MINISTRY FOR ENVIRONMENTAL PROTECTION AND NUCLEAR SAFETY

NUCLEAR REGULATORY ADMINISTRATION

MAIN STATE INSPECTION FOR NUCLEAR SAFETY

STATE SCIENTIFIC AND TECHNICAL CENTER FOR NUCLEAR AND RADIATION SAFETY

REPORT

on the Status of Nuclear and Radiation Safety in Ukraine in 1998

KYIV 1999

Foreword[1]

This Report "On the status of nuclear and radiation safety in Ukraine for 1998" (hereinafter referred to as the Report) was developed upon request of the Ministry of Environmental and Nuclear Safety of Ukraine (hereinafter referred to as MEPNS) – state regulatory authority on nuclear and radiation safety – in order to inform the Supreme Rada, the President of Ukraine and the Cabinet of Ministers about the status of nuclear and radiation safety in Ukraine in 1998.

The Report was prepared by the State Scientific and Technical Centre on Nuclear and Radiation Safety (hereinafter referred to as SSTC NRS) and the Main State Inspectorate of Nuclear Safety of Ukraine and was based on the current Ukrainian normative acts and official Reports of ministries, agencies, enterprises and organisations dealing with activities in the area of nuclear energy utilisation and radiation protection.

During the development of the Report the following tasks has been solved:

- Describe the status of nuclear and radiation safety in Ukraine in 1998;
- Assess observance of safety priority principle that is established by the legislation of Ukraine
- Highlight the most significant issues of nuclear and radiation safety the settlement of those will perform the basis for upgrading nuclear and radiation safety level reached in Ukraine in 1998.

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Content

List of abbreviations and terms.

NPP	Nuclear Power Plant
NRA	Nuclear Regulatory Administration
WWER	Pressurised Water-Water Reactor
VostGOK	East Ore Mining and Processing Plant
SIR	Source of Ionising Radiation
SSTC NRS	State Scientific and Technical Centre of Nuclear and Radiation Safety
IAEA	International Atomic Energy Agency
MEPNS of Ukraine	Ministry of Environmental Protection and Nuclear Safety of Ukraine
NAEK "Energoatom"	National Energy Generating Company "Energoatom"
NRBU-97	Ukrainian Radiation Safety Norms, GGH 6.6.1.-6.5.001-98
SIP	Shelter Implementation Plan (Measures to transfer Shelter facility into environmentally safety system)
RW	Radioactive Waste
RBMK	High power fuel-channel-type boiling reactor
DSFSF	Dry spent fuel storage facility
FE	Fuel element
Radon enterprise	State enterprise "Radon"

NUCLEAR POWER PLANT – facility designed for generation of electricity and energy for the process purposes.

RADIATION SAFETY – observance of permissible radiation exposure limits for the personnel, the public and environment, established safety norms, rules and standards.

SPENT NUCLEAR FUEL – separate fuel element or assembles of fuel elements that were operated in the reactor and further on use of is not planned.

NUCLEAR SAFETY – observance of norms, rules, standards and conditions to use nuclear materials which ensure radiation safety.

NUCLEAR INSTALLATION – denotes any nuclear reactor except for those purposed to equip sea and air transport means as power source to set them in motion or with any other purpose, any plant that use nuclear fuel for manufacturing of nuclear material or any plant that processes activated nuclear fuel, and any site for nuclear material storage except for storage site connected with transportation of such material providing that several nuclear installations of one operator are situated at one site and considered as united nuclear installation.

NUCLEAR MATERIALS – nuclear fuel, except natural uranium and depleted uranium which can generate energy by self-sustaining chain nuclear fissile beyond the reactor independently or in a combination with any other material, and radioactive products and waste except a small quantity of radioactive products, radioactive waste and nuclear fuel that are established by norms, rules and standards of nuclear and radiation safety provided that this quantity does not exceed maximum limit established by Board of Governors of the International Agency of Atomic Energy.

Introduction

The main Law of Ukrainian nuclear legislation ***Law on the Use of Nuclear Energy and Radiation Safety*** establishes the priority of safety for the public and environment whilst performing all types of activity in the area of nuclear energy utilisation. This Report presents information about the situation in 1998 regarding nuclear and radiation safety ensuring whilst performing all types of activity related to nuclear facilities, facilities designed for radioactive waste management and the use of sources of ionising radiation.

The nuclear energy is the pivotal part of energy complex of Ukraine. Electricity production at the Ukrainian NPPs in 1998 was more than 43% out of the total scope of energy production. Currently, in Ukraine there are 14 power units in operation at 5 NPPs. Construction of four units at Rivne and Khmelnytskyi NPP is underway. In accordance with the Decree of the Cabinet of Ministers of Ukraine decommissioning works at power units #1 and #2 of Chernobyl NPP are underway. List of main characteristics of NPP power units *is given in Appendix A.* In the Report the special attention is given to power unit #4 of Chernobyl NPP that was destroyed during Beyond Design Basis Accident in April 1986 and lost all functional properties of power unit. “Shelter” facility was constructed to reduce the accident consequences. Currently the works are being carried out to maintain the reached level of nuclear and radiation safety and to transfer “Shelter” facility to environmentally safe system.

In addition to facilities of nuclear energy in Ukraine there are other facilities requiring a sharp attention in terms of nuclear and radiation safety. The enterprise on uranium ore mining and milling is located in the area of Zhovti Vody City. This enterprise is considered as one of the biggest in Europe. Research reactors, located in Kiev and Sevastopol, are used for scientific researches on material science during studying mechanical properties of materials being under exposure. Sources of ionising radiation are widely used in all branches of industry, medicine and scientific activities.

Special attention should be paid to the consideration of the problem of radioactive waste and spent fuel management. The major amount of RAW accumulated for the present time in Ukraine have resulted from the accident at power unit #4 of Chernobyl NPP. RAW generated by NPP operation are in the stage of interim storage at the site. Ukraine does not have national or regional storage facilities designed for spent nuclear fuel – except one local storage facility at Chernobyl site. Spent nuclear fuel of the Ukrainian NPPs with WWER type reactor is shipped to Russia for reprocessing and disposal. Activities on establishment of spent nuclear fuel storage facility at Zaporizhia NPP have been commenced. Currently review process of design documents to issue permit for commissioning is being completed. Program for spent fuel management of all Ukrainian NPPs being a part of comprehensive program for nuclear fuel cycle problems is under development.

1.Legislative and normative basis in the area of nuclear energy utilisation and radiation protection.

1.1.Legislation in the area of nuclear energy utilisation and radiation safety.

The Conception of State Regulation of Safety and Management of Nuclear Industry in Ukraine was approved by *Verkhovna Rada* in January of 1994. This document became the first step towards establishment of legislative basis for safety regulation during nuclear energy utilisation. During the fulfilling the Conception a number of laws were elaborated and approved. These laws define legal base for safety ensuring and set forth social-legal relations between subjects of regulation whilst performing permissive types of activity. The fundamental law of nuclear legislation in Ukraine is ***Law on the Use of Nuclear Energy and Radiation Safety*** that was approved by the Supreme Rada in February 1995. While drafting the law the following was taken into account:

- legislative regulatory practice in the countries with large nuclear programs;
- The IAEA recommendations;
- Recommendations of skilled specialists in the international nuclear law.

The law set forth the priority of safety for the public and environment, unambiguously defined the delimitation of responsibilities between regulatory authority and operating organisation, entrusted full responsibility for safety to operating organisation (licensee), established institute of licensing activity on nuclear energy utilisation. List and brief description of laws in forth as of the beginning of 1999 is given in the Table B.1, Appendix B.

Having considering the development of nuclear legislation in Ukraine it is worth to mention that Ukraine is a Party in a number of international-legal acts aimed at safe nuclear energy utilisation (the Table b.2, Appendix B). Thus, Ukraine has confirmed the adherence to main provisions of the Convention on Nuclear Safety, ratified by Ukraine in 1997. The ratification of the Convention of Nuclear Safety had been forerun by analysis of legislative and normative acts, decisions in forth that been accepted by state executive authorities. Analysis of current safety status in nuclear-energy industry has revealed a range of problems related to the need to develop and amend the legislation. Therefore, the Cabinet of Ministers of Ukraine has been committed to develop and submit the following two laws in draft to the Supreme Rada for consideration:

1) ***On permissive activity in the area of nuclear energy utilisation*** sets forth legal basis to establish effective permissive system in the area of nuclear energy utilisation in pursuance to the international commitments of Ukraine;
2) ***On state regulatory authorities of nuclear and radiation safety*** is aimed to specify Article 23 of the *Law on the Use of Nuclear Energy and Radiation Safety* and delimit the competence of state regulatory authorities, define legal basis for ensuring their activities whilst regulatory decision making, and also set forth principles and sources of financing.

Law in draft *On permissive activity in the area of nuclear energy utilisation* was considered and approved on first reading by the Supreme Rada of Ukraine.

Previously approved Law of Ukraine "On ratification of Safeguards Agreement between Ukraine and the IAEA" served as a basis for additional review of the law in draft ***On physical protection of nuclear facilities, nuclear materials, radioactive waste, other sources of ionising radiation***".

The gained experience in the utilisation of laws in forth shall be subject to thorough and comprehensive analysis. On the basis of this analysis the main trends and directions intended to improve legislative regulatory basis of nuclear and radiation safety will be defined.

1.2. Significant Governmental decisions related to nuclear and radiation safety matters.

During 1998 a number of important decisions were taken by state authorities aimed at normative-legislative regulation of nuclear and radiation safety.

On August 19, 1998 the Cabinet of Ministers of Ukraine has considered the item "The status and the ways of improvement of nuclear and radiation safety in Ukraine" and approved respective Protocol decision. This decision envisages the development and implementation of measures aimed at:

- Strengthening the supervision over observance of norms, rules and standards, fulfilling by operating organisation and licensees of Safety upgrading programs and special license conditions;
- Fulfilment of Ukrainian legislative requirements regarding the licensing of physical and legal entities utilising the sources of ionising radiation;
- Arrangement of works at Shelter facility according to the Statement on regulatory policy while transformation of the facility into environmentally safety system;
- Safety upgrading whilst radioactive waste management;
- Co-ordination of R&D in the area of nuclear and radiation safety;
- Provide social protection for inhabitants living in the vicinity of nuclear installations, and
- Optimise financial funds for research, research-design and expert activities in order to bring normative & technical documentation in line with the legislation in forth.

On October 29, 1998 session of National Board on safe public live being took place. The issue "The status of safety during utilisation of the sources of ionising radiation in the econmy of Ukraine" was discussed during the session.

Core reasons representing both potential safety hazards during sources of ionising radiation use and risk of radiation accident have been mentioned. The National Board made decision on the measures the implementation of which could resolve the existing problems. Some of the mentioned measures are:

- Ensure financial funds for "Program to establish state register of sources of ionising radiation" approved by the Decree #847 of the Cabinet of Ministers of Ukraine of August 4, 1997;
- Submit for consideration the draft of "Program for the prevention of the illicit trafficking of sources of ionising radiation within the territory of Ukraine", developed in pursuance to the Decree #207 of the Cabinet of Ministers, of March 4, 1997.

On December 24, 1998 session of the Supreme Rada approved Decree "On Measures to ensure functioning of fuel-energy complex under the crisis conditions". Along with other reasons causing the crucial situation in the energy sector the Decree has identified insufficient normative & regulatory basis in the part of regulating relations in fuel-energy complex, management structure, separation of authorities and responsibilities. In this respect the Supreme Rada of Ukraine approved the decision to approve urgently the laws ***On permissive activity in the area of nuclear energy utilisation*** and ***On Physical protection of nuclear materials, radioactive waste and sources of ionising radiation***.

