STATE NUCLEAR REGULATORY COMMITTEE OF UKRAINE

Nuclear and Radiation Safety in Ukraine
Annual Report
2002

KYIV – 2003

LIST OF ABBREVIATIONS

ABDBA	- Analysis of Beyond Design Basis Accidents
ADBA	- Analysis of Design Basis Accidents
AWT	- Active Water Treatment
CF	- Capacity Factor
ChNPP	- Chornobyl NPP
CMU	- Cabinet of Ministers of Ukraine
CPS	- Control and Protection System
CR	- Control Rods
DE	- Deep Evaporator
ECCS	- Emergency Core Cooling System
ER	- Exposure Rate
FCM	- Fuel Containing Materials
FE	- Fuel Element
FS	- Feasibility Study
GICS	- Group and Individual Control System
IAEA	- International Atomic Energy Agency
IACS	- Integrated Automated Control System
IMS	- In-core Monitoring System
RF	- Reference Specimen
IRC	- Ionising Radiation Source
KhNPP	- Khmelnitsky NPP
Liquid Radwaste	- Liquid Radioactive Waste
LRSF	- Liquid Radwaste Storage Facility
MFE	- Ministry of Fuel and Energy of Ukraine
MSB	- Multi-Place Sealed Basket
MSI	- Main State Inspectorate for Nuclear and Radiation Safety
NF	- Nuclear Facility
NNEGC Energoatom	- National Nuclear Energy Generating Company ”Energoatom”
NPP	- Nuclear Power Plant
INR	- Scientific Centre “Institute for Nuclear Research”
PPM	- Planned Preventive Maintenance
PSA	- Probabilistic Safety Analysis
Radwaste	- Radioactive Waste
RC	- Refuelling Container
RCP	- Reactor Coolant Pump
RF	- Reactor Facility
RICP	- Radioactive Waste Interim Confinement Point
RM	- Radiation Monitoring
RNPP	- Rivne NPP
RV	- Reactor Vessel
RWDP	- Radioactive Waste Disposal Point
SAR	- Safety Analysis Report
SCFR	- Self-Sustained Chain Fission Reaction
SE	- Separate Entity
SF	- Spent Nuclear Fuel
SFA	- Spent Fuel Assembly
SG	- Steam Generator
SINEI	- Sevastopol Institute for Nuclear Energy and Industry
SIP	- Shelter Implementation Plan
SISP	- State Interregional Specialised Plant

SNRCU	-	State Nuclear Regulatory Committee of Ukraine
Solid Radwaste	-	Solid Radioactive Waste
SRS	-	Safety-Related System
SRSF	-	Solid Radwaste Storage Facility
SS	-	Safety System
SS	-	Surveillance Specimen
SSE	-	State Specialised Enterprise
SUNPP	-	South Ukraine NPP
TACIS	-	Technical Assistance to the Commonwealth of Independent States
TC	-	Training Centre
VSC	-	Ventilated Storage Container
WWER	-	Water Cooled Power Reactor
ZpNPP	-	Zaporizhzhya NPP

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INTRODUCTION

This Report on Nuclear and Radiation Safety in Ukraine for 2002 has been prepared by the State Nuclear Regulatory Committee of Ukraine to meet the requirements of the Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters and the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", and pursuant to the Statute of the SNRCU.

The objective of the Report is to:

- Describe state policy in nuclear energy and compliance with requirements on nuclear and radiation safety in 2002, which is intended to:

    - Exercise state regulation of nuclear energy safety, ensure compliance with requirements on nuclear and radiation safety;

    - Improve the Ukrainians nuclear legislation and develop national regulatory framework on nuclear and radiation safety;

    - Exercise state oversight of compliance with legislation, standards and rules on nuclear energy and requirements on nuclear and radiation safety;

    - Coordinate activities of central and local governmental bodies that regulate nuclear and radiation safety as required by legislation;

- Characterize the Ukrainians nuclear and radiation safety in 2002;
- Demonstrate actual results of applying the safety-priority principle in nuclear energy, established by the Ukrainian legislation;
- Reveal problems serious in terms of nuclear and radiation safety to be solved through activities of the central governmental bodies to improve the level of nuclear and radiation safety achieved in 2002.

This Report provides information on measures taken by competent governmental bodies, enterprises and organizations of the nuclear field for the benefit of nuclear and radiation safety to reduce risks of radiation exposure to personnel, population and environment.

These measures, along with positive changes in Ukrainian economy in 2002, have improved the state of nuclear energy.

Ratio of money paid in 2002 for the energy produced by the NNEGC Energoatom per cost of the produced energy greatly increased as compared to the previous years (54.5% in 2001, 39% in 2000) and constituted 74% (without consideration of other payments). This permitted increase of energy production in parallel with measures to improve operational safety of nuclear power plants.

Nuclear power plants have produced 78,000 Mln kW·h of electricity in 2002, that is 2.4% greater than in 2001. The capacity factor increased by 1.7% as compared to the last year. The number of operational incidents decreased to 45 against 67 in 2001 and 71 in 2000. According to the comprehensive safety analysis of the SNRCU, safety of the Ukrainian NPPs confirms to the world standards. Viewpoint of the Ukrainian regulatory authority is entirely shared by the competent bodies of foreign states as confirmed by the final documents of the Second Meeting of Contracting Parties under Convention on Nuclear Safety held in the IAEA headquarters, Vienna in April 2002.

The Report pays special attention to emergency preparedness, staff and scientific support, international cooperation and public relations.

Issues of physical protection of nuclear facilities, nuclear material and other radiation sources and nuclear weapon non-proliferation have acquired special significance all over the world under the threat of nuclear terrorism. The Report sets forth state governmental bodies' activities intended to prevent nuclear terrorism.

Inspection materials, reports of institutions that deal with nuclear energy, informational and analytical documents provided by the Ministry of Fuel and Energy of Ukraine, National Nuclear Energy Generating Company "Energoatom", Ministry of Health of Ukraine and Ministry of Ukraine of Emergencies and Affairs of Population Protection From Consequences of Chernobyl Catastrophe have been used for the Report.

1. STATE REGULATION OF NUCLEAR AND RADIATION SAFETY

The State Nuclear Regulatory Commission of Ukraine (SNRCU), established according to Decree of the President of Ukraine No. 1303/2000 dated 5 December 2000, plays the key role in implementation of the state policy in the field of nuclear energy use and security of observance of requirements on nuclear and radiation safety.

The objective of state regulation of nuclear and radiation safety in nuclear energy use is to reduce the risk of radiation exposure to personnel, population and the environment through:

- Bringing the safety of NPPs under operation into compliance with current legislation of Ukraine and international requirements on nuclear and radiation safety;
- Ensuring the safety of the ChNPP decommissioning;
- Ensuring the safety of radwaste and IRS management and transport;
- Reducing the radiation impact of uranium facilities;
- Improving the state supervision over observance of nuclear legislation, standards, rules and regulations on nuclear and radiation safety;
- Participation of Ukraine in improvement of international safeguards for nuclear weapons non-proliferation according to the Non-Proliferation Treaty;
- Ensuring physical protection of nuclear facilities, nuclear materials, radioactive waste and other radiation sources.

Basic functions of the SNRCU as the state nuclear regulatory authority include the following:

- Identify safety criteria, requirements and conditions for nuclear energy use;
- Issue permits and licenses for activities in the field of nuclear energy use;
- Conduct state supervision over compliance with legislation and nuclear and radiation safety standards, rules and regulations.

Improvement of nuclear legislation and national regulatory framework on nuclear and radiation safety was continued according to the Statute on the State Nuclear Regulatory Committee of Ukraine approved by Decree of the President of Ukraine No. 155/2001 dated 6 March 2001. Law-making activities resulted in the development of 3 draft laws, which are being reviewed by the Verkhovna Rada of Ukraine, as well as in development, agreement with appropriate Ministries and submission of 6 draft laws to the Cabinet of Ministers of Ukraine, 2 of which were approved in 2002. In addition, 8 regulations related to the SNRCU area were developed and approved (see Annex "List of Regulations on Nuclear and Radiation Safety Developed by the SNRCU and Issued in 2002".)

A Working Regulatory Commission was established to improve the development of standards and rules on nuclear and radiation safety. The Commission held 7 meetings to solve problems encountered in regulation of nuclear and radiation safety and to discuss prospects of its development. Discussion of the following draft regulations can be considered the most important:

- Provisions on State Review of Nuclear and Radiation Safety;
- General Procedure for Making and Approving Decisions on Modernization and Reconstruction of the NPP Safety-Related Systems and Components and Requirements on the Scope and contents of documents substantiating these decisions;
- Certification Procedure for Software Applied in Design and Safety Assessments of Nuclear Facilities and Radiation Sources;
- Extension of Nuclear Power Unit Operation beyond the Designed Lifetime. General Provisions.

30 meetings of the SNRCU Licensing Commission were held within the permissive activity. Based on the safety assessment, 52 licenses were issued according to the Commission proposals. As of the end of the year, 650 enterprises, establishments, and organisations of Ukraine obtained licenses for radiation sources. This constituted about 80% of all entities (excepting medical establishments) using IRS. Licenses were issued to almost all enterprises using high-power radiation sources or the great number of radiation sources.

At the same time, licenses to operate ZNPP, KhNPP, and RNPP power units were not issued although drafts of these licenses were prepared. This was caused by failure of the operating organisation to submit appropriate documents to confirm the availability of funding for civil liability for nuclear damage.

In order to solve issues related to SNRCU competence, discuss the most important activities and scientific and technical support to regulatory activities of the Committee, meetings of deliberative bodies – Collegium and Scientific and Technical Council – were held.

The SNRCU Collegium held 10 meetings and issued recommendations on resolution of the first-priority issues, in particular:

- Status of the Comprehensive Program for Training of State Employees and status of the SNRCU staffing;
- Review of draft licenses to operate the NNEGC Energoatom nuclear facilities: SUNPP-1-3, ZNPP-1-6, KhNPP-1 and RNPP-1-3;
- Issuance of a license to decommission nuclear facilities of the State Specialized Enterprise “Chornobyl NPP”;
- Status and perspectives of international scientific and technical cooperation of the SNRCU.

The Scientific and Technical Council held 3 meetings to review NPP lifetime extension, technical requirements on the regulation entitled “General Provisions on Safety Assurance of Radwaste Disposal in Geological Repositories”, a state-level plan of response to radiation accidents and strategy of nuclear energy development up to 2030, as a component of Ukrainian energy strategy.

Completion of the Program for Transfer of Ukrainian Nuclear Energy Facilities to the Requirements of “Radiation Safety Standards of Ukraine. NRBU-97” (Joint Resolution of the Ministry of Health of Ukraine and the SNRCU No. 86/41 dated 7 March 2002) was one of the most important achievements in regulation of nuclear and radiation safety of the last year; this was possible owing to joint efforts of operating organizations and state nuclear regulatory authorities of Ukraine.

2.1. NUCLEAR ENERGY

Characteristic of the Ukrainian Nuclear Energy Complex

In 2002, 4 nuclear power plants were operated in the united power grid of Ukraine. 13 WWER power units were under operation (2 WWER-440/213, 9 WWER-1000/320 and 2 WWER-1000 of small series). 2 WWER-1000/V-320 power units were under completion at the Rivne and Khmelnitsky NPPs. The total installed capacity of Ukrainian NPPs is 11,835 MW. Nuclear power plants produced 78,000 Mln kW·h of electricity in 2002, this is 2.4% greater than in 2001 (Figure 2.1). Total generation of electricity in Ukraine was 172,982 Mln kW·h; share of nuclear power plants was 45.1%.

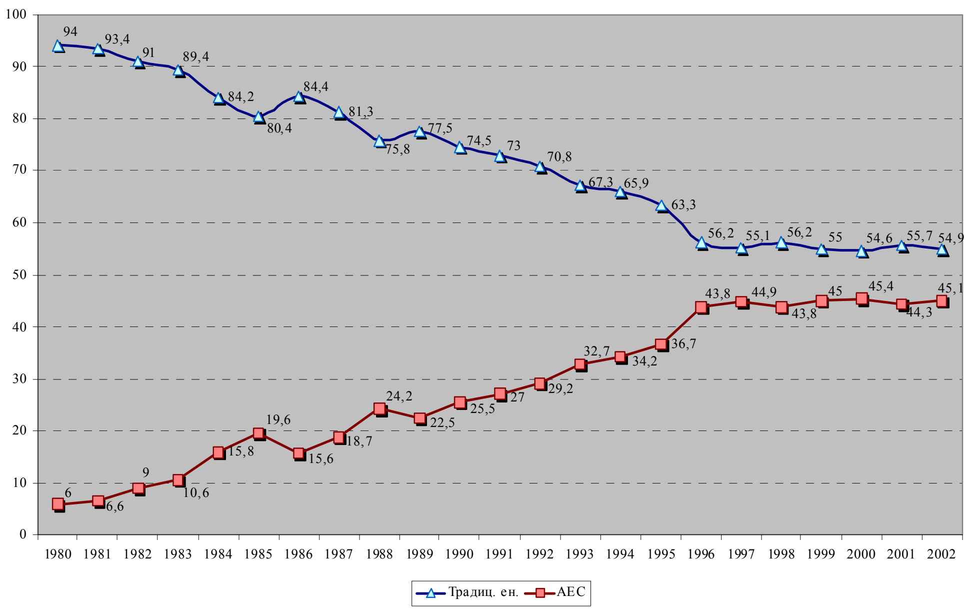


Figure 2.1. Dynamics of the NPP Energy Production in 1980-2002, percentage

The capacity factor (CF) is an important indicator of the energy branch performance. In the reporting year the CF increased by 1.7% as compared to the previous year. The CF for the branch constituted 75.2 % on average in 2002 (Figure 2.2). In 2002 the underproduction of energy by the Ukrainian NPPs was 25,685 Mln kW·h.

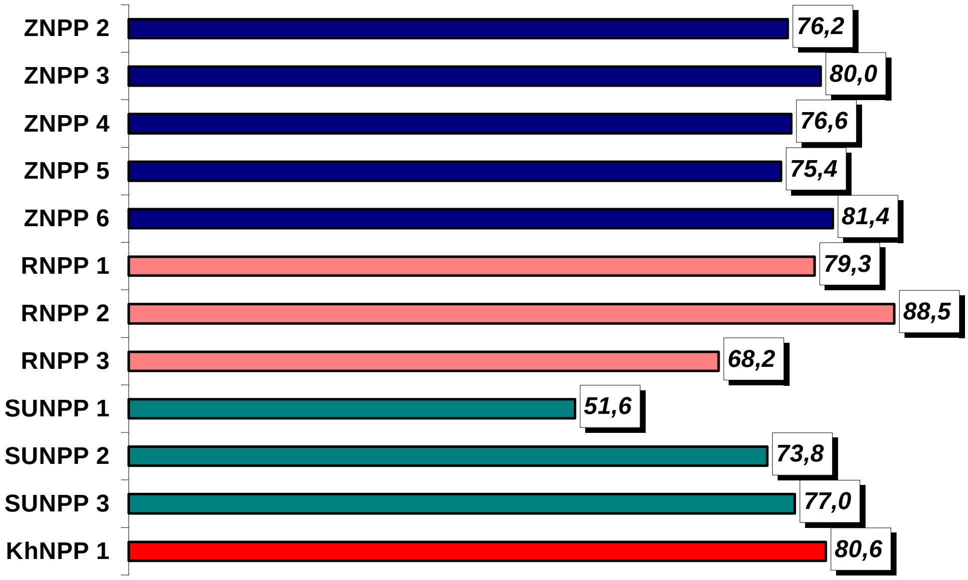


Figure 2.2 Capacity Factor of Ukrainian NPPs in 2002, percentage

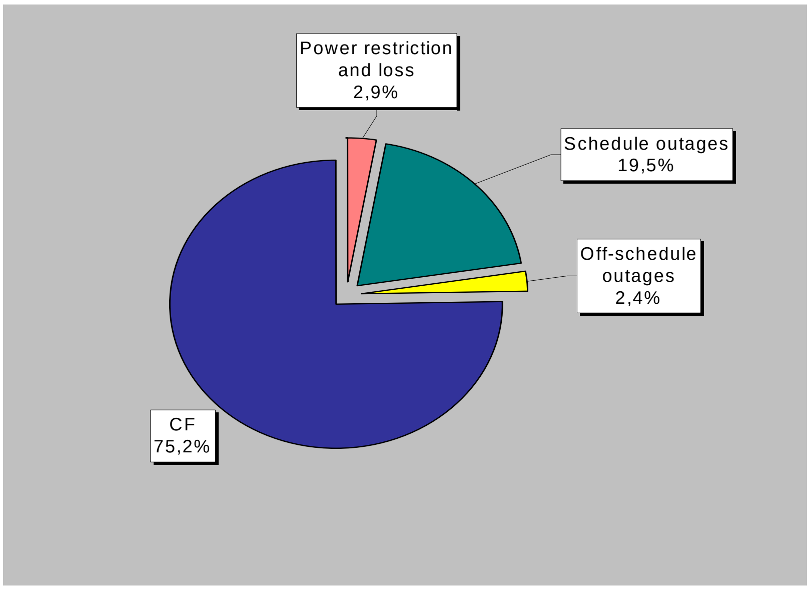


Figure 2.3 Basic Components of Energy Production Losses in 2002, percentage

Figure 2.3 shows basic components of energy production losses in 2002, which are used for CF calculation.

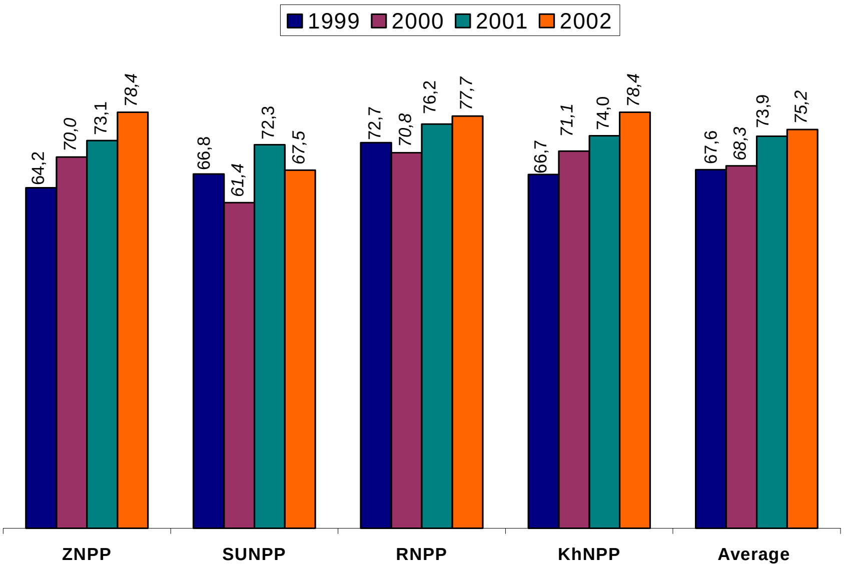


Figure 2.4. Capacity Factor for the Branch from 1999 to 2002

Figure 2.4 shows CF for the branch from 1999 to 2002.

General Safety Assessment of Ukrainian NPPs

The SNRCU Collegium assembled on 9 April 2002 to consider the safety level of Ukrainian NPPs under operation.

Laws of Ukraine "On Nuclear Energy Use and Radiation Safety" and "On Permissive Activity in the Field of Nuclear Energy Use" establish the permissive principle to use nuclear facilities. In compliance with the requirements of these Laws, a nuclear facility shall be operated under a license for operation. A decision to issue a license for operation is made by the State Nuclear Regulatory Committee of Ukraine based on comprehensive safety assessment. Licensing should ensure NPP operation at the safety level complying with international requirements.

According to Ukrainian legislation, the operating organization – NNEGC Energoatom – has made substantial efforts to reassess the safety of NPPs under operation. The NPP safety was reassessed within the development of Safety Analysis Reports (SAR) and combined the periodic safety assessment required after a certain operational period and in-depth safety analysis applying up-to-date methods:

- Probabilistic safety analysis (PSA);
- Analysis of design-basis accidents;
- Limited analysis of beyond design-basis accidents, including some transients without scram.

Review and assessment of documents submitted to the SNRCU permitted a conclusion that the following was carried out in the SAR development:

- Design documentation was revised to incorporate changes and amendments resulted from reconstruction and implementation of technical decisions and to incorporate the actual state of safety-related systems as regards safety significant parameters and characteristics;
- Safety analysis was carried out based on additional and/or specified safety factors, principles, and criteria as compared to those incorporated in the design;
- Operational experience for the recent 5-10 years was analysed in terms of the NPP safety assurance: results of the analysis confirmed that all safety indicators (first of all, availability of safety systems, condition of protective barriers, NPP impact on personnel, population and environment, etc.) were at a high level and had no tendency to decease; owing to safety improvement measures implemented at NPPs, the number of operational violations was two times less than at the beginning of the 90s;
- Core damage frequency was qualitatively assessed as one of the safety criteria: comparison of level 1 PSA with PSA results for European NPPs with WWER showed that safety of the Ukrainian WWER power units complied with that of foreign analogues;
- Dominant accident sequences and minimal cross-section spectra were determined for the main contributors to the core damage frequency;
- Instrument for prioritising safety improvement measures was obtained to identify specific safety improvement measures and establish their priorities within the integral SAR.

International experts during their safety missions at Ukrainian NPPs have confirmed these positive conclusions. According to findings of these missions*, the operational safety of Ukrainian NPPs is acceptable and meets the international practice in key aspects:

- Valid positive trends are observed in all assessment areas as compared to the situation during previous missions in the middle and second half of the nineties;
- NPP administration and medium-level staff widely apply international experience to identify and solve various safety issues;
- Substantial improvement is observed in personnel training, and effective use of full-scale simulators permits training at the acceptable quality level;
- NPPs implement essential measures that reflect commitment of the NPP management and personnel to improve safety culture. The operating organization plays an important role in branch measures intended for safety self-evaluation, systematic feedback of operational experience and improvement of quality assurance;
- Up-to-date technologies and techniques were successfully implemented during in-depth safety assessment of Ukrainian NPPs (in particular, based on IAEA review, the PSA technique applied in the in-depth safety assessment of Ukrainian NPPs was considered adequate);
- NPP personnel actively participated in safety assessments in part of management of the most important tasks, development of heat-hydraulic calculations, assistance in subcontractors' activities. Some drawbacks and weak points in the design being determined in the safety assessment require implementation of safety improvement measures. Programs for modernization of operating power units and improvement of operational practice permit to solve successfully these issues and assure that Ukrainian operating power units are capable of safe performance over the designed lifetime.

In order to prioritise measures and optimise efforts intended for safety improvement, the following main aspects of the further in-depth safety assessment should be implemented:

- Finally specify results of level 1 PSA for internal initiating events relative to the reactor core based on findings of the State Review on Nuclear and Radiation Safety, findings of IAEA* missions and independent peer reviews and complete analysis of design-basis accidents; assess safety improvement measures in terms of their impact on safety functions and assess target safety indicators, set priorities for these measures;
- Continue the in-depth safety assessment (analyse the impact of extreme internal and external events, analyse events related to violations in heat removal from the cooling pond, assess frequency of over-normal releases, conduct limited analysis of the beyond design-basis accidents);
- Complete revising the safety analysis report and additional material on safety assessment to remove remarks of the State Review on Nuclear and Radiation Safety.

Having considered the safety of Ukrainian NPPs and substantiation submitted by the operating organization, Collegium has concluded that the designed safety of Ukrainian WWER power units was acceptable according to national and international requirements on nuclear and radiation safety, taking into account implemented and planned modernization measures, and a license should be issued to operate nuclear power facilities up to the expiration of the design service life on condition that the license should incorporate requirements for measures on safety reassessment and improvement of operating power units and specific schedule for implementation.

**The following missions were conducted at Ukrainian NPPs in 1993-2001: ASSET (assessment of safety significant events, their causes, and corrective measures), OSART (8 areas of operational safety review for assessment: control and management, operation, repair, and so on) and IPSART (adequacy analysis of PSA methodology, technical feasibility assessment of PSA results and findings).*

There were no nuclear or radiation accidents at Ukrainian NPPs in the reporting year. The number of operational events decreased to 45 in 2002 against 68 in 2001 and 71 in 2000 as shown in Figure 1.5 (without ChNPP).
The highest number of violations is observed at Khmelnitsky power unit 1 – 10 violations, the lowest at Zaporizhzhya power units 5 and 6 and South Ukraine power unit 2 – 1 event per unit.

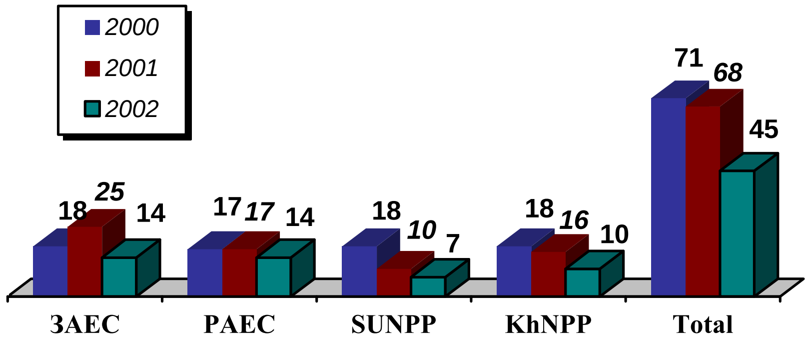


Figure 2.5 The Number of Operational Violations in 2000-2002

Rating of events by INES demonstrates that number of operational violations decreased as compared to the last year. For comparison, 5 violations occurred in 2002 which were classified by INES as level "1" ("anomaly") and 13 events in 2001; 40 events in 2002 which were rated by INES as level "0" and as below scale ("deviation"), and 55 events in 2001 (Table 2.1.)
Distribution of events rated by INES as level "1" for 1996-2001 shows that such events tended to increase since 1997. In 2002 this tendency turned backward. The data for 2001 are provided in round brackets.

Table 2.1

Classification of Operational Events at Ukrainian NPPs in 2002 According to INES

NPP	*INES*							
	ACCIDENT				*Incident*		*Anomaly*	*Deviation*
	7	*6*	*5*	*4*	*3*	*2*	*1*	*Zero and below scale*
Zaporizhzhya	-	-	-	-	-	-	1(4)	13 (21)
Rivne	-	-	-	-	-	-	- (3)	14 (14)
South Ukraine	-	-	-	-	-	-	- (3)	7 (7)
Khmelnitsky	-	-	-	-	-	-	4 (3)	6 (13)
Total:	-	-	-	-	-	-	5 (13)	40 (55)

Operational violations at NPPs in 2002 resulted in:
power unit shutdown – 14 against 23 in 2001;
including shutdown with scram – 6 against 10 in 2001;
electrical power drop – 16 against 21 in 2001;
without impact on power unit operation – 15 against 24 in 2001.

Underproduction of electricity in 2002 due to operational events constituted:

ZNPP – 201.6 Mln kW·h;
SUNPP – 1,503.9 Mln kW·h;
RNPP – 117.1 Mln kW·h;
KhNPP – 5.52 Mln kW·h;

Total for NPPs is 1,828.1 Mln kW·h.

