
Brebovščica, 1.5 km downstream from Todraž	30317	15	7

5.3.6. Radioactivity in the Environment of the Former Uranium Mine at Žirovski Vrh

The former uranium mine at Žirovski vrh is located in a small village of Todraž, in northwester Slovenia, 35 km from the Austrian and Italian borders and 30 km from Ljubljana. The mining area lies in a subalpine region of the country, in a deep valley with frequent temperature inversions (about 50 % of the time every year). About three hundred inhabitants live in the area within a radius of 2 km from the mine.

Relatively low grade ore was excavated and treated (less than 0.1% U_3O_8) in the period 1985-1990. Radioactive wastes, such as hydrometallurgical tailings of about 600,000 tons, were deposited on the slope of a hill, above the valley of the Todraščica stream. The mining waste disposal (1.5 million tons of waste rock, containing about 70 ppm U_3O_8) and a temporary deposit of several thousand tons of uranium ore are located on the western slope of the Brebovščica valley.

The regular environmental monitoring programme, based mainly on the US Regulatory Guide No.4.14, which started in 1985 has covered all critical pathways. Since the cessation of mining and milling, the monitoring programme has been continuous. Generally, the most important consequences of uranium mining and milling are usually observed as contamination of the surface and ground waters with U, ^{226}Ra, ^{230}Th and ^{210}Pb. In the case of the Žirovski Vrh Mine it was found that the main radiological impact to the critical population group originated from inhalation of radon and its short-lived daughter products.

The most important pathways are: inhalation of enhanced levels of radon and its short-lived progeny, inhalation of dust particles with long-lived radio nuclides, ingestion of food and water biota, and exposure to external radiation.

Table 18: Environmental concentrations in the surroundings of the mining area at Žirovski vrh in the operating period 1985-1990

Sample	Radio nuclide	Mine environment	Reference point
Air particulates	^{238}U	0.03-0.12 mBq/m³	0.015 mBq/m³
	^{226}Ra	0.01-0.08 mBq/m³	0.010 mBq/m³
	^{210}Pb	0.5-1.3 mBq/m³	0.5 mBq/m³
Radon	^{222}Rn	10-40 Bq/m³	10-25 Bq/m³
Rn-progeny	EEC ^{222}Rn	5-25 Bq/m³	5-15 Bq/m³
Surface water	uranium	10-30 mg/m³	0.5 mg/m³
	^{226}Ra	12-30 Bq/m³	5 Bq/m³
	^{210}Pb	2-10 Bq/m³	2 Bq/m³
Sediments	uranium	15-35 mg/kg	5 mg/kg
	^{226}Ra	250-600 Bq/kg	50-60 Bq/kg
	^{210}Pb	250-600 Bq/kg	60 Bq/kg
	uranium	5-6 Bq/kg	4-5 mg/kg
	^{226}Ra	50-70 Bq/kg	50-60 Bq/kg
	^{210}Pb	60-150 Bq/kg	60-90 Bq/kg
Ext.dose-rate on tailings		2.0-3.5 µGy/h	0.1 µGy/h

Measurements of environmental radioactivity were performed at numerous places in the vicinity of the mine and also at some distant points. The results obtained were compared with measurements at reference points, beyond the environmental influence of the mine.

Table 19. Annual effective dose equivalent in 1995 - the contribution of the Žirovski Vrh U-mine to the natural background annual exposure of 5.5 mSv

Pathway	Detailed description, important radio nuclides	Annual effective dose equivalent * (mSv)
Inhalation	aerosols (U, ^{226}Ra, ^{210}Pb)	0.006
	^{222}Rn (gas),	0.006
	Rn short-lived progeny	0.302
Ingestion	drinking water (U, ^{226}Ra, ^{210}Pb),	(0.016)
	water biota (^{226}Ra, ^{210}Pb)	< 0.002
	agricultural products (^{226}Ra, ^{210}Pb)	0.046
External radiation	Rn progeny (immersion, deposition),	0.003
	long lived radio nuclides,	-
	direct radiation from waste piles	0.003
Total annual effective dose equivalent (rounded)		0.37 mSv

* Dose conversion factors from BSS (1996) except for radon decay products the factors for which were taken from the ICRP 50 publication

Former Uranium mine at Žirovski vrh

5.3.7. IAEA Expert Mission at the Žirovski Vrh Mine

A two-week International Atomic Energy Agency mission was carried out in 1995. The objectives of the mission were to assess the radiological safety during and after the closure of the mine and to review plans for the decommissioning of the facilities and for the disposal of radioactive wastes.

The mission prepared the following recommendations to the government:

- To clarify responsibilities and procedures between the bodies involved in mine closure (Article 11 of the Law on Closing of the RŽV),

- To request from RŽV to evaluate again the alternatives for the decommissioning of the Boršt disposal site. In the evaluation of the long-term environmental impact of the alternatives, the consequences of possible dispersion of tailings due to landslide or water erosion or because of any other reason, should be seriously considered.

- To assess the costs of remedial actions required in such cases
- To request from RŽV to prepare a detailed technical decommissioning project (DTDP) with time schedule and budget for the approval by the Government

- To request from RŽV to prepare a quality assurance programme to be applied during the implementation of DTDP

- To secure the RŽV budgeting for the elaboration of DTDP

- To conceive a long-term public information programme to provide correct information on the risk from the environmental radiation from the RŽV.

5.4. TEMPORARY RADIOACTIVE WASTE STORAGE ZAVRATEC

The radioactive wastes from the Oncological Institute, Ljubljana, resulting from contamination of premises with 10 mg of Ra - 226 sulphate ($3.7x10^7$ Bq), were stored in 1961 in an old caserne close to the Zavratec village, situated between Idria, Godovič and Logatec.

In order to perform conditioning or to move the radioactive wastes from Zavratec, several initiatives were raised in the past years. The Government of Slovenia has authorized the Agency for Radioactive Waste Management (ARAO) for remedial action. The ARAO issued a tender for public bidding. The IB Elektroprojet from Ljubljana was selected and suggested two options:

1. repacking of waste and its transport and storage at the temporary storage of LIL waste at Podgorica

2. repacking of waste and its storage on the same location at Zavratec.