In pursuance to the ***Law On local self-governing***, ***Law on the Use of Nuclear Energy and Radiation Safety*** and ***On Radioactive waste management***, the Decree #1122 of the Cabinet of Ministers of Ukraine of July 18 1998 approved ***Procedure for public hearing on nuclear energy utilisation and radiation safety matters***. This document sets forth a mechanism to fulfil the citizen rights to take part in discussions of legislative acts and programs in the field of nuclear energy utilisation.

In 1998 the Cabinet of Ministers of Ukraine reviewed the draft Decree of the President of Ukraine ***On strengthening of the state regulatory regime of nuclear and radiation safety*** which envisages restructuring of regulatory authorities system.

Development of the Cabinet of Ministers' Decree ***On amendments and supplements to "Provision on procedure for control over import, export and transit of goods related to nuclear activities that can be used in manufacturing of nuclear weapons"*** is underway.

Activities on agreement of IAEA document ***Supplementary provisions to Safeguards Agreement*** have been commenced.

List of normative & legal acts on nuclear and radiation safety approved by the Cabinet of Ministers of Ukraine is presented in the Table B.3, Appendix B.

1.3. Normative basis for nuclear and radiation safety regulation.

At the present time Ukraine mainly uses normative & legal and normative & technical acts developed in the time of the former Soviet Union. These documents regulate nuclear, radiation, technical safety at all stages of facility life cycle and use of radiation technologies, determine requirements both to safety important systems and equipment and operational arrangements and operational procedures, and determine safety criteria and factors. A reiterated comparison analyses of the mentioned normative basis with the IAEA standards, and analogues documents of countries with nuclear programs (see [1]), have demonstrated that main safety principles meet internationally recognised approaches. Above all this corresponds to industrial safety principles of nuclear facilities being based on defence-in-depth conception. However, the development of nuclear legislation and analysis of modern conceptions of international nuclear legislation has given rise of the need to develop national system of normative & legal and normative & technical acts of nuclear facilities safety. As the result of the revealed drawbacks MEPNS of Ukraine has developed a conception to develop such a system. The following approaches have created the basis for the conception:

- Bring normative & legal acts in line with the legislation in forth;
- Analysis of normative & legal documents in forth in order to assess their completeness and compliance to internationally recognised approaches;
- Systematisation of valid and planned to be put in forth normative & legal acts in terms of topic-hierarchy principle;
- Primary priority development and putting in forth of normative & legal acts required due to lack (or insufficiency) of existing normative requirements;
- Systematic and step-by-step review of normative & technical acts being currently in forth taking into account internationally recognised approaches, results of scientific studies, feed back experience and safety assessment of NPPs under operation.

Mentioned strategy intended to establish national normative basis was approved by Ukrainian MEPNS in October 1997, and currently is in the process of implementation. List of normative & technical acts of nuclear and radiation safety that were put in force in 1998 are presented in the Table B.4, Appendix B.

Moreover, during 1998 the IAEA document ***Safety rules for radioactive material transportation*** has been prepared to putting in force as national normative document instead the rules inherited from the former Soviet Union. Implementation of ***IAEA Rules*** which determine international norms and rules for radioactive material transportation will foster ensuring accepted safety level, unification of the accountancy, registration and procedures, in particular during crossing the state borders. ***IAEA Rules*** were translated into Ukrainian Language. IAEA permitted to use and apply them. Relevant comments how to apply ***IAEA rules*** are being drafted.

Interagency Working Group, established together with NAEK “Energoatom”, have completed final revision of the document “General provisions for NPP safety” (OPBU-99). This document will regulate safety issues related to NPPs, specify criteria, requirements and conditions for nuclear and radiation safety ensuring, and main principles and nature of technical and organisation measures intended to reach safety goals.

2. Nuclear energy

2.1. Nuclear energy status.

Nuclear energy sector during last years is the significant part of the energy complex in Ukraine. In 1998 the Ukrainian NPPs produced 75.239 millions kWt/hour of electricity [5]. A share of nuclear produced electricity was 43,5% out of the total electricity production in Ukraine. Electricity production in Ukraine for the period of 1992-98 and electricity production structure in 1998 are given in Figures B.1 and B.2, Appendix B.

During 1998 Ukraine operated 14 units with two types of reactors located at five NPPs (See Appendix A). 4 units with WWER reactors are in different stages of construction.

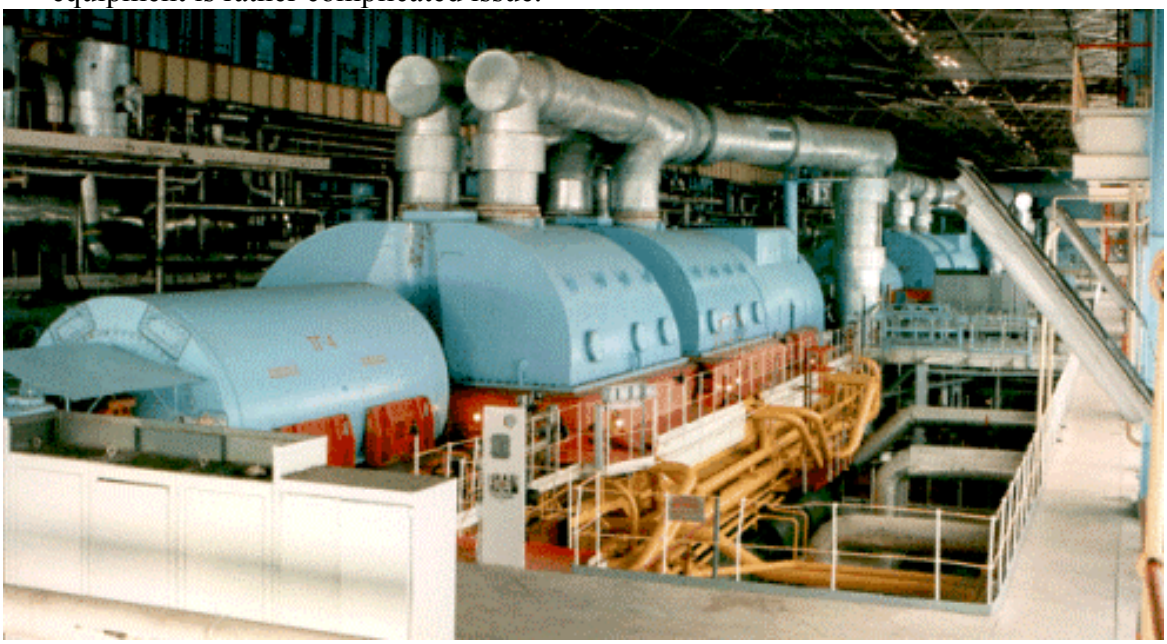
NPP location at the territory of Ukraine

Operation of units is carried out on the basis of temporary permit conditions that are annually granted operating organisation by the Ukrainian MEPNS. The basis for obtaining the temporary permit is “Technical substantiation of safety for NPP units construction and operation”. Issuance of permanent licenses will be made once operating organisation will submit Safety Analysis Reports for each unit.

Feedback experience analysis of NPPs in 1998 gave the basis for revealing either common technical issues for all NPPs and specific for each type of reactor facility. NPP common problem is related to the fact that equipment have expired the design basis service life. This situation can be explained by the following factors:

- Operation term for safety important system equipment on the Ukrainian NPP units is more than ten years;

- Within the framework ***Safety Upgrading Program*** the primary importance attention is given to reconstruction and replacement of safety system equipment;
- Significant number of safety important system elements (valves, pumps) were manufactured in Russia and due to financial restrictions the procurement of new equipment is rather complicated issue.



Turbine Hall of WWER-440 reactor unit

For WWER reactor units the main technical problems are:

- Exceeded time drop of Reactor Control and Protection System control rods;
- Loss of integrity in heat exchange surface for the steam generator;
- *Lack of technical means for adjustment and testing of pressuriser pilot operated relief valve.*

For RBMK reactor units the main technical problems are:

- Weld cracking of the multiple forced circulation pipeline contour;
- Exceeding of permissive values in internal diameter of technological channels;

With the purpose to reveal technical problems the below given special conditions were included into temporary permits to operate units with WWER reactor type:

- Regular (once per three months) testing to check relevant control rod time drop of reactor Control and Protection System in terms of the design basis value (not more than 4 seconds);
- Establishment of substantiated criteria for steam generator (SG) heat exchange tubes plugging subject to the degree of wall thinness and requirements to tube integrity control system and SG headers switches;
- Development and assembly “hot” loop for adjusting and testing the pressuriser pilot operated relief valve;
- Implementation of complex measures that are intended to ensure equipment operation, that run out its service life.

The special permit conditions to operate Chernobyl unit #3 are:

- Conduct ultrasonic and radiography weld control of primary piping and piping of safety relevant systems during unit outage;
- assess scope of channels to be replaced basing on the criteria of gas gap exhaust;

In order to fulfil the special permit conditions in 1998 the operating organisation undertaken a number of measures for WWER units where the following directions of activity were covered:

1) *Ensure design basis RPCS (Reactor Protection and Control System) rod time drop.*
   - Reduce spring units pressure of fuel assemblies heads by means of enlarging support plates thickness of protection tubes;
   - Perforation and increase the weight of drive bars of RCPS control rods;
2) *Ensure Steam Generator (SG) reliable operation;*
   - SG chemical treatment;
   - SG tubes status diagnostic (eddy current control of heat exchange surface);
   - Water-Chemistry regime optimisation (test operation of morpholine regime of South Ukrainian NPP unit #1).

The implementation of measures has resulted in improvement of reliable operation of the mentioned equipment and positive outcome for general level of operational safety.

In December 1998 Chernobyl NPP unit #3 was shutdown for planned outage to control weld status of the primary piping, piping of safety relevant systems and technological channels status. Non-destructive method control has performed a good basis for revealing and elimination of defects in 8 welds of the reactor distributing group header.

On the basis of results of in core technological channels control, that were obtained during operational process, and reactor material property study for technological channels Chernobyl NPP has developed step-by-step replacement program (200-300 replacements per year). Works to replace technological channels owing to the current status are planned to commence in 1999.

Due to financial cuts the implementing process of measures for equipment modernisation, technical status assessment and safety upgrading measures is carried out not in the full scope. For examples, during the last two years only 30% out of the planned sums have been allocated for the modernisation purposes.

2.2. Safety Assessment of the Ukrainian NPPs.

In accordance with the legislation of Ukraine the Operating organisation *"bears all responsibility for radiation protection and nuclear safety of nuclear facility"*. *The MEPNS* discharges *"State safety regulation during the use of nuclear energy"* on the basis of permissive principle. The mandatory condition to receive permit to operate nuclear facility is safety case (nuclear and radiation safety substantiation documents). During the year the activities aimed at justification of nuclear and radiation safety have been carried out for the following directions of activity:

- Development of Safety Analysis Reports for units in operation and under construction;
- Special research studies performance;
- NPP operational safety analysis.

Main Control Room of RBMK reactor unit

Development of Safety Analysis Reports for units in operation and under construction;

Acting in pursuance to provisions of ***Nuclear Safety Convention*** Ukraine committed itself to complete Safety Analysis Reports till the end of year 2000. In order to fulfil these commitments the activities on safety analysis for Rivne NPP unit #1 (WWER-440/V213), South Ukraine NPP unit #1 ("small series" unit WWER-1000/V-302), Zaporizhia NPP unit#5 (typical facility WWER-1000/B-320) have been performed. Safety Analysis is performed on the basis of Deterministic and Probabilistic approaches. Obtained outcomes are planned to be adapted for other WWER reactor units. Requirements to the structure and content of Safety Analysis are defined in normative documents (regulations).

