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NUCLEAR AND RADIATION SAFETY IN SLOVENIA

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NUCLEAR AND RADIOLOGICAL
SAFETY IN SLOVENIA IN 2000

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NUCLEAR AND RADIATION SAFETY IN SLOVENIA
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Slovenian Nuclear Safety Administration

SUMMARY

The Slovenian Nuclear Safety Administration (SNSA), in co-operation with the Health Inspectorate of the Republic of Slovenia, the Administration for Civil Protection and Disaster Relief and the Ministry of the Interior, has prepared a Report on Nuclear and Radiation safety in the Republic of Slovenia for 2000. This is one of the regular forms of reporting on the work of the Administration to the Government and National Assembly of the Republic of Slovenia.

The SNSA gives special attention to nuclear safety, especially to high safety level of the Krško NPP. This concern includes improvements in the power plant itself based on the best international practices and the latest findings in the nuclear field. In 2000, the Krško NPP had 33 modifications, 15 of them went trough licensing procedure. Year 2000 was the closing year for the Krško NPP modernization programe which consisted of five projects: supply (design, manufacture and transport) of steam generators, steam generator replacement (installation: removal/replacement), power uprate analyses by 6.3 % , storage of old steam generators (a multi-purpose building), and supply of full-scope simulator. All the projects were successfully finished, except power uprate analyses project. The analyses under the title »Snubber Reduction Program«, prerequisite the use of "Leak Before Break" concept and have been carried out within the framework of the power uprate analyses for the Krško NPP but under the separate administrative procedure which is not finished yet.

The whole production of the electrical energy in Slovenia was 12,829 GWh, the share of the nuclear energy production being 35.4%. In 2000, the Krško NPP generated 4,760,700 MWh (4.7 TWh) of electrical energy at the output of the generator, or 4,548,788 MWh (4.5 TWh) net. The generator was connected to the electrical grid for 7295.91 hours or 83.06% of the total number of hours in the year. The electrical production was 1.1 % lower than planned, due to heating limitation of Sava river. In addition to high production the operational reliability of the Krško NPP was also at a very high level. Load and avaliability factors were high, 81% and 83% respectively. In 2000, there were not any automatic or unplaned shutdowns. The comparison of the basic indicators of fuel reliability for 2000 showed that the integrity of the nuclear fuel was high. Introduced fuel modifications proved extremely satisfactory as well as fuel element modifications. In the year 2000, 32 fuel elements were stored in the pool, in total 594. In 2000, 319 drums were filled with low and intermediate level radioactive wastes. The accumulated quantity of standard drums is 13,365 or 2,806 m^3. Compacting the wastes the volumen was reduced to 2,157 m^3. The competent administrative authorities were regularly informed about the releases of radioactive waste into the environment by the Krško NPP on daily, weekly, monthly, quarterly and yearly basis in 2000.

The Radiological Protection Unit at the Krško NPP is organised for the task of measuring, calculating and regular recording of received effective doses for all workers, who have access to the controlled area of the power plant, regardless if they are members of the NPP staff or external contractors. In 2000, the average effective dose to workers was 2.30 mSv, which is approximately 4.6% of dose limit to workers who are professionally exposed to ionizing radiation or 11.5% of it in accordance with the latest ICRP recommendations (1991) and BSS (1996). The average effective dose to workers from the NPP was 0.96 mSv and to outside workers 2.88 mSv. Workers received the major part of the dose during the annual outage of the power plant. It was found out that in the recent years the average individual and collective doses have shown a rising trend as a consequence of plant modification works performed, plant upgrade and the modernisation programe. The competent authorities were regularly informed about the releases of radioactive waste into the environment by the Krško NPP on daily, weekly, monthly, quarterly and yearly basis in 2000. The liquid releases into the Sava river are registered for the main water supply, discharging into the Sava river in front of the dam. The major contribution to the dose is done by the radionuclides caesium and cobalt. In liquid releases, the dominating radionuclide was tritium (H-3). In 2000, the annual released activity of this radionuclide was approximately 53.5% of the annual limit value 20 TBq. The annual activity of other radionuclides in liquid releases was about a thousand times lower. Radioactive gases from the Krško NPP were released to the atmosphere mainly from the reactor building stack and through the vent of the condenser in the secondary coolant loop. In 2000, the released radioactivity of noble gases was 2.1% of the acceptable annual value. Emissions of noble gases were lower than in last years because of improved nuclear fuel.

The Research reactor TRIGA Mark II was designed for experimental work, training of the Krško NPP personnel and the preparation of radioactive isotopes for medicine, industry and nuclear chemistry. Altogether 339 samples were irradiated in the F-channel and reactor rotary system. 1500 samples were irradiated in the pneumatic transfer system. The reactor worked one week in the pulse too.

Since 1999 the Agency for Radwaste Management (ARAO) is the operator of Central interim storage for radioactive waste in Brinje. The operation of the storage is a part mandate of public service for radioactive waste management. In the year 2000 ARAO made "remediation plane and refurbishment" of storage facility. In the year 2000 last 13 drums (of total of 76) of waste generated during remediation action of temporary storage at Zavratec were accepted into the storage bringing the total to 774 pieces of waste with total assessed activity of 3700 GBq. The collective effective dose was 2.21 man mSv.

The decommissioning of the Žirovski vrh mine was performed on the basis to the Operational plan of activities for the year 2000 and amendments of this plan. In view of the Uranium Mine the amended plan was successfully carried out. In the report it is stated that the planned final workings on the facilities for the production of uranium concentrate and licensing activities were accomplished. In addition an effort was made to acquire loans as additional financial resources. The mine influence on the environment stayed on the same level as in previous years, since there was only one minor intervention to decrease it. The values of annual effective doses were very low. The maximum effective dose for 2000 was 1.95 mSv or 4% of the still valid dose limit 50 mSv, while the average value of all calculated annual effective doses was less than 1 mSv.

Agency for Radioactive Waste Management (ARAO), together with contractors implemented remediation action on Zavratec facility, where radioactive waste from the accident at the Oncological Institute in 1961 had been stored. By the end of March 2000 the waste was transported to the Central Interim Storage at Brinje. The facility was handed to the local community.

SNSA Inspectors for Nuclear and Radiation Safety were surveying nuclear facilities during the year in accordance with their competencies and the approved Programme of the Inspection for Nuclear and Radiation Safety for 2000. Inspection for Nuclear and Radiation Safety concludes on the basis of inspections that no major deficiency or violation of the existing legislation, deviations from required/expected condition, or other non-conformances had been found, which would indicate that the nuclear or radiation safety in Slovenia was jeopardised.

For many years the Slovenian Nuclear Safety Administration, the competent authority for providing radiological monitoring, has been concerned with the establishment and permanent improvements of the Radiation Early Warning System for immediate detection of potential contamination in case of a nuclear or radiological accident in the country or abroad. There are 43 probes for dose rate measurement of external gamma radiation throughout Slovenia; real-time data retrieval is possible from all 43 probes. Since 1996, when the fully computer-supported Central Radiation Early Warning System of Slovenia (CROSS) was established within the SNSA, the real-time measurement data from all the existing systems of this type in Slovenia have been collected at one site. All the data are transmitted on the internet and are presented at the SNSA homepage. In the year 2000 the SNSA has been weekly sending data from CROSS to the European system EURDEP located in the European research centre JRC in Ispra (Italy). By joining the European network, the SNSA gained the possibility of insight into data from other European countries. All data are checked on-line automatically and are sent daily by the officer on duty and according to the bilateral agreements automatically to Austrian, Croatian and Hungarian authorities.

In 2000, the radioactivity monitoring programme in the living environment in the Republic of Slovenia was the same as in previous years. Annual effective dose due to ingestion of the artificial radionuclides are quite comparable to those obtained in the neighbouring countries (Austria, Switzerland 5 microSv), while the assessment of external exposure for the Slovenian territory is likely overestimated (54 microSv).
Annual exposure from external radiation should be estimated on other, less conservative assumptions (staying outdoors 7.2 hours daily, shielding factor in dwellings 0.1) to be comparable with results in the neighbourhood.

All monitored and quantitatively evaluated radiation burdens in the environment due to emissions from the Krško NPP have been below regulatory limit of 50 microSv/year. Conservatively estimated dose burdens received by members of the reference (critical) population group as the result of NPP emissions and based both on the directly measured values in the environment and on model calculations from the data for annual emission values from the Krško NPP, in the year 2000 amounted to a value of the **effective dose smaller than 20 microSv/year**. This value represents less than 1 % of the annual dose received from natural and artificial sources by a member of a general public in the normal environment.

Radioactivity monitoring in the vicinity of the Reactor Centre at Podgorica in 2000 was carried out in accordance with the same programme as in the past. Only two exposure pathways were considered: external exposure due to ^{41}Ar immersion and ingestion of contaminated water. Due to lower releases compared with previous years the estimated annual effective doses to the population were exceptionally low. The external immersion dose due to releases of ^{41}Ar into the air was estimated to 0.024 microSv per year. The very conservative estimate of the ingestion dose (drinking of potentially contaminated river water) due to release of effluents into the Sava river gives 0.027 microSv per year. Thus the total dose received by the public was estimated to be less than 0.05% of the annual dose limit to the population.

The monitoring programme of the environmental radioactivity monitoring in the vicinity of the Central LILW storage facility at Brinje was not carried out completely in accordance with the current regulations and the decree of the SNSA. For the first time was performed the dose assessment due to ^{222}Rn releases to the environment and due to direct exposure from the radioactive waste storage. It was found that the effective dose received by the member of the public in the area affected by the LILW storage facility is likely higher than the effective dose due to releases originating from the research reactor operation.

The radioactivity measurements in the surroundings of the former uranium mine at Žirovski vrh showed that the cessation of uranium ore exploitation only partially reduced the impact of the radioactive sources, although the mine was closed almost ten years ago. Significant changes are not expected until the restoration of disposal sites with radioactive waste residues will be completed. Radon concentrations in the settled area in the surroundings of the mine have remained quite similar as in operational period, in spite of the considerable total radon emission decrease. Radioactivity of surface waters slightly increased (concentrations of ^{226}Ra, ^{210}Pb) compared to results of the previous year. The annual radiation exposure of the nearby population from the presence of the former uranium mine and mill (0.34 mSv) in 2000 is almost equal to the values obtained for the last years of the operational period of the mine. Radon sources remained the major sources of radioactive contamination of the environment; its decay products contribute at least with ¾ of the additional exposure. All other pathways like inhalation of long-lived radionuclides, water pathway, ingestion of local food and water and enhanced contribute less than 0.10 mSv per year. The effective dose for adults represents one third of the current annual dose limit of 1 mSv, prescribed by the national regulations and by international recommendations (ICRP 90) and international basic safety standards (IAEA, EU). Taking into account the total population exposure from natural radiation in this area (5.5 mSv), the former uranium mining at Žirovski vrh still represents about 6 % of this value.

In year 2000, three inspectors from the Office of the Chief Health Inspector of the HIRS carried out 120 inspections in total. The share of the inspections during which deficiencies were found is on the level of average values from the previous years – i.e. slightly above 50 %. The regional inspectors performed 48 additional inspections in organizations storing unusable radioactive substances with the aim of updating the records and stimulating the transfer of sources to safer locations. The HIRS inspectors issued in total 47 licences for the purchase and use of radioactive substances, 63 licences for use of X-ray devices, 2 licences for use of accelerators, 70 licences for transport of radioactive materials, 83 approvals of licences for SNSA permits for the transport of radioactive materials, 30 orders with measures to remedy the deficiencies, 5 decisions prohibiting the use of radiation sources, and 1 decision for execution of the order.

Radiation protection for the population and the environment against harmful effects of ionizing radiation in year 2000 improved in comparison to the situation noticed in 1999. Control of radioactive substances transport has slightly weakened, but there were also no major domestic or international problems noted. The number of refused shipments of scrap iron on the border crossings with Italy has also greatly diminished. Surveillance of the facilities with increased radon levels remained at the same level. Surveillance of the radioactive substances in nuclear facilities and elsewhere has improved. Storage of old and useless radioactive sources still poses a problem. In year 2000 no regular professional inspections were carried out in 32 organizations containing radiation sources, so that the situation for about 120 sealed radiation sources has not yet been regulated in accordance with the valid regulations. To regulate this situation an additional inspector would be required who would cooperate more frequently with the SNSA, with authorized organizations (IOS, JSI), and ARAO. One of the reasons why the state was not improved in 2000, in comparison to the previous year, is also the problem of modernization of the store at Brinje.
Criteria for the implementation of thermoluminescence personal dosimetry, based on the international standards, have been elaborated. More experts are also required by HIRS in this field. The Central national dosimetric register - permitting users with basic knowledge of programming, and possessing an authorization to make various enquiries on persons or statistical analyses in connection with doses - has also been improved. Yet we need new rules and regulations which would control the execution of measurements, registration of doses and issuance of official documents on doses.

The proposed activities of the HIRS in the future shall be based on carrying on systematic inspections, particularly in medical organizations, and on determining the tasks and obligations of persons responsible for ionizing radiation protection. The European Community directives (EURATOM 97/43) require dose assessment in all radiological examinations in which ionizing radiation is used. Consequently, the pilot measurements which were carried out in the project »Exposure of patients to radiation in the General hospital of Slovenj Gradec due to standard X-ray examinations« should be continued.

Necessary measures should be taken for continuation and enlargement of current records on the sources and use of ionizing radiation and on exposure of the population and examined persons to ionizing radiation. Special emphasis should be placed on drafting the legislation in the field of use of ionizing radiation sources and protection against the harmful effects of ionizing radiation.

Storage, transport, safeguards of radioactive and nuclear material is regulated by the Act on Radiation and the Safe Use of Nuclear Energy. (Off. Gaz. of SFRY No. 62/1984) and Regulations based on above mentioned Act. Transport of dangerous goods is regulated by Act on transportation of dangerous goods-ZPNB (Off. Gaz. RS No. 79/99) which entered into force on 1. 1. 2000. The SNSA in consent with Health inspectorate issued in year 2000 91 transport licences. After subsidiary regulation entered into force less licences were issued due to the fact that transport licences are needed only for transport over prescribed limits. SNSA also issued 137 licences among them 54 were issued for single import, 76 for multiple imports and 7 licences for export of radioactive substances. SNSA start to investigate the inventory of nuclear material at potential small holders. The purpose of investigation is to check if the reporting to IAEA is in compliance with provision of Safeguard Agreement.
Physical protection of nuclear facilities NPP Krško, research reactor TRIGA at Brinje and nuclear material is being conveyed in respect of regulation.

In 1999, Slovenian Government issued a Decree on Mode Subject and Terms of Performing Public Service of dealing with radwaste (Decree), that is governing the radwaste management generated by small producers. According to Decree the mandate for public service for radwaste management is given to the Agency for Radwaste Management. Based on the Decree, the Slovenian Government issued a price list for public services related to radioactive waste management in November 2000, by which the principle "polluter pay" is partially introduced. Due to the some delay related to the refurbishment of Central Interim Storage for Radioactive Waste at Brinje, public service has not been performed yet in fool scope but only in some emergency cases.

Administration for Civil Protection and Disaster Relief of the Republic of Slovenia (ACPDR), as a competent agency in the field of emergency preparedness, was putting its efforts in finalization of the national emergency response plan for nuclear accidents (Protection and Rescue Plan for Nuclear Accidents), and co-ordination of regional and local emergency planning. For this reason the Government of the Republic of Slovenia has appointed a special working group consisting of representatives from different agencies involved in emergency response. Furthermore, establishing, training, and equipping of protection and rescue forces was very successful. In different training courses held last year 771 members of protection and rescue units were trained. Last year ACPDR also took an active role in international projects OSEP and RER/9/050. In 2000 in the framework of the SNSA Emergency Plan there were 11 procedures, which were revised, three of them were written from scratch (tasks of the SNSA on-duty officer, tasks of the on-duty radiological monitoring officer, operation and use of automatic radiological monitoring system). On 12th December 2000 the nuclear emergency exercise »NEK-2000« took place. During the exercise the emergency preparedness organisation on local and state level was tested. On 27th June the IAEA and the WHO 2000 organised the exercise. The aim of the exercise was to test of the WMO procedures and products which are supplied under the agreement between IAEA and WMO on meteorological support. In 2000 the activities in the emergency planning in the Krško NPP were focused in the maintenance and improvement of the existing emergency preparedness. The priorities were: establishment and operability of the »Emergency Off-site Facility«, training and exercises with the simulator and modernization of the the emergency organisation activation system.

The structure or organisational scheme of the SNSA was not substantially changed in 2000. The Administration still consists of 5 divisions, some of which have acquired new departments. The number of staff increased from 37 to 40, which is still below the recommendation of the European Union mission RAMG. Special attention has been divoted to the education of the SNSA staff. In 2000 the SNSA was intensely preparing a new Act on Nuclear and Radiation Safety and continued with the harmonization of the domestic legislation with the *acquis communautaire*.

In 2000 Slovenia ratified 3 multilateral and 5 bilateral agreements. Intensive was co-operation with IAEA. SNSA actively participated at the work of the IAEAş General Conference and regulary attend the Board meetings. The most intensive co-operation was in the area of technical assistance and co-operation and in participation at meetings, of which dozens were held in 2000. In addition to the representatives of SNSA, many experts from organisations working for the SNSA also attended the meetings. Within the scope of co-operation between the SNSA and IAEA, Slovenia has hosted a number of fellowships and scientific visits. Western European Nuclear Regulators Association issued a report on nuclear safety in a candidate countries. The nuclear safety Co-operation with European Union is shown also trough RAMG (Regulatory Assistance Management Group) - PHARE assistance programme, CONCERT Group, ECURIE and in the NRWG groop. Slovenia endeavours to attain full membership of the OECD/NEA. Representatives of the SNSA took part in some of the meetings organised by NEA. Traditionally, the most effective and useful form of co-operation was trough the emergency exercise INEX.

Provision of open and authentic information presented to the public is a fundamental policy of the SNSA. The Report on Nuclear and Radiation Safety in 1999 was published in **Poročevalec** (Reporter), the publication of the National Assembly, and is available in public libraries throughout Slovenia and on the Internet in Slovene and English. Reports on the SNSA activities are also published in the bulletin **Okolje in prostor** (Environment and Spatial Planning). In 2000, 33 articles were published. For publishing the English version of The Report on Nuclear and Radiation Safety in 1999 the SNSA didn't have any funds. The funds assigned from the national budget to the SNSA were not onlyally but also in reality lower than in the previous years, especially for some important economic purposes. Particularly worrying is the fact that the implementation of some program activities in the area of nuclear and radiation safety is being made difficult. In spate of financial problems SNSA financed and co-financed 7 research projects and analyses to support safety decision making in licensing process.
The Nuclear Safety Expert Commission (NSEC), which has an advisory role to the SNSA, met five times in 2000. Within the SNSA there is also an Expert Commission

for Operators Exams, which holds exams to asses the professional competence of the staff (operators) of Krško NPP.

Technical support organizations represent a vital part in monitoring operations, backfitting, introducing improvements and monitoring maintenance work on nuclear facilities. The work of technical support organisations is supplemental to the work of the Nuclear Safety Inspection Division which has insufficient manpower to cover all the activities in the nuclear facilities related to nuclear safety. The report by the technical support organisations shows that the major part of their engagement involves surveillance of annual outage and refuellings. With the replacement of steam generators the duration of annual outage will be shorter, and the Inspectorate and the technical support organisations should be prepared accordingly. The shorter outage will require better planning of surveillance activities and even better coordination and co-operation between the Krško NPP, the Inspectorate and the technical support organizations. The report also shows that technical support organizations take care of the regular training of their personnel in the fields within their responsibility. One vital part is the organisation of quality assurance, verified also by the SNSA. The primary concern of the Milan Čopič Nuclear Training Centre (ICJT) is the training of personnel in nuclear technologies and ionizing radiation and providing public information on these activities. The four main areas of activity of the Centre are: the training of the Krško NPP personnel, training activity in the field of radiological protection, organisation of international courses and meetings in the field, and public information.

The Pool for insurance and reinsurance of nuclear risks GIZ (Nuclear pool GIZ) is the special legal form of an insurance company for insurance and reinsurance against nuclear risks. It is noteworthy that, up to the end of 2000, the Krško NPP did not report any damage to the Nuclear pool GIZ.

The Pool was established in conformity with the "Act on Pool for Decommissioning of the Krško NPP and for Radwaste Disposal from the Krško NPP" with the purpose of raising funds for the decommissioning of the Krško NPP, and for storage and permanent disposal of low and intermediate level radioactive waste and spent fuel from the Krško NPP. On 31 December 2000, the active assets of the Pool amounted to 10,415,000,000 SIT.

According to the information provided by the International Atomic Energy Agency, at the end of 2000, there were 438 nuclear power plants, that is two more than in 1999. The IAEA information system - the International Nuclear Event Scale (INES) received 25 reports in 2000. The most serious accident with radioactive substances occurred in Meet Halfa (Egypt) were two persons died and some other were badly injured because they received high doses of radiation. It was established, that a family member found iridium-192 source with estimated intensity of 1,85 TBq and brought it home. After analysis the event was classified on fourth degree – "accident without significant off-site risk" on the INES Scale.

In 2000, there were no anomalies found by the regulatory bodies of the Republic of Slovenia in operation of nuclear facilities, transportation of nuclear and radioactive materials; in use of radiation at research and development; in medical care and industry that could endanger safety or have negative impact on the environment and to the health of the population. and workers exposed to radiation.

1 INTRODUCTION

The present report is one of the regular forms of informing the Government and the National Assembly of the Republic of Slovenia on the state of nuclear safety in our country. The report is likewise intended for both the professional and the general public as it summarizes the state of affairs as well as activities in the widest possible segment of this domain. Therefore the report is not only a general survey of the work of the Slovenian Nuclear Safety Administration, but also endeavours to include the activities of other administrative authorities, agencies, institutes and organizations whose field of work is more or less involved with the issues of nuclear or radiation safety. Contributions were provided by: Krško NPP, The Agency for Radwaste Management, The Žirovski Vrh Mine, Institute of Metal Constructions, Welding Institute, Institute of Metals and Technologies, Milan Vidmar Electrical Institute, Faculty of Mechanical Engineering, IBE Consulting Engineers, Institute for Energy and Environment Protection – Ekonerg, Jožef Stefan Institute, Institute of Occupational Safety, Energy Institute Ltd. , Enconet, High Voltage and Energetics Department, Faculty of Electrical Engineering, University of Zagreb

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

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

And finally, a word about our expectations. The elaboration of such a report is a demanding and responsible task. We look forward to receiving your opinion and an assessment of its quality. Any remarks and proposals received in the period before we draw up the 2001 report will be considered and reflected in our future work.

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2 NUCLEAR SAFETY IN SLOVENIA

2.1 THE KRŠKO NUCLEAR POWER PLANT

2.1.1 OPERATIONAL SAFETY

2.1.1.1 Operational and Safety Indicators

In 2000, the Krško NPP generated 4,760,700 MWh (4.7 TWh) of electrical energy at the output of the generator, or 4,548,788 MWh (4.5 TWh) net. The generator was connected to the electrical grid for 7295.91 hours or 83.06 % of the total number of hours in the year. The electrical production was 1.1 % lower than planned, beacuse the level of Sava river was 55 days to low to operate on power at 100 % . The generation of thermal energy in the Krško NPP reactor was 13,601,750 MWh. The whole production of the electrical energy in Slovenia was 12,829.5 GWh, the share of the nuclear energy production being 35.4 %. The most important safety and operational indicators are shown in Table 2.1 to 2.3, while their changes over several years are presented further below in the report.

Table 2.1 Safety and operational indicators of the Krško NPP (y. 2000)

Safety and Operational Indicators	Year 2000	Average
Availability factor (%)	83.06	82.34
Load factor (%)	81.15	78.47
Forced outage factor	0	1.44
Net electrical energy production (GWh)	4548.8	4245.4
Reactor shut-down - manual (Number)	1	2.23
Reactor shut-down - automatic (Number)	0	3.6
Incident reports (Number)	1	4.06
Outages duration (Days)	62	56.18
Fuel reliability indicator (FRI) (GBq/m^3)	0.00814	0.13

Figure 2.1 presents annual operating of NEK in 2000, figure 2.2 presents monthly operating for September 2000 (lower power because of lower tide of Sava river). The production of electric energy was satisfied and expected.

Figures 2.3 to 2.5 present charts showing the number of reactor shut-downs per year, the forced outage factor and the number of incidents per year.

The data in Figure 2.5 differ from those before 1991, since the Krško NPP introduced a new system of labelling the incident reports (i.e. some reports were registered under the same number, ref. a letter from the Krško NPP No. SRT-356/4150 of 8.4.1991).

In addition to record production and load factor, the operational reliability of the Krško NPP was also at a very high level. In 2000, there were no abnormal events or automatic shut-downs. A planned manual shut-down took place during the 2000 annual outage.

Table 2.2: Schedule of planned and realized production in the Krško NPP in 2000.

Month	Planned Production (GWh)	Actual Production (GWh)	Difference (%)
January	450	456.583	1.46
February	410	432.006	5.37
March	450	459.884	2.20
April	220	201.740	-8.30

May	0	0	0
June	160	169.027	5.64
July	480	479.505	-0.10
August	480	438.309	-8.69
September	470	416.155	-11.46
October	500	499.690	-0.06
November	480	488.651	1.80
December	500	507.238	1.45
Total	4.600,000	4,548.788	-1.11

Table 2.3: Analysis of operation of the Krško NPP in 2000.

Analysis of operation	Hours	Percentage (%)
Number of hours in a year	8784	100
Operation of the NPP (in the grid)	7295.91	83.06
Duration of shut-downs	1488.09	16.94
Duration of annual outage	1488.09	16.94
Duration of planned shut-downs	0	0
Duration of unplanned shut-downs	0	0

Figure 2.4 presents the time diagram of energy production in the Krško NPP in 2000, and Figure 2.5 the monthly diagrams of operation of the power plant. The availability of the nuclear power plant is the ratio between the number of hours of generator operation (synchronized with the grid regardless of the power of the reactor) and the total number of hours in the given period. This shows the percentage of time of the NPP being connected to the grid. The load factor is the ratio between the electrical energy produced and the electrical energy which could have been theoretically produced at the maximum capacity in the same time period. In calculations of the availability factor, load factor and forced outage factor, the total production of electrical energy from 1 January 1983, when the start-up tests were finished, was taken into account.

The charts in Figures 2.6 to 2.9 present the main operational data for the entire period of regular operation of the Krško NPP and enable a comparison to be made between the 2000 results and the previous period. The load factor (Figure 2.6) is used world-wide as the main indicator of operational reliability of the power plant; in 2000, it was the highest ever in the entire operation period of the Krško NPP. The availability factor (Figure 2.7) is another important factor, since in a number of power plants the power is intentionally reduced because of fluctuations in the demand for electrical energy and, therefore, a better load factor cannot be achieved. In Figure 2.8 the total electrical energy production for all years of the nuclear power plant operation is presented; in 2000, there was a record production of 4548 GWh. Figure 2.9 offers a comparison between nuclear, hydro and thermal electrical energy production in Slovenia over several years. Figure 2.10 presents the outage duration, which has been getting shorter in recent years but this year a little bit longer because of the plant modernisation (steam-generator replacement and power-uprate).

Thermal performance, figure 2.11, shows percentage of produced energy compared with planned predictions.

Figure 2.12 demonstrates the unplanned capability loss factor. This factor is calculated as a ratio of the unplanned energy losses to the reference energy generation (maximum production of energy).

Figure 2.13 indicates the number of unplanned automatic scrams per 7000 hours critical, which represents the annual amount of critical hours in the plant in most countries.

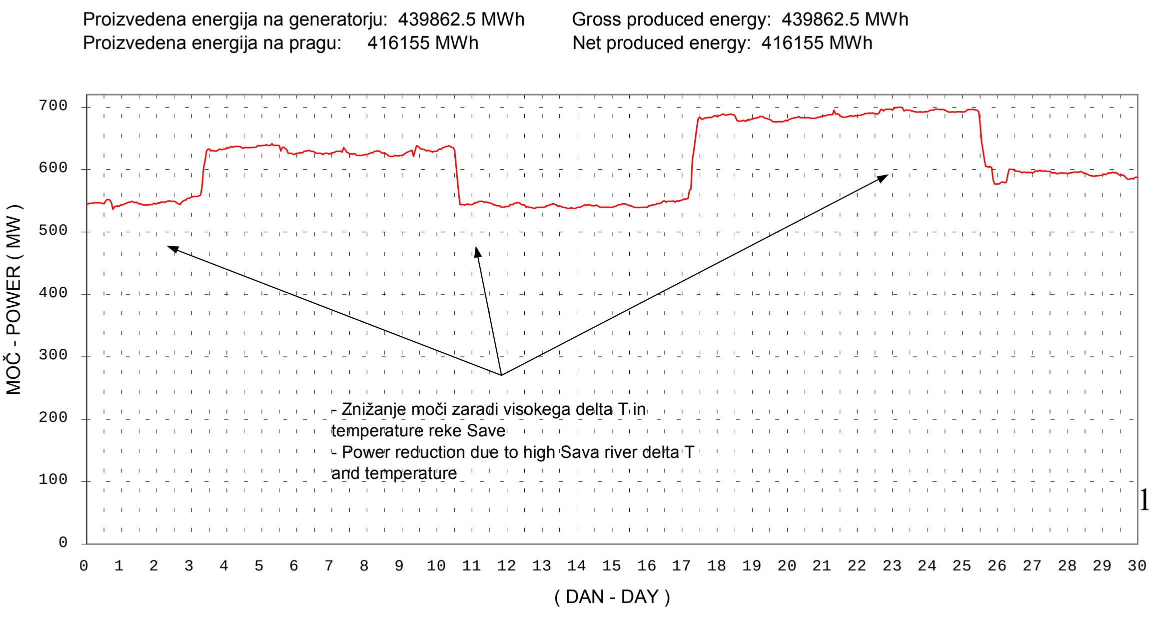
Collective radiation exposure (Figure 2.14) shows a further decrease in personnel exposure at the plant.

Figure 2.15 shows High pressure safety system performance factor, which was from 1998 a little bit higher because of the maintenance works during the operating of plant. Maintenance of the plant on power shortens annual outages on minimum. In 2000, valuable of this indicator is 0.00338 which is still lower than INPO value 0.02 and NEK value which is 0.005.

The industrial safety rate (Figure 2.16) presents the ratio between the number of lost working hours resulting from occupational injuries and the total of working hours. In 2000, valuable of this ratio is 0.96 in 200 000 working hours and is two times higher than INPO value (up to y. 2000) and NEK value which is 0.4.

Figure 2.17 presents the number of unplanned actuations of the safety injection system and there haven't been any in 2000.

Figure 2.1: Time diagram of energy production in the Krško NPP for 2000



1

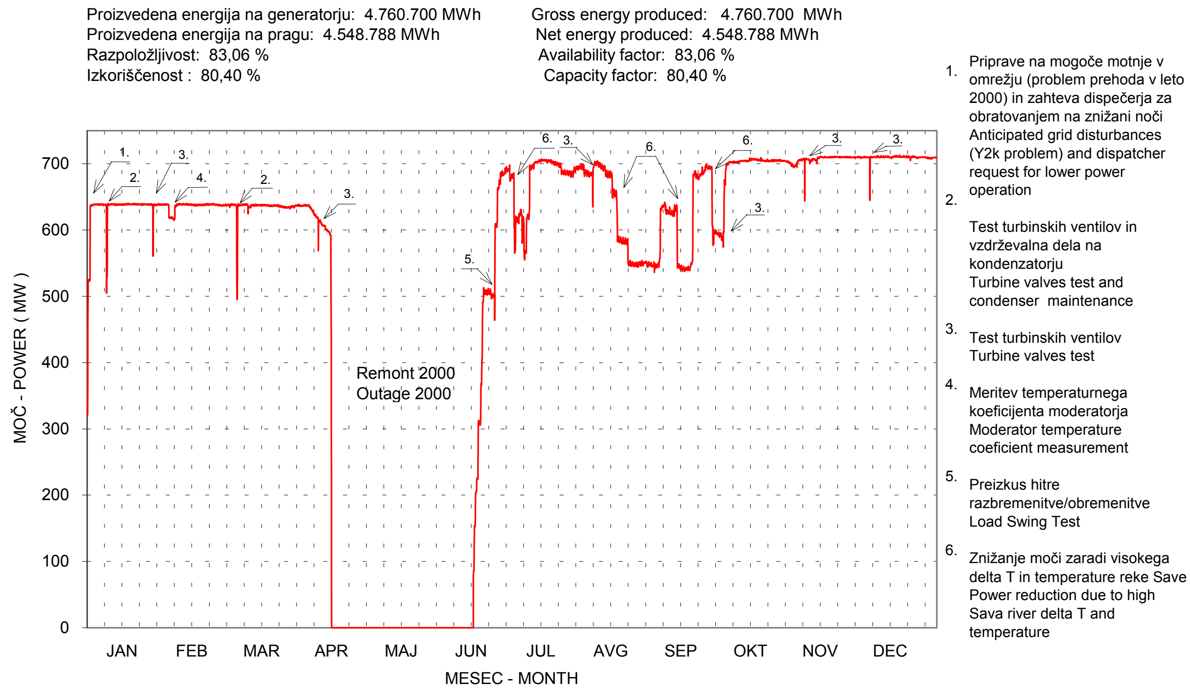


Figure 2.2: Time diagram of energy production in the Krško NPP for September 2000

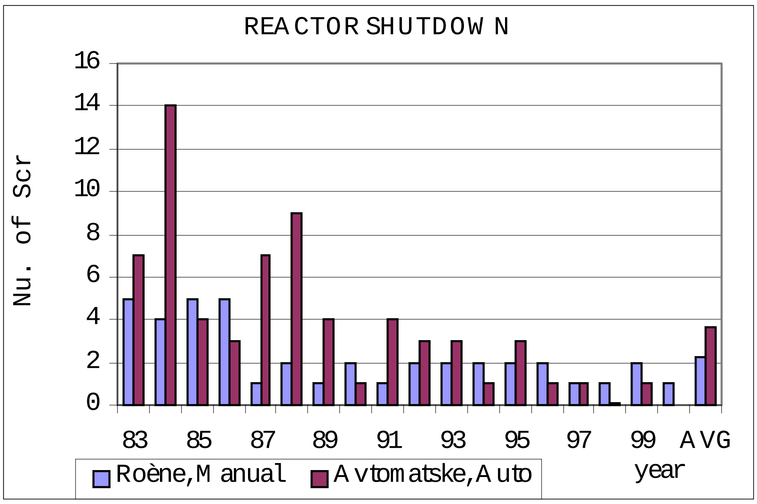


Figure 2.3: REACTOR SHUTDOWN

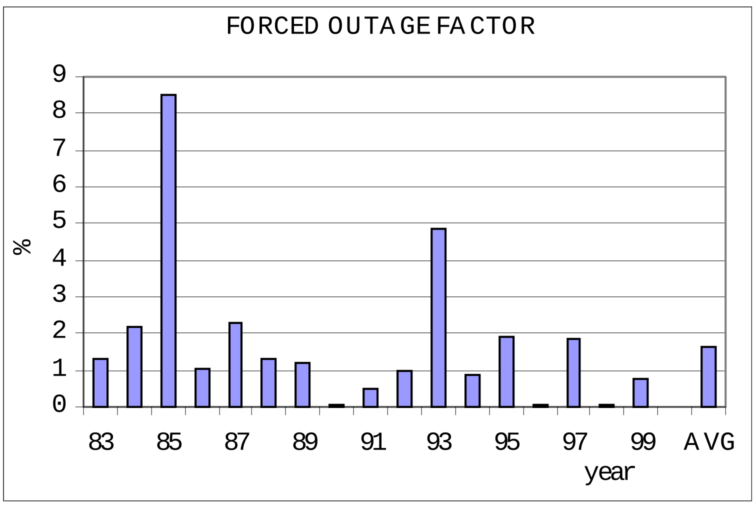


Figure 2.4: FORCED OUTAGE FACTOR

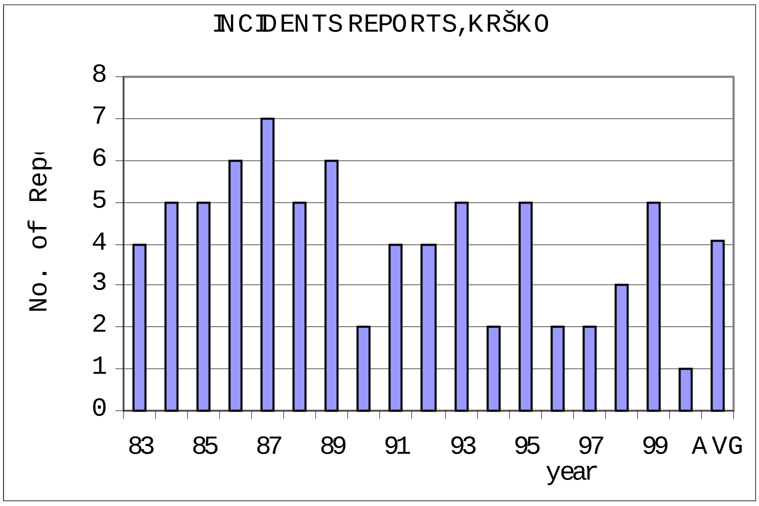


Figure 2.5: INCIDENTS REPORTS, KRŠKO

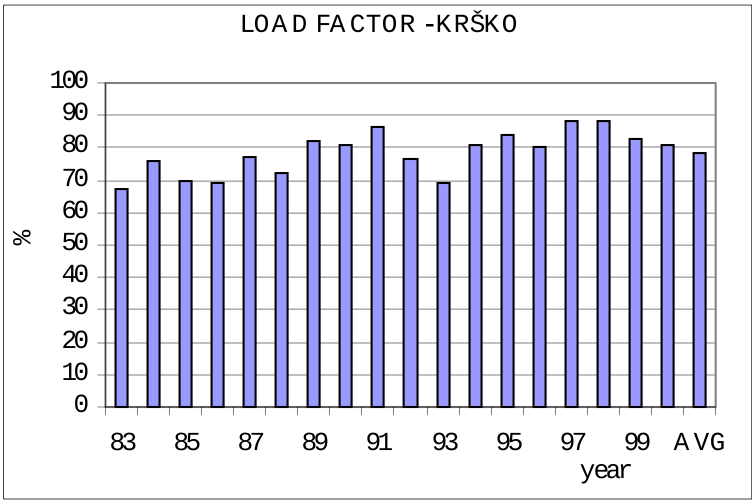


Figure 2.6: LOAD FACTOR – KRŠKO

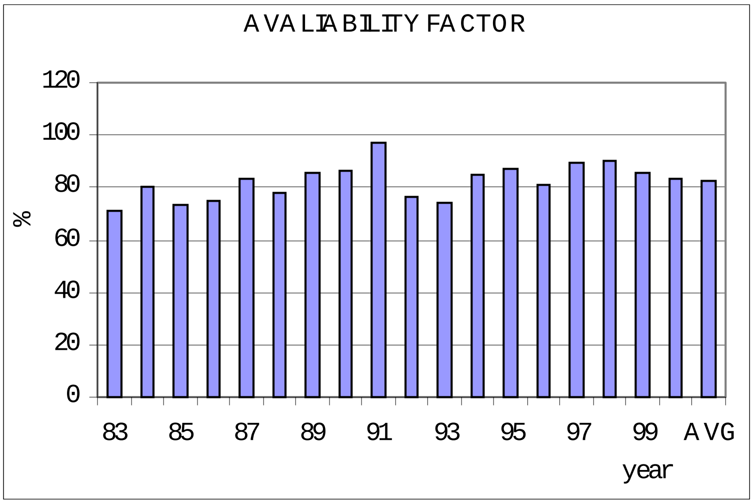


Figure 2.7: AVALIABILITY FACTOR

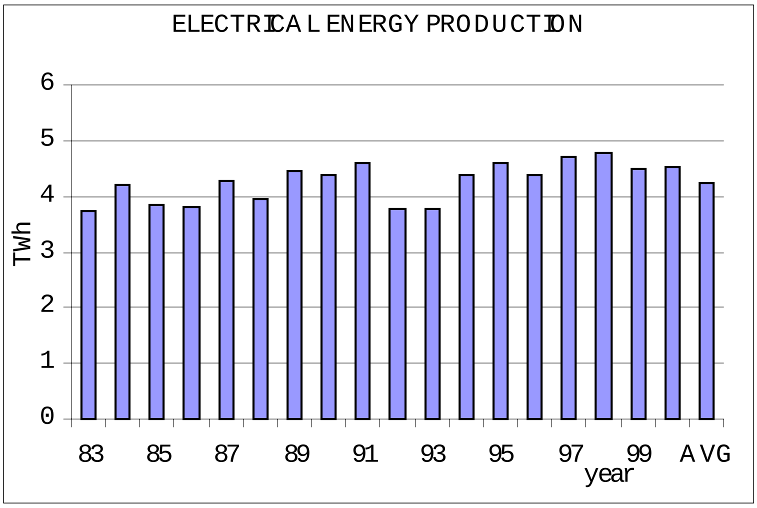


Figure 2.8: ELECTRICAL ENERGY PRODUCTION

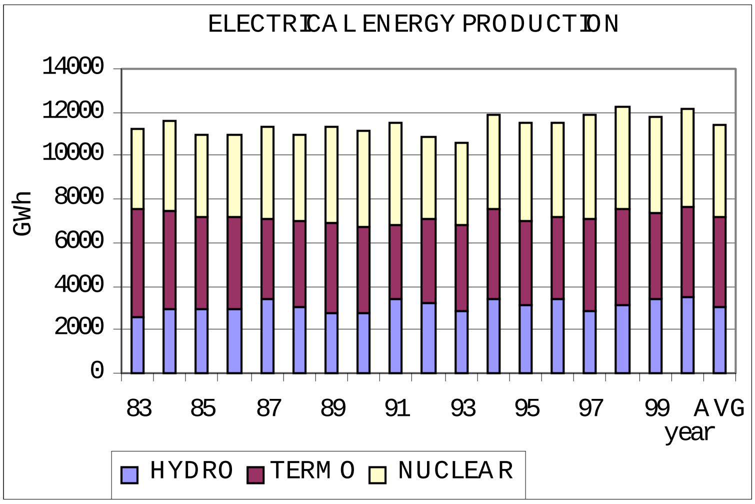


Figure 2.9: ELECTRICAL ENERGY PRODUCTION

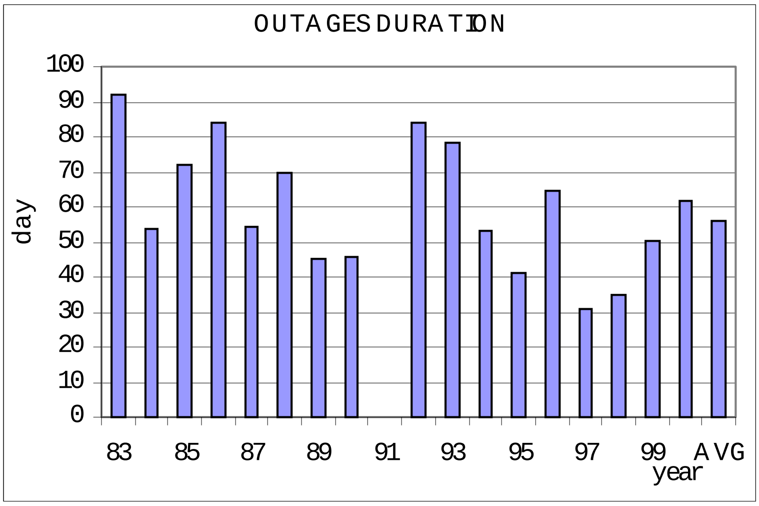


Figure 2.10: OUTAGES DURATION

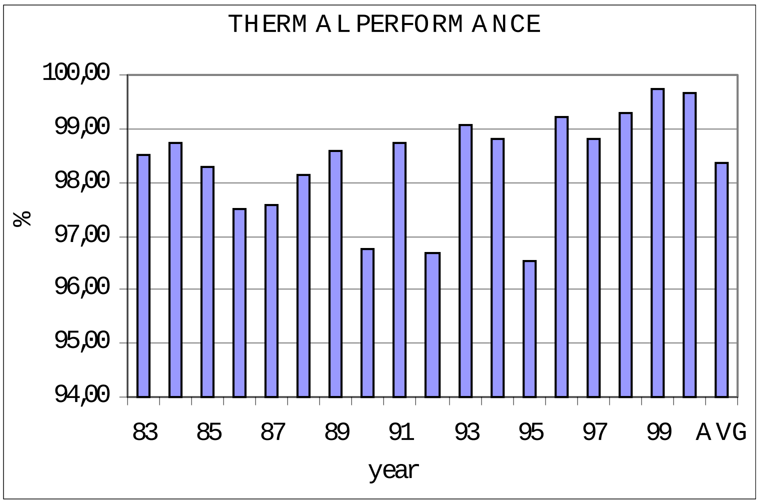


Figure 2.11: THERMAL PERFORMANCE

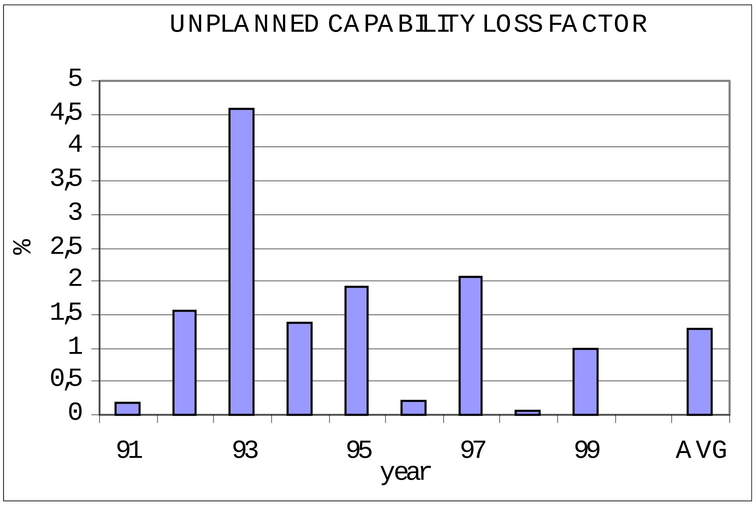


Figure 2.12: UNPLANNED CAPABILITY LOSS FACTOR

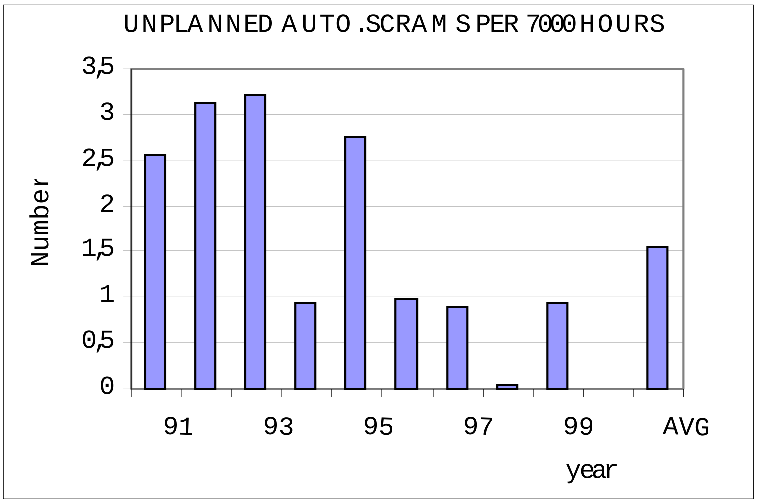


Figure 2.13:UNPLANNED AUTO. SCRAMS PER 7000 HOURS

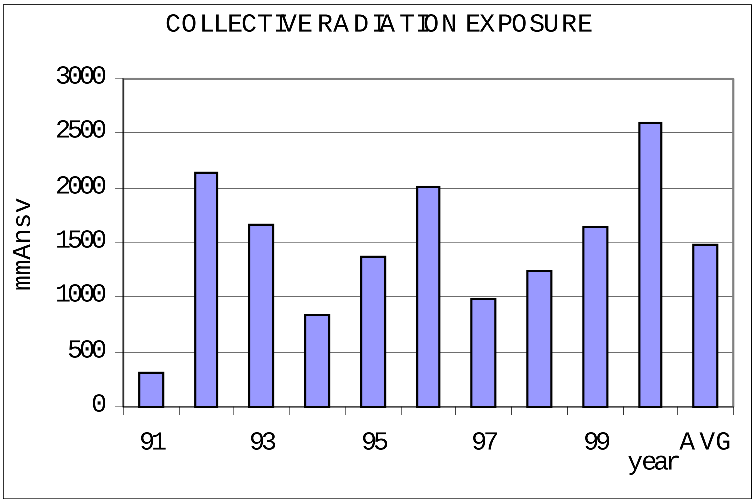


Figure 2.14: COLLECTIVE RADIATION EXPOSURE

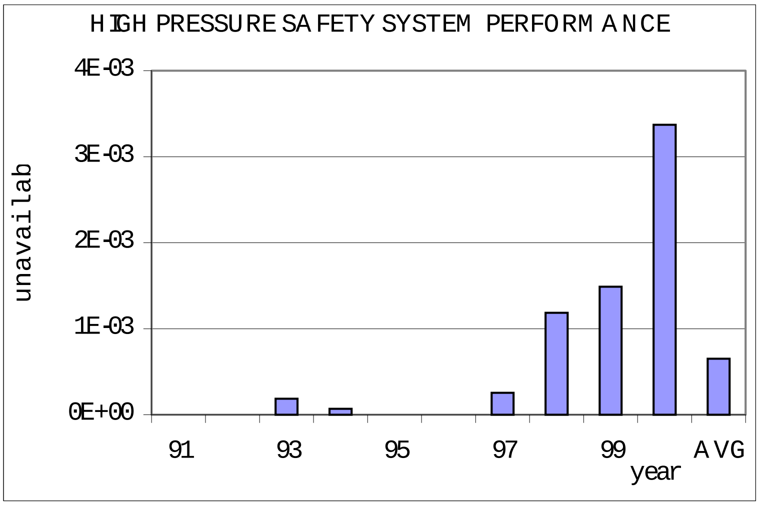


Figure 2.15: HIGH PRESSURE SAFETY SYSTEM PERFORMANCE

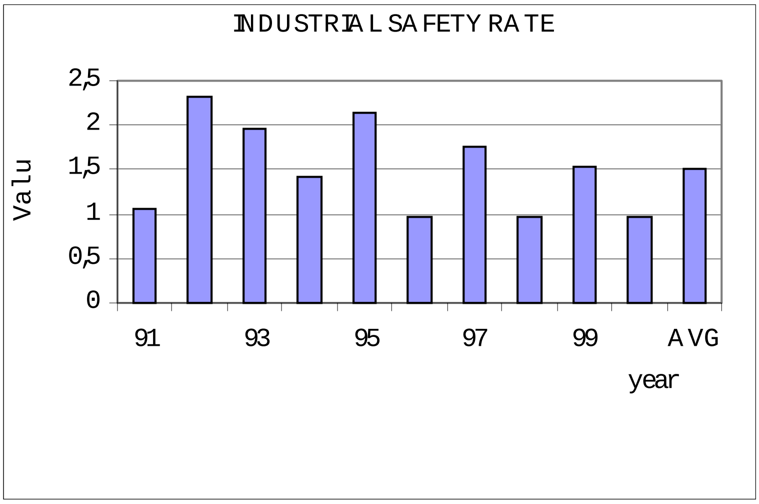


Figure 2.16: INDUSTRIAL SAFETY RATE

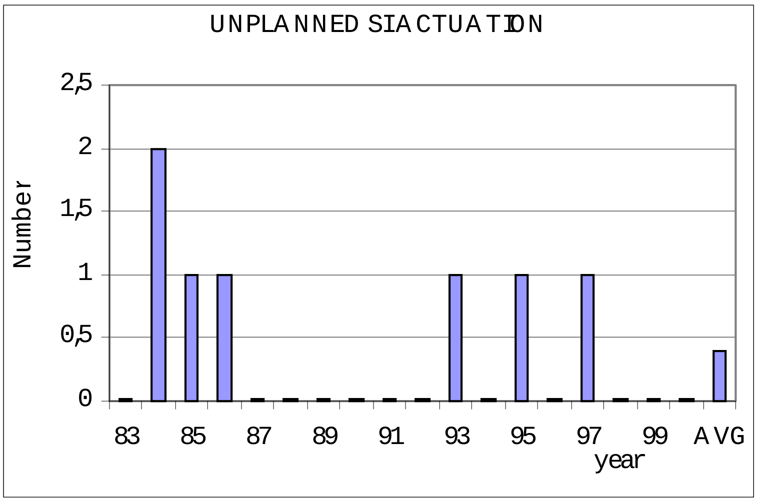


Figure 2.17: UNPLANNED SI ACTUATION

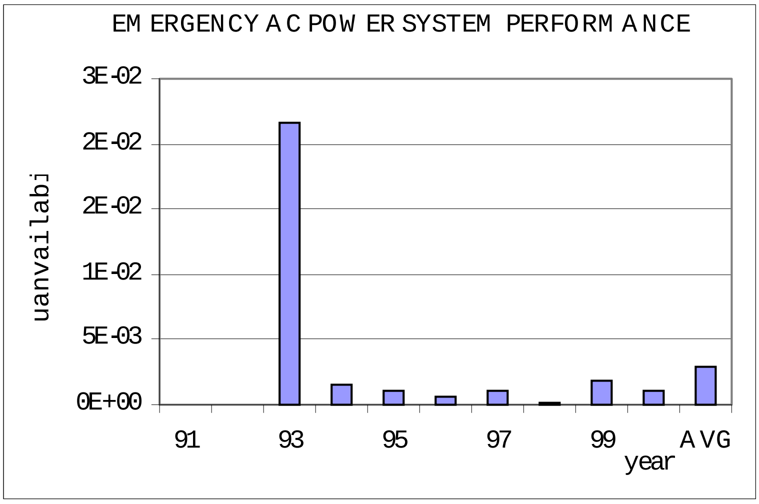


Figure 2.18: EMERGENCY AC POWER SYSTEM PERFORMANCE

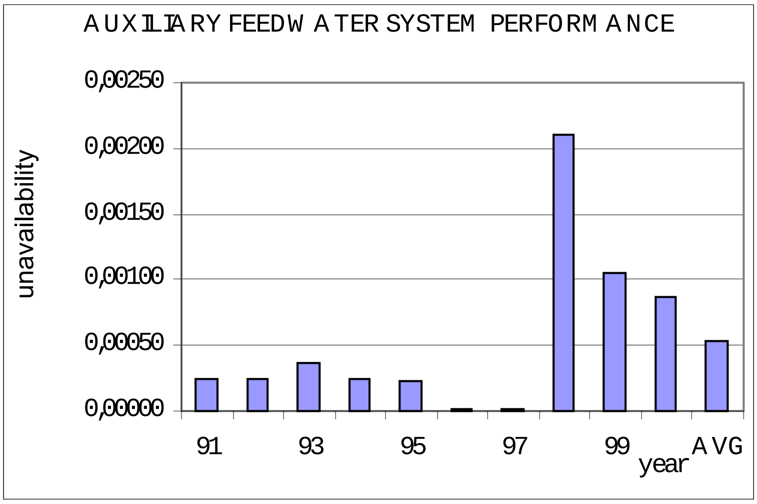


Figure 2.19: AUXILIARY FEEDWATER SYSTEM PERFORMANCE

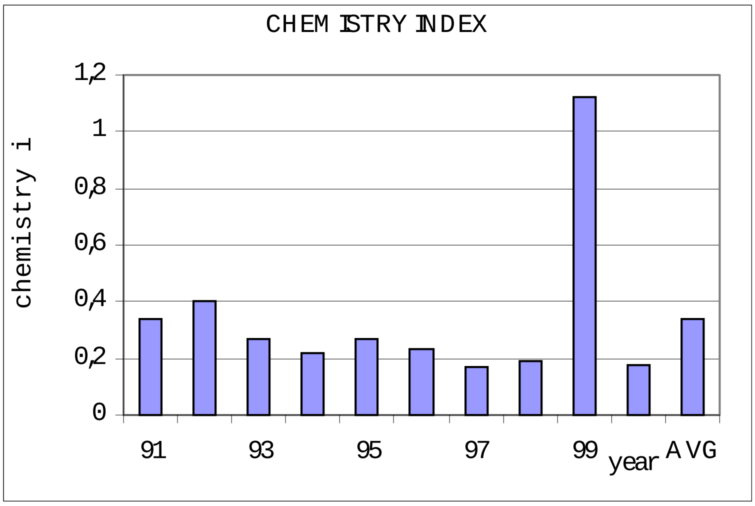


Figure 2.20: CHEMISTRY INDEX

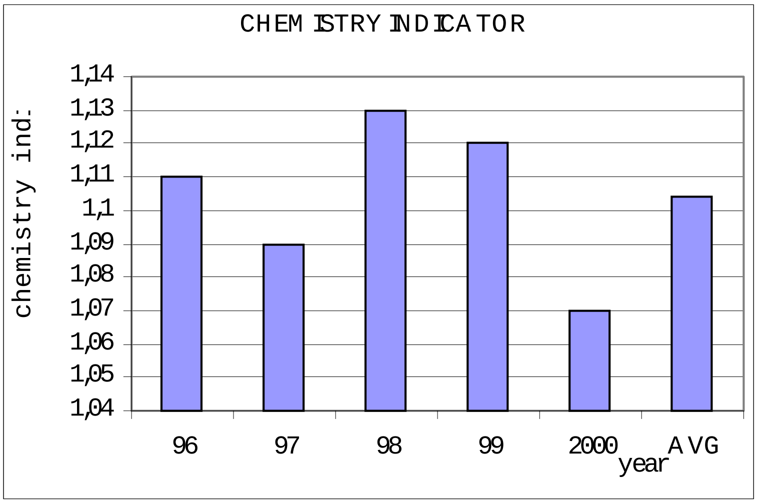


Figure 2.21: CHEMISTRY INDICATOR

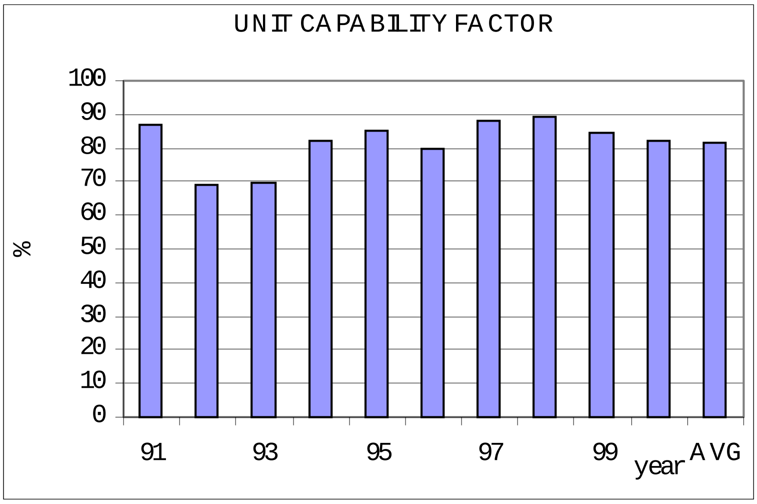


Figure 2.22:UNIT CAPABILITY FACTOR

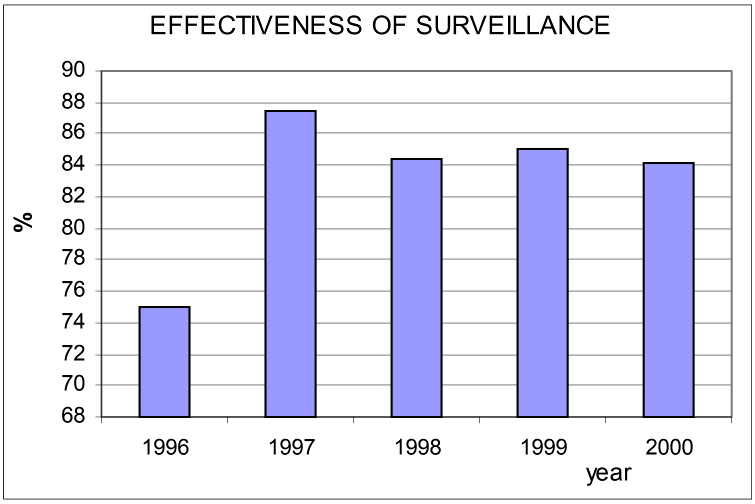


Figure 2.23: EFFECTIVENESS OF SURVEILLANCE

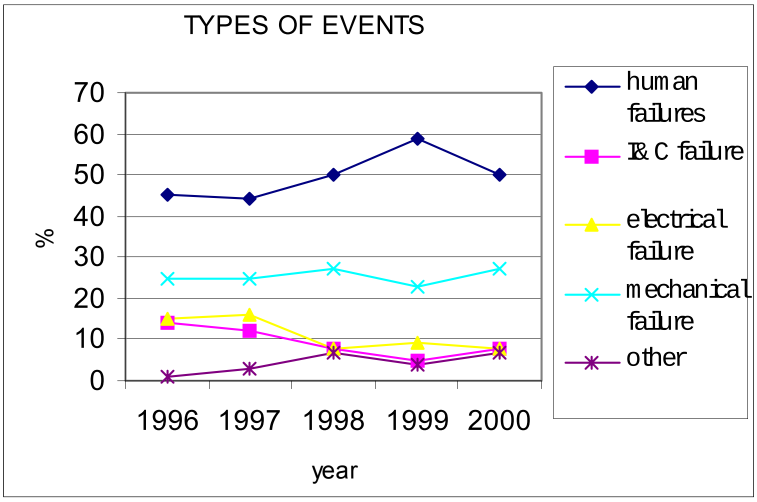


Figure 2.28: TYPES OF EVENTS

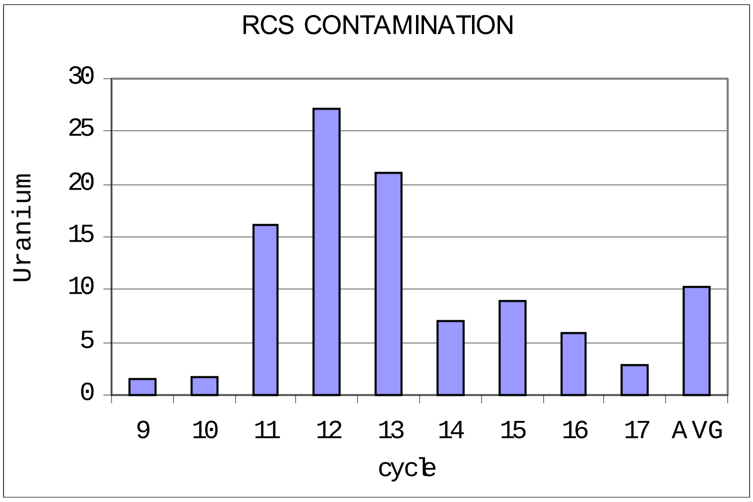


Figure 2.29: RCS CONTAMINATION

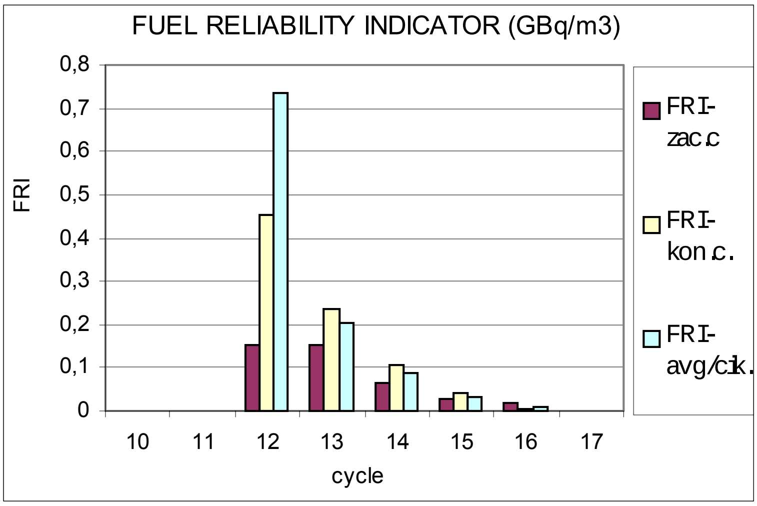


Figure 2.30: FUEL RELIABILITY INDICATOR (GBq/m3)

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

The purpose of the indicators in Figures 2.17, 2.18 and 2.19 is to present the system performance, i.e. reliability of important safety systems to respond to abnormal events or incidents. The indicators show the impact of effective operational and maintenance practices on the availability of safety systems components. Figure 2.18 presents the emergency AC power system unavailability factor, i.e. the electrical power system performance in case of on-site or off-site loss of AC power. Figure 2.19 presents the auxiliary feedwater system unavailability factor (AFW), i.e. the performance of the auxiliary system for supplying the feedwater into the steam generators of the pressurized water NPP, when the main feedwater system is unavailable. AFW factor is 0.0008 in year 2000 higher than previous years but still smaller then INPO value 0.025, because of the maintanance works during operating of plant. Figure 2.20 indicates the chemistry index for secondary side water, comparing concentrations of chosen impurity samples with their limit values. The average of such daily measurements for each impurity sample is divided by its limit value, and the sum of ratios normalized to 1.0. Chemistry index value of 0.18 shows high quality of chemical control. Figure 2.21 indicates the chemistry indicator, which shows the quality of chemistry control of secondary water. Indicator is combination of allowed Sodium, Chloride and Sulphate concentrations in Steam Generator blowdown system, iron and copper in main feedwater system and oxygen in water. Indicator`s value is equal to one when concentrations are lower than permmited. Values of chemistry indicator are followed in NEK from 1996 and are very close to INPO value of 1.1. Chemistry indicator in 2000 was 1.07.