Analysis of operational violations in 2002 has revealed the following main causes:

- equipment failure
- personnel errors
- procedure violations.

Analysis of direct causes of operational violations has shown that they are mainly resulted from equipment failures (equipment insufficient reliability, adequacy, functional features, wear and tear). The lack or inadequacy of equipment efficiency monitoring or imperfection of procedures constitute root causes of equipment failure at nuclear power plants.

Analysis of the NPP operational experience in 2002 confirmed both technical problems common for all NPPs and those typical for each reactor type. Expiration of the equipment designed service life is the common problem for all NPPs. Taking into account the long-term operation of some nuclear power units, special attention should be paid to management of their service life. The most important measures on lifetime management are those associated with buildings, structures, systems and components whose replacement is either impossible or extremely expensive. Reactor pressure vessel lifetime is the main problem. Therefore, a program should be developed, first of all, for assessing embrittlement of the WWER-1000 reactor pressure vessels based upon tests of reference specimens and program for improvement of operational safety of reactor pressure vessels.

Based upon tests of reference specimens for vulnerability to embrittlement of pressure vessel weld metal, the above measures should be primarily implemented at SUNPP-2 and KhNPP-1.

Considering the importance of integrity and safe operation of reactor pressure vessels, the methodology for preliminary thermomechanical loading of WWER pressure vessels (thermal "pressure testing") should be further developed in order to increase their radiation lifetime, and a bench should be installed and adjusted for comprehensive testing in order to try out thermal pressure mode of WWER -1000 and WWER -440 pressure vessels.

Quality of NPP radiation monitoring, as one of the radiation safety components, is an important issue related to lifetime management. Increased attention to the proper level of radiation monitoring at Ukrainian NPPs has resulted from the lifetime expiration of current radiation monitoring systems, absence of serial production of component parts for replacement during maintenance, and insufficient compliance of technical characteristics of these systems with regulatory and technical requirements. In addition, plants should make arrangements to expend functions of the radiation monitoring system in view of future decommissioning of power units.

In 2002 the regulatory authority agreed the branch "Program for Reconstruction of Radiation Monitoring Systems at Ukrainian NPPs for 2002 – 2010" to establish general principles and procedure of reconstruction. According to this program, radiation monitoring systems will be reconstructed through component-by-component replacement of individual subsystems and step-by-step expansion of their functions to fully comply with current requirements on nuclear and radiation safety. Some NPPs have started implementing this program. For example, component-by-component replacement of basic equipment of the central radiation monitoring instrumentation system for power units 1 and 2 by new equipment is underway at Khmelnitsky NPP. Implementation of an automated monitoring system for airborne releases to the ventilation stack is underway at South Ukraine NPP.

In 2002 Ukrainian NPPs continued implementing fire measures under branch and plant programs with the purpose of:

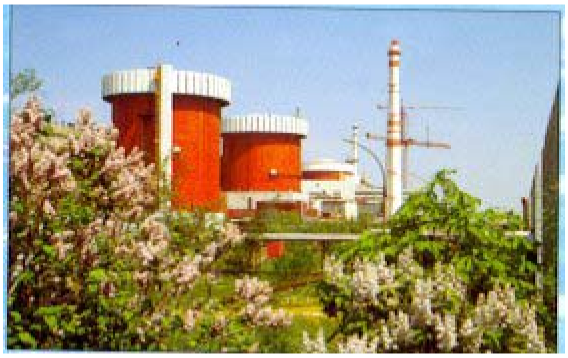
- Improving fire resistance of fire barriers and their components between different channels of safety systems (replacement of fire doors, improvement of fire resistance of transit air ducts, application of fire resistance coating on cables);
- Preventing fires (replacement of cables by incombustible ones, replacement of electric switches);
- Reconstructing the automated fire alarm system to comply with up-to-date safety requirements.

The operating organization developed the "Methodology for Fire Safety Analysis of Nuclear Power Units with WWER", which is under agreement now.

Fire safety analysis with this methodology should permit specification of safety deficiency and optimisation of correction measures.

In order to provide a sound basis for service life extension, the branch makes substantial efforts to restore operational features of equipment through timely maintenance and repair, partial replacement of critical components, surveillance over operational reliability, etc. In order to improve analysis of equipment operational reliability, a new approach is applied: service life of typical equipment of nuclear power units is extended based upon analysis of the branch database on failures in single-type equipment.

2.5. SOUTH UKRAINE NPP



South Ukraine NPP is situated near the Pivdenny Bug river in Myckolaiv region. The plant was designed as a new-type power enterprise to solve the problem of comprehensive and rational use of energy produced by nuclear, hydroelectric, and pumped-hydrostorage power plants.

Construction of the South Ukraine power complex was intended to provide the south of Ukraine with sufficient amount of electricity, using cycling hydroelectric power and water supply of the Pivdenny Bug. Construction of the nuclear power plant and the satellite town of South Ukraine was started in the spring of 1975.

The first power unit was constructed and prepared for operation within 72 months that met the European standards for construction of similar power facilities. It was connected to the power grid on 22 December 1982. In parallel with operation of the first unit of 1000 MW, the second and third power units were being constructed and were started-up in January 1985 and September 1989 respectively.

SUNPP produces approximately 17-18 TWh of electricity per year; this constitutes over 10% of the state's energy and about 25% of nuclear power plants' energy. In April 1999, the State Commission accepted the Olexandriv Hydroelectric Plant for commercial operation. Construction of this plant was started in 1984 and then was suspended by the moratorium and completed in March 1999. There are two hydraulic units with installed capacity of 11.5 MW. Olexandriv Hydroelectric Plant is the only hydroelectric facility constructed in the period of the Ukraine's independence.

At the end of 2001, the operating organization NNEGC Energoatom applied to the SNRCU for a license to "operate nuclear facilities" on the SUNPP site. The documents were reviewed according to the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and the Law of Ukraine "On Permissive Activity in the Field of Nuclear Energy Use".

Based on positive findings of the application documents review, the SNRCU issued on 19 July 2002 a license to the NNEGC Energoatom to operate nuclear facilities on SE SUNPP site.

Implementation of safety improvement measures at power units and lifetime extension measures at some systems of SE SUNPP were underway in 2002. Hence, in the reporting period, activities were carried out or decisions were approved at power units 1-3 for modernization of refuelling machines, modernization of steam generator feedwater control systems, replacement of continuous power supply units, reconstruction of control valves on confining safety systems and automatic cascade start of safety systems, replacement of safety valves of emergency cooling systems, etc.

There were no nuclear or radiation accidents in 2002. 7 operational events were recorded. Analysis of direct and root causes of power unit operational events showed that the main factors contributing to events were equipment failures and non-compliance with the established procedures.

Direct causes of equipment failure resulted from its insufficient reliability, unavailability for different operational modes, and wear and tear.

Root causes of operational events resulted from either lacking or insufficient monitoring of equipment performance or drawbacks of procedures, defects of equipment and non-observance of the established procedures.

The dynamics of violations at the SUNPP for the recent years is shown in Figure 2.24.

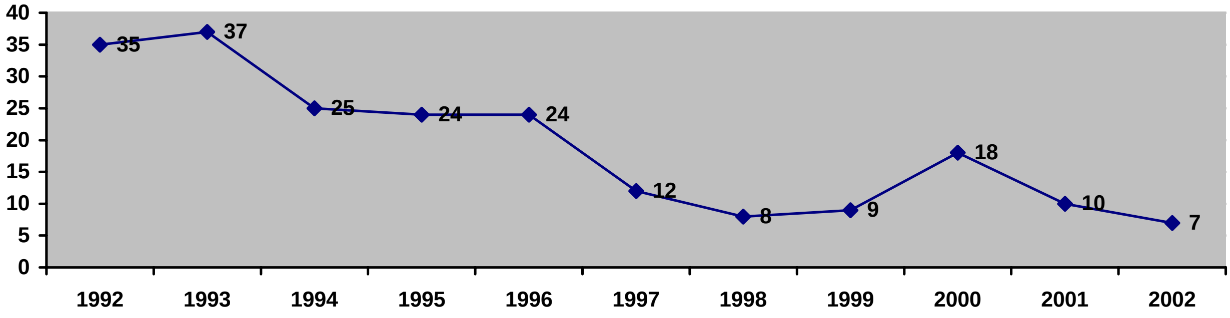


Figure 2.24. Dynamics of SUNPP Operational Events

SUNPP Safety Surveillance

State surveillance over nuclear and radiation safety at SE SUNPP in 2002 was exercised by the Main State Inspectorate for Nuclear and Radiation Safety (MSI) and SUNPP resident inspectorate. MSI inspectors conducted 4 scheduled inspections to check compliance of safety-related systems and components with requirements of standards and rules and check personnel training system and performance of system for accounting and control of nuclear material. Based on the inspections, 4 acts prescribing to eliminate violations were issued.
The main drawbacks revealed in the inspections were:

- Ineffective application of operational instructions;
- Lack of interrelations between departments;
- Undetermined procedure for replacement of equipment after expiration of its lifetime.

Routine surveillance over nuclear and radiation safety on site is exercised by the SNRCU State Inspectorate for Nuclear Safety at South Ukraine NPP consisting of 5 inspectors. Available are 4 inspectors.

State inspectors conducted 29 inspections during the year and issued 29 acts prescribing to eliminate violations.

Daily monitoring and analysis (excepting holidays) were conducted during the year to verify the operational procedures requirements and check the main parameters of power unit equipment. Observance of requirements on nuclear and radiation safety during radioactive material transportation was checked, compliance with standards and rules during radioactive waste management was verified, etc.

Inspectors participated in 10 IAEA inspections in 2002 conducted in compliance with the Agreement between Ukraine and the International Atomic Energy Agency on Safeguards concerning the Nuclear Non-Proliferation Treaty.

The SUNPP personnel involved in reactor facility control obtained 20 licenses in 2002, 29 licenses were extended (including 15 licenses for new jobs), 1 license was cancelled. In order to train personnel to operate nuclear facilities, there is a training centre (TC) at the South Ukraine NPP licensed by the SNRCU.

Radioactive Waste Management

The SUNPP liquid radwaste processing and storage scheme includes: active water treatment facilities, including 2 evaporators; compartment of reagents; liquid radwaste storage facility.

Solid radioactive waste management involves waste sorting, compaction on facility C-26 and storage in the SRSF.
The program for South Ukraine NPP radwaste management was developed for 2000 – 2003 period. Solid radwaste storage module with total capacity of 10,000 m^3 has been commissioned. The designed capacity of the radwaste storage facility will be sufficient till the end of NPP service life.

14,135 m^3 of solid radwaste and 3,319 m^3 of liquid radwaste were accumulated on site as of 1 January 2003. Figure 2.25 shows general dynamics in liquid and solid radwaste accumulation during the last five years.

According to the program for South Ukraine NPP radwaste management, it is planned to develop (purchase), assemble and commission the following:

- Liquid radwaste processing complex for waste cleaning from radionuclides by ion-exchange sorbents and for waste cementation;
- Solid radwaste processing complex, including facilities for sorting, compaction, and incineration.

Absence or insufficient capacity of NPP facilities for radwaste initial processing results in its rapid accumulation. It is impossible to reduce substantially the radwaste accumulation without systems for liquid and solid radwaste processing at NPP.

There were no abnormal situations in operation of the solid radwaste processing and conditioning systems in 2002. Failures and operational events at facilities did not occur either.

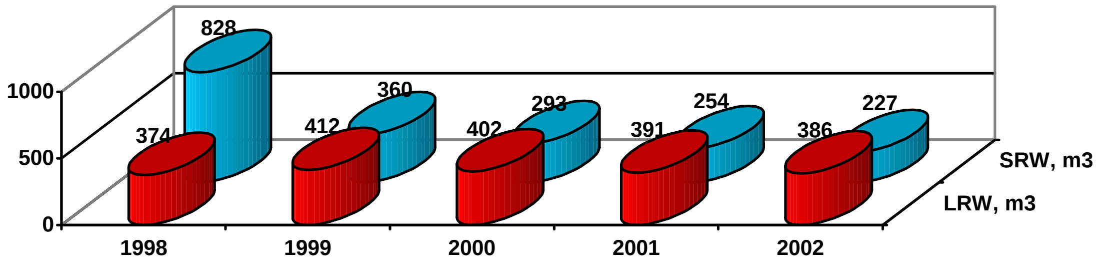


Figure 2.25. Dynamics of Liquid and Solid Radwaste Accumulation at SUNPP

SUNPP Impact on Environment

Figure 2.26 shows the dynamics of iodine-131 releases from the SUNPP ventilation stacks from 1997 to 2002. The plant reference level is 40,700 kBq/d.

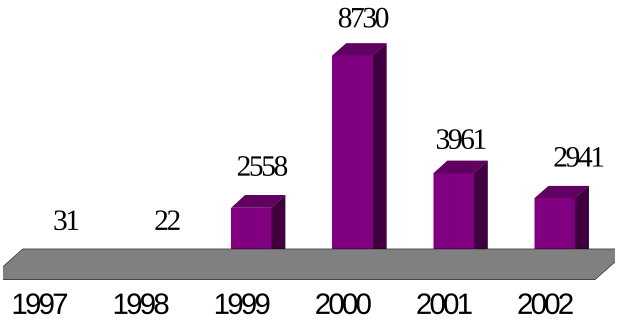


Figure 2.26. Iodine Releases from SUNPP Ventilation Stacks, kBq/d

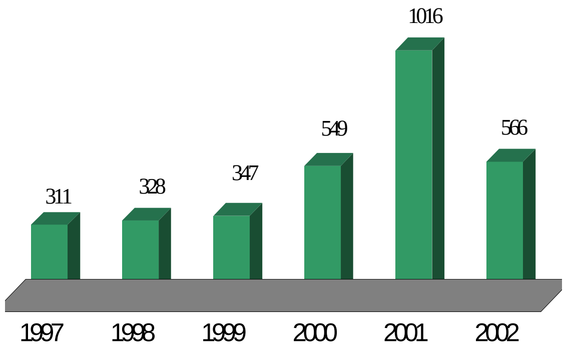


Figure 2.27. Releases of Long-Lived Radionuclides from SUNPP Ventilation Stacks, kBq/d

Figure 2.27 shows the dynamic in releases of long-lived radionuclides from SUNPP ventilation stacks. The plant reference level is 40,700 kBq/d.

Figure 2.28 shows the dynamics in releases of inert gases from SUNPP ventilation stacks from 1997 to 2002. The plant reference level is 750 GBq/d.

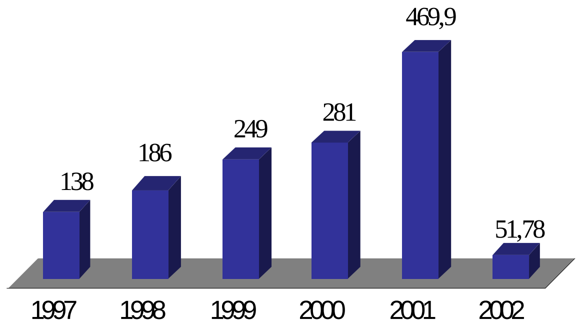


Figure 2.28. Releases of Inert Gases from SUNPP Ventilation Stacks, GBq/d

These figures show that releases from SUNPP ventilation stacks are much lower than the reference levels.

Radionuclide releases to ponds did not exceed the permissible and reference levels at SUNPP in 2002.

Concentrations of radionuclides in the surface air, surface and underground water at SUNPP area are lower by several orders than their permissible values established in the Radiation Safety Standards of Ukraine (NRBU-97).

Personnel Radiation Protection

The reference individual doses for SUNPP personnel are 15 mSv/y (for personnel of separate contingent – 18 mSv/y). The plant personnel who participate in highly qualified radiation and hazardous work belong to the separate contingent.

No cases of exceeding the personnel annual permissible dose (20 mSv/year) and reference individual annual dose occurred in 2002.

One of the main indicators used to characterize plant personnel radiation protection is the ratio of the personnel collective dose to the number of power units under operation, which constitutes 1,949.92 person·mSv/unit for SUNPP. This indicator is practically the same as in 2001 at SUNPP (1,957.32 person·mSv/unit). 1000 person·mSv/unit is considered acceptable in the world practice for WWER reactors.

Figure 2.29 shows the dynamics in ratio of the personnel annual collective dose to the amount of produced electricity (person·cSv/MW·y).

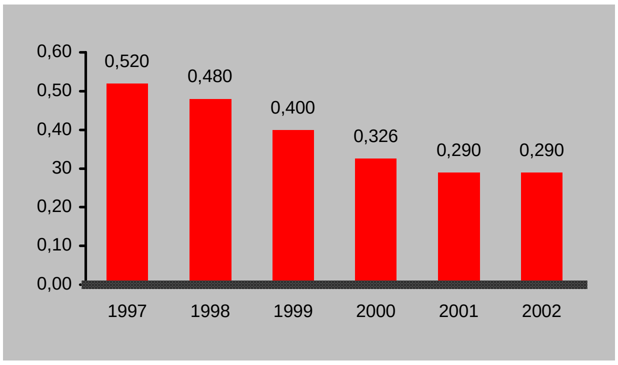


Figure 2.29. Ratio of Personnel Annual Collective Dose to the Amount of Produced Electricity, person·cSv/MW·y

2.4 KHMELNITSKY NPP

KhNPP is situated in Slavutsky area of Khmelnitsky region near the Goryn' river.

It was designed as a four-unit plant. The KhNPP construction was started in 1981. The first power unit was put into commercial operation late in 1987. Sites for other three power units were prepared. Construction of the second unit was started in 1983, and its commissioning was due in late 1991.

However, in 1990 the Verkhovna Rada terminated construction of plant power units by its Resolution "On Moratorium on Construction of New Nuclear Facilities on the Territory of Ukraine".

Basic technical systems had been installed and personnel had been trained to operate the second power unit by that time.

Even after the moratorium was cancelled, construction of the second power unit was not effective because of the lack of funding.

At present, completion of Khmelnitsky and Rivne NPPs is funded owing to the purpose-oriented extra charge for electricity produced by the NNEGC Energoatom.

The KhNPP unit 2 is 85-95% completed. A series of technical measures were implemented at Khmelnitsky NPP during 2002 to improve nuclear safety. Basic measures were as follows:

- Methodology was developed and implemented for inspection of piping of safety system channel 1;
- Dosimetry monitoring was modernized within the program of reference specimens to improve its result representation;
- Continuous power supply units for safety system channels 1-3 and plant continuous power supply unit were replaced.

The following projects are under implementation at Khmelnitsky NPP in the frames of the TACIS program:

- "Modernization of Reactor Vessel Monitoring System SK 187 KhNPP" to provide on-line information on the reactor pressure vessel condition;
- "Development and Implementation of Equipment and Methodology for Eddy Current Monitoring of Threaded Holes at Flanges of Primary Circuit Main Equipment at KhNPP" to provide for more reliable in-service inspection of primary equipment.

The dynamics of violations at KhNPP during 1992-2002 is shown in Figure 2.18.

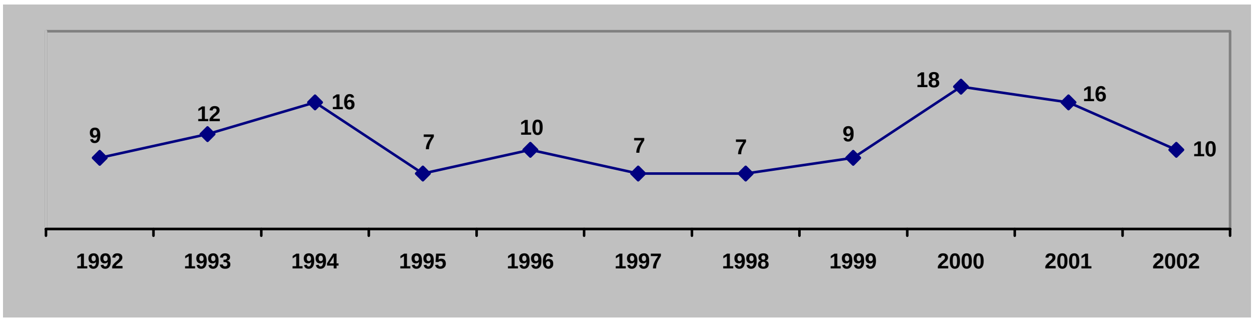


Figure 2.18. Dynamics of Violations at KhNPP during 1992-2002

There were no nuclear, radiation or operational accidents at Khmelnitsky NPP in 2002. 10 violations were recorded.

The great number of operational events at the beginning of 2002 caused essential concerns. Therefore, the SNRCU Collegium assembled on 30 May 2002 to consider the safety of SE "Khmelnitsky NPP".

Analysis of operational safety revealed tendency to decrease operational safety indicators of unit 1. Analysis of "Reports on Operational Events at SE "Khmelnitsky NPP" Unit" showed that substantial number of equipment failures was caused by poor repair, maintenance, equipment ageing, personnel errors, and drawbacks of operational and administrative documents.

In order to implement the SNRCU Collegium Resolution, a series of measures were taken to improve the KhNPP situation, including: the NNEGC Energoatom considered personal compliance of the KhNPP management staff with occupied positions and made fundamental replacements of plant management. The regulatory authority established strict monitoring at KhNPP and conducted investigation of plant violations. Analysis of root and direct causes of events at KhNPP revealed that equipment failures were, as previously, the main factors contributing to operational events.

As a result of implemented measures, the plant situation was stabilized. The number of operational events greatly reduced from August to December 2002.

KhNPP Safety Surveillance

State surveillance over nuclear and radiation safety at SE KhNPP in 2002 was exercised by the Main State Inspectorate for Nuclear and Radiation Safety (MSI) and KhNPP resident inspectorate. MSI inspectors conducted four scheduled inspections to check administrative management of operational quality, check compliance of safety-related systems and components with requirements of standards and rules, and check personnel training system and performance of system for accounting and control of nuclear material. Based on the inspections, three acts prescribing to eliminate violations were issued.

Inspections of the SNRCU Main State Inspectorate for Nuclear and Radiation Safety revealed drawbacks in the administrative management system and inefficiency of the enterprise quality system. Work with personnel became essentially poor in part of responsibility of each employee, there were essential drawbacks in a work with operating documents, plant management staff did not establish unified policy related to safety culture and did not ensure clear differentiation of authorities.

Surveillance over nuclear and radiation safety on site is exercised by the State Inspectorate for Nuclear Safety at Khmelnitsky NPP consisting of 5 inspectors. Available are 2 inspectors.

40 inspections were conducted in 2002 to check various aspects, and 16 acts prescribing to eliminate violations were issued.

Inspectors participated in 6 IAEA inspections conducted in compliance with the Agreement between Ukraine and the International Atomic Energy Agency on Safeguards concerning the Nuclear Non-Proliferation Treaty.

In order to verify compliance of the KhNPP operation with standards, rules, and regulations on nuclear and radiation safety, the State Inspectorate for Nuclear Safety at KhNPP conducted inspections in the following areas:

- Observance of terms of licenses and permits, standards and rules on nuclear safety;
- State of the KhNPP operation, maintenance, and repair;
- System for accountancy and control of nuclear material;
- Technical state of thermomechanical equipment and piping.

The main drawbacks revealed in the inspections were:

- Acceptance testing of spare parts and materials for repair was not conducted in full scope (lack of quality certificates);
- Low quality of certificates for acceptance of equipment and systems from repair;
- Some job descriptions were not developed in full scope and others should be revised.

In order to verify the status of Rivne-2 completion and preparedness for startup and commissioning, compliance with standards, rules, and regulations, inspectors conducted 4 unscheduled inspections.

Under the Peer Review Program (that constitutes a part of activities of the World Association of Nuclear Operators), peer review at Khmelnitsky NPP was conducted in 2002.

Radioactive Waste Management

Radioactive waste is processed in the main building of the power units, special building with communal service modules and solid and liquid radwaste storage facilities. The liquid radwaste processing and storage scheme includes: active water treatment facilities, including evaporators; compartment of reagents; oil purification facility, radioactive oil incinerator; deep evaporator UGU-1-500, liquid radwaste storage facility.

Solid radioactive waste management involves waste sorting and storage in the SRSF. The salt fusion cake is temporary stored in containers “BB – cube” in the specially arranged area.

The program of the KhNPP radwaste management is under review and revision. According to the current program for the KhNPP radwaste management, the solid radwaste storage facility (SRSF-2 – storage compartment) has been completed and commissioned, this permitted to solve the problem of capacities for solid radwaste storage.

3,595 m^3 of solid radwaste and 675 m^3 of liquid radwaste were accumulated on site as of 1 January 2003.

Figure 2.19 shows general dynamics in liquid and solid radwaste accumulation during the last five years.

It is planned to construct a plant for radwaste processing, including liquid radwaste solidification and solid radwaste treatment to reduce its amount and accumulation.

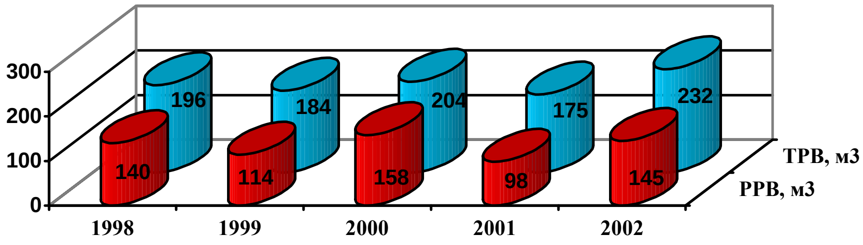


Figure 2.19. Dynamics of Liquid and Solid Radwaste Accumulation at KhNPP

KhNPP Impact on Environment

Figure 2.20 shows the dynamics of iodine-131 releases from the KhNPP ventilation stacks from 1997 to 2002.

The KhNPP reference level (RL) of iodine-131 releases is 44,000 kBq/d. It should be noted that iodine-131 release exceeded the RL on 9 May 2002. The value of the release was 84,800 kBq/d, this constitutes about 23 % of the permissible release (iodine-131 permissible release is 370,000 kBq/d).

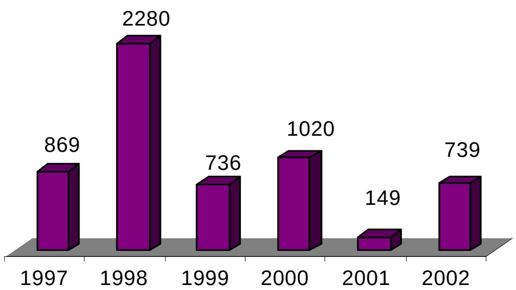


Figure 2.20. Iodine Releases from KhNPP Ventilation Stacks, kBq/d

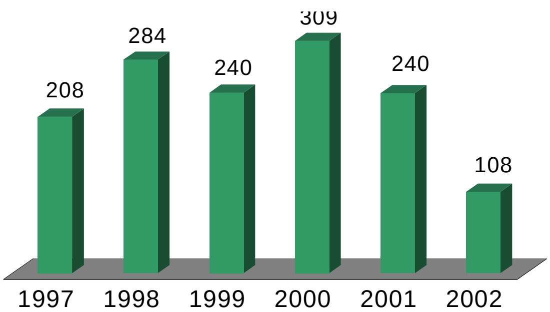


Figure 2.21. Releases of Long-Lived Radionuclides from KhNPP Ventilation Stacks, kBq/d

Figure 2.21 shows the dynamic in releases of long-lived radionuclides from KhNPP ventilation stacks from 1997 to 2002. The plant reference level is 5500 kBq/d.