For RBMK reactors the activities to complete Safety Analysis Report of Chernobyl NPP unit #3 were performed in 1998.

Requirements to the content of Safety Analysis Report for WWER units being in stages of permit issuance for commissioning were developed for units, which are under final stages of construction. Currently the development of these reports for Khmelnytskyi #2 and Rivne #4 is being completed.

For Khmelnytskyi units #3 and #4 being in the initial stage of construction the main document for obtaining the license for construction is Preliminary Safety Analysis Report. In order to receive license for commercial operation the Operating organisation shall submit Final Safety Analysis Report.

Special Research implementation.

Carrying out of special research studies in the area of nuclear energy utilisation is one of the integrated parts of general nuclear and radiation safety status assessment in Ukraine. The expert & analytical and software & hardware base was established at SSTC NRS to carry out research works. The capabilities of SSTC NRS are being continuously improved. The main directions of activity are:

- A comprehensive safety assessment;
- Safety deficits detection;

The following tasks are to be resolved during works implementation process:

- Analysis of the decision making adequacy to the requirements of normative documentation in force;
- Analytical safety substantiation sufficiency assessment during decision implementation process;
- Analysis of the impact of deviations from the requirements of safety rules and norms in forth.

The SSTC NRS performs a comprehensive safety assessment of design and operational documents to be submitted by the Operating organisation to NRA for review. Results of the comprehensive assessment give an opportunity to detect safety deficits and are grounds for regulatory authority decision-making concerning issuance of the permit for operation.

NPP operational safety analysis.

NPP operational safety analysis of units in operation is performed by means of operational feedback analysis, modernisation measures efficiency, equipment and process systems reconstruction. Results of this analysis are presented annually in ***Annual Reports on current status of NPP units operational safety study*** and submitted to the Regulatory authority. ***Annual Reports…*** are developed on the basis of requirements of normative documentation and cover the whole spectrum of factors being characterising the operational safety, in particular:

- List of deviations from normal operation regimes and equipment failures, root cause analysis, measures to eliminate such deviations and failures in the future;
- Information about performance of planned and unplanned equipment repairs;
- Protection barriers status analysis;
- Assessment of safety impact factors on unit operation;
- Information about performance of planned safety upgrading measures;
- Data on radiation impact on the personnel and the environment;
- Information about accumulation and reprocessing of radioactive waste;
- Data on physical and fire protection status;
- Information about training and advanced training of personnel.

The information given in ***"Annual Reports…"*** serves for operational feedback experience i.e. performs a good framework for revealing actual safety problems requiring further on studies.

Inspection results of NPP activity, carried out regularly by inspectors of *the Main State Inspectorate of Nuclear Safety*, play the key role in operational safety assessment. The main goal of these inspections is control over observance of radiation safety norms and rules requirements. Inspection results are followed by acts (prescriptions) which in case of breach of requirements of nuclear and radiation safety norms and rules shall prescribe undertaking relevant elimination measures.

One of main directions of NPP operational safety analysis is analysis of violation that can occur during operation of equipment and systems. Records keeping of violations in NPP operation to be reported to the Regulatory authority is carried out on the basis of requirements of ***Requirements to procedure for investigation and Records keeping of violations in NPP operation.*** It should be mentioned that the general number of violations being the subject to investigation in pursuance to the mentioned provision, for the period of 1997-98 is kept practically on the same level, while from 1992 till1998 a trend was observed to scale it down (see Figure B.3, Appendix B).

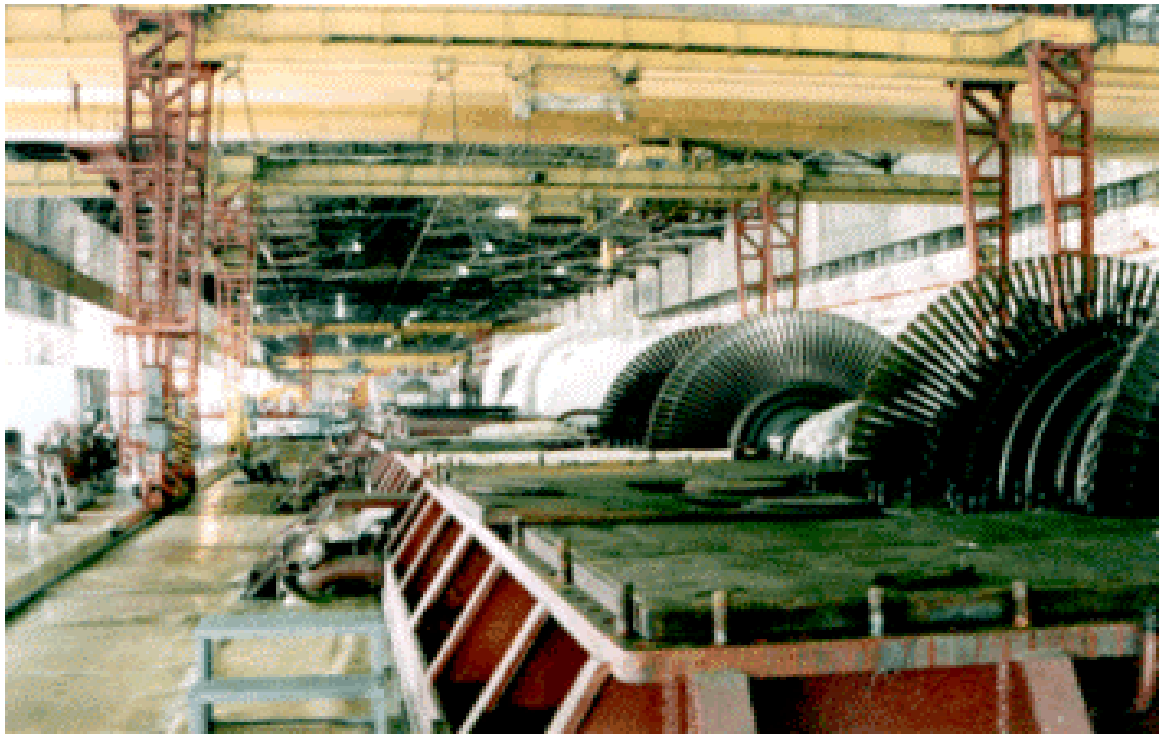
The accumulated experience of violation cause analysis has given the opportunity to define main factors leading to their occurrence [12]. These factors are:

- Design drawbacks;

- Poor repairs and maintenance of the equipment;
- Equipment physical ageing;
- Mechanical damage of equipment elements;
- Personnel errors.

The contribution of violations related to design drawbacks within the recent years has scaled down and in average is 11-18% out of the total number of violations per year (see Figure B.4). This can be explained by the fact that within the framework of development process of SAR, and on the basis of nuclear and radiation safety norms and rules being in forth the reassessment of design decisions is underway in terms of their impact on safety impact of entire power unit. A need to make the reassessment is called up by the reason that all power units of the Ukrainian NPPs and the equipment either was designed and developed in line with norms and rules that were valid during the time of the former Soviet Union that did not take into account modern requirements to safety assessment.

A number of violations caused by poor repair and maintenance in 1994-98 was almost on the same level. A partial contribution of such kind of violations is in diapason of 15-20% out of the total quantity of violations related to human factor impact. The situation is stipulated by ineffective Quality Assurance Program. Aimed at fulfilling provisions of Article 13 of ***the Nuclear Safety Convention*** in 1998 the Operating organisation has commenced activities to review and upgrade the Industrial QAP. The system covers both some NPPs and the entire branch of industry. Activities related to optimisation of the Quality Assurance System are under continuous control of state regulatory authorities of nuclear and radiation safety.

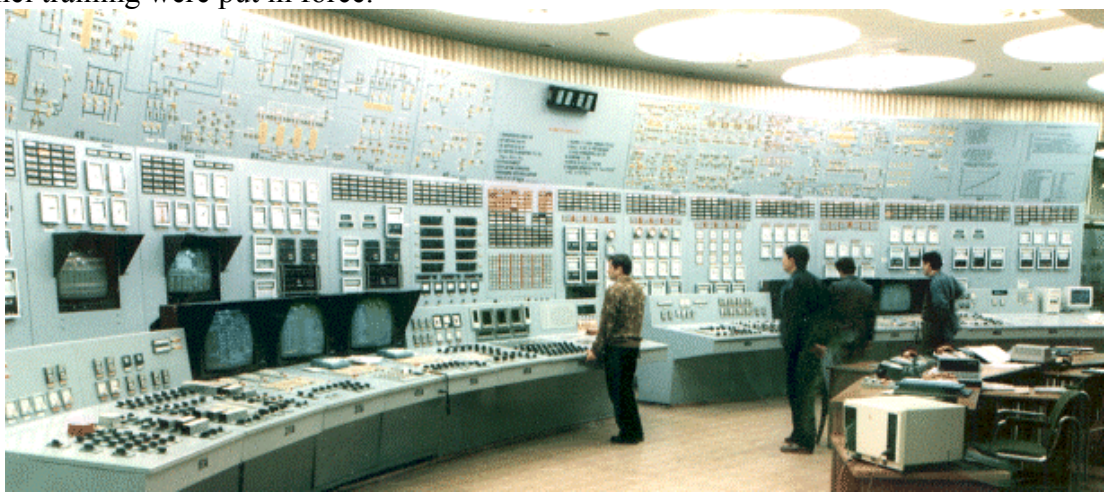


Turbine Hall of NPP unit

For the recent time period a number of violations caused by equipment ageing problem is kept on the same level and is 10-15% out of the total number of violations per year. In order to reveal such violations each NPP has developed equipment modernisation measures that are the part of ***Safety Upgrading Program,*** however due to economical instability the planned measures are carried out only partially.

A range of violations caused by mechanical damage of equipment elements in 1994-1998 was scaling down and in the percentage ratio is 17-25% out if the total number of violations per year (see Figure B.5). This fact gives the evidence of efficiency of the Operation organisation in implementing measures ***Safety Upgrading Program***. *The Main State Inspectorate of Nuclear Safety* exercises control over these activities.

Personnel errors are 34% out of entire violations per year (see Figure B.6, Appendix B). For the reduction of the number of violations induced by the human factor during 1998 the ***Branch program for establishment and upgrading of staff training system for the nuclear energy of Ukraine*** has been carried out in the framework of ***Conception of NPP personnel training.*** In 1998 new normative documents establishing procedure and requirements to NPP personnel training were put in force.



Main Control Room of WWER unit

Having summarising the information on the Ukrainian NPPs operation for 1998 the following conclusions can be drawn up:

1. The status of nuclear and radiation safety are on acceptable level. Ukraine meets commitments stipulated by the ratification of the ***Convention of Nuclear Safety.*** The obvious confirmation of this fact is that ***the National Report of Ukraine*** was approved by the Cabinet of Ministers of Ukraine and was submitted furnished to the IAEA in April 1999.
2. A number of technical and organisational measures were undertaken to maintain the reached safety level.
3. Performance of works on periodical safety assessment of units in operation according to the schedule, development of ***Safety Analysis Report***, the QAS upgrading, full-scope simulators for NPP purpose perform a good framework for further on NPP safety enhancement.
4. A number of violations took place at Ukrainian NPPs in 1998 and their nature rise up the need to strengthen requirements to development of procedures for maintenance works on safety important systems, and the Quality Assurance procedures.
5. Problems of equipment replacement and hardware completeness are still pending. A lack of spare parts leads to either repair of failed equipment, or composition of some serviceable parts taken from failed equipment, or direct effect on failed element (welding, weld overlay etc.). Missing parts of equipment are made rarely under NPP conditions. The presented situation is a favourable for repetition of violations on the same kind of equipment.