Figure 2.22 Unit capability factor shows ability of safe production of energy and plant maintenance and managing. Value of factor is in year 2000 82.24% which is lower than INPO value of 87% or NEK value of 89%. This is due to prolonged In-Service Inspection and steam generators replacement.

Figure 2.23 Ability of fault discovering with testing is calculated as ratio between failures of equipment at surveillance testing and total number of (nuclear safety) equipment failures from 1996 to 2000.

Figure 2.24 - 2.27 Nature of events from 1996 to 2000 consists of human failures, electric failures, instrumentation failures, mechanical failures and others. Percentage of human failures is every year higher partly because in the revision of procedure "Report of deviations" the limits are lower. Figure 2.28 presents different types of events from 1996 to 2000

There are 373 fire detectors in NEK which in year 2000 detected 13 events from which two of them were detected as a real fire. In table 2.4 there are shown all events and real fire accidents in the technological part of the plant in term from 1983 to 2000.

Table 2.4: Number of fire alarms and real fire

Year	No. of alarms	No. of fires
1983	*	0
1984	*	0
1985	*	0
1986	*	1
1987	*	0
1988	*	0
1989	*	0
1990	*	0
1991	*	1
1992	*	2
1993	*	0
1994	*	0
1995	*	0
1996	*	1
1997	*	0
1998	43	0
1999	20	1
2000	13	2

Operational safety can be followed as number of violations of operational conditions specified in Technical specifications of NPP Krško (STS). In a period from 1996 to 2000 there were no such violations. The data about operating in LCO – Limited conditions for operation (operating time limitation of equipment at low functionality conditions still required for safety operation of NPP) is placed in Table 2.5.

Table 2.5: Operating in LCO-Limiting conditions for operating

	1999 (št.)	2000 (št.)
Breaker Change due to corrective maintenance	0	10

Breaker Change due to Failure of component or equipment	0	0
Breaker change due to surveillance	57	26
Corrective maintenance	55	55
Equipment failure	54	74
Modifications	0	7
Preventive Maintenance	75	69
Surveillance	111	102

Table 2.6 shows results of reliability for both diesel generators from 1985 to 2000. Results shows that start-up and operation reliability are bigger than required reliability in Technical specifications (3.8-1). There were 128 working orders ordained for corrective maintenance of safety systems on power in 2000. 22 working orders weren`t carried out or concluded in three months in 2000.

	Start-up (No.)		Operating (No.)		Reliability (%)		
	Tests	Inefficiency	Tests	Inefficiency	Start-up	Operation	Total
DG1	271	2	269	5	0.99	0.98	0.97
DG2	268	3	265	3	0.99	0.99	0.98

Sources:

1. Annual report NPP Krško 2000, feb. 2001
2. Performance indicators for the year 2000, NEK feb. 2001
3. Data of realised electrical energy production in 2000, ELES, office for operational department
4. Examination of operational and safety indicators, letter from NPP Krško No. ING.NOV-041/2001/6000, 14.5.2001

2.1.1.2 Shut-downs and Reductions of Power

Data on shut-downs and reductions of power of the Krško NPP are presented in tabular form (Table 2.7).

Table 2.7: Planned and unplanned shut-downs of the Krško NPP and reductions of reactor power by more than 10% of the installed power with duration longer than 4 hours.

Date	Duration (h)	Type	Mode	Cause
01.01.	11	Planned	Manual	**Operating at reduced power (50%)** due to Y2K and possible problems connected with it.
01.01.	22	Planned	Manual	**Operating at reduced power (80%)** – order of the dispatcher.
09.01.	5	Planned	Manual	**Operating at reduced power (80%)** due to testing of the turbine valves and maintenance of filtration system of condenser`s cooling water.
29.01..	5	Planned	Manual	**Operating at reduced power (91%)** due to testing of the turbine valves.
05.03.	14	Planned	Manual	**Operating at reduced power (80%)** due to testing of the turbine valves and maintenance of filtration system of condenser`s cooling water.
09.04.	3	Planned	Manual	**Operating at reduced power (90%)** due to testing of the turbine valves.
14.04.	1488.09	Planned	Manual	**2000 annual outage** (14.04. - 15.06.2000).

03.07.	168	Planned	Manual	**Operating at reduced power (max 83%)** due to limitation of heating Sava river (as source of cooling)
06.08.	3	Planned	Manual	**Operating at reduced power (92%)** due to testing of the turbine valves.
14.08.	420	Planned	Manual	**Operating at reduced power (max 77%)** due to limitation of Sava river heating (as source of cooling)
01.09	720	Planned	Manual	**Operating at reduced power (max 80%)** due to limitation of Sava river heating (as source of cooling)
01.10.	39	Planned	Manual	**Operating at reduced power (max 80%)** due to limitation of Sava river heating (as source of cooling)
05.11	3,5	Planned	Manual	**Operating at reduced power (92%)** due to testing of the turbine valves.
03.12.	3,5	Planned	Manual	**Operating at reduced power (92%)** due to testing of the turbine valves.

2.1.1.3 Fuel integrity and activity of reactor

Year 2000 comprises parts of 16th and 17th fuel cycle. 16th fuel cycle has ended on 15th of April 2000. After planned shutdown reactor achieved criticality on 15th of June 2000, when 17th fuel cycle started.

In the core of the 16th fuel cycle 80 fuel elements had modified lower in-nozzle (DFBN). Cladding, guide tubes of control rods and instrumentation of 56 fuel elements has been made from ZIRLO material. 28 new fuel elements had changed enrichment (2.6%) and geometry of fuel pellets of upper and lower Axial Blanket.

In the core of 17th fuel cycle 107 fuel elements had modified lower in-nozzle (DFBN). Cladding, guide tubes of control rods and instrumentation of 88 fuel elements has been made from ZIRLO material. 60 fuel elements had circular enriched Annual pellets in the Axial Blanket. 32 new fuel elements in 17th cycle have Removable Top Nozzle.

The fuel integrity is monitored indirectly by measuring specific activity of reactor coolant. Isotopes of iodine and noble gases are especially suited for this purpose. Data on the activity of the primary coolant are presented in Table 2.8, while Figure 2.29 presents contamination of the primary coolant with uranium.

Analysis of the reactor coolant specific activity till end of March 2000 have shown that no fuel elements in the core have been damaged during the 16th cycle. Increase of noble gases and iodine activities at the end of the 16th cycle have originated in degraded fuel integrity (leakage in fuel element P30 has been determined). Even though the fuel leakage has occured the specific activity has, according to the performed analysis, remained within the limits prescribed by Technical Specification TS-3.4.8.

Fuel state fundamental indicators for the core of the 17th cycle have shown that no fuel elements have been degraded till end of December.

Fuel reliability indicator (FRI) presents I-131 specific activity corrected for I-134 contribution from dispersed uranium in the primary coolant circuit normalized to constant value of cleaning speed.

NEK has calculated the reliability indicator by improved calculation method, described in NEK ESD TR 27/99. FRI values calculated by improved method for cycles 16 and 17 are presented together with values for cycles 14 and 15 in Table 2.9 and Figure 2.30.

Control of cladding tightness has been performed during Outage 2000 by “In Mast Sipping” (IMS) method. This test confirmed that a damage occured on fuel element P30 at the end of 16^{th} cycle. Element is from region 15B and has been burning in cores of cycles 14 to 16 achieving 39370 MWD/MTU burnup. The element has been then taken out of use.

Integrity test of the screws of upper nozzles of 37 fuel elements from spent fuel pit have been performed before the outage (in March). Two elements had damaged springs while 5 elements have been classified as suspicious. After emptying of the core of the 16^{th} cycle inspection of spring screws of upper fuel element nozzles on 108 elements has been performed. 28 elements had damaged springs and have therefore been taken out of use and are now deposited in spent fuel pit. Westinghouse then prepared a modified scheme for the core of the 17^{th} cycle where instead of damaged elements other already used elements from the pit that have been properly inspected have been used.

Average burnup of elements with damaged springs is 40 GWD/MTU, most affected are elements from regions 15 and 15B, supplied in 1996.

Table 2.8: The average values of the primary water activity.

ISOTOPE	average activity [10^9 Bq/m^3]											
	cycle 12		cycle 13		cycle 14		cycle 15		cycle 16		cycle 17 (15.6.-31.12.2000)	
	a)	b)	a)	b)	a)	b)	a)	b)	a)	b)	a)	b)
I-131	0.44	0.66	0.18	0.31	0.09	0.08	0.04	0.04	0.02	0.16	0.01	0.01
I-133	2.22	2.12	2.22	1.8	1.24	1.16	0.57	0.54	0.34	0.41	0.12	0.11
I-134	5.81	6.03	9.29	0.72	4.50	4.25	2.75	2.59	1.38	1.28	0.49	0.43
Xe-133	12.62	18.61	5.04	4.32	2.36	2.18	1.14	1.06	0.68	1.21	0.28	0.25
Xe-135	13.65	17.39	5.4	4.82	3.23	3.11	1.41	1.36	0.79	0.79	0.32	0.29
Xe-138	5.92	7.03	7.31	6.55	3.81	3.72	2.01	1.97	1.01	0.98	0.35	0.32
Kr-85m	2.11	2.62	0.71	0.64	0.38	0.36	0.17	0.17	0.09	0.09	0.04	0.03
Kr-87	3.53	3.85	1.28	1.18	0.71	0.68	0.33	0.33	0.21	0.23	0.07	0.07
Kr-88	4.92	5.51	1.75	1.69	0.97	0.93	0.45	0.44	0.24	0.24	0.08	0.08
EFPD	336.7 days		274.2 days		309.6 days		298.4 days					
max. burnup of element [MWd/tU]	48333		44215		45677		49271					

Legend:
a) stable condition
b) all measurements

Table 2.9: FRI values for 14th, 15th, 16th and 17th fuel cycle.

	FRI [Ci/m^3]			
	14th cycle	*15th cycle*	*16th cycle*	*1 7th cycle*
Start	1.73E-03	7.75E-04	4.78E-04	8.66E-06
End	2.90E-03	1.08E-03	1.43E-04	/
Average (all measurements)	2.33E-03	8.69E-04	3.01E-04	3.92E-05 (in year 2000)

Guide tube support pins problems

Control rods' guides are connected to the upper core plate and supported at edges with guide support pins. Control rods' pins at NEK are made from Inconel X-750, material revision A, material. It is well known that this material experiences strong tensial corrosion after a certain number of operating hours which causes cracks in pins.

Westinghouse informed NEK in 1997 about the pins problems and suggested exchange of all pins. On SNSA insistence NEK acquired Westinghouse technical report about possible aftereffects due to pins failure and safety estimation of power plants operation in the 17th cycle. The documents contain assurance that pin problems are not non-reviewed safety issue. It has been assured that NEK can safely operate in the 17th cycle even though the number of operating hours exceeds the value at which Westinghouse recommends pin exchange. In year 2000 NEK installed 1st phase of loose parts monitoring system even though no damage of support pins has been detected during operation up till now. Complete pins exchange is planned for 2001 outage.

2.1.2 SAFETY ASSESSMENTS AND LICENSING

2.2.2.1 Technical Improvements and Modifications to the Krško NPP

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

Modifications in 2000, for which a decision was issued by the SNSA:

2.1.3 PROJECT FOR MODERNIZATION OF THE KRŠKO NPP

Year 2000 was the closing year for the Krško NPP modernization programe which consisted of five projects: supply (design, manufacture and transport) of steam generators, steam generator replacement (installation: removal/replacement), power uprate analyses by 6.3 % , storage of old steam generators (a multi-purpose building), and supply of full-scope simulator.

The programme started in 1997. The Siemens-Framatome consortium is the manufacturer of the new steam generators and is the main contractor of the steam generator installation as well. The contractor for safety analyses is Westinghouse, the supplier of full-scope simulator is the Canadian Aerospace Electronic (CAE).

In the year 2000 all project successfully finished, except power uprate analyses project. The analyses under the title »Snubber Reduction Program«, prerequisite the use of "Leak Before Break" concept and have been carried out within the framework of the power uprate analyses for the Krško NPP but under the separate administrative procedure which is not finished yet.

Design, Manufacturing and Transport of Steam Generators

The steam generators, delivered by Siemens-Framatone, were designed in accordance to requirements of the ASME Boiler and Pressure Vessel Code. It was necessary to replace worn out (old) steam generators because of the degraded tubes (nearly 18 % SG tubes was already plugged). In the design and manufacture of the new steam generators a lot of changes were anticipated which would be ensure better resistance to tubes degradation. One of the major things is the new steam generator tubing material. Tubes in the new steam generator are made from Inconel 690 TT alloy.
In the phase of steam generator design and manufacturing the regulatory body and the authorized (technical support) organizations took part in QA audits at the steam generator designer, components manufacturers and at the steam generator assembly plant, as well. Additionally, manufacturing and testing of the new steam generators were independently checked by the authorized organizations, including: the Faculty of Mechanical Engineering, the Institute for Metal Structures, the Institute of Metals and Technology and the Welding Institute.

During the licensing process the Slovenian Nuclear Safety Administration (SNSA) requested the confirmation that the new steam generators are designed for hydraulic forces which come from postulated double ended guillotine break of primary pipes (DEGB). This question become important in connection with "Leak Before Break" methodology licensing process. According to that the designer Siemens-Farmatome performed additional analysis to proved mechanical integrity of steam generators for original design postulated accident of double ended guillotine break of primary pipes.

Furthermore there were no significant findings and major non-compliance’s, and the SNSA approved licensing package for design and manufacturing of steam generators.

The steam generators were on the Krško NPP site in September 1999, and they were stored in the storage building (multipurpose building), until the successfully replacement in May 2000.

Power Uprate Analyses

A feasibility analysis of parallel power uprating was undertaken (Westinghouse report: WENX 91-42, 1991) within the framework of the preparatory works for steam generator replacement. The main conclusion of that study was that a power increase of 6,3 % (from 1882 MW_t to 2000 MW_t) is feasible without extensive modifications to the plant system and components.

Comprehensive analyses were started 1997 with the adjective by Westinghouse to demonstrate plant safety performance and to confirm the mechanical integrity and life time of systems and components. The analyses encompass five major parts:

- A1: Analysis with focus on LOCA and transient analysis
- A2: Analysis with focus on DNB and Containment analysis,
- A2: Analysis with focus on DNB and core,
- B: Mechanical analysis and evaluations,
- C: System verifications.

The replacement of the steam generators and the power uprating have affected the current primary operating parameters. In addition, the new steam generators have different geometry, material properties and different hydraulic characteristics. All changes and modifications have had an impact on the original and current licensing and design basis documentation; therefore, new safety analyses and assessments have been required to prove that the plant will be able to operate safely. The safety reassessment and analyses cover thermal-hydraulic (TH), mechanical and structural aspect of modifications introduced by the modernisation project. The analyses needed to prove that all transients and accident conditions remain within the limits and acceptance criteria for the operating window. The original analyses were performed for one operating condition only, while the new analyses covered an operating window. The concept of the operating window provided more flexibility in the plant operation than the currently licensed operating point. The analyses verified the plant manoeuvrability for a selected operating window and safe operation with new steam generators at an uprated power.

The analyses supporting the operating window were consistent with American and European practice.
All of the above analyses are documented in Work reports, Updated Safety Analyses Report (USAR) and Technical Specification was accordingly revised.
These documents have been submitted to the regulatory body (SNSA) for approval.
Each of work reports was reviewed in parallel by the Krško NPP, the Technical support organizations (TSO's) and the SNSA. Those reviews resulted in a list of comments and required changes. After the clarification and resolution of all comments TSO's according to the Slovenian licensing legislation prepared Independent evaluation report(s), which were submitted together with other licensing documentation (Work reports, ect.) to the SNSA for final review and their approval.

The following Technical support organizations took part act as independent reviewers for the analyses performed by Westinghouse:

- Jožef Stefan Institute, Ljubljana;
- Faculty of Electrical Engineering and Computing Department of Power Systems, Zagred, Croatia;

- Faculty of Civil and Geodetic Engineering, Ljubljana;
- Enconet, Vieena, Austria.

Their findings support an appropriate safety level of the Krško NPP after power uprating and the steam generator replacement. The steam generator replacement and power uprating are now supported by a substantial set of adequate analyses. The reports comprise safety analyses, which are the prerequisite for granting the licences. The final reports of analyses are mainly finished in the year 2000, with the exception of some documentation changes, which are related to power uprate and new operating condition.

In 2000 the SNSA issued Krško NPP temporary licensing permit for power uprate operation where temporary approved all completed analysis, Technical Specification changes and start up tests.
The SNSA issued temporary licensing permit for power uprate operation (up to outage 2002), because Krško NPP needed temporary approved Technical Specification changes for start up and continuos operation to avoid outage prolongation because »Leak-Before-Break« (LBB) concept as part of uprate analyses is still under review.

The temporary licensing permit for Krško NPP had the following changes in the operating license:

- increase of thermal power in "Nuclear Steam Supply System" (NSSS) (from previous 1,882 MWt to 2,000 MWt) for 6.3 %
- definition of operating window instead of previous operating point
- possibility of 12-month or 18-month operating cycle
- removable fuel thimble plug assembly use
- "Revised Thermal Design Procedure" (RTDP) methodology use
- use of water entrainment phenomena into calculation of mass and energy releases for Main Steam Line Break (MSLB) design accident
- calculation of residual heat according to the ANSI/ANS 79 standard
- update of complete 15th chapter of safety report (USAR) - accident analyse – according to the up-to-date Regulatory Guide 1.70, Rev.3
- removal of NaOH tanks from the "Containment Spray System" (CIS) (SAT Removal Modification)
- all mechanical analyses used LBB concept for large diameter RCS pipes and for other safety class 1 pipes with nominal diameter larger than 6 inch, instead of previous postulated double ended guillotine break of piping.

In the scope of license SNSA took an active part also in supervision and assessment of start-up tests after the steam generator replacement. Comprehensive start-up tests program was determinate in Westinghouse report SSR-NEK-10.2 "Start-up Test Program", Rev.1.

Leak-Before-Break« (LBB) Concept

In the scope of analyses, performed for the NPP Krško steam generator replacement and power uprate, were analyses known as "Leak Before Break" (LBB) concept. The same LBB concept is also applicate in the snubber reduction on the steam generator and on the 1st class piping inside the containment building. The LBB analyses are according to the significance of the changes subject of the separate licensing process. This segment of the analyses is documented in the reports, which comprise besides mechanical analyses also a seismic loads analyses. Prerequisite for the snubber reduction is implementation and approval of the LBB concept.

During the licensing process NPP Krško withdraw the snubber reduction program. Till the end of the year 2000 NPP Krško submitted to SNSA all important analyses from the anticipate analyses program (with exception of final report "Class 1 Lines Reconciliation Analysis Summary") and some additional reports, performed by Technical Support Organisations (TSO's):

- IIS-DP-8234, "Nekateri vidiki uvedbe koncepta puščanja pred zlomom (LBB) v NE Krško" (Some aspects of the LBB implementation in NPP Krško), Maj 2000, IJS-R4, Ljubljana (Institute of Josef Stefan),
- SP-ES-410, "Leak Before Break metodologija v projektu modernizacije NE Krško" (LBB methodology in the NPP Krško modernisation project), Marec 2000, FS, Ljubljana (Faculty for mechanical engineering),
- NCRI-149/2000, "Vpliv obratovanja primarnega kroga na žilavost nerjavne dupleks jeklene litine" (Influence of the primary circle operation on the toughness of duplex casting stainless steel), April 2000, IMT, Ljubljana (Institute for metal and technology) ,
- "Model puščanja skozi razpoko" (Model of leakage through crack), April 2000, Fakulteta za pomorstvo in promet, Portorož (Faculty for maritime studies and transport).

In the scope of licensing process in the year 2000 on the basis of intensive collection of foreign experience regarding the LBB (review of analyses, up-to-date foreign technical literature) the SNSA demanded, from NPP Krško, additional analyses concerning:

- enhancement of the "In Service Inspection" (ISI) program (more than the ASME demands) on the piping where the LBB will be implement, regardless of the already enhanced NPP Krško own ISI program (which is not in the sense of LBB),
- the analyses of the consequences on the pipes, which connected the pressurizer with the primary cooling system (RCS), due to thermal fatigue (thermal stratification),
- the analyses of the consequences of thermal stresses on the residual heat removal (RHR) piping system due to eventual untightness of isolation valves,
- the reliability and variety of leakage detection through cracks on the piping and possibility of improvements,
- the evaluation of influence of off-limit gap tolerance in the supports due to loading and deformation of the RCS piping and supports,
- the evaluation of thermal ageing in the RCS primary welds system,
- the comparable evaluations of RCS response spectrum (RG 1.60 – "Artificial time histories") for different values of throttling.

SNSA will make final decision about implementation and conditions of LBB concept after some additional works will be performed:

- detail evaluations of additional required analyses and technical expertise,
- completion of analyses which were ordered by SNSA at TSO (realisation of analyses are in delay due to very late acquirement of data from NPP Krško and Westinghouse),
- evaluation of the start-up tests results, RCS measurements and inspections data, and NPP Krško initial operation experience after the steam generator replacement and power uprate,
- further supervisory and evaluation of foreign licensing demands, experience and practice.

Steam Generator Replacement

In February 1998 the Krško NPP awarded the contract for the Steam generator replacement project to the Siemens-Framatome Consortium. The project was performed on a "turnkey" basis, which means that the Consortium performed all engineering, preparation of the modification packages and site activities. The regulatory body (the SNSA) requested separate licensing process for the RCS pipes cutting and welding of new steam generators to the RCS pipes. SNSA approved the SG replacement methodology with some additional requests to the licensee. After SG replacement and according to licensing amendment Krško NPP had to perform the following:

- Report of measurements of pipes displacements and analysis of primary RCS pipes loads,
- Report of RCS supports and restraints gap measurements at different temperatures (cold and hot conditions) during heat-up,
- Special report of ultrasonic examinations of new RCS pipe to SG nozzle welds as base line for further in-service inspections (ISI),
- Final report of SG replacement with the non conformance analyses.

Additionally Krško NPP must performed chemical analyses of RCS piping material acquired during cutting process of old SG's.

A project review of the modifications was completed on the following systems: reactor coolant, main feedwater, steam generator blowdown and condensate water.

The steam generators were successfully replaced during the outage in June 2000.

Multi-purpose building

Within the scope of the project for the steam generator replacement, a multi-purpose building has been included for the following purposes:

- storage of old steam generators,
- storage of low and intermediate-level waste from the steam generators replacement,
- decontamination area,
- mock-up area,
- personnel radiation-health area.

Further technical data and informations about radioactive waste stored into the multi-purpose building comprise chapter 2.1.5.

Full Scope Simulator

The Krško NPP full scope simulator enables the training of all operators activities that are performed from the main control room and from the local shutdown panels. It has been built in accordance with the American standard, ANSI/ANS-3.5. This standard is used by most countries as acceptance criteria for determining simulator comformance.

The project of full scope simulator supply and site acceptance testing did not follow the schedule due to the delay in factory tests. The Krško NPP applied for the extension of the deadline for the installation of the full scope simulator, which was set on January 1, 2000. The licensing process finished on March 1, 2000. After the final phase of simulator acceptance testing, it was ready for training in April 2000. More comprehensive information about personal training is described in chapter 2.1.8.

Use of plant specific full scope simulator represents an improvement in the nuclear safety and training system. Acquisition of a plant specific full scope simulator represents the fulfillment of a licensing amendment of the SNSA and the recommendations of international missions.

2.1.4 Spent Nuclear Fuel

At NPP Krško all spent fuel are stored in a spent fuel pool. Approximately 2/3 of pool are occupied by racks having 228 positions for storage of spent fuel. During the outage 2000 thirty-two fuel elements were removed from the core. At the end of the year 2000 594 fuel elements (approximately 229 t of heavy metal) were stored. Five positions are occupied by containers and one by control rods. Therefore, for the storage 228 position are still available. Out of this121 positions have to be as a permanent reserve for entire reactor core inventory. Only 107 unoccupied positions are practically available for further storage of spent fuel, which is sufficient for only three years of operation of NPP Krško. In order to facilitate operation of NPP Krško until the end of its design life in 2023, the NPP Krško is planing to refurbish pool to accommodate storage of spent fuel that will be generated until the end of its operation.

Table 2.10: Data on quantity of spent fuel at NPP Krško

Year	Number of spent fuel elements in the spent fuel pool, comulative per year	Annual increase
1983	40	40
1984	82	42
1985	122	40
1986	154	32
1987	194	40
1988	226	32
1989	266	40
1990	314	48
1991	314	0 *
1992	358	44
1993	406	48
1994	406	0 **
1995	442	36
1996	470	28
1997	498	28
1998	530	32
1999	562	32
2000	594	32

* There was no refuelling in the year 1991

** In the year 1994 the outage started in December 1994, fuel was reloaded in January 1995;

2.1.5 Radioactive Waste

Various radioactive substances in liquid, gaseous and solid form that are generated during the operation of the NPP are processed by the system for treatment of radioactive waste. In order to minimise releases to the environment, the system is designed for collection, processing, storage and packaging of waste into a suitable form. Three main subsystems for radioactive waste management are being in use: for liquid, solid and gaseous radioactive waste.

In the year 2000, Krško NPP started to update radwaste database which will be included for each stored package:

1. order number,
2. category, type (with data on physical-chemical and radiochemical composition),
3. generation date,
4. quantity,
5. volumetric mass,
6. specific activity,
7. contact dose rate,
8. dose rate at 1m,
9. activity of all isotopes, corrected on decay
10. total alpha activity
11. date of storage and location in storage

Radwaste, stored in the year 2000

In the year 2000, 319 standard 200 L drums with solid LILW were stored with total activity of 2,722.83 GBq.

Table 2.11: Type of LILW stored in the year 2000

Type of waste	No. of drums	Activity [GBq]
EB-DC	6	50.91
CW	140	34.35
O	151	61.22
SR-PR	9	2453
SR-BR	6	17.25
F	7	106.1
Total	319	2.722.83

EB-DC dried evaporation bottoms
CW compressible waste
O other
SR-BR dried spent blowdown resins
SR-PR - dried spent primary resins

F filters

From the beginning of its operation up to the end of 2000, Kško NPP produced 13,365 standard drums of LILW which amounts 2,806.65 m^3. In the previous years, the volume of generated waste was reduced using following methods: compaction, supercompaction, drying and incineration. At the end of the year 2000, the volume of stored waste at Krško NPP was 2,157.60 m^3.

Table 2.12 presents the actual quantities and types of waste at the end of the year 2000 namely: types, amounts, activity calculated on the basis of dose of rate at 1m distance of 1m, specific activity and dose rate at surface of a drum

Table 2.12: State in storage facility at NPP Krško at the end of the year 2000

Type of waste	No. of drums	Activity [GBq]	Volume [m^3]	Specific activity [GBq/m^3]	Radiation level [μSv/h] from	to
SR	689	16130	144.69	111.5	5	100000
CW	483	620.1	101.43	6.1	5	40000
EB	251	260.3	52.71	4.9	50	3000
F	105	2072	22.05	94.9	20	50000
O	438	221.8	91.98	2.4	5	15000
A	33	2.82	6.930	0.4	20	100
SC	617	531	197.44	2.7	10	25000
ST-TTC	1753	6784	1514.59	4.5	0.9	70000
TI-TTC	18	2645	15.64	169	50	200000
TTC-insert.	12	1.6	10.36	0.2	10	200
Total	4399	29268.62	2157.61	13.6	0.9	200000

Source: data from the NPP Krško

Type of waste:

SR spent resins
CW compressible waste
EB evaporation bottoms
F filters
O other
SC waste compacted in the year 1988 and 1989
A ash and filter dust
ST- TTC waste compacted in years 1994, 1995 and 387 non-compacted standard drums inserted in TTC
TTC-insert 200 L drums inserted in TTC
TI- TTC drums from IDDS inserted to TTC

Temporary storage of spent resins in RADLOC containers

In the storage facility in RADLOC-500 HIC (High Integrity Containers) containers spent resins are temporarily stored and pending for processing by the IDDS system. In six containers 17 m^3 of spent resins from primary circuit and in four 4 containers 9,4 m^3 of blow-down spent resins are stored. Considering the capacity of "In Drum Drying System", of about 6 m^3 /year, it is foreseen to process all spent resins within the next four years.

Contaminated waste oil

NPP Krško is temporarily storing 30 drums of various types of contaminated waste oils. Contaminated waste oils are stored in 200 L drums that are loaded into EKO type containers to prevent spilling. Specific activity of oils is ranging between 110 and 95.900 Bq/l. Prevailing radio-nuclides are Co-60 and Cs-137. NPP Krško seeking for suitable method for conditioning of contaminated waste oil.

Unauthorised use of the IDDS system

During the 2000 outage, because of greater extend of the work, more wet radioactive waste was produced (wet kerchiefs). In June 2000 Krško NPP dried this waste using IDDS station for drying of evaporator bottom against the valid licence and procedures for its use. Krško NPP successfully dried three drums of above-mentioned waste. Four days after the fourth drum was dried-up the, waste has ignited and IDDS premises were filled with smoke. There was no fire and the fire-brigade did not intervene, because NPP's staff isolated burning waste in drum from the atmosphere before the fire could start. After a detailed analysis, it was found out that:

- the drum contained some cotton kerchiefs, used paper-glue ribbon, a rubber glove and metal cover of an oil drum;
- all contains of the drum was black and partially charred;
- the drum was characterised as a low level waste with total activity of 10E+8 Bq;
- with respect to drum inventory and findings on ignition it is possible that ignition started during heating of the drum and became more intensive with access of fresh air that accelerated generation of smoke
- there was no release of radioactive effluents to environment during the incident.

The SNSA issued a decision of August 4, 2000, with which temporary prohibited use of the IDDS system, and requested a detailed analysis of the event, the evidence that the unauthorised use did not effect the functions of the system and installation of an automatic fire detector. After operator fulfilled all requested, the decision which allowed further use of the IDDS system was issued on August 28, 2000.

Radioactive waste, stored in the Decontamination Building

In the year 1999 a special facility was constructed for storage of two old steam generators, so called Decontamination Building; consisting of the following three areas:

- area for decontamination
- "mock-up" area; and
- area for storage of old steam generators

In the area for storage of old steam generators beside two steam generators with volume 600 m^3 and activity 8,79 E+12 Bq, 7 containers with thermal insulation and other non-compressible radioactive waste (pipes, valves, structural elements), generated through replacement of steam generators, were stored at the end of the year 2000. This items have surface contamination ranging from 100 up to 1000 Bq/dm^2. In this part of the building 7 m^3 of other contaminated material (steel cables, valves, wooden crates), produced during the steam generators replacement is also stored. Some of this material will be decontaminated and re-used.

In the area for decontamination approximately 17 tonnes of contaminated material, generated through replacement of steam generators, was temporarily stored at the end of 2000. It is expected that majority of this material will be decontaminated. It is handled is in accordance with procedures for decontamination and for clearance from the institutional control.

2.1.6 RADIOACTIVE RELEASES FROM KRSKO NPP IN THE ENVIRONMENT

The limits of radioactive releases into the environment are stipulated by the licence for operation of the NPP Krško No. 31-04/83-5, issued on 6 February 1984 by the Energy Inspection Authority of the Republic of Slovenia.
The competent authorities were regularly informed about the releases of radioactive materials in the environment by the Krško NPP on a daily, weekly, monthly, quarterly and yearly basis.

2.1.6.1 Liquid releases

The liquid radioactive releases are discharged into the Sava river through the main water supply in front of the dam. The activity of liquid releases indicates that the dominating radionuclides are: Xe-133, Xe-135, Xe-131m, Xe-133m, Kr-85, Co-60, Fe-59. The activity of Cs-134, Cs-137, Co-58 and Sb-125 is for two to three orders of magnitude lower. The main contribution to the dose is made by the radionuclides caesium and cobalt. The concentrations of each radionuclide in the liquid releases are measured and controlled by reactivity meters. These automatically close the local valves, once the prescribed limit concentration is reached, and thus prevent further releases into the environment. In liquid releases, the dominating radionuclide was tritium (H-3). Even though the activity of tritium is high compared with other radionuclides, due to it’s low radiotoxicity its impact is insignificant. In 2000, the annual released activity of this radionuclide was 10.7 TBq, which was approximately 53.5% of the annual limit value of 20 TBq. Figure 2.31 presents the changes of the aggregate activity of tritium in releases over several years. The annual activity of other radionuclides in liquid releases was about a thousand times lower, and is shown in figures 2.32 to 2.35 for the entire period of the Krško NPP operation. The releases for the year 2000, compared to previous years were significantly lower, due primarily to stable power plant operation and suitable waste water decontamination systems.

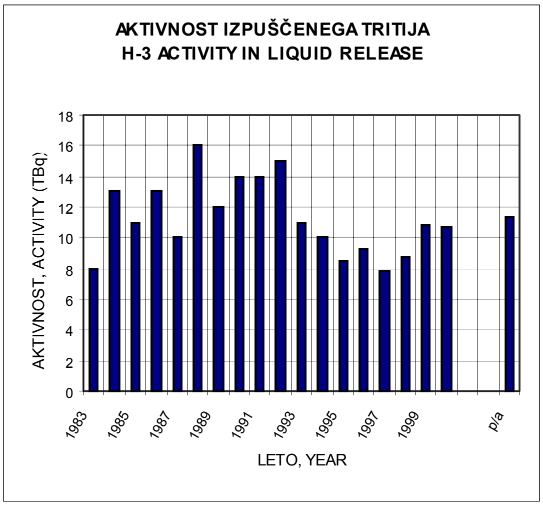


Figure 2.31: Tritium activity in liquid releases (administrative annual limit 20 TBq).

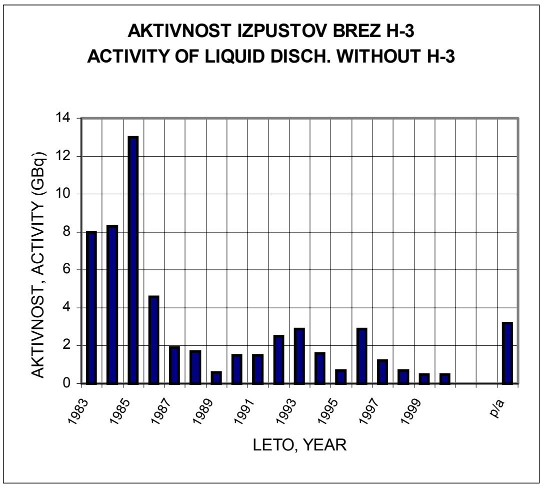


Figure 2.32: Fission and activation products activity in liquid discharges without tritium

Figure 2.33: Co-60 activity in liquid releases

Figure 2.34: Cs-137 activity in liquid releases

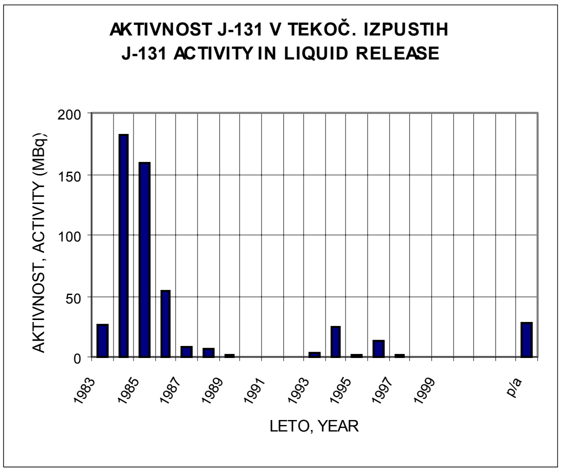


Figure 2.35: I-131 activity in liquid releases

2.1.6.2 Gaseous releases

Radioactive gases from the Krško NPP were released into the atmosphere mainly from the reactor building stack and through the vent of the condenser in the secondary coolant loop. The radiation monitoring system continuously measures and controls concentrations of individual radioactive elements at both discharge points.
The released activities and limit values for all important gaseous emissions in 2000, where the activity of noble gases prevails, are given in Table 2.13. In 2000, the radioactivity of noble gases was 2.29 TBq (Xe-133 equivalent), which represents 2.1% of the annual limit value. Low values of gaseous releases in the last few years is expected due to the fact there was no significant fuel leakage in the reactor core. Most of the release occurred during the outage and steam generator change. Figure 2.36 presents changes of the total activity of noble gases in discharges, Figure 2.37 the activity of C-14 in atmospheric discharges and Figure 2.38 the activity of H-3 in atmospheric discharges for each year. Figure 2.39 shows the discharge of noble gases in the year 2000.

Emissions of radioiodine in the year 2000 were 97.8 MBq (56.8 MBq I-131 equivalent)., which amounts to 0.3% of the annual limit. Most of this was released during the outage, so a considerable increase of radioiodine in gaseous releases was observed in April and May, which was due to the opening of the primary system (reactor vessel, steam generators); this is normal and expected. Figure 2.40 shows the released activity of radioiodine for each month in 2000.
The activity of other radionuclides in aerosol releases is lower by several orders of magnitude due to efficient filtering in the main ventilation channel. Released activity in the year 2000 was 1.1 MBq, which is 0.006%of the annual limit. H-3 and C-14 emissions are constant and in the year 2000 NPP Krško released 1.2 TBq of H-3 and 0.12 TBq of C-14. Figure 2.41 presents the released activity of tritium, and Figure 2.42 the activity of C-14 for each month in 2000.

Table 2.13: Gaseous releases activity in 2000

Gaseous emissions	Released activity (Bq)	Limit values of emissions (Bq/year)	Limit value percentage (%)
Noble gases	2.29 E +12 (Xe-133 equiv.)	110 E+12 (Xe-133 equiv.)	2.1
Iodines	52.3 E+06 (I-131 equiv.)	18.5 E+9 (I-131 equiv.)	0.3
Aerosols	1.06 E+06	18.5 E+9	under 0.01
Tritium	1.2 E+12	no restriction in TS*	
C-14	0.12 E+12	no restriction in TS*	

*TS - technical specifications

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

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

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

Note: In Figures 2.37 and 2.38 the estimate for the Krško NPP is given for the period 1983-1990, based on periodical measurements of concentrations and flows, and - as from 1991 - on the estimate by the Jozef Stefan Institute, derived from results of continuous measurements.

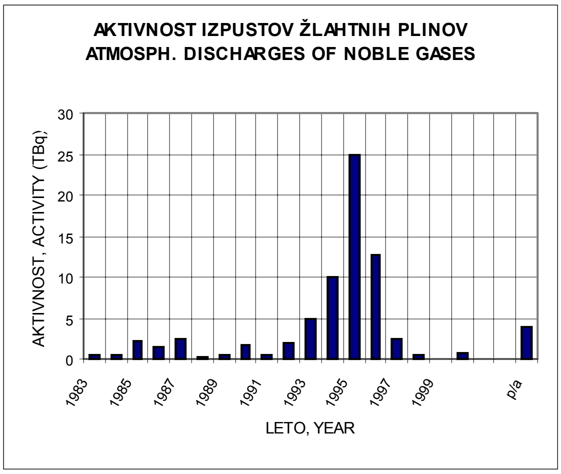


Figure 2.36: Noble gases activity in gaseous emissions in previous years

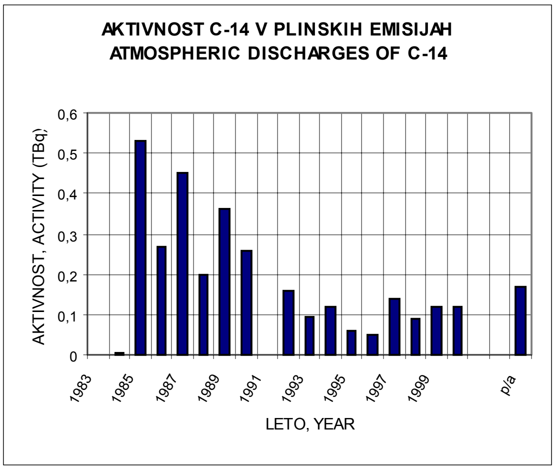


Figure 2.37: C-14 activity in gaseous emissions in previous years

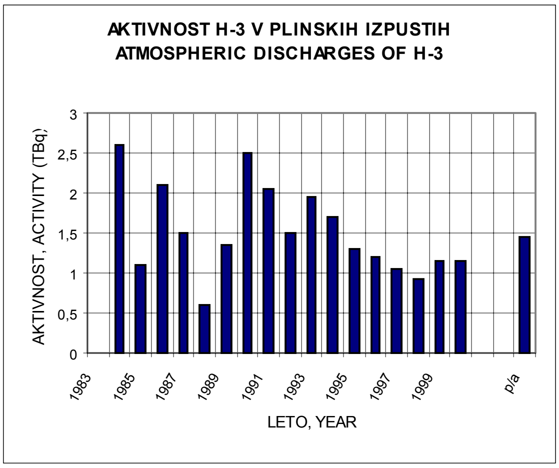


Figure 2.38: H-3 activity in gaseous emissions in previous years

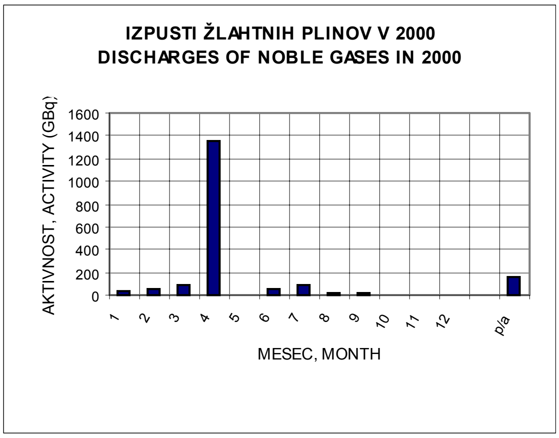


Figure 2.39: Noble gases activity in gaseous emissions the year 2000

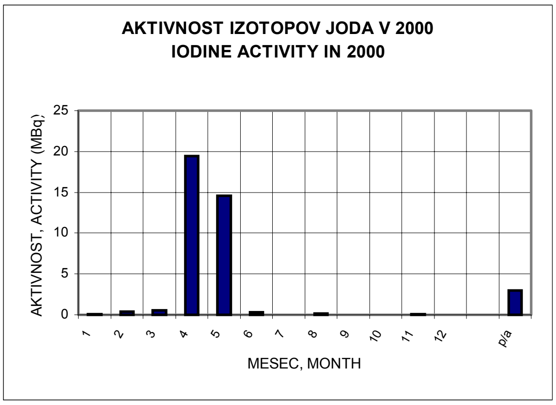


Figure 2.40: Radioiodine activity in gaseous emissions the year 2000

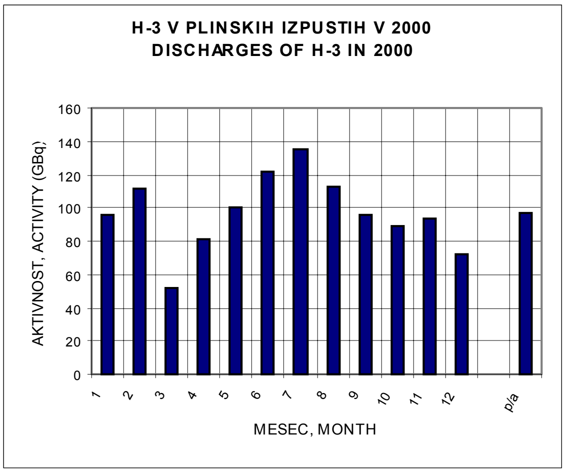


Figure 2.41: H-3 activity in gaseous emissions the year 2000

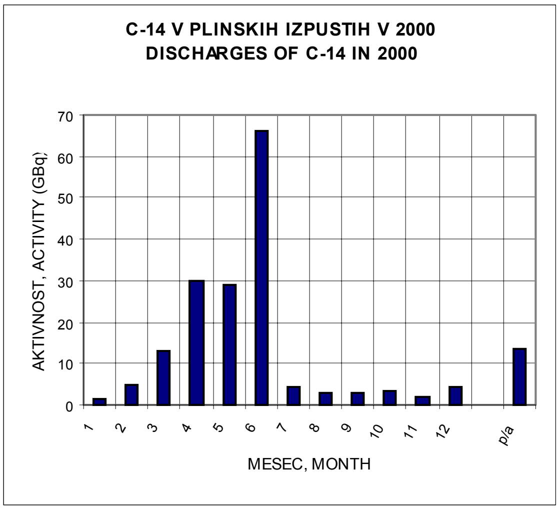


Figure 2.42: C-14 activity in gaseous emissions the year 2000

Source: Periodical and annual reports of NPP Krško and reports of authorised organisations.

2.1.7 THE KRŠKO NPP PERSONNEL EXPOSURE TO RADIATION

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

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

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

The average exposure of workers to ionizing in the NPP is low. In 2000 the average effective dose to workers was 2.30 mSv, which is approximately 4.6% of the dose limit to workers who are professionally exposed to ionizing radiation (the still valid Regulation on Dose Limits to Population and Radiation Workers, Individual Monitoring and Monitoring of the Workplaces, (Off. Gaz. SFRY, No. 31/89) or 11.5% in accordance with the latest recommendations ICRP (1991) and BSS (1996).

The average effective dose to the NPP personnel was 0.96 mSv, and to external workers 2.88 mSv. Workers received the major part of the dose during the annual outage of the power plant. It is found out that in the recent years the average individual and collective doses have shown a rising trend as a consequence of plant modification works performed, plant upgrade and the modernisation programme.

In Table 2.12 the distribution of effective doses to workers in the Krško NPP for the entire period of its operation is shown. Altogether 8 NPP workers received annual effective doses of more than 5 mSv, of which the highest effective doses of 7 mSv were received by them. Of the external contractors, 146 received effective doses were above 5 mSv, of which 48 contractors received an effective dose above 10 mSv. The highest effective dose in the Krško NPP, received by an external worker (from SIEMENS) was 20.99 mSv.

The dose values stated in Table 2.13 refer to workers who received effective doses above 5 mSv regarding to work performed and regarding to personnel. It is found out, that the most exposed workers are maintenance workers during the annual outage of the power plant.

Table 2.14 shows that in 2000 the collective effective dose to workers at the Krško NPP was 2.60 mSv, which is more than it was in last years (1999 – 1.65 manSv, 1998 – 1.25 manSv, 1997 – 0.99 manSv). The collective effective dose in 2000 is higher than the average value for the whole period of commercial operation of the Krško NPP from 1983 to 1999 which is 1,56 manSv. (Figure 2.38). Higher effective doses are due to major plant modification works performed, plant upgrade and the modernisation programme. Systematic prevention work to minimize the workers` exposure is taking into account (education, training for specific tasks in the radiation area and suitable planning of operations in compliance with the ALARA principle). In 2000, the collective dose to the Krško NPP staff was only 0.33 manSv, and to the external contractors and the main supplier workers 2.27 manSv.

In 2000, the collective effective dose per unit of net electrical energy produced was 4,78 manSv/Gwyear, which is more than in the last three years (1999 – 3.22 manSv/Gwyear, 1998 – 2.28 manSv/Gwyear, 1997 – 1.81 manSv/Gwyear) (Figure 2.39). The distribution of the received effective doses in the Krško NPP from 1983 to 2000 is presented in Figure 2.38. The effective dose was the lowest in 1991. In 1991, there was no refueling and, therefore, the annual outage was shorter.

In 2000 no radiological event at the Krško NPP occurred to cause unplanned exposure of the workers, either from external radiation or from internal or external contamination.

Krško NPP regularly submits annual reports on radiological events and doses received by its workers to the international organisation OECD/NEA International System on Occupational Exposure (ISOE). The members of the organisation have at their disposal:

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

Slovenia has two representatives in the ISOE organisation – one from the Krško NPP, and one from the SNSA.

Table 2.12: Distribution of effective doses for all workers at the Krško NPP in the years noted

Year	Range of received Annual Effective Doses (mSv/year)							***Total number of workers***
	0-1	1-5	5-10	10-15	15-20	20-25	Nad 25	
1981	475	45	0	0	0	0	0	520
1982	275	313	9	13	10	1	1	622
1983	462	206	53	45	34	27	4	831
1984	375	205	15	3	2	0	0	600
1985	517	277	79	17	2	0	0	892
1986	524	301	79	3	4	1	0	912
1987	486	242	65	16	6	1	0	816
1988	506	298	60	21	3	1	0	889
1989	443	200	66	19	3	0	0	731
1990	390	265	92	38	5	2	0	792
1991	257	89	8	0	0	0	0	354
1992	448	219	0	127	22	1	0	817
1993	401	183	87	26	9	1	0	707
1994	536	187	32	2	0	0	0	757
1995	521	248	62	16	3	0	0	850
1996	489	258	114	25	3	0	0	889
1997	559	211	46	5	0	0	0	821
1998	560	221	72	6	0	0	0	859
1999	578	297	97	11	0	0	0	983
2000	588	389	106	29	15	4	0	1131

Table 2.13: Collective effective dose for NPP staff, the main supplier workers and the external contractors in Krško NPP in 2000 and number of workers who received doses higher than 5 mSV regarding job or system and personnel.

JOB / PERSONNEL	**Number of workers who received the dose more than 5 mSv**			**Collective dose (manSv)**		
	Osebje jedrske ga objekta	**Glavni dobavit elj opreme**	**Ostalo osebje**	**Osebje jedrske gaobjek ta**	**Glavni dobavit elj opreme**	**Ostalo osebje**
Normal reactor operation and supervision						
Maintenance personnel				0.03363		0.70719
Operators				0.02307		
RPU personnel				0.00492		
Inspection personnel				0.00903		
Regular maintenance works						
Maintenance personnel	3	42	104	0.09533	0.27821	1.26501
Operators				0.05245		
RPU personnel	3			0.03421		0.01694
Inspection personnel				0.03310		
Inspection of equipment before start						
Maintenance personnel						
Operators						
RPU personnel						
Inspection personnel						
Extraordinary maintenance						
Maintenance personnel						
Operators						
RPU personnel						
Inspection personnel						
Processing of radioactive wastes						
Maintenance personnel						
Operators	2			0.02717		
RPU personnel						
Inspection personnel						
Refueling of the reactor						
Maintenance personnel						

Operators RPU personnel Inspection personnel				0.01790		
Total Maintenance personnel Operators RPU personnel Inspection personnel	 3 2 3	 42	 104	 0.12897 0.12059 0.03913 0.04213	 0.27821	 1.97220 0.01694
TOTAL	8	42	104	0.33082	0.27821	1.98914

Table 2.14: Collective and average effective dose to workers in 2000

	Collect. effect. dose (manSv)	**Number of workers**	**Povprečna doza (mSv)**
NPP staff	0.33	343	0.96
Contractors	2.27	788	2.88
Total	2.60	1131	2.30

Figure 2.38: Received collective effective doses by all workers at the Krško NPP per year

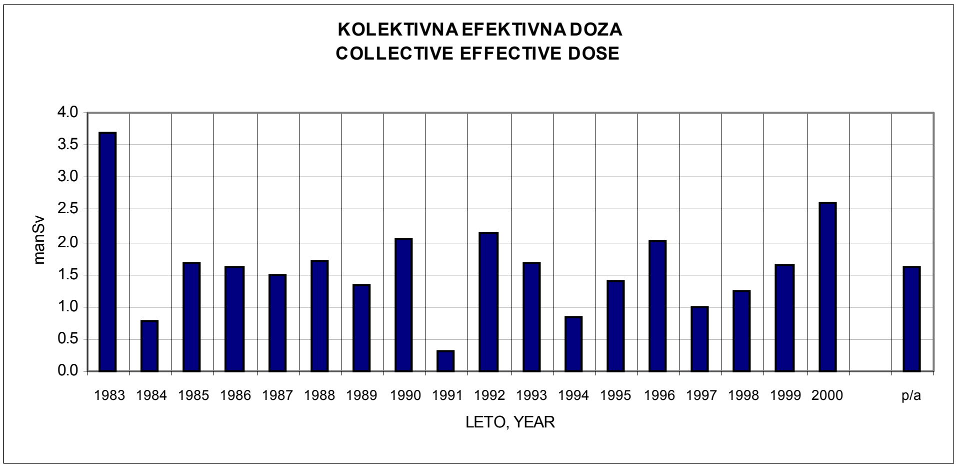
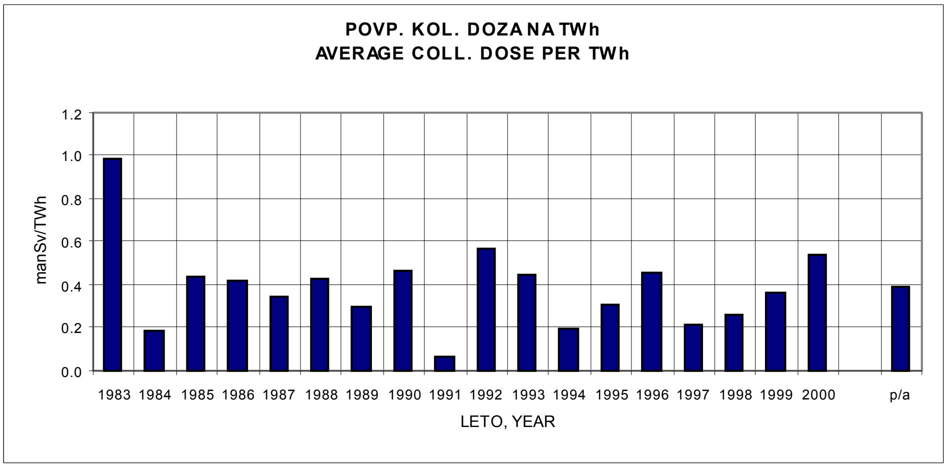


Figure 2.39: Collective effective dose per unit of produced electrical energy



2.1.8 TRAINING

Annual training plan for the year 2000 was developed based on training needs identified by plant organizational units. Documented requests were analyzed and evaluated with leaders of organizational units and plant management. Training plan was developed in consistence with training program requirements, described in chapter 13.2 of Safety Analysis Report, and with administrative plant procedure ADP-1.1.009, Training and Professional Education of NEK Personnel.

With increased internal training capabilities during the year 2000, the amount of domestic training for operations and maintenance personnel significantly increased. Some special training needs were covered by using outside (domestic and foreign) resources.

There were no major obstacles during realization of the training plan for the year 2000.

All the training that was planned for licensed personnel, personnel with duties related to nuclear safety and personnel required to receive re-qualification training in accordance with domestic regulations, was smoothly performed and completely covered as planned.

Most important training activities, outlined consistently with training program structure and training areas, are further described in more detail.

2.1.8.1 Initial training

Operations personnel initial training

Operations personnel initial training consists of the segments that are conducted for the candidates for operator licenses and for the persons filling various positions in operations, or for other areas where additional knowledge is required.
In September 2000 eleven (11) trainees started a course on Nuclear Power Plant Technology. Theoretical part will be finished at the end of January 2001. The group will continue training with the lectures on NPP Krško plant systems. This part will consist of classroom presentations and practical training at the plant. From this group certain number of candidates will be selected for continuation of training on NPP Krško full scope simulator.

As a part of cooperation between NEK and WANO association, two participants attended “Shift Supervisor Professional Development Seminar”.

Other technical personnel initial training

Initial training for other technical personnel consists of training courses aimed to provide additional general and special knowledge needed in the maintenance area and for other support functions.

Some courses for specialists required for larger number of participants were organized at NEK. Specialist courses that needed special equipment for practical training were organized at equipment vendor locations or at specialized training organizations.

Maintenance training instructor group prepared and conducted a series for maintenance personnel. The quality and quantity of training for maintenance personnel significantly increased by putting in function the Training center for maintenance personnel. The training center was built in renovated warehouse building and is equipped with classrooms and workshop space, equipped for individual maintenance organizational units.

The amount and content of training for various support organizations was highly influenced by changes in Slovenian regulations and requirements for training related to activities on various plant projects.

Additional general training was provided to larger number of NEK personnel to assure high quality performance during the outage 2000. General employee training and radiation protection training was provided to high number of contracted maintenance personnel as well.

2.1.8.2 Continuing training

Operations personnel continuing training

Operations personnel continuous training consists of the programs that are regularly conducted in accordance with regulatory requirements to keep main control room operators licenses (nuclear regulations) as well as licenses for field operators (conventional regulations).

Licensed personnel training

In the year 2000, 29 candidates passed examination for acquisition or renewal of a license for reactor operator or senior rector operator. In spring time 4 candidates renewed reactor operator license, in June two candidates acquired reactor operator licenses for the first time. In autumn 22 candidates renewed their licenses and one acquired senior reactor operator license. For the candidates that were scheduled for examination in the first half of the year, a refresher course on nuclear technology was conducted. In autumn the refresher course was not conducted as the theoretical elements were included in classroom portion of the two year cyclic retraining program for licensed personnel.