An ad-hoc Nuclear Safety Commission evaluated the study and provided guidance on remedial action on Zavratec waste and its storage on the same location at Zavratec for the year 1996. Due to limited financial resources, the ARAO purchased in 1995 only the elaboration of the programme for the repacking of waste and its storage on the same location at Zaratec for the year 1996.

Summary of measurements of external radiation at Zavratec

Detailed measurements of external radiation of the building and its surroundings was performed in 1992. The measurements were carried out as part of the research work at the high school of Idria and in cooperation with the Jožef Stefan Institute. The measurements were performed with a portable scintillation counterwith NaJ(Tl) detector.

The measurement of gamma doze-rate on the front wall of the building, showed slightly enhanced values above background radiation (0.08 - 0.11 micro Gy/h), mainly in the range of 0.10 - 0.12 micro Gy/h. The maximum values were up to 0.15 micro Gy/h, possibly indicating the position of radioactive waste in the building.

RADIOACTIVITY MONITORING IN SLOVENIA

Environmental Laboratory Mobile Unit

6.1. RADIOACTIVITY IN THE HUMAN ENVIRONMENT

6.1.1. Monitoring of the Global Radioactive Contamination in Slovenia

The radioactivity monitoring programme for global contamination in the living environment in the Republic of Slovenia was determined by the Regulation on the locations, methods and time periods for the radioactive contamination control (based on the former Official Gazette of the SFRY, No. 40/86), and on the basis of expert opinions adopted after the Chernobyl accident. The programme is performed by the Institute for Occupational Safety of the Republic of Slovenia and the Jožef Stefan Institute.

The programme encompasses:

1. Surface waters - semi-annual grab sampling of river water: the river Sava at Ljubljana (down streams), the river Drava at Maribor and the river Soča below Anhovo. The concentrations of gamma emitters and H-3 in river water were analyzed.

2. Air - continuous daily sampling in Ljubljana, Jezersko and Predmeja. Isotopic analyses of gamma emitters were performed monthly.

3. Soil - sampling twice a year (in May and October) three depth layers, 0-5 cm, 5-10 cm and 10-15 cm, on grassland in Ljubljana, Kobarid and Murska Sobota. The contents of Cs-134/137 and Sr-90 were determined. The external gamma radiation (dose rate) was measured in Ljubljana, Maribor, Novo Mesto, Celje, Nova Gorica, Portorož, Murska Sobota, Kredarica and Lesce. In addition, monthly doses from external radiation were measured at 50 locations by thermoluminescent dosimeters.

4. Precipitations - continuous sampling of precipitations in Ljubljana, Kobarid, Murska Sobota and Novo Mesto. In Ljubljana, concentrations of gamma emitters and Sr-90 were measured in composite monthly samples, and in composite quarterly samples at other places.

5. Drinking water - quarterly isotopic analyses of gamma emitters and specific analyses of Sr-90 and H-3 were made in samples from Ljubljana, Celje, Maribor, Koper, Škofja Loka and Kranj.

6. Food - contents of gamma emitters and Sr-90 in food from plant and animal origin were measured at locations in Ljubljana, Novo Mesto, Koper, Celje, Murska Sobota, Maribor and Slovenj Gradec. The radionuclide analyses in milk as a staple diet were made on a monthly basis in Ljubljana, Bohinjska Bistrica, Kobarid and Murska Sobota.

7. Animal feed, grass - the programme provides the analysis for the content of gamma emitters and Sr-90 in grass, hay, feeds, manure and phosphates, particularly in the areas where milk is controlled.

The measurements of activity concentration in environmental samples: in air and in precipitations in 1995, no significant reduction in levels compared to the previos period.

The measurement of the external gamma radiation dose rate showed that the Chernobyl contribution still accounts for an average 17% - 30% of the total external outdoor dose measured in Slovenia. The country average annual dose of external gamma radiation measured by thermoluminescent dosimeters amounts to 888 microSv.

The results of measurements of specific activity in samples of unploughed soil taken in Ljubljana, Murska Sobota and Kobarid showed a similar distribution of the Chernobyl isotopes Cs-134/Cs-137 in depth layers as in 1993 and 1994. Samples from Ljubljana and Kobarid show an almost uniform distribution of Cs-134/Cs-137 in all three layers, while in Murska Sobota 70% of contamination is located in the first layer, depending on local hydrometeorological and pedological characteristics. The content of Sr-90 was the same as in previous years, i.e. it is uniformly distributed in all three layers of soil.

In 1995 there was a significant decline in radioactivity in the food samples of vegetable origin. Since the contamination of vegetables with Cs-137 is mainly the foliar deposit, the content in 1995 was negligible. On the other hand, radionuclide Sr-90 may, due to its mobility, contaminate vegetables via the roots. The activity of gamma emitters and Sr-90 in fruit samples remained, with a few exceptions, at the same level as in the previous year.

The results of specific activity of gamma emitters and Sr-90 in food samples of animal origin showed that contamination with Sr-90 in 1995 did not change compared to results of the preceding year.

On the basis of measured concentrations of artificial and natural radionuclides in food samples, the effective doses from ingestion pathway were estimated. The annual dose from external gamma radiation was measured in larger towns in Slovenia. In Ljubljana, the annaul dose (measured by TLD) was 876 microSv, out of which the Chernobyl accident was estimated to be responsible for 146 microSv.
Based on the results of environmental contamination, it was established that the annual intake of artificial radionuclides in 1995 was well within the limits prescribed by the Regulations on the maximum contamination of human environment and on decontamination (Official Gazette of the SFRY, No. 8/87).

In view of the river Sava's high contamination from hospitals, the contribution of I-131 and of other isotopes from the Krško nuclear power plant is quite negligible.