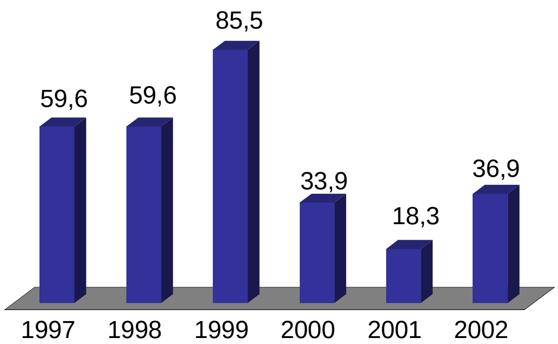


Figure 2.22. Releases of Inert Gases from KhNPP Ventilation Stacks, GBq/d

Figure 2.22 shows the dynamics in releases of inert gases from the KhNPP ventilation stacks from 1997 to 2002. The plant reference level is 2,800 GBq/d.

These figures show that releases from KhNPP ventilation stacks are much lower than the reference levels.

Radionuclide releases to ponds did not exceed the permissible and reference levels at KhNPP in 2002.

Concentrations of radionuclides in the surface air, surface and underground water at KhNPP area are lower by several orders than their permissible values established in the Radiation Safety Standards of Ukraine (NRBU-97).

Personnel Radiation Protection

The reference individual doses for KhNPP personnel are 15 mSv/y, and during preventive repairs are 10 mSv.

No cases of exceeding the annual permissible dose (20 mSv/year) and reference individual annual dose occurred in 2002.

One of the main indicators used to characterize plant personnel radiation protection is the ratio of the personnel collective dose to the number of power units under operation, which constitutes 1,724.1 person·mSv/unit for KhNPP. 1000 person·mSv/unit is considered acceptable in the world practice for WWER reactors.

Figure 2.23 shows the dynamics in ratio of the personnel annual collective dose to the amount of produced electricity, person·cSv/MW·y.

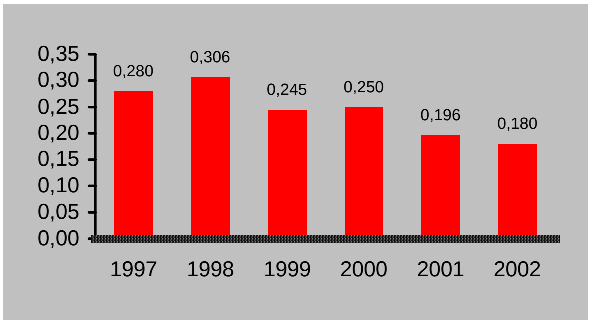


Figure 2.23. Ratio of Personnel Annual Collective Dose to the Amount of Produced Electricity, person·cSv/MW·y

2.3 RIVNE NPP

Rivne NPP is situated in the west of Polissya near the Styr river in Kuznetsovsk. Its history started in 1971 with designing the West Ukraine NPP, which was later renamed into Rivne NPP.

Construction of the plant began in 1973. Two first WWER-440 power units were commissioned in 1980-1981, and the third power unit of 1000 MW was put into operation in 1986.

Construction of the fourth power unit was started in 1984 and its commissioning was due in 1991. However, the work was suspended that year because of the moratorium of the Verkhovna Rada on construction of nuclear facilities on the territory of Ukraine. The construction was recommenced in 1993. Civil engineering design and equipment installation are 90% completed.

Rivne NPP Safety Improvement Measures

A series of technical measures were implemented at Rivne NPP during 2002 to improve nuclear safety. Basic measures are as follows:

Power units 1, 2:

- Steam generator auxiliary feedwater system was designed;
- Rejection of forced blackout of essential supply buses upon signals from the core cooling system was designed;
- Hydrogen removal from the accident confinement system was designed;
- Structural reinforcement of relief devices for the accident confinement system is underway;

power unit 3:

- Activity monitoring system for spent fuel pit was implemented;
- Spent fuel pit underwater lighting was designed;
- Modernization of the SG blowdown system is underway.

The following projects are under implementation at Rivne NPP in the framework of the TACIS program:
"Hydrogen Management in Containment under Operation and Accidents at RNPP Units 1,2" intended to prevent hazardous concentrations of hydrogen in the reactor containment;
"Containment Sump Protection against Clogging at RNPP Units 1,2" intended to improve reliability of the emergency core cooling system;
"Modernization of the Overpressure Protection System at RNPP Units 1,2". In addition to improvement of equipment reliability, this project is intended to ensure control of beyond design-basis accidents (assurance of the feed & bleed mode with pressurizer safety valves).

There were no nuclear, radiation, or operational accidents in 2002. 14 operational events were recorded. The number of violations decreased as compared to 2001.

The dynamics of violations during 1992-2002 is shown in Figure 2.12.

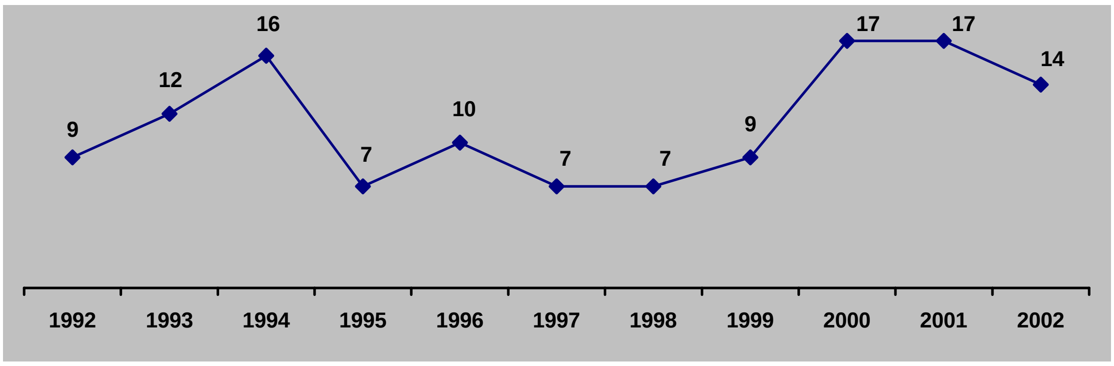


Figure 2.12. Dynamics of RNPP Violations

RNPP Safety Surveillance

State surveillance over nuclear and radiation safety at SE RNPP in 2002 was exercised by the Main State Inspectorate for Nuclear and Radiation Safety (MSI) and RNPP resident inspectorate.

MSI inspectors conducted six inspections to check administrative management of operational quality, check compliance of safety-related systems and components with requirements of standards and rules, and check personnel training system and performance of system for accounting and control of nuclear material. Based on the inspections, three acts prescribing to eliminate violations were issued. One of the main drawbacks revealed during inspections was incomplete implementation of measures for operational safety improvement at RNPP.

Surveillance over nuclear and radiation safety on site is exercised by the State Inspectorate for Nuclear Safety consisting of 6 inspectors. Available are 5 inspectors.

The State Inspectorate conducted 13 inspections in 2002 and issued 9 acts prescribing to eliminate violations.
State resident inspectors conducted 45 inspections in 2002 and issued 10 acts prescribing to eliminate violations.

Daily monitoring (excepting holidays) was conducted during the year to verify fulfilment of the operational procedures requirements and check parameters of power unit equipment. Observance of requirements on nuclear and radiation safety during radioactive material transportation was checked, compliance with standards and rules during radioactive waste management was verified, etc.

In order to verify the status of Rivne-4 completion, inspectors checked technical condition of thermomechanical equipment and piping and checked compliance with requirements to monitor welds and claddings of primary and secondary equipment and piping of power unit 4. A registration procedure was started for equipment and piping to be installed at power unit 4.

RNPP personnel involved in reactor facility control obtained 20 licenses in 2002, 28 licenses were extended (including 8 licenses for new positions), and 5 licenses were cancelled.

In order to train personnel to operate nuclear facilities, there is a training centre (TC) at Rivne NPP licensed by the SNRCU. TC experts are responsible for acceptance examination of future licensees, training and final examinations. Based on examinations, application documents are submitted to the SNRCU Licensing Commission to issue a license to an individual for direct control of the nuclear power reactor. After passing the licensing procedure in compliance with legislation, the individual obtains a 2-year license. In September 2002, the second full-scale simulator was put into trial operation at RNPP.

Inspections of the RNPP personnel training systems did not reveal any violations in 2002.

In October 2002, the SNRCU Board assembled to consider licensing of the operating organization SE "Rivne NPP" to conduct all activities and measures related to operation of nuclear facilities at SE "Rivne NPP" power units 1-3 as stipulated by the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and the Law of Ukraine "On Permissive Activity in the Field of Nuclear Energy Use".

The following documents were developed and viewed to ensure that SE "Rivne NPP" was capable of implementing all safety measures over power unit operation:

- Safety analysis reports for RNPP units 1-3;
- Probabilistic safety analysis for RNPP unit 1;
- Analysis of the design-basis accidents for RNPP unit 1.

The draft license was approved, however, its issuance was suspended until the operating organization would take measures for insurance of liability for nuclear damage or otherwise ensure this liability as required by the Law of Ukraine "On Civil Liability for Nuclear Damage and Financial Provision".

The US Nuclear Regulatory Commission provided technical assistance in safety assessment of Ukrainian pilot nuclear power units with the purpose of substantiating a decision to issue licenses to operate Ukrainian NPPs. Rivne NPP unit 1 was selected as one of the pilot units.

Radioactive Waste Management

Radioactive waste is processed in the two main buildings of three power units, two special buildings with communal service modules and solid and liquid radwaste storage facilities.

The liquid radwaste processing and storage scheme includes: active water treatment facilities, including two evaporators; compartment of reagents; bituminization facility; liquid radwaste storage facility.

Solid radioactive waste management involves waste sorting and storage in the SRSF. There are no facilities for solid radwaste processing at Rivne NPP at present.

The program for Rivne NPP radwaste management was developed up to 2005 and agreed by the SNRCU.

Measures for radwaste minimization and improvement of the RNPP radwaste treatment system under the program for RNPP radwaste management resulted in installation of a boron water leakage collection system and a system for water collection after flushing of terminal seals of the reactor coolant pumps. As a result, radioactive drains were reduced to 2,000 m^3/y and 8,000 m^3/y respectively.

4,115 m^3 of solid radwaste and 8,148 m^3 liquid radwaste were accumulated on site as of 1 January 2003.

Figure 2.13 shows general dynamics in liquid and solid radwaste accumulation during the last five years.

The increased generation of radwaste in the reporting period was due to modernization and replacement of the expired equipment, and replacement of thermal insulation at RNPP in 2002.

According to the program for radwaste management, it is planned to develop (purchase), assemble and commission the following for liquid radwaste processing:

- Deep evaporator UGU-1-500M – 2 pieces;
- Facility for resin and sludge dehydration and drying;
- Facility for salt dilution and retrieval of bottoms;
- Facility for purification (reduction of activity) of radioactive oil;
- Facility for treatment of radioactive drains (centrifuge).

For solid radwaste processing, it is planned to purchase and commission the following:

- Sorting facility;
- Fragmentation facility;
- Radwaste drying facility;
- Facility for solid radwaste retrieval from storage facilities;
- Facility for determination of solid radwaste specific activity.

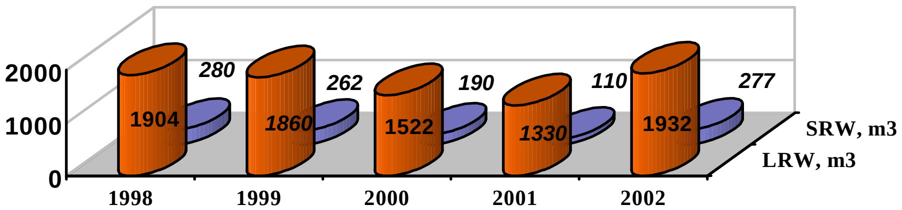


Figure 2.13. Dynamics of Liquid and Solid Radwaste Accumulation at RNPP

RNPP Impact on Environment

Figures 2.14-2.16 show the dynamics in releases of iodine-131, long-lived radionuclides, and inert gases from RNPP ventilation stacks during 1997-2002.

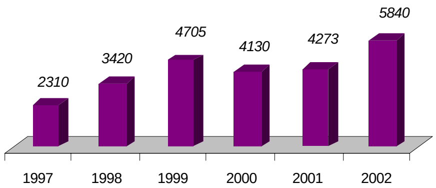


Figure 2.14. Iodine Releases from RNPP Ventilation Stacks, kBq/d

For iodine-131 releases from RNPP ventilation stacks, the reference level is 75,000 kBq/d.

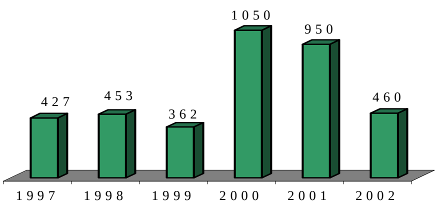


Figure 2.15. Releases of Long-Lived Radionuclides from RNPP Ventilation Stacks, kBq/d

Figure 2.15 shows the dynamic in releases of long-lived radionuclides from RNPP ventilation stacks from 1997 to 2002. The plant reference level is 18,000 kBq/d.

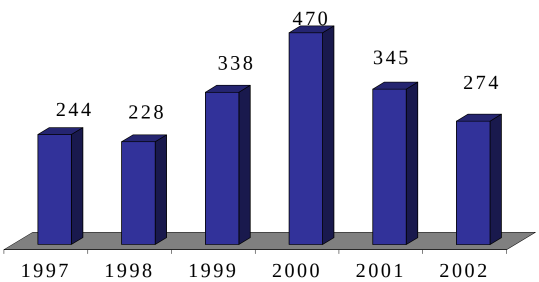


Figure 2.16. Releases of Inert Gases from RNPP Ventilation Stacks, GBq/d

Figure 2.16 shows the dynamics in releases of inert gases from RNPP ventilation stacks from 1997 to 2002. The plant reference level is 4,000 GBq/d.

These figures show that releases from RNPP ventilation stacks are much lower than the reference levels.

The actual radionuclide releases to ponds did not exceed the reference levels at Rivne NPP for different elements more than by several percents.

Concentrations of radionuclides in the surface air, surface and underground water at RNPP area are lower by several orders than their permissible values established in the Radiation Safety Standards of Ukraine (NRBU-97).

Personnel Radiation Protection

The reference individual doses for RNPP personnel are 15 mSv/y (for personnel of separate contingent – 19 mSv/y). The plant personnel who participate in highly qualified radiation and hazardous work belong to the separate contingent.

No cases of exceeding the annual permissible dose (20 mSv/year) and reference individual annual dose occurred in 2002.

One of the main indicators used to characterize plant personnel radiation protection is the ratio of the personnel collective dose to the number of power units under operation, which constitutes 1,989.5 person·mSv/unit for RNPP. 1000 person·mSv/unit is considered acceptable in the world practice for WWER reactors.

Figure 2.17 shows the dynamics in ratio of the personnel annual collective dose to the amount of produced electricity from 1997 to 2002.

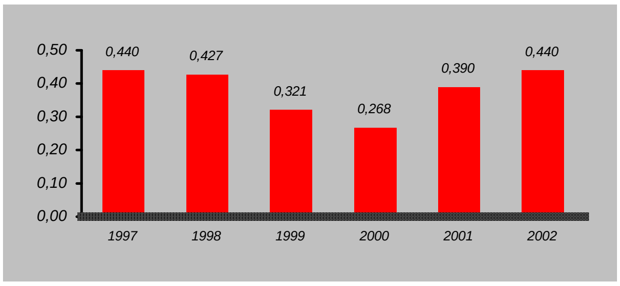


Figure 2.17. Ratio of Personnel Annual Collective Dose to the Amount of Produced Electricity, person·cSv/MW·y

2.2 ZAPORIZHZHYA NPP

Zaporizhzhya NPP is situated in the steppe area of Ukraine on the bank of the Kakhovka reservoir in Kamyansko-Dniprovsky district. This is the largest nuclear power plant in Europe.

ZNPP operates six WWER-1000 power units with the total installed capacity of 6000 MW.

A decision to construct ZNPP was made in 1978. Stage-by-stage construction of the plant power units was started in 1981. During 1984-1987, four power units were put into operation. Power unit 5 started its operation in 1989, and power unit 6 was started up in 1995 – this is the only power unit that was commissioned in the period of Ukraine's independence.

At present ZNPP is a high-technology enterprise. A series of measures have been implemented at the plant to ensure safe and ecologically clean production of energy. ZNPP is the most reliable energy source that produces almost half the total electricity of Ukrainian NPPs.

ZNPP Nuclear Safety Improvement Measures

In order to improve safety, modernization of Zaporizhzhya NPP equipment is underway. Replacement of expired equipment by up-to-date one ensures safe and reliable operation of power units. During preventive maintenance at power unit 3, electric equipment of the group and individual control system (GICS) and drives of the control and protection system were replaced, and in-core monitoring system (IMS) was partially upgraded. Licensing of projects for replacement of similar equipment at power units 1, 2, and 4 is underway.

New technology has been implemented at ZNPP power unit 5 for secondary coolant correction with morpholine. This technology has essentially reduced corrosion of secondary circuit equipment and piping. This is especially important for steam generator heat-exchange tubes.

In compliance with the Program for Modernization of Blowdown System of ZNPP Steam Generators, this system is to be reconstructed at power units 1-6 to substantially improve the reliability of steam generators.

Modernization of pilot-operated relief valves of pressurizers at power units 1-6 is carried out within the TACIS program. Licensing of these projects is underway.

It should be noted that Zaporizhzhya NPP carries out replacement of thermal insulation of primary equipment and piping within the "Comprehensive Program for Upgrading and Safety Improvement of Nuclear Power Units under Operation" approved by the Cabinet of Ministers of Ukraine on 29 August 2002. This measure is extremely important since replacement by non-destructive insulation is a step towards solving the problem of common-cause failures in the emergency core cooling system.

Summarizing activities under equipment modernization projects, it should be noted that Zaporizhzhya NPP tends to increase the number of such projects. This is an objective indicator of safety improvement.

There were no nuclear, radiation or operational accidents at Zaporizhzhya NPP in 2002.

Events recorded at ZNPP during 1992-2002 did not exceed conditions (limits) of safe operation (Figure 2.6.).

The underproduction of electricity at ZNPP that resulted from the above events constituted 21.6 Mln kW·h.

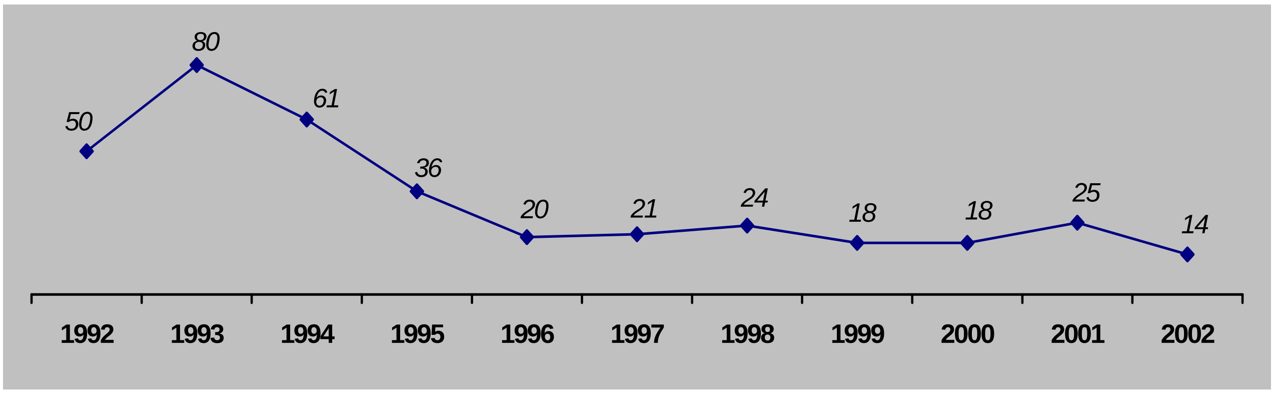


Figure 2.6. The Number of Events in 1992-2002

ZNPP Safety Surveillance

State surveillance of nuclear and radiation safety at SE ZNPP in 2002 was exercised by the Main State Inspectorate for Nuclear and Radiation Safety (MSI) and ZNPP resident inspectorate. MSI inspectors conducted three scheduled inspections to check compliance of safety-related systems and components with requirements of standards and rules and to check personnel training system and performance of system for accounting and control of nuclear material. Based on the inspections, two acts prescribing to eliminate violations were issued. One of the main violations revealed at ZNPP during inspections was the lack of straightforward and consistent policy to prevent equipment failures caused by ageing.

Surveillance over nuclear and radiation safety on site is exercised by the SNRCU State Inspectorate for Nuclear and Radiation Safety acting as a territorial body and consisting of 7 inspectors. Available are 5 inspectors. In addition to routine surveillance and monitoring over observance of standards and rules, special terms of licenses, and inspection prescriptions by officials and personnel of SE "Zaporizhzhya NPP", as well as by other organizations involved in on-site operations (two construction, nine assembly, and nine commissioning organizations), 64 inspections were conducted during the year, which resulted in acts prescribing to eliminate violations.

Inspections were conducted during the year to verify fulfilment of requirements of legislation, safety standards, rules and regulations, and terms of licenses (permits) issued to SE ZNPP. Implementation of prescriptions and associated measures was monitored as well. 13 acts with prescriptions were issued during the year.

Inspectorates surveyed over development, implementation, and performance of the quality assurance programs for NF operation.

The procedure for notification of SE ZNPP operational events was monitored. State resident inspectors of the SNRCU Inspectorate participated in commissions established to investigate causes of events.

SE ZNPP units were inspected after repair prior to issuing temporary permits for operation. Inspection of the spent fuel storage facility (SFSF) was conducted prior to its commissioning into commercial operation.

Resident inspectors along with the MSI inspectors conducted 10 in-depth examinations devoted to some safety issues. Officials of the SNRCU Inspectorate participated in 18 IAEA inspections under the Agreement between Ukraine and the International Atomic Energy Agency on Safeguards concerning the Nuclear Non-Proliferation Treaty to examine fresh fuel storage, modernization of the IAEA video system, accounting and reporting documents.

The main shortcomings revealed during inspections are:

- Lack of effective standard procedures for inspection and maintenance of safety-related equipment provided by the operating regulations;
- Insufficient monitoring over observance of the procedural discipline by management of the NPP departments;
- Untimely insertion of changes and supplements to instruction manuals and administrative documents that provide organization and performance of certain activities.

From 8 to 20 July 2002, the SNRCU inspection team consisting of state inspectors of Department of Nuclear and Radiation Safety Assessment, Central Inspection Department, and State Inspectorate for Nuclear Safety of Zaporizhzhya NPP verified assurance of nuclear and radiation safety by NNEGC Energoatom during ZNPP operation from 1997 to 2002.

ZNPP personnel involved in reactor facility control obtained 16 licenses in 2002, 66 licenses were extended (including 17 licenses for new positions), and 9 licenses were cancelled.

In order to train personnel to operate nuclear facilities, there is a training centre (TC) at Zaporizhzhya NPP licensed by the SNRCU. TC experts are responsible for acceptance examination of future licensees, training and final examinations. Based on examinations, application documents are submitted to the SNRCU Licensing Commission to issue a license to an individual for direct control of the nuclear power reactor. After passing the licensing procedure in compliance with legislation, the individual obtains a 2-year license.

Radioactive Waste Management

Radioactive waste is processed in the main buildings of six power units, two special buildings with communal service modules and in the SRSF.

The liquid radwaste processing and storage scheme includes: two deep evaporators UGU-1-500; eight evaporators; compartment of reagents; liquid radwaste storage compartment; oil purification facility; liquid radwaste and solid radwaste storage facility.

Liquid radwaste is collected in places of production and transferred to the chemical shop where it is processed in active water treatment facilities to the state of bottoms. Interim storage for bottoms is organized in the liquid radwaste storage facility. The interim system of liquid radwaste storage allows piping bottoms for their subsequent processing in deep evaporator UGU-1-500. The output of evaporation – salt fusion cake where content of salt is near 2000 g/dm^3 – is filled in 200-L drums. It is solidified after cooling and turns into salt monolith. Drums with the salt fusion cake are stored in the solid radwaste storage facility.

Solid radwaste is collected in place of its production, sorted into combustible, compactable and non-compactable waste, and classified by activity. Then solid radwaste is transferred to the decontamination shop. Solid waste sorted by activity is transmitted for storage to the solid radwaste storage facility. Partial processing of solid radwaste is performed on site in incinerators and compacting facilities. Further minimization of solid radwaste requires additional equipment.

Figure 2.7 shows generation of liquid and solid radwaste during the last five years in m^3.

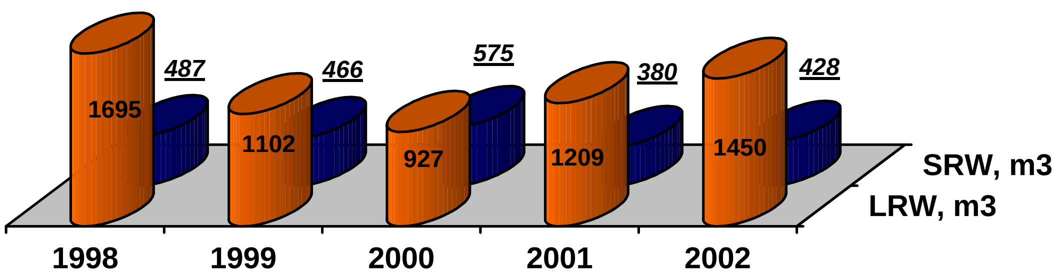


Figure 2.7. Generation of Liquid and Solid Radwaste during 1998-2002

The increased amount of bottoms in 2001 – 2002 is associated, first of all, with chemical treatment of steam generators and with washout of crystallization salt in interim storage casks for liquid radwaste.

8,251,4 m^3 of solid radwaste and 3,775 m^3 of liquid radwaste were accumulated on site as of 1

January 2003. Solid radwaste storage facilities are filled more than 40%. The available capacity of the solid radwaste storage facilities with the existing technology should be sufficient until termination of power unit designed service life.

The program for Zaporizhzhya NPP radwaste management was developed up to 2004. Measures of the program will permit minimizing annual generation of radioactive waste.

In compliance with the program for Zaporizhzhya radioactive waste management, the following activities were carried out in 2002:

- Secondary water chemistry technology involving alkalisation of steam generators with lithium metaborate was developed and implemented, this resulted in reduction of floor drains by 2000 m^3 per year;

- Repeated use of flushing water for regeneration of active water treatment facility filters allowed reduction of floor drains by 70 m^3 per each regeneration;
- Reconstruction of the boron gauge cooling system and pump sealing circuit allowed reduction of floor drains by 1600 m^3 per year, and so on.