Licensed operator training program was revised in 2000 to incorporate the use of newly acquired full scope simulator. The training program was designed using Systematic Approach to Training concept. Based on results of Job and Task Analysis, the tasks requiring regular retraining were identified. Entire retraining program is designed as a two year cyclic program divided into eight weekly training segments and each year for segments are conducted. Eight teams participate in each training segment. Each segment consists of 15 hours of classroom presentations and 20 hours of simulator exercises. Operational teams therefore receive 80 hours of simulator training which is comparable to the practice in developed countries. NEK started to use full scope simulator in April 2000 and therefore only three segments of continuing training program were conducted. In 2000, the training program was partially adapted due to special needs, driven by plant modifications, especially replacement of steam generators. The first segment was especially oriented towards expected plant behavior after replacement of steam generators. Operational teams exercised on the simulator start-up performance tests procedures that were later actually performed at the plant.

The following is a list of scenarios and evolutions performed on the simulator:

Turbine valves testing (10% power decrease, testing, power increase back to full power)
Automatic reactor trip due to nuclear instrumentation failure
Steam generator level control failure and loss of main feed pump at 80% power
Small break Loss Of Coolant Accident with failure in safety injection sequence
Main steam line leak and spurious safety injection
Steam line break inside containment
Reactor Startup
Main generator synchronization, power increase and stabilization at 20%
Large break Loss Of Coolant Accident
Steam generator tube leak propagating to steam generator tube rupture
Startup performance tests after replacement of steam generators
Loss of condenser vacuum followed by small break Loss Of Coolant Accident
Loss of reactor coolant pump seal injection (forced shutdown)
Individual system operation (CVCS, AF, SD)
Steam generator tube leak greater than technical specification limit and main steam line break
Main generator fault (main turbine and reactor trip)
Anticipated transient without scram and steam generator tube rupture
Fault on diesel generator and loss of all off-site power
Natural circulation cooldown
Switchyard, equipment manipulation and switchover of 6.3kV bus
Small break Loss Of Coolant Accident
Rod drop recovery
Loss Of Coolant Accident outside containment
Loss of Heat Sink
Loss of core cooling
Faulted and ruptured steam generator #2
Loss of reactor coolant pump seal cooling
Pressurizer steam space Loss Of Coolant Accident

As a part of examination for obtaining or renewal of operator licenses the simulator operating exam were conducted. Simulator examination was performed in accordance with NEK training procedure TSD-13.409, Izvajanje preizkusov usposobljenosti na simulatorju. The group of examiners was composed of members of special commission of experts, operations department management and instructors. Examination scenarios were selected by the members off members of special commission of experts appointed by URSJV. Exam scenarios will be kept and maintained separately from training scenarios in accordance with URSJV policy and policy of special commission of experts.

At the end of the last segment other licensed personnel took annual exam, which in addition to questions related to last segment contained also questions from previous segments. In addition to written exam, practical operating exam on the simulator was also conducted in accordance with NEK training procedure TSD-13.409, Izvajanje preizkusov usposobljenosti na simulatorju. This scenarios were conducted after the scenario for license renewal.

Other technical personnel continuing training

Training courses in this area are aimed to refresher and upgrade knowledge for different areas as required by regulations.

Training related to emergency preparedness at NEK was conducted in accordance with procedures for emergency preparedness. Larger scale exercise was conducted in December and this exercise was supported by the NEK full scope simulator.

A large number of general employee courses and radiation protection courses was conducted for NEK employees and for subcontracted personnel. This activity was in 2000 especially intensive as there was a need to organize and conduct high number of courses for the personnel that was involved in replacement of steam generators and implementation of modifications. Retraining on radiation protection level 1 completed 17 NEK employees and 1 subcontractor. Retraining on radiation protection level 2 completed 48 NEK employees and 5 subcontractors. Radiation protection level 3 completed 8 NEK employees and 269 subcontractors. General employee training for NEK specifics completed 176 subcontractors.

2.1.9 INSPECTIONS AT THE KRSKO NPP

SNSA inspections, in the year 2000, carried out in accordance with the approved inspection programme in the Krško NPP, 99 regular - announced inspections and 3 inspections where only official notes were written (two related to the preparations on the Outage 2000 and one to the arrival of the fresh fuel to the port of Koper). Four regular inspections of the Krško NPP were conducted in co-operation with other inspections: two with the Energy Inspectorate and two with the Inspectorate for Civil Protection and Disaster Relief.

Routine inspections at the Krško NPP in 2000 were performed on average twice a week and comprehended in relation to the plan:

Operation:
- review of the implementation of the decisions of SNSA,
- review of the results of measurements of the leak rate of the old steam generators,
- storage of the new steam generators,
- survey of data on the nuclear fuel status (leakage, fuel burnup at the end of the 16th fuel cycle),
- design of the new reactor core for the 17th fuel cycle and activity of the primary coolant,
- keeping the logbooks by the operating personnel,
- preparations for the 2000 outage,
- preparations for the replacement of the steam generators,
- status/changes of the valid revision (Rev. 9) of the Emergency Operating Procedures after the implemented modifications and power uprate,
- status/changes of the valid revision (Rev. 8) of the Abnormal Operating Procedures after the implemented modifications and power uprate,
- status/changes of the General Operating Procedures
- walkdown of the engineered safety systems
- modifications related to the Fire Protection Programme,
- measures for improving housekeeping in the areas of technology process,
- preparation of the power plant for operation in winter time.

Radiological control:
- doses received by personnel during the Outage 2000 (collective, individual),
- doses received by subcontractors during the Outage 2000,
- construction of a new control point and a temporary control point for the Outage 2000,
- performance of training in the field of radiation safety,
- inspection of the ALARA programme for the Outage 2000,
- review of the ALARA programme for the steam generators replacement,
- review of the documentation of the steam generators replacement project (decontamination, shielding, dose limits, organisation of the HP),
- decontamination unit performance.
- increase of the dose rate on the surface of the water in the spent fuel pit due to release of Cobalt - 58,
- radwaste management, taking out of the controlled area, housekeeping in the decontamination and old steam generators building ,

Maintenance and surveillance testing:

- On-line maintenance and accompanying activities (PSA, planning, work orders),
- implementation of the 10 CFR 50.65 Maintenance Rule,
- periodic witnessing of the regular monthly testing of diesel generators for emergency power supply (DG 1 and DG 2),
- review of results of the surveillance testing of safety injection pumps,
- review of results of the surveillance testing of the auxiliary feedwater system pumps,
- review of results of the surveillance testing of the auxiliary feedwater system turbine driven pump,
- review of results of the residual heat removal pumps surveillance testing,
- review of results of the essential service water pumps surveillance testing,
- review of results of the reactor protection system surveillance testing,
- review of results of the monitoring of the generator atmosphere,
- calibration of instrumentation,
- activities in the field of testing of the motor operated valves,
- temporary storage of new and old steam generators,
- programme of inspections of pressure vessels and the inspections results,
- warehouse of spare parts, lubricants and corrosive or hazardous materials.

Emergency preparedness:

- inspection of status of the document "Emergency plan" - implementation of the Revision 21,
- training in emergency response planning,
- preparation of the NEK-2000 emergency drill,
- participation in the NEK-2000 emergency drill (as trainees and observers - at the Krško NPP site) and appraisal of the drill,
- performance of the technical support centre, the operation support centre and the offsite emergency centre.

Physical protection:

- plant security performance
- walkdown of the safety fence;
- planned and implemented modifications.

Engineering and training of personnel:

- review of planned modifications for the Outage 2000,
- review of planned modifications for 2000 to be implemented outside the Outage 2000,
- status of preparation of the procedures/instructions for severe accident management (SAMG),
- modernisation project of the Krško NPP,
- programme of performance tests (in the shop) of the full scope simulator of the Krško NPP,
- correcting deficiencies of the full scope simulator of the Krško NPP,
- status of the Process Information System,
- performance of the Independent Safety Assessment Group (ISEG),
- preparation for the procurement of a new transformer GT3,

- inspection of status of the procurement of the new transformer GT3,
- review of the results of acceptance testing of the new transformer GT3,
- feedback of operating experience (OEF),
- status of the Document Control Centre of the NPP Krško

Quality assurance:
- status of spare parts,
- review of the list (base) of work orders,
- status of external and internal audits,
- activities of the Quality Systems Division during an outage,
- quality assurance (QA) in the manufacturing of the steam generators,
- QA Programme and the list of qualified subcontractors of the Krško NPP.

Other activities:
- insurance of liability for nuclear damage,

Inspection of arrival of fresh nuclear fuel:

Fresh nuclear fuel, designed for the refueling 2000, arrived into the Port of Koper on 1 March at 00:30. All vehicles (4 trucks) had valid certificates for the transport of dangerous goods. The drivers and accompanying persons presented their valid licenses for being qualified for the transport of dangerous and radioactive material. They were equipped with personal digital dosemeters, provided by the Krško NPP.

Each truck or trailer was loaded by one 40' open top sea container, marked as III Yellow, Transport Index 1.6, containing four nuclear fuel transport containers marked as II Yellow, Transport Index 0.4. In the shipment there were 16 standard Westinghouse nuclear fuel transport containers containing 32 fuel assemblies. Transport Index for each nuclear fuel transport container was 0.4, total not exceeding 50. Measured dose rate on contact of the nuclear fuel transport container was 4 to 5 μSv/h and on contact of the canvas of the sea container 1.5 to 2.5 μSv/h.

Loaded trucks were placarded RADIOACTIVE III and UN Class 7 for fissile material. Vehicles were equipped by yellow rotating lights.

Before the start of unloading importer's documents were checked for the compliance with the decision of SNSA on trade with nuclear material, as stated in Item II of the decision issued by SNSA, No.: 392-02/2000-17-24258/Mpe of 17 February 2000. The inspection concluded that the importer has fulfilled all the requirements and had all the documents needed available. Representative of the importer presented a protocol of inspection and testing of the container crane, performed on 25 February 2000 particularly for this transport. Unloading started on 1 March 2000 at 01:30 and took one and a half hour. After the unloading was finished the transport departed for the Krško NPP.

Reports on unusual events - reported by the Krško NPP

In 2000, the Krško NPP in conformity with the Rules on Reporting (Off. Gaz. SRS, No. 12/81) sent to the SNSA one report an unusual event: Smouldering in a drum after drying of a wet radwate in the IDDS (In-Drum Drying System).

Outage and Refuelling 2000 at the Krško NPP (end of the 16th fuel cycle)

Outage 2000 and replacement of the steam generators of the Krško NPP started on 14 April by power reduction to zero power parameters. The outage, which was scheduled for 63 days was completed on 15 June one day earlier as scheduled. Besides the refueling, regular maintenance and in-service inspection the main objective of the outage was the replacement of the steam generators.

Critical path was partially determined by activities related to the replacement of the steam generators (28 days), and acceptance testing related to the new steam generators.

During this outage special attention of the inspection was given to the follow-up of the steam generator replacement and power uprate activities.

SNSA introduced for the first time during this outage a 24 hours presence of an inspector on a weekly basis. The inspector's duty was to follow the outage and report daily to the SNSA office. 59 daily reports were produced until 15 June. These reports were also presented on the SNSA Itranet. During the Krsko NPP outage there were 20 regular inspections performed by the SNSA inspectors.

The staff of the technical support organisations reinforced the Inspection in the Outage 2000 inspection activities. In the Outage 2000 eight technical support organisations were involved, 6 from the Republic of Slovenia and 2 from the Republic of Croatia (EIMV, IE, JSI, IMK, FME, IMT, WI), co-ordinated by the EIMV.
According to Annex 2 of the contract for the supervision of the outage, resulting in Joint Expert Assessment of the Works, Interventions and Tests, during the Krško NPP Outage and Refuelling at the End of the 16th Fuel Cycle the technical support organisations also reviewed documentation on on-line maintenance performed in this cycle.

During the 2000 Outage regular weekly meetings with representatives of all technical support organisations were taking place, where the organisations reported in writing and verbally on the outage works they supervised, on their findings and recommendations, and presented the working plan for the following week. Besides weekly meetings, nuclear and radiation safety inspectors held discussions on current problems with representatives of the individual authorised technical support organisations concerned.

The major outage activities inspected were the following:

- shutdown of the plant, safety at shutdown, availability of the safety functions,
- replacement of the steam generators with the supporting activities,
- refueling,
- surveillance testing,
- start-up testing,
- maintenance of the electric, mechanical and I&C equipment,

- in-service inspection programme,
- overhaul of the emergency diesel generators,
- overhaul of the generator,
- overhaul of the reactor coolant pump motors,
- functional testing of the snubbers,
- modifications of the safety systems,
- maintenance works in the switchyard,
- test of the emergency external 110 kV power supply from the standby thermal PP Brestanica,
- collective dose (planned vs. actual),
- review of the radiological data,
- start-up and synchronisation of the plant to the grid.

During the Outage 2000 27 modifications were implemented, eight of them were related to the replacement of the steam generators, two were outcome of result of the analyses for the power uprate, the rest of them were planned as technical improvements or elimination of problems experienced in individual components or systems, and upgrading of the plant information system,

Dosimetry:

Systematic radiological monitoring of Krsko NPP staff and external contractors is carried out in accordance with the internal procedure ADP – 1.7.006 "Personal dosimetry", Rev. 2, valid from 20 October 1998. As stated by the Krsko NPP (Regular inspection of 14 September 1999) the procedure is in agreement with EU Directives No's 90/641 and 80/836. According to the Krsko NPP statement method and content of keeping records of received doses by the workers satisfy EU standards. General prerequisites for issuance of permit for entering and working in the controlled area (in accordance with the internal procedure ADP - 1.7.008) are valid exam from radiation protection and medical certificate.

Collective dose to workers during the Outage 2000 was 2.42 manSievert (manSv), 1.57 manSv was attributed to the steam generator replacement works and 0.61 to other activities.

Collective dose planned for the steam generator replacement works was 1.37 manSv and comprised only Siemens-Framatome (S-F) activities. Work of the Krsko NPP Radiation Protection Unit and engineering supervision were not considered in the plan.

Actual collective dose for the S-F activities was 1.43 manSv, by taking into account the Krsko NPP staff the total dose was 1.57 manSv, which agrees quite well with the projection.

Collective dose planned for routine outage activities was 0.37 manSv. Some maintenance and other works, which were decided later, were not included. At the end of the outage the measured dose was 0.61 manSv.

Statistics of the individual doses: totally 1,057 workers working in radiation areas were registered, 754 of them were of external contractors. Average individual dose was 2.25 mSv. The highest individual doses (except one - 20.95 mSv) were lower than 20 mSv. Number of persons that received doses between 10 and 20 mSv were 45.

Radioactive waste:

During the outage 160 drums of radioactive waste were produced consisted mainly of protective clothing and material (102 drums of compressible waste). Wastes resulting from the steam generator replacement works were not counted. They were store separately in 6 containers in the Multi-Purpose Building.

Problems encountered:

- During testing of motor operated valve (MOV) 8804 (between SI and RHR) inadvertent drop of pressure in the primary circuit from 25 to 6 bar occurred because of simultaneous maintenance of the same valve. The valve was erroneously put on the list for the testing at inappropriate time. Quite a few people overlooked this mistake. Loss of the coolant from the primary circuit through the IS and RHR systems was approx. 1.5 m^3. As a corrective measure the Krsko NPP introduced an additional administrative control over the testing schedule of MOVs. (Inspection report of the Krsko NPP No. 029/2000 of 18 April).

- Increased dose rate from Cobalt-58 at the surface level of the Spent Fuel Pit (SFP) due to a crud burst. The operator mitigated the problem by purifying the water in the Spent Fuel Pit and in the Refueling Water Storage Tank (RWST). Access to the RWST area was restricted for 5 days and personal dosimeters were introduced in this area. (Report of the on duty inspector of 25, 26, 27 and 28 April).
- Visual inspection of the reactor pressure vessel detected on the bottom (approx. 18 meters below the surface of the water) a bright foreign object. The first attempt to collect the object by using a magnet was not successful. When they succeeded to get hold of the object it was identified as a piece of a tape. A second inspection confirmed that the vessel was clean. (Report of the on duty inspector of 3 June).
- A regular inspection of the Steam Generator Blowdown System detected a leak in the heat exchanger #2. A few leaking tubes were plugged. (Report of the on duty inspector of 5 June).
- Problems with the supply of spare parts for the Reactor Coolant Pump. Urgent order was effective and a new seal was installed in time. (Report of the on duty inspector of 8 June).
- A partial discharge test of the main generator was several times unsuccessful which indicated ageing of the stator insulation. Expert opinion suggested that the operation of the generator can continue and the status of the insulation should be carefully monitored (Inspection reports of 18 May and 23 May).
- Visual inspection of the fuel assemblies planned to be inserted in the 17th fuel cycle revealed that 28 out of 108 fuel assemblies had indications of cracks in the upper nozzle spring screws. These assemblies were put aside and were not inserted into the core. (Inspection report of 9 May).
- Electrical testing of the auxiliary power transformer T2 has been performed with primary and secondary side busbars disconnected (insulation resistance, polarisation index, dissipation factor-tan delta, capacitance, stray inductance and magnetising currents). The Value measured of dissipation factor was 1,7 %, which exceeds the permissible value of 1 %. The problem was solved with additional cleaning of the transformer oil.
- Planned collective dose of the outage (1,740 manSv) was exceeded by 25%. This was due to unplanned activities, which were also not optimised according to the ALARA principle

in the original plan of projected doses. At the end of the outage an increase in doses was noticed because of removal of the shielding while the works were still going on. The containment equipment hatch was already closed and the shields were carried out through the emergency airlock.
- During the outage 92 non-conformance reports were issued. According to the existing rules no reporting to the SNSA was needed.

Krsko NPP Independent Safety Assessment Group (ISEG) dealt with the following items directly related to the outage: inadvertent drop of pressure in the primary circuit, inspection of the fuel assemblies, damage of the membrane of the Condensate Water Storage Tank, radiation protection during the outage, doses, decontamination, radwaste from the steam generators replacement works, unexpected increase of radionuclides concentration in the reactor pool during the refueling at the beginning of the outage.

Good practices, improvements:

- no safety related events occurred during the outage,
- a new automatic measuring system for controlling personal doses and entering the controlled area with electronic dosimeters was introduced,
- the access control facility was renovated and additional portal monitors were installed, which increased its capacity,
- progress in co-ordination and control of the outage activities,
- improvement of the quality of works in the outage confirmed by performance indicators and stable operation with increased power for 50 MW (uninterrupted operation until the end of the cycle would mean 83% availability)
- amount of the produced radwaste was in accordance with the plan,
- special attention was given to occupational safety,
- good support given to the SNSA's inspectors.

Milan Vidmar Electric Institute as a co-ordinator of the technical support organisations - issued on 13 June the "Joint Statement for Re-establishment of the Krško NPP Criticality after the Outage 2000 and Refuelling at the End of the 16^{th} Fuel Cycle", on 5 July the "Joint Statement for Full Power Operation of the Krško NPP after the Outage 2000 and Refuelling at the End of the 16^{th} Fuel Cycle", and on 29 August the co-ordinator of the technical support organisations submitted to the SNSA and the Krško NPP the report "Joint Expert Report on the Assessment of Works, Interventions and Tests during the Outage 2000 and Refuelling in the Krško NPP".

SNSA issued to the Krško NPP on 13 June a consent for reaching the criticality at the beginning of the 17^{th} fuel cycle, on 6 July a consent was given for power increase up to 100%, and on 28 November a consent for full power operation with a condition that when the pump SW101PMP03C is in operation temperature of the Sava river at the intake to the SW must not exceed 21.1^0C.

The Nuclear and Radiation Safety Inspection carried out inspections with representatives of all technical support organisations and the Krško NPP on the " Joint Expert Report on the Assessment of Works, Interventions and Tests during the Outage 2000 and Refuelling in the

Krško NPP", with particular attention given to the recommendations and elimination of the non-conformances.

It is a conclusion of the Inspection that the outage performance has been improved from organisational as well as from quality aspect, which is confirmed also by the operational indicators. The Inspection also assesses that the performance of the technical support organisations during the outage has improved over the last few years. There was no significant critique on the mutual co-operation during the outage neither from the technical support organisations nor form the Krsko NPP.

General conclusion on the outage was that all the works were done correctly and were assessed by the technical support organisations within their scope of authorisation. The technical support organisations satisfied the requirements from the contract between the Milan Vidmar Electric Institute and the Krsko NPP on the elaboration of the Joint Expert Report on the Assessment of Works, Interventions and Tests during the Outage 2000 and Refuelling in the Krško NPP consisting of the expert assessments of individual technical support organisations.

2.2 RESEARCH REACTOR TRIGA MARK II IN BRINJE

2.2.1 OPERATION IN THE YEAR 2000

The purpose of the reactor is experimental work, training of the Krško NPP personnel and the preparation of radioactive isotopes for medicine, industry and nuclear chemistry. Altogether 339 samples were irradiated in the F-channel and reactor rotary system. 1500 samples were irradiated in the pneumatic transfer system. The reactor worked one week in the pulse mode in year 2000, five pulses were performed.
Five core changes (fuel removing) were made for experimental purpose.
The reactor TRIGA Mark II produced during year 2000 242 MWh of thermal energy.

Reactor shutdowns

200 shutdowns of reactor have been carried out in year 2000, three of them were unplanned. The reason of unplanned shutdowns was loss of off-site electrical power.

Fuel

Altogether 94 fuel elements were kept in the reactor building. They were situated on the following locations:

- reactor core	56
- reactor tank	0
- irradiate fuel store	0
- fresh fuel store	38
	94

In year 2000 no fuel damage was detected.

Personnel

The personnel was same as previous years 2000 (the head of reactor centre, four operators). The operating scheme is organised in accordance with organisation scheme, which is described in the Safety report of reactor.

2.2.2. RECEIVED DOSES BY WORKERS AT THE JSI REACTOR CENTER AT BRINJE

The workers operating and using the reactor and were managing the interim storage for radwaste until the middle of the 1999 are classified under the following three categories: reactor operators, the Radiation Protection Unit personnel and researchers working at the reactor or handling the irradiated material. According to the data received by the Radiation Protection Unit in 2000 45 workers were exposed to ionizing radiation. The average effective dose (without neutrons) to workers was 0.05 mSv and collective dose was 2.11 man-mSv.

2.2.3 INSPECTIONS AT THE REACTOR CENTRE PODGORICA

An inspection of the Reactor Centre Podgorica was performed on 7 June with the following topics: Report on monitoring of the environment, doses received by workers, status of the project of refurbishment of hot cells, operation of the research reactor TRIGA, isotope production, liability for nuclear damage, physical protection, interim storage of LIL radioactive waste. There were no discrepancies found.

A second inspection was held on 13 December. The inspectors examined operating logbooks, review of major maintenance works and plan for the next year, status of the emergency plan, screening of the operators for competency, doses received by workers and planned operating strategy for 2001. No non-conformances were detected.

Reference: Operating Report of the TRIGA Reactor in Brinje in 2000, IJS No. RIC/MR-sd of 7 May 2001.

2.3 CENTRAL INTERIM STORAGE FOR RADIOACTIVE WASTE AT BRINJE

Since 1999 the Agency for Radwaste Management is operator of this storage. The operation of the storage is a part mandate of public service for radioactive waste management.

2.3.1. REFURBISHMENT OF THE STORAGE

When Agency for Radwaste Management took over the operation of the storage, the SNSA issued a decision with which requested submission of the project for refurbishment and preparation of Final safety report for the storage in compliance with the project for refurbishment.

Based on this decision, Agency for Radwaste Management prepared "Plan for remediation and refurbishment of the Central Interim Storage for Radioactive Waste at Brinje" and revision 1 of this document and the Safety report representing current situation. The SNSA is considering this document as a kind of conceptual plan, representing an overview of measures, to be performed in order to refurbish the storage itself as well as the optimisation and rearrangement of inventory.

Measures, to be performed on the facility:

- replacement of complete hydro-insulation
- remediation of internal concrete surfaces due to the corrosion iron
- remediation of electric installations
- remediation of water installations and sewage system
- replacement of ventilation system
- assurance of appropriate fire safety (fire doors, smoke detectors)
- removal of the non-operational transportation facility

The received Plan and the Safety Analysis Report, do not present the Project for Refurbishment and Final Analysis Safety Report considering it. For this reason the SNSA requested from the Agency for Radwaste Management the submission of projects for refurbishment and for Final safety report that will present final situation of facility and inventory after refurbishment.

2.3.2 RADWASTE

In the year 2000 last 13 drums (of total of 76) of waste generated during remediation action of temporary storage at Zavratec were accepted into the storage. The tables below show the inventory of radioactive waste accepted in the year 2000 and the total inventory of radwaste in the storage.

Table 2.17: Radwaste stored in the year 2000

Package	**Number of drums**	**Volume [m^3]**	**Isotopes**	**Activity [MBq]**
Drum 320 L	2	0.64	Ra-226, Cs-137, Pb-210	< 10 MBq
Drum 200 L	11	2.31	Ra-226, Cs-137	< 40 MBq

Total:	13	2.95	Ra-226, Cs-137, Pb-210	< 50 MBq

Table 2.18: Inventory of the Central Interim Storage for Radioactive Waste at Brinje by the end of 2000

Type of waste	State in the storage	Main isotopes	Total assessed activity At the end of 2000 [GBq]
Drums	253	Co-60, Cs-137, Ra-226, Eu-152, uranium	from 3 to 20
Special bulky items	141	Co-60	2903
Sealed sources	346	Co-60, Cs-137, Kr-85, Sr-90	560
Undefined sources*	34	-	-
Total	774	Co-60, Cs-137, Ra-226,Kr-85, Eu-152, uranium	~3700

** Undetermined sources without adequate label, that were not registered in the inventory of previous storage operator.*

2.3.3 RADIOACTIVE RELEASES INTO THE ENVIRONMENT

Rn-222 and its progeny emissions from the LILW storage facility were estimated based on a release model. It showed the released activity to be 70-80 Bq/s, almost independent of storage ventilation, which amounts to a yearly release of 2.2-2.5 GBq. Measurements with TL dosimeters indicate that at the distance of 10 to 20 meters from the storage facility the radioactivity level falls down to the level of natural background. Measurements of soil samples at the ventilation exhausts do not indicate any increase of radionuclide concentrations

2.3.4. THE AGENCY FOR RADIOACTIVE WASTE PERSONNEL EXPOSURE TO RADIATION

The personnel of the Agency for radioactive waste is under the monthly dosimetric control since 1999. Dosimetric control is implemented by approved dosimetric service, Institute for Occupational Health. Table 2.19 presents collective effective doses and average annual effective doses of external radiation for 1999 and 2000.

Table: 2.19: Collective and average annual effective doses in 1999 and 2000

Year	Collective effective dose (man mSv)	Number of workers	Average dose (mSv/year)
1999	0.92	5	0.18
2000	2.21	5	0.44

2.3.5 INSPECTIONS AT THE CENTRAL INTERIM STORAGE FOR RADIOACTIVE WASTE AT BRINJE

On 3 April an inspection was performed in the Agency for Radwaste Management (ARAO) with the intention to check fulfilment of the Partial Decision of SNSA No. 392-04/99-1-22907.io of 14 September 1999 and to verify implementation of the Decree on mode, subject and conditions of practising a public service of radwaste management (Off. Gazette of RS No. 32/99). The findings of the inspection were: ARAO has prepared a project specification for modernisation of the Central interim storage of LIL waste at Brinje, certain procedures were in preparation, Preliminary Safety Report for the storage was being assembled, radwaste produced in Slovenia in medical applications, industry and research has been accepted for the storage, training of ARAO workers in radiation protection was going on. Inspectors requested from ARAO to present to SNSA a Report on identified non-conformances between the hand-over documentation from IJS on inventory of the storage and inventory taking performed by the Institute of Occupational Safety.

On 17 July an inspection was performed in ARAO to review the progress in the fulfilment of the Partial Decision of SNSA No. 392-04/99-1-22907.io of 14 September 1999 and of the Decree on mode, subject and conditions of practising a public service of Radwaste management (Off. Gazette of RS No. 32/99). It was established: ARAO made an application at SNSA to extend due time from the Partial Decision, a register of all recorded users of open and sealed radioactive sources was established, ARAO turned over to the SNSA Report on identified non-conformances between the hand-over documentation from IJS on inventory of the storage and inventory taking performed by the Institute of Occupational Safety.

On 11 October an inspection of the Central interim storage of LIL waste at Brinje was performed with the following topics: condition of the storage facility, radiological control of the storage, radiation protection, physical protection and fire protection of the storage facility. The findings of the inspection were: environmental impact and keeping records on entries - nothing abnormal detected, however there was no phone line in the storage, phone directory of important numbers did not contain SNSA, elevator on the ceiling was not operational, some barrels containing the waste were not sealed, traces of moisture in the storage were apparent, Institute of Occupational Safety was contracted to do radiation protection services, physical protection - security alarm was actuated three times but no guard arrived as they assumed that the alarm was false. It was also established that ARAO didn't have all the internal procedures needed and specially no approved internal procedure for carrying out the materials.

2.4 ŽIROVSKI VRH MINE

2.4.1 ACTIVITIES FOR PERMANENT CESSATION OF EXPLOITATION OF URANIUM MINE

The decommissioning of the Žirovski vrh mine was performed on the basis to the Operational plan of activities for the year 2000 and amendments of this plan.

In view of the Uranium Mine the amended plan was successfully carried out. In the report it is stated that the planned final workings on the facilities for the production of uranium concentrate and licensing activities were accomplished. In addition an effort was made to acquire loans as additional financial resources. The draft Act proposal was prepared for reconstitution of the enterprise Uranium Mine and the Revision of Programme as required by provisions of Law on permanent cessation of exploitation of uranium mine and prevention consequences of the exploitation at Žirovski vrh mine (Of. G. of RS, No. 28/2000).

Although the Act on the reconstitution and Revision of Programme were not adopted by the Government in year 2000, it is believed that only execution of revised Programme and other measures shall facilitate planned works and successful accomplishment of cessation of exploitation by the year 2005.

2. 4. 1.1. Activities carried out on the facilities

Facility for production of uranium:

- Accomplishment of work on construction of drainage tunnel and in surrounding of its entrance
- dismantling of equipment and installations of the primary (object 131) and electric transformer station TP – 3 at the primary crusher (object 132), decontamination and dismantling of equipment,
- demolition of the primary crusher and TP-3 and landscaping of the area around primary crusher,
- removal of the mining waste from P-10 and its transport to Jazbec mine waste disposal, soil cover and final remediation of this site
- disposal of type ROV containers on the on Jazbec mine waste disposal site,
- refurbishment of drainage channels at the land slide behind the resque station,
- regular maintenance of roads and drainage system at Jazbec waste disposal site and disposal sites P-1 and P-9,
- construction of shaft for refurbishment of drainage channel under Jazbec mine waste disposal site,
- refurbishment of the air station P-1 and preparation of the station for its operation in spring 2001,
- refurbishment of the air station P-36 and preparation of the station for its operation in spring 2001,
- regular control and maintenance of the mine entrances.

Facility for production of uranium concentrate:

- dismantling of remaining equipment,

- demolition of objects
- decontamination dismantling and classification of dismantled equipment,
- removal of material, foundations and contaminated material associated with objects and backfill it with inert material,
- removal of contaminated soil, mostly from green area and from storage area of the plant and backfill with inert material,
- transport of ROV type containers containing contaminated equipment to the Jazbec mine waste disposal site,
- regular maintenance of mill tailing Boršt and its channels of meteoritic and sipping water.

Besides above mentioned activities the following was carried out:
- acquisition of permit for use of the drainage tunnel, drainage drill-holes curtain, drainage tunnel portal, and accession roads,
- acquisition of permit for use of objects 301, 302, 303 and 313

2.4.2 RADIOACTIVE WASTE

During the year 2000 on the Jazbec mine waste disposal site, 46,300 t of contaminated materials and ruins from facility for production of uranium concentrate, facility for production of uranium ore and other surroundings sites were disposed. From this:

- 6900 t from facility for production of uranium concentrate, with average contents 12g/t of U_3O_8 or 79 kg U_3O_8 in total
- 11200 t from area of primary crusher with average contents of 36 g/t U_3O_8 or 404 kg U_3O_8 in total and 28,000 t from P-10 and soils from facility for production of uranium concentrate with average contents of 28 g/t U_3O_8 or 788 kg U_3O_8 in total
- 28 ROV type containers (volume 2 m^3) filled with contaminated scrap metal, plastic and ash from facility for production of uranium concentrate,
- 7 ROV type containers filled with contaminated scrap metal, plastic and ash from the primary crusher. Containers were temporarily disposed on the Jazbec mine waste disposal site.

2.4.2.1 Position of Slovenia Nuclear Safety Administration

In the report of Žirovski vrh is stated that all activities associated with acquisition of appropriate licences for permanent cessation of the exploitation at Žirovski vrh mine are accomplished. However, from the report is not clearly understood which licensing processes are accomplished.

Although it was stated that all activities associated with acquisition of appropriate licences for permanent cessation of the exploitation at Žirovski vrh mine are accomplished the Žirovski Vrh mine in the year 2000 still did not submit to SNSA:

- Environment Impact Assessment report in the format that was agreed between SNSA and Žirovski vrh Mine on June 18, 1996,
- Report of seismic hazard at Žirovski vrh mine providing the with peak ground acceleration and spectra for 1000 year return period as the input for calculation of dynamic loads on the disposal sites,

- Report on maximal rainfall for the area of Žirovski vrh mine for the period of 1000 years as input data for estimation of erosion, as requested in the SNSA Denial of consent the Amended site Licence for final remediation of exploitation area for Uranium mine, disposal sites Boršt and Jazbec.

SNSA participated in Technical review for acquisition of permit for use of object 301, 302, 303, 313 and drainage tunnel. The SNSA put on the record that the work that was performed on the basis of construction licence No. 351-01-099/96, dated September 9, 1996 was not carried out in respect of the SNSA consent No. 350-4/95-9358, dated 8. 8. 1995. In this consent it was stated that the SNSA will issue a special consent for the final disposal of radwaste material pursuant to the article 8, paragraph 1 of the Act on Implementing Protection against ionising radiation and measures for the safety of nuclear facilities (Off. Gaz. SRS, 28/80). This consent has been never issued.

In the relation to drainage system of disposal site Boršt, SNSA requested from Žirovski Vrh mine to submit evidence which would prove that all conditions set in the document no. 351-01/94-2-6344/GU, opinion on site documentation dated May 9, 1994, were fulfilled. In this document the SNSA is expressing doubts on justification of construction of the drainage tunnel and proposed the review of this decision considering also other options such as backfill of mill tailings into the mine. SNSA has not received adequate answer to this request yet.

2.4.3 RADIOACTIVE RELEASES INTO THE ENVIRONMENT

2.4.3.1 Impact on the living environment

The monitoring of the impact of the Žirovski vrh Mine and both waste sites on the environment was performed in the same scope since 1992 according to the programme for emission and imission monitoring and the programme for radioactivity monitoring in the vicinity of the Žirovski vrh Mine, approved by the radiation protection commission of the Slovenian health inspectorate.

The mine influence on the environment stayed on the same level as in previous years, since there was only one minor intervention to decrease it. An air flow barrier was mounted on the outlet under the Jazbec mine waste, thus decreasing the ^{222}Rn contribution (decrease is estimated to be 1.2 TBq/year, i.e. 1/6 of the whole ^{222}Rn contribution). Due to the changing meteorological conditions, it is questionable whether this decrease can be confirmed by measurements (average annual radon concentration was measured to be 7.3 Bq/m^3 in 2000., a decrease from 7.8 Bq/m^3 for the year 1999). The above mentioned activities did not have any additional influence on the environment.

2.4.3.2 Liquid emissions

The schedule of the monitoring of liquid effluents in the releases from the Žirovski vrh Mine involved measurements of uranium and ^{226}Ra in all liquid releases samples from the Žirovski vrh Mine, including meteoric waters from the mine pits and all the releases which contributed to contamination of surface waters.

The number of measuring and sampling points for liquid emissions monitoring increased by one as the water source by the lower edge of the temporary mine dump P-9 was added. Thus there are 18 points where in the sampling programme, 10 of which are at the mine outlets.

The programme for liquid emissions includes monthly samples collected on all sampling points including meteoric waters from asphalt surfaces and roofs (usually on the first wednesday each month), while the monthly composite of daily samples was collected for the points that contribute to the contamination of waterways, the Todraščica and Brebovščica creek. Samples were taken on working days and in the case of holidays if the work cessation exceeded 2 days.

In the process of permanent regulation of uranium concentrate production daily decontamination of scrapped pieces of equipment was being conducted in the first quarter of 2000, continuing to the month of april. In addition to that, periodical sweeps of the plateau where the scrapping was being conducted were made, as well as sweeps of floors of mine objects. To minimise water expenditure, high pressure (150 bar) water hoses were used. The contaminated water was then collected in the collection sump 313, where it mixed with meteoric water collected on the plateau surface. Thus the waste water was diluted and periodically released in the Brebovščica creek. In the first 6 months 700 m^3 of waste water was released from the sump with average flow of less then 0.5 l/s with an average U_3O_8 concentration of 14 microg/l. The amount of U_3O_8 thus released was 0.001 kg or 0.003% of the whole U_3O_8 amount released from the mine in the year 2000.

Table 2.17: Monitoring of liquid effluents from the Žirovski vrh Mine and water courses

Sampling site	Annual flow (1000 m^3)	Average conc. of dissolved U_3O_8 (mg/m^3)	Average conc. of dissolved ^{226}Ra (Bq/m^3)	Measurements 13.12.00: concentrations:	
				U_3O_8 (mg/m^3)	Ra-226 (Bq/m^3)
Monitoring of liquid releases					
Mine water treatment plant	595.5	254	73	278	68*
The Jazbec str. under the mine waste	301.5	399	38	280	30*
Joint drainage of the Boršt tailings pile	7.1	642	332	601	374
Overflow of the solids trap at Boršt	21	543	763		
Drainage of the solids trap at Boršt	2.5	586	407		
Drainage tunnel at the Boršt tail. pile	20	3	12		
Results of measurements in water courses					
The Boršt stream	354	1.2	26		

- From monthly composite

Table 2.18: Cumulative annual emissions of U_3O_8 and ^{226}Ra in individual facilities of the Žirovski vrh Mine in 2000.

	Amount of U_3O_8 (kg)	Emission share (%)	Activity ^{226}Ra (MBq)	Activity share (%)
Mine	151	52	43	58
Jazbec mine waste	120	42	11	15
Boršt tailings pile	17	6	20	27
Total ŽVM 2000	288	100	74	100

During the working days and in case of a release the water from the mine waste Jazbec where the contaminated containers and scrapped equipment were temporarily stored during the years 1999 and 2000 was always sampled by the Radiological Safety Service of the mine. The site is temporarily covered but not watertightly. The release consists of meteoric and waste waters, flowing over the contaminated scrap material, being collected in a concrete trap and conducted through piping in the channel by the P-10 to P-1 road. The average annual concentration of U_3O_8 was 637 microg/l, with an average flow of 0.01 l/s amounting to 100 m^3 released water. The amount of U_3O_8 thus released was 0.08 kg or 0.03% of the whole U_3O_8 amount released from the mine in the year 2000.

In the year 2000 there were no activities that would change the amount of U_3O_8 or ^{226}Ra released from the Mine to the environment

2.4.3.3 Gaseous emissions

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

a. Releases from the mine

To decrease the release of ^{222}Rn from the ventilation shaft mouths air flow barriers were mounted on the P-1, P-10 and P-36 tunnels and partly on the P-9 tunnel. The direction of natural ventilation varied with outside temperature. At the temperatures lower than 9° the air in the mine rose, at higher temperatures it descended. Measurements of ^{222}Rn concentration, ^{222}Rn shortlived progeny concentration (PAEC) and air flow were made. Table 2.19 gives maximum and minimum values at each mine outlet and the Jazbec mine tailings pile by-pass.

Table 2.19: Maximum and minimum ^{222}Rn and short-lived radon progeny (PAEC) concentrations in emissions (1WL = 3700 Bq/m^3)

Source/Concentration	**^{222}Rn concentration (Bq/m^3)**		**PAEC(WL)**	
	Rn-222 (Bq/m^3)		**PAEC (WL)**	
	Min.	**Max.**	**Min.**	**Max.**
P-11 tunnel	1281	14308	0.25	3.23
P-10 tunnel	8452	11771	1.27	2.83

P-9 tunnel	9343	19352	2.18	5.13
Ventilation shaft 6/2	751	9187	0.16	1.54
Ventilation shaft ZJ-8	*No air flow was measured*			
Ventilation shaft with P-12 tunnel	515	1570	0.03	0.17
Ventilation shaft PV tunnel	6224	20498	0.56	1.66

b. Release from the Jazbec mine waste outlet

In the end of the year 1999, a flow barrier was mounted on the outlet under the Jazbec mine waste, used for water drainage. This barrier allows water drainage but bars air flow, thus eliminating a considerable source of ^{222}Rn during the warmer part of the year.

c. Annual emissions of ^{222}Rn from mine facilities

Emissions from each particular source are estimated to be 12 TBq in the year 2000. Table 2.20 shows contributions from different mine facilities.

2.4.3 4 Final assessment of environmental impact

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

Table 2.20: Annual emissions of ^{222}Rn from different mine facilities

Source		Activity (TBq)
Low altitude sources *	Jazbec mine waste, plateau P-10	1.70
	Jazbec mine waste outlet	0.00
	P-10 tunnel, natural ventilation	0.05
	P-11 tunnel, natural ventilation	3.37
High altitude sources **	Ventilation station P-1, natural ventilation	0.21
	Ventilation station P-36, natural ventilation	0.97
	P-9 tunnel, natural ventilation	1.51
	Ventilation shafts, natural ventilation	1.11
	Mine dump P-1	0.28
	Mine dump P-9	0.47
	Tailings pile Boršt (upper layer 80% covered)	2.00
Total for year 2000		11.67

* Low altitude sources – below the limit of average temperature inversion (altitude below 500 m)

** High altitude sources – over the limit of average temperature inversion (altitude below 500 m)

2.4.4. EXPOSURE OF WORKERS TO IONIZING RADIATION

Within the scope of decommissioning, the Radiological Protection Unit (RPU) of the Žirovski vrh Mine regularly monitored the working site for uranium ore extraction and for uranium concentrate production, and measured contamination of the waste material and the facility surfaces.
Exposure of workers to ionizing radiation was assessed by the RPU based on measurements of radon progeny concentrations and gamma radiation dose (Thermoluminiscent Dosimetry), whereby the exposure time of workers at workposts was considered. The calculation of annual effective dose received by workers during underground work was made in accordance with the generally applicable methodology. Due to low concentrations of short live radon progeny and low dose rates the values were as low as expected. The dosimeters were replaced quarterly.
Readings from TLD-s were generally very low or even under the detectable level. The calculation of annual effective doses was made for 61 workers of the Žirovski vrh Mine. The values of annual effective doses were very low. The maximum effective dose for 2000 was 1.95 mSv or 4% of the still valid dose limit 50 mSv, while the average value of all calculated annual effective doses was less than 1 mSv.

Table 2.21: Exposure of workers of the Žirovski vrh Mine to ionizing radiation

A. Year	**Number of workers**	**Average (mSv)**	**Maximum dose (mSv)**	**Collective dose (man.Sv)**
*1989**	*350*	*5.0*	*18.00*	*1.75*
1996	55	0.9	2.64	0.05
1997	70	1.3	3.40	0.09
1998	65	1.5	2.97	0.10
1999	60	1.0	1.89	0.06
2000	61	< 1.0	1.95	0.05

* in period of regular operation

2.4.5 INSPECTIONS AT THE ŽIROVSKI VRH MINE

In 2000, two routine inspections were carried out at the Žirovski vrh Mine. The hydrometallurgical waste and mill tailings storage sites and general condition of the Žirovski vrh Mine were inspected. Official notes of the findings were generated.
On 3 October an inspection of the hydrometallurgical waste and mill tailings storage sites Boršt and Jazbec was performed. The results of the inspection were the following:

- It was raining during the inspection,
- The shape of the surface of the hydrometallurgical waste storage site does not allow accumulation of the rainfall. The southern steepest part of the storage site shows signs of erosion and mild stripping of the material. On the testing ground for the wastes cover rainwater has been retained. A system of drains of the storage sites was well kept and functioned properly.

- A hold-up pond at Boršt was overgrown with rush and filled with silt. If it was raining the water from the pond flows out through the outlet from both fields.
- Entrance to the drainage tunnel of the hydrometallurgical waste storage site Boršt was tiled. Technical take-over of the drainage tunnel was foreseen for 18 October 2000. Drains from the tunnel are discharged into the creek, which flows, by the western edge of the storage site.
- All the containers of type ROV were disposed of on the mill tailings storage site Jazbec and covered with the storage material. An approx. 13 m deep shaft was dug into the storage. Sixty to hundred meters long horizontal drainage boreholes would be drilled from the shaft. There were no major pools of water or signs of erosion noticed on the storage. During the inspection there were no works going on.

On 7 November the Žirovski Vrh mine and the hydrometallurgical waste and mill tailings storage sites Jazbec and Boršt were inspected. In the official notes the following was established:

- The objective of the inspection was to check the condition of the storage sites and to sample the drained water. The days before the inspection there was a heavy raining (from 6 to 7 November in 24 hours in the area of Škofja Loka 77.6 mm and at Poljana above Škofja Loka 71.5 mm),
- Management of the Mine denied the inspectors to perform inspection by issuing an internal instruction No. 5/2000 of 7 November 2000 where it was stated: If the inspector can not prove its legal competence for doing inspection of the mine, the technical supervisor can allow only a walk down of the Žirovski Vrh mine. As explained by the technical supervisor SNSA would be officially informed about this decision. The unofficial visit of the site was done and samples were taken.
- The samples of the water were taken at the in flow to the hold-up pond, at the overflow from the hold-up pond and from the Toderščica creek.
- About 25 snap-shots were taken of the storage sites and drained water. Since it was not raining on the day of inspection the flow of the drained water was low.

2.5 TEMPORARY STORAGE L/IL WASTE AT ZAVRATEC

2.5.1 Final remediation actions

Agency for Radioactive Waste Management (ARAO), together with contractors accomplished remediation action on facility, where radioactive waste had been stored. The waste was transferred to this location for storage after the accident at the Oncological Institute in 1961. By the end of 1999 the waste was transported to the Central Interim Storage at Brinje. The remediation was carried out in compliance with Decree on Mode, Subject and Terms of performing public service of dealing with RAW and Decision on restructuring the Public Agency for radioactive waste management into public enterprise.

The remediation was carried out in respect of "ALARA" principle and in compliance with provisions of the IAEA Safety Standards "International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources" - Safety Series No.115-I and EU Council Directive 96/29/EURATOM of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation.

Slovenian Nuclear Safety Administration (SNSA) issued to ARAO between 1999 and- 2000, the following administrative documents:

- Request of 14 July 1999; No. 392-03/98-3-18330/JC, "The Transfer of radioactive waste from temporary storage at Zavratec to Central Interim Storage at Brinje"
- Approval of 3 November 1999; No. Z. 1/99-23454/JC, "Approval of plan and procedures for the accomplishment of final remediation of temporary storage Zavratec"
- Decision of 30 November 1999; No. 392-03/98-3-23614/JC, "Extension of deadline for decontamination of the Temporary L/ILW storage Zavratec"
- Decision of 31 January 2000; No. 392-04/2000-3-24222/JC, "Extension of deadline for decontamination of the Temporary L/ILW storage Zavratec"
- Licence of 16 June 2000; No. 392-04/2000-4 -25411/JC, "Clearance for unlimited use of abandoned barrack at Zavratec, where L/ILW was temporarily stored "

On 31 March 2000, last two transports of contaminated building material generated due to temporary storage of radwaste at Zavratec were carried out to Central Interim Storage at Brinje. With all together five transports, approximately 16 m^3 (= 77 packages; total mass ~ 11,5 t) of low level radioactive waste was transferred to Central Interim Storage at Brinje. The radioactive waste was transported in either 200 L drums or 320 L drums. Non-radioactive waste was considered as municipal waste and was transported to the local dump-yard. Volume of this waste was around 37 m^3.

After decontamination of the storage at Zavratec, the Agency ARAO applied, in accordance with Article 47 of the Regulation "E1". In the process of licensing for permanent closure, the SNSA reviewed the Report on radiological measurements during decontamination of Temporary radwaste storage at Zavratec, No.: IJS-DP-8235, prepared by Jožef Stefan Institute. This report concluded that there are no significant differences of values between interior of storage and external background for ^{137}Cs and ^{226}Ra. In the report is also stated that all contamination with beta emitting radio-nuclides has been removed. During its inspection, SNSA after preliminary evaluation with its own instruments, expressed concern that instead of ^{14}C, which was advocated by Jožef Stefan Institute, the ^{90}Sr may be present.

Radiochemical analysis of a sample from material in the storage, that was performed by the Laboratory of the Environmental Chemistry of the IJS confirmed SNSA assumptions. This fact should be considered in preparation of inventory for the Central Interim Storage at Brinje.

In process of licensing SNSA also reviewed reports prepared by contractors: IBE, The report on technical part of the remediation and Jožef Stefan Institute, The report on measurements during the remediation of Temporary radwaste storage Zavratec..

The preparation of work and decontamination was supervised by inspections of SNSA (two inspections, dated 13 March and 23 March 2000; minutes No. 24749/DK and No. 24859/AJ). Finally the SNSA issued a licence confirming that the whole building and all rooms are decontaminated to extend that the barrack on plot No.: 889/1 (katastrska občina Dole) can be used for other activities or unlimited use. The facility was handed over on 25 June 2000 during meeting with local community.

Figure 2.45: Subcontractor's staff during decontamination of the room, where radioactive waste had been stored

Figure 2.46: The outer walls of the barrack – placards and inscription "radioactive" *were removed*

2.5.2 INSPECTIONS AT TEMPORARY LILW STORAGE AT ZAVRATEC

On March 13 an inspection of the temporary storage of radwaste at Zavratec was carried out. The following was established in the official notes:

- There were no activities going on at the time of inspection and no contractor worker were present. Nothing unusual was noticed.
- The main storage area, where the drums with the radwaste used to be stored, was empty. In the corridor an uncovered drum was found containing contaminated waste from the repackaging operation. In the empty storage only scaffolding was left and wooden bench covered with plastic. A crack in the ceiling was protected by a plastic foil, which retains the leaking moisture. Ventilation was set up.
- Inspectors performed some measurements of the dose rate and surface contamination of the floor and walls. The results were available at SNSA. The Mobile Unit (ELME) measured the most contaminated spots on 6 January 2000. Report on the measurements was issued on 17 February 2000. The hot spots were marked by a colour spray and were clearly visible. The marking of the measured locations on the floor was not visible. No irregularities were detected. The work has not been completed at that time.

On 23 March a second inspection of the temporary storage of radwaste at Zavratec was performed. The official notes contained the following findings:

- The condition in the storage has changes in the sense that the walls were chemically decontaminated and up to two meters also mechanically cleaned. Five centimetres of the concrete on the floor of the storage was mechanically removed. On the right side relative to the door a contaminated material was removed approx. 2.5 m in length, 0.75 m in width and 0.5 m in depth.
- At the time of the inspection the measurements of the dose rate and surface contamination were going on. Experts from IJS and ARAO found two additional hot spots, which were immediately removed. Samples of the contaminated floor were taken for a gammaspectroscopic analysis.
- Inspectors did some measurements in the storage on the randomly selected spots and on the previously established spots with the highest contamination. The results were available at SNSA.
- Based on the measurements of the external radiation and the surface contamination, the conclusion of the inspection was that the former temporary storage of radwaste at Zavratec was decontaminated up to the level for unrestricted use. This has been verified by the results of the measurements in the main storage and in other rooms of the building and in the immediate environment. The final expertise on measurements performed by IJS was also substantiated by the gamma analyses of the samples taken from the floor where increased contamination was detected and by the results of a liquid scintillation counter.

2.6 INSPECTION CONTROL

2.6.1 CO-OPERATION WITH OTHER INSPECTIONS

The SNSA endeavours to continue co-operation with other inspections in the field of nuclear safety. In 2000, the inspectors of the SNSA co-operated with the following inspectorates:

- Ministry of Economic Affairs – Energy Inspectorate,
- Ministry of Health - Health Inspectorate,
- Ministry of Defence – Inspectorate for Civil Defence and Disaster Relief
- Ministry for Internal Affairs.

2.6.2 CONCLUSIONS OF THE SNSA INSPECTION

Inspectors for Nuclear and Radiation Safety were performing inspections of nuclear facilities through the whole year in accordance with their competencies and the approved Programme of the Inspection for Nuclear and Radiation Safety for 2000. Detailed description of the activities is presented within the chapters devoted to the selected nuclear facilities (Chapters: 2.1.9, 2.2.4, 2.3.5, 2.4.5 and 2.5.2).

Inspection for Nuclear and Radiation Safety concludes on the basis of the above mentioned inspections that no major deficiency or violation of the existing legislation, deviations from required/expected condition, or other non-conformances had been found, which would indicate that the nuclear or radiation safety in Slovenia was jeopardised.

2.6.3 **CONCLUSIONS OF THE HEALTH INSPECTION (HIRS)**

ZIRS inspects nuclear facilities: Krsko NPP, Jozef Stefan Institute with the TRIGA Reactor at Brinje near Ljubljana and Agency for Radwaste Management with the Central Interim Storage of LIL Radwaste at Brinje.
Detailed description of HIRS activities is presented within the Chapter 4 Radiation Protection in the Working Environment.

HIRS found when performing inspections just a few irregularities, which have not endangered workers with radiation in the nuclear facilities. HIRS therefore concludes that basically protection of people against radiation has been assured.

3 RADIATION PROTECTION IN THE LIVING ENVIRONMENT

This chapter contains a summary of reports on the radioactivity monitoring in the living environment. Firstly it gives an information on Radiation Early Warning System in Slovenia which enables immediate detection of increased radiation on the territory of Slovenia; it is followed by summaries of reports on the global contamination and on the operational impact of nuclear installations in the country.

3.1 RADIATION EARLY WARNING SYSTEM

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

3.1.1 External radiation measurements

There are 43 probes for dose rate measurement of external gamma radiation throughout Slovenia; real-time data retrieval is possible from all 43 probes. Since 1996, when the fully computer-supported Central Radiation Early Warning System of Slovenia (CROSS) was established within the SNSA, the real-time measurement data from all the existing systems of this type in Slovenia have been collected at one site. These network systems are managed by the following organisations: the Krsko NPP, the Hydro-meteorological Institute, the SNSA, the Milan Vidmar Electrical Institute, the Trbovlje thermal power plant and the Brestanica thermal power plant.
The SNSA has an agreement with the measurement network operators for transfer of the collected and archived data in half-hour intervals. The communication and computer infrastructure required for data transfer, archiving, analysing and representation as well as for alerting has been provided.

All the data are transmitted on the internet and are presented at the SNSA homepage. The data are graphically presented a form of a map of Slovenia (figure 3.1) and also in a form of table (table 3.1)

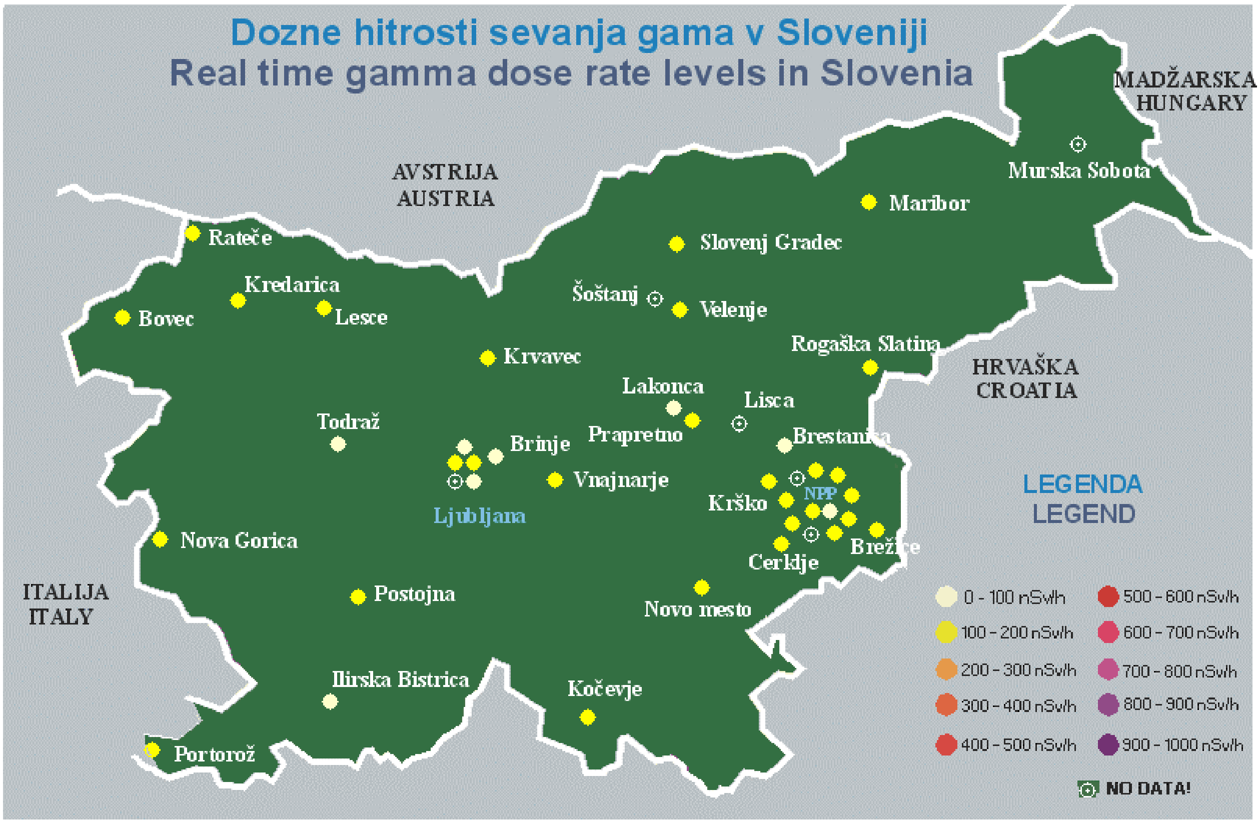


Figure 3.1: Map of Slovenia with probe locations including colour presentation of radiation ranges

Table 3.1: Numerical values of real time gamma dose rate levels on the territory of Slovenia

Predstavitev Uprave za jedrsko varnost

MONITORING SEVANJA

Zunanje sevanje

Dozne hitrosti sevanja gama na ozemlju Slovenije

DOZNE HITROSTI SEVANJA GAMA NA OZEMLJU SLOVENIJE

Uprava RS za jedrsko varnost
Čas izdelave tabele: **11.05.2001** **07:30** (UTC-1, ostali časi UTC)
Opomba: Podatki se obnavljajo avtomatično, zato se v tabeli lahko pojavijo nepreverjene vrednosti

		Dan: 10.05.2001			**Dan:** 11.05.2001					
Sonda	**OZAD. 10 DNI**	**POVP. VRED.**	**MAKS. VRED.**	**ob**	**POVP. VRED.**	**MAKS. VRED.**	**ob**	**ZAD. VRED.**	**ob**	**LOKACIJA**
	nSv/h	*nSv/h*	*nSv/h*	*ura*	*nSv/h*	*nSv/h*	*ura*	*nSv/h*	*ura:mi*	
A01	74	71	80	00	73	80	08	80	08:00	14°31',46°04' Ljubljana-URSJV
A02	80	80	90	07	80	80	08	80	08:00	14°08',45°35' Ilirska Bistrica
A03	68	65	70	01	68	70	01	70	08:00	14°31',46°03' Ljubljana-ZVD
A04	87	81	90	01	85	90	01	90	08:00	14°36',46°05' Ljubljana-Brinje
A05	93	92	100	23	95	100	08	100	08:00	14°09',46°05' Todraz-RUZV
A06	78	70	80	11	71	80	05	70	08:00	15°31',45°56' Krsko-NEK
M06	118	116	122	01	119	124	07	124	07:16	14°31',46°04' Ljubljana-URSJV
M15	131	128	136	00	129	137	02	123	08:04	15°36',45°54' Brezice
M18	125	122	129	13	126	134	03	125	08:03	15°31',45°53' Cerklje
M21	110	109	114	08	109	114	04	111	08:01	15°29',45°57' Krsko-Videm
M23	113	109	115	06	109	114	01	110	08:00	15°31',45°56' Krsko-NEK
M11	125	123	128	09	124	128	05	121	08:02	15°31',45°57' Libna
M12	121	119	123	16	121	125	05	119	08:05	15°32',45°57' Stari Grad
M13	131	129	136	00	132	135	08	135	08:14	15°33',45°56' Pesje
M14	132	128	134	13	132	138	07	138	08:05	15°34',45°56' Gornji Lenart
M16	127	124	133	08	124	129	08	129	08:04	15°33',45°54' Skopice
M19	123	119	124	02	122	126	01	126	08:07	15°30',45°55' Brege
M20	126	122	128	16	124	133	03	129	08:30	15°28',45°56' Leskovec
M01	125	122	128	21	125	131	01	125	07:17	15°38',46°32' Maribor
M03	114	112	118	21	117	124	04	120	07:19	15°10',45°48' Novo mesto
M05	106	104	108	13	106	109	02	104	07:29	13°38',45°53' Nova Gorica

M07	109	109	118	05	109	116	05	116	05:45	13°35',45°31' Portoroz-Secovlje
M08	124	119	122	04					:	16°11',46°39' Murska Sobota
M09	131	132	138	16	130	137	05	128	07:15	13°51',46°23' Kredarica
M10	132	130	136	13	128	133	07	133	07:13	14°10',46°21' Lesce
M25	141	140	151	15	147	153	00	143	07:09	15°10',46°28' Slovenj Gradec
M26	131	129	136	18	128	133	05	133	05:38	14°35',46°18' Krvavec
M27	127	125	132	17	131	135	04	129	07:13	14°11',45°45' Postojna
M28	129	125	132	05	130	134	02	126	07:16	14°31',46°03' Ljubljana-HMZ
M29	165	164	172	07	170	176	03	166	06:56	14°51',45°32' Kocevje
M30	122	118	123	08	120	123	02	117	07:22	15°07',46°22' Velenje
M31	124	121	127	03	123	124	00		:	15°17',46°04' Lisca
M40	120	116	121	15	116	120	05	119	07:21	15°38',46°14' Rogaska Slatina
M41	108	107	112	22	106	112	01	107	07:29	13°34',46°20' Bovec
M42	137	136	141	15	135	143	07	143	07:07	13°43',46°30' Ratece
M50	98	97	103	19	94	97	04	93	05:56	15°29',45°59' Brestanica
M45	120								:	15°03',46°23' Sostanj
M49	122	118	132	19	118	123	07	123	07:51	14°40',46°03' Vnajnarje
M48	94	92	99	11	92	98	03	91	07:20	15°03',46°08' Lakonca
M47	116	114	122	07	117	122	02	120	05:39	15°05',46°08' Prapretno

Uprava RS za jedrsko varnost. Vojkova 59, tel.: 01 4721 100, fax: 01 472 11 99, ursjv@sigov.si
Oblikovanje in računalniška izvedba: Matixa. Vse pravice pridržane.