Table 20: Radioactivity of soil in Slovenia - Surface activity of Sr-90 in the top layer of the grass land (0 to 5 cm) in Bq/m^2

Year	LJUBLJANA	KOBARID	MURSKA SOBOTA
1982	126	222	69
1983	157	161	43
1984	102	161	48
1985	107	154	56
1986*	123	680	115
1987	115	465	90
1988	120	395	84
1989	129	384	89
1990	130	335	81
1991	80	240 +	73
1992	82	255	71
1993	93	280	54
1994	77	230	70
1995	71	210	79

* Results are not reliable due to the presence of short-lived radio nuclides with high activity in the period following the Chernobyl accident
+ Sampling site was changed

Table 21: Radioactivity of milk in Slovenia - Sr-90 concentrations in milk correlated with its specific activity in precipitations

	Sr-90(Bq/kg) in milk		Rainfall Sr-90(Bq/m^3)		Rainfall (mm)	
Year	Ljubljana	Kobarid	Ljubljana	Bovec	Ljubljana	Bovec
1984	0.17	0.33	1.1	2	1423	2792
1985	0.19	0.33	0.9	1.9	1611	2855
1986*	0.28	0.81	450	630	1264	2137
1987	0.4	87	6.1	12	1528	3316
1988	0.22	0.53	1.8	5.3	1179	2498
1989	0.17	0.38	1.2	3.6	1212	2125
1990	0.19	0.43	0.38	1.1	1334	2865
1991	0.16	0.36	0.48	1.8	1178	2340+
1992	0.22	0.32	0.65	1.2	1434	3164
1993	0.15	0.3	1.4	1.1	1178	2343
1994	0.14	0.22	1.1	1.4	1397	2282
1995	0.12	0.22	0.43	0.6	1404	2549

* Results are not reliable due to the presence of short-lived radio nuclides with high activity in the period following the Chernobyl accident
+ results for May 1986 not included

Table 22: Radioactivity of the ground in Slovenia - External gamma radiation, Ljubljana

Year	External gamma radiation (micro Sv)	Calc. Chernobyl contribution (micro Sv)
1988	1080	360
1989	1131	280
1990	994	220
1991	966	190
1992	975	190
1993	904	180
1994	876	146
1995	872	150

6.1.2. Environmental Radioactivity around the Former Coal Mine in Kočevje

Radioactivity in the environment at the former coal mine in Kočevje, arising from the high uranium content of brown coal, was also investigated. Enhanced levels of gamma dose-rate and radionuclide contents were found on the tailings and in deposited coal respectively. The results showed that radioactivity in the disposal terrain is not uniformly distributed; in central parts of the depository, gamma dose-rates up to 0.3-0.4 microGy/h were measured. Mostly, values of 0.15-0.25 microGy/h were found over the total area.

Table 23. Gamma dose-rate levels on the coal and ash depository at the Kočevje Lake

Location	Detailed description of sampling points	Sample	Absorbed dose-rate (microGy/h)
Open-pit mine	E side of the lake	coal, ash	0.20, 0.15-0.30
Depository	NE from the lake	slag, ash	0.20
Lake shore	E side of the lake W, NW side of the lake	slag, ash coal, soil	0.20-0.25 0.10-0.20
Šalka vas Trdnjava	village farmyard village garden	soil, ash, coal	0.20-0.25, 0.4 0.10-0.12, 0.3
Šal.vas Mlaka	N, NE of the Kočevje	soil (grassland)	0.10, 0.10-0.12

All coal samples and its mixtures with ash or soil contain considerable quantities of uranium and radium. Great variations in contents were found: mainly in the range of 400-1200 Bq/kg, but in some places (at Šalka vas: on coal tailings, at a courtyard) even more than 4000 Bq/kg.

Indoor radon concentrations measured in numerous houses situated within the mining area showed an average value of 200 Bq/m^3, in one case it reached 2600 Bq/m^3 in a living-room, and in a cellar, concentration reached 3150 Bq/m^3. The town of Kočevje is situated in a closed circular valley. In a period of strong temperature inversions, the daily average was about 80 Bq/m^3, with early morning maxima even up to 150 Bq/m^3. Even in summer, peaks of equilibrium-equivalent concentrations (EEC) exceed levels of 100 Bq/m^3 and outdoor radon concentrations are supposed to be the highest in the country. There is no satisfactory explanation for high outdoor levels; they are probably a consequence of high radon potential in background soil, hgh radioactivity in the nearby coal tailings area, and also of the topographical and climate characteristics of the site. The radioactivity of surface waters (lake, water) is well above the levels found in unpolluted waters.

6.1.3. Radiation Measurements in the Lead and Zinc Mine at Mežica

The lead and zinc mine at Mežica was classified among those mines in Slovenia at which the highest concentrations of radon were measured. The mean values of 1420 Bqm^{-3} were determined at workplaces and even 77 k Bqm^{-3} at an unloaded part of the mine. Mine galleries are vented naturally, so radon concentrations at workplaces change during the seasons of the year. External radiation in the mine is very low due to the low content of radionuclides in dolomite. More intensive measurements of radon have been started in the last period at all workplaces in the mine. The highest concentrations were measured at a workplace named Graben, i.e., at the deepest location in the mine. In summer time they reached up to 3000-3700 Bqm^{-3} equilibrium equivalent concentration or 0.8-1 WL potential alpha energy concentration of radon short-lived daughters. In 1995, during the first phase of the mine close-out, when the deepest parts of the mine were flooded, radon daughter concentrations decreased (down to 0.5-0.7 WL). Since then, radiation exposures of miners have been reduced. A dose assessment was made for the past period; doses received in 1994 were quite high: the median value for Mežica miners was 28.6 ± 14.6 mSv or around 60% of the dose limit for occupational exposure. Considering the lower concentrations in 1995, the average annual exposure also decreased almost to half the previous value (15.0 ± 11.6 mSv). The comparisons of annual doses received in 1994 and 1995 with a statistical evaluation are in Table *24*.