According to the program for Zaporizhzhya NPP radwaste management, it is planned to develop (purchase), assemble and commission the following:

- Process line for liquid radwaste processing into ceramic fusion cake (glass melting);
- Technology for the liquid radwaste transfer into non-radioactive product by its passing through selection sorbent and solidification of ion-exchange materials and sludge.

For solid radwaste conditioning, commissioning of the following facilities is planned:

- Facility for solid radwaste retrieval from the solid waste storage facility;
- Sorting facility;
- Thermal insulation remelting facility.

NPP Impact on Environment

Assessment of nuclear power plants environmental impact is based on analysis of airborne releases from power unit ventilation stacks into the atmosphere, releases into water reservoirs, and environmental monitoring.

Figures 2.8.-2.10 show the dynamics in releases of iodine-131, long-lived radionuclides, and inert gases from ZNPP ventilation stacks during 1997-2002.

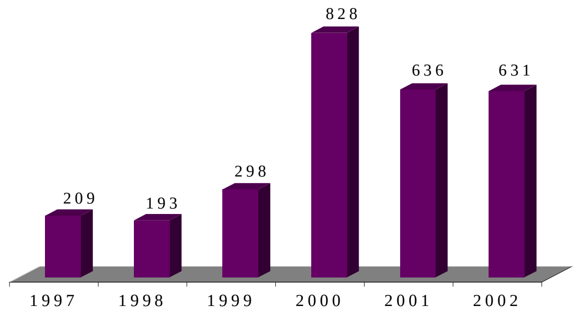


Figure 2.8. Iodine Releases from ZNPP Ventilation Stacks, kBq/d

For iodine-131 releases from ZNPP ventilation stacks, the reference level is 300,000 kBq/d.

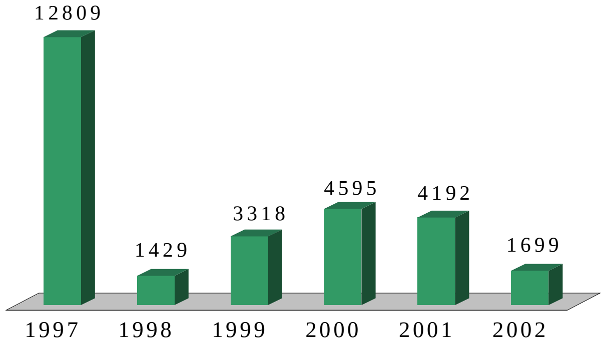


Figure 2.9. Releases of Long-Lived Radionuclides from ZNPP Ventilation Stacks, kBq/d

For releases of long-lived radionuclides from ZNPP ventilation stacks, the reference level is 19,000 kBq/d.

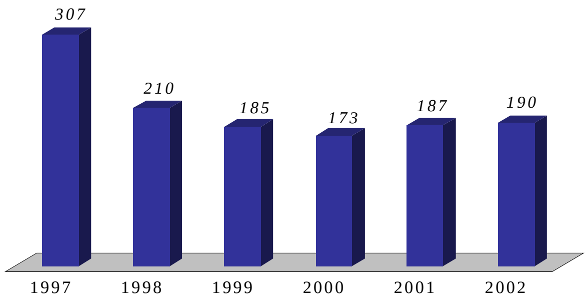


Figure 2.10. Releases of Inert Gases from ZNPP Ventilation Stacks, GBq/d

For releases of inert gases from ZNPP ventilation stacks, the reference level is 3300 GBq/d.

These figures show that releases from ZNPP ventilation stacks are much lower than the reference levels.

The actual radionuclide releases to ponds did not exceed the reference levels at Zaporizhzhya NPP for different elements more than by several percents in 2002.

Concentrations of radionuclides in the surface air, surface and underground water at ZNPP area are lower by several orders than their permissible values established in the Radiation Safety Standards of Ukraine (NRBU-97).

Personnel Radiation Protection

The reference individual doses for ZNPP personnel are 15 mSv/y, for personnel of separate contingent (129 individuals) – 18.5 mSv/y. The NPP personnel who participate in highly qualified radiation and hazardous work belong to the separate contingent. The need to increase the reference level to 18.5 mSv/y resulted from extensive repairs at ZNPP units 2 and 5.

No cases of exceeding the annual permissible dose (20 mSv/year) and reference individual annual dose occurred in 2002.

One of the main indicators used to characterize NPP personnel radiation protection is the ratio of the personnel collective dose to the number of power units under operation. 1000 person·mSv/unit is considered acceptable in the world practice for WWER reactors. For ZNPP this value constitutes 1126.27 person·mSv/unit. Increase of this indicator as compared to 2001 (720.68 person·mSv/unit) resulted from extensive repairs at ZNPP units 2 and 5.

An objective indicator characterizing personnel radiation protection is the ratio of the annual collective dose of the NPP personnel to the amount of electricity produced at NPP.

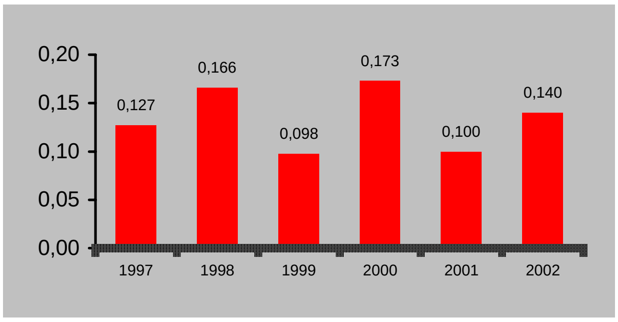


Figure 2.11. Ratio of Personnel Annual Collective Dose to the Amount of Produced Electricity, person·cSv/MW·y

Figure 2.11 shows the dynamics in ratio of the personnel annual collective dose to the amount of produced electricity from 1997 to 2002 (person·cSv/MW·y).

Zaporizhzhya NPP Spent Fuel Storage Facility

Zaporizhzhya NPP spent fuel after preliminary cooling in spent fuel pits had been transported to Russia for temporary storage and subsequent processing till August 2001.

After construction and licensing of the spent fuel storage facility for commissioning (License series EO No. 000014, issued on 16 July 2001 to the operating organization NNEGC Energoatom), spent fuel from ZNPP units has been also placed in this storage facility since 2001.

Zaporizhzhya NPP SFSF is located on site; spent fuel assemblies are stored in WWER-1000 ventilated storage containers. These containers are modified VSC-24 containers of the spent fuel temporary storage system used at the United States NPPs. Each WWER-1000 ventilated storage container is designed to contain up to 24 spent fuel assemblies of WWER-1000 reactors. Trial commercial operation of the SFSF was conducted during the term of the commissioning license.

The first three WWER-1000 ventilated storage containers were loaded and located on site during August-September 2001 in compliance with license terms. In 2002, spent fuel was stored in 3 WWER-1000 ventilated storage containers whose condition was monitored in compliance with appropriate procedures. Each of the three containers was loaded with 22 spent fuel assemblies. According to the license terms, SE ZNPP submitted monthly reports to the SNRCU on results of procedural monitoring of the ventilated storage containers. Results of the monitoring confirmed that all radiation parameters complied with the designed values during the trial commercial operation of the containers.

The SFSF refuelling containers and multi-place sealed basket were certified as safety-related components. Appropriate certificates were issued in 2002.

In compliance with the license terms, SE ZNPP developed and submitted a report on commissioning the ZNPP SFSF into trial commercial operation to the SNRCU. Findings of the state review on nuclear and radiation safety confirmed that results of the trial commercial operation complied with regulatory and technical requirements of Ukraine and fundamental safety principles of nuclear facilities. Some problems encountered in loading the first three multi-place sealed baskets were mainly caused by technological issues and were further eliminated through appropriate measures. Based on results of the SFSF trial commercial operation set forth in the report and on findings of the state review on nuclear and radiation safety of the report, ZNPP developed measures required for loading the next batch of WWER-1000 ventilated storage containers and elaborated SFSF prospective measures. The above measures were implemented by Order No. 1274 of the SE ZNPP Director General of 5 November 2002.

In October 2002, SE ZNPP submitted the Safety Analysis Report on a dry storage system for Zaporizhzhya NPP spent fuel (version 02). The Report was approved according to results of its assessment and findings of the state review on nuclear and radiation safety. Based on the experience in loading the first three containers and initial storage stage, current documents were revised and new regulations were developed to govern SFSF operation.

WWER-1000 ventilated storage containers should be further loaded with 24 fuel assemblies, i.e. full loading was needed according to the gained experience and reasonableness. The applicant developed the branch regulation entitled "Spent Fuel Storage in SFSF Ventilated Storage Containers WWER-1000. Authorizing Procedure, Requirements on Documentation and Neutronic Calculations of ZNPP SFSF Ventilated Storage Containers" to regulate full loading of the Containers. This document was agreed with the SNRCU. In compliance with this regulation, the applicant grounded nuclear safety of typical loading of ventilated storage containers WWER-1000 with spent fuel. Based on results of the assessment and findings of the state reviews on nuclear and radiation safety, the SNRCU agreed the report substantiating the safety of such loading.

In November 2002, the SNRCU received the Certificate of the State Acceptance Commission, approved by Ordinance No. 680 of 22 November 2002 of the Ministry for Fuel and Energy of Ukraine, on acceptance of the Zaporizhzhya NPP spent fuel storage facility in operation.

However, after the comprehensive assessment of the ZNPP spent fuel storage facility for operational preparedness, the applicant concluded that the SFSF commissioning stage should be continued. The NNEGC Energoatom submitted an appropriate application to the SNRCU in November 2002 for extension of the license for ZNPP SFSF commissioning.

Based on review of the application and on Decision of the SNRCU Licensing Commission No. 29/2002 dated 11 December 20002, the license for ZNPP SFSF commissioning was extended to 31 May 2003 in compliance with the licensing procedure entitled "On Extension of the NNEGC Energoatom License Series EO No. 000014 dated 16 July 2001 Authorizing Commissioning the Spent Fuel Storage Facility at SE Zaporizhzhya NPP". The period from 1 December 2002 to 31 May 2003 was identified as the commissioning stage II devoted to loading and transfer to the storage site of containers with 24 spent fuel assemblies (in addition to the 3 containers loaded with 22 spent fuel assemblies at SFSF commissioning stage I). The license terms were revised in compliance with the gained experience.

2.6. CHORNOBYL NPP

Status of ChNPP Decommissioning and Shelter Transformation into Ecologically Safe System

Chornobyl NPP is situated in the north of the Ukrainian Polissya at a distance of 12 km from the town of Chornobyl on the right bank of the Pripyat' river.
There are three power units with high-power uranium-graphite reactors (RBMK-1000) and the Shelter facility at Chornobyl NPP.

The Shelter facility is the fourth power unit, which was destroyed by the beyond design-basis accident in 1986 and lost all its functional capabilities. Emergency measures were taken at the unit to mitigate accident consequences. Maintenance, repair, modernization of structures, systems, and equipment are underway at the Shelter to ensure its nuclear and radiation safety. The main peculiarity of the Shelter is its potential hazard caused by the great amounts of radioactive materials not confined within reliable physical barriers from the environment on the one hand, and the lack of monitoring over Shelter condition according to safety standards and rules, on the other hand. Moreover, there are no reliable quantitative assessments of different hazards because comprehensive inspection of the facility is impossible.

ChNPP unit 2 was decommissioned on 15 October 1991 as a result of a fire in the turbine hall. A decision was made on 30 November 1996 to decommission power unit 1 ahead of schedule. Power unit 3 was shut down on 15 December 2000. Therefore, all three power units have been under decommissioning since December 2000.

On-site activities are carried out by the operating organization SSE "Chornobyl NPP" under License No. EO 000033 issued for Shelter operation by the regulatory authority in December 2001 and License No. EO 000040 issued for ChNPP Decommissioning on 22 March 2002. The Shelter operation license establishes the scope and conditions of the permitted activities and provides for Shelter transformation into an ecologically safety system, in particular, within the Shelter Implementation Plan (SIP).

It should be noted that any Shelter-related activity is intended to protect personnel, population and the environment against the impact of radioactive materials located in the facility and on its site. Activities intended for any other purposes are prohibited at the Shelter.

License for the ChNPP decommissioning permits the operating organization – SSE "Chornobyl NPP" – to conduct all activities and operations associated with decommissioning of nuclear facilities.

This license also establishes requirements on obtaining permits for individual activities or operations at decommissioning stages, such as design, construction, commissioning, and operation of radioactive waste management facilities, as well as a series of measures to retrieve spent and fresh nuclear fuel, liquid and solid radwaste accumulated during ChNPP operation from existing facilities.

In 2002 ChNPP units were operated according to operating procedures establishing standards and rules for maintenance and operation of equipment and systems that remained in service and limits and conditions of their safe operation.

Retrieval of potentially hazardous materials from power unit systems and equipment was underway during the year.

As of 1 January 2003, activities at 110 systems and individual equipment components were completed; power unit 2 and turbine halls of all three power units were completely cleared of fire hazardous materials. Over 120 m^3 of liquid and 600 m^3 of solid radwaste was retrieved from power units. Over 22,000 m^3 of radioactive drains were treated. Comprehensive engineering and radiation examination of power unit 2 was completed in 2002.
In 2002 experts of the Ministry for Fuel and Energy, SNRCU and other competent authorities continued developing documents for the ChNPP decommissioning, namely:

- National program for decommissioning and Shelter transformation into an ecologically safe system;
- Integral program for radioactive waste management at the stage of ChNPP operation termination and Shelter transformation into an ecologically safe system;
- ChNPP decommissioning concept.

Shelter nuclear safety is assured through regulated monitoring over state and subcriticality of fuel-containing materials and through preventing a self-sustained chain fission reaction by injecting neutron-absorbing solution (0.1% gadolinium nitrate solution).

The Shelter served for its main purpose during 15 years as the quite effective barrier preventing spread of radioactive materials contained in the destroyed power unit. Implementation of stabilization measures is the key aspect taking into account the state of structures being the main physical barrier preventing spread of radioactive materials into the environment. The integrated stabilization and shielding design is intended to stabilize structures of Shelter different zones.

According to preliminary assessments, the stabilization program should improve stability of structures for the period required for implementation of new safe confinement. Stabilization measures should be implemented as soon as possible.

Elaboration of the safe confinement conceptual design has been started, involving the SNRCU and other regulatory authorities in review of design materials at early stages.

On-Site Radioactive Waste Management

Licensing requirements on ChNPP safe decommissioning include safe management of radioactive waste accumulated at ChNPP and generated in decommissioning.

ChNPP radioactive waste is stored in special storage facilities constructed in accordance with the design (liquid radwaste is stored in stainless steel tanks, solid radwaste in reinforce concrete containers). The radwaste designed storage period is more than 50 years. Radwaste storage facilities are equipped with protective systems: special ventilation, radioactive drain, physical protection and alarm, radiation monitoring. There are boreholes for monitoring of ground water along the perimeter of the storage facilities.

Compartments for low- and intermediate-level waste have been filled up and preserved, waste resulted from current activities is transported to the "Buryakivka" radioactive waste disposal site of the SSE "Complex". High-level waste is stored in the special on-site storage facility, whose filling does not exceed 27%, however, it is not sufficient for decommissioning of power units and Shelter transformation.

Shelter solid radioactive waste results from decontamination of Shelter premises and nearby territory, operation (maintenance, repair modernization) of Shelter systems and equipment, and SIP-related activities.

8,449 m^3 (including 245 m^3 from the Shelter) of low-level and 82 m^3 (including 6 m^3 from the Shelter) of intermediate-level waste was transported during 2002 to the "Buryakivka" radwaste disposal site. 5.7 m^3 (including 3 m^3 from the Shelter) of high-level waste with the total activity of 64.6 Ci was transferred to the ChNPP solid radwaste storage facility. As of 1 January 2003, the total amount of radwaste disposed in the storage facilities constituted 2,500 m^3. There is about 19,438 m^3 of liquid radwaste accumulated on site, 40.5 m^3 was generated during the reporting year. This is essentially lower than that of the previous year – 327.6 m^3. Liquid radwaste tanks have been filled to 57 % of the designed capacity; however, all radwaste has to be treated to the state acceptable for storage and disposal.

The state of the ChNPP radwaste management program was satisfactory in 2002. Radwaste management conditions complied with safety regulations.

The following decommissioning facilities are under construction at Chornobyl NPP site for radioactive waste management: liquid radwaste treatment plant (LRTP), industrial complex for solid radioactive waste management (ICSRM), including facility for retrieval of solid waste form the existing solid waste storage facility, facility for processing solid waste, and engineered disposal facility for low- and intermediate-level short-lived waste.

The design and construction of the facilities are funded by the European Commission in the framework of international assistance rendered to Ukraine for ChNPP decommissioning (Nuclear Safety Fund).

The LRTP "turn key" construction contract was signed with the Belgatom International Consortium on 16 September 1999.

LRTP is constructed under the project "Chornobyl NPP. Liquid Radioactive Waste Treatment Plant". The project was subjected to a state comprehensive review, including that on nuclear and radiation safety, and was approved by Resolution of the Cabinet of Ministers of Ukraine No. 105-re dated 22 March 2001. The LRTP preliminary safety analysis report was agreed in the framework of the SNRCU comprehensive review. SSE "Chornobyl NPP" works out the interim safety analysis report to constitute the basis for permission for LRTP commissioning and operation after SNRCU approval.

The LRTP building has been practically completed. Equipment installation has been started.

In compliance with the LRTP construction contract, its safety-related systems and equipment are to be delivered according to technical specifications preliminary agreed by the SNRCU. Technical documents on some systems and equipment that are being or should be installed in the nearest future have been agreed: liquid radwaste tanks, protective doors, the system for liquid radwaste retrieval from the existing liquid waste tanks, radiation monitoring systems.

The industrial complex for solid radioactive waste management – ICSRM – is intended for waste retrieval from solid waste storage facilities, waste sorting, incineration, compaction, and cementation. The SNRCU agreed the ICSRM specifications for a tender on 6 July 1999. The Commission of European Communities officially recognized the German NUKEM Company as the winner of the tender for the ICSRM construction. A construction contract was signed in March 2001. The preliminary general schedule of ICSRM construction and preliminary schedule for submission of design documents for agreement were provided to the SNRCU. The conceptual design and preliminary safety analysis reports on ICSRM are under development.

The final product of LRTP and ICSRM will be transferred for disposal to the near-surface storage facility Lot 3 (a part of ICSRM) to be constructed at the "Vector" site of SSE "Tekhnocentre".

In this regard, SSE "Tekhnocentre" is preparing documents required for appropriate licenses.

ChNPP Safety Surveillance

State surveillance over nuclear and radiation safety at ChNPP in 2002 was exercised by the Main State Inspectorate for Nuclear and Radiation Safety (MSI). MSI inspectors conducted three scheduled inspections to check quality of administrative management and check personnel training system and performance of system for accounting and control of nuclear material. Based on the inspections, three acts were issued. Special attention was paid to quality assurance in safe decommissioning of ChNPP units 1-3 and Shelter transformation into an ecologically safe system. The main drawback revealed in the inspection is that SSE ChNPP is not capable of fulfilling the Shelter Implementation Plan. This affects the safety of Chornobyl NPP. Surveillance over nuclear and radiation safety on site is exercised by the State Inspectorate for Nuclear Safety at Chornobyl NPP consisting of 7 inspectors. Available are 5 inspectors.

State inspectors conducted 46 inspections in 2002 to verify observance of legislation, safety standards, rules, and regulations, terms of issued licenses (permits), as well as the following:

- Work with personnel of Shelter departments;
- ChNPP operational management, state of the reactor facility, safety systems, safety-related systems, normal operation systems, and water chemistry during operation;
- Radioactive waste management;
- Management of assembly, repair, and maintenance at SSE ChNPP;

- State of the nuclear fuel accountancy and control system;
- Adherence to technical discipline.

31 acts prescribing to eliminate violations were issued.

In-depth inspections of Chornobyl NPP were referred to:

- Observance of standards and rules during operation of the cooling ponds;
- Evaluation of work performers;
- Status of lifetime extension of the "SKALA" centralized monitoring system;
- Performance of the "Signal" and "Finish" information diagnostic systems;
- ChNPP current structure: fulfilment of safety standards and rules for nuclear power facilities during NPP operation termination.

9 inspections of the Shelter were conducted during the year. ChNPP personnel involved in reactor control obtained 8 new licenses in 2002, 8 licenses were extended, 19 licenses were cancelled.

State inspectors participated in 4 IAEA inspections conducted in compliance with the Agreement between Ukraine and the International Atomic Energy Agency on Safeguards concerning the Nuclear Non-Proliferation Treaty.

Personnel Radiation Protection

No cases of exceeding the personnel annual permissible dose (20 mSv/year) and reference individual annual dose (17 mSv/year) occurred at ChNPP in 2002.
One of the main indicators used to characterize plant personnel radiation protection is the ratio of the personnel collective dose to the number of power units under operation, which constitutes 4,472.09 person·mSv/unit (including individuals on assignment).

NPP Impact on Environment

Since ChNPP units are not operated and are being decommissioned, radioactive releases in the environment contain only long-lived radionuclides whose total release for 2002 was 663 kBq/d; this constitutes about 4.5% of the plant reference level for releases of long-lived radionuclides.

Shelter Air Monitoring

Activity of air samples by long-lived α-aerosols was from 3.7×10^{-4} to 18.9 Bq/m^3 (in unattended rooms) in the reporting period. Activity of air samples by long-lived α-aerosols beyond the Shelter varied from 7.4×10^{-4} to 1.7×10^{-2} Бq/м^3. According to γ-spectrometry, airborne radionuclide composition is as follows: ^{137}Cs -

98%, ^{134}Cs – 1%, ^{241}Am – 0.63%, $^{154,155}Eu+^{60}Co$ – 0.37%.

Shelter Water Monitoring

482 samples were taken in the reporting period.
Specific activity of groundwater samples by ^{137}Cs was from 3.3×10^2 to 2.3×10^4 Bq/m^3, by ^{90}Sr – from 6.3×10^2 to 1.8×10^6 Bq/m^3.
Specific activity of radioactive drains was from 1.1×10^7 to 1.3×10^8 Bq/m^3.
Specific activity of water in deaerator rooms varied from 3.7×10^7 to 3.3×10^8 Bq/m^3.
Specific activity of water in the turbine hall was from 8.1×10^7 to 9.6×10^7 Bq/m^3.
Specific activity of water in block B rooms varied from 1.0×10^7 to 1.5×10^{11} Bq/m^3.
Caesium isotopes mainly contribute to the total activity of unit water.

Shelter Releases to the Environment

The total controlled release of long-lived radionuclides constituted 3.59×10^7 Bq in the reporting period.
According to the "Shelter" International Science and Technology Centre, the upper values of radioactive airborne releases through the Shelter roofing structural openings ("uncontrolled release") were 7.22×10^6 Bq (^{241}Am, ΣPu) for α-nuclides, 5.62×10^8 Bq (^{134}Cs, ^{137}Cs) for β-nuclides. The data were obtained by radioactivity measurements on four flatbed facilities located on the light roof above the process apertures. The total "uncontrolled" release constituted 9.83×10^8 Bq (the fraction of α-nuclides does not exceed 1.13% of the total activity).
The total release of long-lived radionuclides in the reporting period was 10.19×10^8 Bq; this constitutes 1.08% of the permissible value (in terms of 2.6×10^8 Bq/d).

Shelter Discharges to the Environment

19 boreholes and 3 survey stations were used to monitor radiochemistry.
^{90}Sr content was from 2×10^3 to 1.42×10^5 Bq/m^3.
^{137}Cs content was from 4×10^3 to 9.6×10^4 Bq/m^3.
^{3}H content was from 2×10^3 to 1.88×10^6 Bq/m^3.

Chornobyl NPP Spent Fuel Storage Facility ISF-2

Development of the detailed design and construction of spent fuel storage facility ISF-2 were continued in 2002. ISF-2 is intended to store Chornobyl RBMK spent fuel assemblies over the next 50-100 years.

According to design, ChNPP ISF-2 constitutes:

- Building of the facility for spent fuel treatment for storage;
- Number of horizontal reinforced concrete storage modules to contain sealed steel canisters with spent fuel. ISF-2 canisters contain sealed steel cartridges, each with one RBMK spent fuel assembly cut in halves.

The ISF-2 design is based on the NUHOMS technology developed in the USA for spent fuel of power reactors. The main functional tasks of ISF-2 are to:

- Receive and cut spent fuel assemblies;
- Dispose spent fuel assemblies in sealed canister and cartridges;
- Transport canisters with spent fuel assemblies to storage locations;
- Locate canisters with spent fuels assemblies in reinforced concrete modules for long-term storage;
- Collect and utilize solid and liquid radioactive waste;
- Protect spent fuel assemblies from possible extreme natural and man-caused events;
- Protect personnel and the environment against ionising radiation;
- Ensure physical protection, accounting and control of nuclear material;
- Provide for transport of spent fuel assemblies from ISF-2 to processing plants or repositories.

The ISF-2 site is located nearby the Chornobyl NPP site within the 10-km exclusion zone with fencing in which strict administrative regime is established. There are no facilities around the site, which could affect the safety and functional purpose of ISF-2.

A license to “design nuclear facilities” for Chornobyl NPP RMBK-1000 spent fuel storage facility (ISF-2) was issued to the operating organization NNEGC Energoatom on 22 November 2000.
A license to construct Chornobyl NPP spent fuel storage facility ISF-2 was issued to the NNEGC Energoatom on 27 June 2001.

After certain structural changes in Ukrainian nuclear branch, State Specialized Enterprise “Chornobyl NPP” was established to act as the operating organization (operator) of ChNPP nuclear facilities. Since change in the licensee legal status authorizing individual nuclear activities requires that issued licenses be redrafted, the license for ISF-2 design and license for ISF-2 construction of the operating organization were redrafted.

According to the review of documents submitted with the SSE ChNPP application of 19 February 2002 and Resolution of the SNRCU Licensing Commission No. 14/2002 of 17 July 2002, the State Specialized Enterprise “Chornobyl NPP” obtained License No. EO 000063 for design of nuclear facilities of 19 July 2002. The application for redrafting the license for construction of the Chornobyl NPP spent fuel storage facility (ISF-2) was submitted to the SNRCU and accepted for review.

3. RESEARCH REACTORS

Research Reactor of the Scientific Centre "Institute for Nuclear Research" of the National Academy of Sciences of Ukraine

The WWR-M research reactor of the Institute for Nuclear Research of NASU is one of the first research reactors constructed and commissioned in the former USSR. The WWR-M reactor was created 40 years ago on the initiative of Academician I. Kurchatov to implement the program intended to provide nuclear regional centres with research reactors. Construction and operation of the research reactor was managed by the first director of the Centre, NASU Academician M. Pasichnyk.