In the table 3.1. the codes of the measuring points, and results are presented in the so-called Nordic format: 10-days averages, 24-hours averages, and the last half-an-hour dose rate levels. The data of the location for each probe are defined by the name and geographical co-ordinates.

The new system for automatic on-line quality control of the incoming data was introduced into the SNSA monitoring system at the end of the year 2000. It controls the content of all data received from the measuring sites. The results of QA/QC analyses for each station are presented in the form of coloured dotted lines. For example, in the figure bellow the yellow dots mean that the data are received in time and are within all required criteria, while red dots in the yellow field mean that data are missing. Green coloured dots shows the data have been coming too late and (or) contain error codes. Each particular monitoring subsystem (i.e. Krško NPP, Hydro-meteorological Institute (HMI), SNSA and Slovenian TPP systems) has its own display of QA/QC results, as can be seen from the menu in (figure 3.2). Field of red dots means that all data have yet to arrive during the rest of a day.

Figure 3.2: The graphical presentation of the arrival and quality of the data

Monthly and yearly summary reports on the results of measurements are elaborated. These reports contain a graphic presentation of dose-rate values and their frequency distributions. Averages, maximal and minimum values of daily dose-rates, frequency distribution of monthly dose-rates and descriptive statistics of results are presented in a table form for each of existing locations. The target of the report is to promote a multilevel application of QA/QC procedures of the early warning radiation data in Slovenia.

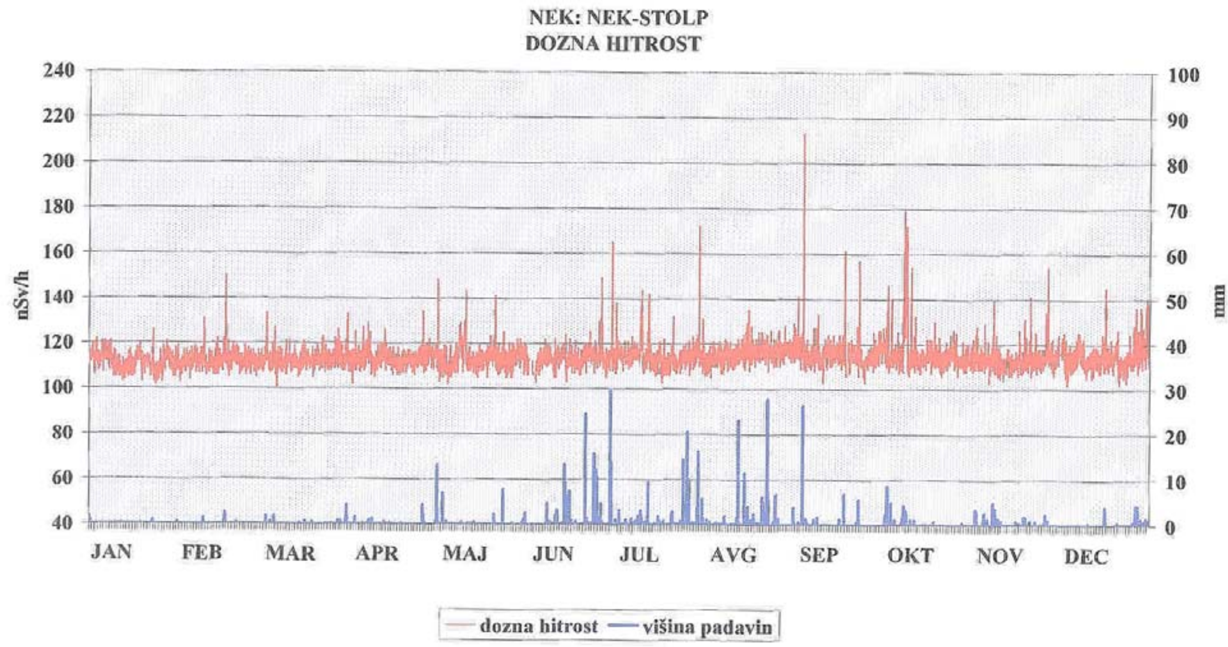


Figure 3.3: Daily values of gamma dose rate and daily precipitation for probe located at the Nuclear power plant in Krško

In the year 2000 the SNSA has been weekly sending data from CROSS to the European system EURDEP located in the European research centre JRC in Ispra (Italy). By joining the European network, the SNSA gained the possibility of insight into data from other European countries. All data are checked on-line automatic and are sent daily by the officer on duty and according bilateral agreements automatically to Austrian, Croatian and Hungarian authorities.

3.1.2 AUTOMATIC MONITORING OF THE AEROSOL RADIOACTIVITY

In the middle of 1998 the first automatic aerosol monitoring system was put into operation at Brinje near Ljubljana (location of the Research Reactor Centre) by the Slovenian Nuclear Safety Administration. The system was provided in the framework of the IAEA technical co-operation project. The second system was installed by the SNSA in May 1999 at Krško on the NPP site. All automatic aerosol systems daily pump the air through filter and measure the concentration of artificial alpha and beta activity in the air, concentration of gamma emitting radionuclides, concentration of radioactive iodine I-131 in the air in all chemical forms (particles, gas, organically bound iodine) and concentrations of natural radon and thoron progeny. Identical stations were installed also in the neighbouring countries: eight in Austria, mostly along its borders and one at the Paks NPP in Hungary. At the end of 1999 the Austrian government granted the SNSA advanced aerosol monitoring station with high resolution gamma spectrometry. It is installed at Drnovo near Krško.

Provided that there is no increased radioactivity observed in the air, data are presented in terms of detection limits. The detection limits are: for artificial alpha activity in air 0.01 Bq/m^3, for artificial beta activity 0.1 Bq/m^3, for ^{137}Cs in the air 0.10 Bq/m^3 and for ^{131}I 0.01 Bq/m^3. The device gives simultaneous values of concentration of natural radon (^{222}Rn) and thoron (^{220}Rn) progeny in the air. (table 3.2)

Table 3.2: Detection limits and typical concentration values of natural radionuclides (radon decay products), detected by the aerosol monitoring stations at Brinje, at the Krško NPP, and Drnovo.

	ARTIFICIAL RADIOACTIVITY			
Limit of detection	Alfa [Bq/m^3]	Beta [Bq/m^3]	^{131}I [Bq/m^3]	^{137}Cs [Bq/m^3]
Ljubljana-Brinje, Reactor Centre	0.024	0.350	0.057	0.220
Krško-Vrbina, Location NPP	0.039	0.190	0.085	0.290
Krško-Drnovo	0.030	0.140	0.066	0.001

	NATURAL RADIOACTIVITY	
Measured concentration	^{222}Rn EEC [Bq/m^3]	^{220}Rn EEC [Bq/m^3]
Ljubljana-Brinje (Reactor Centre)	2.200	0.018
Krško-Vrbina, (Krško NPP)	2.100	0.026
Krško-Drnovo	1.400	0.012

3.1.3 Automatic measuring system of radon progeny concentrations

Radon progeny measurements represent an additional part of the Slovenian automatic radiation monitoring network. The monitoring station is located at Todraz near Gorenja vas in the very vicinity of the disposal sites of the former Zirovski vrh uranium mine. Six such instruments (type WLM 200+) were manufactured at GSF in Neuherberg, Germany and were kindly provided to Slovenia by the Bavarian government in the framework of bilateral co-operation in 1996. The system is operated by the Zirovski vrh Mine Company with close cooperation of the SNSA.

The concentrations of radon progeny are periodically changing: the lowest values are measured during the day, in late afternoon they start increasing and reach the highest values early in the next morning, just before the decomposition of temperature inversion. Radon progeny concentrations are measured hourly and are expressed in terms of equilibrium equivalent concentrations of radon (EEC) and in interval from 20 to 40 Bq/m^3.

3.1.4. RADIOACTIVE DEPOSITION MEASUREMENTS

In a nuclear accident, radioactive particles can be released into the atmosphere and the flow of air masses may transfer them over a large area, even thousands of kilometres away. During the atmospheric transport process some particles are deposited on the ground (dry deposition), or washed down by precipitation (wet deposition). The upper layer of the ground - including water and vegetation - becomes radioactive, which results in increased values of external gamma dose rates.
When this happens, information on the presence of radioactive contamination on the ground and on its radioisotopic composition is urgently needed. For this reason the SNSA developed and installed an automatic gamma-spectrometry system equipped with a scintillation detector for the measurements of radioactive ground deposition. The system is designed for on-line detection and evaluation of possible contamination with fission products such as ^{131}I and ^{137}Cs. The measuring system for radioactive deposition collects data and performs a gamma spectroscopic analysis of the measured spectrum every 6 hours. The measurement time interval can be easily changed. A special software enables an on-line evaluation, display and storage of the results of surface ground contamination and alarming. The results are displayed on the SNSA internet homepage.

	Artificial radioactivity [kBq/m^2]		Existing contamination [kBq/m^2]	Natural radioactivity [kBq/m^2]		Gamma dose rate [microSv/h]
Radionuclide	^{131}I	^{137}Cs	^{137}Cs	^{214}Pb	^{214}Bi	
Measured contamination	-	-	1.5	-	-	0.075

Tabel 3.3: The table shows the results of the gamma spectrometry measurements in Ljubljana at SNSA location.

The values of surface ground contamination of the most important fission products, marker isotopes ^{131}I and ^{137}Cs, are calculated. The results are based on the assumption of surface-only contamination without taking into account depth distribution. The natural radioactivity is presented as an average surface activity of newly deposited radon daughters ^{214}Pb and ^{214}Bi in the last measurement interval. The dose rate was measured with the GM counter at the same location.

	Artificial radioactivity [kBq/m^2]		Existing contamination [kBq/m^2]	Natural radioactivity [kBq/m^2]	
Radionuclide	^{131}I	^{137}Cs	^{137}Cs	^{214}Pb	^{214}Bi
Detection limit	0.03	0.04		0.08	0.10

Tabel 3.4: Detection limits of radioactivity for individual nuclides

The detection limits for individual radionuclides are hundred times greater then the nuclear accident operational intervention levels (for ^{131}I general food 10 kBq/m^2, cow milk 2 kBq/m^2 and for ^{137}Cs general food 2 kBq/m^2, cow milk 10 kBq/m^2).

3.1.5 NOVELTIES IN YEAR 2000

Main novelties on automatic radiation monitoring system are:

- two new measuring location for measuring the external radiation are included into the automatic radiation monitoring system, that are under operation of thermal power plant at Trbovlje and thermal power plant at Brestanica.
- the automatic measuring for the radioactive deposition is included into the automatic republic monitoring system for the control of the radiological situation
- an agreement with the measurement network operators for transfer of the collected and archived data (including the ecological and meteorological data) was signed
- establishment of simultaneous control and quality of the incoming data
- increased frequency of sending data from daily to every half hour interval in Austria on base of the bilateral agreement
- establishment of daily sending of data in Croatia and Hungary on base of the bilateral agreement
- automatic daily sending of data in EURDEP (European Union Radiological Data Exchange Platform) system instead of weekly sending
- modified outlook of the SNSA internet homepage

All data from probes are analysed, checked and recorded on the following internet page:
http://www.sigov.si/ursjv/monitoring/sevanje.html

3.2 GLOBAL RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT IN SLOVENIA IN 2000

INTRODUCTION

The basic scope of the programme was determined by the *Regulation on Sites, Methods and Time Periods for the Radioactive Contamination Control* (Reg. Z1, Off. Gaz. SFRY, No. 40/86). In 2000, the general radioactivity monitoring programme in the living environment in Slovenia was performed at the same extent as in the preceeding years. In addition to measurements foreseen in the programme, parallel measurements of air and precipitation samples were performed by both contracting institutes as well. The results of food control of samples imported from or exported to foreign countries are also included in the report.

The monitoring programme was financed by the Ministry of Health of the Republic of Slovenia and was performed by the authorised technical support organisations Institute of Occupational Safety and Jožef Stefan Institute, both from Ljubljana.

3.2.1 MONITORING PROGRAMME

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

1) Surface waters

A semi-annual grab sampling of water from the Sava river near Ljubljana (Laze-Jevnica), the Drava river near Maribor, the Savinja river near Celje and the Soča river near Anhovo. Specific activity of gamma emitters and H-3 was determined. *(Remark: According to the regulations the river water samples should be collected daily for period of 3 months; radioactivity of the Mura river has not been monitored).*

2) Air

Continuous pumping of air through air filters at the sites in Ljubljana, Jezersko and Predmeja. The air monitoring consisted of concentrations measurements of gamma emitters in the monthly composite samples of daily filters. *(Remark: radionuclide Sr-90 should be monitored in monthly samples in Ljubljana).*

3) Ground

- *Soil.* Samples of the undisturbed grassland are taken in Ljubljana, Kobarid and Murska Sobota. The content of gamma emitters and Sr-90 in three layers of soil (0-5 cm, 5-10 cm and 10-15 cm) was measured twice a year.
- *External gamma radiation.* TL dosemeters were installed at 50 outdoor sites throughout Slovenia, forming a 20 km x 20 km network, for the purpose of determination of semi-annual doses received from external gamma radiation. In addition, continuous measurements of dose rate levels within this programme were performed in Ljubljana, Maribor, Novo mesto, Celje, Nova Gorica, Portorož, Murska Sobota, Kredarica and Lesce.

4) Precipitations

Continuous sampling of dry deposition and precipitations (fallout) in Ljubljana, Novo mesto, Bovec and Murska Sobota. Specific activities of gamma emitters and H-3 were measured on a monthly basis, while those of Sr-90 were monitored quarterly. *(Remark: measurements of H-3 and plutonium are prescribed but not performed)*

5) Drinking water

Sampling of drinking water from water mains twice a year in Ljubljana, Celje, Maribor, Kranj, Škofja Loka and Koper. The specific activity of gamma emitters, Sr-90 and H-3 was determined. *(Remark: collective monthly samples should be monitored in Ljubljana and Maribor).*

6) Food

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

7) Fodder, grass

Sampling of grass at sites in Ljubljana, Kobarid and Murska Sobota twice a year. The content of gamma emitters and Sr-90 was determined. *(Remark: broader extent of monitoring was prescribed, including factory produced fodder, concentrates and silage)*

3.2.2 CONTRACTORS

The monitoring programme has been performed by technical support organisations, the Institute of Occupational Safety, Ljubljana, Bohoričeva 22a, and the Jožef Stefan Institute, Ljubljana, Jamova 39. Both contractors are authorised by the Ministry of Health for performing radiological surveillance of the environment. Both of them regularly participate in the international intercomparison measurements within the IAEA with the purpose of assuring the quality control of measurements. They also carried out additional comparative measurements of samples within the framework of the radioactivity monitoring programme in the surroundings of the Krško NPP.

3.2.3 RESULTS

a) Monitoring of river water in Slovenia has not been performed according to the regulations; instead of daily collection of samples and anlysing a composite quarterly sample only grab sampling has been provided twice a year. The Mura river is not controlled in spite of fact that this water was in the past the most contaminated due to I-131 releases from Austrian hospitals. The results of measurements of artificial radionuclides in all four largest **rivers** in Slovenia showed that Cs-137 concentrations could only be found in traces up to a maximum of 0.5 Bq/m^3 in Slovenian rivers (Sava, Savinja, Soča) and up to 1.0 Bq/m^3 in the Drava river (international river). Levels of H-3 concentration in river water varied between 1500 to 1800 Bq/m^3.
Concentrations of the radionuclide I-131 - released from nuclear medicine centres in Ljubljana, Maribor and Celje - varied from about 10Bq/m^3 in the Sava and Savinja rivers and up to 21 Bq/m^3 in the Drava river.

b) No major changes occurred in the specific activity of radionuclides in the **air** as compared to 1998. Levels of Cs-137 were of the order of magnitude of 3 microBq/m^3, levels of Sr-90 were not measured, but usually they have been far less than 1 microBq/m^3. The results of natural radionuclides such as ^{7}Be and ^{210}Pb were in the range of 2.3-2.8 miliBq/m^3 and around 0.5 miliBq/m^3 respectively.

c) Radioactivity measurements of **precipitations** showed levels of Cs-137 concentration mostly of the order 2-5 Bq/m^3 (deposition: 1-3 Bq/m^2) and for Sr-90 on average 0.4 Bq/m^3 (deposition: 0.6 Bq/m^2). Levels are similar as in the previous year. Strontium-90 in precipitation in the nineties was much lower than in the early eighties (0.1-1 Bq/ m^2 versus 1-8 Bq/ m^2). Deposition of the natural radionuclide ^{7}Be was in Ljubljana 0.5 kBq/m^2 and of ^{3}H 2.7 kBq/m^2 with its concentration in the rain water of 2.0 kBq/m^3.

d) The results of measurements of artificial radionuclides in **soil** layers indicated that distribution by depth was very similar to that established in previous year: a slight decline from the surface to deeper layers. In Ljubljana, the average specific activities of Cs-137 in the first 15 cm were in total 10 kBqm^{-2} (at the time of the Chernobyl accident about 25 kBqm^{-2}) and in Murska Sobota only about 6 kBqm^{-2}. Surface activity of Sr-90 was found to be much smaller and was within the range of about 220 Bqm^{-2} (contamination in 1986: 450 Bqm^{-2}). About nearly 30% of this figure appeared in the upper layer from 0 cm to 5 cm. The highest contamination of soil (0-15 cm) was measured in Kobarid (0.57 kBqm^{-2}) and at Murska Sobota (0.35 kBqm^{-2}).

e) The measurements of the **external gamma radiation** showed that an average value in Ljubljana in 2000, measured with TL dosemeters, was 98 nanosieverts per hour and is higher than in 1999 (92 nSv/h). The contribution of the Chernobyl contamination in Ljubljana region was estimated to be still about 0.14 mSv per year i.e. 20 % of the value of natural background (0.7 mSv/y). In 2000 the average dose rate in the country, measured with automatic radiation monitors on 12 locations, was 123 nSv/h. This value is for 25% higher than results obtained with the TL dosemeters at the same locations. No explanations for this difference was done.

f) Radioactivity of Cs-137 in **drinking water** from the public water supply in bigger towns in Slovenia was found only in trace quantities, i.e. 0.2-0.7 Bq/m^3. Concentration of strontium-90 was several times higher as Cs-137 (in Koper even 3 Bq/m^3). No results on contamination of drinking water from rainwater tanks are available. Concentration of H-3 in tap water was in the same range as in river water (1500 Bq/m^3).

g) The decreasing trend in the specific activity of radionuclides Sr-90 and Cs-137 **in food** has been continuously found also throughout 2000 as in previous years. The mean value of Cs-137 in vegetables, fruit was mostly in the range of 0.01-0.08 Bq/kg and and cereals (in barley, buckwheat, oats 0.1-0.8 Bq/kg). The highest value was measured in plums from Lower Carniola (Suhor): 2 Bq/kg. Contents of Sr-90 in cerals, fruits and vegetables was in the equal range as in previous year, namely on average 0.2 Bq/kg. Among the food of animal origin, meat contains about 0.2 Bq/kg of Cs-137). Cow milk from central Slovenia had on average 0.3 Bq/L of Cs-137 and 0.08 Bq/L of Sr-90, while milk samples from the alpine region (NW) of Slovenia showed values of 0.8 Bq/L Cs-137 and 0.15 Bq/L of Sr-90. In cheese higher contents of Sr-90 were found in cheese samples (0.7-1.2 Bq/kg). Levels of Cs-137 (1.1-1.2 Bq/kg are an order of magnitude higher as in previous year but there is no comment about the reason. In general it was stated that the great variability of very low absolute values for C3-137 and Sr-90 (near detection limit) does not make possible good statistical comparability of results.

h) Contents of Cs-137 and Sr-90 in **grass** showed levels of order of magnitude of 1 Bq/kg of fresh samples. Levels of Cs-137 are on average 0.9 Bq/kg and are more or less permanently several times lower than levels of Sr-90 (mean 5 Bq/kg); this results are quite similar as in previous years. Far highest contamination of grass originates from natural long-lived radon decay product ^{210}Pb content (due to dry and wet deposition from the atmosphere) was found at the average level of 8 Bq/kg, and from cosmogenic radionuclide ^{7}Be where levels up to 30 Bq/kg were determined.

3.2.4 EXPOSURE DUE TO GLOBAL RADIOACTIVE CONTAMINATION

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

On the basis of average specific activities of the long-lived fission radionuclides in the air, water and food for 2000 and the average annual intake, taking into account the dose conversion coefficients according to IAEA Basic Safety Standards (1996), the cumulative committed effective dose E_{50} was estimated. The contribution of both radionuclides to the dose due to inhalation was estimated to be actually negligible in comparison with the doses received along other transfer pathways. This contribution was estimated to be a few nanoSv in the case of Cs-137 and a few tens of nanoSv in the case of Sr-90. The ingestion dose amounted to 3.8 microSv per year, of which Sr-90 accounted for three quarters of the dose and Cs-137 for one quarter. The external radiation caused by the soil contamination with Cs-137 represented the largest contribution to the global contamination of the environment in 2000. The measuring data from the measuring point in Ljubljana have been used in estimation of the annual dose due to external radiation. On the assumption that every inhabitant spends 30% of the available time outdoors, and factor of structure shielding of 0.1, the effective dose due to external radiation (mostly from the Chernobyl accident) was estimated to 54 microSv. This figure is overestimated and should be probably several times lower. The cumulative dose to an adult, caused by the global contamination of the environment with both long lived fission radionuclides, was estimated to be 58 microSv/year, as shown below (Table 1). This exposure cannot be comparable to the low values obtained in the neighbouring countries (10-20 microSv/year in Austria, Germany, etc.) due to different assumptions and methodology.

Table 3.5: Exposure to the population in 2000 originating from global contamination of the environment with long-lived fission radionuclides

Transfer pathway	**Effective dose (in microSv/year)**
Inhalation (Cs-137, Sr-90)	some 0.01
Ingestion : food (Cs-137, Sr-90) drinking water (rain water tanks, Cs-137, Sr-90, 2 L/daily)	3.8 (0.05)* (0.5)*

Transfer pathway	**Effective dose (in microSv/year)**
drinking water (Sava river, I-131, 2L/daily	
External radiation (Cs-137)	51.8*
Total in 2000	**57.5 microSv**

* … estimation by SNSA, based on measured value in the IOS report and conservative assumptions

3.2.5 CONCLUSION

Considering the results of the monitoring of the radioactive contamination in the living environment in the Republic of Slovenia in a year 2000 the technical support organisations claimed that the specific activities of artificial radionuclides in air, water and food are much lower than the values of derived limits prescribed by the *Regulation on the Radioactive Contamination Limits of the Human Environment and on Decontamination* (Off. Gaz. SFRY, No. 8/87).

Annual effective dose due to ingestion of the artificial radionuclides are quite comparable to those obtained in the neighbouring countries (Austria, Switzerland 5 microSv), while the assessment of external exposure for the Slovenian territory is likely overestimated (54 microSv).
Annual exposure from external radiation should be estimated on other, less conservative assumptions (staying outdoors 7.2 hours daily, shielding factor in dwellings 0.1) to be comparable with results in the neighbourhood. In annual reports for countries as Austria an annual external dose of 15 microSv was quoted (6 hours outdoors and shielding factor of buildings), in Germany 20 microSv, and for Switzerland 10-500 microSv per year was reported.

3.3 RADIOACTIVITY MONITORING IN THE ENVIRONMENT OF THE KRŠKO NUCLEAR POWER PLANT

3.3.1. SCOPE

The regular monitoring at the Krško NPP includes monitoring of the inventory of liquid and gaseous effluents at the source (undiluted emission monitoring), and an independent off-site surveillance programme of the nearby surroundings (ambient monitoring). The off-site monitoring predominantly comprises surveillance of an area extending up to a radius of 12 km around the facility - where the highest impacts are anticipated and possible changes should be first detected - while surveillance of the Sava river and groundwater extends up to 30 km downstream into the Republic of Croatia from Jesenice (at the Slovenian-Croatian border) to Podsused. This report also includes some reference data which are relevant to emergency preparedness in Croatia and are related to early detection of gaseous effluents and their ground deposition. They are collected from measuring sites at larger distances from the plant (14 km to 27 km) towards Zagreb and its vicinity (continuous dose rate monitors, passive TL dosemeters placed along a western arc of the city of length 45 km).

3.3.2. PARTICIPATING INSTITUTIONS

Continuous emission monitoring is routinely performed by the Krško NPP staff, together with some additional technical support (periodic intercomparisons, parallel measurements of representative samples) from external authorised institutions. Regular off-site monitoring is performed following the authorised yearly programme by the following independent institutions: the "Jožef Stefan" Institute (IJS) and the Institute for Occupational Safety from Ljubljana, and on Croatian territory the "Rudjer Bošković " Institute - Centre for Marine and Environmental Research (IRB) and the Institute for Medical Research and Occupational Health from Zagreb (IMI). IRB also preforms some measurements of the Sava river from Krško to Jesenice parallel to those performed by IJS.

3.3.3. RESULTS OF MONITORING

The contributions of general contamination to the radiation burden of the environment, predominantly due to the presence of Chernobyl caesium isotopes (as well as the effects of their technological concentration in the emissions of local industry with massive processing of polluted raw materials), after a rapid decline in 1987, underwent a steady decrease during the next seven years, while agricultural products reached pre-Chernobyl levels already by 1990. In 1994 this trend reached its lowest value and in the next following years the standard sample collection of agricultural products from the Krško - Brežice region showed even a slightly higher content of caesium. A decrease was again observed from 1997 to 1999, while during the year 2000 the presence of caesium-137 in some agricultural products was again somewhat increased. An increase was also noted in ground deposition (dust, precipitation) and in external radiation doses. With reference to the previous year of 1999, the average dose due to external radiation in the surroundings of the Krško NPP increased (especially during the first half of the year) and reached the level of 1997. During the 2000 a noticeable increase in the average yearly dose was also recorded in other regions of Slovenia.

The decreased contribution of the Videm paper-mill to the radioactive burden of **the river Sava water** with man-made (by a factor of 0.5) and natural radionuclides (by a factor of 0.25) was a consequence of its decline in the production during 1992 and 1993, and was followed by a new rise, especially of natural radionuclides, in the year 1994 (by a factor of 2). Since then, roughly the same level with smaller or larger oscillations has been maintained for both natural and artificial radionuclides. Tailings coming from the ash of the paper-mill's coal-fired plant released into the Sava river, responsible for the increased concentration of natural radionuclides, have contributed slightly more during the year 2000; on the other hand, during the last three years little change in the pollution level of artificial radionuclides (strontium-90, caesium-137) accumulated in varying concentrations in processed wood has been observed. As in several previous years, because of the reduced concentration of caesium, pre-Chernobyl strontium has maintained and increased its relative importance among the long-lived artificial radionuclides. The prevailing share in dose burden from artificial radionuclides, however, is due to short-lived Iodine-131, predominantly contributed since 1990 by hospitals.

For the year 2000, by taking into account increase in Tritium concentration from the Krško NPP effluents as well as Iodine-131, Caesium and Strontium isotopes, it was estimated that the contribution of the Krško NPP to the annual dose burden of reference man due to potential drinking of Sava water at Brežice was less than **0.7 microSv/year**, and for the reference child (of the age 1 - 2 years) was less **1.6 microSv/year**. For the child this amounts to approximately 8 % of the estimated total dose burden caused by artificial and natural radionuclides together. The estimates are comparable with those from the years 1999 and 1998. Taking into account recent changes in dose factors, it is also comparable within an order of magnitude with results of previous years. A somewhat lower dose burden due to the Krško NPP (**0.4 microSv/year** for reference man, and **1.1 microSv/year** for a child) was assessed at Jesenice (border with Croatia). These data are rather sensitive to the somewhat uncertain estimate of the contribution of short-lived iodine-131 released from hospitals during 2000, as in previous years. A rough estimate of **the iodine-131 contribution from hospitals** to the dose burden of the reference child (age 1 - 2 y.) can be made from the data taken at Krško, where the effluents of the Krško NPP are excluded. This yields a dose of **1.1 microSv/year**.

The estimated dose increase due to ingestion of **fish from the river Sava**, using rather conservative assumptions (the highest detected concentrations of man-made radionuclides - regardless of the origin; fish as a whole) yields a value of less than **1.3 microSv/year** for reference man and less than **4.5 microSv/year** for the reference child (with 60 % of adult consumption). Fish which had represented critical pathway for KNPP effluents to the food chain until 1986, in the year 2000 did not show a caesium content (predominantly from Chernobyl) different from the average in other protein food. Short-lived iodine-131, which contaminates Sava waters upstream and downstream of the Krško KNPP, also here occasionally causes predominant dose increases (especially to children).

An independent **model assessment of the effective dose** to the potentially most exposed members of the general public from the reference group of inhabitants at Brežice, for different transfer pathways through the river Sava, based on a dilution factor estimated from measurements and the yearly inventory of liquid discharges from the Krško NPP (monthly reports of the Krško NPP for the year 2000), was also made. For the year 2000 it yielded a committed effective dose of **0.6 microSv/year** for an adult, and **0.7 microSv/year** for a child. This estimated dose is close to those made in the previous two years.

In the eighties (from 1982) during operation of the Krško NPP the concentration of tritium in **drinking water** from the Brežice watrer supply was twice as high as that in other water boreholes in the Krško-Brežice plain or in the Krško water supply. Studies and analysis made in 1985 confirmed the assumption that the increase was due to the Krško NPP contributions of tritium through Sava water. Since the second half of 1990 the Brežice drinking water was predominantly (70 %) supplied from a new deeper water well with an exceptionally low tritium content, so that connections to Sava waters were disrupted. Therefore, after 1990 the contributions of all man-made radionuclides from Brežice tap water to the dose of reference man through drinking has reduced to a few percent of a microSv/year (in the y. 2000 around **0.020 microSv/year** for an adult, and **0.024 microSv/year** for a child) with a negligible **contributions of the** Krško NPP through the old water well. The total dose burden due to the presence of natural and man-made radionuclides in drinking water in Bre ice was estimated to be 6 microSv/year for adults, and 15 microSv/year for children (age 1 - 2 y.). During the year 2000 **control bores** in the alluvial ground in the Samobor area (Croatia) did not show any significant influence of global contamination, nor any influence of the Krško NPP (tritium).

During steam-generator replacement work (April, May 2000) **off-site measurements of** continuously collected **aerosols** did not show any increase of airborne cesium concentration or the presence of any fresh, short-lived isotopes, in spite of the fact that such traces were detected in one example of ground deposit collectors (sticky plates) at the fence of the Krško NPP. The detected low concentrations were of no significance for the environment at the collecting spot. Estimates based on **an inventory of gaseous emissions** (monthly reports of the Krško NPP for 2000, completed with data from IJS for gaseous emissions of tritium and carbon-14), **emissions of particulates** (monthly reports of the Krško NPP for 2000 complemented with additional filter measurements from IJS) and averaged monthly dispersion factors (meteorological reports of the HMI), yielded for the highest dose burden from inhalation **(0.17 microSv/year)** as well as external radiation caused by the plume **(0.04 microSv/year)**, a total dose of **0.2 microSv/year** at the settlement of Sp. Stari grad (direction ENE at a distance of 0.8 km). This dose was constituted by a higher contribution during the first half of the year, but was lower than that one from the previous year of 1999 because of a reduced inhalation dose. Continuous **measurements of airborne iodine-131** at 6 sites in the surroundings of the plant did not recorded iodine above the lower measuring limit, which corresponds to the thyroid yearly dose caused by inhalation of < 0.4 microSv.

The average **dose value due to external radiation** measured at 57 sites in the vicinity of the Krško NPP throughout the year 2000 was **793 microSv/year**. This value was about 4 % higher than in the year 1999, and also 4 % less than in the year 1998 (when a similar dose increase was observed), and 35 % higher than before Chernobyl contamination. A slightly less than 7 % increase in average dose was also measured in other regions of Slovenia (50 permanent sites), where since the beginning of measurements in 1991, the average yearly dose has reached higher absolute values than in the Krško - Brežice region. Compared to the average values in 1999, the average dose at the plant fence (9 measuring points) during the first half of the year 2000 showed a 13 % increase and an annual increase of 8 % (40 microSv/year). The highest increase observed during the first half of the year was at the western side of the fence and amounted to 80 - 100 microSv/year. While a smaller part of the increase could be attributed to the general increase of external radiation doses in the region, the majority of it arose within the limited time period used for the removal and final storage of the old steam-generators. The **continuous dose rate monitors** (at 13 permanent measuring sites) with autonomous display and recording, connected on-line by radio links and telephone lines to the central computer at the Krško NPP, primarily intended for **early warning**, showed similar but less pronounced site-specific variations in doses as the TL dosimeters. They displayed (as during previous years) temporary excursions of doserate (up to 160 % over the monthly average) with duration of a few hours which were attributed to the wash-down of radon decay products with precipitation and their temporary retention in the upper wet layer of the ground. These occurrences have also been observed at other measuring sites in Slovenia where such continuous monitors are installed (19 sites at the HMI weather stations), and as a rule are not correlated with plant gaseous emissions but predominantly with precipitation.

Table 3.9: Partial and total exposure of individual members of the population through all transfer pathways due to the Krsko NPP releases in 2000

Transfer path	**Annual Effective Dose (microSv)**	
	Adults	**Children**
Internal exposure through inhalation - tritium, carbon-14, iodine-131, particulates	0.17	0.08
Internal exposure through ingestion - water	< 1.3 < 0.7	<4.5 <1.6
External exposure through submersion and deposition	6	6
Total effective dose due to the Krsko NPP releases in 2000	**8.2**	**12.2**

Intercomparison measurements of liquid samples and aerosol filters between the laboratories of Krško NPP and IJS showed acceptable agreement for the radionuclides detected by both labs. The **parallel checking** of composed aliquot **representative samples of liquid effluents** and **composed samples of aerosol filters** of programme B showed no disagreements which would significantly change the estimate of the yearly dose burdens due to gaseous and liquid releases. In all cases of divergence, the less favourable (higher) values were used for dose estimation.

3.3.4. CONCLUSIONS

All monitored and quantitatively evaluated radiation burdens in the environment due to emissions from the Krško NPP have been below regulatory limit of 50 microSv/year. Conservatively estimated dose burdens received by members of the reference (critical) population group as the result of NPP emissions and based both on the directly measured values in the environment and on model calculations from the data for annual emission values from the Krško NPP, in the year 2000 amounted to a value of the **effective dose smaller than 20 microSv/year**. This value represents less than 1 % of the annual dose received from natural and artificial sources by a member of a general public in the normal environment.

Table 3.10: Survey of sources and dose values to the population in the vicinity of the Krško NPP in 2000

1 INTERNAL EXPOSURE (due intake and presence of radionuclides in the body and their radiation effects to the body)	**Effective dose in 2000 (*2) (microSv/year)** **Adults**	**Children 1-2 years**
1.1 due to intake by breathing (inhalation) from the following sources:		
1.1.1 natural radioactivity - radon-222 and its short-lived progeny in the air (*3)	1300	
1.1.2 general contamination with dust particles (aerosols) - accumulated lead-210 (from industrial and natural sources) - resuspended artificial radionuclides	38 0.003	18 0.001
1.1.3 gaseous emissions from the Krško NPP - tritium, carbon-14, iodine-131, particulates	0.17	0.08
Total for inhalation	**1338**	
1.2 due to intake with food and water (ingestion) from the following sources(*4):		
1.2.1 natural radioactivity - potassium-40 - uranium and thorium chain - other total	180 140 40 360	
1.2.2 general contamination (Chernobyl, nuclear explosions, industrial accumulation of artificial radionuclides) - food - water total	5.2 0.06 5	4.4 0.08
1.2.3 liquid effluents (the Sava river) and gaseous (deposition) emissions from the Krško NPP - food - water total	< 1.3 < 0.7 2	<4.5 <1.6
Total for ingestion	**367**	
Rounded total for internal exposure	**1700**	
2 EXTERNAL EXPOSURE (as a result of radiation sources outside the body in the environment and their radiation effects on the body)		

2.1 due to medical diagnostics (*5)	300 to 1500	
2.2 due to natural radiation (cosmic and terrestrial) (*6) - cosmic neutronic component - cosmic and terrestrial radiation (U, Th chain, K-40, cosmic radiation)	 60 770	
2.3 due to Chernobyl deposition in the environment (*7)	58	
2.4 due to gaseous emissions from the Krško NPP (inert gases and deposition) (*7)	6	
Rounded total for external exposure	**2400**	
Total for internal and external exposure (rounded) **with highermedical contribution (1500 microSv/year)** **with lower medical contribution (300 microSv/year)**	 **4100** **2900**	

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

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

(*3) For dwellings with an average equilibrium radon concentration of 15 Bq/m3 (or a concentration of Rn-222 of 38 Bq/m3 at an equilibrium factor of 0.4) and an indoor occupancy factor of 0.8 and an outdoor occupancy factor of 0.2. According to the proposal of the ICRP Publication 65 from 1993, an inhabitant living in the environment with an average equilibrium radon concentration of 22 Bq/m3 and spending 80% of his time at home and 20% at work, would receive the same annual dose. The latter concentration values are closer to those measured in Slovenia (M. Križman et al., Proceedings, Symposium on Radiation Protection in Neighbouring Countries in Central Europe - 1995, Portorož, Slovenia, p. 66, January 1996).

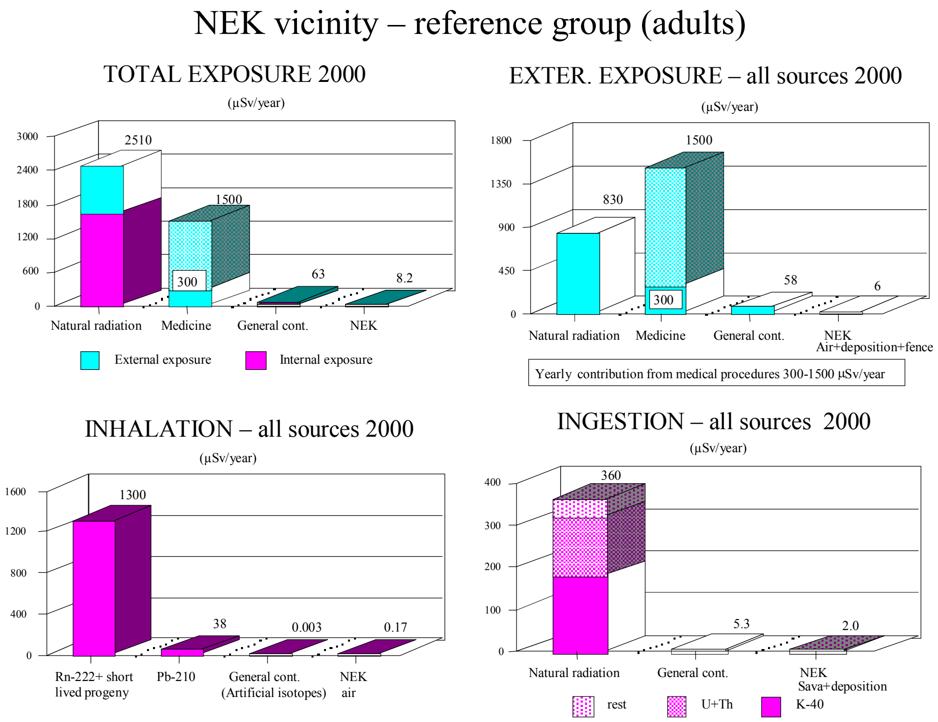
(*4) Consumption determined on the basis of data of the Statistical Office of Slovenia on Consumption by the Population from 1993 to 1996 (Statistical Yearbook of Slovenia). The data from the publication UNSCEAR 1988 Report (p. 95), United Nations, New York 1988 were used for the average dose from natural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

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

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

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

Figure 3.4: Dose exposures for adult residents of the reference group in the vicinity of NPP Krško in the year 2000



Source: Radioactivity monitoring in the environment of NPP Krško – Report for the year 2000, IJS, no. IJS-DP-8340, Ljubljana, March 2001

3.4 RADIOACTIVITY MONITORING IN THE ENVIRONMENT OF THE TRIGA RESEARCH REACTOR

The radioactivity monitoring programme in the environment of the Research Reactor Centre at Brinje in 2000 was carried out in accordance with the Regulation on Radioactivity Monitoring in the Environment of Nuclear Facilities (Off. Gaz. SFRY, No. 51/86) and was approved by the SNSA Decision No. 391-01/00-5-26546/MK on 10 November 2000.

Within the location area of the reactor centre the two nuclear installations are operating: the TRIGA MARK II research reactor and the low and intermediate level waste storage. Monitoring of radioactivity in the environment of the research reactor was carried out by the Jožef Stefan Institute.

3.4.1 SCOPE OF MONITORING

Measurements of releases from the source in order to enable impact assessment of the facilities:

- gaseous releases (aerosols and gases released from the exhaust from the reactor hall)
- releases of liquid effluents (radioactive isotopes in the discharge water from the Department of Environmental Chemistry, and monitoring of some other liquids of the reactor systems, not released to the environment).

Measurements of radioactivity in the environment in order to assess the impact of the facility or to identify the impact from the external polluters:

- air: radioactivity of aerosols at the control point.
- liquids: radioactivity of precipitation and well water;
- external radiation: monitoring of dose rate levels at the control point.
- radioactive isotopes in the nearby soil;
- radioactive isotopes in the Sava river sediment.

Meteorological measurements are provided by an automatic meteorological station situated at the control point by the west fence of the centre. Data are available on-line in the control room of the reactor.

3.4.2 MONITORING RESULTS

In 2000 no special events were found in the reactor operation and the other related activities, and the total produced thermal power was comparable to those in previous years (242 MWh). Releases of ^{41}Ar into the air (approx. 0.9 TBq in 2000) were directly correlated to the period of reactor operation and were also similar. Measurements of radioactivity on the ventilation shaft with TL dosimeters showed an increase for a factor of 1.5 compared to the background due to ^{41}Ar releases.

Radionuclides ^{24}Na, ^{60}Co ^{134}Cs and ^{137}Cs were detected in the liquid effluents during the year 2000. The total released activity was 10 MBq resulting from the research work at the Department of Environmental Chemistry. The activity of liquid effluents was measured by the radiation protection department of the J. Stefan Institute and were 3-4 times higher than in 1999. Results of upper layer soil analysis showed no contamination with other artificial radionuclide beside ^{137}Cs from Chernobyl. The same being true for the river Sava sediments downstream the discharge site. Results of radioactivity measurements in water wells and precipitation were under the detection levels, which were not quoted in the report.

3.4.3 EXPOSURE OF THE POPULATION

The same methodology was used for exposure evaluation of population as in the past. Only two exposure pathways were considered: external exposure due to ^{41}Ar immersion and ingestion of contaminated water. Due to lower releases compared with previous years the estimated annual effective doses to the population were exceptionally low.
There are no authorised dose limits for the operation of the research reactor (and also for the operation of the central low and intermediate level radioactive waste storage) thus the general limit for members of the public applies.
The external immersion dose due to releases of ^{41}Ar into the air was estimated to 0.024 microSv per year. The very conservative estimate of the ingestion dose (drinking of potentially contaminated river water) due to release of effluents into the Sava river gives 0.027 microSv per year. Thus the total dose received by the public was estimated to be less than 0.05% of the annual dose limit to the population.

3.5 RADIOACTIVITY MONITORING IN THE ENVIRONMENT OF THE CENTRAL LOW AND INTERIM STORAGE FOR L/IL RADIOACTIVE WASTE AT BRINJE

The radioactivity monitoring programme in the environment of the Central low and intermediate level radioactive waste storage at Brinje for the year 2000 was conceived in accordance with the Regulation on Radioactivity Monitoring in the Environment of Nuclear Facilities (Off. Gaz. SFRY, No. 51/86) and approved by the SNSA Decision No. 391-01/00-5-26546/MK on 10 November 2000.
The monitoring programme was carried out in somewhat lesser extent as in the previous year. Measurements of radioactivity were carried out by authorised technical support organisations, the Institute for Occupational Safety and the Jožef Stefan Institute (IJS).

3.5.1 SCOPE OF MONITORING

Measurements of releases at the source in order to enable impact assessment of the facilities:
- gaseous releases (radon progeny from the radioactive waste storage)
- releases of liquid effluents (radioactive isotopes in the common discharge water from the storage and the Dept. of Environmental Chemistry of the IJS.
- External radiation on the outdoor parts of the storage

Measurements of radioactivity in the environment in order to assess the impact of the facility or to identify the impact from the external polluters:
- liquids: radioactivity of precipitation and well water;
- external radiation: monitoring of dose rate levels with TLD at two control points;
- radioactive isotopes in soil near the storage and storage exhausts;
- radioactive isotopes in the Sava river sediment, upsteram and downstream the release point.

Measurements connected to emergency preparedness:
- in-situ gamma spectrometry near the storage facility

3.5.2 MONITORING RESULTS

The monitoring programme performed in the year 2000 showed that it is possible to distinguish the radiological impact to the environment and to the members of the public due to operation a single nuclear facility, namely the radioactive waste storage and the research reactor.

Emission measurements: The emission of ^{222}Rn was estimated to be 70-80 Bq/s depending on whether the ventilation in the storage is turned on or off. This amounts to a yearly release of 2.2 to 2.5 GBq. The average concentration of ^{222}Rn in the storage was about 6300 Bq/m^3. During the normal operation there are no liquid releases from the storage. (note*: The released activity with liquid effluents into the Sava river measured in 2000 by the J. Stefan Institute was 3-4 times higher than last year*). External radiation measurements at the entrance to the storage showed 0.44 microSv/h, dose rates on the exhausts were 0.14 and 0.16 microSv/h. Background radiation in the storage vicinity is roughly 0.10 microSv/h.

Measurements of environment: Additional ^{222}Rn concentration in the very vicinity of the storage was estimated based on emission measurements and the Gaussian dispersion model. Soil samples in the vicinity do not show presence of any radionuclides apart from ^{137}Cs from Chernobyl, naturally occurring ^{40}K and uranium and thorium decay chains. Reference measurements of external radiation were not given in the report.

3.5.3 EXPOSURE OF THE POPULATION

As the critical group of population the security officers of the JSI, doing their rounds around the storage facility, were chosen. Annual effective dose was conservatively estimated based on the following assumptions: staying 65 hours per year at the distance of 10 m from the storage facility. ^{222}Rn progeny inhalation and direct exposure to radiation from the storage were considered; immersion dose from ^{222}Rn daughters in the air was not taken into account, neither was the influence from the eventual liquid releases to the Sava river. Individual dose contributions from specific pathways were not given in the report. As for research reactor no authorised dose limits for the operation of the central LILW storage was establish by the competent authority and thus the limit for members of the public is applied. Total dose received by the member of the public (the above mentioned safety officer) is estimated to be 7 microSv/year which is less than 0.7% of the annual dose limit. Annual dose at the fence of the reactor centre site, received by the neighbourhood farmer (under the same assumptions of staying 65 hours per year), would be around 0.3 microSv.

3.5.4 CONCLUSIONS

The monitoring programme of the environmental radioactivity monitoring in the vicinity of the Central LILW storage facility at Brinje was not carried out completely in accordance with the current regulations and the decree of the SNSA. For the first time was performed the dose assessment due to ^{222}Rn releases to the environment and due to direct exposure from the radioactive waste storage. It was found that the effective dose received by the member of the public in the area affected by the LILW storage facility is likely higher than the effective dose due to releases originating from the research reactor operation.

Source: Radioactivity monitoring at the Central LILW storage in Brinje – Report for the year 2000, ARAO, num. ARAO T1511-3/3, march 2001

3.6 RADIOACTIVITY MONITORING IN THE ENVIRONMENT OF THE ZIROVSKI VRH MINE

INTRODUCTION

The former uranium mine at Žirovski vrh is situated at the small village of Todraž, in Northwest Slovenia, 35 km distant from Austrian and Italian borders and 30 km from Ljubljana, the capital. The mining area lies in the subalpine region of the country, in a deep valley with frequent temperature inversions (about 50% of time of the year). Some hundreds of people live in the area within a radius of 3 km from the facilities of the former mine and mill.

Relatively low grade ore was excavated and treated (less than 0.1 % U_3O_8) in the period 1985-1990. Radioactive wastes, such as chemical tailings of about 600,000 tonnes were deposited on the slope of a hill, about 100-150 m above the small and narrow valley of Todraščica. The waste rock deposit (1.5 million tonnes of mine waste rock, with the content of 70 ppm U_3O_8) and a temporary deposit of ten thousands tonnes of uranium ore are located near the bottom of the main valley of Brebovščica. Both sites are now under planning and restoration.

3.6.1. MONITORING PROGRAMME

The regular environment monitoring programme of environmental radioactivity has been running continuously for a decade and a half. It was established at the beginning of the yellow cake production (1985). The programme based mainly on US Regulatory Guide 4.14 (1980) and was approved by the competent regulatory authority. After cessation of mining and milling, during the current close-out period, the surveillance programme has been running continuously and only some minor changes in the programme scope were made.

The programme covers all the critical pathways and therefore comprises radioactivity measurements in air, i.e. concentrations of long-lived natural radionuclides of the uranium-radium decay chain in aerosols, measurements of radon and its short-lived progeny outdoors, and radioactivity measurements of surface waters, sediments and water biota, food and the fodder and in the soil, as well as measurements of the external gamma radiation. The area of monitoring extends in particular on the valleys and other inhabited areas in the vicinity of the mine and milling facilities, mostly up to a distance of 3 km. The reference measurements are also performed at remote sites outside the mine impact area and using these background data, the mine contribution to the radioactive contamination of the environment is estimated and exposure of the population is assessed.

In 2000, the monitoring was carried out by both technical support organisations for radiation protection, the Institute of Occupational Safety in co-operation with the Jožef Stefan Institute, both from Ljubljana.

3.6.2. RESULTS

During the operational phase of the mine and mill at Žirovski vrh, radioactivity of the environment in the nearby vicinity was considerably higher than at more distant locations. In the present phase of mine closure, a decline in the total emissions of radon and liquid effluents into the environment was observed, which brought up a partial decrease of radionuclide concentrations in individual media.

Air radioactivity - The difference in concentration levels was best noticeable in aerosols with *long-lived radionuclides*, which were determined by quarterly composite samples obtained by continuous sampling. Immediately after the cessation of ore exploitation these concentrations dropped almost to the normal environmental values. At the nearest villages (Todraž, and Gorenja Dobrava) the levels of uranium decreased to 0.006-0.019 mBq/ m^3. In spite of some inconsistencies in results, it is obvious that tailing pile at Boršt and waste rock pile at Jazbec do not represent a significant contribution to the local radioactive contamination with long-lived radioactivity in air.
The results for 2000 showed that the estimated increase in *radon* concentrations in the mine vicinity amounted to an average of 7.3 Bq/m^3 and was therefore similar to those in the previous years (the estimated contribution of the mine in 1990-95 was 7.7 Bq/m^3, in 1996 7.8 Bq/m^3, in 1997 7.0 Bq/m^3, in 1998 8.2 Bq/m^3, in 1999 7.8 Bq/m^3). The enhancement of radon concentrations was significant in the cold period of the year in stable meteorological conditions when the temperature inversions are more frequent and long lasting. Concentrations of outdoor radon in the densely settled Brebovščica valley are affected by emission from the low-altitude sources only (in particular from the Jazbec mine waste deposit and the outlet drainage channel below). The continuous measurements of radon progeny showed on low equilibrium factor of radon near emission sources, which was taken into account in the calculation of inhalation exposure. Usually maximum equilibrium-equivalent radon concentrations could reach the peak values up to 40 Bq/m^3 in the valley and can exceed the value of 100 Bq/m^3 within the disposal areas. Since the dispersion of radon into the valley is not very efficient due to the specific topographical and already mentioned meteorological characteristics of the site, as the consequence is that relatively high radon concentrations may be found along the valley, even as far as 3-4 km from the sources.

In 2000, the radioactivity of *surface waters* was similar to those from the previous year. The average annual concentration of ^{238}U in the Brebovščica stream, calculated on the basis of results in the monthly composite samples, was 157 Bq/m^3 (155 Bq/m^3 in 1999). The mean annual concentration of uranium in the Todraščica strea was found to be lower as in the previous period (1996: 128 Bq/m^3, 1997: 58 Bq/m^3 , 2000: 38 Bq/m^3). The average annual concentration of ^{226}Ra in the Brebovščica was 10.5 Bq/m^3 (8.1 Bq/m^3 in 1999) The concentration of ^{210}Pb increased considerably from the previous year (from 10 Bq/m^3 in 1999 up to 25.3 Bq/m^3 in 2000). The principal remaining sources of water pollution after the cessation of ore exploitation are the mine water, and drainage waters from the Jazbec mine waste deposit and the Boršt tailings pile. The discharge water with dissolved radioactivity from the Boršt tailings pile flows directly into the environment while suspended matter is retained in the settlings pond. This is the main reason why radium concentrations in the Todraščica stream, in particular in the dry season, are significantly higher than those in the Brebovščica stream. I*n sediments* the content of radionuclides of interest in surface waters remained 2 to 4 times lower than in the operational period 1985-90. The reduction of the contamination is supposed to be due to the soil covering of the tailings at Boršt. Sediments in the Sora river downstream the confluence with the Brebovščica stream showed an increase of the mass specific activity up to a factor of 2 for a single radionuclide.

The contents of the radionuclides ^{226}Ra and ^{210}Pb in *fish* contents in contaminated streams (Brebovščica)are higher than in reference surface water Selška Sora). Radioactivity levels in *agriculture products* are generally low in show great fluctuations, sometimes cannot be distinguished from samples collected at non-contaminated reference locations. Some fodder samples (grass) were taken at the source of contamination (i.e. at disposal area at Jazbec and Boršt);

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

After the cessation of ore exploitation, the *external gamma radiation* in the vicinity of the piles has varied according to the character of remedial works such as formation and consolidation of pile surfaces, taking materials from other sites to a common pile, partial covering of surfaces etc. In 1999 the external gamma radiation in the vicinity of the tailings pile at Boršt did not differ significantly from the values from previous years and at the Jazbec waste rock pile as well. Maximum values were measured at the north fence of the Boršt pile, up to 0.40 microGy/h.

3.6.3. POPULATION EXPOSURE

The impact of the mine releases extends over the area where about 250-300 inhabitants are living. Most of the local adult population is either farmers and craftsmen or workers employed at more remote places. In the estimation of effective dose to individuals from the reference group received from the former Žirovski vrh Uranium Mine sources, the following transfer pathways have been considered:

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

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

The dose assessment for adults in a population group in the surroundings of the mine, who received the highest annual doses, was made. Inhalation of radon and its progeny from the mine is the main factor of contribution to the exposure. The most exposed population are the inhabitants of Gorenja Dobrava, the settlement situated 1.3 km to the north of the mining and milling facilities. Based on thorough investigations of radon and radon progeny in the area, and considering meteorological parameters, it was found that this was the place with the highest equilibrium equivalent concentrations of radon originating from the uranium mine complex. In 2000, the exposure of the population was close to the values obtained in the previous years as well as to the values during operation of the mine.

Table 3.11 : Effective dose to the population in the vicinity of the Žirovski vrh Uranium Mine in 2000

Transfer Pathway	Detailed Description, Major Radionuclides	Annual Effective Dose (mSv)
Inhalation	- aerosols with long-lived radionuclides U, ^{226}Ra, ^{210}Pb	0.019
	- ^{222}Rn (gas)	0.005
	- short-lived radon progeny	0.235
Ingestion	- U, ^{226}Ra, ^{210}Pb, ^{230}Th in drinking water (surface waters, underground water)	(0.027)
	- fish (^{226}Ra, ^{210}Pb)	0.002
	- agricultural products and food (^{226}Ra and ^{210}Pb)	<0.07
External radiation	- gamma radiation of ^{222}Rn and its progeny (deposition, immersion)	0.002
	- gamma radiation of long-lived radionuclides (aerosols)	-
	- direct gamma radiation (vicinity of tailings piles)	0.002

Total annual effective dose in 2000(rounded) 0.34 mSv

The dose assessment was done for adult members of the public inside the broader critical group of population, receiving annually the highest additional exposure. These the inhabitants live in the settlement Gorenja Dobrava, located 1.3 km northern from the former of the former uranium mine and mill facilities. The highest contribution to the estimated dose belongs to inhalation of radon decay products.

3.6.4. CONCLUSIONS

The radioactivity measurements in the surroundings of the former uranium mine at Žirovski vrh showed that the cessation of uranium ore exploitation only partially reduced the impact of the radioactive sources, although the mine was closed almost ten years ago. Significant changes are not expected until the restoration of disposal sites with radioactive waste residues will be completed. Radon concentrations in the settled area in the surroundings of the mine have remained quite similar as in operational period, in spite of that the total radon emission considerably decreased. Radioactivity of surface waters slightly increased (concentrations of ^{226}Ra, ^{210}Pb) compared to results of the previous year.

The annual radiation exposure of the nearby population from the presence of the former uranium mine and mill (0.34 mSv) in 2000 is almost equal to the values obtained for the last years of the operational period of the mine. Radon sources remained the major sources of radioactive contamination of the environment; its decay products contribute at least with ¾ of the additional exposure. All other pathways like inhalation of long-lived radionuclides, water pathway, ingestion of local food and water and enhanced contribute less than 0.10 mSv per year.

The effective dose for adults represents one third of the current annual dose limit of 1 mSv, prescribed by the national regulations and by international recommendations (ICRP 90) and international basic safety standards (IAEA, EU). Taking into account the total population exposure from natural radiation in this area (5.5 mSv), the former uranium mining at Žirovski vrh still represents about 6 % of this value.

Source: Annual report on Implementation of Radiological Protection and Environmental Impact of the Žirovski vrh Mine, The Žirovski vrh Mine, April 2001

4.0 RADIOLOGICAL PROTECTION IN THE WORKING NVIRONMENT

4.1 THE REPORT BY THE HEALTH INSPECTORATE OF THE RS

4.1.1 INSPECTION OF NUCLEAR FACILITIES

The Health Inspectorate of the Republic od Slovenia (HIRS) surveys the nuclear facilities of the Krško Nuclear Power Plant (NPP), the Jozef Stefan Institute (JSI) with the TRIGA Reactor at Brinje near Ljubljana, and the Agency for Radwaste Management (ARAO) with the Storage for Intermediate and Low Level Radioactive Wastes at Brinje near Ljubljana. The Health Inspectorate carried out thirteen inspections and 4 technical surveys at the NPP. Two inspections were performed jointly with the Slovenian National Safety Agency (SNSA). At the Jozef Stefan Institute, the health inspector carried out four inspections (three at Brinje and one at Jamova street 39), and two inspections at ARAO (one at Zavratec and another one at Brinje). The principal goal of the inspections performed was to ascertain the state of protection of workers against the risk from ionizing radiation sources.

The inspections carried out at the NPP included the following areas: projects and steam generator replacement, training in radiological protection, facility for storage of old steam generators and their decontamination, operators training simulator, imports of nuclear fuels, reports on received radiation doses to workers, communal purification plant, preparations for outage works, records of radioactive sources, new personal dosemetres, sampling site for the Sava river near Brežice, transformer TP 4, parking ground, plateau of the decontamination facility, workshop for valves, progress of works during outage, use of Sodium-24 in evaporator tests, reasons for excessive doses during outage with regard to plans, »ALARA« reports, increased doses in April at the entrance to the NPP and near the cooling towers, radiological report on outage, transformer base GT 3, radioactive wastes and reorganization of technical operational units for radiological protection and chemistry.

Surveillance of the NPP was more frequent during outage works in the period from April to June. From the viewpoint of radiological protection, the health inspector found twice too high collective doses with regard to planned doses, particularly by the end of outage, the result of which was that the SNSA and HIRS requested a special radiological report which was discussed at the joint inspection meeting held last week of September. Four technical surveys were also carried out – of the steam generator building, the station at Brežice, the TP 4 transformer, the parking ground, the plateau of the decontamination facility, the workshop for valves, GT 3 transformer base, purification plant, and twelve approvals were given to decrees of the Ministry of the Environment and Spatial Planning for construction or use of facilities.