Table 24: The statistics of the annual doses for miners of the lead and zinc mine at Mežica in years 1994 and 1995

YEAR	Number of miners	Arithm. mean (mSv)	Geom. mean (mSv)	Standard. deviation (mSv)	Median value (mSv)	Interval (mSv)
1994	182	278	216	146	286	0.2-59.4
1995	159	174	126	116	150	0.2-43.0

There are more than 30 mine waste rock deposits and Pb-Zn tailing piles with a total amount of 20 million tonnes, deposited on areas of about 380,000 m^2. Due to dolomite rock, the content of natural radionuclides in this material is very low. This is reflected also in the results: the dolomite sand contains only about 10 Bq/kg uranium ^{238}U and ^{226}Ra, 1-3 Bq/kg thorium ^{232}Th and only about 10 Bq/kg potassium isotope ^{40}K. Outdoor concentrations of radon daughters were measured continuously for some days at Žerjav in December 1995; in this closed valley, and in a period of temperature inversions, the average daily values exceed 30 Bqm^{-3} with maxima up to 50 Bqm^{-3} in the morning. Indoor radon concentrations in the region were not measured.

6.1.4. Environmental Radioactivity Due to the Fly-ash Disposal at Velenje

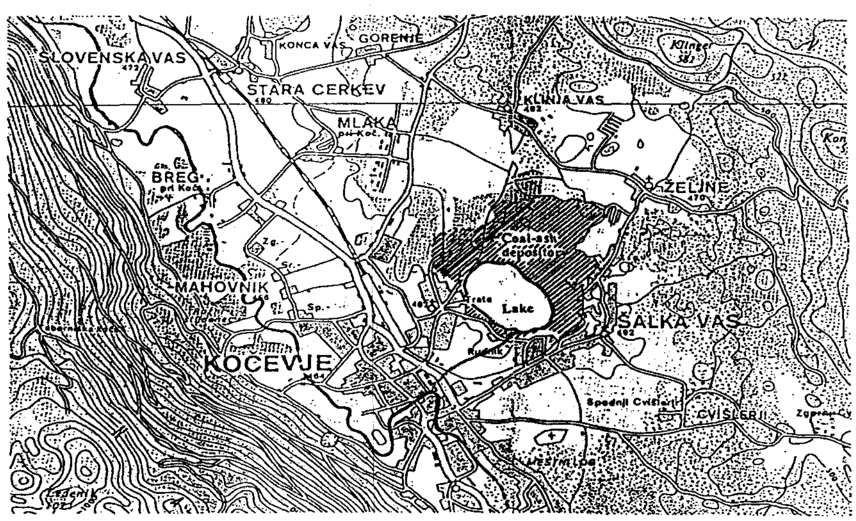
The Šoštanj coal-fired power plant (750 MW) has been in operation for more than 20 years and currently produces almost a million tonnes of coal ash per year. Fly ash with a U content of 25-30 mg/kg is transported as a slurry, disposed into wet ponds and finally to a lake, located just on the edge of the fly ash deposit. The size of the landfill area is about 0.50 km^2. The dry part of the disposal site is partly covered with a soil layer and recultivated.

Radioactive materials from the disposal site are dispersed into the environment and transferred through various pathways, leading to external and internal human exposure. In the last two years a short term surveillance programme was already conducted to investigate these routes.

The programme covered radioactivity in the air (long-lived radioactivity in dust particles, radon and its short-lived progeny), in the lake and river water (U, ^{226}Ra), in water sediments (U, ^{226}Ra, ^{210}Pb, ^{40}K), radionuclide content in deposited materials and in soil, external radiation, and radon exhalations rate.

The results presented show only the local radiological impact of deposited radioactivity. The main impact is due to surface water contamination. Enhanced gamma radiation was measured within the area of uncovered deposited material (0.20-0.24 microGy/h) compared to background levels (0.08-0.12 microGy/h). The annual average of mass concentration of air dust particles was 27 microg/m^3 on the fly ash depository, and 31 microg/m^3 in the prevailing wind direction (Škale), which means on average up to about 10 micro Bq/m^3 of ^{238}U and ^{226}Ra. The average concentrations of radon and its daughters over the landfill were very similar to those in its nearby vicinity (about 10 Bq/m^3) while EEC (equilibrium-equivalent radon concentration) maxima reached up to 20 Bq/m^3.

The leaching of radio nuclides by lake and rain water and by pile drainage water is the main source of radioactive contamination of the lake, its outflowing waters and sediments. The high alkalinity of the lake water due to the presence of fly ash (the pH was 11-12) strongly influences the solubility and therefore the radionuclide concentrations: a very low concentration of uranium (0.02 mg/m3) was measured while radium (^{226}Ra) is present in concentrations (up to 70 Bq/m3) which are an order of magnitude higher than in uncontaminated waters. Water and sediments in the Paka river showed increased radioactivity even at longer distances from the discharge points: the content of radium in sediments is twice as high as in unpolluted water, while radium in the river Paka remains enhanced 3-4 times along the rest of the watercourse.



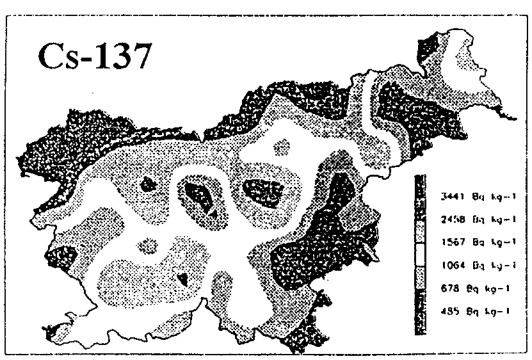
6.1.5. Natural and Artificial Radio Nuclides in Epiphytic Lichens

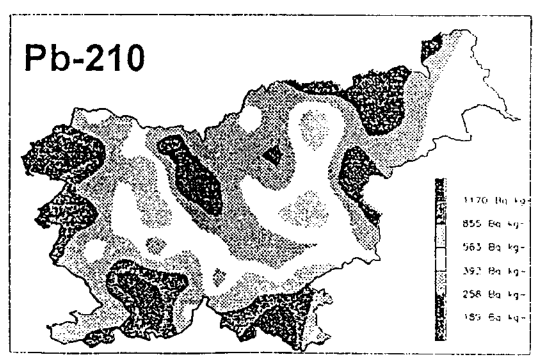
An investigation of air pollution with heavy metals and radionuclides using epiphytic lichens was carried out in the period 1992-1995 at the Laboratory for Radiochemistry of the Jožef Stefan Institute.