From its first years, the research reactor constituted the science and technology basis not only for the institute scientists but also for the other organizations in Ukraine and the former USSR. Various research activities in nuclear and radiation physics, radiation physical metallurgy, production of radioisotopes and radiation biology were conducted during forty years.

The operation of the NRI WWR-M research reactor was terminated in 1993. Its operation was recommenced in 1998 under a **temporary permit** issued by the Nuclear Regulatory Administration after the Centre had taken safety improvement measures, namely:

- Up-to-date system of physical protection was put into operation;
- Computer system for nuclear material accountancy was implemented;
- New system for automated fire alarm was installed;
- Two diesel power stations of 100 kW each were installed and connected to electricity supply; they are the source of the emergency power supply system;
- Lifetime of equipment for the research reactor control and protection system was extended;
- Lifetime of the research reactor vessel, piping, and primary equipment was extended;
- Operation of the liquid radwaste processing facility was recommenced;
- Lifetime of cables and switching units of safety-related systems was extended.

In conformity with Article 8 of the Law of Ukraine "On Permissive Activity in the Field of Nuclear Energy Use" implemented in 2000, a **license** issued by the state nuclear regulatory authority is the basis for activities and operations associated with the nuclear facility life stage in question.

Therefore, in September 2001, the Centre started preparing documents required for a license. The SNRCU experts assessed the documents submitted by the Centre for completeness and authenticity.

The SNRCU Collegium assembled on 15 March 2002 to approve a decision to issue the license to the Scientific Centre "Institute for Nuclear Research" of the National Academy of Sciences of Ukraine for operation of the nuclear facility – WWR-M research reactor. This was the first license issued by the SNRCU to authorize such activity. The license will be valid till completion of the life stage "Operation of Nuclear Facility".

Research Reactor of Sevastopol Institute for Nuclear Energy and Industry (SINEI)

There are 3 nuclear facilities on site of the Sevastopol Institute for Nuclear Energy and Industry:

- IR-100 research reactor;
- Physical test bench (critical assembly placed in the reactor biological shielding matrix);
- Subcritical uranium-water assembly (located in the laboratory of the Nuclear Steam Supply Systems Department in the Institute training building).

Reactor physical startup took place on 18 April 1967. Control and protection system was upgraded in 1977. The reactor thermal power is 200 kW. The last startup of the reactor took place on 4 January 1995. The physical test bench (critical assembly) was commissioned in 1974. The reactor and critical assembly cores contain the same fuel rods of 10% enrichment by uranium-235. The subcritical uranium-water assembly was commissioned in 1964.

Territory of the IR-100 reactor and production premises are equipped with up-to-date intrusion-detection techniques designed under assistance of the US Department of Energy. Their improvement and modernization were continued in 2002.

All nuclear facilities are intended for educational and scientific purposes, as well as other activities. There are more than 20 experimental devices. Some of these devices are unique and have no analogues either in Ukraine or other Independent States. According to Resolution of the Cabinet of Ministers of Ukraine No. 1709 of 19 December 2001, the nuclear facilities of the Institute, as educational and research complex, were put on the list of facilities constituting national property.

Nuclear and radiation safety is ensured in accord with Ukrainian current standards, rules, and regulations. Inspection, maintenance, and repair of safety-related systems are carried out by personnel in accordance with engineering documentation. The facilities are provided with devices, tools, and spare parts.

Specialized enterprises were involved in analysis of technical state of the expired systems and equipment. Based on these efforts, potential for further safe operation was determined.

The research reactor is equipped with regular means for storage of liquid and solid radwaste. Radwaste accounting is conducted. Information on the radwaste presence and amount is regularly provided to appropriate state bodies. Radwaste is transported to the Odessa specialized enterprise of the “Radon” Association for storage under the appropriate contract. Transport and disposal are funded out of the Institute budget. The transport plan was coordinated with the Ministry for Fuel and Energy of Ukraine. There is no spent fuel on Institute site. Radiation safety of personnel, population and the environment is ensured according to proper standards, rules and regulations. The safety certificate on the facilities was issued by state health and safety supervisory authorities.

The State Department for Ecology and Natural Resources in Sevastopol issued the license to the Institute for the use of radiation sources (series YaRB – 26 No. 000005 dated 14 November 2001).

Background radiation and radioactive contamination of the environment in duffer area, control area and sea water area near Uchkuyevka beach are measured by IR-100 personnel in conformity with current requirements and techniques. The reliability of measurements is monitored by state health and safety authorities and Department for Ecology and Natural Resources in Sevastopol.

There were no accident releases and discharges into environment during operation of nuclear facilities. Exceeding of natural background radiation was not recorded. Analysis of nuclear facilities characteristics demonstrated that they did not cause any damage to the environment under normal operation.

Dosimetric monitoring of personnel, instructors and students is conducted in accordance to the established procedure. The nuclear facilities are provided with complete devices for dosimetric monitoring. Exposure doses of personnel and other individuals were not exceeded during operation of the facilities.

By Order of the Chairman of Derzhkomatom No. 531 of 25 November 1996, the SINEI was appointed the operating organization of the IR-100 reactor with full responsibility for its safe operation.

In 2002 the reactor licensing procedure lasted. Work programs were coordinated for operational safety substantiation of the IR-100 reactor control and protection system and operational safety substantiation of the IR-100 reactor vessel. Technical decision “On Subsequent Operation of IR-100 Cable Lines and Switching Equipment” was agreed. In December 2002, the SINEI submitted an application for a license for activity “Operation of Nuclear Facility on SINEI Site”. Review of the documents in compliance with the Law of Ukraine “On Permissive Activity in the Field of Nuclear Energy Use” showed that some of them had to be revised. The applicant was notified of that. The SINEI is revising the documents to incorporate comments made by the SNRCU.

8. EMERGENCY PREPAREDNESS AND EMERGENCY RESPONSE

Uniform State System for Prevention and Response to Man-Induced and Natural Emergencies

In Ukraine all measures on emergency preparedness and emergency response are integrated into the Uniform State System for Prevention and Response to Man-Induced and Natural Emergencies (USSE). The System was created and implemented under Resolution of the Cabinet of Ministers of Ukraine No. 1198 dated 3 August 1998.

In compliance with this Resolution, experts of the State Nuclear Regulatory Administration of Ukraine, upon agreement with the Ministry of Emergencies, developed provisions on the USSE functional subsystem for state regulation of nuclear and radiation safety in 1999.

USSE administrative provisions and performance modes were legalized in 2000 by the Law of Ukraine "On Protection of Population and Territories against Man-Induced and Natural Emergencies".

The SNRCU is currently responsible for managing the establishment and performance of the functional subsystem "Safety of Nuclear Power Facilities", which acts at facility and state levels of the USSE.

At the level of facility, this functional subsystem is employed by state on-site inspectorates for nuclear safety. According to the Provisions on USSE Functional Subsystem "Safety of Nuclear Power Facilities", the role of appropriate SNRCU Departments becomes more important in that they interact not only with plant personnel but also with local commissions for man-made ecological safety and emergencies in NPP satellite towns, territorial bodies of the Ministry of Emergencies and other USSE subsystems.

The plan of response to state-level emergencies approved by Resolution of the Cabinet of Ministers of Ukraine No. 1567 dated 16 November 2001 determines basic measures on mitigation of consequences resulted from any man-induced or natural emergencies, action procedure for administrative authorities, forces and means of the USSE required financial, material and other resources.

In 2002, SNRCU experts with involvement of the Ministry of Emergencies, Ministry of Health, Ministry of Fuel and Energy, and Ministry of Environment and Natural Resources started developing the State Plan for Response to Radiation Accidents (according to Resolution of the Cabinet of Ministers of Ukraine No. 122 dated 7 February 2001 "On Comprehensive Measures Aimed at Effective Implementation of State Policy in the Field of Population and Territory Protection against Man-Induced and Natural Emergencies, Prevention and Emergency Response to them, for the Period to 2005") to reflect specific character of response to radiation accidents. The State Plan for Response to Radiation Accidents is developed taking into account the IAEA recommendations.

Decision Support System RODOS

Another measure provided by Resolution of the Cabinet of Ministers of Ukraine No. 122 dated 7 February 2001 was to develop technique for prediction and assessment of radiation conditions during accidents at power reactors and to develop computer scenarios for occurrence and progression of radiation and nuclear accidents of different severity. This measure was implemented during 2002 through introducing the decision support system RODOS in Ukraine within the EC TACIS program.

The RODOS has been designed as a comprehensive system containing models and databases for presentation, calculation, and assessment of radiation accident consequences on different territories covered by appropriate countermeasures. Flexible coding of the system permits consideration of different local characteristics, releases, and availability and quality of monitoring data. The RODOS system allows creation of a databank on different accident scenarios and calculations of radiation consequences taking into account specific landscape, geographic, demographic, and other conditions in accident areas.

Experts from the Ministry of Environment and Natural Resources, Ministry of Emergencies, NNEGC "Energoatom" were involved in this project, and so were staff of the Institute for Problems of Mathematical Machines and Systems of the National Academy of Sciences to take part in the development of RODOS software.

The TACIS project was successfully completed in July 2002 and after that the press conference was held in the Ministry of Environment and Natural

Resources of Ukraine with participation of Mr. Norbert Jousten, Head of Delegation of the European Commission in Ukraine, Moldova, and Byelorussia.

NNEGC "Energoatom" Emergency Centres

In compliance with the "General Provisions on the Organization of NNEGC "Energoatom" System for Preparedness and Response to Accidents and Emergencies at Ukrainian NPPs, the main and alternative emergency centres should function in the NNEGC "Energoatom".

The alternative emergency centre of the NNEGC "Energoatom" is currently situated on the premises of the former emergency centre of Chornobyl NPP in Dniprovs'ke village, Chernigiv region. During accident-free periods, the alternative emergency centre premises are used for personnel training on actions in the event of accidents at NPPs.

In order to provide Ukrainian NPPs with reliable communication in the event of emergencies, NNEGC "Energoatom" developed and approved statement of work for the emergency space communication system in the framework of cooperation with the US Department of Energy. Equipment of the system will be installed at Rivne, Zaporizhzhya, Khmelnitsky and South Ukraine NPPs and at the main and alternative emergency centres of the NNEGC "Energoatom". The project is to be completed in 2004. The NNEGC "Energoatom" started a tender at the end of 2002 to select a subcontractor.

In addition to the above main and alternative emergency centres of the NNEGC "Energoatom", current regulations provide for establishment of internal (on site) and external (in the surveillance zone) emergency centres at each NPP.

The internal on-site emergency centre serves for control of actions on confining an accident and mitigating its consequences on site and in buffer area. The emergency work leader located in the centre manages activities of emergency teams and groups on monitoring, prediction of radiation situation and personnel protection, makes recommendations on population protection, communicates with the NNEGC "Energoatom" emergency centre, appropriate departments of local governmental authorities and other organizations.

The NPP external emergency centre is to be used in the event of the accidents when control from the internal emergency centre becomes impossible. For these purposes, the external emergency centre should be provided with necessary means for information collection and reliable communication means. The external emergency centre can be also used, upon the NPP agreement, by local executive authorities for control of activities to protect inhabitants living nearby NPP.

In order to provide both operating and other organizations involved in establishment of the on-site emergency centres with appropriate criteria and requirements, the SNRCU started developing a regulation in 2002 to determine requirements on internal and external emergency centres of Ukrainian NPPs.

State Emergency Technical Centre of Ukraine

The NNEGC "Energoatom" System for Emergency Preparedness and Response is a component part of the functional subsystem of the USSE of the Ministry of Fuel and Energy of Ukraine; this system also includes the State Emergency Technical Centre of Ukraine (SETC). The SETC was established under Resolution of the Cabinet of Ministers of Ukraine No. 447 dated 16 June 1993 in order to ensure permanent preparedness for mitigating consequences of nuclear and radiation accidents at nuclear power enterprises, in industry, during transport of spent fuel.

If an emergency occur, the SETC is brought into complete preparedness, its forces and means are sent to the emergency facility to be at the disposal of the individual who manages mitigation of accident consequences. The SETC assists personnel of the emergency facility in radiation and engineering surveys, collection and confinement of radioactive waste, decontamination, etc. The SETC applies robotics and other unique equipment if necessary.

SNRCU Information Emergency Centre

To carry out its tasks in the field of emergency response, the State Nuclear Regulatory Authority established the Information Emergency Centre (IEC) in 1998.

In compliance with the Convention on Early Notification of a Nuclear Accident and intergovernmental agreements with other States, which provide for mutual notification and subsequent information exchange in the event of a nuclear or radiation accident, the IEC provided twenty-four-hour duty according to the SNRCU Plan for Emergency Preparedness and Response for 2002.

As of 1 January 2003, Ukraine concluded and implemented 11 intergovernmental agreements with Hungary, Germany, Austria, Norway, Finland, Poland, Slovakia, Sweden, Turkey, Byelorussia and Latvia. In accordance with these agreements the IEC staff conducted testing of communication with competent bodies of the above countries during the year.

Personnel on duty keep on-line communication with Ukrainian NPPs, analyse and record information on radiation incidents in Ukraine and abroad. Databases entitled “NPP Operational Events” and “Daily Reports on NPP Operation” are updated on a regular basis. “Information Summary on Ukrainian Nuclear Power Units” is prepared on a daily basis and placed on the SNRCU site and sent to the Ministry of Foreign Affairs.

The IEC operative personnel submit daily data on situation at Ukrainian NPPs to the unit of information analytical processing of the Governmental Information Analytical System on Emergencies (GIASE) of the Cabinet of Ministers of Ukraine and to the GIASE alternative unit in the Ministry of Emergencies according to regulations for interaction between central and local executive authorities within GIASE, as well as to the Department for Review and Analysis on Development of Man-Made, Ecological, and Nuclear Safety and Nature Management of the Secretariat of the Cabinet of Ministers of Ukraine.

In order to further improvement of cooperation between the Ministry of Emergencies and the SNRCU concerning notification of emergencies, joint Resolution No. 29/14 was issued on 30 January 2002 to regulate interaction between emergency duty services in the event or threat of an emergency.

Training System

Radiation Safety Standards of Ukraine (NRBU-97) require planned training of operating organizations’ personnel who participate in emergency measures.

Requirements of the General Provisions on Safety Assurance at Nuclear Power Plants provide for establishment of a training centre for nuclear power plant personnel. Each NPP has developed an annual program of emergency training and an associated quarterly training schedule. The schedule provides for training of each individual from operative personnel at least once a quarter. Based on schedule, the NNEGC “Energoatom” and NPP administration conduct plant emergency training once a year, involving emergency departments of the NNEGC “Energoatom” Directorates and representatives of external organizations, including the Ministry of Emergencies, Ministry of Fuel and Energy, and the SNRCU.

Such training was conducted at Zaporizhzhya NPP in 2002. The SNRCU participated in the training and involved its own IEC. The State Inspectorate for Nuclear Safety on site participated in the training at the level of facility.

In 2002 the Ministry of Emergencies arranged and conducted command staff training at the national level in order to get ready for Ukrainian-French training “Oranta-2002” on response in the event of radiological accidents. The SNRCU, Ministry of Fuel and Energy, Ministry of Health, Ministry of Environment and Natural Resources, Ukrainian Hydrometeorological Centre took part in the training. The training scenario dealt with a conditional accident at Chornobyl NPP involving radioactive release into the atmosphere. The training was intended to determine if state authorities of USSE were prepared for appropriate actions in the event of an accident at NPP. Issues related to the transfer of data and information for appropriate decisions were checked for consistency, radiation assessment procedures were checked for availability, mobile radiological laboratories were checked for availability, and interaction with local executive authorities was worked through.

7. RADIOACTIVE MATERIAL TRANSPORT

Radioactive materials for industrial, medical, and scientific purposes, radioactive waste, uranium ore and its concentrates, fresh and spent nuclear fuel from Ukrainian NPPs, as well as transit nuclear fuel, are transported through the territory of Ukraine.

Pursuant to legislation, a license is required for the transport of radioactive materials. Additional temporary licenses are granted by the SNRCU for some other types of transport (fissile materials and international transport). Safety certificates on package design and special transport conditions are issued in cases specified by regulations.

During 2002, 8 licenses were issued to legal entities dealing with transport of radioactive materials and 2 licenses were extended.

In compliance with the Provisions on Basic Conditions for the Transport of Radioactive Materials through the Territory of Ukraine, approved by Resolution of the Cabinet of Ministers of Ukraine No. 1332 dated 29 November 1997, and the Instruction on Issuing Permits for the Transport of Radioactive Materials, 106 licenses for the transport of radioactive materials were issued in 2002 (Figure 7.1), among them:

- Transport of fresh fuel for Ukrainian NPPs – 15;
- Transport of spent fuel from Ukrainian NPPs to Russia – 6;
- Transit transport of fresh fuel from Russia to Slovakia and Hungary – 10;
- Transit transport of spent fuel from Bulgaria to Russia – 1;
- Transit transport of uranium ore concentrate from the Czech Republic to Russia – 5;
- Transport of other radioactive materials – 69.

In compliance with the Procedure for Issuing Safety Certificates for Transport of Radioactive Materials, 2 safety certificates were issued for the package design and 1 safety certificate was issued for special transport conditions in 2002.

In 2002, there were no events and accidents in the transport of radioactive materials that would affect personnel, population and the environment.

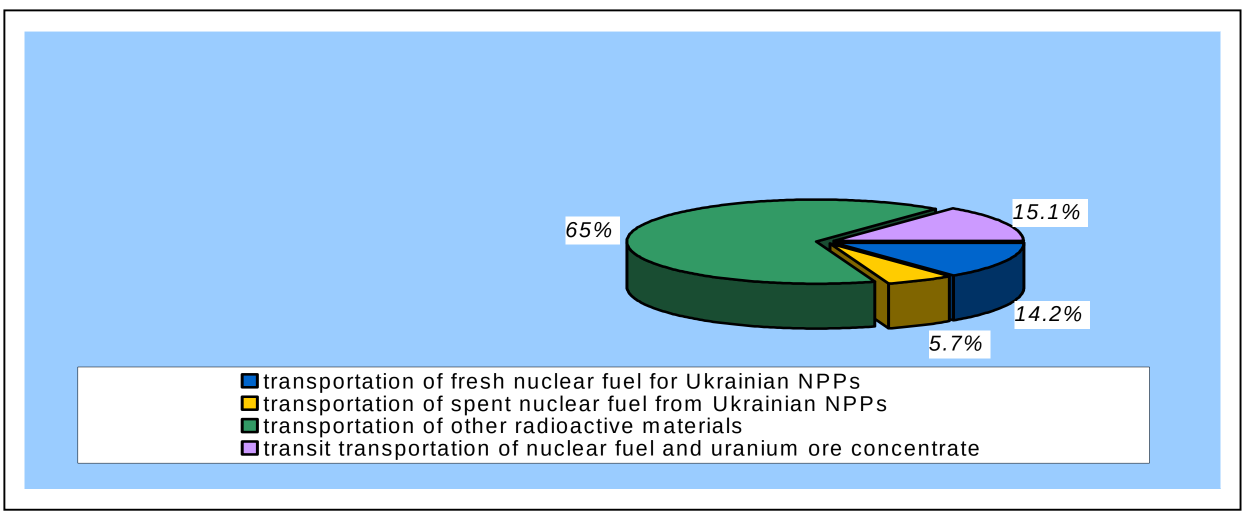


Figure 7.1. Structure of Radioactive Material Transport through the Territory of Ukraine

6. URANIUM MINING AND MILLING

The State Enterprise “Eastern Ore Mining and Processing Plant” (SE “SkhidGZK) deals with uranium ore mining and milling in Ukraine. Prior to 1991, the Industrial Association “Prydniprovsky Chemical Plant” (IA “PKhZ”) was also involved in uranium ore processing.

Work under conditions of high concentrations of natural radionuclides at workplaces is typical for uranium ore mining and processing, therefore, special attention should be paid to personnel radiation protection. Moreover, great amounts of radioactive waste are generated in this activity – uranium ore tails (tail pulp), dumps of mining rocks, mine water, releases and discharges (liquid, gaseous) that constitute sources of environmental radioactive contamination.

Tailing pits of the uranium processing enterprises represent the main danger for the environment and population by their great amounts and high activity. Tailing pits, located on the area of 542 hectare, contain radioactive materials whose total amount comes to 66 million tons with total activity above $4.4 * 10^{15}$ Bq (120,000 Ci).

In 2002, the State Nuclear Regulatory Committee of Ukraine, as in previous years, supervised implementation of decisions made by the State Commission for Man-Induced Hazards and Emergencies to improve radiation conditions at facilities of the SE “SkhidGZK”, the former IA “PKhZ”, and regions of their location (Minutes No. 3 dated 17 September 1999).

Special attention was paid to emergency environmental measures at IA “PKhZ” facilities in Dniprodzerzhynsk and its outskirts for closure of IA “PKhZ” radiation hazardous facilities and decontamination of its territory.

The lack of funding resulted in low effectiveness of this work, therefore, the SNRCU initiated the development of the program for closing the IA “PKhZ” radiation-hazardous facilities. Moreover, in order to establish legal and financial provisions for closure and reclamation of these facilities and contaminated territory of the plant, it was proposed that a working group be established to involve representatives of interested ministries and departments in development of the draft Law of Ukraine “On Closure and Reclamation of Facilities at Former IA “PKhZ”.

In 2002, the SNRCU carried out reviews on nuclear and radiation safety of SE “SkhidGZK” design materials entitled “Feasibility Study for Expanding the Capacity of the “Scherbakivske” Tailing Pit of the “SkhidGZK” Hydrometallurgical Plant and SE “Baryer” design materials on closure activities at the SE “PKhZ” “Sukhachivske” tailing pit.

Since review of the SE “Baryer” design materials revealed essential drawbacks in view of radiation safety of closure activities, these materials were returned for revision.

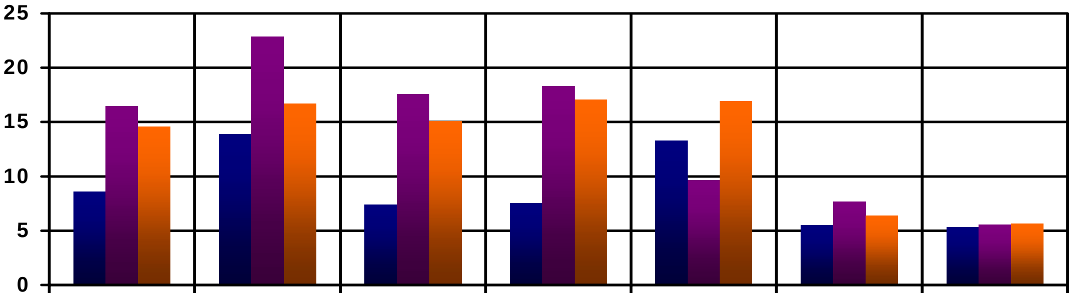
In 2002 SE “SkhidGZK” acted under the license for uranium ore processing, that includes uranium ore processing at the Hydrometallurgical Plant (in Zhovti Vody), uranium ore processing with pile (at the Smolinsky mine) and unit (at the Ingulsky mine) leaching, operation of the “Scherbakivske” tailing pit, reclamation operations at the “KBZ” tailing pit, and environmental monitoring on restored areas of underground leaching at “Devladove” and “Bratske”.

SE “SkhidGZK” personnel involved in uranium ore mining and processing are exposed to simultaneous impact of several radiation-hazardous factors (radon, its decay daughter products, ore dust containing long-lived natural radionuclides). In accordance with analysis of radiation safety reports on SE “SkhidGZK” for 2002, annual effective doses of personnel from any departments are within the limits established by the “Program for Transferring Ukrainian Energy Facilities to the Requirements of NRBU-97”.

It should be noted that exceeding permissible concentration (specific activity) of airborne radionuclides (by decay daughter products) was recorded in 2002 at some workplaces of the Smolinsky mine – for shaftmen, miners for drilling, and rippers, of the Ingulsky mine – for timbermen and miners for drilling. Exceeding of permissible concentration of the long-lived alpha-active airborne radionuclides was not recorded at the Hydrometallurgical Plant.

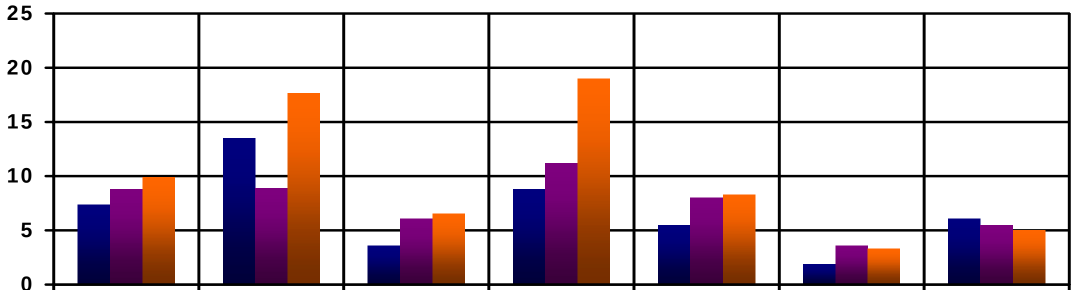
Since there are no devices for measuring individual doses resulted from radon and its decay daughter products, personnel individual effective doses were assessed by means of calculations using data on radionuclide concentrations, therefore the accuracy of such calculations is not high.

The average annual effective doses of personnel from the Smolinsky and Ingulsky mines, and personnel of the Hydrometallurgical Plant (GMZ) are provided in Figures 6.1, 6.2 and 6.3 respectively.



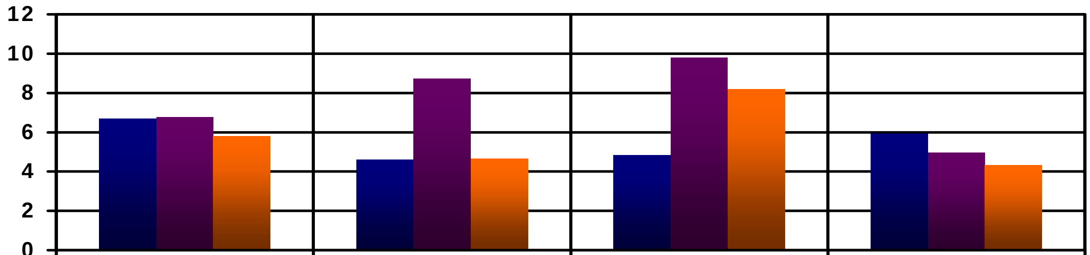
	Shaftman	Miner ripper	Miner for extraction	Miner for drilling	Timberman	Machinist	Engineers
2000	8,60	13,89	7,40	7,54	13,26	5,50	5,30
2001	16,45	22,86	17,59	18,30	9,64	7,67	5,56
2002	14,58	16,71	15,10	17,06	16,92	6,39	5,61

Figure 6.1. Personnel Average Annual Effective Doses for Basic Positions of the Ingulsky Mine in 2000 - 2002, mSv



	Shaftman	Miner ripper	Miner for extraction	Miner for drilling	Timberman	Machinist	Engineers
2000	7,40	13,50	3,60	8,80	5,50	1,90	6,10
2001	8,80	8,90	6,10	11,20	8,00	3,60	5,50
2002	9,92	17,65	6,56	18,99	8,30	3,35	5,03

Figure 6.2. Personnel Average Annual Effective Doses for Basic Positions of the Smolinsky Mine in 2000 - 2002, mSv



	Ore-preparation section	Main production process	Repair section	Decontamination section
2000	6,71	4,6	4,83	5,92
2001	6,78	8,72	9,8	4,97
2002	5,81	4,66	8,19	4,31

Figure 6.3. Personnel Average Annual Effective Doses for Main Process of the Hydrometallurgical Plant in 2000 - 2002, mSv

5. RADIATION SOURCES USE

Radiation Safety of Activities Related to Radiation Sources Use

Radiation sources (RS) as radioactive materials or devices that generate ionising radiation are effectively used in many branches of Ukrainian national economy. At the same time, RS use causes a risk of additional exposure; therefore, the RS hazard is limited by the State through state safety regulation of RS activities.