Inspections at the JSI – Reactor Infrastructure Centre (Brinje) dealt with the remediation of hot cells, the storage of radioactive wastes, the production of sodium-24 for NPP, Rules on radiological protection and production of radioactive elements from americum-241 for ionizing fire detectors. Deficiencies were detected twice – the newly produced radioactive wastes are stored in inappropriate places in the reactor hall or nearby the hot cells, for ARAO has not taken them over for storage at the same location. One inspection at the JSI (Jamova street 39) dealt with medical certificates, reports of medical examinations and records of radioactive sources, and a report on the remedial action on the interim radioactive wastes storage at Zavratec.

At ARAO, two inspections were carried out. The remedial actions on the interim storage at Zavratec were successfully completed in spring and the health inspector did not find any deficiencies. The inspection at ARAO – the storage for low and intermediate level radioactive wastes of the Republic of Slovenia at Brinje - showed again that the former manager of the JSI storage did not maintain its condition in accordance with regulations. Cracks, leakage and peeling off the concrete cover layer were detected, as well as unserviceability of a transport device, inadequate ventilation with regard to project requirements, incomplete records of radioactive sources – inaccurate location, activities, dimensions, and marks. The Institute for Occupational Safety (IOS) and ARAO have otherwise completed the list of stored sources during the inventory, yet the remediation plan and modernization of the storage, including new measurements, sorting and packing procedures, still have to be completed. Certain documents have not been submitted to the inspector – such as work procedures with ionizing radiation sources, tasks of the Radiation Protection Group, procedures to be followed in case of accidents and »ALARA« planning; consequently, a regulatory decree was issued, against which ARAO lodged a complaint. The proceedings are carried on by the Ministry of Health (MH).

4.1.2 INSPECTIONS IN MINES AND IN OTHER FACILITIES WITH THE RADON SOURCES

The HIRS, together with the authorized organizations, regularly surveys the Žirovski vrh Mine in Decommissioning (ŽVM), and periodically the Mežica Lead and Zinc Mine in Decommissioning (MLZM), the Cave of Postojna and other facilities with increased levels of radon and of its decay products.

At the ŽVM, three inspections and one technical survey in connection with dosimetry of the external and internal radiation were carried out, control of radioactivity in the environment, remedial works on the processing plant and pulling down of facilities, remedial works on the drainage tunnel under the Boršt site and other parts, and washing of contaminated clothes. A deficiency was established – the programme for monitoring the working environment, discharges and impacts on the environment during the performance of permanent cessation of uranium concentrate extraction – has not obtained in time the official approval from HIRS. Apart from radon releases from the tailing piles, no major radiological problems were noted at the Žirovski vrh Mine.

The shutdown works in the Mežica Lead and Zinc Mine (MLZM) are coming to an end, but they still take into account the requirements specified in the HIRS decision from 1995. From the report for 1999 it can be seen that workers from the MLZM received a radiation dose which amounted, on average, to approximately 5 mSv a year, and up to 22 mSv according to the methods from ICRP 32 recommendation. Four workers received doses exceeding 15 mSv. The measurements were carried out by the ŽVM in cooperation with the IOS.

The Cave of Postojna was monitored for the exposure of guides and other workers in the cave to radon progeny in the air. The radiological measurements were carried out by the JSI, and the medical examinations by the Institute for Occupational Safety of the Republic of Slovenia. In year 1999, the annual occupational exposure doses were estimated to be approximately around 6 mSv and not more than 20 mSv, according to the methods in ICRP 32 recommendation. Six workers received doses exceeding 15 mSv.

Additional measures were also necessary for the Slovenian Railways. In the offices of the Passenger Traffic Department in the building at Kurilniška 3, Ljubljana, the JSI assessed by measurements the radon level between 700 and 3300 Bq/m^3. On the basis of the findings of this inspection, a regulatory decree was issued (determination of exposure doses of workers, ventilation, detection of radon sources, medical examinations, remedial action, control measurements). The health examinations were carried out by the Institute of Occupational, Traffic and Sports Medicine, while occupational exposure doses were measured by the JSI. Annual doses in year 1999 for 28 employed persons were around 16 mSv on average, and not more than 26 mSv following the methods in ICRP 32. Twelve workers received doses exceeding 15 mSv. The measures prescribed in the decree were carried out and the control measurements have everywhere (except in the archives) shown in the end values below 200 Bq/m^3.

In connection with the radon problem in schools and kindergartens the JSI continued during winter 1999/2000 with radon concentration measurements at the most critical locations, where radon concentrations present in the previous period of measurements (1990-1998) exceeded 600 Bq/m^3. The HIRS provided funds for the programme of radon concentration measurements in 12 schools and in 15 kindergartens. The results of measurements have mostly confirmed the initial results. The established average levels were even higher than 1000 Bq/m^3 in five kindergartens and in one school. For directors of these institutions a conference was held again in June 2000, jointly with the JSI, at the Nuclear Training Centre at Brinje, at which they were acquainted with the radon problem, and where measures to be taken for reducing the radiation exposure of children and adults, were proposed. In year 2000, the health inspector carried out 15 inspections in the facilities with increased radon level and issued 11 regulatory decrees (VVZ Mladi rod in Ljubljana, Kindergarten Ribnica, ES Koroška Bela, ES Velika Dolina, VVZ Cerknica, ES Velike Lašče, Kindergarten Ivančna Gorica, Kindergarten Novo mesto, ES Radovljica, ES S. Jenko Kranj, ES Stična) and one decision permitting execution of the decree (ES Škofja Loka-Podlubnik).

4.1.3 INSPECTIONS IN MEDICAL INSTITUTIONS

Assessment of the present state

In year 2000 the HIRS paid most attention to the establishment of the existing state in the area of usage of various ionizing radiation sources in medicine. In this respect the greatest attention was paid to:

- the establishment of records of X-ray devices and periodical annual examinations of their quality,
- the prescription of procedures for the implementation of protection against ionizing radiation in the framework of good work practice, and
- the problems arising in the purchase of the devices and acquisition of usage licences.

According to the records of the HIRS, there were 684 X-ray devices in use in human and in veterinary medicine at the end of the year 2000. The distribution of the devices with regard to their intended purpose is presented in Table 1.

PURPOSE	Status in 1999	New	Writen-off	Status in 2000
DENTAL	330	24	14	340
DIAGNOSTIC	271	8	21	258

THERAPEUTIC	4	0	0	4
SIMULATOR	2	0	0	2
MAMMOGRAPHS	29	0	0	29
COMPUTER TOMOGRAPH CT	15	1	1	15
DENSITOMETRES	13	2	0	15
VETERINARY	20	1	0	21
TOTAL	685	35	36	684

Table 1: Number of X-ray devices in human and veterinary medicine as to their purpose.

In private medical organizations (239) 282 X-ray devices are in use, and 402 of them in public health organizations (103). More precise distribution of X-ray devices with regard to their ownership is illustrated in Table 2.

PURPOSE	Private out-patient clinics	Hospitals	Public health institutions	Total
DENTAL	232	4	104	340
DIAGNOSTIC	21	184	53	258
THERAPEUTIC	0	4	0	4
SIMULATOR	0	2	0	2
MAMMOGRAPHS	10	14	5	29
COMPUTER TOMOGRAPH CT	2	13	0	15
DENSITOMETRES	10	5	0	15
VETERINARY	7	0	14	21
TOTAL	282	226	176	684

Table 2: Number of X-ray devices in human and veterinary medicine with respect to their ownership.

In year 2000, the HIRS issued 54 usage licences for work with X-ray devices for new devices and for those requiring major repairs or replacement.

The IOS submitted 684 reports of examinations of X-ray devices. From these reports it can be seen that 25 (3.7%) devices were not inspected at all, 118 (17.2 %) devices did not satisfy the quality criteria, for 38 of them (5.6 %) a remedy of the deficiencies was proposed until the next annual inspection, while 503 (73.5 %) devices were without defects or had minor deficiencies not affecting the quality of the work performed.

35 inspections were carried out. On the basis of the findings of inspections, four decisions were issued prohibiting the use of an X-ray apparatus (Clinic of Gynecology, Clinical Institute of Radiology, General Hospital Celje (2), and two regulatory decrees (the Institute of Oncology for carrying out a proficiency test in protection against ionizing radiation, and the Department of Anaesthetics and Surgical Intensive Care of the University Medical Centre for delivery of documentation on the work with ionizing radiation sources) .

Departments and laboratories for nuclear medicine

Seven clinics or hospitals in Slovenia use unsealed radiation sources (radiopharmaceuticals) for diagnostics and therapy. These are: Medical Centre Ljubljana – Department of Nuclear Medicine (DNM), the Institute of Oncology and the general hospitals in Celje Maribor, Slovenj Gradec, Šempeter near Gorica and Izola. In year 2000 the health inspector carried out two inspections in these facilities.

At the Institute of Oncology there are under control, besides the unsealed radiation sources, also the sealed ones in the departments of teleradiotherapy and brachyradiotherapy. At the DNM the health inspector carried out one inspection during which he observed no particular deficiencies, except some invalid medical certificates. However, a special closed system for the retention of liquid radioactive effluents has not yet been established, although the decision was issued already in 1995.

In Celje, Maribor and at Šempeter near Gorica, IOS did not find any major deficiency during the examinations. Irregularities were observed in Izola (contamination) and Slovenj Gradec (contamination, worker's lack of adequate skills). The inspection was carried out only in Celje where minor shortcomings were found (invalid calibrations of radiation measuring devices, non optimal arrangement of the sanitary control point, poor air-conditioning system, old »gamma« camera, emergency procedures in case of accidents were not displayed at conspicuous places.

Organization of the system of responsible persons

Legal entities using ionizing radiation sources should have a qualified expertsresponsible for implementation of radiation protection against ionizing radiation (second paragraph of Article 23 of the Act on Ionizing Radiation Protection and on Special Safety Measures in the Use of Nuclear Energy -ZVISJE, Official Journal, No. 62/84). The professional qualifications of persons who may be engaged in services for ionizing radiation protection, are specified in Article 7 of the Regulation on education, health conditions and medical examinations for the personnel working with sources of ionizing radiation Z5 (Official Gazette of SFRY, No. 40/86).

On the basis of the discussion between the representatives of medical organizations and HIRS, the responsibilities for carrying out tasks in the field of ionizing radiation protection were defined. Short instructions for the successful execution of these tasks are given in the following chapters: legislation, obtaining licences, medical examinations, education and training, dosimetry, verification of quality of ionizing radiation sources, work, exposure of examined persons due to use of ionizing radiations sources, cooperation, cessation of use of an ionizing radiation source.

Exposure of population to doses from use of radiation sources in medicine

The activity of the European Commission in the area of protection against ionizing radiation is based on the contents of the »Euratom Treaty« which imposes the establishment of basic safety standards intended for protection against harmful impacts of ionizing radiation. Due to specific nature of health protection of individuals exposed to ionizing radiation in medical use, the safety standards from this field are laid down in a separate Directive 97/43/Euratom, also called »Medical Exposure Directive (MED)«; they summarize the instructions from the publication International Commission on Radiological Protection (ICRP) 73.

Diagnostic radiology represents by far the greatest contribution to radiological exposure of the population due to artificial ionizing radiation sources. Approximately 15 % of the total dose, received by average European, is the result of medical use of ionizing radiation. With the exception of natural radiation sources, almost 90 % of the collective dose is the result of radiological diagnostics.

In 2000 the HIRS, therefore, provided funds for the pilot project whose purpose is to incorporate patient personal dosimetry into various radiological examinations. The research study with title »Exposure of patients to radiation in the General Hospital of Slovenj Gradec due to standard X-ray examinations«, carried out by IOS, represents a trial for performing similar measurements at other radiological departments in Slovenia. In this way the HIRS would like to make its contribution to the establishement of uniform criteria for quality assessment of radiological examinations, which also includes the assessment of diagnostic reference levels at the national level. Diagnostic reference levels are one of the criteria for objective comparison of different diagnostic procedures, reflecting the state in a country and permitting the development of optimization procedures. The activity of HIRS surpasses in its contents merely formal compliance with the European Community legislation and is intended in the first place to improve the quality of radiological services in Slovenia, and for the well-being of all persons examined and patients.

4.1.4 INSPECTIONS IN INDUSTRY

X-ray devices, electron microscopes and accelerators

In the past year the control of the use of X-ray devices was intensified, which was possible due to the Central register of X-ray devices in industry, which has been compiled at HIRS since 1998, and in which the data on inspections and usage of the devices in industry (103) are kept. The register enables tracing of the life time of each individual device from its first use until its decommissioning; it also includes technical characteristics, as well as the name of the responsible person and the comments of authorized institutions on the inspection of the device. In Slovenia, two authorized institutions are in charge of the inspections of these devices, which are performed periodically each year or after each intervention in it which could change the safety conditions - i.e. the JSI and IOS which carries out about 90 % of all inspections. The HIRS received 96 reports on inspections of the devices; the inspections of two devices were not carried out and the procedure for obtaining the usage licence is under way now, while for 5 devices it should be checked whether the institutions still use them. For approximately 20% of them irregularities were established already during inspections, such as: use of the device without usage licence, insufficient training of personnel in relation to radiological protection, either of the responsible person or of workers working with sources, and the like. The health inspector carried out 12 inspections related to industrial X-ray devices. During the inspections it was also found out that there were some devices in organizations which were not in use, yet the HIRS was not notified of their status in the past; consequently, the number of devices recorded in the Central register of X-ray devices in industry is generally greater than the number of devices which are regularly annually inspected. According to the Slovenian legislation the user of a device should notify the authority which issued the usage licence within 15 days of the cessation of its use. Furthermore, it was established during inspections that the time which passes from filing in the application for issuance of usage licence and the purchase of the device is often a couple of years in some companies; during this time the companies which had imported the devices, use them without proper protective measures. Seven regulatory decrees and nine usage licences were issued.

In addition to the above mentioned sources, there are also two accelerators in Slovenia, both of them at the JSI; the Institute, however, uses only one (i.e. the Tandem accelerator with U = 2 MV) and approximately 10 electron microscopes, primarily in scientific institutions.

Sealed radiation sources

The HIRS also surveys users of sealed radiation sources in industrial plants and elsewhere. In a special list of 26 January 2000, a total of 96 work organizations or economic units are recorded, in which 567 sealed radiation sources were used for supervision of work processes, and 19 other organizations or laboratories which possessed above all low-level radiation sources for education, research or testing of the measuring devices. Ionizing fire detectors are recorded separately.

For industrial radiography with iridium, selenium, cobalt or caesium, 93 sources in total were recorded in 11 organizations. The number of the records of sources is now approximately twice the former number, as the containers or devices with depleted uranium for radiological protection and radiographic sources are kept separately. Lightning rods with europium or cobalt were installed on 13 facilities of 9 organizations. Thickness or density gauges in the processing of products, or switches of cable railways with 114 sealed sources, which contain americium, strontium, curium, ferrum, cobalt, caesium, thallium, promethium or krypton, were found in 31 organizations. There have been recorded 145 humidity and density metres of materials at road construction sites and at geological work sites, containing caesium as source of gamma rays, and americium and beryllium alloy as neutron source, in 22 organizations. There were in service 193 levels gauges for liquids, melts, free flowing and other substances in 23 organizations, in which cobalt, caesium or americium were used. There were also recorded 9 radioactive sources intended for other purposes.

Sealed low-level radiation sources have also been used in the education process of pupils of the grammar school Gimnazija Bežigrad and students of the Faculty of Physics and the Faculty of Medicine – the Institute of Biophysics; in the research work carried out at the Biotechnical Faculty (Department of wood science and technology) and in calibration or testing of the measuring devices at IOS, JSI (Department for low and medium energy physics, Department for experimental particle physics, Department for secondary standards, the »Milan Čopič« Nuclear Training Centre and the Radiation Protection Group), the Institute of Metallury, the Faculty of Geotechnology, SNSA and the Customs Administration of the RS. The Ministry of Defence uses tritium on the night-sightning systems, while Hermes Plus uses nickel in ionizing cells for mass spectrometres. The new Mikrohit has a licence for use of low activity tritium. Expo Ljubljana uses sodium for testing "gamma" cameras in nuclear medicine. In year 2000 one inspection was carried out at the Ministry of Defence at Todraž, where an irregularity was found because workers were repairing damaged sources without proper instructions and appropriate protective equipment. For this reason no approval was given for the construction permit for workshops.

In industrial plants four inspections were carried out in 2000 in relation to the use and storage of radioactive substances. The inspection at VIPAP Krško was necessary because six sources had to be replaced due to unreliable functioning of the level gauges. A decision on the removal of radioactive lightning rods and their transportation to the storage at Brinje was issued, and licence for the purchase and use of the new sources. Similar inspections, carried out in the companies Litostroj EI, Novoles in Pfleiderer Novoterm, have shown that their unusable sources were safely stored, yet a decision to remove and transport useless radioactive radiographic sources to the storage at Brinje was issued to Litostroj at its own request, and a proposal to Novoles that an authorized organization examines the source and issues a report on radiation measurement.

Regional health inspectors carried out 48 inspections in companies which were not examined by authorized organizations or whose records of stored sources were not complete. Despite the established irregularities in the majority of facilities, a decree was issued in 2000 only to Biotechnical Faculty for the removal and transport of unusable radioactive sources to the storage at Brinje. In year 2001 other administrative procedures for regulation of the situation are also going on.

The records of the ionizing fire detectors (IFD) are kept by the HIRS on the basis of the reports of authorized organizations which carry out regular annual inspections. These are: IOS, Institute for Occupational Safety Maribor (IOSM) and Varnost Maribor. Varnost Maribor surveys 4048 sources (35 reports), IOSM 505 (5 firms) and IOS 23,488 (351 reports). Ionizing fire detectors with americium are exchanged and stored by Iskra Sistemi Ljubljana (records of 1331 pieces are kept), Iskra Prins Ljubljana (about 1300 pieces) and Zarja Kamnik (180 pieces), until they are delivered to the storage for low and intermediate level radioactive wastes at Brinje. At the ŽVM 181 fire detectors are recorded, 23 in Thermal Power Plant Brestanica, and 18.264 fire detectors namely sources in storage at Brinje. Thus a total of 49,320 ionizing fire detectors are currently recorded in Slovenia.

Transport of radioactive materials

The records of road transporters who fulfilled in 2000 the prescribed conditions for transport of radioactive substances are no longer kept by the HIRS because with the validity of the new Act on Transport of Dangerous Goods (Official Journal of RS, No. 79/99) transporters do not need to apply for licences any more, if they satisfy the ADR requirements. Besides, the SNSA is sole competent for issuance of licences in agreement with the Ministry of Health. The Ministry of Health is responsible only for radiopharmaceuticals.

The transboundary transport of radioactive materials was organized by various import/export companies, of which the most important in radiopharmacy were Biomedis Maribor and Karanta Ljubljana. The others (Genos, Iris, JSI, Lek, NPP, IMP Ljubljana, Editrade, etc.) acquired licences for single transports. Important transit transporters were Biovit from Varaždin and Jasika from Zagreb, which transported every week radiopharmaceuticals to Croatian hospitals from the Sežana and Starod border-crossings or across Šentilj and Gruškovje.

In year 2000, the HIRS issued 70 licences for transport of radiopharmaceuticals (63 for imports, 6 for transit and 1 for export) and 83 approvals of licences for transport of other radioactive materials, issued by the SNSA (58 import, 3 transit, 2 export licences and 20 licences for internal transport in Slovenia). The transporters announced individual transports with regard to conditions in their licences at least 48 hours before their commencement to HIRS, SNSA and the Ministry of the Interior or the Police. The records of notifications show that in year 2000 there were registered altogether 393 single one-way transportations to border-crossings (285 for imports, 6 for exports and 102 for transit), while in the interior of the country 307 two-way inland transportations (to working sites and back to companies) were announced. The statistical data do not include transports by the majority of road construction companies which did not announce to HIRS the transportations of probes.

Transport of radioactive materials by rail is still not permitted, pending the fulfilment of all prescribed conditions (measuring instruments, qualifications, medical examinations). Air transports are limited according to the international requirements concerning transport of dangerous goods. Brnik airport fulfils all the prescribed conditions.

In year 2000, the health inspector carried out 3 inspections associated with the transport at the border crossing Sežana. For the last transport the refusal of the shipment because of its too high radioactivity level was proposed. The transporter Mr. Fekete (Black Family, Hungary) carried the ore containing zirconium silicate, which is rich in natural radioactive isotopes uranium, radium and thorium. After the acquisition of the relevant activity data it was found out that its concentration did not exceed 70 Bq/g and that no special licence was required.

This material may else represent a threat to workers in industry as a source of ionizing radiation. It is used in the manufacture of ceramic glazes. Zirconium silicate deposits are found in Australia and South Africa. It comes to Slovenia as fine sand intended for direct use. The manufacturers of this product did not give, as a rule, the data on radioisotope levels in the accompanying importation documentation. The representative of the enterprise Impol from Slovenska Bistrica found out on 29 March 2000, with manual dose rate metre, that a material with increased radioisotope level was present on the truck with shipment for Emo Kemija d.o.o. The analysis carried out by the JSI revealed that this was the isotope K-40. At the same time it was found that circonium silicate was present in the company Emo Kemija d.o.o., which the latter imports from Italy. In March 2000, an inspection was carried out on the basis of which the JSI prepared a proposal for the assessment of doses received. After obtaining from HIRS the approval of the programme, the analysis of workplaces was carried out in November 2000, whereas an inspection was performed again in November 2000. The results of analyses have not as yet been submitted to the HIRS.

Radiochemical and other laboratories

The HIRS also surveys the work of other laboratories with unsealed radiation sources where radioactivities are mostly about one thousand times lower than in hospital wards. The records of 23 laboratories in total are kept. In year 2000 no inspection was carried out in these laboratories. An authorized organization (JSI or IOS), which observed minor deficiencies in some, inspects them once a year.

4.1.5 RADIOACTIVITY IN THE LIVING ENVIRONMENT

The programme of radioactive contamination measurements, which is financed by the Ministry of Health, is intended for early detection of environmental contamination. It was introduced after the Chernobyl accident and consists of the control measurements which have the character of direct control of the degree of radioactive contamination, and of measurements of received daily and monthly doses from external gamma radiation. Radiological control of food of plant and animal origin, serving as the basis for the calculation of received doses due to ingestion, has been used for monitoring long-term trends in environmental contamination from artificial sources. The programme comprises the following measurements:

- rivers – withdrawal of two samples yearly from the Sava river near Ljubljana (Laze–Jevnica), the Drava river near Maribor, the Soča river below Anhovo and the Savinja river near Celje,
- air – daily sampling in Ljubljana, Jezersko and Predmeja,
- soil – samples of soil collected twice a year (in May and October) in three depth layers: 0-5 cm, 5-10 cm and 10-15 cm on grassland at locations in Ljubljana, Kobarid and Murska Sobota,
- precipitations – samples of solid and liquid precipitations were collected continuously in Ljubljana, Kobarid, Murska Sobota and Novo mesto,
- drinking water – semi-annual isotopic analyses of gamma emitters and specific analyses of Sr-90 and H-3 were made in Ljubljana, Celje, Maribor, Koper, Škofja loka and Kranj,
- food - the programme of activity concentrations in food samples of animal and plant origin comprises analysis of the content of gamma emitters and Sr-90 at locations in Ljubljana, Novo mesto, Koper, Celje, Murska Sobota and Maribor for food of plant origin, and at locations in Ljubljana, Murska Sobota, Novo mesto, Koper, Slovenj Gradec and Celje for food of animal origin,
- milk – sampling took place at locations in Ljubljana, Bohinjska Bistrica, Kobarid and Murska Sobota, and
- animal feed – measurements of grass, hay, feeds, manure and phosphates, particularly in the areas where milk is controlled.

On the basis of the average value of specific activities of long-lived fission radionuclides in air, water and food for year 2000, of average annual intake, and taking into accout the dose conversion factors (Basic Safety Standards), the expected effective dose was estimated. The contribution of Cs-137 (some nSv) and Sr-90 (some 10 nSv) to the inhalation dose of fission radionuclides was assessed. The contribution from inhalation is negligible in comparison to radiation doses transferred through other pathways (ingestion and external radiation). The annual dose due to ingestion has been estimated to 3.8 μSv (of which Sr-90 71%, and Cs-137 29 %). External radiation due to contamination of soil with Cs-137 represents the greatest contribution to global environmental contamination dose. The effective dose from external radiation in the past year was estimated to be 53.7 μSv. In year 2000 the total dose of an adult inhabitant, induced by general contamination of the environment with fission radionuclides, was estimated to 57.5 μSv.
Long-term trends indicate that the state of radioactive contamination of the environment is already at the level before the Chernobyl accident. The only exception is the external gamma radiation due to the presence of Cs-137 in the ground.
On the basis of measured radioactivity of living environment in the Republic of Slovenia in year 2000, the Institute for Occupational Safety and the Jozef Stefan Institute established that specific activities of artificial radionuclides in food and air are below 1 % limit values, prescribed by the Regulations on the maximum established limits for radioactive contamination of human environment and on decontamination.

4.1.6 DOSIMETRY OF WORKERS IN SLOVENIA

In the National programme of the RS for adoption of the EU acquis by the end of 2002, which the Republic of Slovenia issued in May 1999, it is stated in chapter Quality of Life and of Environment, Environment, that Slovenia will establish a new uniform computer system for maintaining records of received doses. In accordance with the above mentioned national programme and the envisaged complementation of the Central national dosimetric register, which began to take shape in April

1999, the HIRS started completing the aforesaid register in 2000. The latter should contain, in addition to cumulative doses, current doses from 1 January 2000 for external and internal workers in Slovenia, as well as internal and external doses until 1 January 2000. The health inspector carried out 24 inspections in the field of control of dosimetry of workers and compiling the Central national dosimetric register, i.e. 10 at the JSI (including supervision of the National Laboratory of Dosimetry Standards), 6 at the IOS, 4 in the NPP, 2 at ŽVM, 1 in the Mercury Mine Idrija in Decommissioning, and 1 at the Lead and Zinc Mine Mežica (MLZM). During these inspections technical and professional issues related to the entry of workers in the internal records of dosimetric services, problems of identification of external workers in Slovenia, quality assurance in dosimetric services, and transmission of data to HIRS were discussed. Given below are preliminary results of the analysis of effective doses for year 2000. These data show that that year 4526 persons in Slovenia worked with radiation sources; approximately 15 % were external workers, i.e. workers who were not permanently employed in individual organizations. According to the valid legislation the protection of external workers is the same as protection of workers with full-time employment (Regulations on dose limits which should not be exceeded in case of radiation to which the population and those working with ionizing radiation sources are exposed, on measurements of the degree of exposure of persons working with radiation sources, and on testing of the contamination in the working environment (Official Gazette of SFRY, No. 31/89, 63/89)). The table below illustrates the number of workers included in personal dosimetry in each individual year since 1994. Increase in the number of workers after the year 1994 is, above all, the consequence of better control of the use of radiation sources and not the result of an increase of activities related to ionizing radiation sources.

Year	**Number of registered persons working with radiation sources**
1994	2600
1995	3490
1996	3788
1997	4365
1998	4305
1999	4693
2000	4526

The table below presents the distribution of the number of workers with regard to individual activities performed in year 2000.

Activity	**Percentage of workers [%]**
Medicine	51.0
Reactor operation*	24.7
Industry	7.8
Mines	5.1
Workplaces with increased Rn-222 level (except mines)	4.6
Veterinary medicine	0.9
Other	5.9

*This datum is given jointly for the NPP and the TRIGA reactor.

The total collective effective dose amounts to 4.50 manSv. Approximately 24 % of this dose is the result of Rn – 222 inhalation at workplaces in mines and other workplaces with increased Rn - 222 levels. In this case all calculations related to the inhalation of Rn – 222 are made according to ICRP 65 methodology. The table below shows the distribution of received collective doses related to individual activity and the mean effective dose in relation to each activity.

Activity	**Share in the collective dose [%]**	**Mean dose [mSv]**
Medicine	16.1	0.31
Reactor operation *	57.8	2.29
Industry	1.9	0.42
Mines	6.2	1.19
Workplaces with increased Rn – 222 level (except mines)	17.3	3.69
Veterinary medicine	0.2	0.21
Other	0.5	0.08

*In year 2000 the replacement of the steam generators in the NPP took place.

According to legal limitation imposed to annual doses which are given in the above mentioned regulations, no worker received an annual dose above 50 mSv. One worker received an effective dose exceeding 30 mSv which could not be explained with wrong use of dosemetre. This worker was employed in industry. Doses in the ranges between 20 mSv and 30 mSv were received by 5 persons, of whom 4 in the NPP and 1 in industry. 45 persons received doses between 10 mSv and 20 mSv, and 172 workers doses in the range from 5 mSv to 10 mSv.

In relation to dose limitations in Council Directive 96/29/Euratom, 6 persons therefore received annual effective doses exceeding 20 mSv. Data on received doses on the skin and extremities are not systematically kept, whereas the Central national dosimetric register may simply be further completed with entry of the above data after the establishment of the aforesaid systematic control.

Criteria are based on the international standards given in CEI IEC (International Electrotechnical Commission) 1066 Thermoluminescence dosimetry systems for personal and environmental monitoring (1991-12) and the document EN 14851 Radiation Protection 73, 1994, EU. In addition to these documents the expert commission has also partly considered the recommendations by EU and USA (DOE standards) and long lasting experience in the management and inspection of dosimetric services. The commission is of the opinion that this protocol is a suitable basis for relevant regulations which will govern the work of dosimetric services, i.e. for performance of external and internal radiation measurements, and for Regulations on the registration of doses in Slovenia.

4.1.7 EDUCATION AND TRAINING

The professional qualifications of persons working with ionizing radiation sources are mainly in accordance with our out-of-date regulations. Training, advanced training and tests of competence are carried out by two authorized organizations (namely JSI and IOS). For improvement of conditions in the field of ionizing radiation protection and safety of radiation sources adequate education and training are of vital importance. Already by the end of 1999 the HIRS started recording and reviewing the existing training programmes which provide knowledge on radiological protection. This group includes undergraduate and postgraduate programmes at the

Faculty of Medicine, the University College of Health Care and the Faculty of Mathematics and Physics – Department of Physics. Included in this frame is also specialist training and education for professional examinations. Proposal were drawn up for certain fields which should, in our opinion, be added to the existing content and which should be incorporated in the training programmes.

4.1.8 MEDICAL EXAMINATIONS

Only persons fulfilling health conditions prescribed in the Regulation on education, health conditions and medical examinations for the personnel working with sources of ionizing radiation (Official Gazette of SFRY, No. 40/86) are permitted to work with ionizing radiation sources. The health examination includes an examination with a specialist in occupational, traffic and sports medicine, hematological and biochemical blood tests and urine analysis, ECG, examination of eye lens and determination of the share of structural chromosomal aberrations, where this is prescribed by the above Regulations. The authorized medical organizations carrying out the examinations are:

I - IOS, the Institute for Occupational Safety, Centre of Occupational Medicine;
II - Medical Centre Ljubljana, Institute of Occupational, Traffic and Sports Medicine, Centre of Health Protection against Ionizing Radiation Sources;
III – Health Centre Krško;
IV - OZG OE Health Centre Škofja Loka;
V - Aristotel d.o.o., Medical and Business Consulting.

In Table 3 is represented the number of performed health examinations of persons working with the ionizing radiation sources, or in the area of these sources, by activity, sex and authorized health organization which carried out the examinations.

Table 3.: Frequence of medical examinations performed in year 2000

Field of activity	I			II			III			IV			V			Σ
	Σ	M	Ž	Σ	M	Ž	Σ	M	Ž	Σ	M	Ž	Σ	M	Ž	
Health workers	1474	586	888	32	11	21										1506
Workers in industry	632	592	40	67	58	9	388	382	6				270	270	0	1357
Workers in mining	72	65	7	17	15	2				104	89	15				193
Workers in education and research	72	54	18	15	7	8										87
Total	2250	1297	953	131	91	40	388	382	6	104	89	15	270	270	0	3143

Of pathological results, the head of the Centre of Occupational Medicine with the Institute for Occupational Safety of the RS points out lens opacity in 25 % of the examined persons. In-depth monitoring and consistent use of personal protection equipment were advised.
Seven examined persons were appraised and ranged by medical institutions into a group of temporarily and permanently disabled for the proposed work. The others were assessed to be able to work, or able to work with temporal or actual limitations which were evident from individual medical certificates. In no case occupational genesis of a disease was suspected. Limitations to

work with ionizing radiation sources mean only a warning for consistent use of the proposed personal protection equipment and their control within the prescribed time limit, whereas other limitations do not reflect work with ionizing radiation sources.

4.1.9 CO-OPERATION

In 2000, the health inspectors took part in the following tasks, conferences and seminars:

- meeting of the IAEA technical committee to assure safety of radioactive sources and their control with presentation of the state in Slovenia;
- with the SNSA they conducted the beginning of the IAEA project with title ORPAS on the control of doses to persons working with ionizing radiation sources in Slovenia;
- they gave 24 lectures to approximately 800 participants in the training courses for health workers, organized by the Institute for Occupational Safety (IOS), which is as much as all lectures together in the past four years from 1996 to 1999;
- they gave lectures on radiological protection prescriptions in nine courses organized by the JSI - the Milan Čopič Nuclear Training Centre (ICJT);
- they gave two lectures on transport of radioactive substances (IOS);
- they gave lectures to customs and police officers on control of radioactive goods during transportation;
- they gave lectures on radon in the ICJT at Brinje to representatives of elementary schools and kindergartens;
- they actively participated in five sessions of the Nuclear Safety Expert Commission;
- they took part in the Commission on Radiological Protection, designated by the Ministry of Health in January 1999;
- discussions held with the Slovenian Association of Radiology, Chamber of Radiology and Chamber of Stomatology, and
- participation in the conference on evaluation of the health insurance card;
- they participated twice at the NPP as members of the examination boards of ICJT for radiological protection technicians,
- they trained physicians specializing in preventive medicine,
- they participated in the preparation of the following legal acts and executive regulations: Rules on conducting professional examinations for inspectors, Proposal for the strategy of natural radioactive waste management, Order on protective equipment, Tariffs of the Public Service for Radioactive Waste Management.

4.1.10 CONCLUSION

In year 2000, three inspectors from the Office of the Chief Health Inspector of the HIRS carried out 120 inspections in total. The share of the inspections during which deficiencies were found is on the level of average values from the previous years – i.e. slightly above 50 %. The regional inspectors performed 48 additional inspections in organizations storing unusable radioactive substances with the aim of updating the records and stimulating the transfer of sources to safer locations. The HIRS inspectors issued in total 47 licences for the purchase and use of radioactive substances, 63 licences for use of X-ray devices, 2 licences for use of accelerators, 70 licences for transport of radioactive materials, 83 approvals of licences for SNSA permits for the transport of radioactive materials, 30 orders with measures to remedy the deficiencies, 5 decisions prohibiting the use of radiation sources, and 1 decision for execution of the order.

The situation in the field of protection of the population and of the environment against ionizing radiation in year 2000 has improved again in comparison to the situation observed in 1999. Control of transport of radioactive substances has slightly weakened, but there were also no major domestic or international problems noted. The number of refused shipments of scrap iron on the border crossings with Italy has also greatly diminished. Surveillance of the facilities with increased radon levels remained at the same level. Surveillance of the radioactive substances in nuclear facilities and elsewhere has improved. Storage of old and useless radioactive sources still poses a problem. In year 2000 no regular professional inspections were carried out in 32 organizations containing radiation sources, so that the situation for about 120 sealed radiation sources has not yet been regulated in accordance with the valid regulations. To regulate this situation an additional inspector would be required who would cooperate more frequently with the SNSA, with authorized organizations (IOS, JSI), and ARAO. One of the reasons why the state was not improved in 2000, in comparison to the previous year, is also the problem of modernization of the store at Brinje.

Criteria for the implementation of thermoluminescence personal dosimetry, based on the international standards, have been elaborated. More experts are also required by HIRS in this field. The Central national dosimetric register - permitting users with basic knowledge of programming, and possessing an authorization to make various enquiries on persons or statistical analyses in connection with doses - has also been improved. Yet we need new rules and regulations which would control the execution of measurements, registration of doses and issuance of official documents on doses.

The proposed activities of the HIRS in the future shall be based on carrying on systematic inspections, particularly in medical organizations, and on determining the tasks and obligations of persons responsible for ionizing radiation protection. The European Community directives (EURATOM 97/43) require dose assessment in all radiological examinations in which ionizing radiation is used. Consequently, the pilot measurements which were carried out in the project »Exposure of patients to radiation in the General hospital of Slovenj Gradec due to standard X-ray examinations« should be continued.

Necessary measures should be taken for continuation and enlargement of current records on the sources and use of ionizing radiation and on exposure of the population and examined persons to ionizing radiation. Special emphasis should be placed on drafting the legislation in the field of use of ionizing radiation sources and protection against the harmful effects of ionizing radiation.

4.2. COMPUTERISED REGISTRATION SYSTEM OF OCCUPATIONAL EXPOSURE IN NUCLEAR FUEL CYCLE IN SLOVENIA

4.2.1 INTRODUCTION

In the early 1999 the SNSA started to develop a computerised registration system of occupational radiation exposure for workers in a nuclear fuel cycle (NFC) in Slovenia. Introduction of the NFC Register at the SNSA makes it possible to the authority to supervise all the data on individual and collective exposures, make statistical analyses and written reports from the occupational radiation exposure. At present the Register includes data of about 5000 persons, among them the data of approximately 1200 workers that are employed (or were employed) in facilities at the NFC in Slovenia and about 3800 outside workers that are (that were) engaged in maintenance work at NPP.

The legal basic for introduction of the Register of received doses is valid legislation of the Republic of Slovenia: Act on Radiation Protection and Safe Use of Nuclear Energy (Off. Gaz. SFRY No. 40/86) art. 65, Regulation on Records of Ionising Radiation Sources and on Exposures of Population and Workers (Off. Gaz. SFRY No. 40/86) art. 4, Act on compentences and working areas of ministries (Off. Gaz. RS No. 71/94). SNSA established the Register in accordance with the requirements from the EU directives – Number 96/29/EURATOM from 13 May 1996 and Number 90/641/EURATOM from 4 December 1990.
The LOTUS NOTES DOMINO is used as a basic software. Its advantage is the possibility to receive the data on occupational exposure in the original electronic form as it used at dosimetric services in Slovenia. An application named as the "NFC Register" permits that data are put into the Register by hand or automatically in an electronic way (e-mail, disk or web home page), independently from SW and HW used in dosimetric services (the Dosimetric Service at the Institute of the Occupational Safety (IOS), the Dosimetric Service at the "Jožef Stefan" Institute (JSI) and the Dosimetric Service at the Krško NPP). System is prepared in a way that owners of the data have as less as possible work in preparing them for the application.

4.2.2 THE DATA IN THE NFC DOSE REGISTER

The register is the fundamental data collection of received doses, personal data of workers and facilities data in nuclear fuel cycle. Into the NFC Register are included workers from the facilities in nuclear fuel cycle in Slovenia: the Krško nuclear power plant, the research reactor at Brinje (Ljubljana), the storage facility for low and intermediate level radioactive waste nearby and the uranium mine&mill at Žirovski vrh which is in the decommissioning phase.
Data on received doses include monthly dose, quarterly dose, dose received in the last year, dose received in last twelve months, dose received in last five years and the lifetime dose. (2) Personal data of workers include the identification number, first and second name, sex, date of birth, education, date of beginning of work with ionising radiation, differentiation if the worker is employee or contractor, the facility where the dose is (was) received, job classification, the employer, data on medical examination and the certificate on radiation protection exam. The data on external (gamma, neutrons) and internal exposure are recorded separately. There is a possibility to insert into the register the data on sort of dosimeters and the old series of previous data archived in paper documents. (3) Data on facilities include the facility name and sign, address, zip code, town, country, telephone number, fax number, e-mail and the way of transferring the data to the Register.

4.2.3 LOOKING THROUGH THE DATA IN THE NFC DOSE REGISTER

In the end of the 2000 some of the recorded dosimetric data (individual and collective doses) have been statistically evaluated by a software system and different written reports on received doses have been prepared.
Statistical review on individual`s received doses
Statistical view of the stored data make it possible to have a look through the whole history of occupational exposure of the individual worker – when and where he or she was exposed (a) according to workplaces and (b) according to workplaces after the years. In the end of the 2000 only the data existing in the electronic form were provided by the dosimetric services to the NFC

Register. That means the data from the Krško NPP have been available since 1985 to 1998 yearly and from 1999 to 2000 monthly, from Uranium Mine and Mill since 1995 to 1999, from Research Reactor at Jožef Stefan Institute since 1988 to 1999 monthly, from the SNSA since 1991 quarterly and the data on received doses for workers from the Agency for Radioactive Waste, working on interim storage for radwaste at Brinje and Zavratec, monthly since june 1999.
Statistical review on collective doses of workers according to employers

Statistical views on collective doses from register make immediate supervising on cumulative collective effective dose possible, annual collective effective dose on different sorts of work or activities separately on employers after years or employees on workplaces.

4.2.4 WRITTEN REPORTS

The application of the dose register makes it possible to prepare different written reports about data from the register. Currently, three most important kinds of written reports are available:
Report on received doses for an individual contains personal data and the whole history of worker′s exposure, separately lifetime dose, annual received dose, dose in last five years, dose received in the last year, last twelve months, last three months, last recorded dose, ... This report is requested upon getting permission for work in controlled area and should be submitted prior medical examination to the approved occupational health service. Data about the received dose in a certain period and cumulative dose of the worker and personal data are included.
Statistical report on received effective doses of workers in a single facility where annual distributions of effective doses in dose intervals for all the period of operation are presented
Special statistical report SNSA on received doses – general statistical view on received doses which comprises cumulative collective and average doses in the NFC facilities.
Beside the written reports, the application is able to present the data on received doses in graphic presentation according to the needs and interests of the user.

4.2.5 PROTECTION OF THE PERSONAL DATA

Protection of the personal data is ensured by the software which was elaborated in accordance with the Act on Protection of Personal Data (Off. Gaz. RS 8/90 and 19/91). Access to the NFC Register is possible only to authorised personnel at the SNSA. An authorised administrator and an authorised radiation protection officer of the application have the access to all the data in the data base system and to all parts of the NFC Register application.

4.2.6. Conclusions

Introduction of the NFC Register at the SNSA makes it possible to the authority to supervise all the data on individual and collective exposures, make statistical analyses and written reports from the occupational radiation exposure in nuclear fuel cycle in Slovenia. According to the EU directive 90/641/EURATOM requirements on equal radiation safety, it comprises the dosimetric data also for outside workers.
In the future quite big efforts will be needed to get the data on the whole history on occupational exposure in nuclear fuel cycle in Slovenia. Lots of the data are still archived only in paper/written forms and those data should be put into the register by hand.
With data included into the Register it is possible to prepare Personal Dosimetric Document for all workers and for contractors, too. Personal data and the whole history of worker′s exposure are included into this document.

The dosimetric data in the NFC Register are organised in a way that enables easy founding whatever information. The NFC Register application should be open (via internet, with password protection) to approved outside users under special conditions. This project makes possible quick transposition of the dosimetric data on the request/needs of international organisations.

4.3 REPORT BY THE INSTITUTE OF OCCUPATIONAL SAFETY (IOS)

In a year 2000 the Radiation protection department of Institute of Occupational Safety performed professional supervision of occupational radiation protection implementation and control of radioactive contamination of living environment within their authorisation.

- Supervision of practices that include use of ionizing radiation include regular professional control of ionizing radiation sources and procedures for their usage, monitoring of radiation at workplaces, monitoring of occupational exposures and training for safe work with sources or inside fields of ionizing radiation. In medical use professional supervision include also elements of radiological equipment quality checks with the emphasis on the equipment acceptability for their proposed usage. They restart monitoring pacient exposures during the medical radiological procedures within the pilot project, implemented in the General hospital Slovenj Gradec.

- Monitoring of radioactive contamination in the living environment was performed within following programmes:
  - monitoring of global radioactive contamination in the environment (regulation Z -1)
  - operational monitoring of radioactive contamination in the environment of the Krško NPP (regulation Z - 2)
  - operational monitoring of radioactive contamination in the vicinity of the Žirovski vrh Uranium mine (regulation Z - 2)

In addition, a study on radon and radon progeny concentrations in dwellings and outdoors at Kočevje site due to the former opeartion of local coal mine mine was carried out, supported by local community.

IOS reported regularly about the implementation of radiation protection measures in a working and living environment to the Health inspectorate of the Ministry of health, the competent regulatory body.

4.3.1 CONTROL OF RADIATION SOURCES

Within the regular professional supervision of ionizing radiation sources that are used in the medicine and industry 918 inspections was performed in a year 2000. Total number of sources in a register is not equal to the number of inspections carried out in one year, because some of them are not in use at the moment, some sources were inspected several times due to greater changes (services, essential parts changed…)
All reports on inspections are sent to the user and to the Health Inspectorate . The latter carried out an administrative control on application ionising radiation.

4.3.2 CONTROL OF RADIATION SOURCES IN MEDICINE

In medicine 651 inspections of ionising radiation sources were performed. Table 4.7 shows types of inspected sources and the number of corresponding inspections.

Table 4.7: Number of inspections of ionizing radiation sources

DIAGNOSTIC RADIOLOGY EQUIPMENT	
X-ray conventional units for imaging	126
X-ray units for imaging and/or diascopy	94
Mobile x-ray equipment for imaging or diascopy in a patient rooms or operation rooms	34
Mammography X-ray machines	27
Computer tomography	12
Bone densitometry	15
DENTAL RADIOGRAPHY	
Conventional X- rays	274
Dental tomography	43
RADIOTHERAPY	
X-ray machines for therapy simulation	2
Therapeutic X-ray machines	3
NUCLEAR MEDICINE and RESEARCH LABORATORIES	
Isotopic laboratories, that use open ionising radiation sources	21

In addition to this, 21 X-ray machines that are used in veterinary medicine were inspected as well.

Professional supervision of a ionizing source in medicine include occupational safety of workers and all other persons, that could come into a radiation field. During regular inspections of radiological equipment parameters, having an influence on patient exposure and the quality of result achived (mainly the quality of radiographic images) , are checked, predominantly due to patient radiation protection. By doing this mainly European criteria are followed [European Commission Criteria for Acceptability of radiological (including radiotherapy) and nuclear medicine installations, European Commission, Radiation Protection 91, Luxembourg, 1997] as the current legislation is obsolete and criteria in regulations are often useless . Regarding the quality of separate types of radiological equipment it is classified into some classes:

A. in operation , without defects
B. service needed
C. proposal for write-off
D. written-off in the current year
E. new equipment
F. equipment, currently not in use or out of order

This categorisation with separate classes which represents the status of radiological equipment is shown graphically on the next pages.

4.3.3. CONTROL OF RADIATION SOURCES IN INDUSTRY

Alltogether 246 different radiation sources were examined in industry. Table 4.8 presents number of sources checked by separate types.

Table 4.8 : Number of sources inspected by separate types

INDUSTRY	
Industrial X-rays	74
Defectoscope	8
Static electricity eliminator	2
Quantometers	15
Thickness gauges	8
Level gauges	49
Lightning rods	9
Density gauges	38
Density and humidity probes	43

4.3.4 EXPOSURE AT WORKPLACE

In a year 2000 exposures of alltogether 2866 persons , employed in about 630 organisations were controled by dosimetric service of the Institute of Occupational Safety.. Dose statistics by separate working fields and dose intervals are presented in two forms similar to last year presentation. In the first form, doses below the reporting limit (0,04 per month) are considered , in the second one these values are considered to be 0 mSv.
Reports on measured doses are sent : in written form to users and to the Health Inspectorate of RS in electronic form to allow filling the data into central state dose register that started to run in the year 2000.
As evident from tables all doses were below regulatory limit of 50 mSv in a year 2000, as well. Three persons had doses that exceed 20 mSv. In one case only the dosimeter was irradiated , the other two cases have not been explained yet

In order to provide a good quality of dosimetric services the IOS took part in two intercomparison runs in a year 2000 , namely:

- Intercomparisons of dosimeters for measuring doses of natural radiation in outside environment , that was organised by Environmental Measurements Laboratory of American Department of Energy and

- Intercomparisons of personal dosimeters that was organised by National Laboratory of Dosimetry Standards at Jozef Stefan Institute in Ljubljana.

Results of both intercomparisons will be known this year.

4.3.5 EXPOSURE OF PATIENTS

In a year 2000 the Health Inspectorate of Republic of Slovenia funded pilot research project for determination of patient exposure levels undergoing some common X-ray examinations. Project was performed in cooperation with the General Hospital Slovenj Gradec and National Laboratory of Dosimetry Standards at Jozef Stefan Institute in Ljubljana.
In table 4.9 results of entrance surface dose (ESD) measurements(mediana of measured values) and comparison with recommended reference diagnostic levels are presented. These were taken from European Commission Guidance on diagnostic reference levels (DRLs) for medical exposures, European Comission, (Radiation Protection 109, Luxembourg, 1999). In cases where values are missing IAEA recommendations (International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115-I, Vienna 1994) were considereed. In the last column the data on entrance surface doses measured within the of research work " Population exposure owing to medical use of ionizing radiation in Republic Slovenija" are shown..

Table 4.9: Entrance surface doses (ESD) and their comparison with recommended diagnostic reference levels.

Examination	ESD (mGy)	Reference level (mGy)	ESD_{1996} (mGy)
PC / PA	0,31	0,3	0,23
PC / LAT	0,48	1,5	0,84
LSH / AP	3,71	10	4,57
LSH / LAT	6,63	30	10,16
LSJ / LAT	8,49	40	15,30
TH/AP	0,99	3,5	3,70
TH/LAT	1,24	10	6,57
Skull PA	0,70	5	1,16
Skull LAT	1,10	3	1,17
Abdomen AP	2,41	5	2,78
Pelvis AP	1,67	10	3,42
CH / AP	0,66	-	1,37
CH / LAT	0,98	-	0,97

Pilot project was designed as starting phase of potential introduction of patient dosimetry as a regular praxis on the basis of this research work results and gained experiences. This is also a requirement of latest european legislation on radiation protection (European Union Council Directive 97/43/Euratom on Helath Protection of Individulas against the Dangers of Ionizing Radiation in Relation to Medical Exposure, Official Journal of the European Communities No. L180/22 – 29.9.07.97, 1997).

4.3.6 TRAINING

In a year 2000 Institute of Occupational Safety organised several seminars on training for safe work with ionizing radiation sources. Table 4.10 presents numbers of trainees by working fields.

Table 4.10 : Training for safe work with ionizing radiation sources

SEMINAR for	Number of participants
Radiologists (medical doctors)	41
Dentists	112
work with open sources	44
Radiologists (radiological engineers)	138
work in industry	135
Sometimes exptsed	487
work in uranium mine	8
Postgraduate students of Faculty of biology	11
Krško NPP personnel	11
Radiation protection officers	12
Workers of Institute of Oncology	126
Alltogether	**1125**

4.3.7 INSPECTION OF RADIATION SOURCES AND DOSES RECEIVED

Tables 4.11 to 4.16 presents occupational exposure in Slovenia. Meaning of abbreviations are:

DR Diagnostic radiology
ZR Stomatology – dental X-ray
NM Nuclear Medicine
I Industry
VET Veterinary Medicine
O Other
TR Radiotherapy

Table 4.11: Doses received. Doses below report limits are considered as 0.04 mSv.

Code of practice	Number of workers	Collective dose (manmSv)	Average dose (mSv)	Practice (UNSCEAR code)
DR	1708	1030,1	0,60	Diagnostic radiology(2000)
ZR	308	153,0	0,50	Stomatology – dental X-ray(2200)

NM	168	98,4	0,59	Nuclear medicine (2300)
I	359	274,0	0,76	Industriy (3200, 3700)
VET	43	23,0	0,53	Veterinary (6200)
O	280	170,0	0,61	Other (2400, 2500, 6300)
Skupaj	2866	1748,4	0,61	

Table 4.12 : Number of workers in separate dose intervals. Doses below reporting limit are considered as 0.04 mSv.

MSv	< 0.5	0.5 – 0.99	1.00-4.99	5.00-9.99	10.0-14.99	15.0-19.99	> 20
DR	1021	558	117	11	0	1	0
ZR	224	76	8	0	0	0	0
NM	98	45	25	0	0	0	0
I	279	49	27	2	0	0	2
VET	25	17	1	0	0	0	0
O	213	57	8	0	1	0	1

Table 4.13 : Collective dose by separate dose intervals (man mSv). Doses below reporting limits are considered as 0.04 mSv.

mSv	< 0.5	0.5 – 0.99	1.00-4.99	5.00-9.99	10.0-14.99	15.0-19.99	> 20
DR	390,1	351,4	198,8	72,7	0,0	17,3	0,0
ZR	93,9	46,0	13,1	0,0	0,0	0,0	0,0
NM	31,8	30,0	36,7	0,0	0,0	0,0	0,0
I	113,8	30,4	51,0	14,5	0,0	0,0	64,3
VET	11,0	10,8	1,2	0,0	0,0	0,0	0,0
O	65,2	31,8	13,5	0,0	11,4	0,0	48,0

Table 4.14 : received radiation doses. Doses below reporting limit are considered as 0.0 mSv.

Code of practice	Number of workers	Colective dose (manmSv)	Average dose (mSv)	Practice (UNSCEAR code)
DR	1708	527,8	0,31	Diagnostic radiology(2000)

ZR	308	46,4	0,15	Stomatology – dental X-ray(2200)
NM	168	60,5	0,36	Nuclear medicine (2300)
I	359	151,8	0,42	Industriy (3200, 3700)
VET	43	9,2	0,21	Veterinary (6200)
O	280	89,2	0,32	Other (2400, 2500, 6300)
Together	2866	884,9	0,31	

Table 4.15 : Number of workers in separate dose intervals. Doses below lreporting limit are considered as 0.0 mSv.

mSv	< LLD	LLD – 0.99	1.00-4.99	5.00-9.99	10.0-14.99	15.0-19.99	> 20
DR	650	948	98	11	0	1	0
ZR	149	153	6	0	0	0	0
NM	67	79	22	0	0	0	0
I	204	128	23	2	0	0	2
VET	10	32	1	0	0	0	0
O	158	113	7	0	1	0	1

Table 4.16 : Collective dose by separate dose intervals (man mSv). Doses below reporting limits are considered as 0.0 mSv.

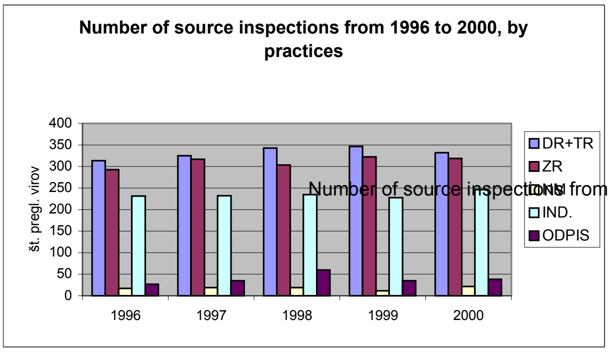
	< LLD	LLD – 0.99	1.00-4.99	5.00-9.99	10.0-14.99	15.0-19.99	> 20
DR	-	266,6	172,4	71,8	0,0	17,1	0,0
ZR	-	35,6	10,9	0,0	0,0	0,0	0,0
NM	-	27,8	32,6	0,0	0,0	0,0	0,0
I	-	29,3	44,4	14,5	0,0	0,0	63,7
VET	-	8,2	1,0	0,0	0,0	0,0	0,0
O	-	19,9	10,7	0,0	11,1	0,0	47,6

In table 4.17 and pictures 4.1 and 4.2 inspection number are presented from 1996 to 1999 and their classification by practices.

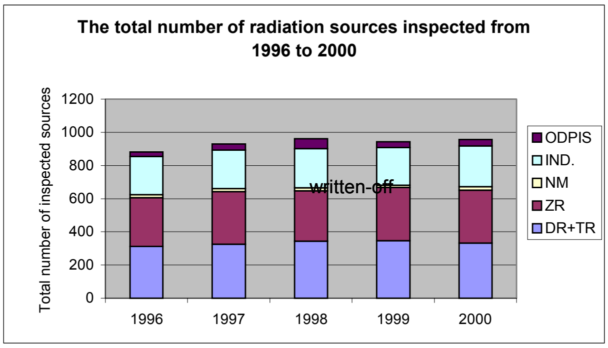
Table 4.17 : Number of source inspections from 1996 to 2000

	1996	1997	1998	1999	2000
DR+TR	313	325	343	346	332

ZR	293	317	304	322	319
NM	17	19	19	12	21
IND.	231	232	235	228	246
written-off	27	35	60	35	38
Total	881	928	961	943	956

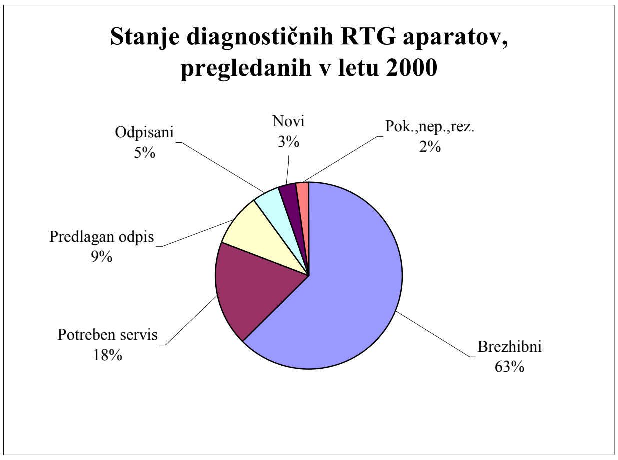


Picture 4.1 Number of source inspections from 1996 to 2000, by practices

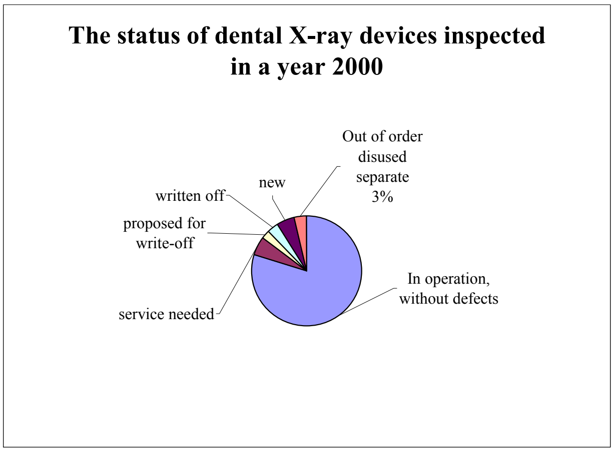


Picture 4.2: Total number of inspected sources from 1996 to 2000

The status of X-ray diagnostic devices is presented on picture 4.3 and dental X-ray devices on picture 4.4.



Picture 4.3: The status of diagnostic X-ray devices, inspected in a year 2000



Picture 4.4 : The status of dental devices, inspected in a year 2000.
Reference: Report of Institute of occupational Safety for the year 2000, june 2001.

5. RADIOACTIVE MATERIALS

5.1 TRANSPORT OF RADIOACTIVE AND NUCLEAR MATERIAL IN SLOVENIA

Storage, transport, safeguards of radioactive and nuclear material is regulated by the Act on Radiation and the Safe Use of Nuclear Energy. (Off. Gaz. of SFRY No. 62/1984) and Regulations based on above mentioned Act. Transport of dangerous goods is regulated by Act on transportation of dangerous goods-ZPNB (Off. Gaz. RS No. 79/99) which entered into force on 1. 1. 2000. ZPNB among others regulates also approval of packaging (art. 7), labeling of packaging (art. 8), inappropriate packaging (art. 9), measures in the event of spill of dangerous goods (art. 21), permit for transportation (art. 22) and safety measures (art. 35). Responsibilities for the transport of radioactive and nuclear material is assigned to the Minister for the environment and spatial planning.

Minister for the environment and spatial planning delegated to the director of the SNSA administrative responsibilities for the following:

- approval for packaging (art. 7),
- revoke of approval for packaging (art. 9),
- approval of location for temporary storage of contaminated substances (par. 3 of 21. art.)
- issue of permits for transportation (par. 3 of art. 22),
- approval of parking sites for vehicles transporting radioactive substances (par. 2 of art. 35).

The new act incorporates provisions of international conventions and agreements regulating the transport of dangerous goods.

The new act also incorporates requirements of the Recommendations of International Atomic Energy Agency - IAEA (Safety Standards Series No. 6, No. St -1, Regulations for the Safe Transport of Radioactive Material which was substituted by ST-1, 1996 edition).

The SNSA organized together with Ministry of interior, Health Inspectorate and Occupational Safety Institute, Ljubljana one day seminar with the aim to present laws and regulations which regulate transport of radioactive and nuclear material.

Experiences with transport of radioactive and nuclear material in Slovenia are connected with operation of the NPP Krsko and research reactor TRIGA; production of isotopes at the Josef Stefan Institute; use of radioactive isotopes in industry medicine and research.

SNSA issued licence for import of 32 fresh fuel elements from United States of America with maximal enrichment 4,35 %. On march the fuel arrived with ship to Port of Koper and from there by road transport to the NPP Krško.

Transport of radioactive substances, mostly sealed sources and open source radioisotopes were conveyed to meet need of hospitals (diagnostics/therapy), research institute and industry.