It was early demonstrated that lichens retain appreciable amounts of various radionuclides which are deposited from the air and precipitation. Their remarkable accumulative capacity for pollutants is based on their intrinsic biology. The uptake of redioactive fallout by lichens is rapid and non-selective, also allowing immediate determination of short-lived isotopes. Samples of Hypogymnia physodes L.(Nyl.), an epiphytic lichen, were collected in the period from September to November 1992 on a regular 16 x 16 km bioindication grid covering the whole territory of Slovenia. In each sample about 20 elements were determined using the co-standardization method of instrumental neutron activation analysis (INAA), while natural and artificial radionuclides were measured using gamma spectrometry.

Fig 16 shows typical geographical contour maps of 210Pb and 137Cs. The radionuclide 210Pb is produced in the atmosphere by radioactive decay of its gaseous parent 222Rn, while 137Cs was released into the atmosphere mainly during the Chernobyl accident. The highest activity levels of 210Pb, up to 1900 mBq g-1 (Fig.16a), were found in lichens collected in the southern, Dinaric region and in the NW parts of Slovenia. Elevated levels in the Dinaric region coincide with naturally elevated levels of uranium (precursor of 210Pb). The highest activitis of radiocesium were found in samples from the northern and northwestern parts of Slovenia (Fig.16b), which had the highest amounts of precipitation following the Chernobyl accident.

Fig. 16 The geographical activity isocontours of 210Pb (a) and 137Cs (b) obtained from lichen data, divided into 7 classes of percentile values





6.2. RADIATION EARLY WARNING SYSTEM OF SLOVENIA (ROSS)

Recognizing that a nuclear or radiological accident may have a widespread effect, the Slovenian Government has decided to establish an early warning system. Its aim is to detect as soon as possible any incident (either in Slovenia or abroad) where radioactive material is dispersed into the environment, and to warn responsible organizations to initiate appropriate safety measures.

The primary objective of the project is to establish a reliable system for continuous monitoring of radioactivity in the environment. Local measuring stations are connected to the central computer, where the measured data are collected and processed. From there, the data are transferred to governmental authorities and public information systems. In the case of an abnormal situation (accident), the system automatically and immediately notifies the emergency center of Slovenia and the competent authorities.

The radiation early warning system of Slovenia is based on three subnetworks:

- Krško NPP Ecological Information System (EIS NEK)
- Radiation Alarm Monitoring System (RAMS)
- Radiation Early Warning System (ROS)

Only EIS NEK has been completed, the other two are still in development and under construction.

Krško NPP Ecological Information System (EIS NEK)

EIS NEK is designed to monitor the impact of the NPP Krško on the environment and to provide adequate statistical and emergency data in the case of radiological pollution. It belongs to NPP Krško and was established in 1987 after the Chernobyl accident. In 1995 it was upgraded and renewed. The central unit of the system collects data from four automatic meteorological stations (AMS), a hydrological station on the river Sava, fourteen continuous dose rate measuring devices located in the vicinity of NPP Krško in different directions, and also data from the plant radiation monitoring system. The data are collected automatically every 30 minutes.

Radiological Alarm Monitoring System (RAMS)

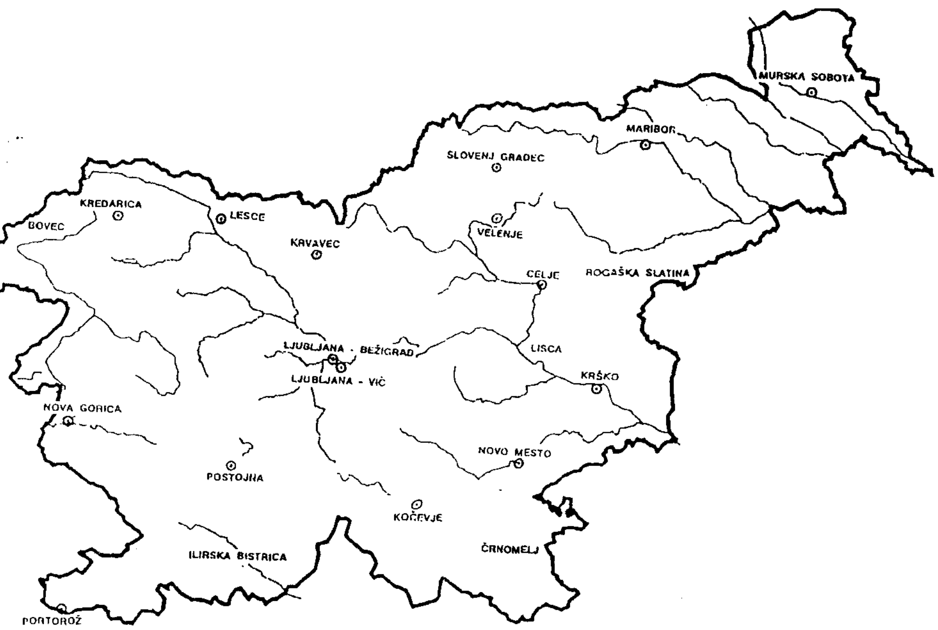
RAMS is designed for continuous monitoring of external radiation after an accident in the Slovenian nuclear facilities (NPP Krško and the TRIGA Research Reactor) and at the Žirovski Vrh Mine. It has been established to give support to the Slovenian Nuclear Safety Administration (SNSA) in evaluation and decision making during accident situations. Four stations are in operation: at TRIGA, Žirovski Vrh Mine and two in Ljubljana. It has a high priority in the maintenance of equipment and in redundant communications with the central computers (leased telephone lines, radio lines, mobile telephone lines or satellite communications).