State regulation of RS activities encompasses:

- Establishment of standards, rules, and regulation on radiation safety;
- Certification of RS involving increased hazards, RS state registration, and licensing of RS-related activities;
- Surveillance over observation of regulatory requirements and terms of issued permits.

In conformity with legislation, RS production and use (including maintenance and storage) are subjected to licensing in RS activities. RS with low potential hazard, which were included in the "List of Radiation Sources Exempt from Licensing" approved by Resolution of the Cabinet of Ministers of Ukraine No. 912 dated 1 July 2002, are not licensed.

As of 1 January 2003, RS-related activities were carried out by 978 non-medical enterprises, establishments and organizations, and above 2,200 medical institutions (not taking into account private dentist's offices and hospitals).

RS production is licensed by the SNRCU.

Decree of the President of Ukraine No. 378/2002 dated 25 April 2002 established that licensing of RS activities shall belong to the SNRCU competence. Prior to this Decree, territorial bodies of the Ministry of Environment and Natural Resources of Ukraine issued licenses for RS activities.

The SNRCU developed and implemented the "Safety Requirements and Conditions (Licensing Terms) for Activities Related to the Use of Radiation Sources" and "Requirements on the Safety Analysis Report on Activities Related to the Use of Radiation Sources" for the licensing process.

In 2002, 151 licenses for RS activities were issued, 90 enterprises received such licenses for the first time (86 – for RS use and 4 – for RS production). The total number of licenses issued to non-medical enterprises constituted more than 620 licenses for 1995-2002. At the end of 2002, 227 non-medical enterprises carried out RS activities without licenses, thus constituting approximately 23% of enterprises dealing with RS. Most of these enterprises are located in Kharkiv and Lugansk regions, and in the city of Kyiv. The dynamics in issuing licenses for RS use to non-medical enterprises for the period from 1994 to 2002 is shown in Figure 5.1

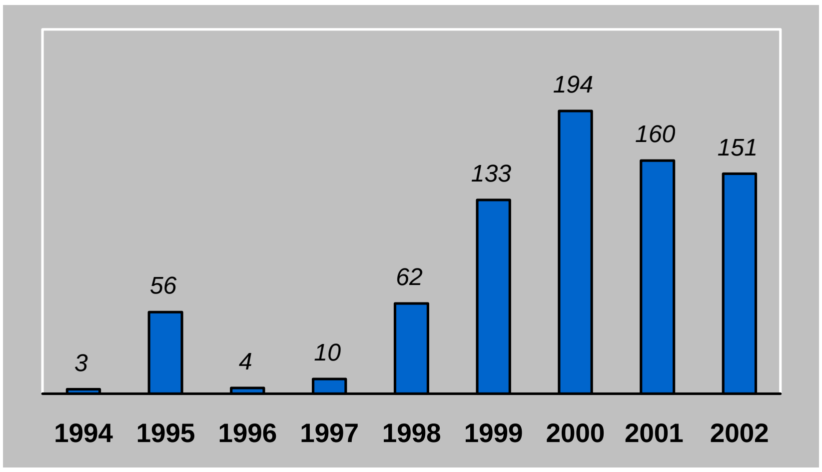


Figure 5.1. Licenses for RS Use Issued in 1994 – 2002

In licensing process, many enterprises take measures to improve radiation safety during RS-related activities, namely:

- ♦ Improving the RS accounting and control system;
- ♦ Improving (or creating) a radiation monitoring system (including individual dosimetric monitoring);
- ♦ Improving the competence in radiation protection of management staff, responsible persons, and personnel;
- ♦ Insuring and other financial provisions for compensation for damage from possible radiation accidents;
- ♦ Implementing quality programs for RS management;
- ♦ Using services of licensed and accredited suppliers;
- ♦ Monitoring of observance of licensing requirements, etc.

Medical institutions use RS for treatment and diagnosis under supervision of the State Health and Epidemiological Service of the Ministry of Health. Because of the lack of funding, medical institutions often operate RS (devices, equipment, etc.) that have worked 2 and more service terms established by the manufacturer, and their maintenance is irregular. This situation increases the probability of overexposure to patients or staff. The SNRCU is going to start licensing RS activities in medical establishments in 2004.

In 2002, 27 enterprises either terminated or declared their intention to terminate RS activities. There are about 80 enterprises that have been licensed to store preserved x-ray units.

More than 120 Ukrainian enterprises, establishments, and organizations have refused to conduct RS activities, however, they are unable to transfer their radiation sources to radwaste specialized plants as required by legislation because of poor financial provisions.

Incompliance with current legislation during RS management causes accidents and incidents. According to the SNRCU, 23 accidents and incidents with RS occurred in 2002 (Figure 5.2).

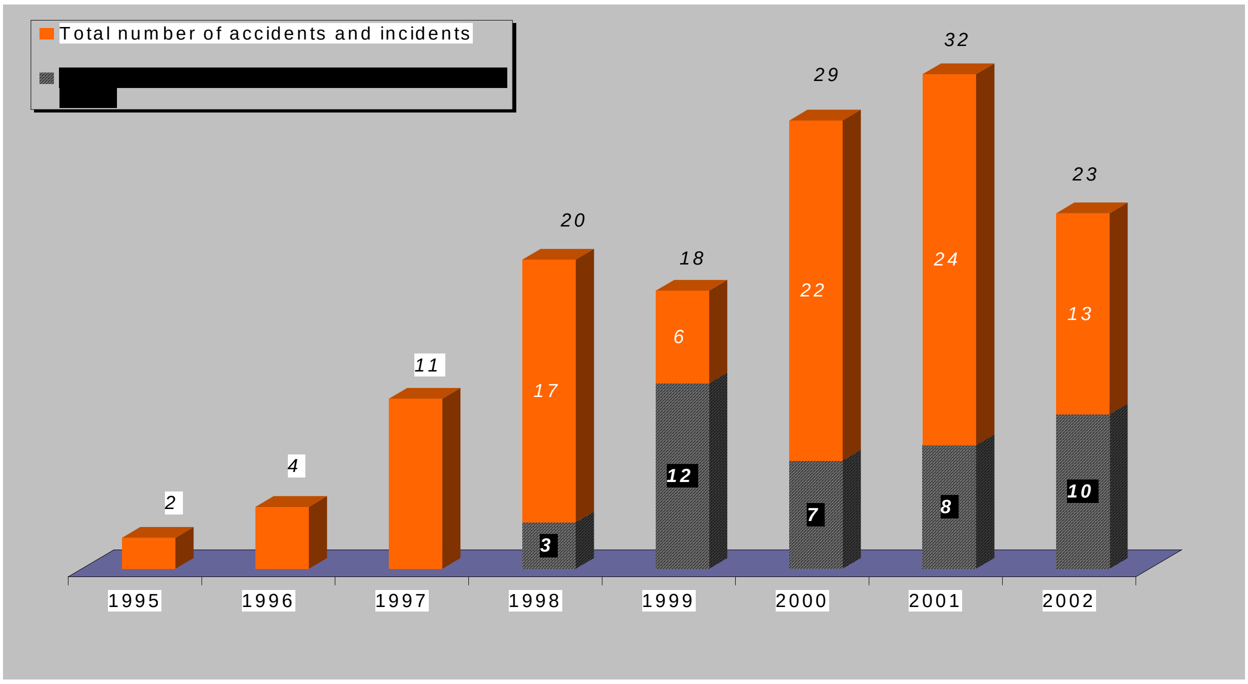


Figure 5.2. Accidents and Incidents with Radiation Sources in 1995 – 2002

The number of events when radiation sources and contamination are revealed in scrap metal remains great. Radiation monitoring of scrap metal transferred to metallurgical plants has proved to be effective in terms of preventing radiation accidents. 9 events were recorded in 2002 when this scrap metal was revealed during acceptance radiation monitoring.

Half the registered accidents and incidents with RS are associated with their illicit use. Control over 6 RS was lost in 4 cases because of their theft, and 10 RS with different activity were found in 6 cases in 2002. The lost of control over RS or their thefts mostly occurred at coal enterprises. In one case, the incident was revealed during special active investigation: activity of an organized criminal group was revealed and terminated, the members of the group illegally brought radioactive material containing strontium-90 with the total activity of 20 μCi to Ukraine from the Russian Federation and tried to push it off as plutonium-239.

In 2002, there were no events and accidents with RS, which would affect personnel, population and the environment.

There is still a problem with the management of spent high-active RS (more than 1000 Ci) based on cobalt-60 and strontium-90. Radioisotope thermoelectric generators and industrial facilities for exposure are typical examples of such RS. Return of spent Russian production RS to Russia was terminated in 1994 due to limitations of their legislation. Therefore, Ukraine has to store such sources at specialized enterprises for radwaste management, this required construction of special storage facilities. Dismantling and transport of radioisotope thermoelectric generators for storage at one of the UkrDO "Radon" enterprises were started in 2002.

Management of Radwaste Generated During Use of Radiation Sources

Radwaste generated in the use of RS in national economy are managed by the State Association "Radon", consisting of six state interregional specialized plants: in Kyiv, Donetsk, Odesa, Kharkiv, Dnipropetrovsk, and Lviv.
SISP deal with collection, transport, storage, and disposal of low- and intermediate-level solid and liquid radwaste, and spent RS from all domestic enterprises, institutions, and organizations, excluding enterprises of the energy industry.

The following is located on SISP sites:

- 14 tanks for solid radwaste disposal – 10 filled and preserved;
- 14 tanks for liquid radwaste temporary storage – 2 filled and preserved;
- 14 tanks for disposal of spent radiation sources – 4 preserved.

In addition:

- Kyiv SISP operates a technical hangar for solid radwaste temporary storage – the remaining capacity is approximately 50 %;
- Kharkiv SISP has a building for disposal of solid radwaste and spent radiation sources – the remaining capacity is approximately 50 %;
- Lviv SISP operates a hangar storage facility for radwaste disposal – the remaining capacity is approximately 90 %.

According to the Comprehensive Program for Radwaste Management, UkrDO "Radon" SISP should be modified to stations for radwaste temporary storage in containers. The SNRCU carried out state review on nuclear and radiation safety of documentation on radwaste typical storage technology at SISP. Based on the review, each SISP should develop a modification design incorporating specific characters of their activity.

In their time, SISP were subordinated to the USSR Ministry for Municipal Economy, and requirements for their activity were the same as for enterprises dealing with conventional domestic waste. SISP storage facilities were constructed under imperfect designs (developed at the end of the fifties), this caused radiation accidents at the Kyiv and Kharkiv SISP that resulted in contamination of ground waters with tritium radionuclides beyond the storage facilities in SISP sanitary-protected zone.

The Kyiv and Kharkiv SISP developed emergency plans that served the basis for emergency training. Most of the planned accident mitigation measures have been implemented; as a result the severity of the accident has been determined, its consequences have been confined and estimate for future has been done.

According to the Kyiv SISP, tritium concentration in ground water of the sanitary-protected zone in 2002 was $1.0 \cdot 10^4$ Bq/m^3. Although this value was higher than the background one for the region (Pyrogove village area – $5.4 \cdot 10^3$ Bq/m^3), it is essentially lower than the permissible concentration (pursuant to NRBU-97 – $3 \cdot 10^7$ Bq/m^3).

The Kharkiv SISP pumped water from and preserved emergency storage facilities. According to monitoring, the centre of radioactive contamination in ground water is stable by activity, slow-moving, and located in the strict access zone under emergency storage facilities. According to the Kharkiv SISP, contamination of soil and vegetation by tritium specific activity is close to background values in the buffer area in the vicinity of the strict access zone. There is no man-made tritium in all environmental objects (underground water, open ponds, soil, vegetation, farm products) at the boundary of the buffer area and surveillance zone.

However, in order to fundamentally solve the problem of radionuclide confinement in emergency storage facilities, solid radioactive waste has to be retrieved.

In 2001, the SNRCU approved the "Plan for Implementing Design Decisions to Minimize the Radiation Accident at the Kyiv SISP RWDP".
In compliance with the Plan, the following was carried out in 2002:

- Comprehensive expert review of the detailed design of radwaste retrieval was conducted, and this design is currently under revision to incorporate conclusions of the review;
- Fabrication of the remote controlled system for radwaste removal is in its completion stage, its design was completed based on experimental removal of 1.4 t of solid radwaste;
- 10 storage containers were manufactured for radwaste to be removed during production testing of the remote controlled system;
- Training on operation of the remote controlled system by SISP experts is underway;
- Experimental design of a mobile facility for liquid radwaste cementation was developed and tested.

Analysis of the above experimental work determined ways for improving process of solid liquid radwaste retrieval intended to introduce "manless" technology and prevent potential for undue exposure of personnel during mitigation of accidents.

According to annual radiation safety reports, individual annual effective doses of "A" category personnel did not exceed the below reference levels at UkrDO "Radon" SISP:

4 mSv/y at Kharkiv SISP, 15 mSv/y at Dnyepropetrovsk SISP, 10 mSv/y at Lviv SISP, 18 mSv/y at Kyiv SISP, 10 mSv/y at Odesa SISP, 2 mSv/y at Donetsk SISP.

Having analysed the SISP activities, one may note that designed capacities of solid radwaste storage facilities are being filled up too rapidly. This is due to the fact that solid radwaste are stored/disposed in these facilities without any conditioning, and spent RS are disposed in biological shielding, while regulatory requirements prescribe that radiation sources should be disposed only in special storage facilities by containerless uploading of sources.

Therefore, the problem of available storage facilities at specialized plants and reliability of their design in terms of radiation safety is the most urgent. The lack of technologies and equipment for radwaste processing at SISP makes this problem even more acute.

The lack of equipment for measuring tritium content in different environments and the lack of equipment for determining radionuclide content of alpha- and beta-active materials at SISP is another problem demanding appropriate solution as soon as possible. However, this problem remains unsolved for a long period of time because of insufficient funding.

4. NUCLEAR AND RADIATION SAFETY IN EXCLUSION ZONE

Condition and Problems of Chornobyl NPP Exclusion Zone

The Exclusion Zone represents a spatial open radioactive source with its own distribution structure and with different forms and types of deposited radioactive elements. As a result, the radiation factor remains the main contributor to potential hazard for people living on nearby territories and for Ukrainian population in general.

Results of 2002 monitoring confirm existing tendency to further degradation of the radiation situation in environmental components. The Exclusion Zone remains a contamination source for practically all its components. Due to re-distribution and migration of radionuclides deposited after the accident in storages, landscapes, closed ponds, and separate objects, the secondary sources are being formed, which are "accessible" beyond the zone and so potentially they are especially dangerous.

One of the most serious problems is depletion (degradation of quality because of water radiation contamination) of surface and underground water in the Dnipro basin, whose tributary is Pripyat river.

Results of radiation-ecological monitoring demonstrate that:

- Complex multiple-factor radionuclide redistribution processes in ground layer are determinative in environmental contamination;
- Surface water remains the main source for radionuclide transfer beyond the Exclusion Zone. Up to 40% of ^{90}Sr and 90% of ^{137}Cs is transit transfer and is formed beyond the Exclusion Zone, mainly on the territory of Byelorussia;
- Owing to radionuclide contamination of ground water, the formation of new geological environment of radioactive spreading continues, which is not peculiar to natural conditions. Progressing contamination process in quaternary ground water can make it hazardous to use the water of Eocene and Cenomanian - Lower Cretaceous deposits as a source of centralized economical water supply (both within and beyond the Exclusion Zone). The formation of Pripyat under-stream flow, which is contaminated with radionuclides and is not monitored presently, can also cause unexpected consequences;
- As before, airborne radiation contamination depends on economical activity, meteorological conditions and fires in the Exclusion Zone. ChNPP and the Shelter are still essential sources of periodic radionuclide releases into the surface air;
- As a whole, processes of selective accumulation of radionuclides are peculiar for the flora and fauna, and some species (mushrooms, wild animals, fish in closed ponds) come to the level of radioactive waste.

Territorial Structure and Radiation Safety in Exclusion Zone

In accordance with the "Concept of Chornobyl Exclusion Zone on the Ukrainian Territory", the Exclusion Zone was divided into individual zones due to industrial principle, taking into account activities in its different parts, non-uniformity of contamination, location of industrial facilities and infrastructure elements, namely:

Zone 1 (near zone) – includes the territory located within the 5-km radius around Chornobyl NPP. Radiation-hazardous operations in this zone are carried out in accordance with programs agreed by *the State Health and Safety Supervision* authorities. If required, these operations are carried out by dosimetric admission orders, based on results of radiation-dosimetric monitoring;

Zone 2 (far zone) – includes the territory of the Exclusion Zone within the radius of 5 - 30 kilometres from the Shelter (excluding the zone to the external boundary of the residential area of Chornobyl). Work in this zone is conducted according to monthly schedules; regular radiation and dosimetric monitoring is kept;

Zone 3 (residential zone) – includes part of the Chornobyl urban area with the adjacent territory on which hostels and dormitories are located, public catering and trading facilities, facilities of social and cultural and medical purposes, roads between blocks and accesses to them;

Zone 4 (zone with special access procedure) – includes the territory of Zeleny Mys, which is a settlement where shift teams personnel live;

Zone 5 (isolated areas of the Exclusion Zone) – includes the territory of inhabited localities, residents of which were evacuated (several villages of Polissya area of the Kyiv region, Narodichy and Ovruch areas of Zhitomyr region).

In order to maintain the attained level of radiation safety and to conduct on-line monitoring of radiation situation at the Exclusion Zone, sanitary standards "Basic Reference Levels, Exemption Levels, and Action Levels Concerning Radioactive Contamination of Exclusion Zone Objects" were developed and approved (GN 6.6.1.076-01).

Water Radiation Monitoring in Exclusion Zone

Surface water radiation monitoring of the Exclusion Zone in 2002 covered hydrology and radiation condition of the Pripyat, its tributaries, ChNPP cooling pond, filtration water flows of the pond, SSE ChNPP upstream and downstream channels, and downstream channel of stage III, individual water objects of the left-bank and right-bank dam. The Uzh and Grezla rivers on the territory of unconditional evaluation zone were regularly monitored. In order to completely analyse the impact of environmental components on radiation conditions of surface water, monitoring on the north drainage canal of the cooling pond was introduced in accordance with the "Regulations TsREMZV on Radioecology Monitoring in the Chornobyl Exclusion Zone for 2001-2003".

20 waterways, 10 closed and low-flow ponds altogether were constantly monitored at 40 observation dam sites and points. Concentrations of the main contaminating radionuclides – ^{137}Cs and ^{90}Sr – were determined in all water samples. The content of Pu and ^{241}Am isotopes was periodically monitored in Pripyat river, ChNPP cooling pond, left-bank upstream polder near building 7, and the Glyboky lake, and samples were taken from some other water bodies once or twice.

Surface water. The concentration of ^{90}Sr in Pripyat water near Chornobyl was mainly within 0.10–0.25 kBq/m^3. Low spring tides that did not cause essential floods of the dams on Ukrainian and Byelorussian territories resulted in the maximum concentration of 0.36 kBq/m^3 at the drop of spring tides and also in the summer low-water season. Relatively low maximum concentrations as compared to the previous years determined the average annual value, which was the lowest for the post-accident period, however, the values of 0.25 – 0.30 kBq/m^3 prevailed in the summer low-water period as in the previous years. The ^{90}Sr concentration in surface reservoirs of the Exclusion Zone in 2002 did not exceed action levels (2 kBq/m^3) of contamination established by sanitary standards "Basic Reference Levels, Exemption Levels, and Action Levels Concerning Radioactive Contamination of Exclusion Zone Objects" (GN 6.6.1.076-01). Data on river radiation condition in the post-accident period are provided in table 4.1.

Table 4.1

Specific Activity (kBq/m^3) and Transfer of ^{137}Cs and ^{90}Sr (10^{12} Bq) by Pripyat near Chornobyl Dam in 1986-2002

Year	Average annual water flow, m^3/s	Radionuclides				Transfer	
		^{137}Cs		^{90}Sr		^{137}Cs	^{90}Sr
		Mean	Maximum	Mean	Maximum		
1986	302	-	-	-	-	66,2	27,6
1987	246	1,6	18	1,3	-	12,8	10,4
1988	411	0,74	9,6	1,4	9,6	9,48	18,7
1989	392	0,52	0,56	0,74	1,3	6,44	8,97
1990	409	0,36	0,74	0,78	2,4	4,63	10,1
1991	442	0,21	1,0	1,0	12	2,89	14,4
1992	295	0,21	1,1	0,44	1,7	1,92	4,14
1993	537	0,21	0,48	0,85	1,6	3,48	14,2
1994	476	0,20	0,44	0,93	5,9	2,96	14,2
1995	330	0,11	0,34	0,33	0,82	1,15	3,40
1996	319	0,13	0,39	0,34	0,67	1,30	3,42
1997	340	0,16	0,48	0,25	1,3	1,70	2,68
1998	681	0,14	0,68	0,30	1,0	2,95	6,37
1999	656	0,15	0,62	0,50	1,6	3,05	10,2
2000	470	0,11	0,38	0,22	0,52	1,71	3,36
2001	437	0,12	0,38	0,23	0,53	1,54	3,14
2002	**358**	**0,07**	**0,19**	**0,17**	**0,36**	**0,87**	**1,65**
1986-2002						**125**	**157**

^{90}Sr concentration in the ChNPP cooling pond, filtration water flows in the pond and monitored closed pond did not essentially change as compared to the previous period. The reduction of annual indicators for Exclusion Zone waterways resulted from their lower water content, absence of water egress to contaminated areas of the reservoir, and prevailing soil component in river systems.

^{90}Sr concentration settled at the level of 14 – 16 kBq/m^3 in water of the left-bank polder as in the last year after clearing the riverbed in soil-reclamation channels and reducing the water level and area of previously flooded lands. The maximum recorded value was 21 kBq/m^3.

The transfer of ^{90}Sr by the Pripyat river near Chornobyl dam was 1.65 TBq (44.7 Ci), by Uzh river – 0.04 TBq (1.11 Ci), by Braginka river – 0.08 TBq (2.22 Ci) in 2002. These water-flows carried away 1.77 TBq (47.0 Ci) ^{90}Sr altogether into the Kyiv reservoir.

This was the lowest value for the post-accident period.
The contribution of the cooling pond to the ^{90}Sr transfer was 28 % of the total value in the Exclusion Zone.

Since water content in the Pripyat river reduces, the role of the cooling pond, left-bank polder system, and soil water in radioactive contamination of the main river becomes greater. There are many unidentified sources of ^{90}Sr egress, whose parameters of water flows cannot be directly measured and accurate calculations cannot be made with the existing monitoring network. Increased concentration and egress are caused by insignificant waterways and steams with high radionuclide content filtrated through the protective dams. For example, ^{90}Sr content was recorded at the level of 16 – 17 kBq/m^3 in water samples from filtrating streams (which indirectly characterize contamination parameters of the underground stream) in this August-September. Even if water flow is several ten litres per second, the contribution of these sources can be substantial, to several percents of the total egress.

^{137}Cs concentration in Pripyat and Uzh water during the year changed within the limits observed in the recent years: 0.05 – 0.10 kBq/m^3, and sometimes 0.15 kBq/m^3. The transfer of this radionuclide near Chornobyl dam was 0.87 TBq, from which 0.83 TBq (95 %) was formed beyond the Exclusion Zone. The absolute values of this indicator are less than last year's.

The concentration of radioactive caesium in small rivers of the Zone was at the level close to last years' indicators. Specific activity of this radionuclide essentially reduced in the Azbutchin lake. The maximum ^{137}Cs concentration is observed in most closed ponds, especially ChNPP cooling pond, in summer months. This is obviously associated with hydrobiocenosis and ^{137}Cs redistribution in water systems. In 2002, the ^{137}Cs concentration in Exclusion Zone surface ponds did not exceed associated action level of 2 kBq/m^3 for water contamination of such ponds established by sanitary regulations "Basic Reference Levels, Exemption Levels, and Action Levels Concerning Radioactive Contamination of Exclusion Zone Objects" (GN 6.6.1.076-01).

Data on specific activity of transuranium elements in the monitored water objects did not show a clear tendency towards their changes in the recent years.

Underground water. In 2002, as in the previous years, the radiation monitoring system covered underground water of Eocene and Cenomanian-Lower Cretaceous aquifer systems. Radiation parameters of Eocene aquifer underground water (sources of ChNPP centralized water supply) were monitored at the ChNPP water intake facility (the town of Pripyat), and Cenomanian-Lower Cretaceous water (basis of ChNPP centralized water supply) – at the water intake facility in the town of Chornobyl. In addition, water parameters of the water supply network in the town of Chornobyl were selectively monitored in places of consumption. The main attention was paid to the quaternary aquifer, which is deposited first from the surface (soil) and is directly exposed to man-made radiation contamination.

According to "Regulations TsREMZV on Radioecology Monitoring in the Chornobyl Exclusion Zone for 2001-2003", radiation monitoring of quaternary aquifer underground water was conducted at 158 boreholes, whose distribution relative to the main monitoring objects did not practically change as compared to 2001. All water samples were analysed for ^{90}Sr and ^{137}Cs content as in the previous years. ^{241}Am and $^{\Sigma}$Pu concentration was selectively measured in water of the boreholes characterized by the highest concentration of ^{90}Sr (^{137}Cs).

The results received after examining radiation situation of Eocene and Cenomanian - Lower Cretaceous aquifer depositions cannot be used as a basis for the evident statement that they are contaminated with radionuclides of the ChNPP accident release. The ^{137}Cs concentration in water at hydraulic structures of ChNPP and the town of Chornobyl is within 9-16 Бк/м^3; ^{90}Sr - 3-13 Бк/м^3, these values, at given measurement errors of 20-35%, are practically at the limits of measuring possibility. Permissible level-97 for drinking water is 2,000 Bq/m^3 by ^{90}Sr and ^{137}Cs content.

Air Radiation Monitoring in Exclusion Zone

The air observation of the Exclusion Zone presently includes several monitoring areas:
1. Radionuclide concentration:
- in the near zone at 4 points;
- in the far zone at 9 points;
- at two industrial facilities.
2. Intensity of radioactive atmospheric precipitation at 29 points.
3. Content of hot particles in the air at 9 points.