Due to the fact that subsidiary regulation on transport of dangerous goods entered into force few months Act on transportation of dangerous goods the SNSA in consent with Health inspectorate issued in year 2000 91 transport licences. After subsidiary regulation entered into force less licences were issued due to the fact that licences are needed only for transport over prescribed limits

The licences were issued to the following enterprises: IJS, LEK, SOL, Intercontinental, Karanta, Goričane, Nafta Lendava, Cinkarna Celje, Biomedis, M&K, Vipap Videm Krško, Janis, Cestno podjetje Maribor, Inštitut za metalne konstrukcije Ljubljana, IRIS, Fersped, Cestno podjetje Novo mesto, IMP Promont kontrolor ndt Črnuče, Genos, NE Krško, Resped, Sanolobor, Temat d.o.o. Mostly Ir-192, I-125, Co-60, Cs-137, S-35, P-32, Cr-51, Am-241, Ra-226, Se-75 sources were transported. The most common prescribed packages were excepted packages, and type A and B(U) packages. It was also performed transit to Croatia and Hungary. Transported isotopes were used for research purposes, in medicine for diagnostics, therapy, calibration of instruments and for the needs of industry to control processes and for drill hole logging.

5.2 Inspections according to the Act on transport of dangerous goods.

On November 13, 2000 and inspection of IMP PROMONT KONTROLOR NTD d.o.o., a license holder for non-destructive investigation including radiography, was carried out. The equipment, vehicles, records of radioactive sources, qualification of drivers, safety at work with radioactive material, dosimetry, physical protection and procedures were subject of inspection. No anomalies were found.

On December 12, 2000 was an inspection was performed at VIPA Videm Krško, a paper mill. The inspections examined records of radioactive sources, dosimetry, traffic and transport of radioactive sources, documents, procedures and physical protection. No anomalies were found.

5.3 Import and export of radioactive substances

In compliance with Decree on Import and Export of Specific Goods (Off.Gaz.RS;17/1999, 1/2000, 45/2000, 69/2000, 121/200, 4/2001, 15/2001 in 47/2001) Slovenian Nuclear Safety Administration is issuing licences for import fresh fuel elements and radioactive sources which need hospitals, research institutes and industry.

Slovenian Nuclear Safety Administration issued 137 licences in year 2000. 54 licences were issued for single import, 76 for multiple imports and 7 licences for export of radioactive substances.

The biggest importers in Slovenia are Biomedis, Karanta, Genos, Iris, NEK, Temat and IMP Promont Kontrolor ndt, d.o.o. Črnuče. The main imported radioisotopes were Ga-67, Kr-85, Sr-89, Y-90, In-111, I-125, I-131, Xe-133, Ir-192, Tl-201 and Tc-99m.

The imports for year 2000 by user are given in table (first and second part). The past imports of main isotopes are graphically presented in the diagram.

Slovenian enterprises (Tobačna Ljubljana, IMP Promont kontrolor ndt Črnuče, Biomedis, Temat d.o.o. and IRIS) exported or returned in y 2000 cumulatively 816 GBq of radioisotopes (Sr-90, Ir-192, Mo-99 and Am-241).

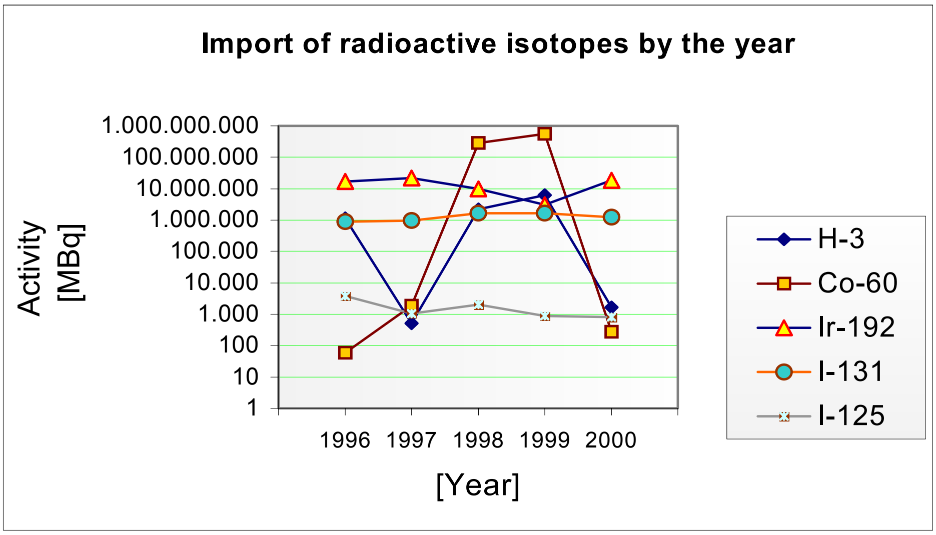

Import of radioactive isotopes by the year
Activity [MBq]
1.000.000.000
100.000.000
10.000.000
1.000.000
100.000
10.000
1.000
100
10
1
1996
1997
1998
1999
2000
[Year]
H-3
Co-60
Ir-192
I-131
I-125

Table 5.1: Import of radioactive isotopes in the year 2000- Part 1 (MBq)

User/Isotope	H-3	C-14	P-32	P-33	S-35	Cr-51	Fe-55	Fe-59	Co-57	Co57/Co58	Co-60	Ni-63	Ga-67	Kr-85	Sr-89	Sr-90	Y-90	In-111
ARAO																0,00044		
Biotehn. F. for zootechnik			46,25															
Hospital of Celje									1,18				1.025					296
Hospital of Maribor						1.147				0,48								488
Hospital of P. Držaja		3,7																
Boln. Slov. Gradec																		
Hospital of F. Derganc																		
Hospital of Izola																		
Cinkarna Celje																		
Faculty for veterinary																		
IJS			27,75													0,001		
IMP Montaža Maribor																		
IMP Promont Kontrolor																		
Industrie																		
Institute for biology-MBP		185																
KC IKKKB									37									
KC KNM, LJ.						444			740,52	4,57							2775	3897
Kemical. Institute of Lj.					74													
Lek								259				611						
M&K Laboratory d.o.o.																		
MF Institute of anatomy																		
MF Institute of biochemy	965,7	0,74	370	17	22,2													
MF Institute of farmacology																		
MF Institute of microbiology	185																	
MF Institute of patalogy	37		83,25		83,25													
NPP Krsko																		
Oncological Institute of LJ.									925				11890		1036			3609
Pivovarna Laško																		
SŽ Devices and equipment, Ravne																		
Tara d.o.o.																		
Temat d.o.o. Sl. Bistr.																		
Termo elect. PP Brestanica																		
Termo elect. PP Brestanica																		
Termo elect. PP Šoštanj																		
Tobačna Ljubljana																740		
Videm Krško							3700				277			14800				
ZZTK, LJ.	444					111												
ZZVD, LJ.																		
Total 2000	1631,7	189,440	527,250	17	179,45	1702	3700	259	1703,70	5,05	277	611	12915	14800	1036	740,001	2775	8290

Tabela 5.1: Import of radioactive isotopes in the year 2000-2.part (MBq)

User/Isotope	Te-123	I-125	I-131	Xe-133	Cs-137	Sm-153	Re-186	Ir-192	Tl-201	Hg-203	Am-241	Tc-99m	mix. Stand
ARAO					0,37						0,000148		
Biotehn. F. for zootechnik													
Hospital of Celje		86,66	84804				1.425		111			867150	
Hospital of Maribor		20,04	51134			2200	11400		28360,5			817900	
Hospital of P. Držaja													
Boln. Slov. Gradec		22,91	19795									12500	
Hospital of F. Derganc												202500	
Hospital of Izola		27,17										91590	
Cinkarna Celje					2220								
Faculty for veterinary		4											
IJS		222								114,8			1,6
IMP Montaža Maribor								2300000					
IMP Promont Kontrolor								2300000					
Industrie								5400000					
Institute for biology-MBP													
KC IKKKB		40,79											
KC KNM, LJ.	555	392,92	555.058	188.700					551			850.000	0,185
Kemical. Institute of Lj.													
Lek													
M&K Laboratory d.o.o.								2300000					
MF Institute of anatomy													
MF Institute of biochemy													
MF Institute of farmacology		0,37											
MF Institute of microbiology		0,53											
MF Institute of patalogy													
NPP Krsko				3700									53,7
Oncological Institute of LJ.		2,96	500279					45360	85			685000	
Pivovarna Laško											3340		
SŽ Devices and equipment, Ravne								2146			0		
Tara d.o.o.											1670		
Temat d.o.o. Sl. Bistr.								6117146					
Termo elect. PP Brestanica											0,481		
Termo elect. PP Brestanica											0,37		
Termo elect. PP Šoštanj					15540								
Tobačna Ljubljana													
Videm Krško													
ZZTK, LJ.													
ZZVD, LJ.					185000								0,01
Total 2000	555	820,35	1211070	192400	202760	2200	12825	18464652	29107,5	114,8	5010,851	3526640	55,50

5.4 NUCLEAR NON-PROLIFERATION

5.4.1 PROTOCOL ADDITIONAL TO SAFEGUARD AGREEMENT

International legally binding instruments for safeguard of nuclear material were additional strengthened by Protocol Additional to Safeguards Agreement. Until end of 2000 the Protocol was signed by 55 countries out of which 19 has ratified it. Among signatories are all 15 EU Member-states.

Additional Protocol was on behalf of Republic of Slovenia signed by the director of SNSA, Miroslav Gregorič on 16. 7. 1998. It was ratified by Parliament in year 2000. It was published in the official gazette as "Zakon o ratifikaciji dodatnega protokola k Sporazumu med Republiko Slovenijo in Mednarodno agencijo za atomsko energijo o varovanju v zvezi s pogodbo o neširjenju jedrskega orožja (MAEVPN) - Official Gazette RS-MP No.: 18/2000 (RS 71/2000).

Protocol entered into force on August 22. 2000. SNSA prepared report that will be submitted to IAEA in year 2001

5.4.2 COMPREHENSIVE NUCLEAR TEST-BAN TREATY

Additional effort in strengthening nuclear non-proliferation is the Comprehensive Nuclear Test-Ban Treaty (CTBT). CTBT is signed by 160 countries out of which 76 has ratified it. Out of 44 countries that are needed for its entry into force only 31 has signed and ratified. Slovenia has signed CTBT in 1996 and ratified it in 1999. Procedures for its ratification were prepared Ministry of Foreign Affairs and SNSA. The SNSA is informing about the activities of the CTBTO the following organisations: Geophysical Survey, Jožef Stefan Institute, and Institute of Occupational Safety.

5.4.3 EXPORT CONTROL OF DUAL USE GOODS

In parallel with global efforts for nuclear non-proliferation two additional international organisation are dealing with restriction of trade with goods that may be used for production of nuclear explosive devices. The firs such organisation is the Zangger Committee, which is interpreting article 3.2 of NPT which provisions are restricting trade with equipment or material especially designed or prepared for use in nuclear industry. The second international organisation setting restrictions and conditions for export of goods that may be used in production of nuclear weapon is the Nuclear Suppliers Group, NSG. This organisation extended export control on so called dual use goods. The list of goods that are subject of export control under NSG is included in legislation of EC (Council Regulation (EC) No 3381/94 of 19 December 1994 setting up a Community regime for the control of exports of dual-use goods). With this legal document the European Union established a uniform regime for export control that covers all goods that may be used for production of weapons for mass destruction.

Adoption of equivalent legal instrument in the Republic of Slovenia was carried out in the scope of preparation for accession to European Union. In Slovenia this law was prepared by Ministry of Economic Affairs in co-operation with other relevant ministries. The SNSA co-operated in revision of the document and in preparation of provisions that are relevant to nuclear non-proliferation. The Law on Export of Dual-use Goods (Off. Gazz. RS, No.: 31/2000) and relevant subsidiary legislation facilitated the membership of Slovenia in Zangger committee in spring 2000 and in NSG in fall 2000. SNSA, together with Ministry for foreign Affairs co-ordinates and conveys activities pertinent to membership in this organisations.

5.4.4 NUCLEAR SAFEGUARDS IN REPUBLIC OF SLOVENIA

The nuclear material that is subject to safeguards are in only possession of NPP Krško and in Reactor centre of Jožef Stefan Institute. The nuclear material is confined in both cases in nuclear fuel assemblies. Only the NPP Krško is possessing less than g quantity of highly enriched uranium in sensing instrument. In the NPP Krško the nuclear material is under IAEA surveillance with cameras and seals. There were seven IAEA inspections at the NPP Krško in year 2000. No anomalies were reported. In y 2000 the identity of fuel assemblies was verified by SFAT (Spent Fuel Attribute Tester). The advanced notification on receipt of fresh fuel for NE Krško and inventory change were sent to IAEA in compliance with Safeguard Agreement.

Because of small amount of nuclear material the IAEA routine inspections of Reactor centre of Jožef Stefan Institute are being carried out in four year intervals. The last such inspection was performed in 1998. Exceptionally an additional inspection was carried out in june 1999 because of return of spent fuel to USA.

SNSA start to investigate the inventory of nuclear material at potential small holders. The purpose of investigation is to check if the reporting to IAEA is in compliance with provision of Safeguard Agreement.

5.5 PHYSICAL PROTECTION OF NUCLEAR MATERIALS

Physical protection of nuclear facilities NPP Krško, research reactor TRIGA at Brinje and nuclear material is being conveyed in respect of regulation. The regulatory matters are carried out in good co-operation between Ministry of Internal Affairs (MIA) and SNSA. The system for physical protection of NPP is controlled regularly by SNSA inspectors and MIA personnel. Issuing the permits for construction of object within or in the vicinity of controlled area or their refurbishment (construction of transformation station, refurbishment of main entry pint), the SNSA appropriately considered also a physical protection measures.

The NPP Krško informed responsible authorities about intention to modernise or replace the ageing components for technical system for physical protection. NPP Krško prepared presentation of planed modernisation and on the request of MIA and SNSA submitted for review document Design Basis for modernisation. Modernisation is of such nature that will preserve and partially improved the existing performances of physical protection system. The plans produced on the basis of the document Design Basis will be submitted to responsible authorities for review and approval.

The physical protection of nuclear material at the research reactor TRIGA at Brinje was strengthened by direct transfer of alarm to Police. After initial problems associated with nuisance alarms the system functions satisfactory.

The Commission for physical protection of nuclear facilities that was established at the at the MIA, has prepared on the basis of information received from Police, state intelligence services, SNSA and operators of Nuclear facilities the updated design basis threat. The design basis threat was issued by the director of Police.

6. DISPOSAL OF RADWASTE

6.1 PUBLIC SERVICE FOR RADIOACTIVE WASTE MANAGEMENT

In 1999, Slovenian Government issued a Decree on Mode Subject and Terms of Performing Public Service of dealing with radwaste (Decree), that is governing the radwaste management generated by small producers. According to Decree the mandate for public service for radwaste management is given to the Agency for Radwaste Management.

Based on the Decree, the Slovenian Government issued a price list for public services related to radioactive waste management in November 2000, by which the principle "polluter pay" is partially introduced. With payment for public service, all responsibilities related to final disposal and costs for final disposal of radioactive waste are transferred to the Agency for Radwaste Management.

The deadline for full function of public service was May 2000. Due to delays in refurbishment of the Central Interim Storage for Radioactive Waste at Brinje, public service is not in function with exception of few emergency cases. Small producers of radwaste have shown a great interest for utilisation of the public service.

6.2 STRATEGY ON LOW AND INTERMEDIATE LEVEL RADIOACTIVE WASTE MANAGEMENT

Besides the strategy on spent fuel management, that was adopted by Slovenian Government in 1996, the Strategy on low and intermediate level waste (LILW) management shall be one of the key documents in the area of radioactive waste management.

In year 2000, the Agency for Radwaste Management prepared document "Proposal of the strategy on low and intermediate level waste management" and submitted it to the Government for approval. The Strategy defines the necessary long-term goals in the area of LILW management and among others provides information on current situation, projection on LILW generation, possible solutions for long term LILW management, comparison with LILW management in other counties and the proposal of permanent solution for LILW management in Slovenia.

The strategy is proposing the construction of repository for disposal of all short lived LILW as the most rational and sound final solution for the LILW management.

The Proposal of the strategy on low and intermediate level waste management is at present subject of inter-ministerial harmonisation.

6.3 STRATEGY ON NUCLEAR SPENT FUEL MANAGEMENT

"Strategy on nuclear spent fuel management" (Strategy), was adopted by Slovenian Government in the year 1996. This strategy does not provide final solution for spent fuel management therefore, deferred decision was proposed as a temporary solution. Meanwhile, necessary measures shall be taken either to increase the spent fuel pool capacity at Krško NPP or to examine the option for a dry storage. Decision on final solution for disposal of spent full is postponed until 2020; the construction (commissioning) of a final disposal site should be accomplished by 2050 or even beyond. The Strategy that was prepared on the basis of present experiences and foreign practices will be revised every three years. Until now, the revision has not been accomplished.

6.4 CONSTRUCTION OF LOW AND INTERMEDIATE LEVEL WASTE DISPOSAL FACILITY

Since unsuccessful first campaign for selection of site for LILW disposal facility, the Agency for Radwaste Management resuming activities for site selection. According to the working plan of the Agency for Radwaste Management and proposed "Strategy on low and intermediate level waste management", the goal is to obtain few tens of potential sites by 2001-2002; the site should be selected and approved by 2005. A final disposal should be constructed in the period between 2007 and 2010.

For this purpose the Agency for Radwaste Management carried out following activities:

- preparation of input into the Spatial Plan of Slovenia for the period until 2020;
- preparations of terms for introduction of mediator into the process of site selection;
- preparation of spatial data to for evaluation of the whole area of Slovenia;
- evaluation of an area on the basis of geological and hydro-geological parameters;
- preliminary evaluation of site characteristics for generic surfacial and underground repository using draft designs produced in 1999.

6.5. REVISION OF THE DECOMMISSIONING PLAN FOR NPP KRŠKO

Based on provisions of Act on Fund for Financing the Decommissioning of the Krško NPP and on Radioactive Waste Disposal from the Krško NPP, the Ministry of Economy prepared in 1996 The Decommissioning plan for the Krško NPP, in which decommissioning alternatives and needed financial resources are presented. By the Decommissioning plan it is required to revise it every three to five years. The revisions should evaluate all inputs and to consider all new developments as the basis for new estimation of needed financial resources for decommission and for assessment of levy per kWh of electricity produced by the Krško NPP.

In the scope of preparation for revision of The Decommissioning plan, three experts visited Slovenia in September 2000 through the IAEA technical assistance. They reviewed The Decommissioning plan and provided recommendations for its revision. Based on recommendations, the Ministry of Economy shall prepare the terms of reference for revision which preparation should start in 2001.

7.0 EMERGENCY PREPAREDNESS

7.1 ADMINISTRATION FOR CIVIL PROTECTION AND DISASTER RELIEF OF THE RS

In 2000 the Administration for Civil Protection and Disaster Relief of the RS (ACDPR) in the field of nuclear emergency preparedness continued with the efforts for the efficient response on the state level. The focus was on the completion of the national nuclear emergency response plan (the state plan), establishing and equipping the protection and rescue units and co-operation in the international projects.

7.1.1 NUCLEAR EMERGENCY PLANNING

In the area of planning the finalisation of annexes and supplements was under way in order to assure the operability of the state plan. Special effort was devoted to the regional emergency response plan for the Posavje region. The Government has appointed the »Working group on co-ordination and maintenance of the state nuclear emergency response plan«. The group comprises representatives of planning authorities and nuclear and radiation experts. The goals of the group are to assist in amending and maintenance of the state plan providing the interfaces to the local and regional plans. One of the main problems in planning and response was the inactivity of particular ministries and other state institutions, which are responsible for the preparation of emergency plans.

7.1.2 ORGANISATION AND EQUIPMENT OF THE CIVIL PROTECTION TEAMS

In all 13 regions in Slovenia the ABC units were established. These teams have the status of national teams. Each unit comprises 9 members, mostly with the high school or B. S. in chemistry. The members received basic and advanced training in the Training Centre for Civil Protection and Disaster Relief .

All teams have vans, adapted for the transport of equipment and 6 persons. Members of the unit have the following equipment: 3 autonomous breathing apparatuses with spare bottles, 6 coveralls for ABC protection, radiation detector SSM-1 and detector for contamination monitoring of foodstuff and water LMS-1, PC, GPS, sampling equipment, labelling equipment and other. All team members have personal protection equipment, the team leaders are equipped with personal monitor »Rados RAD50«. For training purposes all teams have adaptor for radiation detector SSM-1, which transforms radio signal into electrical signal, when the radiation source is simulated by special radio transmitter.

In 2000 the decision was taken on purchasing the radiation probe for radiation detector SSM-1 suitable for use in vehicles (cars, helicopters), meteorological set and decontamination set, thus meeting the requirements stipulated by Regulation on organisation, training and equipment of protection and rescue units.

The ACPDRS lent to the Institute of Occupational Safety three LMS-1 detectors which are used for the contamination monitoring of mushrooms. In return for that the the Institute of Occupational Safety provides calibration of detectors and training of the team members for free.

In 2000 the staff of the state ABC decontamination unit was completed. 18 volunteer civil protection members became members of this unit. The team has protective equipment, decontamination unit with selfinflatable tent, 6 showers and electrical lighting, high pressure compressor, spray unit with decontaminants, pool for clean and contaminated water, water collector, decontamination unit for vehicles, electrical power supply and electrical heater. In 2000 the team was familiarized with the equipment, in 2001 it will be fully trained to work with it.

7.1.3 EDUCATION AND TRAINING OF THE CIVIL PROTECTION TEAMS

Regular training is conducted by the Training Centre for Civil Protection and Disaster Relief. In 2000 there were 771 persons trained in different fields in relation with nuclear and radiation accidents. The training and number of participants is depicted below:

Training	**Number of participants**
Leaders of intervention (ABC)	12
Additional training (ABC) – for regions	50
Introductory and basic (ABC) – for municipalities	22
Introductory and basic (ABC) – for companies	6
Use of autonomous breathing apparatus	29
Use of autonomous breathing apparatus*	337
Use of autonomous breathing apparatus – practical exercises	155
Hazardous materials	90
Hazardous materials – refresher*	30

* training by the program of the Firefighting Association of Slovenia

The members of the ACPDRS took part also in the training in the framework of "OSEP" programme in Trnava, Slovakia (see chapter 9.4.2).

7.2 SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

In 2000 the SNSA continued with the activities to strengthen its capacity in the field of emergency preparedness and to promote its expertise in this field, assure implementation of international standards and to stimulate the other institutions to put more effort in the tasks in relation with the emergency preparedness.

7.2.1 THE SNSA EMERGENCY PLAN

In case of an emergency the SNSA activates the internal emergency plan (EP), which stipulates the notification of the staff and organisational structure of the SNSA during an emergency. The EP provides each member of the emergency organisation with the instructions on describing how to accomplish the task. The EP includes, besides the instructions, also the documents on training and equipment lists. In 2000 the 11 procedures were revised, three of them were written from scratch (tasks of the SNSA on-duty officer, tasks of the on-duty radiological monitoring officer, operation and use of automatic radiological monitoring system).

The EP procedures cover the following six chapters:
- internal organisation and responsibilities,
- notification and activation of the staff (especially experts from other organisations),
- accident assessment (instructions for the expert groups),
- informing of the domestic and foreign public,
- instructions for operation of equipment (computers, communication and other),
- maintenance of preparedness.

All administrative tasks of the SNSA during an emergency are managed by three expert groups, which mostly comprise the staff members of the SNSA strengthened with the members of the technical support organisations. These three groups are:
- expert group for accident analysis,
- expert group for dose assessment,
- expert group for technical support and public information.

In May 2000 the job of the on-duty radiological monitoring officer was started. His/her duty is daily surveillance of the automatic radiological monitoring system operation, and in case of an emergency, he/she assists the SNSA on-duty officer in notification the staff and outside experts.

In 2000 the display of the sattelite image from the »Meteosat« sattelite was restored. This image has not been displayed for some period due to technical malfunction.

7.2.2 THE EXERCISE »NEK-2000«

On 12th December 2000 the nuclear emergency exercise »NEK-2000« took place. During the exercise the emergency preparedness organisation on local and state level was tested. The participants in the exercise were: the Krško NPP, the SNSA, the ACPDRS and the regional civil protection headquarters.

The scenario of the exercise assumed a small radioactive release in order to test the protection action planning more realistically. For the first time during an exercise the nuclear power plant simulator was used. The simulator produced the data necessary for the simulation of the emergency. Other participants received these data via various communication means. The »Emergency Off-site Facility« of the Krško NPP was activated as well.

7.2.3 THE EXERCISE »IAEA-WMO (WORLD METEOROLOGICAL ORGANISATION)«

On 27th June 2000 the exercise organised by the IAEA and the WHO took place. The aim of the exercise was to test of the WMO procedures and products which are supplied under the agreement between IAEA and WMO on meteorological support.

The exercise was designed as the communication exercise to test the products of the WMO in case of the nuclear accident. In Slovenia the Hydrometeorological Institute and the SNSA took part in the exercise. The SNSA activated its emergency responseorganisation. The accident was simulated to have been in the Angra NPP, Brasil. The meteorological products were obtained from US National Oceanic and Atmospheric Administration, and regional meteorololigical centres Washington, Bracknell and Toulouse.

7.3 THE KRŠKO NPP

In 2000 the activities in the emergency planning in the Krško NPP were focused on the maintenance and improvement of the existing emergency preparedness. The priorities were: establishment and operability of the »Emergency Off-site Facility«, training and exercises with the simulator and modernization of the the emergency organisation activation system. Until the end of 2000 the 86% of the tasks and training, planned in the period 1993-1999, were completed.

7.3.1 UPDATE OF THE RADIOLOGICAL EMERGENCY RESPONSE PLAN OF THE KRŠKO NPP (RERP)

The new revision of the RERP (rev. 22) became effective on 22nd November 2000. The rev. 22 comprises changes due to:

- introduction of new data after the project of modernization of the Krško NPP was completed,
- completion of the tasks from the previous exercises,
- introduction of the emergency organisation activation system.

Beside the periodic review of the existing EIP (Emergency Implementation Procedures) procedures, there were 5 new EIP procedures written (tasks of the director of the »Emergency Off-site Facility«, tasks of the shift technical advisor during an emergency end three procedures in relation to the maintenance of the emergency preparedness).

7.3.2 PREMISES, EQUIPMENT AND SYSTEMS FOR ACCIDENT MANAGEMENT

The activities of the Krško NPP in this field were focused on:

- establishment of the »Emergency Off-site Facility«, which is activated during the site and general emergency, and is located in the basement of the ACPDRS building, which is adjacent to the SNSA.
- in the simulator room the additional telephone lines, facsimile, internal radio system and automatic activation system were installed,
- the workstations of the plant's internal process computer system were installed in the Technical Support Centre and the Operation Support Centre,
- the activation system was substantially upgraded: instead of staff activation with pagers the automatic system based on cellular phones was introduced.

7.3.3 TRAINING, DRILLS AND EXERCISES

In 2000 there were the following training courses organized by the Krško NPP:

- introductory and basic training of the emergency organisation personnel,
- training of the rescue unit, of the shelter maintenance team and ABC team in the Civil Protection Training Centre in Ig near Ljubljana,

- training of the licensed personnel,
- training of the shift foremen,
- training of the professional fire brigade personnel,
- presentation of the Krško NPP ecological information system to the regional civil protection staff.

The following drills were completed:
- of the professional fire brigade personnel and the Krško NPP professional and volunteer firefighting crew,
- of the radiological mobile unit,
- activation of the Krško NPP professional firefighting crew,
- activation of the Krško NPP emergency personnel,
- monthly communication testing.

7.4 INTERNATIONAL ACTIVITIES

7.4.1 THE END OF THE IAEA PROJECT RER/9/050 »HARMONIZATION OF EMERGENCY PREPAREDNESS IN EAST AND CENTRAL EUROPEAN COUNTRIES«

The regular annual steering committee meeting of the IAEA project RER/9/050 took place in Vienna in March 2000. The program of the meeting included the program of the IAEA in the field of emergency preparedness, report on the IAEA project RER/9/050, presentation of project RER/9/049, reports of the group leaders, reports of the countries observers and reports of the countries participants.

The project RER/9/050 had been active until the end of 2000 and then ceased. The project RER/9/049 addresses to the education of medical staff for the radiological emergencies will continue until the end of 2001. In 2001 the RER/9/050 will be coupled to RER/9/049, after 2001 the projects will be joined. The final goal of the project is to establish a system for the communication between countries and harmonistion of the emergency actions without the auspices of the IAEA. The IAEA will offer some services in the nearest future, such as EPREV (Emergency Preparedness Review Team), advisory role in the emergency classification, exercise preparation and Interras modification.

The IAEA is working on the co-ordination of emergency preparedness with different organisations (international committee on emergency coordination which will have representatives of the IAEA, WHO, WMO and OECD/NEA. The organistion of joint exercise is scheduled in May 2001 (JINEX-2000).

The IAEA prodeuced draft of a TECDOC considering public information. The draft comprises three parts: the purpose, scope and use of the document; second part the methodology and basic concept; the third part is manual with templates of the documents to be sent during an emergency.

7.4.2 »OSEP« TRAINING COURSES

From May to July 2000 the training courses on off-site emergency preparedness were run in the framework of Phare programme (Training on Off-Site Emergency Preparedness – OSEP). The training was organised in Trnava, Slovakia, with the participants from Eastern and Central Europe.

The ACPDRS and the SNSA financed the translation of the training materials and nominated the candidates. Training was aimed at 7 categories of trainees – according to their functions during an emergency:

- decision makers,
- planning personnel,
- support personnel for decision makers,
- emergency workers in the field of civil protection,
- accident assessment staff,
- medical and technical staff,
- national OSEP instructors.

All the participating countries have made the presentation on their own radiological emergency plan.

During the training the practical exercises were organised. The working groups consisted from the participating countries and their proposals and solutions reflected their domestic emergency planning.

14 participants from Slovenia took part in the training, the representatives of the ACPDRS, the SNSA, Ministry of Health, Institute Jožef Stefan, Regional Civil Protection Krško, Firefighting Brigade Krško. At the end of the training the participants had to pass the exam.

7.4.3 INTRODUCTION OF »RODOS« SYSTEM IN SLOVENIA

The European Commission in 1999 announced its intention to financially and technically support the installation of »RODOS« system in Slovenia and Czech republic. In 2000 Slovenia prepared draft of the terms of reference which will be used to invite the tenders for the project of installation of »RODOS« system in Slovenia.

8 SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

8.1 INTRODUCTION

8.1.1 STRUCTURE OF THE SNSA AND ITS SCOPE OF COMPETENCE

In Article 11 paragraph 6 of the Act on Organization and Competencies of Ministries (Off. Gaz. RS, No. 71/94, 47/97, 60/99 and 30/2001), the scope of competence of the SNSA is defined as follows:

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

In addition to the above Act, the legal basis for the administrative and professional tasks in the field of nuclear and radiation safety as well as inspection control of nuclear facilities is also provided by the Government of the Republic of Slovenia Act (Off. Gaz. RS, No. 4/93, 23/96, 47/97 and 119/2000), the Administration Act (Off. Gaz. RS, No. 67/94), Act on Ionizing Radiation Protection and Special Safety Measures in Use of Nuclear Energy (Off. Gaz. SFRY, No. 62/84), Article 4 of the Constitutional Act for Implementation of the Basic Constitutional Charter on the Independence and Sovereignty of the Republic of Slovenia (Off. Gaz. RS, No. 1/91-I), Act on Ionizing Radiation Protection and on Nuclear Facilities and Equipment Safety Measures (Off. Gaz. SRS, No. 82/80), Act on Transport of Dangerous Goods (Off.Gaz. RS,79/99), Decree on Export and Import Regime of Specific Goods (Off.Gaz.RS, 17/99, 1/2000, 45/2000, 69/2000, 121/2000, 4/2001 and 15/2001) as well as by-laws and rules and regulations based on the above acts and the ratified and published international agreements in the field of nuclear energy and nuclear and radiation safety.

8.1.2 ORGANIZATION SCHEME OF THE SNSA AND EMPLOYMENT POLICY

On 1 January 2000, the SNSA had 37 employees; over the year 2000, two more were employed. As a consequence, on 31 December 1997 there were 39 employees at our Administration. The applicable Rules of Organization and Systematization envisages 48 permanent jobs and 6 trainee workposts.

The 39 employees had the following professional qualifications: there were 3 Doctors of science, 13 Masters of Science, 19 University graduates, 2 employee with a College degree and 2 employees with Secondary education.

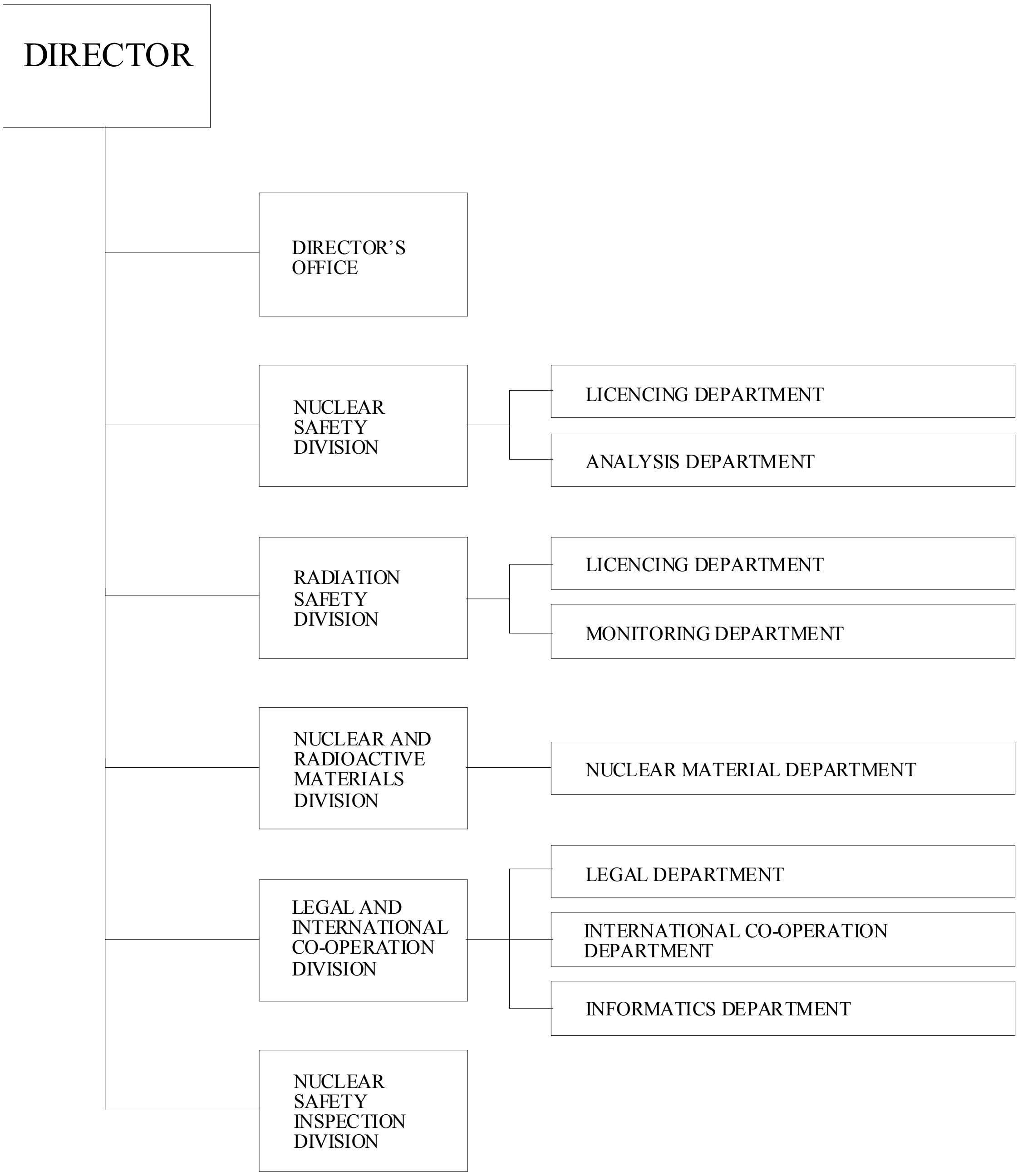
The structure of employees on the last day of the year was as follows: the director, 27 senior civil servants, 8 civil servants, 4 members of technical staff.

As earlier, the SNSA endeavoured to secure, in accordance with the budgetary funds, as many experts as possible;

Table 8.1. Total number of employees at the SNSA (December 2000)

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
No. of employees	5	7	9	11	16	18	20	26	30	32	35	37	39

Figure 2.1: ORGANIZATION CHART OF SNSA



8.1.3 BUDGET OF THE SNSA AND ITS REALISATION

In the budget of SNSA the share of programs is only 34,4% of assured means. But from the amount of 116.717.922,00 SIT, which presents financial means for program activities, the amount of 60 million SIT, which presents membership fee for IAEA and for US NRC research programs, must be deducted.

In reality, the budgetary means are reduced to 56,7 million SIT and includes also symbolic means for work protection (1,1 million SIT), SNSA library (0,3 million SIT), emergency preparedness (1,1 million SIT), safeguards (0,5 million SIT) etc. It is an interesting information, that the amount of average program budgetary item is 4,7 million SIT (except IAEA membership fee).

Like this the budget of SNSA is obviously not comparable to budgets of similar regulatory bodies, competent in the field if nuclear and radiation safety; it is also not comparable to budgets of countries, candidates to EU entry, which have a nuclear program (Czech Republic, Slovak Republic, Hungary).

Such estimation was also given by many international missions or institutions, which were reviewing administrative and legislative regulation in the field of nuclear and radiation safety in Republic of Slovenia (see paragraph 8.1.3).

Such budget ranges SNSA among the most insignificant budgetary users, which is in unquestioned contrary to proved needs, supported also by declarative obligation of the Republic of Slovenia to ensure and maintain a high level of nuclear safety in Republic of Slovenia.

Purpose	**Adopted Budget**	**Current Budget**	**Consumption**	**Realisation in %**
Wages	174,301,000.00	185,666,000.00	184,516,218.00	99.38
Material Expenses	25,414,000.00	25,414,000.00	25,078,837.00	98.68
Programs	114,401,000.00	116,717,922.00	114,595,223.00	93.68
Investment	11,912,000.00	11,912,000.00	11,577,093.00	97
Total	326,028,000.00	339,709,922.00	335,767,371.00	97.09

8.1.4 **INTERNATIONAL ASSESSMENTS OF REGULATORY REGIME IN THE NUCLEAR FIELD**

In the past years activities in the nuclear and radiation fields were assessed by different international institutions. In this connection the following assessments related to the regulatory and legislative regime of the field are mentioned:

- in 1993 an assessment was made by the EC Regulatory Assistance Management Group – (11.8.1993, Rev. 2) – (the RAMG Exploratory Mission);
- in 1996 an assessment on physical protection of nuclear facilities was made by the IAEA International Physical Protection Advisory Service Mission – (the IPPAS Mission);
- in 1999 an assessment was made by the IAEA International Regulatory Review Team Mission (the IRRT Mission);
- in 1999 an assessment on transport of nuclear and radioactive materials and comparability of the Slovenian legislation with IAEA regulations was made by the IAEA TRANSaS Mission;

- in 2000 the European Commission prepared a report on the progress of Slovenia's accession to the EU, containing an evaluation on the status of nuclear energy and nuclear safety (within the frame of chapter 22 – Environment) – (the EU Report 2000);
- in 2000 an assessment on the status of the legislative framework and regulatory regime was made by the Western European Nuclear Regulators' Association - WENRA – (the WENRA Report);
- in 2000 an assessment on legislative and regulatory infrastructure was made by ENCONET within the frame of the EC project "Nuclear Safety in Central and Eastern Europe), in November a report on the status in Slovenia was issued – (the ENCONET Report).

Some of these assessments are based on the actual review of the status in Slovenia, the others were prepared on the basis of questionnaires and information gained by reviewers from different sources (International Atomic Energy Agency, OECD/NEA, the Final Report on the Preparatory Meeting for the Convention on Nuclear Safety). Especially, it is worth mentioning that in the nuclear safety field (less in the radiation safety field) operation of nuclear facilities is also evaluated. The operation of Nuclear Power Plant Krško was evaluated by many IAEA's expert missions (i.e. OSART, ASSET, IPPAS), World Association of Nuclear operators - WANO, the ICISA Commission (the International Commission for an Independent Safety Assessment), the activities of the latter based on a mandate given by the Slovenian Government between 1992 to 1993. A general summary of assessments can be summed up in one fact: the safety of the Krško Nuclear Power Plant operation is on high level and is comparable to European standards, while the status of regulatory regime and legislative framework is not completely comparable with good (European) practice. These issues have to be arranged by a new law on nuclear and radiation safety.
With regard to the regulatory regime and legislative framework the following issues were most frequent and most important for the preparation of reports and assessments:

- clear distribution of competence among different governmental bodies and their co-operation (the IRRT Mission, the RAMG Mission, the ENCONET Report, the AQG Report);
- assurance that the SNSA acts as an independent regulatory body (the RAMG Mission);
- possibility of appeal against the issued decisions (the IRRT Mission, the RAMG Mission, the WENRA Report, the AQG Report);
- effective and independent safety assessment in the licensing process; assurance of sufficient staff and financial sources to obtain external independent opinions (the IRRT Mission, the RAMG Mission, the WENRA Report, the AQG Report);
- system of financing of the SNSA and assurance of sufficient financial sources for the implementation of its obligations and responsibilities (the IRRT Mission, the WENRA Report, the AQG Report);
- assurance of sufficient expert staff and increase in salaries (the RAMG Mission, the WENRA Report, the ENCONET Report, the EU 2000 Report, the AQG Report);
- inclusion of provisions on periodic safety reviews into a new law (the IRRT Mission, the WENRA Report);
- Nuclear Safety Expert Commission should ensure independent advice to the regulatory body (the IRRT Mission, the RAMG Mission);
- definition of clear role of the so-called technical support organizations in the process of independent safety assessment of open safety issues (the IRRT Mission, the RAMG Mission, the AQG Report);

- necessity to prepare a national plan in the case of radiological emergency (the IRRT Mission, the WENRA Report).

8.1.5 EDUCATION AND TRAINING

Just as before, so too in the year 2000 the SNSA paid particular attention to the professional training of its employees.

The Rules of Internal Organization and Job Systematization of the SNSA require that the employees pass the state examination which is a prerequisite for civil service. Out of 39 senior and junior civil servants and technical personnel, 37 have already passed the examination, while out of the remaining two employees will pass it in one year since they started to work in the SNSA as it is required in the Act in State Employees Act.
All the junior and senior civil servants have also a working knowledge of a foreign language (English).

Also this year, special emphasis was given to computer training, most of the workers of the SNSA participated special administration course “SPIS 4”, three of them participated SQL ORACLE training course.

Nevertheless, the major part of the training was focused on nuclear safety and radiation protection. Several of the SNSA employees (among others, naturally, all the inspectors) have participated in special courses and passed corresponding examinations within the scope of basic and advanced training programme of the U.S. Nuclear Regulatory Commission as well as the courses and examinations on the corresponding U.S. simulators (a copy of a nuclear power plant control room).

Three of the employees completed a six-weeks' course in "Basic of Nuclear Technology" at the Milan Čopič Training Centre; two employees completed a course in "Radiation Protection II" and three employees completed a course in "Radiation Protection III"; one employee successfully completed a course "Radiation Safety for Open Sources of Ionizing Radiation".

Since the scope of work of the SNSA is in the process of continuous development, much of the training and education was carried out abroad. The SNSA employees are participating the international courses organized by IAEA, OECD/NEA and European Commission.

The SNSA is also stimulating off-the-job post-graduate studies so one of employees is studying at University of Ljubljana, Faculty of Civil Engineering and Geodesy: interdisciplinary study of environmental protection, topical course: geotechnology and environment (in co-operation with the Faculty of Natural Sciences, Department of Geology).

8.2 LEGISLATION IN THE FIELD OF NUCLEAR SAFETY

8.2.1 LEGISLATION

In 2000 SNSA was intensely preparing a new Act on Nuclear and Radiation Safety. The concept of the new act is based on principles, which are implementing through all the provisions of the act. Some of this principles are universal and result from contemporary knowledge and concepts in the field of nuclear or radiation safety (peaceful use of nuclear energy, primary responsibility of the operator, justification, priority to safety, quality assurance). Some other principles are specific for certain areas of international legislation, that bind the Republic of Slovenia (absolute liability for nuclear damage, ALARA principle, dose limitation, equivalent protection of outside workers). Finally, there are some principles, which will, according to the SNSA opinion, increase efficiency and rationality of regulation in the field of nuclear and radiation safety in the republic of Slovenia (prohibition of practice without prior authorization, integrity of regulation, concentration of competences, causer-pay principle).

The provisions of draft, relating to the establishment of new Public regulatory agency for nuclear and radiation safety are based on draft Law on Public Agencies – EPA 1292, Parliament Bulletin, Nr. 74/2000. The proposal of SNSA is, that the new Act on Nuclear and Radiation Safety should also be an act, which will establish a new Nuclear and radiation safety agency. The provisions on new agency are very reduced. There is a provision on subsidiary use of new Law on Public Agencies. Such organization of nuclear and radiation safety field is also foreseen by draft changing and supplementing the Administration Act.

Draft of new Act also includes a list of new regulations in the field of nuclear and radiation safety. The drafts of new regulations shall be prepared in ad-hoc working groups, in which the experts of various field shall participate. The new legislation should cover the whole field of nuclear and radiation safety.

8.2.2 MULTILATERAL AGREEMENTS

- **Convention on Third Party Liability in the Field of Nuclear Energy** of 29th July 1960, as amended by the Additional Protocol of 28th January 1964, and by the Protocol of 16th November 1982 (act of ratification of the convention published in the Official Gaz. of the RS, no. 18/2000)
  Paris Convention arranges third party liability and insurance for third party liability regime. Together with Brussels Supplementary Convention makes a complete system of liability and financial obligations of the operators, state and contracting parties in case of nuclear damage. When becomes a contracting party to Paris and Brussels Convention, Slovenia shall denounce Vienna Convention on Civil Liability for Nuclear Damage (Act on Notification of Succession Off.Gaz. RS-IA, No.9/92, text of the convention published in the Off.Gaz. of the SFRJ- IA, No. 5/77).

- **An Amendment of Article VI of the Statute of the International Atomic Energy Agency** (adopted in Vienna on 1st October, published in the Off.Gaz. of the RS-IA,No.,5/2000)

- **An Amendment of Article XIV of the Statute of the International Atomic Energy Agency** (adopted in Vienna on 1st October, published in the Off.Gaz. of the RS-IA,No.,5/2000)

- **Convention of 31st January 1963 Supplementary to the Paris Convention** of 29th July 1960, as Amended by the Additional Protocol of 28th January 1964 and by the Protocol of 16th November 1982
  Brussels Convention supplements the Paris Convention on Third Party Liability in the Field of Nuclear Energy. Both Conventions together make a complete system of liability and insurance for nuclear damage.
  On 28th September 2000 the Government of the Republic of Slovenia determined a Draft Law on Ratification of Brussels Supplementary Convention and gave it to the Parliament for adoption. The Parliament of the Republic of Slovenia should ratify the Convention in the beginning of 2001.

8.2.3 BILATERAL AGREEMENTS

- **Arrangement between the Nuclear Safety Administration of the Republic of Slovenia and the Nuclear Installations Safety Directorate of the Republic of France for the Exchange of Technical Information and Co-Operation in the Regulation of Nuclear Safety** (signed in Ljubljana on 18 February 2000, published in the Off. Gaz. of the RS-IA, No. 18/2000)
  The Arrangement is based on mutual interest to exchange the information relating to regulations and standards in the field of safe use of nuclear energy. The Arrangement has been signed for the period of 5 years and foresees the option to prolong the Arrangement.

- **Arrangement between the Nuclear Safety Administration of the Republic of Slovenia and the Ministry of Science and Technology of the Republic of Korea for the Exchange of Information and Cooperation in the Field of Nuclear Safety** (signed in Ljubljana on 7 January 2000, published in the Off. Gaz. of the RS-IA, No. 18/2000)
  The Arrangement is an execution act of the Arrangement between the Government of the Republic of Slovenia and the Government of the Republic of Korea for Scientific and Technical Co-operation. The Arrangement shall be a basis for stronger co-operation between regulatory bodies of both countries in the field of nuclear safety. The Arrangement is based on mutual interest to exchange the information relating to regulations and standards in the field of safe use of nuclear energy.

- **Arrangement between the Nuclear Safety Administration of the Republic of Slovenia and the Council for Nuclear Safety of South Africa for the Exchange of Technical Information and Co-Operation in the Regulation of Nuclear Safety** (signed in Ljubljana on 15 December 1999, published in the Off. Gaz. of the RS-IA, No. 18/2000)
  The Arrangement is based on mutual interest of both regulatory bodies to exchange the information relating to standards, technical reports and operational experiences in the case of radiological emergency and the administrative practice concerning nuclear and radiation safety. The Arrangement has been signed for the period of 5 years and foresees the option to prolong the Arrangement.

- **Protocol Additional to 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** (signed by the Republic of Slovenia on 26 November 1998, published in the Off. Gaz. of the RS-IA, No. 18/2000)
  Basic international legal act, which arrange the field of non-proliferation of nuclear weapons is Treaty on the Non-Proliferation of Nuclear Weapons (NPT). NPT demands from contracting states to make safeguards agreement with the International Atomic Energy Agency. As a result of this demand the Republic of Slovenia has concluded 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 (signed in Ljubljana on 29 September 1995, published in the Off. Gaz. of the RS-IA, No. 11/97). Protocol Additional means further arrangement in the field of safeguards.

- **Agreement between the Government of the Republic of Slovenia and the Government of the Slovak Republic for the Exchange of Information in the Field of Nuclear Safety** (signed in Bratislava on 25 September 1999, published in the Off. Gaz. of the RS-IA, No. 12/2000)
  The contracting parties shall exchange the information relating to nuclear and radiation safety issues through letters, reports, other documents and through visits and meetings. The Agreement has been signed for an undetermined period. This Agreement abolished the agreement between SFRJ and CSSR for co-operation in the field of peaceful use of nuclear energy from 1966.

- **Arrangement between the State Office for Nuclear Safety in the Czech Republic and the Slovenian Nuclear Safety Administration for the Exchange of Information** (signed in Prague on 18 December 2000)
  The contracting parties shall exchange the information, relating to the nuclear safety, safeguards, radwaste management, siting, building, operating and decomissioning of nuclear facilities. Besides this information, the contracting parties shall exchange all other important information for the experts and for the laic public of both countries. This Arrangement shall formalize so far existing successful co-operation between regulatory bodies in the field of nuclear safety. The Arrangement should be ratified in the first half of 2001.

8.3 INTERNATIONAL CO-OPERATION

8.3.1 COOPERATION WITH IAEA

8.3.1.1 GENERAL

The IAEA is an independent international organisation, established in 1957 by decision of the General Assembly of the United Nations Organisation. Among the functions of the IAEA, defined in the IAEA Statute, the following are included: to broaden and increase the contribution of nuclear energy to peace, health and progress in the world; and, in particular, to promote research and development in the field of the peaceful use of nuclear energy; to exchange scientific and technical information; to establish and maintain control over nuclear materials; and to prepare and adopt health and safety standards for the use of nuclear energy. Slovenia has become a member of IAEA in 1992.

8.3.1.2 GENERAL CONFERENCE

the 44^{th} regular session of General Conference, which is the highest representative body of IAEA, was held in Vienna from September 18 to September 22 2000. There has been 114 delegations of 131 member states (among delegates there were several ministers), a large number of observer states and representatives of international organizations. Mr. Miroslav Gregorič, m.s., was a leader of Slovenian delegation.

During the 44^{th} session Azerbaijan, Tajikistan and Central African Republic became members of IAEA.

General Conference adopted with acclamation 29 resolutions and 2 presidential statements. Adopted resolutions are related to: the financing of Technical Co-operation, the financing of Safeguards, measures to strengthen international co-operation in nuclear, radiation and waste management, education and training in radiation protection and nuclear safety and waste management, the safety of nuclear research reactors, radiological criteria for long-lived radionuclides in commodities, Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, safety of transport of radioactive materials, strengthening of the IAEA's technical co-operation activities, strengthening the effectiveness and improving the efficiency of the safeguards system and application of the Model Protocol, measures against illicit trafficking in nuclear materials and other radioactive sources, plan for producing potable water economically, strengthening co-operation between nuclear research centres in the area of the peaceful applications of nuclear technology, strengthening the Agency's activities related to nuclear science, technology and applications, the Agency's accounts for 1999 and regular Budget for 2001. General Conference devoted a great deal of time to more political items: implementation of the agreement between the Agency and the Democratic People's Republic of Korea for the application of safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons; implementation of United Nations Security Council resolutions relating to Iraq; application of IAEA safeguards in the Middle East and Israeli nuclear capabilities and threat.

Member states supported measures strengthening the effectiveness and improving the efficiency of the safeguards system and application of additional protocols which improve Agency's abilities to detect non- registered nuclear materials and activities.

General Conference adopted several resolutions to improve world safety framework, including its safety standards and international safety conventions. The following resolutions were adopted: the safety of radioactive waste management; education and training in radiation protection and nuclear safety and waste management; safety of transport of radioactive materials; radiological criteria for long-lived radionuclides in commodities; the safety of nuclear research reactors and Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Delegation of the Republic of Slovenia actively participated on General Conference, both on Plenary Session and on the Committee of the Whole which formed proposals of most resolutions. This year Slovenia chaired the Committee, because Mr. Gregorič was elected to be a chairman of the Committee on the proposal of Eastern Europe Group of IAEA member states. Slovenian delegation also took part as co-proposer in adoption of six resolutions – also as accession country to EU. During the session of General Conference the representatives of Slovenian delegation also participated in Europe Regional Meeting Group of the Department of Technical Co-operation and Senior Regulators Meeting.

Parallel with General Conference the Third Scientific Forum on the theme of radioactive waste management ran: Turning Options into Solutions.

8.3.1.3 BOARD OF GOVERNORS

The Board of Governors is a body which runs and directs the work of this specialized organization within UN between two sessions of General Conference. The Board of Governors met eight times in 2000, five times as the Board of Governors (in March, June, September and December), twice as the Programme and Budget Committee (in January and May) and once as the Technical Assistance and Co-operation Committee (in December). In the frame of financial abilities and other working engagements the representatives of SNSA participated in sessions of the Board of Governors (also in the sense of continuity of the Slovenian chairmanship from October 1998 to October 1999). Otherwise the work of the Board of Governors was covered by the Embassy of the Republic of Slovenia in Vienna.

8.3.1.4 TECHNICAL ASSISTANCE AND COOPERATION

Meetings within the frame of the IAEA

In 2000 the IAEA organized several workshops, seminars, courses, conferences and symposia all over the world, 8 of them also in Slovenia, in co-operation with Jozef Stefan Institute-Milan Čopič Training Center and the Milan Vidmar Elektroinstitut. SNSA as a contact point of the Republic of Slovenia for operational relations with the IAEA was informing organizations in Slovenia about this meetings. Many Slovenian experts took an active part in the conferences and symposia by presentations. Slovenian experts also participated in many missions of the IAEA as expert specialist.

Fellowships and Scientific Visits

Another area of the SNSA-IAEA collaboration within the scope of technical assistance and cooperation covers fellowships and scientific visits. In 2000, we received 25 applications for the training of foreign experts in Slovenia. 8 applications out of 25 were implemented. In 2000 also 8 applications from 1999 were implemented.
The following issues were realized:

- Jordania, four one-month advanced study courses in the field of radiation protection;
- Bosnia and Herzegovina, four one-month advanced study courses in the field of radiotherapy.

The following fellowships or scientific visits, for which the applications were received in 1999, were completed in 2000:

- Hungary, a two-month advanced study course in the field of environmental protection;
- Lithuania, a two-month advanced study courses in the field of environmental protection;
- Belarus, a one-month advanced study courses in the field of use of isotopes and radiation in agriculture;
- Ukraine, five two-month advanced study courses in the field of radiation protection.

Also a one-month advanced study course, for which the appplication was received already in 1998, was completed:

- Argentina, in the field of nutrition and with that related health.

The applications were addressed to the Jozef Stefan Institute, University of Ljubljana - the Faculty of Chemistry and Chemistry Engineering, the University Medical Center Ljubljana - the Institute of Nuclear Medicine and the Institute of Oncology, Institute of Occupational Safety and to the NPP Krsko.

Training through fellowships and scientific visits is in most cases connected to a certain project of technical assistance.

Research Contracts

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

In 2000, Slovenia submitted to the IAEA 10 new research contract proposals, prepared by the Jozef Stefan Institute, the Institute of Oncology and by the Institute of Occupational Safety. In one case a contract has been renewed.

Projects of Technical Assistance

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

IAEA is constantly trying to improve the field of technical cooperation with Member States, especially IAEA endeavours to allocate funds, earmarked for Member States within particular project, to those areas where these funds are most needed. IAEA IAEA's efforts are directed also to the permanent development of the before mentioned areas. For this reasons IAEA formed a mechanism, so called "CPF – Country Programme Framework". Country Programme Framework related to Slovenia is stating a development priorities of our country and shall be considered when projects of technical assistance for the period 2000 – 2006 shall be planed: long-termed abandoning of use of nuclear energy in the safe, ecological and economic acceptable way; maintaining of high level of operational safety in Krsko NPP throughout the life of the NPP; assurance of reliable supply of energy; assurance of high level of nuclear safety and disposability of NPP, with consideration of recommendations of international review missions.

During the session of the General Conference there was the Europe Regional Meeting Group of the Department of Technical Co-operation. In the Meeting the programme of technical co-operation for the period 2001-2002, both regional and national, was represented. The Department of Technical Co-operation assigned three new projects of technical assistance to Slovenia, the proposals of projects were verified also by the Board of Governors on its December session. Approved projects for 2001 – 2002 cycle are:

- "Facility for Cyclotron-produced Short-lived Medical Isotopes", counterparts are the Jozef Stefan Institute, the Institute of Nuclear Medicine and the Institute of Oncology;
- "Performance Assessment for Low- and Intermediate-level Waste Repository" model project, counterpart is Public Agency for Radwaste Management;
- "Capacity Upgrade for Use of Environmental Isotopes as Natural Tracers" ("footnote a" project – IAEA contributes a part of means, the other part of means is contributed by sponsors), counterpart is the Jozef Stefan Institute.

"Irradiation Facility for Industrial and Medical Sterilization" project, in implementation by the JSI, was approved in 1999, and for the 2001 cycle some supplementary funds were proposed.

Besides the above mentioned projects also some other projects, which started in 1999, are in progress:

- "comparing Health and Environmental Impacts of TPP and NPP", IJS project was approved for 1999-2000 period;
- "Expansion of Accelerator-based Ion Beam Analytical Methods", this IJS project is an advanced project of "Beam Transport System in Van de Graaff Accelerator" project;
- "Fast Pneumatic Transfer System for TRIGA Mark II Reactor", IJS project ("footnote a").

8.3.1.5 IAEA MISSIONS

IPSART Mission

From March 20 to 24 2000 there was a mission of IAEA in NPP Krsko. The purpose of the mission (IPSART – International Probabilistic Safety Assessment Review Team Service) was to review the existing documentation of Probabilistic Safety Assessment of the NPP Krsko. The following areas were reviewed: internal initial events in the case of fire, flood and seismic and other external events. The aim of the IPSART Mission was not to replace independent reviews of existing methodologies and their application, but also not to confirm the existing methodologies or to substitute quality assurance.

The structure of the mission was: three experts from USA, Switzerland and Netherlands, the representative of the IAEA and two representatives of Enconet Consulting. From Slovenia representatives of NPP Krsko and SNSA cooperated in this mission.

The outcome of the mission was the final report, finished in June 2000. These are the conclusions: a bit disused methodology is used for the human errors evaluation, therefore the use of newer and more systematical methodology is recommended, the abolishment of certain mistakes, that the mission found at the human errors evaluation, was also recommended; the second recommendation relates to the abolishment of to conservative access to intersystem-LOCA; furthermore the examination and improvement of restoring measurements were recommended; probabilistic assessment of total loose of off-site AC power is not entirely specified for NPP Krsko, therefore the examination and improvement of this data is recommended; information for uncertainty analysis are not included in the assessment, the mission laid great stress upon the completion of uncertainty analyses, therefore the assessment should necessarily be completed with uncertainty analyses.

8.3.2 CO-OPERATION WITH EUROPIAN UNION

8.3.2.1 ACCESSION TO THE EU (ADOPTION OF THE ACQUIS)

In 2000 the SNSA continued with the harmonization of the domestic legislation with the *acquis communautaire*. The Euratom Treaty is the fundamental document (i.e. primary legislation) for all regulations in the area of nuclear safety and radiation protection in the EU. The Euratom Treaty, together with the regulations stipulated by it, forms the regulatory framework, which is binding for each Member State. This framework, which comprises nuclear safety, radiation protection, research, safeguards, supply, external relations and peaceful use of nuclear energy, is equally binding for the Candidate States as well as it is for the Member States.