Radiological Early Warning System (ROS)

ROS is designed for radiation monitoring throughout Slovenia. In its final phase it will consist of 21 continuous dose rate measuring stations, located at the existing meteorological stations. These locations are shown on the map in Fig. 17. The advantages of this approach are the possible correlation between local dose rates and meteorological parameters, and transmission of data via the meteorological network. Every half hour, the data will be automatically collected through the public switched telephone network at the central computer at the Hydrometeorological Institute, Ljubljana.
The ROS programme was started in 1991. The existing network consists of independent gamma monitors (MFM-202) on 12 meteorological stations: Ljubljana-Bežigrad, Maribor, Celje, Novo mesto, Nova Gorica, Portorož, Murska Sobota, Slovenj Gradec, Lesce, Postojna, Šoštanj and Kredarica. They are operating in automatic mode providing data and on-site triggering alarms. Data are locally numerically and graphically recorded on a small printer and are collected at the Hydrometeorological Institute, Ljubljana once a day, by operator phone calls to the sites. It is

foreseen that in 1996, six-radiation probes will be connected on-line to the central data collecting computers at the Hydrometeorological Institute: at Šoštanj, Murska Sobota, Ljubljana, Novo mesto, and Nova Gorica. Two probes: (Ljubljana-Vič and Ljubljana-Bežigrad) are already on-line connected to the central collecting computer at the SNSA.

Figure 17. Locations of ROS gamma monitors on meteorological stations. Sign ⊙ marks monitors in operation, locations without signs are planned.



3. Data distribution

All data of the subsystems are planned to be collected at the SNSA where they would be checked, analyzed, processed, stored, interpreted and presented to users in the requested forms. Data users such as Civilian Protection Administration and Health Inspectorate, will be directly connected with the computers at the SNSA through telephone lines. Part of the data would be published daily in TELETEXT (Slovenian TV).

The ROSS system is designed to be compatible with the early warning systems in the neighboring countries, with a possibility of international exchange of data, and should be completed in five years.

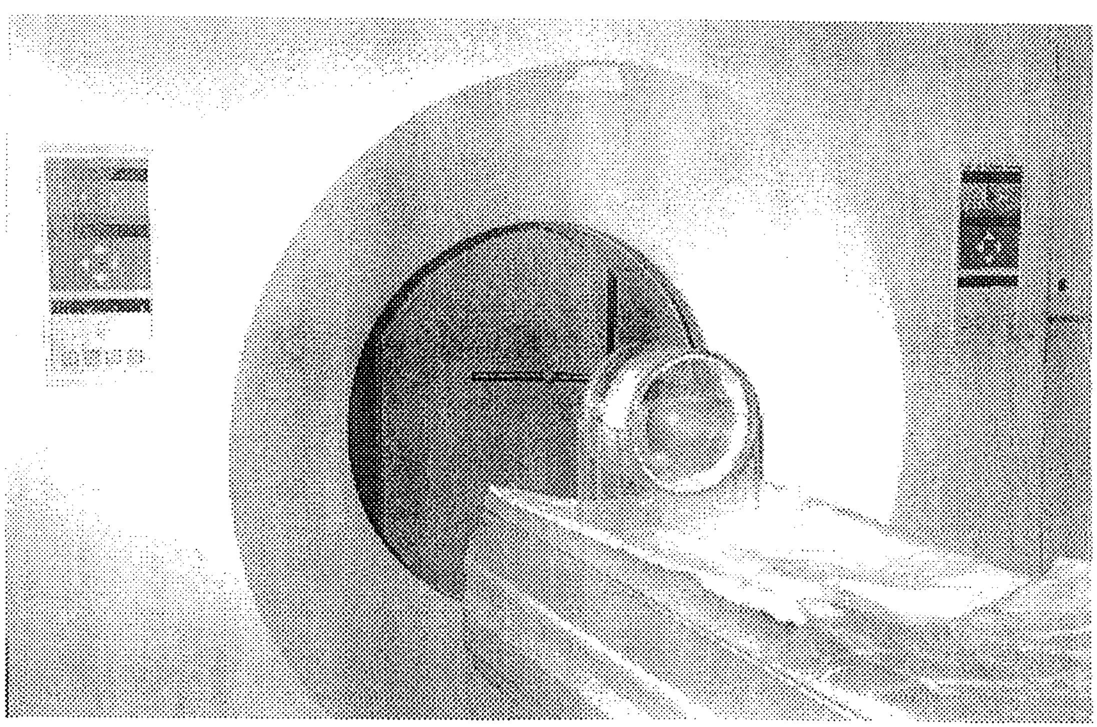
Some of the collected data are already shown on the Internet connection:

http://www.sigov.si/cgi-bin/spl/ursjv/dose.html?language=winee - RAMS
http://www.sigov.si/cgi-bin/spl/ursjv/5_1.html?language=winee - EIS

CONTROL OF

IONIZING

RADIATION



Quality Measurements of Computer Tomography, Institution for Occupational Health

The Health Inspectorate of Slovenia controls sources of ionizing radiation and work with them. Besides the nuclear facilities, about 100 production organizations were also under the control, including users and all medical and research institutions. Further, all radioactive materials which cross the Slovenian border, domestic transport and fire detectors are controled, including the licensing procedures. Technical control of the ionizing radiation sources is carried out by licensed organizations such as the Jožef Stefan Institute and the Institution for Occupational Safety of Slovenia.

In Slovenia there are 3490 registered workers dealing with ionizing radiation sources under the control of the Jožef Stefan Institute and the Institution for Occupational Safety of Slovenia. Personal dosimetry is done by film and thermoluminescent dosimeters. The annual effective doses received in 1995 were below the limit value of 50 mSv. In general, 75% of workers received less than 1 mSv, about 22% workers received between 1 and 5 mSv, 3% received more than 5 mSv, and nobody received more than 20 mSv. High doses were mostly received by workers at NPP Krško during the outage and supercompacting of wastes.