2.3. Radiation protection of the personnel and environment.

2.3.1. Personnel Radiation Protection.

Monitoring and control of radiation impact on the personnel.

Status of NPP personnel radiation protection is characterised by the personnel exposure level. The Ukrainian NPPs use principle of established reference dose exposure levels that are really less then those envisaged in norms for permissive values. Reference and permissive values of individual exposure dose for NPP personnel include the following:

- Individual dose control of external personnel exposure;
- Individual dose control of intake and keeping radio-nuclides inside the human body or in critical body organ;
- Monitoring of external contamination of skin, individual protection means and their decontamination efficiency;
- Estimation of absorbed dose on crystalline lens;
- Estimation of collective personnel exposure dose;

Each case of exceeding reference level is subject to detailed investigation and relevant information is forwarded promptly to state regulatory authorities. In 1998 a case of reference level and annual individual dose limit excess was recorded in laboratory of metals at Zaporizhia NPP. The violation was thoroughly investigated and the results were reported in "Violation Report" in pursuance to ***Requirements to the content of Technical Status Report of Chernobyl NPP units (KND 306.711-95)***. Violation cause analysis was followed by corrective measures intended to prevent repetition of the violation in the future.

With the purpose to reduce radiation impact on the personnel the Ukrainian NPPs have developed and currently are in the process of implementation of planned measures covering the following:

- Technological processes optimisation;
- Operational procedures upgrading (primarily related to equipment maintenance and repair programs);
- Improvement of reliability and efficiency of filtering and cleaning systems;
- Modernisation of radioactive waste management technologies;
- Foster promotion of the safety culture.

Personnel individual exposure dose rate

The main operations causing exposure doses at NPPs in 1998 were:

- repair of SG, valves, pumps;
- transport-process activities with in-vessel internals;
- visits to containment to fix equipment failures;
- inspection, repair and testing of the primary piping.

The most critical individual exposure doses are being received by the following groups of the personnel: Reactor Hall operators, Repair Halls craftsmen, specialist for laboratory metal testing, dosimetry specialist on duty, Repair & Construction Hall workers, specialist on decontamination, craftsmen and welders of Centralise Repair Hall.

Dynamic of changes in average individual exposure dose values of NPP personnel bears logarithmically normal nature with maximum shifted toward small values 0,1-0,3 cZv/year. Individual exposure dose rate for a majority of personnel (90-97%) at NPPs is in the diapason 0,1-0,5 cZv/year. Percentage ratio of individuals with annual effective dose limit greater then 1,5 cZv/year to the total quantity of the personal is: Khmelnytskyi NPP – 0,05 %, Zaporizhia NPP – 0,3%, South Ukrainian NPP – 0,7%, Rivne NPP – 0,97%, Chernobyl NPP – 4,9%. It is worth mentioning that average annual individual exposure dose values of personnel of the Ukrainian NPPs with WWER reactor meet value indices of analogue types of foreign NPPs. According to data of international organisations on nuclear energy these indices in average for European NPPs are 0,2-0,3 cZv/year.

Collective personnel exposure dose.

For the recent years the collective exposure dose values of the Ukrainian NPP personnel are kept in stable level (see Figure G.2, Appendix D). One of key factor used in the world-wide practice to characterise radiation protection status of NPP personnel is ratio of collective personnel exposure dose value to the quantity of power units being operated at the site (see the Table G.2, Appendix G). The data presented in the Table demonstrates that Zaporizhia and Rivne NPPs are compatible to foreign NPPs.

Another factor that gives characterisation to personnel radiation protection level is ratio of annual collective exposure dose of NPP personnel to the quantity of produced energy at NPP during reported year (the Table G.3, Appendix G). This factor for Ukrainian NPPs is considerably higher than relevant foreign figures. This fact highlights the need to implement measures aimed at improvement of personnel radiation protection efficiency. Primarily this relates to reducing the dose impact whilst outages, that are up to 85% of collective exposure dose of the personnel.

Radionuclide content.

In 1998 at the Ukrainian NPPs no records on exceeded permissive limit of radionuclide body burden of NPP origin were identified. According to assessments available the annual inhalation intake of alpha isotopes for NPP employees did not exceed, in average, 1% out of annual intake rate, and the in-taken dose was rather low comparing to external exposure dose.

Body burden monitoring of NPP employees has shown that the principal contributors to external exposure dose rate are Cs-137 and Co-60. Radionuclide body intake of employees was through ingestion intake. Dynamics of this intake depends on microclimate of working place, nature and scope of performed works. The body burden data analysis of NPP employees has shown that the greater content of incorporated radionuclides and multifarious radionuclide content were received by specialists of Centralised Repair and Reactor Halls, that were directly involved in repairs and refuelling activities.

Thus, basing on radiation protection status analysis of NPP personnel one can make the following conclusions:

- Radiation protection of the Ukrainian NPP personnel, according to external exposure factors, is satisfactory, however the respective figures are worse as compared with the world-wide factors.
- Annual inhaled alpha intake, in average, for employees at all NPPs does not exceed 1% of the annual intake rate, and the in-taken dose is negligible comparing to external exposure dose.
- Due to a lack of sufficient instruments a number of indices of radiation safety status can not be assessed accurately. This primarily relates to exposure of repair personnel during routine repair of unit being in operation.

2.3.2. NPP environmental impact.

Special dose limits are established for inhabitants living in the vicinity of nuclear facility. These limits are the basis for defining permissive releases and effluents for each NPP.

In 1998 new national radiation safety norms (NRBU-97) were put in forth in Ukraine. These norms set forth the new values for key dose limits (including those for public), new categories for population with exposure dose limits accountancy, and give main emergency countermeasures depending on radiation impact scale, introduce new terminology of radiation protection, such as anticipated dose, radiation risk. It is planned to carry out step-by-step transfer towards new national radiation safety norms at NPP under operation. Terms and strategy of the transfer will be defined after full-scope analysis of ways towards optimisation of radiation protection. All nuclear energy facilities shall meet requirements of national radiation protection norms.

Tashlytske reservoir. South Ukrainian NPP

Specialized directorates and sanitary – epidemiological institutions of the *Ministry of Health of Ukraine, as well as the Main Environmental Inspectorate of the Ministry of Environmental Protection of Ukraine* are implementing the state supervision over the radiation safety state on Ukrainian NPPs on the continous basis. The special attention is paid to the application of the *Radiation Conditions Automatic Supervision System* on the territories around NPPs. The supervision area covers the 30-km territory around the nuclear installation site. An independent system "Gamma" is installed on Zaporizhia and Rivne NPPs. It provides monitoring of the radiological conditions on the adjacent territory each 10 minutes. The system sensors' indications are transferred to the *Emergency Center of the Ministry for Environmental Protection and Nuclear Safety of Ukraine* through the telecommunication channels.

Presently, implementation of this system is planned on all NPPs. It shall present the part of the national radiation control system to be established on the territory of Ukraine. An international project related to implementation of the computer system "Rodos" is on the implementation phase; this system allows to forecast changes of radiation conditions in the real-time mode.

2.4 Radioactive wastes treatment on NPPs

Radioactive wastes generated by NPPs are presented as the liquid and solid radioactive waste. Liquid wastes consist mainly of the drainage water, the primary circuit non-controlled leakages, of the regeneration water from the special water purification system. Solid wastes arise while the technical servicing and maintenance of power units and during decontamination. The average annual increase of the radioactive wastes on Ukrainian NPPs is 4 – 6% of the design volume of the radioactive waste' storage's for solid wastes and 11 – 13% for liquid wastes. The data about the dynamics of radioactive waste generation and filling up the storage's on Ukrainian NPPs in the period from 1994 till 1998 *are presented in the Attachment E.*

The filling of the radioactive waste storage's on some Ukrainian NPPs is close to the critical level. If the storage filling rate during the next years will remain, the problem related to operation of these NPPs could arise. The state inventory of radioactive wastes planned for 1999 will complement and specify the data related to the radioactive waste accumulation and storages filling up, and also will allow to implement the more complete analysis of the conditions of the radioactive waste treatment on Ukrainian NPPs.

Generalising the conditions of the radioactive waste treatment on Ukrainian NPPs in 1998, the following conclusion could be made: presently, the radioactive waste treatment practice in Ukraine in general does not comply with the level reached in the developed countries, which is shown in the IAEA publications. This is due to the following reasons:

- There are no economic incentives to decrease the volume of earlier accumulated radioactive waste, as well as to treat these wastes to decrease the volume.
- There are practically no modern technologies and installations for the radioactive waste treatment available; this causes accumulation of unjustified large volumes of wastes.
- Activity of liquid radioactive waste on Ukrainian NPPs is mainly (over 90%) defined by radioisotopes Cs137 and partially by radioisotopes Cs134, Co60, Mn54. Not on all NPPs have the capability to measure solid radioactive waste' isotope content.
- Organisation measures and administrative supervision over their implementation during the preliminary sorting of solid radioactive waste in the places where they are generated are applied not fully, therewith increasing expenses on the following stages of the treatment.
- The practices of solid radioactive waste storage without casks in bulk can be observed on all plants; this does not comply with the modern requirements of radioactive waste management and presents the potential hazard to the environment contamination. Solid wastes are stored practically without conditioning.

To enhance the safety culture and to minimise the generated volume of radioactive waste, *Nuclear Regulatory Administration of the Ministry of Environmental Protection and Nuclear Safety of Ukraine* has expanded the temporary permits for operation of NPPs power units with the requirements to utilities to develop and agree upon with the NRA the radioactive waste treatment programs. An integral part of the permits are the programs for the radwaste volume minimisation. Such programs were developed in 1998 and agreed upon with the *NRA of the MEPNS* based on the positive conclusions of the nuclear and radiation safety state expert evaluation. However as the analysis shows, measures related to minimisation of radioactive waste were not very effective in 1998.

As to the implementation of radioactive waste management programs related to the volumes' decrease, the following is panned to be developed and commissioned at Zaporizhia NPP:

- The process lines for the liquid radioactive waste reprocessing into the conditioned ceramic alloy (vitrification);
- Technologies for transforming the liquid radioactive waste into the non-contaminated product by the preliminary passing it through the selective sorbent, as well as solidification of ion-exchange materials and slimes;
- Technologies and equipment for the wastes retrieval from the earlier filled tanks.

Moreover, modernisation of the present installation for the radioactive waste combustion with the purpose to improve their process characteristics is planned. Creation of complexes for the treatment and conditioning of radioactive waste is planned on other NPPs. These are:

- Commissioning of the liquid radioactive waste treatment complex is planned at South Ukraine NPP; it will allow to perform decontamination of radioactive waste using selective sorbents, their concentration till the salt melt and solidification of ion-selective sorbents. To solve the problem associated with the solid radioactive waste reprocessing, creation of the solid radioactive waste reprocessing complex based on the NUKEM (Germany) equipment is planned; this one will consist of installations for sorting, compressing and combustion of solid wastes.
- Construction of the liquid and solid radioactive wastes treatment plants is planned on Chornobyl NPP in accordance with the agreement between the G-7 countries, the European Bank for Reconstruction and Development, the Government of Ukraine and the Chornobyl NPP.
- The complex for the radioactive waste reprocessing is planned to be constructed on Khmelnytskyi NPP; it will include solidification of liquid wastes and reprocessing of solid wastes to decrease their volume.
- Purchase and commissioning of installations for sorting, pre-compressing, fragmentation and drying of solid radioactive waste, as well as erection of the deep evaporation installation for the treatment of liquid radioactive waste is planned on Rivne NPP.