Scheduled monitoring of surface air radiation parameters in the near zone was carried out at stations VRP-750, Naftobaza, Pripyat-LZD, BNS by means of aspiration devices. Airborne radioactivity in the far zone was monitored at the observation points of the Automated Radiation Monitoring System (ARMS) using filtration ventilation devices.

Locations where Exclusion Zone personnel stay mostly are also covered by the system: the town of Chornobyl and village of Dytyatky.

In compliance with the 2002 Regulations, atmospheric precipitation was sampled at the ARMS observation points, radwaste disposal points (RWDP), radioactive waste treatment area "Leliv", and at points of the reference network within the 5-km zone.

The largest airborne radionuclide concentration was registered in the near zone, close to ChNPP at monitoring points of the site and "Naftobaza" where the total activity runs up to $3.3 \bullet 10^{-2}$ Bq/m^3. Slightly less concentrations were observed at other points of the near zone. ^{137}Cs air contamination of all monitoring points is characterized by rapid decrease of concentrations during 1986-1988 and slow decrease in the recent years.

Airborne radiation conditions of the Exclusion Zone in the recent years were mostly characterized by the presence of Chornobyl long-lived radionuclides. The airborne radionuclide composition in the near observation zone, which insignificantly changed by natural process of radionuclide "decay-accumulation" as compared to 2001, is provided in Table 4.2.

Table 4. 2

Airborne Radionuclide Composition in Near Observation Zone

	Content, %								
Radionuclide	**^{134}Cs**	**^{137}Cs**	**^{154}Eu**	**^{155}Eu**	**^{90}Sr**	**^{238}Pu**	**$^{239+240}$Pu**	**^{241}Pu**	**^{241}Am**
2000	0,53	67	0,34	0,29	21	0,12	0,25	10	0,47
2001	0,26	68	-	-	22	0,11	0,24	9	0,39
2002	0,24	72	-	-	19	0,09	0,23	8	0,44

Note: the percentage of **^{241}Pu** and **^{241}Am** provided in the table is calculated based on known concentration of **$^{239+240}$Pu**, the difference between calculated and measured concentrations of **^{241}Am** does not exceed 20%.

The Exclusion Zone air, as shown by the long-term monitoring, is highly dynamic environment with a wide (more than 4 orders) range of radionuclide content. Under certain conditions (wet low-wind weather, snow cover), air radionuclide contamination can reduce in some areas of the far zone, thus creating an illusion of radioactive safety. However, there is a permanent hazard that sometimes appears to the less extent (under minor gusts, dust storms, fires, and man-made impacts) because of raising great amounts of radionuclides from the underlying surface. In such events, internal doses increase not only for individuals staying on contaminated territories but also for population living in areas where air with increased radionuclide concentration can be transferred.

Based on radiation air monitoring of the Exclusion Zone, the following conclusions can be made.

- Weather conditions and man-made impacts were determining factors in radiation contamination of the Exclusion Zone surface air in 2002.
- Airborne radionuclide concentration at each monitoring point was mainly determined by the surface contamination of the air-sampled territory.
- Reference levels (RL) of radionuclides in the air of regular monitoring points of the Exclusion Zone, which was established by "Basic Reference Levels, Exemption Levels, and Action Levels Concerning Radioactive Contamination of Exclusion Zone Objects" (GN 6.6.1.076-01) on 1 November 2001, were reached and exceeded during 2002 in 22 events: 9 – for man-made and 13 – for meteorological reasons.
- Analysis of radionuclide content dynamics in the surface air of monitoring points for the 5 last years did not reveal positive changes in the air radioecology of the Exclusion Zone.
- Process releases of SSE ChNPP and Shelter into the atmosphere remain essential and contribute to the contamination of the Exclusion Zone surface air.
- Natural phenomena (wind gusts, dust storms, fires, etc.) remain the main hazard to air radioecology of the Exclusion Zone and nearby territories.

Radioactive Waste Management in Exclusion Zone

Soil, structures, machines, mechanisms with high levels of radioactive contamination, which are located in the Exclusion Zone and in the radwaste interim confinement points (RICP) constitute radwaste sources. The number of the latter is assessed at more than 800 and they all are not operated at present.

State Specialized Enterprises "Complex" and "Tekhnocentre" of UkrDO "Radon" Association implement expedient measures on radwaste management in the Exclusion Zone pursuant to appropriate licenses issued by the SNRCU. This activity includes radwaste collection in highly-contaminated locations, radwaste transport, monitoring and operation of active radwaste disposal point "Buryakivka", monitoring of non-active radwaste disposal points (RWDP) "Pidlisny", "ChNPP III Stage" and RICP, decontamination of rolled metal, plastic items, cables, scrap metal, machines and mechanisms, construction of radwaste disposal facilities.

The SSE "Complex" was established in 1986 and has carried out many activities to improve the radiation situation in the Exclusion Zone after the accident. More than 30 thousand hectares have been decontaminated, above 700,000 m^3 of radwaste have been collected and disposed at the RWDP "Pidlisny", "ChNPP III Stage", and "Buryakivka", about 9,000 tons of materials and equipment have been decontaminated, etc.

In the recent years, "Buryakivka" RWDP receives above 25,000 m^3 of waste annually. The designed lifetime of the operating storage facility in service since 1987 is being exhausted – from the 30 trenches 23,000 m^3 each, there is a reserve of four trenches. In this regard, the state executive authority in radwaste management (Ministry for Emergencies) has made a decision to reconstruct the "Buryakivka" RWDP and construct additional trenches for 120,000 m^3 of radwaste each. The SNRCU has conducted state review on nuclear and radiation safety of the design. Based on review findings, the "Buryakivka" reconstruction design is being revised.

Special terms of licenses for SSE "Complex" identify priority measures intended to bring the Exclusion Zone RWDP and RICP into compliance with current standards, rules, and regulations on nuclear and radiation safety. This is due to the fact that the RWDP and RICP were constructed in extreme post-accident conditions and do not meet radiation safety requirements and are potentially hazardous for the environment.

According to the design approved by the SNRCU, SSE "Complex" fulfilled trial and commercial retrieval of radwaste from "Naftobaza" RICP. Concepts for closure of non-active radwaste disposal points "Pidlisny" and "ChNPP State III" were developed and concurred with the SNRCU. State review of working closure design of "Pidlisny" RWDP was carried out. Based on review findings, the design was returned for revision. Unfortunately, the design has been terminated because of the lack of funding.

According to the Comprehensive Program for Radwaste Management, to solve the problem of safe radwaste management, radwaste disposal facilities (the so-called "Vector" complex) are under construction in the Exclusion Zone to constitute the basis for establishing a centre for processing and disposal of low- and intermediate-level waste. The construction is authorized by License series YaRB No. 000204 issued by the Nuclear Regulatory Administration in April 2000.

The SSE "Tekhnocentre" carries out the construction of the complex based on the design that has received a positive conclusion of the comprehensive review including ecological, nuclear and radiation safety, and other reviews required by current legislation.

"Vector" stage I includes a startup system consisting of two radwaste storage facilities and infrastructure facilities.

Facilities of the startup system infrastructure were to be commissioned in 2002. Unfortunately, planned commissioning schedule has been delayed because of imperfect construction management and irregular funding.
The SNRCU submits quarterly reports to CMU on the status of “Vector” construction.

9. PHYSICAL PROTECTION OF NUCLEAR MATERIALS AND NUCLEAR FACILITIES

Physical protection of nuclear materials and nuclear facilities has become especially important and acute in view of the recent events that affected the world community and in view of the pressing conflict situation in the Near East. Solution of these problems constitutes the first-priority task for the international community.

Physical protection of nuclear material and nuclear facilities used for peaceful purposes provides for prevention from unlawful (intentional or unintentional) acts, which can lead to direct or indirect danger to the environment, population health or safety due to radiation impact. Moreover, reliable physical protection is one of the main elements of ensuring safeguards and preventing illicit trafficking of nuclear material and other radioactive sources.

Two draft resolutions of the CMU were prepared in 2002 as regards basic regulatory functions on physical protection:

- "On Procedure for Determining the Level of Physical Protection of Nuclear Facilities, Nuclear Material, Radioactive Waste, Other Radiation Sources According to Their Categories";
- "On Procedure for State Inspection of Physical Protection System for Nuclear Facilities, Nuclear Material, Radioactive Waste, Other Radiation Sources and Plans of Interaction in the Event of Nuclear Terrorist Acts".

Based on results of licensing activity, 12 licenses were issued in 2002 to 6 business entities for individual activities connected with physical protection:
NASU INR, NNEGC "Energoatom" Industrial Enterprise "Atomremontservice" "Odesem" Ltd, KNMP "Electropivdenmontazh" Ltd, "Alay" Closed Corporation, "Teleprom" Ltd.

Activities on service and maintenance of engineering features for protection systems and modernization of physical protection systems for nuclear facilities and nuclear material were carried out at all nuclear power facilities of Ukraine during 2002.

Working meetings and training on improving measures on physical protection of nuclear facilities and cooperation of responsible authorities in conditions of a threat of nuclear terrorism were conducted.

The effectiveness of physical protection at Ukrainian NPPs, consistency of interaction plans for NPP personnel, security and other subdivisions of the Ministry of Internal Affairs and Security Service of Ukraine in case of attempts to take unauthorized actions were examined during training. In 2002, comprehensive training was conducted at sites of SSE ChNPP, SE SUNPP, SINEI, SE KhNPP, SE RNPP and SE ZNPP with participation of managers and representatives of the Security Service of Ukraine, Ministry of Internal Affairs, SNRCU, Ministry of Fuel and Energy of Ukraine and Institute for Nuclear Research of the National Academy of Sciences of Ukraine.

Inspections and analysis of physical protection and training conducted at the aforesaid facilities revealed problems that resulted, first of all, from the fact that NPPs and other nuclear facilities of Ukraine were designed in the former USSR and did not take into account the threat of terrorist actions. Therefore, these facilities require improvement and modernization in order to comply with contemporary requirements on physical protection systems, world experience and the IAEA recommendations.

In order to strengthen the international nuclear material protection system, representatives of the SNRCU, Ministry of Foreign Affairs, and Ministry of Fuel and Energy participated in the open expert meetings held to discuss the need to revise the Convention on Physical Protection of Nuclear Material. Based on activity and participation of Ukrainian representatives in five drafting subgroups for revision of the Convention text, the interagency work group prepared the last version of the text for approval by competent ministries and departments.

According to the plan of cooperation with the IAEA, the preliminary International Physical Protection Advisory Mission (IPPAS) took place in Ukraine at SE "Khmelnitsky NPP" (Neteshin town). The IAEA Advisory Mission in Ukraine positively impacts on the development of physical protection regulation, licensing, and supervision processes, facilitates the development of regulatory documents and solution of the problems which exist between ministries and authorities dealing with physical protection in Ukraine.

In 2002, great attention was paid to improving the qualification of experts in physical protection of the SNRCU, Ministry of Fuel and Energy, National Academy of Sciences, Ministry of Health, Security

Service of Ukraine, Ministry of Internal Affairs, State Customs Services, other organizations and institutions dealing with physical protection of nuclear facilities and nuclear material in Ukraine under assistance and participation of the US Department of Energy (DOE), GRS/BMU (Germany), and IAEA.

In August 2002, International Workshop S96 devoted to “Physical Protection of Nuclear Material at Stationary Nuclear Installations and During Transport and Measures on Prevention of Illicit Trafficking of Nuclear Material” was conducted in Kyiv under support of the SNRCU and the Nuclear Safety Organization - Gesellschaft für Anlagen- und Reaktorsicherheit (GRS, Germany). The workshop was devoted to licensing of activities associated with physical protection of nuclear material and nuclear facilities and monitoring of compliance with issued licenses and status of the regulatory and legal framework on physical protection in Ukraine, Russia and the Federal Republic of Germany.

Training on improvement of qualification in physical protection was conducted for more than 100 experts on the premises of the Training Centre for Physical Protection, Accounting and Control of Nuclear Material named after J. Kuzmich of the Institute for Nuclear Research in 2002. Activities intended for future use of the Centre as a Regional Training Centre for Physical Protection of Nuclear Facilities and Nuclear Material for the Commonwealth of Independent States, Baltic States, Eastern and Central Europe are carried out under the aegis of the IAEA. This would be a great contribution to international efforts aimed at the struggle with nuclear terrorism.

Cooperation under the “Agreement between the State Committee for Nuclear and Radiation Safety and US Department of Defence on Development of State System of Accounting, Control and Physical Protection of Nuclear Material for Non-Proliferation of Nuclear Weapons from Ukraine” of 18 December 1993 was continued in 2002. This is an implementing agreement for the “Agreement between Ukraine and the United States of America on Assisting Ukraine in Liquidation of Strategic Nuclear Weapons and Non-Proliferation of Weapons of Mass Destruction” of 25 October 1993. Owing to US funding, qualification of 50 experts in physical protection was increased and physical protection of WWR-M research reactor of the NASU Institute for Nuclear Research was improved. Physical protection of the Kharkiv Physics & Technology Institute and SINEI IR-100 reactor was upgraded, activities intended to support the Training Centre for Physical Protection, Accounting and Control of Nuclear Material named after J. Kuzmich of the NASU Institute for Nuclear Research were carried out.

It should be noted that in spite of some achievements in 2002, regulation of physical protection requires:

- Scientific and technical support;
- Expansion of the regulatory framework on physical protection of radwaste and radiation sources;
- Improvement of licensing the operating organizations in physical protection;
- Expansion of international cooperation.

10. PREVENTION OF ILLICIT TRAFFICKING OF NUCLEAR AND RADIOACTIVE MATERIAL

The actual threat of nuclear terrorism requires that prevention and counteraction to illicit trafficking of nuclear and radioactive material be considered as one of the first-priority areas in which the international community should invoke essential efforts in the near future.

Ukraine is situated at crossroads of seaways, motor roads and railways and hence a great number of freights in transit are transported on its territory. Therefore, there is a potential for illegal transport of nuclear and radioactive material through Ukraine. This fact is recognized by the Government of Ukraine and the world community.

In order to prevent attempts of illicit transport, transit, and trafficking of nuclear material, competent authorities take administrative and legislative measures intended to avoid such events. In 2002, the draft Resolution of the Cabinet of Ministers of Ukraine "On Procedure for Interaction of Executive Authorities and Involved Juridical Entities for Nuclear Energy in Case of Illegal Trafficking of Ionising Radiation Sources" was developed to incorporate the experience of current Resolution No. 207 dated 4 March 1997, recommendations of the International Technical Working Group on problems of nuclear contraband (ITWG) and results of implementation of international projects for Ukraine in this field. The draft Resolution was submitted to the Governmental Committee for review.

In 2002, the SNRCU dealt with exchange of information to supplement the IAEA database on incidents associated with illicit trafficking of nuclear material and other radiation sources in compliance with obligations under the Nuclear Non-Proliferation Treaty. Information on 4 incidents was entered into the database by 2000. It should be noted that no event of illicit removal of nuclear material from Ukrainian facilities was recorded in 2002.

There is an urgent need for development of a uniform interagency regulation to govern the process of informing the public and international organizations on incidents associated with nuclear material.

The Swedish Nuclear Power Inspectorate and Institute for Nuclear and Energy Law jointly with the Committee for Fuel Energy System, Nuclear Policy and Nuclear Safety of the Verkhovna Rada of Ukraine organized and conducted the international workshop devoted to the Prevention of Illicit Trafficking of Radioactive and Nuclear Material (legal and administrative aspects) in October 2002. The workshop was intended for exchange of information between national and foreign nuclear experts on solution of issues related to illicit trafficking of nuclear and radioactive materials, consideration of problems in this field and ways for their resolution, including the potential of international cooperation.

Organizational measures were taken to establish an interagency advisory group for legislative provisions on prevention of illicit trafficking of nuclear and radioactive materials in Ukraine on the initiative of the Committee for Fuel Energy System, Nuclear Policy and Nuclear Safety of the Verkhovna Rada of Ukraine. Experts consider that establishment of the national infrastructure for prevention of illicit trafficking is the most important activity at the current stage.

13. SCIENTIFIC AND TECHNICAL SUPPORT IN NUCLEAR ENERGY, PERSONNEL TRAINING AND QUALIFICATION

Scientific and Technical Support in Nuclear Energy

Nuclear energy plays an important role in the Ukrainian economy. This is a pollution-free source of electricity. Economic efficiency and competitiveness ensure stable development of this industry.

In compliance with the Decree of the President of Ukraine "On Development of Energy Strategy in Ukraine for the Period to 2030 and Future Perspective" and for the benefit of economically sound and competitive nuclear fuel complex of Ukraine, the draft Strategy for Nuclear Energy Development as a component of Ukraine's Energy Strategy for the Period to 2030 was developed by the Ministry of Fuel and Energy and the NNEGC "Energoatom" with participation of leading research and design institutes of Ukraine in 2002.

The following organizations should be noted among the leading enterprises and institutions of Ukraine that deal with the issues of nuclear energy safety: Institute for Nuclear Research of the National Academy of Sciences of Ukraine, Kyiv National Taras Shevchenko University, National Scientific Centre "Kharkiv Physics & Technology Institute" (NSC KhPTI), Institute for General Energy of the National Academy of Sciences of Ukraine, Institute "Energoproject", State Science Engineering Centre of Control Systems and Emergency Response (SSEC CSER), State Scientific and Technical Centre for Nuclear and Radiation Safety (SSTC NRS), UkrNDPPromtekhnologia.

During 2002, these scientific institutions conducted research intended to improve the safety of nuclear energy. In particular, on-line and technological analysis of NPP operational events was continued with the purpose of assessing associated corrective measures for adequacy. Results of these activities are applied by the SNRCU in assessing NPP operational safety.

Analysis of data on contamination of the Ukrainian territory with Chornobyl long-lived radionuclides was underway. The uniform database was developed and served as the basis for drawing maps of territory of Ukraine contaminated with ^{137}Cs, ^{90}Sr and transuranium elements.

Experts of the organizations subordinated to the SNRCU carried out 206 preliminary reviews that served as the basis for documents required for issuing licenses and permits to nuclear enterprises.

The SNRCU Scientific and Technical Council held 3 meetings to discuss radwaste management, lifetime extension and safety improvement of Ukrainian NPPs.

Personnel Training

Safe and effective operation of nuclear power plants can be ensured by high-skilled personnel who have passed proper theoretical and practical training.

Qualified personnel in nuclear energy are trained by various Ukrainian educational institutions, among them:

- Kyiv National Taras Shevchenko University;
- National Technical University of Ukraine "Kyiv Polytechnic Institute";
- Odesa State Polytechnic University;
- Sevastopol Institute for Nuclear Energy and Industry;
- Kharkiv National University;
- Kharkiv Polytechnic Institute "National Technical University".

The nuclear industry is annually replenished by approximately 600 fresh experts.

The main areas of experts' knowledge are as follows:

- nuclear physics

- applied physics
- plasma physics
- biophysics of complex systems
- physical science of materials
- physics and chemistry of surface
- energy audit and energy saving
- information protection
- NPP equipment installation and adjustment

The Sevastopol Institute for Nuclear Energy and Industry – the basic institute of the Ministry of Fuel and Energy of Ukraine – provides training of experts for all NPP departments and enterprises of nuclear fuel cycle, environmental protection and energy saving technologies.

After the 1986 Chornobyl accident, the public became prejudiced against nuclear energy and its further development. This may cause shortage of high-skilled staff in the industry in future. In addition, outdated experimental equipment used in higher educational institutions decreases the level of student training and research study in nuclear and medical physics. The lack of proper working conditions resulted in dropout of high-skilled experts from the industry and, as a result, ageing of personnel who work at nuclear facilities is observed. In order to solve these problems, the prestige of nuclear energy should be enhanced and attention of the youth to this industry should be attracted.

Improvement of Qualification

The specifics of nuclear industry require permanent improvement of qualification and retraining of its workers. Ukrainian establishments with up-to-date material and technical basis and wide experience in the industry and qualified staff conduct retraining of personnel. The Institute for Nuclear Research of the National Academy of Sciences and its structural department – Training Centre named after George Kuzmich – is one of such establishments. Retraining of personnel in radiation safety is actively conducted by the Kyiv National Taras Shevchenko University and Engineering Centre for Personnel of Nuclear Energy.

Owing to the cooperation with the International Atomic Energy Agency (IAEA), employees of executive authorities and nuclear industry attend special workshops, training courses, and conferences.

About 60 employees of the SNRCU participated in training courses, workshops, technical and scientific visits under regional and national projects in 2002.

Ukraine pays special attention to the selection and training of NPP personnel. An appropriate multi-level system was established for this purpose.

In compliance with current legislation of Ukraine, NPP personnel should be obligatory licensed by the SNRCU. The following is required in this regard:

• Basic education confirmed by diplomas;
• Not less than two-year experience on positions of operative personnel in NPP basic departments;
• Training at the NPP Training Centre equipped by full-scale simulators, and examinations after training.

There are training centres licensed by the SNRCU to train personnel on nuclear facility operation at all nuclear power plants. The Centres monitor knowledge of future licensees, conduct training and final examinations. Based on examinations, application documents are submitted to the SNRCU Licensing Commission to issue a license to an individual for direct control of the nuclear power reactor. After passing the licensing procedure in compliance with legislation, the individual obtains a 2-year license.

In order to improve personnel qualification, a program was developed according to which licensed personnel have to take examinations once or twice a year. If license requirements are not met, the license may be terminated. If such an individual fails to pass qualification examinations within 6 months, the license is cancelled. Only after additional training, the individual may obtain a license in compliance with the established procedure. Therefore, admission of unqualified personnel to operate a nuclear power reactor is practically impossible.

12. ROLE OF INTERNATIONAL COOPERATION IN STRENGTHENING NUCLEAR AND RADIATION SAFETY

International nuclear and radiation safety assurance is regulated by:

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

Observance of obligations under these international legal documents is verified through reviewing national reports of member states to the Conventions at special meetings held by the IAEA every three years.

The Second Meeting of member states to the Convention on Nuclear Safety was held on April 15-26, 2002 in the IAEA headquarters in Vienna. This meeting was the most important event of the year in that it combined efforts of the world community aimed at achieving a high safety level in the use of nuclear energy for peaceful purposes. Vadym Gryschenko, Chairman of the State Nuclear Regulatory Committee of Ukraine, headed the Ukrainian delegation that participated in the meeting.

The Report on Nuclear and Radiation Safety in Ukraine was of great interest to the member states. This was confirmed by more than 120 questions asked by representatives of 17 states during its presentation. It should be pointed out that the discussion of results achieved by Ukraine in safety assurance of nuclear facilities was open and constructive. Nuclear safety in our State was considered at the objective level rather than through the prism of the “Chornobyl ghost”.

Essential progress achieved by our State during the three years since the First Meeting was pointed out at the final plenary session devoted to results of the Second Meeting. The unanimous acknowledgement **that Ukrainian nuclear safety met the world standards** was the main result.

Activity of the Ukrainian regulatory authority and operating organization was recognized as successful and effective concerning:

- Development and improvement of national legislation in nuclear and radiation safety, first of all, establishment of the independent regulatory authority;
- NPP safety reassessment to be completed by issuing new licenses for operation of all power units in service;
- Activities within the ChNPP decommissioning plan, including licenses for decommissioning of power units 1, 2, and 3;
- Implementation of new requirements on emergency preparedness and early response in the event of a nuclear incident;
- Introduction of more strict standards on releases and discharges into the environment.

At the same time, Ukraine was recommended to pay primary attention to the following issues in the next three-year period:

- Need for more in-depth analysis of NPP safety, applying probabilistic safety analysis techniques,
- Provision for proper funding of safety improvement measures at NPPs as identified by state programs,
- Implementation of the quality system in the internal activity of the regulatory authority as soon as possible,
- Improvement of the state system for personnel training and qualification in nuclear and radiation safety,
- Legal settlement of the problem related to the establishment of appropriate funds for ChNPP decommissioning and mechanisms for their replenishment.

Cooperation with the European Union

Integration of Ukraine into Europe to become a full member of the European Union is a strategic area of national development. Requirements on the safety of nuclear power facilities in member states to the EU are very strict. For example, Lithuania had to undertake obligations to refuse from operation of the two existing power units till 2009. Bulgaria took obligations to shut down 4 of the 6 operating reactors, and 2 of them were shut down at the end of 2002.

The framework of cooperation between Ukraine and the European Union is established by the Agreement on Partnership and Cooperation implemented on 1 March 1998. In the complex structure of authorities established for implementation of the Agreement, coordination of cooperation in nuclear energy and nuclear and radiation safety rests with the Subcommittee for Energy, Cooperation in Civil Nuclear Sector, Environmental Protection, Transport, Telecommunications, Science and Technology, Education and Training (Subcommittee 3).

Two meetings of Subcommittee 3 were held in 2002. Cooperation under the Tacis program, problems preventing timely implementation of action plans on Chornobyl NPP decommissioning, and Shelter transformation into an ecologically safe system were discussed in detail at the meetings in Kyiv (January) and Brussels (November). In addition, the settlement of arguments about the completion project for two power units at Rivne and Khmelnitsky NPPs were in the centre of attention. As a result of negotiations, proposals were prepared to eliminate the existing drawbacks and priority areas of cooperation were identified for the near-term outlook.

It is expected that the partnership in safe nuclear energy between Ukrainian and West European enterprises and institutions should be further strengthened by two agreements ratified by the Verkhovna Rada of Ukraine in 2002:

- Agreement on Cooperation between the Cabinet of Ministers of Ukraine and the European Atomic Energy Authority in the Area of Nuclear Safety,
- Agreement on Cooperation between the Cabinet of Ministers of Ukraine and the European Atomic Energy Authority in the Area of Controlled Nuclear Fusion.

In the context of Ukraine's integration into European structures, participation of the regulatory authority in the Group for Concertation on European Regulatory Tasks (CONCERT) is very important. This Group was established under the aegis of the European Commission with the purpose to shear experience and coordinate regulatory policy in nuclear and radiation safety in European states. At the meetings held twice a year, the most urgent issues arising in practices of the authorities responsible for the safety of nuclear energy are discussed.

The main issues considered at the meetings in Vilnius and Brussels were devoted to the agreement of approaches to:

- Criteria for assessment of nuclear and radiation safety,
- Decommissioning of nuclear power plants before the expiration of their design life,
- Mechanisms for nuclear safety regulation in European Union states in conditions of energy market liberalization.

The International Conference "10th Anniversary of the Tacis Nuclear Safety Program" conducted in Kyiv in June should be noted among the main events of 2002. The Conference was devoted to results of technical assistance projects intended to improve the safety of nuclear power plants in the Commonwealth of Independent States, analysis of efficiency of the selected instruments and methods for cooperation and identification of priorities for further cooperation.

The Conference final documents determined strategic frames for developing the cooperation between Ukraine and the European Commission for the next 3-4 years. The final recommendations of the Conference concerning further priorities of the Tacis Nuclear Safety Program in Ukraine were as follows:

- Improve nuclear safety culture in compliance with the Convention on Nuclear Safety, in particular, through further assistance to the regulatory authority and on-site assistance to NPPs,

- Support development of the national strategy on management of spent fuel and radioactive waste and decommissioning of NPPs units in the context of wide international cooperation,

- Support international initiatives on nuclear safety improvement, in particular, activity of G7 states on Chornobyl NPP decommissioning.