Dosimetry

Table 25: Distribution of effective doses for all workers in Slovenia for 1995

	Range of doses mSv/year for 1995							Total number of workers
	0 -1	-3.99	5.01 -10	10.01-15	15.01-20	20.01-25	over 25	
NEK - N	263	72	10	1	1	-	-	347
NEK - Z	258	176	52	15	2	-	-	503
NEK total	521	248	62	16	3	-	-	850
OI	124	18	4	-	1	-	-	147
IJS	169	30	2	-	-	-	-	201
Others (ZVD)	1679	470	7	3	1	-	-	2160
Others (IJS)	132	-	-	-	-	-	-	132
Total	2625	766	75	19	5	-	-	3490

Control of X - Ray Machines

558 RTG's are registered at the Health Inspectorate of Slovenia, 294 of which are isued for diagnostics, 5 for therapy and 259 for dental service.

Use of RTG devices	Number of RTG devices	
	1994	1995
for radiography	106	92
for computer tomography	9	7
for radiography and radioscopy	18	29
for mammographic radiography	15	16
for surgery rooms (mobile units)	31	37
for radiography with TV camera	115	128
for therapeutic irradiation	5	5
for intraoral tooth radiography	227	214
for panoramic tooth photography.	32	32

Regular quality control shows that there are:

- 15% new units
- 40% units in good condition
- 35% units needed to be serviced
- 5% units which could be used only temporarily as a replacement
- 5% units which should not be used.

Control of Sealed and Unsealed Radiation Sources in the Medical Institutions

There is only one institution dealing in Slovenia with sealed radiation sources. At the Oncological Institute in Ljubljana, the following sources are used: two cobalt-60 sources with 327 and 325 TBQ activity, two linear accelerators, iridium-192, cesium-137, ruthenium-106 and strontium-90.
Seven medical institutions in Ljubljana, Maribor, Celje, Slovenj Gradec, Šempeter near Nova Gorica and Izola deal with unsealed radiation sources. The isotopes mostly used are: technetium-99, iodine-131, thallium-201, xenon-133, yttrium-90, gallium-67, indium-111, strontium-89, and cobalt-57.
The total supply of iodine in 1995 was about 700 GBq (average 15 GBq per week), and the consumption was 550 GBq. Technetium delivery was about 3 TBq (up to 70 GBq per week). Other important isotopes were: xenon (up to 3.7 GBq per week), thallium (up to 2 GBq per week) and iodine-125 (up to 10 GBq per week).
Besides in medical institutions, unsealed open radiation sources are used at research institutions: Chemical Institute, Jožef Stefan Institute, Lek Pharmaceutical Industry, Veterinary Faculty, Institute for Biology and some smaller users.

Control of sealed radiation sources in industry
In industry the following sources are generally used:
- iridium-192 and cobalt-60 with activity up to 2 TBq for industrial radiography,
- cesium-137 and americium/beryllium neutron source with activity 0.3 (1.5 Gbq), for density and humidity measurements in construction work,
- krypton-85, strontium-90, americium-241 with activity up to 20 GBq for thickness measurements of paper, wood and textile,
- europium-152 and 154 with activity up to 20 GBq for lightning rods,
- americium-241, cesium-137, and cobalt-60 in iron industry (up to 740 GBq), breweries (up to 3.7 GBq), and food processing industry (up to 10 GBq).

All radiation sources are registered and under regular annual control. Sources out of use are transported and stored at the Podgorica Interim Storage.

Control of Industrial X-Ray units
At the Health Inspectorate 108 X-Ray, units used in 51 organizations, are registered.

Smoke Detectors
There are about 85000 ionizing smoke detectors in Slovenia which are under the control of the Institution for Occupational Safety in Ljubljana and Maribor, and the Varnost institution from Maribor.
Zarja Kamnik and Iskra Servis Ljubljana are licensed companies for fitting, unfitting and transporting ionizing smoke detectors to the Interim Storage in Podgorica.

Transport of Radioactive Materials
14 companies are licensed for transport of radioactive materials in Slovenia. Most of this work is done by JANIS Maribor, EM Hidromontaža, IMP Montaža Maribor, IMP Prompt Črnuče, M&K Laboratory, IMK, Welding Institute, and the Jožef Stefan Institute.

Import of radioactive material is mostly done by:
- IRIS, KRKA, PETROL, GENOS (radio-pharmaceuticals)
- METALKA, MAŠINOIMPEX (equipment and tools for NPP Krško)
- LEK, IJS, SANOLABOR, EDITRADE (other sources).

Personnel Training
The personnel dealing with ionizing radiation materials are trained and controlled in accordance with the law. Training is organized by the Jožef Stefan Institute and the Occupational Health Institute of Slovenia. In 1995 a special working group appointed by the Ministry of Health worked on proposals for new training programs.