Activities related to implementation of measures, which are foreseen by the adopted radioactive waste management programs were started on all NPPs. Implementation of planned measures will allow to decrease the volume of annually incoming wastes 5-10% for the liquid wastes and 3-7% for the solid wastes.

2.5 Management of the spent nuclear fuel

Presently, an open nuclear fuel cycle is applied in Ukraine. Fresh nuclear fuel is supplied from Russia. The spent nuclear fuel from NPPs with VVER reactors is preliminary stored in the reactor spent fuel pools and sent then for the intermediate storage and the following treatment to Russia. During the past years, complications related to the spent fuel removal are arising. In particular the cost for the fuel removal is constantly increasing. Due to this fact, problems related to accumulation of spent fuel assemblies and overload of the reactor spent fuel pools are arising on Ukrainian NPPs with the VVER-type reactors. The data about availability of the spent nuclear fuel in the NPPs fuel ponds and about its transportation to Russia are presented in the Attachment F. To solve the impending problems of the nuclear fuel cycle, the *Comprehensive Program for the Development of the Nuclear Fuel Cycle in Ukraine* is developed by *the Ministry of Energy of Ukraine.* Corresponding measures are started by the utility to assure implementation of the safe spent fuel management process on NPPs: compression of spent fuel storage racks in the reactor spent fuel pools and construction of independent spent fuel storage facilities on NPPs sites.

Activities related to the establishing of the dry-type spent fuel storage facility (SFSF) are implemented on Zaporizhia NPP since 1993. Having analysed the long-term options for the management of the spent nuclear fuel, the storage facility design developed in USA with so-called ventilated concrete casks was selected as a prototype. The positive distinctive feature of this project is its extremely low price achieved through the design solutions. Consideration and finalisation of safety substantiation report for the storage facility was implemented during the 1998. In April, after the corresponding stages of the licensing process have been implemented, the *NRA* issued to *NNEGC "Enenrgoatom"* authorisation to manufacture the main part of safety important elements: ventilated concrete casks and multi-cell sealed baskets for the SFSF. However, by the end of 1998 the final answers were not given to some technical questions asked by the *NRA of the MEPNS* regarding parameters important for the safe storage of nuclear fuel. Based on the conclusions of the state nuclear and radiation evaluations at the end of 1998 *NRA* did not have any basis to approve the Zaporizhia NPP SFSF safety analysis report. However a considerable progress regarding the improvement of the SFSF design and development of the operation documentation was mentioned. By the end of 1998, working council with participation of all involved parties was held to discuss the reasons, which impede the approval of SFSF safety analysis report, as well as to discuss the ways how these reasons could be solved. The corresponding recommendations have been given to the applicant; it was proposed to amend the safety analysis report and to present the corresponding modifications to the NRA.

The separate subdivisions of the NAEK "Energoatom" – Rivne, Khmelnytskyi and South Ukraine NPP's are also planning construction of intermediate spent fuel storage facilities on sites. At that, different options of the dry type casks storage facilities are considered. The final decision was not taken yet, and utility proceeds with consideration of the possible options for manufacturing or purchase of casks for the spent fuel storage purposes.

The spent fuel from Chornobyl NPP is placed in the pool-type intermediate spent fuel storage facility. There are almost no vacant places left in the facility spent fuel pool. The problem related to the spent fuel storage during the Chornobyl NPP units' decommissioning is aggravating.

In accordance with the *"Chornobyl NPP Power Units' Safety Improvement Program"*, preparatory activities related to the SFSF-2 construction were started. This facility will be located in the Chornobyl NPP exclusion zone. The safe storage of over 25000 spent fuel assemblies will be foreseen by the storage facility design. Design of the SFSF-2 is the part of the Grant Agreement signed between *the Government of Ukraine, European Bank for Reconstruction and Development* and the Chornobyl NPP. The design of the facility will be chosen on the competitive basis. Chornobyl NPP (in collaboration with *the NRA*) has developed some specific documents to assure the safe state of the SFSF-2. In particular, the state nuclear and radiation expert evaluation was organized and applied for the following documents:

- *The Technical Specification for architect-engineering activities, licensing activities, manufacturing, construction and commissioning of the auxiliary spent fuel storage facility for the Chornobyl NPP RBMK-1000 (SFSF-2).*
- *Feasibility Study for siting of the spent fuel storage facility construction SFSF-2.*

Presently, activities related to the *"Licensing and certification program for the SFSF-2"* are in progress. The program is developed in accordance with the Ukrainian legislation with the purpose to define the licensing procedure for design and research activities related to the siting, design, construction, commissioning and operation of the intermediate SFSF on Chornobyl NPP. The program shall define the interaction plans between the applicant and the *NRA*, define the list and content of documents presented for certification and licensing, define the comparative analysis requirements to Western codes, rules and standards regarding their compliance with Ukrainian legislation, as well as define the requirements to the suppliers' activities while obtaining the corresponding licenses. By the end of 1998, Chornobyl NPP issued an application for the licensing of the design and research activities associated with the SFSF-2 siting. Presently, the applicant is correcting some non-conformities, which were found during the previous considerations of documents by the *NRA.*

Implementation of the *Comprehensive Ukrainian Nuclear Fuel Cycle Development Program* will allow to create the own spent fuel management infrastructure, which will eliminate the dependence of the spent fuel transportation from the costs for services for its reprocessing or from the non-foreseen political decisions. At that, expenses of the spent fuel management activities will be considerably lowered. Measures related to the safety enhancement during transportation process operations and spent fuel storage are also foreseen in the "*Comprehensive Program…*"; these are the part of a perspective economic and scientific – technical politics.

2.6 "Shelter" facility

2.6.1 General assessment of the "Shelter" conditions

Status of the "Shelter" facility

The "Shelter" facility is the Chornobyl NPP power unit #4 destroyed by the beyond-the-design-basis accident; it has lost all the functional peculiarities of a power unit; the top-priority measures aimed at the accident consequences elimination have been implemented on this facility, and activities to assure the nuclear and radiation safety are on-going.

Chornobyl NPP power unit #4 destroyed by the beyond-the-design-basis accident. April 1996.

The main feature of the "Shelter" facility is its potential hazard for the personnel, population and the environment, which is determined by the following factors:

- The long-living radioactive substances present at the "Shelter" with the total activity around 20 Mega Curie do not have the reliable physical barriers on the radioactivity spreading way into the environment and thus present IRS;
- Nuclear materials are present at the "Shelter" in the amount, which on the conservative assessment are equal to 20 tons, without means used for the active influence on the criticality, which causes the potential probability of the chain self-sustaining fission reaction;
- The structures of the Shelter, which perform the function of the main physical barrier for the radioactive substances' spreading into the environment, do not correspond with the requirements of the safety regulatory documents from the viewpoints of mechanical strength, structural integrity and constructive reliability and have the non-defined operation period;
- Supervision of the Shelter state, including the state of the radioactive substances and nuclear materials, is not assured as required according to the safety regulatory documents;
- Due to the non-complete investigation of the Shelter, the reliable quantitative assessments of different hazards have not been performed;
- Considerable amount of radioactive substances, which are not isolated from the hydro-geological environment, stayed under the layer of materials (sand, crushed stone, concrete).

Operation of the "Shelter" facility in 1998

Operation of buildings, systems and equipment, which according to the *Process regulations of the "Shelter"facility* are intended to assure the "Shelter" safety, was performed on the "Shelter" in 1998.

To decrease the radioactive dust volumes, 10 planned dust suppression actions in the central hall have been implemented during 1998. Conditions, when the neutron-absorption solutions supply system needs to be applied, have not emerged, however the planned testing of the gadolinium nitric acid solution supply system have been performed.

2.6.2 Radiation conditions inside the "Shelter" facility

Dynamics of values changes, which describe the radiation situation inside the "Shelter" *is presented in the Table G.1 of the Attachment G.* Decrease of the neutron flux density and the gamma-exposure exposition dose intensity in the monitoring points was observed during 1998, but the volume of implemented observations and the technical state of supervision systems do not assure the reliability and quality of implemented measurements.

4 cases of exceeding the alpha-nuclides concentration control levels were registered during 1998 in the air inside the "Shelter" periodically serviced premises (maximal exceeding was in 4 times), and one case of exceeding the control level of the radionuclides' contamination in several periodically serviced premises (for the removable contamination – ten times with alpha-nuclides and twelve times with beta-nuclides). The cause of the control level exceeding was the local source in one of the "Shelter" premises, which arose as a result of a drop leakage from the ceiling.

Exceeding the control levels on beta-nuclides concentration in the air, as well as exceeding the reference levels of specific activity control levels of water was not observed. Analysis of the radionuclides content of water samples taken from the "Shelter" facility premises shows that the major part of the total activity level are caesium and strontium isotopes. The maximal concentration of uranium isotopes in water inside the "Shelter" was 0,095 g/l during 1998, which is considerably lower than the hazardous concentration, because even if the two-percent uranium presence in water is 10 g/l, the neutron breeding rate is under 0,03. However, there is a danger associated with the uranium accumulation presented by the high-active deposits in the places of water accumulation in the lower level compartments of the "Shelter" facility.

2.6.3 The radiation situation on the "Shelter" site

Dynamics of values changes, which describe the radiation situation on the "Shelter" site *is presented in the Table G.2 of the Attachment G.* The total release of long-living nuclides (releases through the ventilation stack and aerosol's releases through the "Shelter" non-tightness' were taken into account) during the 1998 was considerable lower than the release levels accepted for NPP's. However, due to the non-availability of reliable information about the radioactivity releases through the "Shelter" non-tightness, the total release is still not defined. Aside from this, the radionuclides' release can considerably increase in case of dust raise inside the "Shelter". Cases of radionuclides' concentration (ten times) in the air were observed in the southern part of the "Shelter" site during 1998; those were due to the on-site activities related to the hoisting crane dismantling (in the period from March 24 till April 3, 1998) and due to the increased dusting during the high air temperature period (in the period from July 24 till August 20, 1998).

No exceeding of the alfa- and beta-nuclides concentration control levels in the air was observed.

The radionuclides' concentration in the underground waters did not exceed the control levels determined for the radionuclides' mixtures in the observation wells on the "Shelter" territory. But the insufficient number of wells does not allow having the complete and simple picture about the content and migration of radionuclides from the "Shelter" into the ground waters.

2.6.4 Radiation protection of personnel

The radiation-hazardous activities (which mostly contributed to the dose impact burden were the following:

- The renovation activities on the ventilation stack VT-2 structures;
- Inspection of civil structures;
- Maintenance activities associated with erection and operation of the fuel-containing masses' control systems;
- The water sampling inside the "Shelter".

Dynamics of the personnel average individual effective dose changes *is presented in the Table G.1 of the Attachment G*. Increase of the average dose for subcontractors' employees is due to the renovation activities on the ventilation stack structures (94% of the total collective dose for subcontractors' organisations). On the *NRA* demand, the utility has developed and implemented some measures aimed at the decrease of the personnel planned collective dose for mentioned activities. Thus, applying the protective shields/screens during the ventilation stack compartments' decontamination activities and changing the routs used for the loads' delivery to the personnel working places, the planned personnel collective dose exposure decreased from 885 to 473 men-sSv. According to the report on the personnel radiation protection, presented after the maintenance activities have been finalized, the collective dose was 443 men-sSv.