Participation of the Ukrainian delegation in the Annual International Forum on Nuclear Safety EUROSAFE in Berlin should be noted among other European-level events. Harmonization of nuclear safety regulatory practices in Europe, financial support to radioactive waste management programs and nuclear power plant decommissioning were actively discussed.

Large-scale cooperation with the European Commission and individual European states ensures harmonization and compliance of the Ukraine's national nuclear legislation with European Union requirements and international safety standards.

Bilateral International Cooperation

The Convention on Nuclear Safety states that a proper safety level of nuclear facilities worldwide is impossible without further development and enhancement of international cooperation intended for the implementation of up-to-date technologies and advanced regulatory experience for the benefit of nuclear and radiation safety.

In this context, the year of 2002 was characterized by noticeable expansion of bilateral cooperation in nuclear and radiation safety with regulatory authorities of the USA, Russia, Germany, Great

Britain, Sweden, Switzerland, Bulgaria, Slovakia, Czech Republic, and some other countries.

For expansion and improvement of Ukraine's legislative framework for bilateral cooperation in nuclear and radiation safety, the following agreements were prepared and signed in 2002:

- Agreement between the Federal Nuclear and Radiation Safety Authority of Russia and the State Nuclear Regulatory Committee of Ukraine on Exchange of Information and Cooperation in the Field of Safety Regulation in Respect of the Peaceful Use of Nuclear Energy (signed on 14 August 2002 in Moscow),
- Agreement between the State Nuclear Regulatory Committee of Ukraine and Nuclear Regulatory Agency of the Bulgarian Republic on Cooperation in the Field of State Regulation and Control of Safety During the Use of Nuclear Energy (signed on 30 January 2003 in Kyiv),
- Agreement between the Cabinet of Ministers of Ukraine and the Government of the Bulgarian Republic on Early Notification of Nuclear Accidents and Cooperation in Nuclear and Radiation Safety (signed on 31 January 2003 in Kyiv).

Technical and scientific cooperation programs were underway in 2002.

Comprehensive safety assessment at power units of three Ukrainian NPPs (Zaporizhzya-5, Rivne-1, and South Ukraine-1) was carried out under support of the US Nuclear Regulatory Commission. This assessment greatly assisted the SNRCU in substantiating decisions on licenses for power plant operation.

Ukraine implements measures to improve the national system for nuclear material accountancy and control under the technical cooperation program with the Swedish Nuclear Power Inspectorate.

Cooperation with the Federal Ministry of Environment, Nature Conservation and Reactor Safety of the Federal Republic of Germany covered a wide range of issues related to safe nuclear energy. These issues, in particular, included modernization of WWER power units, safety of spent fuel and radioactive waste management, enhancement of physical protection of nuclear facilities, transfer of methodology on nuclear and radiation safety indicators.

In 2002, a number of official and working meetings were held by the SNRCU managerial staff and experts with delegations of regulatory authorities of Bulgaria, Czech Republic, Poland, Germany, Rumania and India with the purpose of updating the existing bilateral cooperation programs and identifying prospective areas of further cooperation.

Experience exchange, integration of scientific and technical potential and financial resources to solve problems encountered by regulatory authorities of different countries permit performing complex tasks in an effective and quality manner and saving costs. It is development and expansion of international cooperation that can ensure a high safety level of nuclear energy worldwide.

Cooperation with the IAEA

The following three events were the most important for the development of cooperation between Ukraine and the IAEA in 2002:

- Ukraine paid off all last-year debts of obligatory fees for all funds, and did not have any debts to the IAEA for the first time since it gained independence,
- Vadym Gryschenko, Chairman of the SNRCU represented our State in the IAEA Board of Governors in the period between General Conferences,
- Ukraine became the largest recipient of assistance both by the number of project and the scope of funding under the Technical Cooperation Program for 2003-2004 signed in September 2002.

During 2002, representatives of the regulatory authority and operating organization took part in 12 national and 31 regional projects under the IAEA Technical Cooperation Program. It should be noted that Ukrainian experts gained essential authority. They are more frequently involved by the IAEA Secretariat as national experts in missions and technical assistance projects implemented in Central and East European states.

Representatives of the SNRCU, Ministry of Health, Ministry of Fuel and Energy, and scientific and research institutes of Ukraine regularly participate in the IAEA advisory boards, such as the Nuclear Safety Standards Advisory Committee, high-level Advisory Group for Safeguards Implementation, WWER Forum, technical committees and working groups.

More than 100 representatives of various Ukrainian organizations were involved by the IAEA Secretariat in workshops and technical meetings in 2002, and 16 experts attended training courses.

As compared to 2001, the number of Ukrainian experts who participated in training courses and workshops under qualification improvement projects implemented under the aegis of the IAEA has increased essentially. In particular, 24 Ukrainian experts from the Institute of Oncology of the Academy of Medical Sciences of Ukraine, Kyiv Medical Academy for Post-Graduate Education by P. Shupik, Institute for Medical Radiology by S. Grigoryev (Kharkiv), Crimean Medical University (Simferopol) participated in the training program for medical staff dealing with radiation exposure for treatment of patients (ESTRO courses).

During 2002, the IAEA together with the SNRCU, Ministry of Fuel and Energy and the NNEGC “Energoatom” conducted 2 workshops, 1 training course, and 6 technical meetings in various places of Ukraine.

In general, the year of 2002 was marked by significant improvement of Ukraine’s authority in the IAEA, as a State that achieved essential progress in the enhancement of nuclear and radiation safety at nuclear facilities and ensured effectiveness of the main functions performed by the SNRCU - regulatory authority.

11. NUCLEAR NON-PROLIFERATION SAFEGUARDS

The threat of proliferating material that can be used for weapons of mass destruction is one of the main contributors to international safety destabilization. The fact that some "problem" countries which strive for possessing weapons of mass destruction take measures to create their own scientific and technical and industrial potential for the development and production of these weapons is of especial concern. Prevention of the use of peaceful nuclear material for nuclear explosive assemblies and assurance of nuclear non-proliferation safeguards become especially important and acute in these unstable conditions.

Our State is one of the active member countries that entered into the Nuclear Non-Proliferation Treaty. Ukraine and IAEA entered into and ratified the Agreement on Safeguards concerning the Nuclear Non-Proliferation Treaty (hereinafter – the "Agreement"). However, some provisions of this Agreement are not sufficiently effective because of the development of new nuclear technologies and because of the fact that one of the states that ratified the Agreement conducted secret work on nuclear weapons. Therefore, new safeguards were established and reflected in additional protocols under the aegis of the IAEA. New safeguards require more openness in nuclear activities and should prevent events of illicit activities involving nuclear materials.

The Additional Protocol, which was composed by the IAEA based on a typical text approved by the IAEA Board of Governors in May 1997, was signed on behalf of Ukraine on 15 August 2000 in Vienna. In 2002, efforts were made to agree problematic issues with involved ministries to harmonise Ukrainian legislation with requirements of the Additional Protocol for further ratification of the Additional Protocol by Verkhovna Rada of Ukraine.

The SNRCU is a competent authority in safeguards, which coordinates implementation of the Agreement on Safeguards. To strengthen the safeguards, the SNRCU established the permanent Working Group for review of safeguards at nuclear facilities of Ukraine. The Working Group includes representatives from the IAEA, Ministry of Fuel and Energy of Ukraine, Ministry of Foreign Affairs of Ukraine, and the NNEGC "Energoatom". Two meetings of the joint Working Group and one meeting of the higher-level Working Group were conducted in 2002. Technical aspects of safeguards for nuclear weapon non-proliferation at Ukrainian nuclear facilities were considered and action plans on implementation of recommendations on the improvement of safeguards at Ukrainian nuclear facilities were agreed upon.

In order to prevent the use of nuclear material, facilities and technologies for military purposes, the State System of Accounting and Control of Nuclear Material (ACNM) was established in 1995 under assistance of donor countries.

In the framework of the ACNM, the SNRCU:

- Keeps the state databank on nuclear material accounting;
- Conducts inspections to verity conformity of procedures with current regulatory requirements and effectiveness of nuclear material accounting and control at enterprises;
- Interacts with the IAEA on issues related to safeguards.

The IAEA exercises international supervision over fulfilment of the Agreement at Ukrainian nuclear facilities through regular inspections since 1995. In 2002, the IAEA held 83 inspections of nuclear material balance zones in Ukraine. The IAEA made positive conclusions on all the inspections.

In 2002, in compliance with the Agreement on Safeguards, Ukrainian experts prepared and submitted to the IAEA 110 reports on nuclear materials being under the jurisdiction of Ukraine, including:

- 59 reports on changes in inventory of nuclear material;
- 25 reports on inventory of nuclear material;
- 26 material-balance reports.

Therefore, Ukraine together with other European countries implements measures to strengthen the nuclear non-proliferation safeguards system in all aspects according to the international requirements.

14. PUBLIC RELATIONS

Any NPP event causes concern of the world community after the Chornobyl accident in 1986. In this regard, public relations intended to clarify the state policy and provide timely and objective information on operational and routine safety of nuclear facilities have become an important activity of all competent state public authorities, enterprises and organisations in nuclear industry.

In 2002, the President and Government of Ukraine issued a number of decrees to streamline the process of public informing.

The SNRCU, Ministry of Fuel and Energy and nuclear power plants established departments for clarification of the state nuclear policy. Comprehensive information on safe use of nuclear energy and measures taken by the state for ensuring nuclear and radiation safety can be obtained at these departments. In order to familiarise the public with nuclear power plant operation, special excursions are arranged at all NPPs.

The SNRCU Department for Public and Mass Media Relations deals with public relations, work with public organisations and mass media. The Department organized workshops, press conferences and meetings with managerial staff for the public and mass media. Information was also disseminated through the mass media and Internet.

The SNRCU website was created in 2001 to disseminate on-line information, the site address: http://www.snrcu.gov.ua/. The Ministry of Fuel and Energy of Ukraine, the NNEGC "Energoatom" and nuclear power plants have their own websites.

The website presents information on NPP safety assurance activities; on-line messages on NPP operational indicators; radiation accidents and incidents that occurred at nuclear power facilities of Ukraine. The website also presents information in English.

Analysis of public calls to the SNRCU website showed that almost each third call was associated with Khmelnitsky and Rivne construction (Figure 14.1). According to website monitoring, the number of calls and interest in this information increased not only in Ukraine but also in other states (Figures 14.2-14.3).

The section "Question – Answer" under the "Work with Public Calls" category was created on the website of the Ministry of Fuel and Energy, where experts respond to calls of the public.

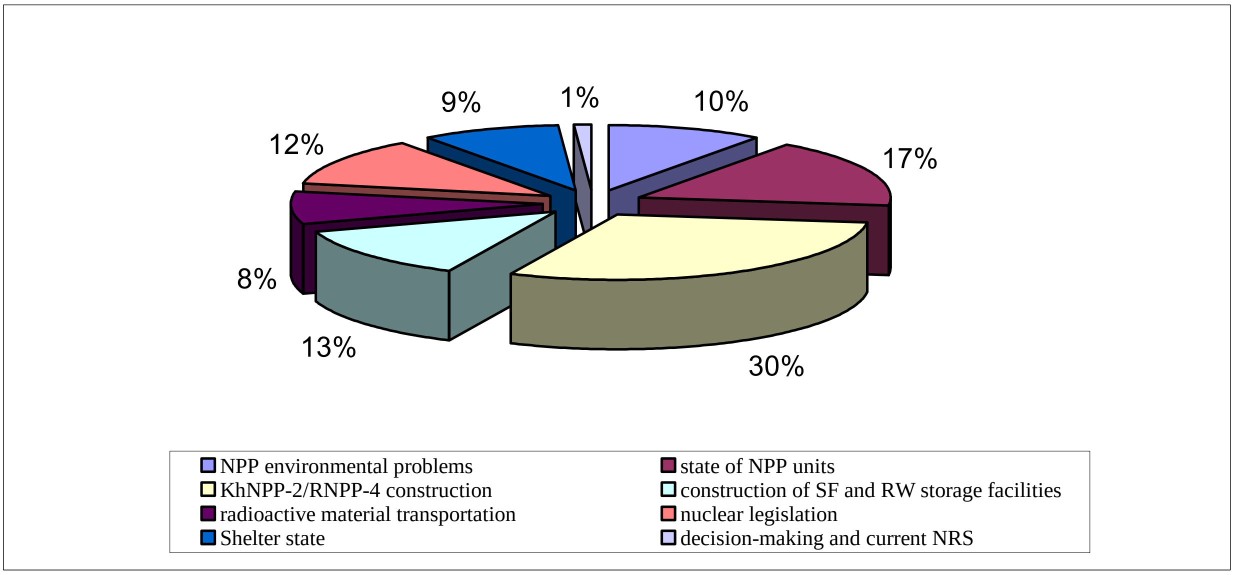


Figure 14.1. Questions Asked by the Public

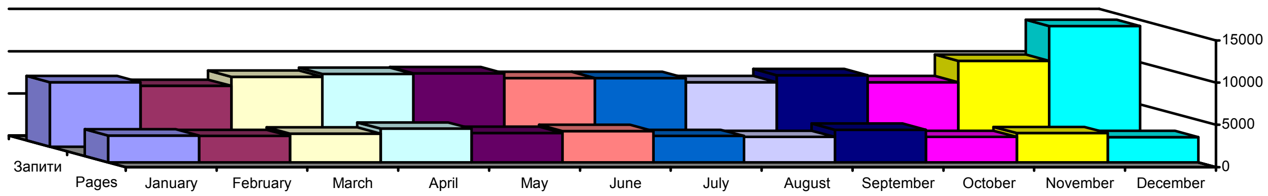


Figure 14.2. Statistics of Calls to the SNRCU Website

Ukrainian citizens were able to receive answers to their questions of concern from managerial staff of the SNRCU and Ministry of Fuel and Energy of Ukraine during governmental direct telephone line sessions on 31 May and 8 November 2002.
All questions of the public addressed to the SNRCU received qualified answers.

The SNRCU coordinates the use of the International Nuclear Event Scale (INES) in Ukraine. The INES is a means for promptly communicating to the public the safety significance of events reported at nuclear installations and other facilities. Information on the INES is provided in Annex 2.

The SNRCU obtains information on operational events at Ukrainian NPPs according to the "Provisions on the Procedure for Investigation and Account of Nuclear Power Plant Operational Events" ND 306.205-96 in the form of preliminary notification of the operational event within 24 hours. The notification is signed by the NPP Chief Engineer and State Resident Inspector for nuclear safety and includes without fail the INES preliminary classification of the event. The SNRCU considers and verifies the accuracy of the classification. If an event is rated at level 2 and above or if it can concern the international community, the notification in a special format is sent to the INES communication system.

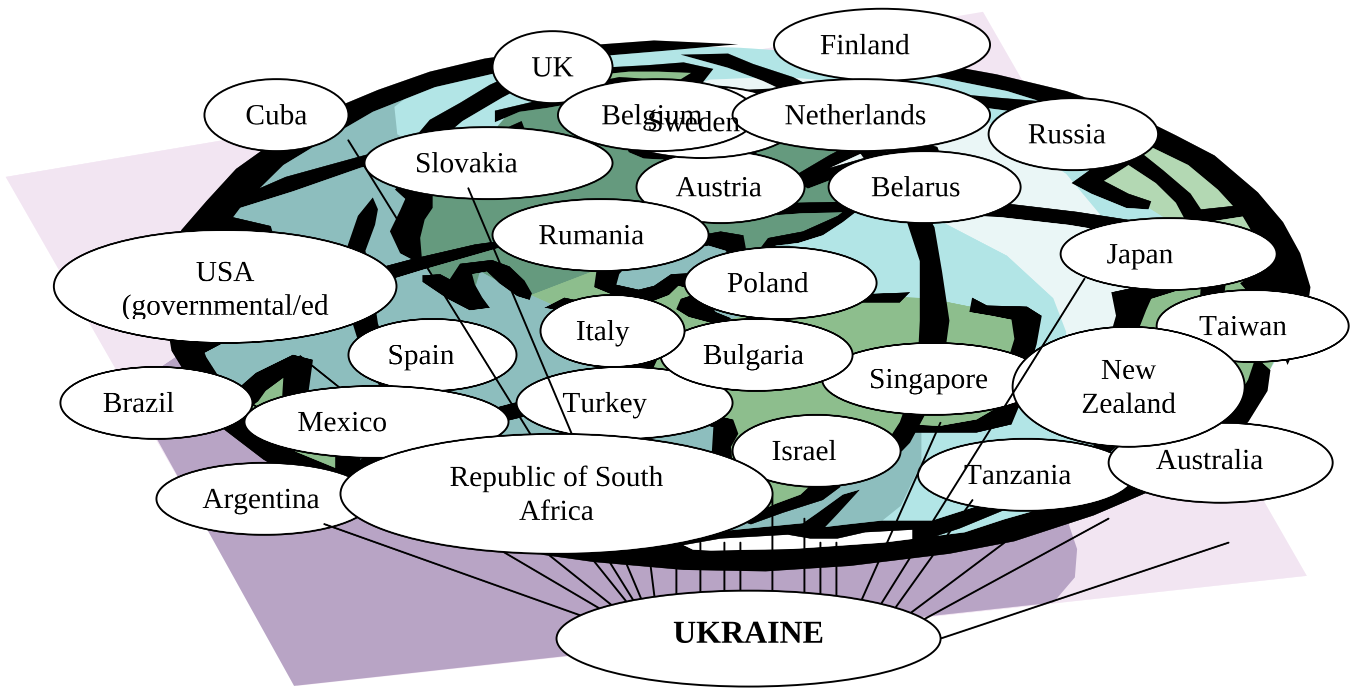


Figure 14.3. Geography of Calls to SNRCU Website

Scientific and Technical Journal “Nuclear and Radiation Safety” is issued each quarter under SNRCU assistance for information exchange between NPP personnel, organizations and institutions in nuclear energy and for involvement of the national scientific potential in the solution of significant issues on nuclear and radiation safety.

Results of scientific, technical and analytical activities on nuclear and radiation safety carried out by research and development organizations of Ukraine and foreign states are published in the Journal.
Special attention is paid to the following information:

- Regulation of radioactive source management;
- Design, operation, and repair of nuclear power facilities;
- Improvement of reliability and safety of thermomechanical equipment;
- Radiation science of materials and strength of nuclear facility components;
- Thermal and physical characteristics of power facilities;
- Participation in international cooperation under agreements and programs of the SNRCU and State Scientific and Technical Centre for Nuclear and Radiation Safety.

The Ministry of Fuel and Energy issues information and analytical bulletin “Information of the Ministry of Fuel and Energy of Ukraine” to inform on events in nuclear energy. Laws of Ukraine, Decrees of the President of Ukraine and draft laws of the Verkhovna Rada of Ukraine pertaining to nuclear energy of Ukraine take the leading place.

The Ukrainian Nuclear Society (UNS) conducted fruitful work to inform the public and cooperate with the youth. The following was conducted with support of this organization:

- 12-15 April 2002 – 5th Ukrainian Festival of KVN Teams for pupils from satellite towns of Ukraine in Netishin;
- 27-28 April 2002 – scientific and practical workshop “Art and Nuclear Energy” in Energodar;
- 15-16 May 2002 – international conference “Youth and Nuclear Energy” in Kuznetsovsk;
- 29-31 October 2002 – workshop “Problems of Environment, Safety of Human Life in NPP Regions, and Their Reflection in Mass Media” in Netishin;
- 11-12 November 2002 – international conference “NPP Lifetime Management” in Kyiv;
- 2 November 2002 – mobile exhibition devoted to the 10th anniversary of the UNS.

Information on UNS activity under agreements between the UNS and Ukrainian NPPs on culture assurance in NPP satellite towns is placed on the Society website: http://www.ukrns.odessa.net

Next year, the SNRCU jointly with the National Complex “Expocentre of Ukraine” is going to organize a standing exhibition in order to increase the public awareness of the Committee activities on nuclear and radiation safety in Ukraine and is going to open the public inquiry room on the SNRCU website in order to establish feedbacks with the public.

Annex 1

List of Regulations on Nuclear and Radiation Safety Developed by the SNRCU and Issued in 2002

1. List of Radiation Sources Exempt from Licensing (Resolution of the Cabinet of Ministers of Ukraine No. 912 dated 1 July 2002);
2. On Amendment of Resolution of the Cabinet of Ministers of Ukraine No. 1782 dated 6 December 2000 (Resolution of the Cabinet of Ministers of Ukraine No. 1362 dated 12 September 2002);
3. Safety Requirements and Conditions (Licensing Terms) for Activities Related to Radioactive Material Transport NP 306.5.06/2.063-02 (the SNRCU Ordinance No. 116 dated 8 November 2002, registered in the Ministry of Justice of Ukraine, reg. No. 934/7222 dated 29 November 2002);
4. Requirements on the Safety Analysis Report for Activities on Radioactive Material Transport NP 306.5.06/3.064-02 (the SNRCU Ordinance No. 116 dated 8 November 2002, registered in the Ministry of Justice of Ukraine, reg. No. 935/7223 dated 29 November 2002);
5. Safety Requirements and Conditions (Licensing Terms) for Activities Related to Radioactive Waste Processing, Storage, and Disposal NP 306.5.04/2.060-2002 (the SNRCU Ordinance No. 110 dated 22 October 2002, registered in the Ministry of Justice of Ukraine, reg. No. 874/7162 dated 6 November 2002);
6. Rules for Keeping the System of Accounting and Control of Nuclear Material at Enterprises Other Than Nuclear Facilities NP 306.5.07/2.061-02 (the SNRCU Ordinance No. 85 dated 22 July 2002, registered in the Ministry of Justice of Ukraine, reg. No. 940/7228 dated 3 December 2002);
7. Requirements on the Annual Safety Analysis Report on Production of Radiation Sources NP 306.5.05/3.055-02 (the SNRCU Ordinance No. 122 dated 29 December 2001, registered in the Ministry of Justice of Ukraine, reg. No. 223/6511 dated 4 March 2002);
8. Safety Requirements and Conditions Related to the Use of Radiation Sources NP 306.5.05/2.065-02 (the SNRCU Ordinance No. 125 dated 2 December 2002, registered in the Ministry of Justice of Ukraine, reg. No. 978/7266 dated 17 December 2002);
9. Requirements on the Safety Analysis Report on Activities Related to the Use of Radiation Sources NP 306.5.05/2.066-02 (the SNRCU Ordinance No. 125 dated 2 December 2002, registered in the Ministry of Justice of Ukraine, reg. No. 979/7267 dated 17 December 2002).
10. Requirements on the Format and Contents of the Typical Certificate for a Reactor Facility NP 306.5.02/3.056-2002 (the SNRCU Ordinance No. 73 dated 13 June 2002, not subjected to registration in the Ministry of Justice of Ukraine).

Annex 2

INES: The International Nuclear Event Scale

The INES scale was designed by an international group of experts from different states in 1989 and was introduced in March 1990 under the aegis of the International Atomic Nuclear Energy Agency and the Nuclear Energy Agency of the Organization for Economic Cooperation and Development for promptly communicating to the mass media and the public the events reported at nuclear power plants and other installations. The scale is designed to be an important tool providing prompt, clear and consistent information on nuclear events in different states. The scale facilitates evaluating the significance of events in terms of nuclear and radiation safety.

The INES National Officer of the country where the event occurred should promptly (within 24 hours) provide official information to all member countries through the IAEA INES communication network. Events that should be reported are determined by the following criteria:
Significance to safety is of level 2 and above;
Interest to the world community (level 1 and 0).

Prior to 2002, international information exchange within the system was conducted through fax messages.

The "Nuclear Events Web Based System (NEWS)" was introduced at the beginning of 2002. The system was designed by the IAEA in collaboration with the Organization for Economic Cooperation and Development and the World Association of Nuclear Operators (WANO) with the purpose of promoting prompt dissemination of information on nuclear events among countries.

At present, information on an event is placed on the IAEA website and the system automatically generates a signal for users: "New Event". The users of the system who are responsible for information exchange in their countries within the INES network familiarize with messages placed on the IAEA website and disseminate information with needed explanations to the national media.

The scale is used by 60 participating countries of the INES communication network.

The structure of the INES is shown in Figure 1 in the form of a matrix with key words, which are not intended to be precise or definitive. Events are classified on the scale at seven levels: the upper levels (4-7) are termed "accidents", and the lower levels (1-3) "incidents". Events, which have no safety significance are classified as below scale at level 0 and are termed "deviations". Events, which have no safety relevance, are termed "out of scale".
As shown in Figure 1, three separate criteria of safety attributes are used in three columns: off-site impact, on-site impact, and impact on defence in depth.
The first column relates to events resulting in off-site releases of radioactivity (nuclear power plant or other facility). Since this is the only consequence having a direct effect on the public, such releases are understandably of particular concern. The lowest point in this column represents a release giving some persons outside the site an estimated radiation dose numerically equivalent to about one tenth of the annual dose limit for the public; this is classified at level 3. Such a dose is also typically one tenth of the average annual dose received from natural background radiation. The highest level is a major nuclear accident with widespread health and environmental consequences.
The second column considers the on-site impact of the event. This category covers a range from level 2 (major contamination and/or overexposure of workers) to level 5 (severe damage to the reactor core or radiological barriers).
The third column relates to incidents in which defence in depth provisions have been violated or degraded.
An event, which has an impact on more than one column in the matrix, is always classified at the highest level achieved in any column. Events, which do not achieve the lowest level in any column are classified as below scale at level 0.
Criteria of nuclear and radiation safety and terminology used to characterize them differ in various countries though they are comparable in a broad sense. The international scale was designed with consideration of this aspect but user countries may specify or clarify the scale according to their national practices.

Figure 1. Basic Structure of the INES

Level	Area of impact		
	Off-site impact	**On-site impact**	**Impact on defence in depth**
ACCIDENT			
“7” Major accident	Major release: widespread health and environmental effects		
“6” Serious accident	Significant release: likely to require full implementation of planned countermeasures		
“5” Accident with off-site risk	Limited release: likely to require partial implementation of planned countermeasures	Severe damage to reactor core/ radiological barriers	
“4” Accident without significant off-site risk	Minor release: public exposure of the order of prescribed limits	Significant damage to reactor core/ radiological barriers/ fatal exposure of a worker	
INCIDENT			
“3” Serious incident	Very small release: public exposure at a fraction of prescribed limits	Severe spread of contamination/acute health effects to a worker	Near accident – no safety layers remaining
“2” Incident		Significant spread of contamination/ overexposure of a worker	Incidents with significant failures in safety provisions
“1” Anomaly			Anomaly beyond the authorized operating regime
“0” Deviation	**NO SAFETY SIGNIFICANCE**		
Below scale	**NO SAFETY RELEVANCE**		

Annex 3

Organisational Chart of the Ukrainian State Committee on Nuclear Regulation