IN 2000 in the area of nuclear energy, nuclear safety and radiation protection that in 2000 the European Commission (EC) adopted the position, that the EC will closely monitor the adoption of the Slovenian legislation and all related activities, but at this stage it has not noticed any obstacles, which might significantly influence the process of accession to the EU.

a) Nuclear Energy

The area of Nuclear Energy comprises the following chapters:

- <u>supply of nuclear materials</u>: This chapter does not comprise special requirements for the transposition to Slovenian legislation. The Member States need to report on the purchase of nuclear materials to the Supply Agency. The contract of the Krško NPP on the uranium hexafluoride supply ran out in 2000. The fuel for the 2001 refueling will be supplied under the conditions of the existing contract. The Krško NPP is in preparation of the new contract for period 2002-2005.

- safeguards: Slovenia agreed with the proposal given by the EU representatives during the last Subcommittee Meeting in December, 1999 that it would be the most instrumental, to have a bilateral meeting of the Euratom Safeguards experts with the representatives of the Slovenian Nuclear Safety Administration to resolve the issues on reporting between the operator, the Euratom Safeguards and the Slovenian Nuclear Safety Administration. This meeting took place on 8 November, 2000, in the Euratom Safeguards offices in Luxembourg. Based on the results of this meeting Slovenia accepts the EU acquis in the field of safeguards i.e. the corresponding provisions of EURATOM, INFCIRC 193, as well as Commission Regulation (EURATOM) No. 3227/76 as amended by No. 220/90 and 2130/93. The Parliament of Slovenia has ratified the Protocol Additional to the Safeguards Agreement between Slovenia and the IAEA in Connection with the Treaty on Non-proliferation of Nuclear Weapons (OG of RS, IA, 18/2000).
- international agreements: Slovenia agreed with Canada the international agreement on cooperation in the peaceful use of nuclear energy. EC did not put any questions in relation with the aforementioned agreement, due to the fact that Slovenia stated that it is willing to replace the existing agreement with the accession to the agreement concluded between European Atomic Energy Community and Canada. The Parliament ratified the bilateral agreements which have been signed between the SNSA and respective regulatory bodies of France, South Africa and South Korea in the field of information exchange and on co-operation in the nuclear and radiation safety. On the list of long term goals still remain the agreement with Italy on the early exchange of information in case of radiological emergency and the agreement between the SNSA and the Czech nuclear regulatory authority on information exchange and on co-operation in the nuclear and radiation safety.
- investments and joint undertakings: The new document had been issued in this area »Council Regulation 2587/1999 of 2 December 1999 defining the investment projects to be communicated to the Commission in accordance with Article 41 of the Treaty establishing European Atomic Energy Community«.

This area is considered in the 14. Working Group »Energy«. European Commission responded to the Slovenian position paper with the request for the information on administrative capacity of Slovenian institutions to meet the acquis. The European Commission in its annual report concluded that in 2000 in the field of »Energy« Slovenia made a very good progress.

b) Nuclear Safety and Radiation Protection

This area is considered in the 22. Working Group »Environment«.

In thew beginning of 2000 Slovenia has finished the third cycle of reporting in the form of the tables of concordance (in relation to directives) and in the form of implementation questionnaires (in relation to regulations considering transport of radioactive substances and import of contaminated foodstuuf and feedstuff after the Chernobyl accident). The Milieu company produced a progress monitoring report, which compiled the data gathered by the questionnaires. The report gives the overview of the status in Slovenia and identifies the gaps between the acquis and the Slovenian legislation.

The SNSA produced the internal plan for the employment of the new staff needed to meet the tasks for the implementation of the legislation in relation to the EU acquis. The plan envisages about 30 new employees which are necessary to fully meet the tasks imposed by the new legislation.

The European Commission in its annual report concluded that in 2000 in the field of »Environment« Slovenia made a very good progress.

c) Dual Use Materials

In March 2000 the Slovenian Parliament passed the Act on Export of Dual use Goods (OG of RS, 31/2000), which provided the legal basis for the Governmental Decree on the Dual Use Goods. In the Annex to the aforementioned Decree one can find the list of dual use goods (which includes also goods contained in the Nuclear Suppliers Group list).

Based on the aforementioned legal provisions Slovenia became a fully member of the Nuclear Suppliers Group in October 2000, while passing the Decree on the Regime of Import and Export of Specific Goods in March 1999 (which comprises “Trigger list”) entitled Slovenia to become the member of the Zangger Committee in April 2000.

d) Other Activites to the Accession to the EU

In March, 2000, the meeting of the Association Commitee EU-SI was held in Brussels. The nuclear safety and nuclear energy matters were considered in the meeting materials (operational aspects, seismicity of the Krško basin, radiation monitoring, fuel cycle, safeguards and measures against illicit traficking of nuclear materials, radioactive waste management and early information exchange in case of a radiation emergency).

On 29 November 2000 the nuclear energy issues were discussed during the Subcommittee Meeting on Transport, Energy, Environment and TENs in Brussels. The items on the agenda were:

- Energy Policy, details on nuclear energy; state of play of discussions with Croatia on the consequences of the dual-ownership,
- Status of legislation approximation in the nuclear field,
- Strengthening of the administrative capacity in the nuclear field,
- Developments in the area of nuclear safeguards : preparations to acquis (including results of technical discussions on modalities for correspondence between operators and Euratom on accountancy reports,
- Developments on nuclear supplies and international nuclear agreements,
- the Krško NPP: state of play of modernisation programme including safety upgrades,
- Longer term solutions for spent fuel and nuclear waste: state of play,
- Seismic studies of Krško basin.

In 2000 the SNSA put a lot of effort into the technical review of the translations of the EU documents. The special committee from the SNSA staff was established to review the documents, which are available on the SNSA home page.

On 20 September, 2001 Mr. Jaime Garcia Lombardero, Head of the EU negotiating team for Slovenia, visited Ljubljana. Slovenian delegation was led by Janez Potočnik, Head of the

Slovenian negotiation team. Mr. Lombardero has briefly discussed the open issues in relation to the safeguards and suggested to be resolved until the Subcommittee Meeting on Transport, Energy, Environment and TENs in Brussels, 29-30 Nov 2001.

e) Summary of the Slovenian Accession to the EU

Slovenian position in accession to the EU in the field of nuclear energy and nuclear safety is well defined. The position paper was finished without major comments from the EC. The main tasks are finalization of the new legislation and strengthening of the regulatory body. These are quite demanding tasks although the preliminary assessments from the EC are favorable for Slovenia.

8.3.2.2 PHARE programme

EU Commission has financed geological and geophysical research in surroundings of the Krško NPP through the Project PH 1.08/95 "Geophysical Research in Surroundings of the Krško NPP". Research was performed by the group: EPTISA, Spain; OGS, Italy and University Leoben, Austria. In November 2000, the final report was submitted to EU Commission and Slovenia. In the same month, the authors of the report presented main conclusions to interested counterparts from Slovenia, neighbouring countries, France, Czech Republic, Slovakia, Spain and EU representatives. The original cost for the contract was ECU 500,000, additional ECU 165,000 were provided through the annex in 2000. On the initiative of Slovenian experts an additional work worth ECU 56,000 (without VAT) was accomplished. For this the funding was provided by Ministry of Environment and Spatial Planning, Ministry of Economy and SNSA. Altogether 51 km of regional reflection seismic profiles and 4 km of high resolution reflection seismic profiles were performed.

SNSA has applied in the scope of PHARE TSO programme for assistance in review of geological research and seismic hazard of the Krško NPP. The programme was named "Support in the review of ongoing seismic-tectonic study and existing seismic PSA of the NPP", Project No. PHARE SL/TS/03. The objective of the project is to support the SNSA in the independent review of performed neo-tectonic research in surroundings of the Krško NPP, final safety report (chapter 2.5) and review of input for PSA analysis on seismic design parameters for the Krško NPP. The costs of the project is ECU 300,000. Its duration is 18 months.

8.3.2.3 CONCERT Group

The CONCERT Group was established as the technical framework of implementation of the European Commission assistance in the field of nuclear safety to the states of Eastern and Central Europe and to newly independent states of the former Soviet Union. The CONCERT Group is consisted of one member from the each competent regulatory authorities, which are competence for nuclear and radiation safety in EU Member States. One representative is appointed by each competent regulatory authority from the Central and Eastern European countries and from the newly independent states of the former Soviet Union. The CONCERT

Group also consists of the members of European Commission (DG XI and DG IA). The CONCERT Group representatives meet twice a year- in Brussels and in one of he CEEC or NIS countries. In 1998 Slovenia hosted one of the CONCERT Group Meeting.
The regularly CONCERT Group Meeting was held in Kiev from 29 June to 1 July 2001. It was divided into two topic discussion and roundtable. The First discussion was continuation of 16th CONCET Group Meeting. The topic was: ”Factors, which influence on nuclear installation efficiency”. They discussed about independence of Regulatory bodies, Technical Support Organisations, finance and staff. The second part of discussion was about quality management of regulatory activities. At the end, the roundtable about national progress was organised, where some formal issues were presented. There was also organised a visit to Černobil NPP.
The last CONCERT Group Meeting should be held in December 2000, but because of financial situation in EC, the meeting was postponed to February 2001.

8.3.2.4 NRWG

The 56th Meeting of the Nuclear Regulators' Working Group (NRWG) was held in Brussels on May 12, 2000. Since April 1998, Slovenia take an active part in the Group, where the representatives of Regulatory Bodies from EU Member States and EU Candidate Countries have been co-operated. The purpose of the Group is the co-operation in the field of nuclear safety and harmonisation of the projects, which are in common interest for financing and technical follow up of Phare RAMG assistance programme
After the presentation on procedural matters, the following projects have been presented:

- Non Destructive Testing (NDT) Qualification Programmes
- Project on Safety Critical Software
- Off-site Releases of Design Bases Accidents (DBAs)
- Project on Safe Management of Ageing
- Study on European Safety Practices during Planned Outages at Nuclear Power Plants
- Study on Risk-Based Approach for In-Service Inspection of NPP Components

Further discussion was about the main priorities for future work. Each participated country determined its own priorities, which will be collected, processed and presented by Secretariat One item was devoted to report on co-operation with EU Candidate Countries. Conclusions of the Meeting on the European Nuclear Installation Safety Group (ENIS-G), Project on Co-operation between Regulatory Authorities of the European Union and their Counterparts in the Applicant Countries of Central and Eastern Europe and study on Guidelines for Periodic Safety Review on VVER Nuclear Power Reactors were also presented.
All participants presented the reports about events in NPPs, which could have potentially generic safety significance. The member from Slovenia reported about the event entitled "Reactor Trip due to Main Feedwater Control Valve Failure".
The item about international co-operation was dedicated to the activities of the Phare-RAMG and CONCERT Group. Phare-RAMg has a delay and it looks like that it will not start working this year.
Report on the last IAEA/NUSAC meeting and report on the research related activities in the area of safety of nuclear installations within the EC were also presented.

8.3.2.5 TSOG

In 2000 the European Commission established Technical Safety Organisations Group for assistance to its projects. The Group consists of 8 Regulatory Bodies/Technical Supported Organisations, which will carry out some missions for implementation of future projects. They will review the possibilities for assistance to Regulatory Bodies and Competent Authorities at the EC projects. They will also suggest new project, which could be implemented in years 2001 and 2002. Spanish Regulatory Body is co-ordinating the co-operation between TSOG and Republic of Slovenia. ANPA and representative from EC are also participated. On the Slovenian side, SNSA and Competent Authorities are participating. First TSOG Mission was held at the Slovenian Nuclear Safety Administration from 4 to 5 May 2001. Mr. Javier Reig from Spain, CSN, Mr. Antonio Madonna from ANPA, and Mr. Patrick Vankerckhoven – the advisor for Slovenia, were the members of the Mission. The purpose of their visit was to give the estimation regarding the EC assistance to review the possibilities for assistance to Regulatory Bodies and Competent Authorities and to suggest some project for the future. In the past, EC has already assisted Central and Eastern European countries and the newly independent states of the former Soviet Union.

8.3.2.6 ENIS-G

The Meeting of the ENIS-G (European Nuclear Installation Safety Group), which was formed from the former Reactor Safety Working Group (RSWG), was held on 11 May 2000. The representatives from Regulatory Bodies and nuclear installation operators from the EU Member States and EU Candidate Countries take an active part in Group.
The main intention of the ENIS-G is to increase co-operation between the Regulatory Bodies and nuclear installation at implementation of pre-accession EC strategy. The ENIS-G will also support the foundation of new institutions in the field of nuclear safety of Europe and the incorporation of the main actors from the Candidate Countries into the system of EC's co-operation an its working methods. The ENIS –G will be also forum for experience exchange in the field of nuclear safety and for identification of topics which could significantly influence on nuclear safety. The Group will assisted in harmonisation of working methods and the experiences of collaborating countries. The methodology for nuclear safety estimation in Candidate Countries will also be prepared.

8.3.2.7 ECURIE programme

The ECURIE (European Community Urgent Radiological Information Exchange) programme, was developed from the necessity of organising a communication system that will be disposable 24 hours per day in case of nuclear accident. The system will in case of accident send off the requested alarms on the correct addresses. It was formed on the base of European Council 87/600/EUROATOM decree for to arranging early warning information matters in case of radiological accident. We have to be aware that the ECURIE programme has no global function and is not expected for small nuclear accidents, but it has to be reachable all the time and has to assure the reply information from all the members in less than one hour.

On the march 2000 Slovenia sent an own representative on the meeting in Bucarest, that was organised by EU organisation with ECURIE system. The meeting stimulated interest for the transmit of ECURIE system into other candidate countries. It was promised that to the end of year 2000 the date and the mode of the accession of new candidates to this information exchange system will be known.

8.3.2.8 EURDEP

The ECURIE was established at year 1987 on the bases of existent telex connections. The time brought modern and more efficient communications and from the need of their use, a new platform for information exchange was developed on the bases of agreement. It is a special platform called EURDEP (European Union radiological data exchange platform). Slovenia has been sending the data according to the agreement in Ispra JRC in Italy, where the data are collected. The frequency of sending the radiological data in EURDEP form was in year 2000 increased from weekly sending to daily sending.

8.3.2.9 Access project

SNSA is taking part in *Access project* that is organised by Euratom office for safeguards. ACCESS is the acronym for Applicant Country Co-operation with Euratom Safeguards System. Euratom established in the scope of the project a Steering Committee and invited the representatives of the applicant countries for EU membership to participate. In first phase of the project only representatives from those regulatory bodies that are reporting to the IAEA in accordance with Safeguard Agreement are invited. The main objective of the project is to establish an unique and automatic way of reporting by nuclear material holders in the member states to the Euratom office in Luxembourg. For that purpose a special software operating on devoted hardware platform will be developed. The project should be developed and tested on the applicant countries and later implemented in all EU member states.

8.3.2.10 Forum ERWR

European Radioactive Waste Regulator's Forum is forum of European Regulatory Bodies, which are competent for radioactive wastes.
The 3rd Meeting was held in Helsinki from 2 to 3 December 1999. On its own initiative, the Republic of Slovenia was admitted as an observer state. Since that time the SNSA, on its own costs, sends the representative to attend the meetings, which take place twice a year in one of the Member States. In the first part of the forum, each country present the news on radwaste management with the respect of Regulatory Body. In the second part, the discussion about the further appointed item is taken.

8.3.3 WENRA

The Western European Nuclear Regulators Association (WENRA) was established in 1998 by nine nuclear Regulatory Bodies from EU Member States (Belgium, Finland, French, Germany, Italy, Netherlands, Spain, Sweden and Great Britain). The objective of the

Association is to give the common appraisal of nuclear safety standards in Founders' Countries and Central and Eastern European Countries and Candidate Countries (Bulgaria, Czech Republic, Hungary, Lithuania, Romania, Slovak Republic and Slovenia). One of the main activity is to harmonise regulation approaches on the basis of common safety criterions.
The first informal meeting, was held in Cordoba on March 10, 2000. The main topic of the meeting is connection between EC and Candidate Countries in the field of nuclear safety.
The second meeting was held on June 16, 2000 in Brussels. It was sponsored by the Belgian Federal Agency for Nuclear Control. The participating members were from EC, GRS, IPSN, Belgian Federal Agency for Nuclear Control and from the Nuclear Regulatory Bodies of EU Member States and Candidate States, which have nuclear power plants. The purpose of the meeting was to make an arrangement about programme for completing the new revision of WENRA report and to harmonise the opinion about the recognition and formal use of that report with the EU. In relation with that report, the members of Candidate Countries emphasised the common interest to examine the nuclear power plants safety in that countries. WENRA report was meant to Governments of WENRA Member States and EC, which pass from branch of profession to politics. Member states will also present the report to Member states, which do not have any nuclear power plant.
Last Meeting was in Paris on October 5, 2000. A new report, which is very advantageous to Slovenia, have been prepared by many experts on nuclear safety in EU Member States and Candidate Countries. It was signed by directors of nine European Nuclear Regulatory Bodies (Belgium, Finland, French, Italy, Germany, Netherlands, Spain, Sweden and The United Kingdom)

8.3.4 NERS

An association called NERS – Network of Regulators of Countries with Small Nuclear Programmes was established inn September 1998 during the International Atomic Energy Agency General Conference session. The regulatory network conists of the following countries: Argentina, Belgium, Czech Republic, Finland, Hungary, Slovakia, Slovenia, South Africa, Switzerland and the Netherlands. Competent authorities of these countries, that are usually small, are responsible for nuclear safety and they share similar problems in the field of nuclear safety, so that the network offers them an exchange of their experience and knowledge enabling prompt solution of their problems.
The NERS group held its third meeting in Helsinki, Finland, from 26 to 27 September 2000. The meeting was attended by the Member States and also by the representatives of the OECD/NEA and the IAEA. The agenda's items were:

- planning and supervision of regulatory inspections
- experience form licensing of programmable automation systems and equipment
- current state of planning and licensing of the Pebble Bed Modular reactor in South Africa
- presentation by IAEA on expert missions to IAEA member states
- presentation by OECD/NEA on the CNRA task forces
- lessons learned from the IAEA-IRRT missions
- quality assurance of regulatory activities
- progress in nuclear waste management
- discussion on future NERS activities.

8.3.5 VISITS TO THE SNSA

25 – 28 January 2000: Five members of the WENRA mission, who were engaged with the preparation of the new report on nuclear safety in EU and candidates for EU, visited the SNSA. The members gatherd the additional new information on the status of the Krško Nuclear Power Plant. The members of the mission from the related organizations like ANPA and CSN visited the headquarters of the SNSA and presented their goals and the main topics of the programme to the management of the SNSA and of the Krško NPP.

16 – 18 February 2000: The SNSA hosted a three-members delegation of the Nuclear Installation Safety Directorate of the French Republic (DSIN) consisted of Messrs. A. C. Lacoste, the Director of DSIN, A. Jouve and M. Schuler. The purpose of the visit was the signature of a bilateral arrangement between the SNSA and the DSIN for the exchange of information and co-operation in the field of nuclear safety. Before the signature took place, the guests had visited the SNSA's headquarters and made an exchange of views from the field of nuclear safety.

1 March 2000: Three members of an Iranian delegation visited th SNSA. The delegation was headed by Mr. Ali Akbar Salehi, the Iranian ambassador to the International Atomic Energy Agency. The delegation was then consisted also by Mr. Ebrahim Rahim Pour, the Iranian ambassador for bilateral relations in Vienna and Mr. Alireza Esmaeili, an official in the Embassy of the Islamic Republic of Iran to Vienna. Within the framework of its visit, the delegation visited also the Jožef Stefan Institute.

19 – 25 March 2000: An expert visit to the SNSA was paid by experts of the Insitute for nuclear safety of South Korea (H. D. Chung, Y. H. Choi and S. H. Ahn). The purpose of the visit was an exchange of experience of the two authorities within the frame of their bilateral arrangement (see 8.3.4) and the assistance provided by the Korean side in licensing the modifications of the Krško Nuclear Power Plant.

26 March 2000: At the invitation of Mr. Miroslav Gregorič, M.S., Mr. Giora Amir, the Israeli ambassador to the International Atomic Energy Agency paid a visit to the SNSA. On 27 March 2000 Mr. Giora visited the Krško Nuclear Power Plant and the Research Reactor TRIGA of the Jožef Stefan Institute at Podgorica near Ljubljana.

4 – 5 may 2001: the EC's Technical Safety Organistaions Group – TSOG composed of three experts visited the SNSA (For more information see 8.3.2.6).

24 – 25 May 2000: A thirteen-members delegation of the Republic of Hungary visited Slovenia within the framework of the first consultative meeting of the Slovenian and Hungarian sides according to the agreement on the early exchange of information in the event of a radiological emergency. The delegation was headed by Dr. Jozsef Ronaky, the Director of the Hungarian Atomic Energy Commission. The first day of the visit was dedicated to the signature of the agreement. The Hungarian guests were taken to see the Krško Nuclear Power Plant the next day.

19 – 22 June 2000: Messrs. Dmitri Miklush and Herrnan Vera Ruiz, the representatives of the IAEA visited the SNSA. The purpose of the meeting was to find a solution to all open issues concerning the application of the new technical assistance project for the cycle 2000-2001 entitled »Production Facility for Cyclotron Produced Short-lived Medical Radioisotopes«. It is a joint project of the Clinic for Nuclear Medicine in Ljubljana, the Institute of Oncology

and the Jožef Stefan Institute. During their stay in Slovenia the guests visited the SNSA's headquarters, the Jožef Stefan Institute, the Institute of Oncology and Medical Centre – Clinic for Nuclear Medicine. There they met with the management of those institutions. The IAEA representatives expressed their support to the project. It was agreed to establish contacts with the Slovak and Hungarian competent authorities performing similar projects through IAEA. The estabished contacts would connect the projects and enable their prompt and more economic execution.

5 – 6 July 2000: Dr. Yong Hwan Kim, Counsellor of the Embassy of the Republic of Korea to Vienna (ex director of the Nuclear Safety Department in the Ministry of Science and Technology of the Republic of Korea) visited the SNSA. It was a courtesy call including discussions with the SNSA representatives and a visit to the Research Reactor TRIGA of the Jožef Stefan Institute at Podgorica near Ljubljana and to the Krško NPP. The purpose of the visit was also to further co-operate with the Ministry of Science and Technology of the Republic of Korea.

6 July 2000: On the initiative of the Austrian side Messrs. Hohenberg and Zimmel of the Federal Office in Vienna visited the SNSA. Technical topics regarding the exchange of data from the Slovenian net to the Austrian one and vice versa were discussed at the meeting. The data are exchanged in accordance with the early exchange of information in the event of a radiological emergency and on issues …

19 - 20 October 2000: The first meeting between the Slovenian and Slovak delegations was held in Ljubljana within the framework of the bilateral Agreement between the Government of the Republic of Slovenia and the Government of the Slovak Republic for the Exchange of information in the field of nuclear safety (see 8.3.4.).

7 - 8 December 2000: An IAEA inspection mission consisted of inspector Lipatov and inspector Janov visited the Krško NPP. They amde an inspection of the nuclear materials control system. Ms. Morimoto of the IAEA joined the mission at the meeting held in Ljubljana the day after. The way of reporting on the Additional Protocol was discussed there.

12 –13 December 2000: Dr. Joachim Ehrhadt of the Forschungszentrum in Karlsruhe and Dr. Neale Kelly of the European Commission paid a visit to the SNSA. The purpose of their visit was to discuss the status of the RODOS programme in Slovenia, which was sponsored by the European Commission. Dr. Ehrhardt made a presentation on the RODOS programme before an audience of Slovenian experts.

8.3.6 COOPERATION WITH OECD/NEA

On October 3 2000 Director of SNSA met Director General, Mr. L. Echavarri, and the Director of Legal Affairs Division of OECD/NEA. The main subject of this meeting was acceptance of Slovenia into OECD/NEA. Mr. Echaverri described the possibilities to accept new members to NEA, which is an independent organisation within OECD. Till now the membership in NEA was almost automatic for Member States of OECD. Steering Committee NEA discusses the application, which is always solved affirmatively. Deviations from this practice began with the acceptance of South Korea, which was first accepted to NEA and then to OECD, which was a precedent. Interest of Slovenia, to become a member to OECD, is perfectly clear, Slovenian application is on OECD since 1996. Slovenian interest to become a member to NEA is also unambiguous, that is also indicated by Slovenian accession to Paris Convention and Slovenian previous efforts to approach NEA. However, for time being Slovenia does not have realistic prospects for NEA membership. With reference to this fact Mr. Echaverri proposed, that Slovenia should formally apply to have a status of observer in the NEA Committees. Formal application was submitted through Slovenian embassy in Paris to Director General of OECD/NEA in beginning of December and contains application to become an observer in the following OECD/NEA Committees:

- Radioactive Waste Management (RWMC)
- Committee on Radiation Protection and Public Health (CRPP)
- Committee on the Safety of Nuclear Installations (CSNI)
- Committee on Nuclear Regulatory Activities (CNRA)
- Nuclear Law Committee (NLC)
- Committee for Technical and Economic Studies on Nuclear Energy Development and Fuel Cycle (NDC)
- Nuclear Science Committee (NSC)

NLC

On October 19 and 20 there was a meeting of   in Paris. Director General, Mr. Luis Echavarri, opened this meeting and explained, that Steering Committee OECD/NEA accepted a new name of the group, the Nuclear Law Committee – NLC, which also expanded its mandate, that was so far restricted to the issues related to liability for nuclear damage, but from now on the Committee will be competent for entire field of law, covered by OECD/NEA. This will bring to even closer co-operation between NLC and other Committees within NEA. In NLC a revision of Paris and Brussels Supplementary Convention is in progress, about which the chairman of Committee was reporting.

One point of agenda was related to international exercises INEX. Secretariat of OECD/NEA presented preparative arrangements for the first exercise from new series of emergency preparedness exercises, that OECD/NEA is organizing for a couple of years in co-operation with other international organisations. The above mentioned exercise shall be INEX – Exercise 3 in NPP Gravelines on May 21 and 22 2001.

8.3.7 BILATERAL CO-OPERATION

Implementation of the Agreement between the Republic of Slovenia and the Republic of Croatia for the Early Exchange of Information in the Event of a Radiological Emergency

The first meeting was held in Zagreb on 3rd March 2000. There were representatives of Ministry of economy of the Republic of Croatia, representatives of Enconet and representatives of Slovenian nuclear safety administration. The agenda of the meeting was: competent authorities, contact points and the method of transmission of information, information in according with Article 6, relating to the nuclear programme, operational experiences, information in according with Article 7, relating to the monitoring programme and the exchange of information coming from early-warning system. The discussion was friendly and constructive. Both delegations believed, that the implementation of the Agreement is satisfying, though it is still in a beginning stage. They also agreed, that the next meeting shall be held in Slovenia. Before that Slovenia shall organize a technical expert meeting on informing in case of nuclear incident in Krško NPP, where also a representatives of civil protection should participate.

Implementation of the Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Hungary for the Early Exchange of Information in the Event of a Radiological Emergency

The first meeting within the framework of above mentioned agreement was held on 24th May in Ljubljana. Hungary was represent by representatives of Hungarian atomic energy agency, Paksz NPP, Ministry of agriculture and regional development, Ministry of economic relations, Ministry of environmental protection, Research institute for radiobiology and radiological hygiene "Frederic Joliot Curie". Slovenia was represent by representatives of Administration of the Republic of Slovenia for civil protection and disaster relief and representatives of Slovenian nuclear safety administration. The agenda of the meeting was: general information relating to the legislation in the field of nuclear and radiation safety, administration procedure for replacement of steam generators, approaching to EU and exchange of information according to the Articles 5, 6 and 7 of the Agreement (competent authorities, contact points, method of transmission of information, exchange of information coming from early-warning system). The meeting was friendly and constructive. Both sides expressed willingness and a great interest to complete on-line exchange of the information, as soon as Hungarian would annul some internal organizing difficulties. Both sides agreed, that the next meeting shall be organized in Hungary.

Implementation of the Agreement between the Governments of the Republic of Slovenia and the Republic of Austria on Early Exchange of Information in the Event of a Radiological Emergency and on Questions of Mutual Interest in the Field of Nuclear Safety and Radiation Protection

There was a second meeting based on above mentioned Agreement on 16th October in Vienna. In Slovenian delegation there was five representatives from Slovenian nuclear safety administration and two representatives from Ministry of foreign affairs. Leader of Slovenian delegation was Mr. Miroslav Gregoric,m.s., director of SNSA. Slovenian delegation prepared extensive letter information on all items of the arranged agenda. Austrian delegation, in which there were twelve representatives from Ministry of foreign affairs, Ministry of agriculture, forestry, environment and water managing, Federal chancellery, Ministry of internal affairs, Federal agency of environment, Government of the Styria land, Government of the Carinthia land, Austrian research center – Seibersdorf, Institute for risk researches and Building office, was leaded by Ms. Gisella Polte, m.s., counsellor to the minister within the Ministry of foreign affairs. The agenda of the meeting was: opening session and confirmation of agenda, current progress in EU, legislative and administrative framework, radiological monitoring, emergency preparedness, nuclear program etc. The meeting was friendly and constructive, but discussion was not on satisfactory expert level and sides could not clarify eventual open issues. Austrian side have not prepared a record of the meeting yet.

Implementation of the Agreement between the Government of the Republic of Slovenia and the Government of the Slovak Republic for the Exchange of Information in the Field of Nuclear Safety

The first meeting within the framework of above mentioned agreement was held on 19th and 20th October in Ljubljana. In Slovak delegation there were representatives of Nuclear regulatory authority of the Slovak Republic and in Slovenian delegation there were representatives of Slovenian nuclear safety administration. Leader of Slovak delegation was Mr. Miroslav Lipar, director and the leader of Slovenian delegation was Mr. Miroslav Gregoric,m.s., director. First day of visit was dedicated to implementation of Agreement. Next day the Slovak guests visited Educational center for nuclear technology and research reactor TRIGA in Brinje where they met with directors of reactor and educational center. The agenda of the meeting was: general information, monitoring system, exchange of information according to Article 1 of the Agreement (competent authorities, contact points, preparing and implementation of international instruments, national legislation, information in the field of licensing, research and development, technical reports and safety evaluations, accident and operation breaks reports, public relations, radiation safety, emergency preparedness, staff training, mutual exchange of experts), exchange of information on technical project Ciklotron for PET, public informing and exchange of information about Paris and Brussels Convention. The meeting was friendly and constructive. Both sides expressed willingness and a great interest to exchange on-line information and to co-operate closely. Both sides also agreed, that the next meeting shall be organized in Bratislava.

8.4 PROVIDING PUBLIC INFORMATION

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

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

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

The Annual Report on Nuclear and Radiation Safety in 1999 was published in Poročevalec No. 83 and 83/1 (Reporter) - the publication of the National Assembly - on 20 September 2000, and is available in public libraries and some specialized libraries throughout Slovenia. It was also send to all Ministries, Mayors, journalists specialized for this professional field, NGO's and Technical Support Organizations and Nuclear Installation.
The Annual Report on Nuclear and Radiation Safety in Slovene language was send also
To the Slovene embassies all over the world.
Report is also available in Slovene on the Internet (http://www.sigov.si/ursjv/uvod.html).
Access to data of the Central Radiation Early Warning System of Slovenia (CROSS), recording the real time (at half-hour intervals) gamma dose rate levels, is also available through Internet.

Reports on the SNSA activities were also published in the bulletin Okolje in prostor (Environment and Physical Planning), published by the Ministry of Environment and Physical Planning. The SNSA regularly contributes articles on courses, seminars and symposia attended at home and abroad. In 2000, 33 articles were published (Table 8.4).

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

Table 8.4: Titles of the SNSA articles in the bulletin Okolje in prostor

Month of Publication	Title
January 2000	Signing of the arrangement between regulatory bodies for nuclear safety of the republic of Slovenia and South Africa. Preparations for exchange the information between Republic of Austria and Republic of Slovenia.
February 2000	IRRT Mission.
	CONCERT Group Meeting.

Month of Publication	Title
	Arrangement between the Slovenian nuclear safety administration and the ministry of science and technology of the Republic of Korea.
	Transport of the radioactive waste from the temporary Radwaste Storage Zavratec.
	Transport of the dangerous goods in accordance with the new Act on transportation of the dangerous goods.
March 2000	WENRA Mission visit in Slovenia.
	Arrangement between the Slovenian nuclear safety administration and the nuclear installation safety directorate of the French republic.
	12 th PIME meeting in Slovenia.
April 2000	Annual Outage in the Krško NPP.
May 2000	Seminar on Public Information on Nuclear Safety.
	First European Nuclear Installations Safety Group Meeting.
	Nuclear Regulators Working Group Meeting.
	International seminar on Implementation of the ECURIE (European Community Urgent Radiological Information Exchange) system.
June 97	Training on the Off-Site Emergency Preparedness (OSEP project) for East and Central European Countries.
	Early Warning Information Exchange Meeting between Republic of Slovenia and Republic of Hungary.
	Regional Workshop on Methodologies of the Safety Analyses of Surface Disposal Systems.
July, August 2000	IAEA Regional Training Course on Regulatory Control on NPT.
	PHARE Project – External managing in the case of emergency.
	Regional Training Course on Combating Illicit Trafficking on Nuclear and Radioactive Materials.
	INIS – International Nuclear Information System.
September 2000	Workshop on Individual Monitoring of External Radiation.
	Regional Workshop on Research Reactor Safety Assessment Standards and Conduct of Inspections.
	Regional Workshop on the use of Probabilistic and Deterministic Approaches in RB Decision Making.

Month of Publication	Title
October 2000	44. Session of the International Atomic Energy Agency General Conference.
	Meeting of the Directors of the Nuclear Safety Administrations.
	Third Scientific Nuclear Waste Forum.
November 2000	Signing of the Agreement Between the Government of the Republic of Slovenia and the Government of the Slovak Republic For the Exchange of Information in the Field of Nuclear Safety.
	The Agreement Between the Government of the Republic of Slovenia and the Government of the Republic of Austria for the Exchange of Information in the Field of Nuclear Safety.
	Possibilities of studying on the International School for Nuclear Law in the University of Montpelliere.
December 97	Geophysical and geological Results of the researches in the Krško NPP area.
	Data base on the Illicit Trafficking on Nuclear and Radioactive Materials.

In 2000, the SNSA continued sending data to the international network in the field of nuclear and radiation safety NucNet and distributed the NucNet data to the interested media in Slovenia. The NucNet - a global reporting agency for atomic energy - was established in 1991 as an information source to all interested in information on the most recent activities in the field of atomic energy.

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

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

All research work and studies being financed by the SNSA are public and available at the SNSA Library, and the international missions' reports are available on the SNSA’s Internet pages and in the National and University Library, the Central Technical Library, Ljubljana and the University Library, Maribor.

Special Library SNSA

Till the end of 1999 the library was only for internal use. Because the extent of library material is becoming bigger from December 1999 in library is working a librarian for organising library materials. The vision of SNSA is to make possible the access of library materials for wide audience and to bring these materials nearer to the public. Therefore in 2000 we have began with active work in system COBISS.

Realised goals in the year 2000:

- Ordering and gathering of materials on bookshelves by the UDC system and partly by publishers (IAEA, US NRC, NRPB, OECD). Serial publications are ordered alphabetically.
- Introduction of monthly notification about new-arrived publications in our library. We notify not only employees of SNSA but also outstanding co-workers (»News in library« are distributed to 40 addresses).
- Professional study for work and use of COBISS.

Short goals of the library:

- To continue ordering of materials on bookshelves.
- Moving part of materials out of the library into basement room.
- Improving the system of monthly notification about new-arrived publications.
- Preparing web pages for the library.

8.5 EXPERT COMMISSIONS

8.5.1 NUCLEAR SAFETY EXPERT COMMISSION (NSEC)

The Nuclear Safety Expert Commission (NSEC), which has an advisory role to the SNSA, met five times in 2000. It is composed of 22 members, of whom 10 are officials from ministries and 12 experts on nuclear and radiation safety. Its scope of work is defined in the Act on Implementing Protection against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off. Gaz. SRS, 28/80) and in its Rules of Procedure, adopted at its 45th meeting on 22 March 1991.

In addition to the standard issue, i.e. "safety of nuclear facilities operation in the period after the last meeting", the NSEC also discussed the following issues in 2000:

- implementation of LBB concept;
- preparations for the 2000 outage in the Krško NPP and the 1999 outage report;
- report on radiological monitoring in Slovenia in 1998 and 1999;
- export of spent fuel from RR Triga to USA;
- report on IAEA transport mission in Slovenia;
- criteria approval for clearance levels;
- report on notices for 5th EURATOM frame program;
- authorization of Izolirka Fire Engineering;
- preliminary 2000 outage report in the Krško NPP;
- status of shutting activities and administrative ruling for Žirovski vrh uranium mine;
- annual report on nuclear and radiation safety in the Republic of Slovenia in 1999;
- 2000 outage report in the Krško NPP;
- status report on new nuclear and radiation safety law;
- pre-accession activities to EU;
- geophysical researches round the Krško NPP – project PHARE results

8.5.2 EXPERT COMMISSION FOR OPERATORS EXAMS

In 2000, the Commission for Testing the Qualifications of the Krško operators organised four exams for 29 candidates, of which 19 candidates for the post of senior reactor operators took the exam to renew their licenses (18 candidates) or took the exam for the first time for one candidate. Other 10 candidates for operators took the exam for to renew their licenses (8 candidates) or took the exam for the first time for 2 candidates.

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

8.6 RESEARCH PROJECTS AND STUDIES

In the budget year 2000, the SNSA financed and co-financed research projects and analyses to support decision making during licensing, and other development projects. The main projects and activities are briefly summarised below.

Geophysical Exploration in the Surrounding of NPP Krško - Geophysical Research of the Surroundings of the Krško NPP" Project N^0 PH 1/08/95. The European Commission has funded through the PHARE geological and geophysical research of the of the Krško NPP site. The project was performed by consortium EPTISA from Spain, the OGS from Italy and the University of Leoben from Austria. The authors presented on November 2000 results of the study to numerous participants from Slovenia, neighbouring countries, France, Czech Republic, Slovakia, Spain and to representatives from EU. The copies of report were made available to those who had interest, among others the copy was mate available also to Austrian political and professional representatives. The value of the contract for this project was 500.000 ECU. With the annex in 2000, additional 165.000 ECU were provided. On the initiative of Slovenian professional the consortium performed additional work in value of 56.000 ECU (without VAT). The funding for this was provided by MOP, MGD and SNSA. All together 51 km of regional reflection seismic lines, 4 km of high resolution reflection seismic lines were performed. The results of geological and geophysical investigations are rejecting until now valid hypothesis that the Krško basin is a tectonic graben delineated by faults on the north and south sides. The new results have shown that the Krško basin is a syncline with some less important faults that are not intersecting younger sediments. The experts of the PHARE study wrote in their conclusions that only two lineaments have been identified that are of sufficient size to warrant further inspection. This two structures do not extend to vicinity of the NPP Krško. They are located 6-7 km away, one on the east and one on the west of the NPP. It was recommended to monitor weak earthquakes that may occur along this structures. At the NPP Krško site and in its surrounding three seismic monitoring stations are installed, one of them is high resolution. With them it weak earthquakes are registered, but it is not possible to determine the position of hypocentres of earthquakes in this area with sufficient precision. The SNSA and URSG opinion is that it will be necessary to install, with respect of recommendation of the PHARE study, additional seismic monitoring stations. The purpose is the establishment of permanent seismic monitoring network that would provide better information about wear earthquakes in this area.

Geotectonical Research for Safety Assessment (geological survey slovenia). in the year 2000 the geological mapping of the north-east part of the krško basin was continued by methodology of mapping all outcrops in scale of 1:5000. the mapping in total 25 km^2, was carried out in two separated areas namely of pišece - bizeljsko and globoko-župelevec. the purpose of the mapping was to investigating two important structures, the artice flexure and the bizeljsko fault.

Modeling of NEK Containment with CONTAIN Program (*IJS, Odsek za reaktorsko tehniko, Ljubljana*). CONTAIN program has been used to simulate first 24 hours of hypothetical severe accident scenario in containment.. Severe accident is caused in this scenario by failure of ECCS at large LOCA. After the core meltdown and reactor vessel failure the molten core is discharged into reactor cavity at low reactor coolant pressure. Hydrogen is created due to core degradation and core-concrete interaction. Containment input model has been developed for simulating processes during severe accident enabling modeling of an inhomogeneous atmosphere. 3rd phase of the project consists of perfecting the input model (checking and changing the characteristics of flow paths in the main containment compartment, modeling of circular part of the main compartment at the steel wall of the containment, modeling of partitions between the main compartment and steam generator and

pressurizer as joint heat bodies, modeling of primary circuit pipelines) what allows for more detailed simulation of hydrogen behaviour in the atmosphere of the containment. Analysis of stratification, mixing and burning of hydrogen has been performed with new model that consists of 36 elemental cells. Parametric analysis of increased surface and mass of heat bodies and of increased hydrogen generation in primary system have been done. Analysis show that uncertainty in modeling heat structures do not influence the simulation very much. Parametric analysis of increased mass of hydrogen due to core-concrete interaction has also been done. Increased mass accelerates the mixing and burning of hydrogen but does not noticeably change pressure, temperature and the whole energy released due to burning.
Most important findings of the analysis are that pressure and temperature in the containment reach their maximum at the time of release of hydrogen from primary circuit and then decrease relatively fast. Formation and burning of hydrogen cause only slow pressure increase and short-lived temperature peaks. Burning of hydrogen occurs in different hydrogen compartments only within first 17 hours and then stops due to too low hydrogen and oxygen concentrations. Hydrogen concentration in the main containment compartment is homogenous except for short variations due to burning in separate cells.

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Computer Based Modeling to Estimate Radionuclide Transfer in Natural Systems - Phase 2 (*Laboratorij za dinamiko fluidov, Fakulteta za strojništvo, Univerza v Ljubljani*). The project includes modeling of radionuclide transfer in natural and technological systems. That is important for estimation of impacts in the biosphere. In the first phase elemental ideas and suggestions that need to be considered in modeling radionuclide transfer in natural and technological systems have been presented. Fundamental physical and mathematical models, model suppositions and simplifications have been developed. Method for solving such models and some calculations of simpler test cases have been performed. In phase 2 physical models have been upgraded with elemental engineering concepts of integrating modeling of radioactive waste disposal sites. The program has been verified on simpler test cases. Preliminary engineering calculations of radionuclide transfer in the vicinity of disposal sites have been added to some simpler cases. Darcy-Brinkman model used in the modeling has been additionally verified. Further development of the solving procedure and the engineering principles for computer modeling of specific natural and technological systems have been presented.

Strengths Analysis of Primary Coolant Circuit and Acceptability of Leak-Before-Break Concept, Phase II a (*Laboratorij za numerično modeliranje in simulacijo v mehaniki, Fakulteta za strojništvo, Univerza v Ljubljani*). The study discusses the numerical analysis of reactor coolant system of NPP Krško. Analysis is done for some critical loads that cause disagreeable mechanical state in key elements of the coolant system. In IIa phase the following project prescribed transient loads are discussed: earthquake that causes shutdown of the system but the integrity of the system is maintained (SSE – safe shutdown earthquake) and three breaks of the primary circuit's pipelines. Deformation-tension state is calculated and compared with Westinghouse analysis. Use of analytical methods has been unsuitable for the calculation. Therefore all responses of the RCS, including mechanical analysis, have been performed numerically on the basis of finite elements method. RCS numerical model includes geometrical description of RCS, inventory of materials' characteristics and edge conditions. For edge conditions prescribed loads have been used. Geometrical model is made entirely of linear finite elements. SSE earthquake analysis used method of response spectra that bases on modal analysis. For the pipeline breaks three different positions of guillotine breaks have been used. For every case dynamic response of the RCS has been calculated and that for four different enlistments of tightness in nonlinear supports.

Radiological Impact of the Emission from the Coal-Fired Power Plant to the Environment. The operation of coal-fired power plants increases the radioactivity in the environment and radiation exposure of population. The collective doses per unit of produced energy could be even four times higher than those in nuclear fuel cycle. Primarily this is due to radioactive contamination from the chimney stack emissions. It is well known that burning of the coal, containing uranium and thorium (in radioactive equilibrium with their progeny) causes enrichment of volatile metals (lead, bismuth, polonium) in stack gases. The radionuclides ^{210}Pb in ^{210}Po are one of the most radio toxic natural radioisotopes. For estimation of the impact due to released radioactivity it is necessary to know the radionuclide concentrations in the stack gases. The stack releases travel in the prevailing wind directions, the radioactive particles are deposited or are washed out from the atmosphere by precipitation, to the ground and vegetation. This causes local radioactive contamination of the environment. In the study carried out by the Jožef Stefan Institute, an impact of radioactive stack emissions was evaluated. From the radiological point of view the two sources are important: fly ash deposit and stack emissions. In the first phase study radioactivity analyses of input and output materials in the Šoštanj coal-fired power plant (in blocks No.4 and No.5) were done. The content of the leading radionuclides were determined, such as ^{238}U, ^{226}Ra, ^{210}Pb, ^{232}Th and ^{40}K. For the first time the content of ^{210}Po was determined in coal, fly ash and bottom slag. Special attention was given to adequate sampling of stack gases and dust particles in both blocks of the TPP. During sampling, in the block No.4 a de-sulphurisation device was operating, while in the 5th block de-sulphurisation process was in the experimental phase. The results showed that uranium and thorium, present in coal, were concentrated in fly ash, while easy volatile ^{210}Pb and ^{210}Po were adsorbed mostly at dust particles in stack gases. The comparison with the results in the another study completed in 1999 by the JS Institute showed that de-sulphurisation device essentially contributes to the efficient reduction of ^{210}Pb and ^{210}Po content in dust particles. The high concentration of ^{210}Pb and ^{210}Po in dust particles from 4th block was comparable to values obtained two years ago, but in 5th block the values were 5 times lower for ^{210}Pb and even 10 times lower for ^{210}Po as regards the values from the period (when de-sulphurisation device was not in operation). For the first time the concentrations of ^{210}Pb and ^{210}Po in stack gases were determined. The results showed the ^{210}Pb values of 1.1-2.7 Bq/m^3 in block No.4 and 1.1-1.7 Bq/m^3 in block No.5. The concentrations of ^{210}Po were 0.37-0.56 Bq/m^3 in 4th block and 1.2-1.7 Bq/m^3 in 5th block of the TPP.

For final assessment of the impact of the radioactive stack emissions, the content of radionuclides shall be determined (the second phase of the study) in the grass, upper layer of soil, precipitation and bio-indicators. The samples will be taken from different locations in the impact area of the Šoštanj TPP. Above all the portion of radionuclides dispersed from the stacks into the affected environment should be investigated and determined. The derived limits for air contamination are set up in the regulations on maximum limits of radioactive contamination of the environment. These limits are: 0.03 Bq/m^3 for ^{210}Pb and 0.07 Bq/m^3 for ^{210}Po.

8.6 RESEARCH PROJECTS AND STUDIES

In the budget year 2000, the SNSA financed and co-financed research projects and analyses to support decision making during licensing, and other development projects. The main projects and activities are briefly summarised below.

Geophysical Exploration in the Surrounding of NPP Krško - Geophysical Research of the Surroundings of the Krško NPP" Project N^0 PH 1/08/95. The European Commission has funded through the PHARE geological and geophysical research of the of the Krško NPP site. The project was performed by consortium EPTISA from Spain, the OGS from Italy and the University of Leoben from Austria. The authors presented on November 2000 results of the study to numerous participants from Slovenia, neighbouring countries, France, Czech Republic, Slovakia, Spain and to representatives from EU. The copies of report were made available to those who had interest, among others the copy was mate available also to Austrian political and professional representatives. The value of the contract for this project was 500.000 ECU. With the annex in 2000, additional 165.000 ECU were provided. On the initiative of Slovenian professional the consortium performed additional work in value of 56.000 ECU (without VAT). The funding for this was provided by MOP, MGD and SNSA. All together 51 km of regional reflection seismic lines, 4 km of high resolution reflection seismic lines were performed. The results of geological and geophysical investigations are rejecting until now valid hypothesis that the Krško basin is a tectonic graben delineated by faults on the north and south sides. The new results have shown that the Krško basin is a syncline with some less important faults that are not intersecting younger sediments. The experts of the PHARE study wrote in their conclusions that only two lineaments have been identified that are of sufficient size to warrant further inspection. This two structures do not extend to vicinity of the NPP Krško. They are located 6-7 km away, one on the east and one on the west of the NPP. It was recommended to monitor weak earthquakes that may occur along this structures. At the NPP Krško site and in its surrounding three seismic monitoring stations are installed, one of them is high resolution. With them it weak earthquakes are registered, but it is not possible to determine the position of hypocentres of earthquakes in this area with sufficient precision. The SNSA and URSG opinion is that it will be necessary to install, with respect of recommendation of the PHARE study, additional seismic monitoring stations. The purpose is the establishment of permanent seismic monitoring network that would provide better information about wear earthquakes in this area.

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9 TECHNICAL SUPPORT ORGANISATIONS

According to Article 14 of the Act on Implementing Protection against Ionizing Radiation and Measures for the Safety of Nuclear Facilities (Off. Gaz. SRS, No. 28/80), technical and research organisations were authorised by a decision of the Republic Committee for Energy, Industry and Construction, or by the SNSA as its legal successor, to perform specific tasks within the scope of its activities and qualifications in the field of nuclear and radiation safety in the Republic of Slovenia.

The conditions and the time-schedule for performing their tasks is laid down in the "Rules on Methods and Terms for Records Keeping and Reporting on Nuclear Safety to the Republic Inspectorate of Energy by Organisations in the Field of Nuclear Safety and by Organisations Operating Nuclear Facilities and Installations, and on Exchange of Information" (Off. Gaz. SRS, No. 12/81).

9.1 INSTITUTE OF METAL CONSTRUCTIONS

By the decision of the Republic Committee for Energy, Industry and Construction No. 31.10-034/80 of 8 December 1980 the Institute of Metal Constructions (IMK), Ljubljana is authorised for:

- quality assurance activities;
- measurements, quality control and functioning, including non-destructive testing and quality assurance for bearing metal constructions and metal parts of equipment, pressure piping and vessels during construction, trial operation and operation of nuclear facilities and installations;
- training of technical staff for the above-mentioned tasks.

Expertise of the IMK in 2000:

As an authorised organisation it has participated in the control of welding and other maintenance works on the reactor pressure vessel, steam generators, primary and secondary piping, heat exchangers, hydromechanical equipment, lifting devices and hangers right from the start of operation of the Krško NPP.

Routine works during the outage overseen by the IMK:

- opening and closing of the reactor vessel,
- control of cleaning of the reactor closure head studs,
- maintenance of the SW trash rack,
- cranes in the reactor building and fuel transport equipment,
- testing and maintenance of snubbers and pipe whip restraints.

Other activities:

- Supervision over fabrication of a rigging equipment for handling of the steam generators of the Krsko NPP and its assembling during the Outage 2000 (modification No. 277 AB-L)

- Supervision over fabrication and assembling of temporary modifications during the Outage 2000:
  - covers of the reactor cavity (modification No. AB-98-19),
  - tilting device (modification No. AB-98-19),
  - additional equipment of the cranes for lifting of the steam generators (modification No. HE 98-21 Part A),
  - final works in the erection of steam generators (modification No. HE 98-21 Part B),
- Qualification of welding procedures for the Krsko NPP,
- Material quality analysis of the pipe and shaft of the emergency diesel generators.

Reference: Yearly Report of the IMK activities in the field of nuclear safety in 2000, No. 407/PK-E of 4 April 2001.

9.2 WELDING INSTITUTE

According to the decision of the Republic Committee for Energy, Industry and Construction (Off. Gaz. SRS, No. 6/82) the Welding Institute, Ljubljana is authorised for the following tasks related to nuclear safety:

- quality assurance activities related to welding;
- quality control of welding;
- verification of welders qualifications, suitability of welding equipment and instrumentation;
- verification of welding-engineering concepts for welded constructions, design and statistics;
- inspection of welds, including non-destructive testing;
- consulting in the use of welding technology in new installations and in maintenance.

During the 2000 annual outage the Welding Institute controlled welding in the following areas:
- modifications,
- replacements of worn valves and other armatures,
- reparative welding.

The Outage 2000 was very specific because of the replacement of the steam generators, which took place during the outage. Welding Institute followed the following activities related to the replacement:
- Cutting and re-connection of the primary piping to the steam generators,
- Construction of a modified part of the steam generator blowdown system and its re-connection,
- Cutting and re-connection of the main steam piping.

A general conclusion of the Welding Institute was that the work was done correctly from the standpoint of nuclear safety. Observations based on the supervision of the welding are presented in the "Expert Assessment of the Outage Activities, Interventions and Tests during the Shutdown of the Krsko NPP for the Refueling at the End of the 16th Fuel Cycle" No. 394/E-2000. The Expert Assessment contains also some recommendations, which are going to be considered by the Krsko NPP.

Reference: Yearly report 2000, Welding Institute, No. PL/AL-608 of 16 January 2001.

9.3 INSTITUTE OF METALS AND TECHNOLOGIES

By the decision of the SNSA No. 318-13/94-6906/AS of 18 November 1994 the Institute of Metals and Technologies (IMT), Ljubljana, is authorised for the following expert activities relating to the construction, trial operation, start-up and operation of nuclear facilities and installations:

- quality assurance and control of metals based on investigations of their chemical, mechanical, microstructural and corrosion properties;
- assurance of quality and adequacy of metals used for metal constructions, piping and pressure vessels.

In 2000 IMT participated as an authorised organisation in the supervision of the Krsko NPP outage and in the assessment of quality of the fabrication and the erection of the steam generators. IMT also made three expertises on testing of drums for radioactive waste and participated in the investigation of the issue of the leak-before-break concept.

IMT produced the following reports:

- Expert Assessment Report on the Outage Activities, Interventions and Tests during the Shutdown of the Krsko NPP for the Refueling at the End of the 16th Fuel Cycle (No. NCRI-157/2000),
- Expert Assessment of Quality of the Fabrication and the Erection of the Steam Generators in the Krsko NPP (No. NCRI-153/2000),
- Expert Assessment on Testing of the Light and the Heavy Drums for Radioactive Waste No's 238-WP-S-MO1 and 238-WP-S-MO2 (No. NCRI-141/2000),
- Expert Assessment on Testing of a Container for Liquid Radioactive Waste (No. NCRI-150/2000),
- Technical Report on a Container for the Transport of Radioactive Material, (No. NCRI-154/2000)
- Impact of the Primary Circuit Operation on the Toughness of the Duplex Stainless Steel Alloy (No. NCRI-149/2000).

Reference: Report on the Nuclear and Radiation Safety in 2000, IMT No. Inz.Kmet/S-326, of 18 May 2001.

9.4 MILAN VIDMAR ELECTRIC INSTITUTE

According to the decision of the Republic Committee for Energy, Industry and Construction No. 31.10-034/80 of 8 December 1980, the Milan Vidmar Electric Institute (EIMV) is authorised for the following tasks relating to construction, trial operation, start-up and operation of nuclear facilities and installations:

- quality assurance, performance of measurements of electric equipment, low and high voltage electric circuits and installation during construction, trial operation and operation of nuclear facilities;
- verification of operability, reliability and quality of the systems for control and automation of nuclear facilities and installations;
- training of technical staff in the above-mentioned areas;
- performance of acceptance tests on the electric equipment.

In 2000 the activities of the EIMV relating to the nuclear safety were as follows:

During the annual outage and refuelling, EIMV carried out all the required measurements and controls on electric components and systems in accordance with the Krsko NPP programme. Furthermore EIMV was following performance of revisions of electric components and systems of all voltage levels and co-ordinated authorised technical support organisations that were supervising the outage activities and the refueling. After the Outage 2000 was completed, EIMV compiled on the basis of individual expert reports the "Joint Expert Assessment Report on the Outage Activities, Interventions and Tests during the Shutdown of the Krsko NPP for the Refueling at the End of the 16th Fuel Cycle".

Research projects related to nuclear energy:

- Electric Equipment Qualification according to the Requirements of the Working Environment in the Krško NPP - includes all safety-related electric equipment, non-safety-related electric equipment, the failure of which can prevent safety function, and monitoring equipment related to the post-accident period;
- Selectivity of power supply for Non-1E buses - a study of the selectivity of protection of the Non-1E electric equipment the failure of which can influence nuclear safety.

EIMV organised Third Joint IAEA/FORATOM Workshop on Integrated Management Systems of Nuclear Installations, which took place from 24 to 27 October in Ljubljana. There were 40 experts participating from West- and East- European countries and 20 domestic experts. Objective of the workshop was to strengthen the importance of the systems of quality management and assurance for safe and reliable operation of nuclear facilities and to exchange experience in this field.

Reference: 2000 Yearly Report, EIMV No. 1068/2001-inž.IZ, of 13 April 2001.

9.5 FACULTY OF MECHANICAL ENGINEERING

The Faculty of Mechanical Engineering, University of Ljubljana, is authorised by the decision of the Republic Committee for Energy, Industry and Construction No. 31.10-034/80 of 8 December 1980 for the following:

- quality assurance and control of mechanical equipment in nuclear facilities and installations during production, installation, pre-operational tests, trial operation and operation of a nuclear facility;
- testing, measurements and operability control of measuring systems, regulation and mechanical equipment operation in a nuclear facility;
- measurements, quality control and operability control of ventilation and heating systems, cooling systems and air-conditioning in a nuclear facility;

- measurements, testing and operability control of mechanical installations and emergency power supply systems;
- acceptance testing of mechanical equipment;
- training of technical staff in the above-mentioned areas.

Activities of the Faculty of Mechanical Engineering related to nuclear safety in 2000 were:

- participation as an authorised organisation in the annual outage works in the Krško NPP - its scope of activities included the steam turbine with subsystems and the auxiliary steam driven pump.
- elaboration of the expertise »Krško Nuclear Power Plant Performance Test« and performance of the yield measurement of the whole plant after the modernisation and the replacement of the steam generators.

Reference: 2000 Yearly Report, Faculty of Mechanical Engineering of 4 April 2001.

9.6 IBE CONSULTING ENGINEERS

The IBE Consulting Engineers (IBE), Ljubljana is authorised for the following (decision of the Republic Committee for Energy, Industry and Construction of 8 December 1980, Off. Gaz. SRS, No. 32/1980):

- preparation of investment and technical documentation for nuclear facilities;
- organisation of construction of nuclear facilities and installations and surveillance during construction, pre-operational tests and trial operation, including organisation of quality assurance in nuclear facilities and installations during construction;
- control of investment and technical documentation for nuclear facilities and installations;
- preparation of physical plans and siting documentation.

Activities of IBE related to nuclear and radiation safety in 2000 were:

9.6.1 Krsko NPP

- Multi Purpose Building (MPB) - supervision of the construction of mechanical installations, devices and equipment of selected systems
- Supervision of the replacement of the steam generators for the Consortium Siemens-Framatome.
- Relocation of the LILW solid radioactive waste baler from the Drumming Room to the MPB.
- Technical-geodetic observation of key buildings and keeping the register of observations.
- Temporary control point for the steam generator replacement activities - as a subcontractor for the Consortium Siemens-Framatome.
- Modification of the control and indication system for the replaced new main transformer GT1
- Within the scope of the modification No. 359-FW-L steam generator WIDE RANGE level transmitters, IBE did some cabling and labelling.
- Modification of the Containment Hydrogen Monitoring System.
- Modification and upgrading of the technical security sistems (physical protection).

9.6.2 Žirovski Vrh Mine

- A revised programme of decommissioning of the Uranium mine and mitigation of consequences of the mining and milling of the Uranium ore taking into account a realistic schedule of activities for the final remediation of the ore processing site at the Žirovski vrh Mine.
- Project of the final disposition of the surface disposals of mine waste, red mud and mill tailings.

9.6.3 Radwaste Agency

- Study: Programme of safety analyses for the LILW repository. The study presents the programme of safety analyses in all phases of the lifetime od the repository from siting to the final closure.
- Participation in the remediation of the provisional storage of low level radioactive waste Zavratec and transfer of the wastes to the Interim storage of LILW at Brinje.

Quality Assurance

In 1996, the IBE Consulting Engineers established a system of quality assurance in accordance with the ISO 9001:1994 standard. Twice a year, the certification body Bureau Veritas Quality International (BVQI) audits the quality assurance system. The Quality and Standardisation Unit of the IBE controls the quality assurance system functioning according to the annual programme of internal audits.

Reference: Report of the Authorised Organisation, IBE No. BD/MJ-141-3/01 of 20 February 2001-08-22

9.7 INSTITUTE FOR ENERGY AND ENVIRONMENT PROTECTION - EKONERG

EKONERG (Institut za energetiku i zaštitu okoliša d.o.o. - Zagreb), within the area of its expertise authorised by the decision No. 318-36/92-2933/AS, is issued by the SNSA of 18 June 1992, for the following:

- quality control and quality assurance of mechanical equipment in nuclear facilities and installations during production, installation, pre-operational tests, trial operation and operation;
- performance of acceptance and functional tests of mechanical equipment;
- verification of the base line condition and periodical in-service inspection of mechanical safety-related equipment.
-

Activities of the EKONERG in 2000:

- Control of maintenance and overhaul works of rotational mechanical equipment, valves, and heating, ventilation and air conditioning equipment (HVAC) during the outage in the Krsko NPP in line with the inspection report no. 68/95 of 20 September 1995 and

according to the technical specifications: engines of diesel generators, diesel engines of the fire pump, compressors of the instrument air, main reactor coolant pumps and part of the secondary pumps, valves of the primary loop and part of the valves of the secondary loop, part of the HVAC equipment, fire protection equipment, and control over the following main components: turbine of the turbo set, pumps of the main feedwater system, circulating water pumps and main condensate pumps.
- Independent evaluation of three modification packages for the equipment under control of the EKONERG: main feedwater valves FCV 551 and 552 and rotors the main feedwater pumps FW105 PMP-001, -002, -003, Auxiliary feedwater flow control valves AF FCV3003A, 3004A, 3019, 3020

Reference: Yearly Report on the Activities in the Field of Nuclear Safety, EKONERG, No. AE/bj/l-9, of 12 February 2001.