The internal exposure control was implemented for personnel participating in activities under the increased alfa- and beta-aerosols concentration control levels in the "Shelter" air. The average estimated internal exposure dose is around 0,1 mSv. The maximal individual internal exposure yearly estimated dose was 1.35 mSv.

No cases of the exceeding the annual external exposure control doses were observed on the "Shelter" during 1998; also no exceeds of the radionuclides' internal content control levels were observed.

2.6.5. Civil structures status

The following conclusions were drawn up basing on inspection of building structures status:

- Deformation process, characterised by changes in planned and high rise reference markers, is kept going at "Shelter" facility;
- Deformation of reinforced frame of deaerator shelf is characterised by changes in planned and high rise location of upper cross sections of columns.

In 1998 additional weak areas of the "Shelter" facility containment were detected. Probable containment failure under static and seismic impacts has been conducted.

From December 1997 till June 1998 works on foundation repair and reinforcement of ventilation stackVT-2 were carried out.

2.6.6. Transformation of "Shelter" facility into environmentally safety system.

Decree #1561 of the Cabinet of Ministers of Ukraine of December 28, 1996 "On measures to transformation of "Shelter" facility into environmentally safety system" has defined that "Shelter" facility transformation is, if feasible, extraction as soon as possible of fuel containing mass for their isolation and disposal.

Operating organisation being guided by the above mentioned Decree, developed two documents that define "Shelter" facility transformation strategy into environmentally safe system:

1) "Shelter" facility transformation strategy;
2) "Shelter" facility stabilisation strategy.

These documents were approved by the Governmental Commission on Chernobyl problems comprehensive resolution and set forth steps for the "Shelter" facility transformation process.

Step 1: Stabilisation:

- civil structures stabilisation;
- establishment of emergency dust suppress system;
- establishment of complex monitoring system;

Step 2: Preparatory phase for transformation of the facility into environmentally safety system:

- development of feasibility substantiation to withdraw fuel containing mass;
- performance of preparatory works to withdraw fuel containing mass;

Step 3: Transfer the facility into environmentally safe system:

- withdrawal of fuel containing mass, and ensure temporary storage under control;
- subsequent facility decommissioning.

"Shelter" facility

Operating organisation together with International Expert Group have developed a comprehensive plan of measures to transfer "Shelter" facility into environmentally safe system. The mentioned document is Shelter Implementation Plan (Plan of measures to transfer "Shelter" facility into environmentally safe system) (hereinafter is referred to as SIP) was officially approved and valid since July 1997. SIP comprises of 22 interdependent tasks to be implemented within 8-10 years.

- Tasks1-5 – "Shelter" building structures stabilisation;
- Task 6 – Structural Investigation and Monitoring;
- Task 7 – Geotechnical Investigation;
- Task 8 – Seismic Characterisation and Monitoring
- Task 9 – emergency preparedness plan;
- Task 10 –11 – dust management;
- Task 12 – Criticality Control and Nuclear Safety Monitoring;
- Task 13 – Water management contained inside "Shelter" facility
- Task 14 – Fuel Containing Material (FCM) Characterisation;
- Task 15 – Radiological Control Program;
- Task 16 – general technical safety;
- Task 17 – integrated monitoring system;
- Task 18 – integrated data base;
- Task 19 – strategy for fuel containing mass withdraw and RAW management;
- Task 20 - FCM Removal and Waste Management Strategy;
- Task 21 – FCM Removal Technology Development;
- Task 22 – Safe Confinement Strategy

In 1998 development of projects in pursuance to SIP was commenced, and implementation of these projects at "Shelter" facility is planned to start up in 2000. Works on reinforcement of B1 and B2 beams (as being the most emergent parts of "Shelter" facility

containment, the collapse of those could result in radiation accident) are envisaged to be performed in 1999.

NRA with SSTC NRS participation and the international support (the G-7 countries in the framework of SIP implementation, regulatory authorities of developed countries and their scientific and technical support organisations) carry out the following activities on safety regulation of "Shelter" facility transfer process:

- Regulatory document ***Statement on regulatory policy for nuclear and radiation safety of "Shelter" facility*** was developed and put in force;
- ***SIP*** was considered and agreed;
- Licensing process to implement ***SIP*** at "Shelter" facility was developed;
- Requirements to the structure and content of Safety Analysis Reports whilst implementation of projects of "Shelter" facility were developed;
- Development of nuclear and radiation safety assessment methodologies for SIP projects is underway;
- Project on VT-2 ventilation stack stabilisation at "Shelter" facility was considered, and permit for implementation of works was granted.

Having summarising the above reported one can make the conclusion that the problem of keeping a huge amount of long-lived radioactive substances, when reliable physical barriers on radioactive substances spreading ways to the environment are missing, and nuclear materials, when there are no active impact means on criticality in place represent a considerable hazard. A lack of information about quantity and location of fuel in premises at "Shelter" facility, content and migration of radionuclides into ground water, and uncontrolled aerosols effluents from "Shelter" facility impede neither making a full picture on interrelation between at "Shelter" facility and the environment nor assess changes in the interrelation in terms of time factor.

Moreover, currently building structures status is of a sharp concern because these structures aimed to serve as physical barrier on the way of radioactivity spreading do not meet requirements of normative documents on safety. Their collapse could cause a serious radioactive dust release from "Shelter" facility. This release will represent a grave hazard for the personnel, the public and environment. Thus, any delay in works to transformation of "Shelter" facility into environmentally safe system is out of the question, and the urgency primarily corresponds to reinforcement of B1 and B2 as being the most critical parts of "Shelter" facility containment, the collapse of those could result in radiation accident.

3. Status and problems of the exclusion zone of Chornobyl NPP

3.1. Radioecology status of the Exclusion zone

Monitoring of radioecology status of the Exclusion zone is performed by State research-production enterprise on regional environment monitoring and decimetre monitoring "Radek" that is being a part of Ministry of emergency situation and protection of the public from Chornobyl catastrophe consequences. Radiecology status analysis of the Exclusion zone territory, presented below, was conducted on the basis of monthly information notes that are submitted by "Radek" enterprise to NRA Radiation Safety Department.

Radiation status of near surface air.

Monitoring over radiation status of the near surface air is made by sampling of aerosols at close surveillance zone (radius 0…5 km) and the far zone (radius 5…30 km) around the destroyed power unit of Chernobyl NPP. There are 17 posts/centres of ASKRO (Automated system of radiation status monitoring) at the far surveillance zone, that surround Chernobyl NPP in a form of circle. Their density becomes greater towards the centre of the Exclusion zone.

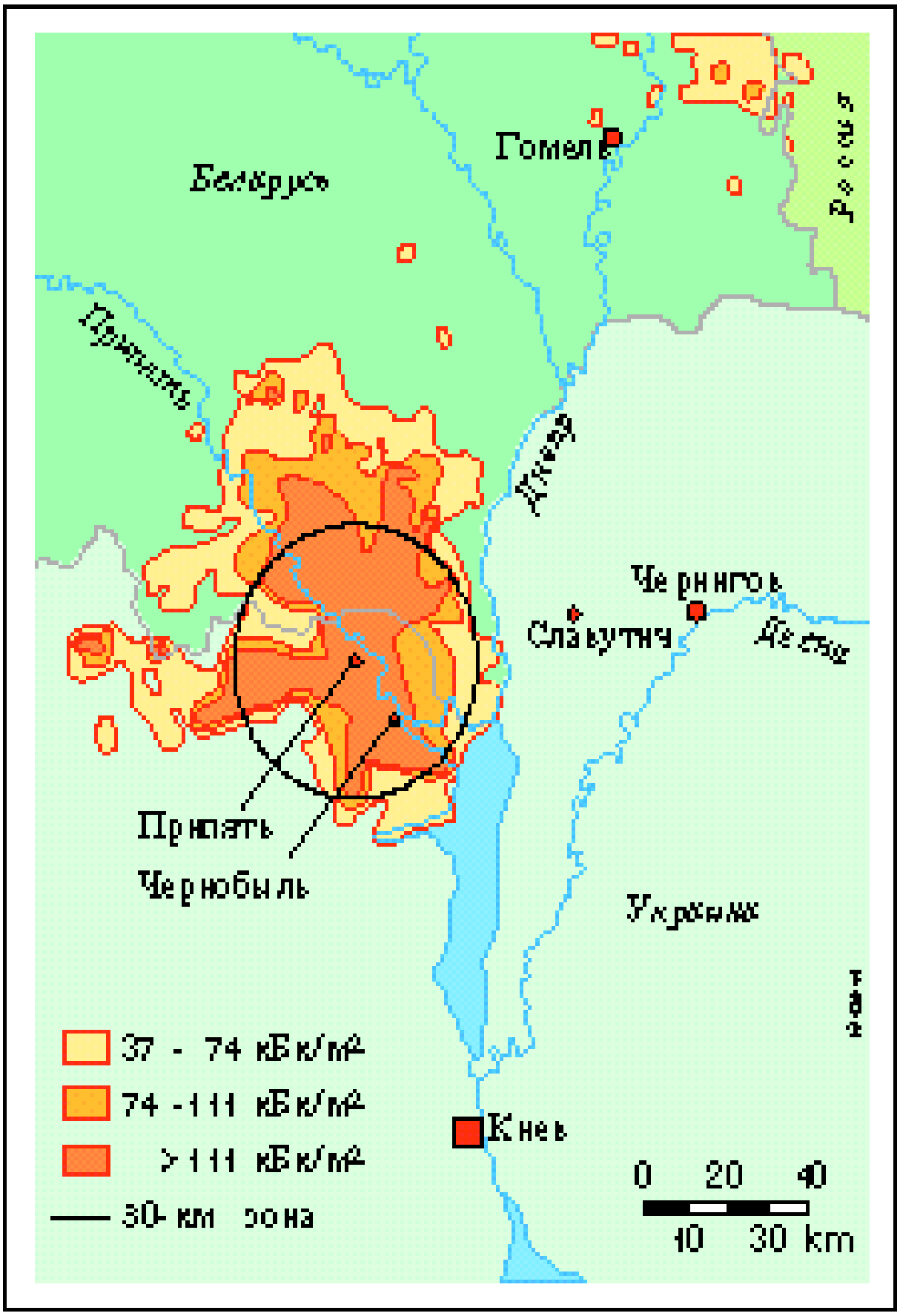
Surveillance and assessment data (the Table G.1, Appendix G) demonstrate that all monitored and estimated values do not exceed reference and established values. No excess in values of reference and estimated values vs. to previous years was recorded.

Hydrology regime and radiation status of on-surface and drain water.

Radiation monitoring of temporary radioactive waste localizing points, radioactive waste disposal points and water protection structures of the Exclusion zone is carried out in local well line being under surveillance, at Quaternary water supply complex. In general for the Exclusion zone the Quaternary and Eocene pressure and Cenomanian cretaceous water supply complexes are under surveillance along regional border of clustered wells under surveillance and located either in the centre and outside. Six experimental clusters are used for surveillance over radionuclides content in ground water samplings

Radionuclide concentration in underground water, water supply system and drain water and radionuclide spreading rate through drain-purification water systems of Chernobyl City and Zeleny Mys village (see the Table 3.2) in 1998 was significantly less than reference levels.

The analysis of dynamics of radio-nuclide spreading gives a possibility to conclude that a certain stability in specific radio-nuclide spreading rate has been reached.