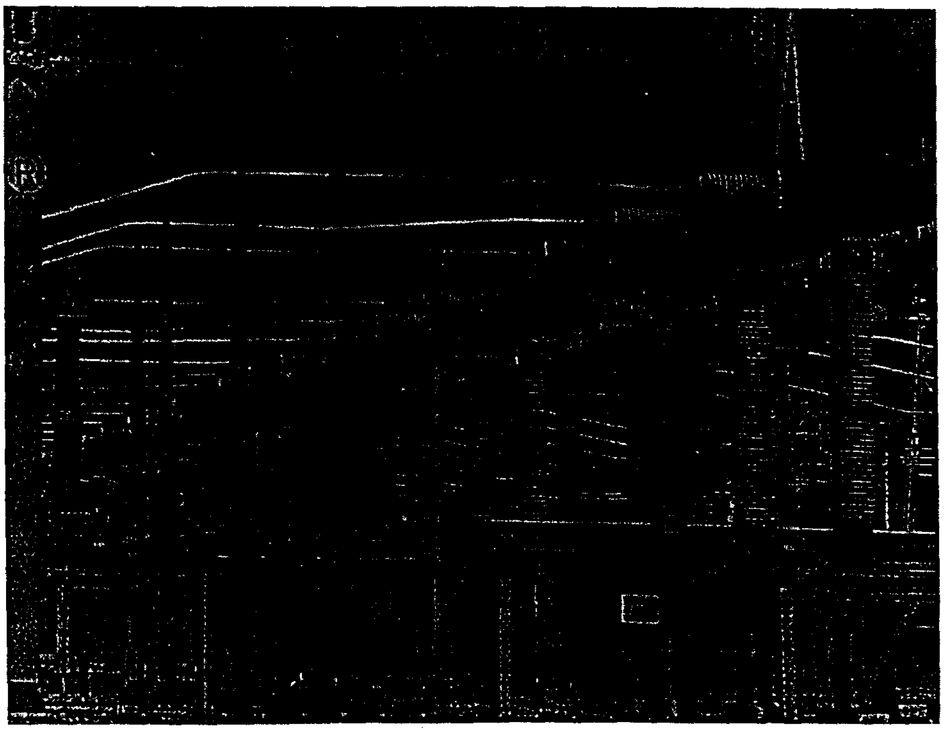
Medical Control

Workers who deal with ionizing radioactive materials are regularly under special medical examinations which are performed at the Occupational Health Institute of Slovenia and the Institute for Occupational Work, Transport and Sport.

Dose to Patients at Medical Examinations

In spite of the regulations prescribing that exposure of patients at medical examinations should be recorded, there is no such record-keeping in Slovenia yet. The exact frequency of medical examinations and therapies is not known. In spite of some case-studies, it is not possible to estimate the total frequency of X-Ray examinations, and of the therapies used, and thereby to estimate the public exposure and associated risks.

NUCLEAR ELECTRICITY GENERATION



At the end of 1995, there were 437 nuclear power reactors with the output power of about 343,792 TW operating in 30 countries. 16 countries covered more than 25% of their needs by electricity generated in Nuclear Power Plants. Slovenia generates 39% but covers only 23% of its needs due to the sharing of nuclearly generated energy with Croatia.

Table 26: Nuclear Power Reactors in operation and under construction at the end of 1995

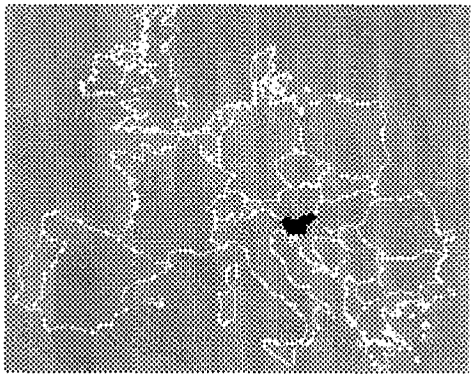
Country	Reactors in operation		Reactors under construction	
	No of units	Total MW	No of units	Total MW
Argentina	2	935	1	692
Armenia	1	376		
Belgium	7	5631		
Brazil	1	626	1	1245
Bulgaria	6	3538		
Canada	21	14907		
China	3	2167		
Czech R	4	1648	2	1824
Finland	4	2310		
France	56	58493	4	5810
Germany	20	22017		
Hungary	4	1729		
India	10	1695	4	808
Iran			2	2146
Japan	51	39893	3	3757
Kazahstan	1	70		
Korea RP	11	9120	5	3870
Lithuania	2	2370		
Mexico	2	1308		
Netherlands	2	504		
Pakistan	1	125	1	300
Romania			2	1300
Russia	29	19843	4	3375
S. Africa	2	1842		
Slovak R	4	1632	4	1552
Slovenia	**1**	**632**		
Spain	9	7105		
Sweden	12	10002		
Switzerland	5	3050		
UK	35	12908	1	1188
Ukraine	16	13629	5	4750
USA	109	98784	1	1165
Total*	437	343792	39	32594

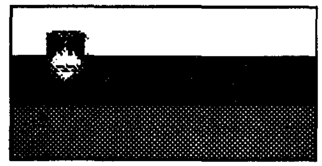
* The total includes the data from Taiwan..
Ref.: IAEA, Press Release PR 96/8, 19.4.1996

Table 27: Total operating Experience and Electricity supplied by Nuclear Power Reactors

Country	Electricity supplied NPP in 1995		Total Operating Experience to end 1995	
	TWH	%	Years	Months
Argentina	7.07	11.79	34	7
Armenia			28	4
Belgium	39.20	55.52	135	7
Brazil	2.50	0.97	13	9
Bulgaria	17.26	46.43	83	1
Canada	92.31	17.26	348	9
China	12.38	1.24	8	5
Czech R	12.23	20.10	38	8
Finland	18.13	29.91	67	4
France	358.60	76.14	878	10
Germany	154.14	29.09	510	7
Hungary	13.20	42.30	42	2
India	6.46	1.89	129	1
Japan	286.9	33.40	704	5
Kazahstan	0.08	0.13	22	6
Korea RP	63.68	36.00	100	10
Lithuania	10.64	85.59	20	6
Mexico	8.44	6.00	7	11
Netherlands	3.70	4.86	49	9
Pakistan	0.46	0.88	24	3
Russia	99.38	11.79	526	6
S. Africa	11.28	6.48	22	3
Slovak R	11.44	44.14	61	5
Slovenia	**4.56**	**39.46**	**14**	**3**
Spain	53.10	34.06	147	2
Sweden	66.70	46.61	219	2
Switzerland	22.49	39.92	103	10
UK	77.64	24.99	1063	4
Ukraine	65.64	37.83	174	2
USA	673.40	22.49	2028	8
total	2227.9		7696	2

* The total includes the data from Taiwan..
Ref.: IAEA, Press Release PR 96/8, 19.4.1996





REPUBLIKA SLOVENIJA MINISTRSTVO ZA OKOLJE IN PROSTOR **UPRAVA REPUBLIKE SLOVENIJE ZA JEDRSKO VARNOST**	**REPUBLIC OF SLOVENIA MINISTRY OF ENVIRONMENT AND PHYSICAL PLANNING** **SLOVENIAN NUCLEAR SAFETY ADMINISTRATION**

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