9.8 JOŽEF STEFAN INSTITUTE

By the decision No. 31.10-034/80, issued by the Republic Committee for Energy, Industry and Construction on 8 December 1980, the Jožef Stefan Institute, Ljubljana is authorised to carry out the following activities in the territory of the Republic of Slovenia:
- analysis of events in nuclear facilities;
- reviewing the results of siting investigations for nuclear facilities;
- analysis of unusual events in nuclear facilities;
- verification of the operational status of the safety systems in a nuclear facility and of physical security;
- testing, measurements and verification of operability of nuclear, in-core and radiological instrumentation, and of the reactor control system;
- nostrification and review of the safety report;
- verification of test results of the safety systems during trial operation;
- preparation and execution of emergency measures during an accident related to radiation protection, labelling of radioactive contamination and decontamination and risk assessment to the environment;
- training of workers in the basics of reactor technology, description of nuclear power plant systems, and radiation protection,
- activities in the field of radiation protection according to the Act on radiation protection,
- systematic monitoring of contamination of food and environment with radioactive substances,
- dosimetric services for occupational safety,
- calibration and adjustment of instruments for the measurement of ionising radiation (dose-rate and dose).

9.8.1 Milan Čopič Nuclear Training Centre

The mission of the Nuclear Training Centre (ICJT) is training of personnel in nuclear technology and ionising radiation and public information about these activities.

Activities of the Centre can be divided into four areas:

training of the NPP Krsko personnel, training in the area of Radiological Protection, organisation of international training courses and public information.

Training of the NPP Krsko personnel is the main activity of ICJT. In 2000 the Centre started a new course TJE - theory (Technology of nuclear power plants) for future control room operators. A short course OTJE (Basics on the technology of nuclear power plants) for the technical personnel. All training materials have been updated. Data base for the Expert commission for exams of the Krsko NPP operators was maintained.

In the field of Radiation Protection 18 courses for medical personnel and for industrial use of sources of ionising radiation were organised.

In 2000 ICJT organised seven international courses under an umbrella of the International Atomic Energy Agency (IAEA). ICJT has obtained respectful reputation on international level and is used by IAEA as an example of how such projects should be organised. ICJT is considered as a Centre of excellence.

The course of BEST2000 "Nuclear Energy a challenge for the future" was a big sucess. It was organised in co-operation with a student organisation BEST. It was attended by 25 students of technology from different countries of Europe.

In the field of public information ICJT continued organising visits of elementary and high schools to listen to the lectures about nuclear energy and radioactive waste, and to the visit of the permanent exhibition. In 2000 a total number of pupils and students that visited ICJT was 6390, which is slightly less than the previous year. In seven years - since ICJT has been running the information centre, the number of visitors reached 50,000. In 2000 they also renewed the exhibition of the Information Centre of the Krsko NPP:

Table of training activities at Nuclear Training Centre in 2000

Date	**Title**	**Weeks**	**Participants**	**Lecturers**	**Partic.-weeks**
31.1.00-2.2.00	Radiation protection for open sources	0,6	19	7	11,4
31.1.00-4.2.00	NPP refresher training	1	4	4	4
4.2.00-4.2.00	Radiation protection for hospital workers	0,2	44	6	8,8
7.2.00-3.3.00	Basics of Nuclear Technology - Theory 1/2000	4	16	8	64
6.3.00-31.3.00	Basics of Nuclear Technology - Systems 1/2000	4	15	9	60
27.3.00-29.3.00	Practical Exercises in Radiological Protection for Medical School	0,4	13	1	5,2
11.4.00-13.4.00	Radiation protection for industrial sources	0,6	8	5	4,8
19.4.00-19.4.00	Radiation Protection for Airport Workers	0,2	8	1	1,6
19.4.00-21.4.00	Practical Exercises in Radiation Protection for Medical School	0,4	11	1	4,4
20.4.00-20.4.00	Radiation Protection for IJS workers, Refresher Course	0,2	8	5	1,6
28.4.00-12.5.00	Radiation Protection For Industrial Sources Of Ionising Radiation (Self-Study Course)	2	1	1	2
8.5.00-19.5.00	IAEA Workshop on Design, Evaluation and Licensing of NPP Modifications	2	15	8	30
11.5.00-11.5.00	Radiological protection for industrial sources of ionizing radiation, Refresher Course	0,2	12	4	2,4
19.5.00-19.5.00	Radiation protection for workers of Salonit Anhovo	0,2	20	1	4
22.5.00-26.5.00	IAEA Regional Workshop on Good Practices in National Approaches to NPP Life Management	1	15	4	15
25.5.00-25.5.00	Radiation Protection for activities with open sources of ionizing radiation (General Hospital Maribor)	0,2	8	4	1,6

Date	Title	Weeks	Participants	Lecturers	Partic.-weeks
26.5.00-26.5.00	Radiological Protection for Postojna Cave Workers	0,2	45	4	9
13.6.00-13.6.00	Excercises in NEK Controled Area (1. Group)	0,2	2	2	0,4
26.6.00-30.6.00	IAEA Technical Committee Meeting on Assessing and Assuring Plant Modification Safety	1	13	0	13
2.7.00-15.7.00	Nuclear Energy - A Challenge For The Future BEST Summer Course	2	23	9	46
4.9.00-8.9.00	IAEA Workshop on Decommissioning Process: Regulatory, Technical and Managerial Aspects	1	29	4	29
4.9.00-8.9.00	IAEA Regional Workshop on Operational Safety Monitoring and Assessment	1	11	5	11
14.9.00-31.1.01	Nuclear Technology - theory	14	11	15	154
19.9.00-21.9.00	Radiation protection for open sources	0,6	6	7	3,6
27.9.00-27.9.00	Radiation Protection for IJS workers, Refresher Course	0,2	32	5	6,4
16.10.00-20.10.00	IAEA Regional Workshop on the Management of Safety and Safety Culture	1	21	4	21
17.10.00-19.10.00	Radiation protection for industrial sources	0,6	2	2	1,2
8.11.00-8.11.00	Radiation Protection for IJS workers, Refresher Course	0,2	10	5	2
13.11.00-24.11.00	IAEA "Train the Trainers" Workshop on Practical Response to a Radiological Emergency	2	22	6	44
28.11.00-30.11.00	Radiation Protection for Unsealed Sources	0,6	7	7	4,2
	Total	**41,8**	**451**	**144**	**565,6**

9.8.2 Department of Reactor Engineering (R-4)

Research and Development

- In the field of SEVERE ACCIDENTS RESEARCH, researchers at the JSI Department of Reactor Engineering have analyzed the behavior (stratification, mixing and combustion) of hydrogen in the Krško NPP containment during the first 24 hours of a severe accident. The analysis was based on a simulation with the CONTAIN computer code.
- As representatives of Slovenia, researchers from the JSI Department of Reactor Engineering have actively participated in the international program CAMP ("Code Application and Maintenance Program"), which is sponsored by the US Nuclear Regulatory Commission.
- In the field of THERMAL-HYDRODYNAMIC SAFETY ANALYSES, a comprehensive simulation and analysis of a series of most important design-basis accident scenarios for the Krško NPP was completed using the RELAP5 thermal-hydraulic computer code. The consequent containment phenomena were simulated separately with the CONTAIN code. These best-estimate analyses were performed for the purpose of the new Krško Full Scope Simulator testing and calibration.
- In the field of STRUCTURAL SAFETY ANALYSES, analyses of aging of Krško NPP steam generator tubes were further carried on. The main purpose of this research work is the assessment of the influence of various operating events on damage initiation and growth rates.
- In the field of PROBABILISTIC SAFETY ASSESSMENT, researchers at the JSI Department of Reactor Engineering have actively participated in the international project "Promoting Cooperation between the Nuclear Regulatory Authorities of the EU and their Counterparts in the Applicant Countries of Central and Eastern Europe". Within this

project, recommendations for implementing nuclear regulations in compliance with basic safety principles of the International Atomic Energy Agency will be provided.

Expert Evaluations and Reports

In the year 2000, in compliance with the granted state authorization and following many years of professional experience in the field of nuclear safety, researchers from the JSI Department of Reactor Engineering were involved in the following activities concerning operation and maintenance of the Krško NPP:

- Expert evaluation of the Krško NPP project modification of the main feedwater system (Report IJS-DP-8207). The modified project of the main feedwater system, which allows a significant simplification of the feedwater regulation system, is a consequence of the replacement of steam generators.
- In conformity with the authorization for monitoring of safety and protection systems operation in nuclear facilities, the following activities were evaluated during the Krško NPP 2000 outage, when the Krško modernization project was also carried out :
- – safety systems testing,
- – measurements of the core power distribution,
- – refueling,
- – dilatations of the reactor coolant system,
- – start-up tests related to power uprating and replacement of steam generators.
- Within the Krško NPP modernization project, researchers from the JSI Department of Reactor Engineering have prepared evaluation reports on the following documents from the supplier firm Westinghouse :
- – Design Transients Specification (IJS-DP-7969),
- – Hydraulic Forcing Functions (IJS-DP-7977),
- – Overpressure Protection (IJS-DP-7980),
- – Balance of Design Transients Specification (IJS-DP-8079),
- – Decrease in RCS Inventory Accidents Report (IJS-DP-8123),
- – Radiological Consequences (IJS-DP-8128),
- – Mechanical Review (IJS-DP-8129),
- – Increase in RCS Inventory Accidents Report (IJS-DP-8134),
- – NSSS Control Systems Study (IJS-DP-8135),
- – ATWS Accident Report (IJS-DP-8140),
- – Startup Tests Program (IJS-DP-8185),
- – Large Break LOCA Issues (IJS-DP-8192),
- – Summary Report (IJS-DP-8193),
- – USAR Changes due to UPR, SGR and RSG (IJS-DP-8194),
- – Westinghouse Inputs for Technical Specifications (IJS-DP-8208).

References: - Yearly report of the authorised organisation IJS No. R4/BM-zv/78 of 11 June 2001
- Milan Čopič Nuclear Training Centre in the year 2000, e-mail of 11 May 2001.

9.9 INSTITUTE OF OCCUPATIONAL SAFETY

The Institute of Occupational Safety, the Center of Ecology, Toxicology and Radiation Protection, Ljubljana is authorized for the following activities in the field of radiological protection:

- by the Ministry of Health to implement measures for radiological protection prescribed by the Act on Protection against Ionizing Radiation (Off. Gaz. SRS, No. 9/91), Decision No. 180-1/80-81 of 9 March 1981;
- by a decree from the Federal Committee for Work, Health and Social Care (SFRY) to perform systematic research of radioactive contamination (Off. Gaz. SFRY, No. 40/86);
- by a decree from the Republic Committee for Health and Social Care it was appointed as an authorised organisation to perform radiological contamination control of food of animal and vegetable origin (Off. Gaz. SRS, No. 25/89);
- in the field of ecology and toxicology for expert tasks in the field of occupational safety (Off.Gaz. SRS, No. 22/87).

In 2000, the Institute of Occupational Safety functioned as a technical support organisation and a research unit for the monitoring and control of radioactive contamination in the living and working environment in the Republic of Slovenia, and helped the Krško NPP in performing radiation protection services at the 2000 maintenance outage.

9.10 ENERGY INSTITUTE LTD.

Energy Institute Ltd. (Institut za elektroprivredu i energetiku d.d., Zagreb - IE) is by decision no. 318-36/4751/AS, issued by the SNSA of 24 August 1993, authorised for the following tasks related to nuclear safety:

- quality assurance and quality control of instrumentation and control systems (I&C) and verification of its operability and reliability during construction, pre-operational tests, trial operation and operation of a nuclear facility.

The activities related to nuclear safety during the 2000 outage and refuelling in the field of instrumentation, measurement and control systems (I&C area), consisted of control of primary systems according to the technical specifications for the Krško NPP

- Preparations for the inspection activities during the Outage 2000 - analysis of the outage plan,
- Review of the Krsko NPP internal procedures in the area of I&C,
- Review of modification packages for the I&C area,
- Inspections of outage activities in the Krško NPP in the I&C area,
- Inspection of the modifications of the I&C equipment and systems during the Outage 2000, with an emphasis in the steam generator replacement and modifications of the related systems (RC, FW, MS and BD).
- On the basis of the inspection activities performed during the outage the IE prepared the following documents:
    - Pre-outage weekly report No. 00 of 17 April 2000,
    - Supervision reports (total of 72) from the I&C area related to the Steam generator replacement,

* Weekly programme of activities (altogether 8) and weekly reports (altogether 8) for SNSA,
* Statement for Re-establishment of Reactor Criticality after the 2000 Outage and Refuelling at the End of the 16th Fuel Cycle in the Krško NPP No. 9/54-33/00.NE of 12 June 2000,
* Statement for Full Power Operation after the 2000 Outage and Refuelling at the End of the 16th Fuel Cycle in the Krško NPP No. 9/54-36/00.NE of 21 June 2000,
* Expert Report on Tasks, Corrective Measures and Tests during the Krško NPP Outage and Refuelling at the End of the 16th Fuel Cycle in the I&C domain No. 9/54-39/00.NEK of 17 July 2000.

  The Expert Report was the basis for the EIMV to compile the "Joint Expert Report on the 2000 Outage and Refuelling in the Krško NPP".

Reference: Report on the Activities of the Energy Institute Ltd., Zagreb in the Field of Nuclear Safety in 2000, No. 9/54-6/01.NE of 11 April 2001.

9.11 ENCONET

In Slovenia ENCONET activities were focused on safety analyses for Krsko and independent evaluation of analyses in relation with NEK modernisation and steam generators replacement (SGR)..

In year 2000, the integrated **safety assessment for Krsko NPP** was completed and final reports were issued during 2000. Also the final version was reviewed by an IAEA mission which found that the analyses is well done and it is representative of plant actual status and improvements over the years.

The details of the ISA work have been included in the report of year 1999.

Within the Steam generator replacement and Power uprate for NEK, ENCONET performed **Independent evaluation of Packages C and D2**, System evaluation and Snubber reduction, respectively. This work has started in 1998. In years 2000, all the analyses belonging to Package C were completed.

In Package C System evaluation, for a total of 13 systems Work reports were prepared and evaluated by ENCONET. In all cases, a preliminary Work report was prepared by NEK's contractor (Westinghouse and Parsons) upon which a preliminary independent evaluation report (PIER) was prepared by ENCONET. After clarification of comments, a final Work report was prepared and a Final independent evaluation report (FIER) prepared by ENCONET.

The following reports have been issued for the Package C system evaluations:

ENCO. FR-(00)-06	FIER "C-ENCO-NEK-1/2000 Expert Evaluation of SSR-NEK 9.5 "Spent Fuel Pit Cooling System, Rev 1"
ENCO-FR-(00)-10	FIER "C-ENCO-NEK-2/2000 SSR 9.8 Main Feedwater and Condensate System

ENCO-FR-(00)-11	FIER “C-ENCO-NEK-3/2000 SSR 9.1 Safety Injection system
ENCO-FR-(00)-12	FIER “C-ENCO-NEK-4/2000 SSR 9.3 CVCS
ENCO-FR-(00)-13	FIER “C-ENCO-NEK-5/2000 SSR 9.11 Blackout and fire analysis
ENCO-FR-(00)-15	PIER “C-ENCO-NEK-6/2000 DMP SAT
ENCO-FR-(00)-16	PIER D2 ENCO –NEK-5/00 NEK SSR 11.3.4 RCl reconciliation analysis
ENCO-FR-(00)-17	FIER “C-ENCO-NEK-7/2000” DMP SAT
ENCO-FR-(00)-18	FIER “C-ENCO-NEK-8-2000 SSR 9.6 NSSS Instrumentation
ENCO-FR-(00)-19	FIER “C-ENCO-NEK-9-2000 SSR NEK 10.4 Preliminary Westinghouse input to Tech Spec.
ENCO-FR-(00)-23	FIER “C-ENCO-NEK-10-2000 SSR 9.4 Make up water system
ENCO-FR-(00)-24	FIER “C-ENCO-NEK-11-2000 SSR 9.2 RHR system Rev 1
ENCO-FR-(00)-27	PIER “C-ENCO-NEK-12-2000 SSR NEK 10.3 USAR changes due to UPR, RSG and SGR.
ENCO-FR-(00)-28	FIER “C-ENCO-NEK-13-2000 SSR NEK 10.4 Tech Spec input Rev 2
ENCO-FR-(00)-31	FIER C-ENC-NEK-14/00 BOP systems Final
ENCO-FR-(00)-42	FIER “C-ENCO-NEK-15-2000 SSR NEK 9.10 TG.
ENCO-FR-(00)-45	FIER C ENCO –NEK-16/00 Expert evaluation of “SSR NEK 9.14 Minimum pump Performance curves.
ENCO-FR-(00)-48	FIER C ENCO –NEK-17/00 Expert evaluation of “SSR NEK 9.14 Minimum pump Performance curves.

Within package D2 snubber reduction, the work in year 2000 was focused on reviews actual analysis within the program and of the reconciliation analysis to accommodate for full snubbers.

The following reports have been issued for package D2 Snubber reduction:

ENCO. FR-(00)-04	Expert evaluation of “RECONCILIATION ANALYSIS CC011 Addendum to WENX 98/01” Structural analysis of Reactor Coolant loop for the Krsko NPP Vol 1 Piping analysis of the Reactor coolant loop”, Rev. 1
ENCO. FR-(00)-05	Expert evaluation of “RECONCILIATION ANALYSIS CC011 Addendum to WENX 98/01” Structural analysis of Reactor Coolant loop for the Krsko NPP Vol 2 Equipment supports”, Rev. 1
ENCO. FR-(00)-07	Expert evaluation of “RECONCILIATION ANALYSIS CC011 Addendum to SSr NEK 11.3.3.B
ENCO-FR-(00)-14	FIER SSr D2 ENCO –NEK-6/00 NEK 11.4.1 Rev. 2 feb 2000, tech justification of removal of large break from structural design basis
ENCO-FR-(00)-16	PIER D2 ENCO –NEK-5/00 NEK SSR 11.3.4 RCl reconciliation analysis
ENCO-FR-(00)-22	PIER SSR D2 ENCO –NEK-7/00 NEK 11.4.2 Rev. 0 feb 2000, technical justification of removal of auxiliarypipe rupture from structural design basis
ENCO-FR-(00)-30	FIER D2 ENCO –NEK-8/00 NEK SSR 11.3.4 RCl reconciliation analysis

ENCO-FR-(00)-34	FIER D2 ENCO-NEK 9/2000 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSr NEK 11.3.3.B Rev 1Final
ENCO-FR-(00)-35	FIER D2 ENCO-NEK 10/2000 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSr NEK 11.3.3.A Rev 1Final
ENCO-FR-(00)-36	FIER D2 ENCO-NEK 11/2000 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSR NEK 11.4.1 Rev 0 Final
ENCO-FR-(00)-37	FIER D2 ENCO-NEK 12/2000 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSR NEK 11.5 Volume 1 rev 2.
ENCO-FR-(00)-38	FIER D2 ENCO-NEK 13/2000 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSR NEK 11.5 Vol. 2 rev 2 final
ENCO-FR-(00)-39	PIER D2 ENCO-NEK 14/2000 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSR NEK 13.2 rev 1 preliminary
ENCO-FR-(00)-40	FIER SSR D2 ENCO –NEK-15/00 NEK 11.4.2 Rev. 1 May 2000, technical justification of removal of auxiliarypipe rupture from structural design basis
ENCO-FR-(00)-41	PIER SSR D2 ENCO –NEK-16/00 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSR NEK 11.5 Volume 3 rev 1.
ENCO-FR-(00)-43	FIER D2 ENCO –NEK-17/00 Expert evaluation of "Structural analysis…SSR NEK 11.5 Vol 1 Piping analysis of RCL. Rev 2.
ENCO-FR-(00)-44	FIER D2 ENCO –NEK-18/00 Expert evaluation of "Structural analysis…SSR NEK 11.5 Vol 2, Analsysi of primary suports. Rev 2.
ENCO-FR-(00)-46	FIER D2 ENCO-NEK 19/2000 Expert evaluation of "CC011 SSR NEK 13.2 Class 1 lines reconcilaition anslysis summary" rev 1 Final
ENCO-FR-(00)-49	FIER SSR D2 ENCO –NEK-16/00 Expert evaluation of "RECONCILIATION ANALYSIS CC011 Addendum to SSR NEK 11.5 Volume 3 rev 1.

ENCONET began working on Krsko PSR project in late 2000. This project is expected to continue over the next few years.

Quality assurance

In 2000 ENCONET maintained its ISO 9001 certification which was originally awarded in October 1998. In June 2000, an audit of certifying organisation (KEMA of Netherlands) was performed at ENCONET offices, which confirmed the certification, and issued several recommendations for improvements. Those were mainly related with the document control and with the procurement practices.

9.12 HIGH VOLTAGE AND ENERGETICS DEPARTMENT, FACULTY OF ELECTRICAL ENGINEERING AND COMPUTING, UNIVERSITY OF ZAGREB

The High Voltage and Energetics Department, Faculty of Electrical Engineering and Computing, University of Zagreb is by decision no. 318-38/90-1413/AS issued by the SNSA on 2 April 1991 authorised for the following tasks and services in the field of nuclear safety in the territory of the Republic of Slovenia:

- safety analysis of installations, components and systems of nuclear facilities;
- safety analysis for qualification of safety class electrical equipment.

Faculty of Electrical Engineering and Computing (FER) focused on two main areas of activities: first, related to the operation of the Krško NPP, and second, related to the educational activity in co-operation with the IAEA.

9.12.1 Activities Related to the Operation of the Krsko NPP

Activities related to the Krško NPP operation cover areas of the safety analysis and expert evaluations.

Safety Analysis

Safety analysis activity consisted of the deterministic and probabilistic safety analysis.

Within the frame of the deterministic safety analysis, RELAP5/mod3.2.2 model has been developed on the basis of RELAP5/mod2 model. Developed model has been used to perform accident analysis in support to the Krško Full Scope Simulator (KFSS) development. In addition, detailed 10-compartment model has been developed for the computer code GOTHIC and used for the same activity. Research activity focused on the development and validation of the coupled RELAP5/QUABOX-CUBBOX code. The code has been validated through the participation to the OECD Main Steam Line Break (MSLB) benchmark. Developed analytical tool has been applied to the Krško NPP MSLB analysis.

In the field of Probabilistic Safety Analysis (PSA) several projects were conducted. Feasibility study for On-line Risk Monitoring Tool was prepared as base for NEK further PSA applications. NEK PSA model was converted from Risk Spectrum DOS format to new Windows Risk Spectrum PSA Professional format. For the purpose of better-advanced PSA applications usage major asymmetries were removed from NEK PSA model.
During the year 2000, FER participated to the international USA NRC (Nuclear Regulatory Commission) co-operation programs: CAMP (Code Application and Maintenance Program) and COOPRA (Co-operative Probabilistic Risk Assessment Research).

Expert evaluations

Focus of the expert evaluations at the FER in the year 2000 was the Krško NPP program. As a part of this activity, Final Expert Evaluation Reports (FIER) were published for following reports:

- SSR-NEK-4.2, “Integrated Core design”, Revision 2, April 2000, Report number: A2-FER-NEK-00/50 (FER-ZVNE/SA/SO-FR35/00-1)
- SSR-NEK-7.9, “Subcompartment pressurisation”, Revision 2, Report number: A2-FER-NEK-00/38 (FER-ZVNE/SA/SO-FR36/00-0)
- SSR-NEK-10.2,“Startup Tests Program” Revision 1, April 2000, Report number: A2-FER-NEK-00/40 (FER-ZVNE/SA/SO-FR38/00-0)
- SSR-NEK-7.8, “Containment Response to LOCA”, Revision 1, Report number: A2-FER-NEK-00/45 (FER-ZVNE/SA/SO-FR40/00-0)
- SSR-NEK-8, “Setpoint Study” Revision 1, April 2000, Report number: A2-FER-NEK-00/49 (FER-ZVNE/SA/SO-FR42/00-0)
- SSR-NEK-4.3, “EOL MTC Relaxation/Elimination”, Revision 1, Report number: A2-FER-NEK-00/51 (FER-ZVNE/SA/SO-FR43/00-0)
- SSR-NEK-6.3.2, “Containment Response to Steam line Break”, Revision 2, May 2000, Report number: A2-FER-NEK-00/52 (FER-ZVNE/SA/SO-FR44/00-0)
- SSR-NEK-10.4, “Westinghouse Inputs for Technical Specifications”, Revision 2, April 2000, Report number: A2-FER-NEK-00/53 (FER-ZVNE/SA/SO-FR45/00-0)

Expert evaluation was performed for the Krško NPP diesel generator modification "NEK Fire Protection Action Plan Implementation, Modification for Diesel Generator A" (report no. FER-ZVNE/SA/SO-ER01/00-0).

9.12.2 Educational Activities in Co-operation with the IAEA

In the year 2000 FER established significant educational activity in the co-operation with the IAEA aiming at the reduction of the "user effect" in the field of safety analysis. As a part of this program a number of the IAEA fellows passed 6-months fellowship programs. The activity peaked with the 3-week Regional Training Course on the Use of System Computer Codes for Accident Analysis. Theoretical and practical lectures were delivered to 22 participants from Middle and Eastern Europe countries. Focus of the course was the application of the world main system computer codes (ATHLET, CATHARE and RELAP) for the NPP safety analysis. Particularity of the course was the final examination that majority of the participants passed with success. Course was independently judged as a success by a vast majority of the participants as well as by the IAEA, opening path for the preparation of similar activities in the future.

9.13 CONCLUSION

Technical support organisations represent a vital part in surveillance of operations, backfitting, modifications and maintenance work on nuclear facilities. The work of technical support organisations is supplemental to the work of the Nuclear Safety Inspection Section, which has insufficient manpower to cover all the activities in the nuclear facilities related to nuclear safety.

The report by the technical support organisation shows that the major part of their engagement involves surveillance of annual outage and refuelling. With the replacement of steam generators the duration of annual outage will be shorter, and the Inspectorate and the technical support organisations should be prepared accordingly. The shorter outage will require better planning of surveillance activities and even better co-ordination and co-operation between the Krško NPP, the Inspectorate and the technical support organisations.

The report also shows that technical support organisations take care of regular training of their personnel in the fields within their responsibility. Very important is the organisation of quality assurance, which is also verified by the SNSA.

10 INSURANCE OF LIABILITY FOR NUCLEAR DAMAGE

Pool for insurance and reinsurance of nuclear risks GIZ (Nuclear pool GIZ) is a special legal-organizational form of insurance company, dealing with insurance and reinsurance of nuclear risks. The pool was established in 1994, when Triglav insurance company, Maribor insurance company, Adriatic insurance company, Tilia insurance company, Slovenica insurance company, Mercator insurance company, Merkur insurance company and Sava re-insurance company signed the Contract on establishment of Nuclear pool. The Nuclear pool GIZ is organized as business association of interest and functions on the base of Ministry of Finance licence from March 17 1994 (decision Nr. 301-13/94). Triglav insurance company and Sava re-insurance company have the largest share in pool. The Nuclear pool GIZ started to function on April 1 1994 and has a registered office in the seat of Triglav insurance company, Miklosiceva 19, Ljubljana. In 2000 the Nuclear pool GIZ accepted a new member, Triglav RE re-insurance company, and increased the number of its members to 9 and supplementary realized the principle, that nuclear risk should be distributed to as many members in state as possible. Because of successfulness of previous operation of the Nuclear pool GIZ, the members of pool decided to increase capacities for domestic risks from 5.600.000 USD to 6.620.000 USD and for foreign risks from 4.550.000 USD to 5.960.000 USD.

Until the declaration of independence by Slovenia and Croatia the NPP Krsko was insured at the then Yugoslav Nuclear Pool, Zagreb. After Slovenia and Croatia became independent states, the Slovenian nuclear pool GIZ and the Croatian nuclear pool agreed to co-insure the NPP Krsko in equal shares of 50%. For the period from May 6 2000 to May 5 2001 both pools issued insurance policies covering nuclear, fire and other risks to the property of the NPP Krsko, with a total annual limit of 800 million USD. Both pools have a 2% joint share in the NPP Krsko, the remaining share is reinsured by 22 foreign pools, of which the British, the German, the French and the Japan pools have major shares.

The NPP Krsko liability for damage to third persons is in accordance with Slovenian legislation insured only by the Slovenian nuclear pool with an annual limit of 42 million USD, which is in accordance with Decree on Establishment of the Amount of Limited Operator’s Liability for Nuclear Damage and on Establishment of the Amount of Insurance for Liability for Nuclear Damage. Slovenia’s own share of the pool is 3%, the remaining share is reinsured by 17 foreign pools, of which the British, the German, the French the Japan and the Swedish pools have major shares.

In 2000 the NPP Krsko did not report any damage to the Nuclear pool GIZ.

CAPACITIES OF NUCLEAR POOL IN 2000

Domestic businesses

MEMBER	Sharing in 2000		Change of shares %
	The amount (USD)	Share %	
1. Triglav insurance company	3.523.902	53,23	- 0,83
2. Sava re-insurance company	786.910	11,89	- 0,19

3. Maribor insurance company	630.532	9,52	- 0,16
4. Adriatic insurance company	551.840	8,34	- 0,13
5. Tilia insurance company	358.000	5,41	- 0,99
6. Slovenica insurance company	413.619	6,25	- 0,09
7. Triglav RE re-insurance company	161.490	2,44	2,44
8. Krek's insurance company	129.138	1,95	- 0,03
9. Merkur insurance company	64.569	0,97	- 0,02
TOTAL	**6.620.000**	**100,00**	**0,00**

Foreign businesses

MEMBER	**Sharing in 2000**		**Change of shares %**
	The amount (USD)	**Share %**	
10. Triglav insurance company	3.185.072	53,44	- 0,62
11. Sava re-insurance company	712.228	11,95	- 0,13
12. Maribor insurance company	570.145	9,57	- 0,11
13. Adriatic insurance company	498.801	8,37	- 0,10
14. Tilia insurance company	291.200	4,88	- 1,52
15. Slovenica insurance company	373.043	6,26	- 0,08
16. Triglav RE re-insurance company	153.570	2,58	2,58
17. Krek's insurance company	117.294	1,97	- 0,01
18. Merkur insurance company	58.647	0,98	- 0,01
TOTAL	**5.960.000**	**100,00**	**0,00**

11 POOL FOR DECOMMISSIONING OF THE KRŠKO NPP AND FOR RADWASTE DISPOSAL FROM THE KRŠKO NPP

11.1 THE FULFILMENT OF LEGAL OBLIGATIONS OF THE KRŠKO NPP FROM THE TITLE OF CONTRIBUTIONS TO DECOMMISSIONING

In the year 2000, it was paid 3,869 million SIT by the Krško NPP that means 74% more payments as in the last year.

Table 11.1: Total review of the payments and long-term obligations of the Krško NPP in period 1995-2000

Period	Payments	Total debt in 000 SIT
1995	0	2.971,316
1996	200,000	6.581,636
1997	698,778	8.645,093
1998	1.864,905	9.699,883
1999	2.226,999	**10.452,197**
2000	3.869,046	9.943,811
Total	**8.859,728**	**9.943,811**

Because of the fact that the Krško NPP was not regularly settle its obligations by 31 May 2000, the Pool and the Krško NPP came to the agreement on settlement of expiration obligations in the amount of 1,719 million SIT. In September 2000 they also came to the agreed annex which determines expiration obligations from the past. With this agreement and the annex, it was regulated all expiration obligations of the Krško NPP for electric energy delivered to the Slovenian electric economy and now these obligations are settled regularly. But the debt of the Krško NPP for electric energy, delivered to the Croatian electric economy, is still outstanding and unregulated.

From 20 June 2000 to the end of the year, the Krško NPP settled all current obligations and all agreed obligations from the past.

On 31 December 2000, the debt of the Krško NPP reached 9,944 million SIT. The portion of the debt of the Krško NPP for electric energy, delivered to the Croatian electric economy was 6,913 million SIT.

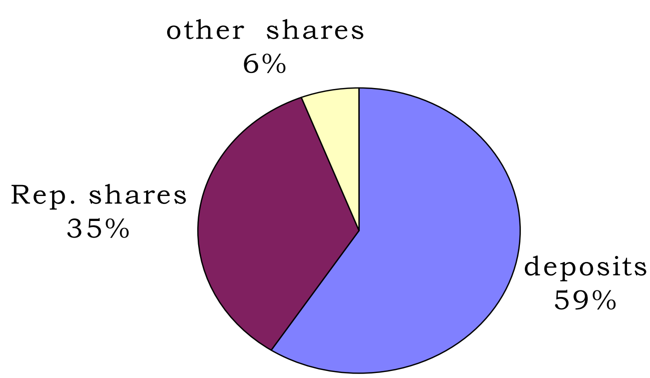
The portion of the debt of the Krško NPP for electric energy, delivered to the Slovenian electric economy was 3,031 million SIT. The Slovenian debt has still not been payable. It is regulated by the settlement I, the agreement IV and the annex to the agreement IV.

In the year 2000 the total debt of the Krško NPP started to lower for the first time, because the Krško NPP paid for 508 million SIT of expiration obligations from the past.

11.2 INVESTMENT POLITICS IN THE YEAR 2000

In the year 2000 the Pool led fully considered principles of safe investing and dispersion. Because of the safe investment the Pool had almost the whole period at least 30% of financial investment in government stocks. These stocks were issued and guaranteed by the Republic of Slovenia.

Picture 11.1: Structure of investment on 31 December 2000



On 31 December 2000 the Pool managed with 1,415 million SIT of financial investments. This represents an enlargement of 96% taking into account the investment situation at the end of 1999. The structure of the investments is: 59% of assets is invested in the form of deposits in different Slovenian banks, next 35% represents governmental stocks (domestic and EURO shares) and 6% has Pool in other shares.

Investments in governmental stocks are dispersed in nine different editions, investments in deposit are dispersed at nine commercial banks.

Profit of portfolio of the Pool was **TOM+5.6% or DEM+7.6%** in the year 2000. Considering all exchange rates on the stocks market, we can find out at assessment of portfolio of the Pool that the Pool can make, in case of selling of all stocks, about 157 million SIT of capital profit.
In the year 2000, the Pool made 1,044 million SIT of financial assets with investment.

Table 11.2: Financial situation of investment of the Pool from 1996 to the end of 2000

Business year	1996	1997	1998	1999	2000
Situation of financial investment in 000 SIT	103.697	911.175	2.855.342	5.314.728	10.414.905

11. 3 ASSESSMENT FOR THE YEAR 2001

According to the financial plan for the year 2001 and assuming that the Krško NPP will settle its obligations, the Pool is planning an income from the title of regular contribution in the amount of 2,389 million SIT and 1,611 million SIT from the title of demands from the past years.

With successful investment of assets the Pool can make about 700 million SIT of real incomes from financing; at the end of the year 2001 the Pool can manage about 16 billion SIT of financial investments.

Sources:

- Information on the financial status of the Pool in the year 2000, prepared by the Pool for Decommissioning of the Krško NPP and for Radwaste Disposal from the Krško NPP, No. 2000-UO, dated 13 December 2000 and
- facsimile sent the Pool for Decommissioning of the Krško NPP and for Radwaste Disposal from the Krško NPP, dated 5 July 2001

12 OPERATION OF NUCLEAR FACILITIES WORLD-WIDE

12.1 REVIEW OF NUCLEAR POWER PLANTS WORLD-WIDE

According to the information provided by the International Atomic Energy Agency, at the end of 2000, there were 438 nuclear power plants in operation in 31 countries and in Taiwan. Six new units were connected to the grid during the last year. The overall nuclear capacity was 351,327 MW. In 2000, six new nuclear power plants were connected to the grid with a total power of 3056 MW, three of them were in India (Kaiga-1, Rajasthan-3 and Rajasthan-4), and one in the Pakistan (Chashma), Brazil (Agra-2) and the Czesh Republic (Temelin-1). At present, 31 nuclear power plants are under construction.

In 2000, the share of electrical energy supplied from nuclear power plants was still considerably high in ten countries: France 76.4%, Lithuania 73.7%, Belgium 56.8%, Slovak Republic 53.4%, Ukraine 47.3%, Bulgaria 45%, Hungary 42.2%, Republic of Korea 40.7%, Sweden 39%, and Switzerland 38.2 %. Overall, 17 countries relied on nuclear power plants to meet at list 25% of their total electricity needs among them is Slovenia with 37.4% share of produced electrical energy. In general, there are 17 countries world-wide and Taiwan, which rely 25% or more of their needs upon electrical energy produced from nuclear power plants.

The total amount of electicity generated by nuclear in 2000 increased by some 2 % to 2447.53 TWh. Comulative world-wide operating experiance from civil nuclear power plants at the end of 2000 exceeded 9800 reactor years. Geografically, the break-down of existing nuclear power units is as follows: North America 118 units, Western Europe 150 units, Central/East Europe and Newly Independent States 68 units, Middle East Far East and South Asia 94 units.

Table 12.1: Country-by-country figure for the number of nuclear power units in operation and under construction and the end of 2000, total nuclear output and nuclear share in total electricity (NucNet News No. 165/01/A, 3 May 2001).

COUNTRY	REACTORS		OUTPUT	
	Operation	Construction	TWh	% Share
Argentina	2	1	5.73	7.26
Armenia	1		1.84	33
Belgium	7		45.4	56.75
Brazil	2	-	5..55	1.45
Bulgaria	6		18.18	45
Canada	14		68.68	11.8
China	3	8	16	1.19
Czech Rep.	5	1	13.59	18.5

Finland	4		21.06	32.15
France	59		395	76
Germany	19		159.6	30.57
Hungary	4		14.72	42.19
India	14		14.21	3.14
Iran		2		
Japan	53	3	304.87	33.82
Korea, Republic of	16	4	103.5	40.73
Lithuania	2		8.4	73.68
Mexico	2		7.92	3.86
Netherlands	1		3.7	4
Pakistan	2		1.08	1.65
Romania	1	1	5.05	10.86
Russia	29	3	119.65	14.95
South Africa	2		12.99	6.58
Slovak Rep.	6	2	16.49	53.43
Slovenia	1		4.54	37.38
Spain	9		59.3	27.63
Sweden	11		54.8	39
Switzerland	5		24.95	38.18
UK	35		78.3	21.94
Ukraine	13	4	72.4	47.28
USA	104		753.9	19.83
Total*	**438**	**31**	**2447.53**	

* Total includes Taiwan: six units, two under construction, nuclear share 23.64%.

12.2 NUCLEAR SAFETY WORLD-WIDE

19.2.1 IAEA Missions

In 2000 IAEA is continuing with its activities in achiving and maintaining a high level os safety of nuclear installations operating worlwide through international harmonisation of safety standards and norms and provision of advice and services. The agency provides safety services which cover the areas addressed by the safety standards, the siting, design and operation of nuclear power plants, the safety of research reactors and the regulatory aspects of safety. In 2000 the IAEA missions are described in tabels from 12.2 to 22.7.

Table 12.2. International Probabilistic Safety Assessment Review Team (IPSART) mission in 2000

REVIEW TYPE	COUNTRY	PLANT
Updated level ½ PSA Level 1 and 2 PSA Level 1 and 2 PSA Level 1 and 2 PSA Risk scoping study Follow up	Slovenia Spain Ucraine Lithuania Netherlands Russian Federation	Krško Jose Cabrera South Ukraine Ignalina High Flux Research Reactor Tianwan WWER 1000 (China)

Table 12.3: Engineering Safety Review Services (ESRS) missions in 2000

COUNTRY	SITE/PLANT	SERVICE
South Africa	Koeberg PBMR	Design safety review
Is. Rep.of Iran	Bushehr	Design safety review
Bangladesh	Roopur	Site safety review preparatory mission
Indonesia	Muria	Site safety review follow-up
China	Tianwan	Instrumentation and control review mission
Egypt	El-Dabaa	Review of regulatory/safety aspects of feasibility study for desalination
Korea, Rep. of	Korea Next Generation Reactor	Review of safety and regulatory requirements and guidance
Morocco	Maamora Centre d`Etudes Nucleaires	Seismic safety review follow-up
Turkey	TR-2 research reactor	Seismic safety review follow-up
Romania	Cernavoda	Seismic safety review
Armenia	Yerevan	Seismic safety review follow-up
Is. Rep. Of Iran	Bushehr	PSAR review assisstance
Bolgaria	Kozloduy 5 and 6	Review of modernization programme

Table 12.4: Operational Safety Review Team (OSART) missions in 2000

TYPE	COUNTRY	LOCATION/NUCLEAR POWER PLANT	PLANT TYPE

Full OSART	France	Belleville	PWR
Full OSART	Switzerland	Muehleberg	BWR
Full OSART	USA	North Anna	PWR
Reduced scope OSART	Czech Republic	Temelin	WWER
OSART lollow-up	France	Golfech	PWR
OSART lollow-up	Spain	Asco	PWR
OSART lollow-up	Ukrine	Khmelnitsky	WWER

Table 12.5: Safety Culture Enhancement Programme (SCEP) services in 2000

TYPE	**COUNTRY**	**LOCATION/NUCLEAR POWER PLANT**
Pilot mission	United Kingdom	Hartlepool
Workshop	Pakistan	Kanupp
Workshop	Ukraine	Khmelnitsky
Workshop	Lithuania	VATESI
Introductary seminar	Russian Federation	VNIIAES

Table 12.6: Incident Reporting System for Research Reactors (INSARR) in 2000

COUNTRY	SITE/PLANT
Netherlands	HOR Research Reactor, Delft
Poland	Maria Research Reactor, Warsaw

Table 19.7: International Regulatory Review Team (IRRT) missions in 2000

MISSION TYPE	COUNTRY
Reduced scope	Czech Republic
Full scope	Finland
Full scope	Hungary
Full scope	China
Preparatory Meeting	Mexico

Source: Annual Report for 2000, IAEA, GC(45)/4

12.2.2 PROGRAMMES OF THE INTERNATIONAL AGENCY FOR ATOMIC ENERGY

The programmes of the International Agency for Atomic Energy are focused on the use of nuclear energy for peaceful purposes as indicated in Table 12.8. Most of the funds are allocated to food production in agriculture for disease prevention and health care and for location and protection of water sources.

Table 12.8.: TECHNICAL CO-OPERATION DISBURSEMENTS BY AGENCY PROGRAMME IN 1997 (in thousands of dollars)

Programme	**Total**
Nuclear power	3.903,5
Nuclear fuel cycle and waste technology	4686.2
Comparative assessment of energy sources	2492,6
Food and agriculture	9554.1
Human health	5470.5
Marine environment, water resources and industry	5759.2
Physical and chemical sciences	8273.9
Nuclear safety	5217.9
Radiation safety	3394.3
Radioactive waste safety	1823.9
Co-ordination of safety activities	2480.7
Safeguards	70617.2
Security of material	861.1
Management and technical co-operation for development	11070.8
Total	**135605.9**

12.2.3 INES - INTERNATIONAL NUCLEAR EVENT SCALE

The IAEA information system - the International Nuclear Event Scale (INES) received 25 reports in 2000, of which 12 were reports on events in nuclear power plants, 11 on orphan sources and 2 on radioactivity event. This year the INES Scale was extended also to the events on use of radioactive sources and on the transport of radioactive substances. Among events in nuclear power plants, 2 reports were on events of the second degree – “incident”, 4 on events of the first degree – “anomaly”, 5 reports were on events which were of no safety significance (below scale - degree 0), and one event was outside the scale. Among other events, 1 report was on event of the fourth degree, 2 reports were on events of the second degree and), 10 on events of the first degree. From Slovenia there were no reports to the INES Scale, because there were no accidents, incidents or other events related to nuclear or radioactive materials.

In 2000 the most serious accident with radioactive substances occured in Meet Halfa (Egypt). On June 26 the authorities ascertained that two persons died and some other were badly injured because they received high doses of radiation. It was established, that a family member found iridium-192 source with estimated intensity of 1,85 TBq and brought it home. The whole family received high doses, two persons died and the other were badly injured. After analysis the event was classified on fourth degree – “accident without significant off-site risk” on the INES Scale.

13 ABBREVIATIONS

13.1 KRŠKO NPP SISTEMS

AF	AUXILIARY FEEDWATER	SISTEM POMOŽNE NAPAJALNE VODE
AS	CONTROL BOARD AND COMPUTER SYSTEM	KONTROLNA PLOŠČA IN RAČUNALNIŠKI SISTEM
BD	STEAM GENERATOR BLOWDOWN SYSTEM	SISTEM ZA KALUŽENJE UPARJALNIKOV
BR	BORON RECYCLE SYSTEM	SISTEM ZA OBNOVO BORA
CA	COMPRESSED AIR SYSTEM	SISTEM STISNJENEGA ZRAKA
CA	STATION SERVICE AIR (SECONDARY)	SISTEM OSKRBNEGA ZRAKA
CB	CONTROL BOARD SYSTEM	SISTEM KONTROLNE PLOŠČE
CC	COMPONENT COOLING SYSTEM	SISTEM ZA HLAJENJE KOMPONENT
CF	CHEMICAL FEED SYSTEM	SISTEM ZA DODAJANJE KEMIKALIJ
CI	CONTAINMENT SPRAY SYSTEM	SISTEM ZA PRHANJE ZADRŽEVALNEGA HRAMA
CK	CONDENSATE POLISHING SYSTEM	SISTEM ZA ČIŠČENJE KONDENZATA
CO	CONDENSER & ACCESSORIES	SISTEM KONDENZATORJA S POMOŽNIMI SISTEMI
CP	ROD CONTROL AND POSITION	SISTEM KONTROLE IN POLOŽAJA PALIC
CS	CHEMICAL & VOLUMNE CONTROL SYSTEM	SISTEM ZA URAVNAVANJE KEMIJSKE SESTAVE IN PROSTORNINE
CT	COOLING TOWER	SISTEM HLADILNIH STOLPOV
CU	COMPUTER SYSTEM	RAČUNALNIŠKI SISTEM
CV	CONDENSER AIR REMOVAL SYSTEM	SISTEM ODVAJANJA ZRAKA IZ KONDENZATORJA
CW	CIRCULATING WATER SYSTEM	SISTEM OBTOČNE HLADILNE VODE
CX	CONTAINMENT TESTING & PRESSURIZING SYSTEM	SISTEM ZA TESTIRANJE IN TLAČENJE ZADRŽEVALNEGA HRAMA
CY	CONDENSATE SYSTEM	KONDENZATNI SISTEM
CZ	CHILLED WATER SYSTEM	SISTEM OHLAJENE VODE
DC	DC POWER SUPPLY & DISTRIBUTION	SISTEM NAPAJANJA IN DISTRIBUCIJE ENOSMERNEGA TOKA
DD	DEMINERALIZED WATER SYSTEM	SISTEM DEMINERALIZIRANE VODE
DF/ DO	DIESEL OIL STORAGE SYSTEM	SISTEM SHRANJEVANJA DIZELSKEGA GORIVA
DG	DIESEL GENERATOR SYSTEM	SISTEM DIZELSKEGA GENERATORJA
DR	FLOOR AND EQUIPMENT DRAINS	SISTEM DRENAŽE TAL IN OPREME
EE	ELECTRICAL SYSTEM	ELEKTRIČNI SISTEM
EI	ELETRICAL INTERCONNECTIONS	SISTEM ELEKTRIČNIH POVEZAV
EP	ELECTRICAL SYSTEM (BOP, AC & POWER SUPPLY)	ELEKTRIČNI SISTEM (IZMENIČNO NAPAJANJE SEKUNDARNEGA DELA ELEKTRARNE)

ER	ENVIRONMENTAL MONITORING SYSTEM	SISTEM ZA NADZOR OKOLJA
ES	ELECTRICAL MISCELLANIOUS A. C. DISTRIBUTION	DISTRIBUCIJA RAZLIČNEGA ELEKTRIČNEGA NAPAJANJA
EX	EXTRACTION STEAM SYSTEM	SISTEM ODVZEMNE PARE
FC	FEEDWATER CHEMICAL ADDITION	DODAJANJE KEMIKALIJ V SISTEM GLAVNE NAPAJALNE VODE
FD	FLOOR & EQUIPMENT DRAINS	SISTEM DRENAŽE TAL IN OPREME
FH	FUEL HANDLING SYSTEM	SISTEM ZA ROKOVANJE Z GORIVOM
FO	FUEL OIL TRANSFER	SISTEM GORIVA ZA POMOŽNE KOTLE
FP	FIRE PROTECTION SYSTEM	SISTEM ZAŠČITE PRED POŽARI
FW	FEEDWATER SYSTEM	SISTEM GLAVNE NAPAJALNE VODE
GH	WASTE PROCESSING GAS SYSTEM	SISTEM OBDELAVE ODPADNIH PLINOV
GN	MAIN GENERATOR & ACCESSORIES	GLAVNI GENERATOR IN NJEGOVI POMOŽNI SISTEMI
HC	H_2 CONTROL & MONITORING	KONTROLA IN NADZOR VODIKA V ZADRŽEVALNEM HRAMU
HD	HEATER DRAIN SYSTEM	SISTEM DRENAŽE GRELNIKOV
HS	AUXILIARY STEAM HEATING SYSTEM	SISTEM PARNEGA OGREVANJA
HT	PIPE HEAT TRACING	SISTEM OGREVANJA CEVI
HW	HOT WATER SYSTEM	SISTEM TOPLE VODE
IA	INSTRUMENT AIR	SISTEM ZRAKA ZA INSTRUMENTACIJO
IC	IN-CORE INSTRUMENTATION SYSTEM	SISTEM INSTRUMENTACIJE V SREDICI
IN	INSTRUMENT & CONTROL	SISTEM INSTRUMENTACIJE IN NADZORA
LO	TURBINE LUBE OIL SYSTEM	SISTEM MAZALNEGA OLJA ZA TURBINO
LS	LIGHTING & UTILITY POWER SYSTEM	SISTEM RAZSVETLJAVE IN NAPAJANJA
ME	MISCELLANEOUS EQUIPMENT – NUCLEAR	RAZLIČNA STROJNA OPREMA
MP	MECHANICAL EQUIPMENT – SECONDARY	STROJNA OPREMA – SEKUNDARNA
MS	MAIN STEAM	SISTEM GLAVNE PARE
MT	MISCELLANEOUS TOOLS, MACHINES & APPLIANCES	RAZLIČNO ORODJE, STROJI, OPREMA
MW	REACTOR MAKEUP WATER SYSTEM	SISTEM REAKTORSKE DODAJALNE VODE
NI	NUCLEAR INSTRUMENTATION	JEDRSKA INSTRUMENTACIJA
PC	PHONE & COMMUNICATION	TELEFONI IN KOMUNIKACIJE
PG	PLANT GAS SUPPLY SYSTEM (O, N, H, CO_2, CL)	SISTEM ZA OSKRBO S PLINI (O, N, H, CO_2, CL)
PW	PRETREATMENT WATER	SISTEM PREDPRIPRAVE VODE
RC	REACTOR COOLANT SYSTEM	REAKTORSKI HLADILNI SISTEMI
RD	RIVER DAM	SISTEM REČNEGA JEZU
RH	RESIDUAL HEAT REMOVAL SYSTEM	SISTEM ZA ODVAJANJE ZAKASNELE TOPLOTE

RM	RADIATION MONITORING SYSTEM	SISTEM RADIOLOŠKEGA NADZORA
SA	AUXILIARY STEAM SYSTEM	SISTEM POMOŽNE PARE
SC	STEEL CONTAINMENT SYSTEM	JEKLENI ZADRŽEVALNI HRAM
SD	STEAM DUMP CONTROL	SISTEM ZA ODVAJANJE PARE
SE	SECURITY SYSTEMS	VAROVALNI SISTEMI
SF	SPENT FUEL PIT COOLING & CLEANUP	SISTEM HLAJENJA IN ČIŠČENJA BAZENA ZA IZRABLJENO GORIVO
SF	SPENT FUEL POOL LEAK DETECTION & SKIMMER	SISTEM DETEKCIJE PUŠČANJA IN POSNEMANJE BAZENA ZA IZRABLJENO GORIVO
SF	SPENT FUEL PIT (vent & drain)	PREPIHOVANJE IN DRENAŽA BAZENA ZA IZRABLJENO GORIVO
SG	SAFEGUARDS ACTUATION	SISTEM SPROŽANJA VARNOSTNIH SISTEMOV
SI	SAFETY INJECTION SYSTEM	SISTEM VARNOSTNEGA VBRIZGAVANJA
SS	SAMPLING SYSTEM (NUCLEAR)	SISTEM VZORČENJA (JEDRSKO)
SW	SERVICE WATER	SISTEM OSKRBOVALNE VODE
SX	TURBINE PLANT SAMPLING SYSTEM	SISTEM VZORČENJA SEKUNDARNIH SISTEMOV
TC	TURBINE PLANT AUX. COOLING WATER	SISTEM VODE ZA HLAJENJE POMOŽNIH TURBINSKIH SISTEMOV
TD	TURBINE DRAINS	SISTEM DRENAŽ TURBINE
TG	TURBINE GLAND STEAM	SISTEM LABIRINTNE PARE TURBINE
TR	THERMAL REGENERATION SYSTEM	SISTEM TOPLOTNE REGENERACIJE
TS	SG TEST PROGRAM	PROGRAM TESTIRANJ UPARJALNIKOV
TU	MAIN STEAM TURBINE ACCESSORIES	PARNA TURBINA IN POMOŽNI SISTEMI
VA	VENTILATION & A/C	SISTEM PREPIHOVANJA IN KLIMATIZIRANJA PROSTOROV
VC	VACUUM PRIMING SYSTEM	SISTEM ZA PRIPRAVO VAKUUMA
VM	VIBRATION MONITORING SYSTEM	NADZOR VIBRACIJ
VP	TB VENTILATION & AIR CONDITIONING SYSTEM	PREPIHOVANJE IN KLIMATIZACIJA TURBINSKE ZGRADBE
WC	WIRE WAY & CONDUIT	SISTEM KABELSKIH POTI
WD	WASTE DISPOSAL SYSTEM	SISTEM ODLAGANJA ODPADKOV
WP	LIQUID WASTE PROCESSING SYSTEM	SISTEM OBDELAVE TEKOČIH RADIOAKTIVNIH ODPADKOV
WS	REFUELING WATER STORAGE TANK HEAT & PURIFICATION	SISTEM SEGREVANJA IN ČIŠČENJA VODE V TANKU ZA MENJAVO GORIVA
WT	WATER TREATMENT SYSTEM	SISTEM PRIPRAVE VODE
XI	PROCESS INSTRUMENTATION & CONTROL	SISTEM PROCESNE INSTRUMENTACIJE IN NADZORA
XR	TRANSFORMER SYSTEM	TRANSFORMATORJI

13.2 ANOTHER ABBREVIATIONS OSTALE KRATICE

ACPDR	Administration for Civil Protection and Disaster Relief of RS
AFW	Auxiliary Feedwater System Unavailability Factor
ALARA	As Low As Reasonable Achievable
AOP	Abnormal Operating Procedure
ARAO	Agency for Radwaste Management
ATWS	Anticipated Transient Without Scram
AVB	Antivibrational Bars
BSS	Basic Safety Standard
CEEC	Central and East European Countries
CFR	Code of Federal Regulations
COBISS	Cooperative Online Bibliographic Systems and Services
CONCERT	Concentration on European Regulatory Tasks
CROSS	Central Radiation Early Warning System of Slovenia
CTBT	Comprehensive Nuclear-test-ban Treaty
CVCS	Chemical Volume Control System
DBE	Deütsche Gesellschaft zum Bau und Betreib von Endlagen für Abfallstoffe G mbH
DFBN	Debris Filter Bottom Nozzle
DG XI	Directorate General XI
DG IA	Directorate General IA
DNB	Departure from Nuclear Boiling
DRLs	Diagnostic reference Levels
EAEC	European Atomic Energy Community
EC	European Commision
ECT	Eddy Current Testing
ECURIE	European Commission for Urgent Radiological Information Exchange
EEAR	Engineering Evaluation and Assistance Request
EIMV	Milan Vidmar Electrical Institute
EIP	Emergency Implementation Procedures
ELME	Ecological Laboratory with Mobile Unit
ENIS-G	European Nuclear Installation Safety Group
EOP	Emergency Operating Procedure
EPA	Environmental Protection Agecy
EQ	Environmental Qualification
ERDS	Emergency Response Data System
ERWD	European Radioactive Waste Regulator's Forum
ESD	Enrance Surface Dose
EURDEP	European Union Radiological Data Exchange Platform
FAGG	Faculty of Civil Engineering and Geodesy
FER	Faculty of Electrical Engineering and Computer Science, Zagreb
FIS	Flow Indicator Switch
FPAP	Fire Protection Action Plan
FRI	Fuel Reliability Data Indicator
FS	Faculty of Mechanical Engineering, Ljubljana
GIZ	The Pool for insurance and Reisurance of Nuclear Damage Risk
GM	Geiger Muller
HIC	High Integrity Containers
HIRS	Health Inspectorate of the Republic of Slovenia
HMI	Hydrometeorological Institute
IBE	IBE Consulting Engineers
IAEA	International Atomic Energy Agency
ICISA	International Commission for Independent Safety Assessment

ICJT	Milan Čopič Nuclear Training Centre
ICRP	International Commision for Radiation Protection
IDDS	In-drum Drying System
IE	Initiating Event
IGGG	Institute of Geology, Geotechnics and Geophysics
IJS	Jožef Stefan Institute
IMI	Institute for Medical Research and Occupational Health, Zagreb
IMK	Institute of Metal Constructions
IMT	Institute of Metals and Technologies
INES	International Nuclear Event Scale
INEX	International Nuclear Exercise
INPO	Institute of Nuclear Power Operations
INSARR	Integrated Safety Assessment of Research Reactors
IOS	Institute for Occupational Safety
IPERS	International Peer Review Service
IPPAS	International Physical Protection Advisory Service
IPSART	International Probabikistic Safety Assessment Review Team Service
IRB	Institute »Rudjer Boškovič«, Zagreb
IRRT	International Regulatory Review Team Mission
ISEG	Independent Safety Evaluation Group
ISI	Inservice Inspection
ISO	International Standard Organization
ISOE	International System on Occupational Exposure
IV	Welding Institute
JRC	Joint Research Centre
NE Krško	Krško Nuclear Power Plant
KFSS	Krško Full Scope Simulator
LBB	Leak Before Break
LCO	Limiting Conditions for Operating
LILW	Low and Intermediate Level Waste
MCB	Main Control Board
MLZM	Mežica Lead and Zinc Mine
MPB	Multi Purpose Building
MSIV	Main Steam Isolation Valve
MTC	Modern Temperature Coefficient
NEA	Nuclear Energy Agency
NEK-STS	Krško NPP Standard Technical Specifications
NFPA	National Fire Protection Agency
NERS	Network of Regulators of Countries with Small Nuclear Programmes
NIS	Newly Independent States
NLC	Nuclear Law Committee
NNSR	Non Nuclear Safety Related
NOAA	US National Oceanic and Atmospheric Administration
NPP	Nuclear Power Plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRC	Nuclear Regulatory Commission
NSEC	Nuclear Safety Expert Commission
NSG	Nuclear Suppliers Group
NSR	Nuclear Safety Related
NRWG	Nuclear Regulators Working Group
OECD/NEA	Operation for Economic Co-operation and Development/Nuclear Energy Agency
QA	Quality assurance
QC	Quality Control
OEF	Feedback of Operating experiance
OSART	Operational Safety Assessment Review Team

OSEP	Training on Off Site Emergancy Preparednes
OTJE	Basics on the Technology of Nuclear Power Plants
PAEC	Short-Lived Radon Progency
PHARE	Central and Eastern European Countries Assistance for Economic Restructuring
PIS	Process Information System
Program TMI	("Three Mile Island")
PSA	Probabilistic Safety Analysis
PSR	Periodic Safety Review
RAMG	Regulatory Assistance Management Group
RB	Reactor Building
RCP	Reactor Coolant Pump
RPU	Radiological Protection Unit
RS	Republic of Slovenia
RSWG	Reactor Safety Working Group
RTD	Resistance Thermal Detector
RWMC	Radioactive Waste Management Committee
RWST	Refueling Water Storage Tank
SAMG	Severe Accident Management
SFAT	Spent Fuel Attribute Test
SG	Steam Generator
SKI	Swedish Nuclear Power Inspectorate
SNSA	Slovenian Nuclear Safety Administration
SSPS	Solid State Protection System
STS	Technical Specifications of Krško NPP
TLD	Thermoluminescent personal dosimeters
TPP	Thermal Power Plant
TRIGA	Training Research Isotope General Atomic
TSO	Technical Support Organizations
TSOG	Techical Safety Organisations Group
TTC	Tube Type Container
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
US-DOE	United States Department of Energy
US NRC	United States Regulatory Commission
UT	Ultrasonic Testing
WANO	World association of Nuclear Operators
WBC	Whole Body Counter
WENRA	Western European Nuclear Regulators Association
WHO	World Health Organization
ZAC	Zanggerjev komite
ZVD	Institute of Occupational Health
ŽVM	Žirovski vrh Mine in Decommissioning