Гомель
Беларусь
Россия
Припять
Днепр
Чернигов
Славутич
Десна
Припять
Чернобыль
Украина
Киев
37 - 74 кБк/м²
74 - 111 кБк/м²
> 111 кБк/м²
30-км зона
0 20 40
10 30 km

30-km zone

3.2 Radiation safety in the Exclusion zone

In pursuance to "Conception on the Chernobyl Exclusion zone at the territory of Ukraine" the territory of the Exclusion zone has been divided into zones in terms of their specific industry area taking into account types of activity in these different parts, irregular contamination, location of enterprises and elements of infrastructure, in particular:

zone 1 (10 km): cover territory located within 10 km radius around the Chernobyl NPP. Radiation hazardous woks are running in accordance to programs agreed by authorities of State sanitary supervision and regional inspection on radiation safety. When necessary basing on radiation-dosimetry monitoring results the performance of these works is subject to special dosimetry permit;

Prypiat City. Central square, Lasarev lieutenant street

zone 2 (the buffer zone) - the territory from the boundary of 10-km exclusion zone (except for zone to external boundary of sanitary monitoring zone of Chornobyl City). The activities are implemented according to monthly time schedule; regular basis radiation and dosimetric monitoring is performed as well;

zone 3 (sanitary monitoring zone) - a part of urban section of Chornobyl City where dormitories with adjacent territory, public catering centers, social, cultural and medical institutions, roads and entrances to them are located;

zone 4 (the zone of the special regime) - the territory of Zeleny Mys village where shift personnel is accommodated;

zone 5 (the separated sites of Exclusion zone) - the territory of populated areas, the inhabitants of those were evacuated in 1986, namely: a number of villages of Kyiv region, Polesky district, Zhytomir region, Narodychi district, Ovruch district.

Reference Levels of radiation safety at the Exclusion zone were developed to monitor radiation conditions at the Exclusion zone. This monitoring is aimed at controlling the parameters on the Exclusion zone: concentration of radionuclides in the air, content of strontium-90 in river Prypiat and its tributaries, radioactive contamination at public roadways, transport means and freights, personal cloth and footwear when leaving the Exclusion zone.

Acting in compliance to the above mentioned documents in force and to monitor radiation conditions at the exclusion zone for enterprises, institutions and organizations located at the territory of the Exclusion zone, in 1998 the following individual reference levels of annual exposure dose was set: 2 cZv. In compliance with the requirements of “Principle rules of radiation safety at the exclusion zone” all persons involved in activities at the Exclusion zone must be under individual dosimetric monitoring. The individual dosimetric monitoring is not obligatory for dispatched persons whose visit is of commercial and information purpose within period of not more than 5 days.

According to information for January 01, 1999 the excess of maximum permissible and reference levels was not observed. Dynamics of changes in average external exposure dose value (the Table H.3) radio-nuclides obviously indicates the sound progress in the dose decrease.

3.3 Radioactive waste management in the Exclusion zone

Radioactive waste management in the Exclusion zone was carried out by State enterprises “Complex” and “Technocenter” that became part of “Radon” state enterprise in 1998.

“Komplex” state enterprise performs licensed activity intended to collect radioactive waste at heavy contaminated areas of the Exclusion zone, radioactive waste shipment, monitoring and operation, maintenance of isolated and operating facilities designed for decontamination, and to dispose radioactive waste at “Buriakivka” facility. Beside “Buriakivka” facility the following facilities are a part of “Komplex” state enterprise: "Pidlisny” disposal facility (preserved), “Chernobyl third line” (preserved), equipment and material decontamination hall with facility for drain water purification, “Lelev” and “Rudnia Veresnia” transport sanitary treatment (preserved), and special laundry of Prypiat City.

Characteristics of radioactive waste disposal points of “Complex” state enterpriseis given in the Table H.4, information of incoming radioactive waste to “Buriakivka” facility in 1998 is presented in Figure H.1.

It is expected that in 2000-2001 design basis repository capacity will be filled in. In order to settle fully the issue of save management of radioactive waste at the Exclusion zone it is planned to construct and commission a complex for decontamination, transportation, reprocessing and disposal of radioactive waste taken from territories contaminated after the Chernobyl accident, - the “Vector” complex that is structural division of “Technocenter” state enterprise. “Technocenter” state enterprise received license for construction of the 1st line of “Vector” complex in September 1997. Currently corrected design of the 1st line of “Vector” complex and Commissioning complex being 1st step activities (radioactive waste disposal) are under consideration.

In October 1998 “Technocenter” state enterprise received license to design equipment for radioactive waste management. At the present time MEPNS of Ukraine considers the project on commissioning radioactive waste management equipment complex designed for decontamination of goods made of metal.

Analysis of the Exclusion zone status makes possible to draw the following conclusions:

- At the surface air all reference and estimated values did not exceed reference levels.
- Radionuclide concentration in underground waters, running water line and drain water is on levels considerable less than reference one.

- Dynamics of changes in average external exposure dose values indicates a progress achieved in dose decrease.

4. Research reactors

4.1. Research reactor of Kiev Nuclear Research Institute

Operation VVR-M research reactor of Kiev Nuclear Research Institute of the Academy of science was suspended in 1993, and till the late April 1997 the reactor was not in operation. In March 1997 Operating organization applied to NRA to obtain permit for operation of the reactor. The Application was supported with all necessary safety submissions in compliance to the procedure for granting permit to operate nuclear facility. All the submissions passed state expertise of nuclear and radiation safety and together with positive expert conclusions were considered thoroughly by NRA. In addition, NRA requested State Administration of Kiev City concerning their opinion on operation renewal of VVR-M research reactor and received positive response.

On the basis of results on works to renovate the core (in pursuance to ***Program for research reactor core renovation*** approved by NRA in December 1997) NRA approved the following:

- "Program for physical experiments to define the core characteristics and control rod efficiency";
- "Program for physical experiments to define CPS control rod characteristic (Control and Protection System), reactivity margins and reactor operation under capacity till 3000kWt".

On the basis of positive results on carried out activities, the mentioned Programs and confirmation by the Main State Inspectorate of Nuclear Safety stating that the rector is operable under the established capacity level, NRA has granted temporary permit to operate VVR-M research reactor in May 1998.

In 1998 Operating organisation implemented a number of measures aimed at nuclear and radiation safety upgrading of research reactor. These measures are:

- modern physical protection system was put in operation;
- computer based nuclear material accountancy system was put in operation;
- new automated fire alarm system was put in operation;
- assembling and launching of two diesel – electric power stations with capacity of 100KWt each that are sources of emergency power supply.

From May till the end of 1998 the reactor was in operation at different capacity levels during 459 hours. Reactor systems and equipment was operated normally and no deviations from norms for equipment operation were observed. No records of excess the reference and permissive levels that could result in overexposure of the personnel were observed.

4.2 Research reactor of Sevastopol Nuclear Energy and Industry Institute.

Early in 1994 the operation of IR-100 reactor of Sevastopol Nuclear Energy and Industry Institute was suspended due to NRA requirements on license issuance for the facility operation. In 1997 Operating organisation submitted application to NRA to obtain permit for DR-100 research reactor operation. The supporting documents to the Application (primary ***Process procedure for DR-100 reactor safe operation*** and ***Technical Safety Analysis Report for DR-100 reactor)*** after state expertise on nuclear and radiation safety and NRA consideration were returned to for revision.

Within 1998 the DR-100 research reactor has been shutdown (unloaded). All systems and mechanisms of DR-100 research reactor were kept in operable status, fuel inventory

amount is sufficient for several years of the reactor operation. The Operating organisation performed the following works:

- Planned inspections, repairs, inspection on operability and examination of equipment and systems;
- Radiation monitoring;
- R&D at shutdown reactor:
- development and trial operation of the methodology of high silicon alloy production;
- development of technology to produce radio-pharmaceutical products of Talium-201, Chromium-51, Indium-113, Gallium-67, Technetium-99;
- testing of technology for incapsulated sources recharging in gamma-testing facilities
- development of methods to increase life cycle of fuel elements;
- development of methodology to study properties of screens within a wide energy range;
- development of methodology to define attenuation of material under neutrons and gamma rays impact.
- Development and review of operational and technical documentation.
  Licensing process of DR-100 research reactor will be continued in 1999.

5. Radioactive waste management resulted from utilisation of sources of ionising radiation

Radioactive waste management generated from the process of sources of ionising radiation utilisation carried out at enterprises of state enterprise "Radon" comprising of: Kyiv, Donetsk, Odesa, Kharkiv, Dnipropetrovsk and Lviv enterprises (since 1998 enterprises "Complex" and "Technocenter" enterprises dealing in the Exclusion zone (see Chapter 3.3) became the part of "Radon" enterprise). Odesa, Kharkiv, Dnipropetrovsk and Lviv enterprises receive and dispose low and medium activity radioactive waste. Kyiv enterprise receives low and medium activity radioactive waste for temporary storage only. Currently, Donetsk enterprise carries out activities on radioactive waste shipment and operates decontamination station. Basic information about these enterprises is presented Appendix F (dynamics of receipt and characteristics radioactive waste).

These enterprises perform their activity on the basis of license granted by State Committee for Nuclear and Radiation Safety (Derzhatomnagliad) in1994-95 for three years term. In 1998 Odesa, Kharkiv, Dnipropetrovsk and Lviv enterprises have renewed their licenses for radioactive waste management. The basis for license granting was: positive results of safety case expert assessment, the documents demonstrating radiation safety of special enterprise in terms of the observance of norms, rules and standards in force. Relevant obligations on safety level upgrading whilst performing permitted activity are subject to special license conditions. Thus, the regulatory authority exercises special control over the progress of works on accident mitigation happened in 1997 at Kharkiv special enterprise. Upon request of NRA this enterprise developed and implemented ***Urgent measures plan for radiation accident mitigation***. Acting in line with the Plan 80% of the total surveillance wells clusters were reconstructed; coverage over preserved storage facilities was constructed.

Special license conditions that were granted to Odesa and Lviv special enterprises state the necessity to reconstruct sanitary access control point at RAW disposal points. Beside this, terms both for completion of equipping perimeter alarm system at RAW disposal points for Lviv special enterprise and commissioning of process equipment of high activity level sources of ionising radiation storage facility for Odesa special enterprise have been set accordingly.

Special conditions included in the license granted to Dnipropetrovsk special enterprise, set the term for submission to NRA for consent the plan for management with liquid radioactive wastes, which expired the term of safe storage. It should be mentioned that at

Dnipropetrovsk special enterprise the reconstruction of the radioactive waste disposal facility and construction of new radioactive waste disposal facilities had started without adjustment by MEPNS of Ukraine. Nuclear Regulatory Administration paid attention of Dnipropetrovsk special enterprise management, Radon enterprise and the Ministry for environmental situations and Chornobyl matters on the need to get separate permission for reconstruction of radioactive waste disposal facility and construction of new radioactive waste disposal facilities. By special license conditions "Construction of the facilities for reprocessing, storage and disposal of radioactive waste without positive conclusions of nuclear and radiation safety expertise, ecological expertise and other expertise according to legislation in force is forbidden"

Application and relevant safety case to get permit on radioactive waste management on Donetsk and Kyiv special enterprises was under review by NRA in 1998.

Donetsk enterprise does not have available radioactive waste disposal units. Donetsk region faces a sharp problem to dispose spent sources of ionising radiation, so they proposed to locate temporary repository for radioisotopes and radioactive waste containers in basement of decontamination station. However, due to a lack of information for safety assessment NRA rejected the technical specification on the repository.

Kyiv special enterprise is the only enterprise in Ukraine being located within city boundary. Due to insufficient design and repository barrier integrity failure a contamination by tritium of water-bearing horizon has been detected. This type of accident had been registered as 1st group radiation accident in 1995. Within the previously issued license the project on atmospheric precipitation and on surface water isolation of emergency solid radioactive waste repository has been developed and implemented. In pursuance to developed plan on accident mitigation consequences the key measure intended to prevent tritium spreading into ground water was water pumping out the repositories.

In 1998 special enterprise “Radon” made decision to dispose and store radioactive waste almost in three times greater amount vs. 1997. More then a half of radioactive waste amount disposed in solid radioactive waste repositories was sources of ionising radiation in bio screening. According to the requirements of the regulation in force sources of ionising radiation shall be stored in special storage facilities by using radioactive source non-container unloading process. Practice to dispose radiation source in screened containers in solid radioactive waste repositories is prevailing. Unfortunately a lack of technology to reprocess radioactive waste is resulted in rapid filling in repository design capacity. A unified scheme is envisaged to settle the task to handle spent sources of ionising radiation at all enterprises: future putting of “Special complex for sources of ionising radiation temporary storage” at Kharkiv special enterprise into trial operation is considered by Radon management as testing of technologies to be applied at all enterprises. Design of the said complex has received positive assessment results on nuclear and radiation safety.

Liquid radioactive waste handling, the term for their storage shall not exceed three years is urgent problem at present. Currently facility for cementing liquid radioactive waste is operated at Kharkiv special enterprise only.

Analysis of Special Enterprise Reports for 1998 has provided the basis to make the below given conclusions:

1. Technologies on radioactive waste storage/disposal do not meet the level achieved in developed countries. Rapid filling in design basis capacity of existing repositories require urgent launching radioactive waste reprocessing complexes in effect.
2. National park of containers for all radioactive waste types is incomplete, in particular it relates to special containers for shipment and storage sources of ionising radiation containing Co-69 isotopes. It is needed to launch industrial manufacture of containers with laser container marking by possibility to remote control reading of bar code

3. I&C instruments to monitor environment are incomplete. Practically, measurement instruments to control tritium content in different environment are missing; and no needed number of instruments to define nuclide composition of α and β exposure is in place.
4. In order to settle the mentioned problems "Radon " enterprise keeps running development and implementation of measures intended to upgrade technologies and approaches for radioactive waste management. In particular, radioactive waste automatic accountancy computer system is in the process of development and implementation for radioactive waste shipped for storage/disposal. This software system will perform a possibility to receive on line information about quantity and characteristics of radioactive waste being kept at any special enterprise.

6. Uranium mining and milling industry

In Ukraine uranium mining and milling industry enterprises are "East Mining and Enrichment Enterprise" (VostGOK). Uranium ore mining is carried out at two sites they are: Ingulsky and Smolensky mines. In 1996 after geology surveys Novokonstantinovsky mine was put in industrial utilization. Uranium ore milling to make oxide uranium is performed by hydro-metallurgical plant located in industry zone of Zhovti Wody City, Dnipropetrovsk region.

A characteristic feature for uranium mining and milling process is that all waste, mining rocks, releases and effluents (liquid, gas) are radioactive contamination sources to the environment. Large size tailings and their activity level represent the main hazard to the public and environment. The radioactive waste having occupying the territory of 542 hectares, total amount of those is 65.5 million tons, have total activities – till 120.000 Curie. Main environment contamination sources are the processes:

- Radon exhalation from tailings surface;
- Radionuclide particles migration for large distances (to 650 m) form main source;
- contaminated mine water discharge and on surface water wash out of radioactive substances from contaminated sites to water bodies;

The personnel being engaged in uranium ore mining and milling activities is under impact of some radiation hazardous factors (radon, daughter products, ore dust). Analysis of Reports on VostGOK Radiation Safety has shown that VostGOK parameters under surveillance meet the limits of radiation safety norms and the current legislation. In 1998 neither excess in permissive dose limit of radon fission daughter products nor excess in permissive annual limit of total alpha body ingress for mine and hydro-metallurgical plant employees was observed. Individual external exposure dose for the personnel and data on radiation releases and effluents are given in Appendix K.

At the same time radiation monitoring procedure available at the enterprise impedes, due to its insufficiency, obtain trustworthy dose assessments of the personnel and public exposure rate. Available assessments of dose rates are not based on modern well-recognised methodology and can give trustworthy information of radiation safety level for solely one factor – external exposure level for the personnel and public. A radical review is required for ***"Radiation monitoring procedure"*** in order to make possible to obtain true external exposure dose of the personnel and public in meeting ***Nuclear Radiation Safety Norms of Ukraine (NRSNU-97***).

Moreover, special inspections by the Main State Ecological Inspectorate demonstrated that VostGOK need to upgrade safety level for ore materials shipment due to detected violations of transportation rules.

According to the information of Main State Ecological Inspectorate at territories of former uranium mining sites for underground lixiviation of PV-1 “Devladove, Dnipropetrovsk region, and PV-2 “Bratske”, Mykolaiv region, a heavy chemical and radioactive contamination of soil and underground water are observed. Relevant studies are needed to detect true scale of contamination, make anticipated progress situation assessment and develop corrective measures accordingly.

7. Physical protection of nuclear materials and nuclear facilities, prevention to illicit trafficking of nuclear materials and safeguards system of nuclear materials.

7.1 Physical protection status of nuclear facilities of Ukraine

Having became the Party of *Convention on Physical Protection of Nuclear Material* Ukraine committed itself for the world community to exert efforts to establish effective physical protection system intended to prevent man-caused accidents and catastrophe that could a result of unauthorised actions against nuclear facility and nuclear materials, and to prevent acts of sabotage and nuclear terrorism, illicit trafficking of nuclear material and other sources of ionising radiation.

With this purpose in 1998 completion works were performed to upgrade physical protection system of South Ukrainian NPP, Sevastopol Nuclear Energy and Industry Institute, and National Scientific Centre “Kharkiv Physics and Technical Institute”. Along with the mentioned activities measures have been undertaken towards incorporating Chornobyl NPP and “Shelter” facility into activities under Agreement between MEPNS and US Ministry of Defence, because these facilities faced a sharp concern on upgrading physical protection system. Actions to involve donor-countries (Germany, Finland and France) to take part in activities on physical protection system modernisation of Khmelnytskyi and Rivne NPPs are kept going.

Zaporozhe NPP. External Perimeter

In accordance to Decree #226-p of April 06 1998 of the Cabinet of Ministers of Ukraine the MEPNS and Ministry of Energy of Ukraine and law enforcement authorities arranged and carried out drills on physical protection at all NPPs and at Scientific Centre "Nuclear Research Institute" in 1998. These drills have checked both effectiveness of physical protection measures at the mentioned facilities and efficiency interaction of NPP personnel and forces of Ministry of Internal Affairs and Security Service of Ukraine in case of revealing attempts of unauthorised actions against nuclear facilities and nuclear materials.

Inspection results and analysis of physical protection status and drills at Zaporizhia, Rivne, South Ukrainian NPPs either have detected serious problems related primarily to the fact that the Ukrainian NPPs and other nuclear facilities were designed during the time of the former Soviet Union and neither take into account threat from so called "internal adversary" (terrorist) nor fully meet modern requirements of physical protection, world-wide recognised experience and the IAEA recommendations. Due to the reported problem there is a sharp need in:

- upgrading and modernisation of computer subsystem of access control and accountancy to both vital areas and nuclear materials;
- establish, along the perimeter of nuclear facilities with nuclear installations or nuclear materials, on-line engineering equipment designed for detection of unauthorised intrusion;
- improve reliability of security engineering means;
- equip transport clearance points with modern explosives detection equipment;
- establish reliable physical barriers on pass-ways to Main Control Rooms and other vital areas of power unit and witch shall meet modern requirements to ensure delay of possible adversary (terrorist);
- modernise central security alarm panels of nuclear facilities on the basis of state-of-the-art means to display and assess information;
- use materials with relevant characteristics to ensure security room functions where guard perform their duties;
- install protection means against external perimeter intrusion by use of transport means at all facilities;
- broaden use of modern communication means;
- undertake measures to complete special guard forces.

7.2 Measures to establish regulatory basis of physical protection.

In response to the revealed problems and to meet the requirement of the Resolutions of the Cabinet of Ministers of Ukraine activities on enhancement of regulatory basis of physical protection of nuclear facilities and nuclear materials were underway during 1998. Law of Ukraine "On physical protection of nuclear facilities, nuclear materials, radioactive waste and other sources of ionising radiation", drafted by MEPNS, was submitted to the Supreme Rada of Ukraine (the Parliament) for consideration. The following regulations in draft have been developed:

- *"Provision to define characteristics of possible types and levels of attack to nuclear facility and nuclear materials, and use these characteristics for physical protection purpose";*
- *"Rules for information management on physical protection of nuclear facilities, nuclear materials, other sources of ionising radiation the access to those is limited".*

Development of documents intended to regulate organisation and practical measures to upgrade physical protection efficiency is underway.

7.3. Arrangements for establishment of state physical protection system elements

With the purpose to establish state physical protection system of nuclear materials and nuclear facilities the Main State Inspectorate of nuclear safety has established within its structure special Department to discharge functions of supervision over observance of requirements to physical protection systems of Ukraine.

A vital part of state physical protection system is training and advanced training for the personnel of physical protection. Within the reported year Training Centre on physical protection, accountancy and control of nuclear materials named after George Kuzmich has been established. More than 100 specialists on physical protection, law enforcement authorities and other authorities involved in physical protection ensuring have received training at this Centre and other special foreign training centres.

7.4. Basic directions of further on physical protection activity

Comparison analysis of developed countries' activities with large nuclear industry programs can be the basis for drawing up a conclusion that a range of measures need to be undertaken to improve the level of physical protection of nuclear material and nuclear facilities in Ukraine. These measures are:

- upgrade existing regulatory basis, i.e. to bring it in line with world-wide recognised standards, the priority for is urgent passing of law of Ukraine "On physical protection of nuclear facilities, nuclear materials, radioactive waste and other sources of ionising radiation" at the Supreme Rada;
- establish a mechanism of purpose funds to finance physical protection upgrading activities;
- complete the process of establishment of infrastructure for state physical protection of nuclear facilities and nuclear materials.

7.5. Prevention illicit trafficking of nuclear materials and other sources of ionising radiation, and response to cases of illicit trafficking detection

Within the reported year in response to Decree # 207 of March 4, 1997 of the Cabinet of Ministers of Ukraine a draft of "Program to prevent illicit trafficking of sources of ionising radiation within the territory of Ukraine till the year 2000" has been developed. Unfortunately, due to financial cuts in income part of the State Budget this draft was not approved. Despite the problem a portion of measures of the Program, in particular, development of some regulations, was succeeded to be financed from funds of the Sate Fund of Environmental Protection.

Since 1997 NRA of MEPNS of Ukraine has started exchange of information with the relevant database of the IAEA concerning incidents related to illicit trafficking of nuclear materials and other sources of ionising radiation. During the reported year there were 4 information noted submitted to. It is worth highlighting that during the year no single case on illicit trafficking of nuclear materials at the Ukrainian facilities was observed.

There were two cases recorded of Cs-137 source detection (Dnipropetrovsk City and Smila City). Another case of an attempt to get out radioactive sample for scientific purpose was detected at Borispil airport when an individual did not declared it in the Custom declaration. One more case (in Mogilev-Podolskyi City, Vinnytsia Region) when foreign mass media rushed to inform about a detection of nuclear material stolen from Khmelnytskyi NPP. A detailed inspection and notification of relevant authorities did not confirm the fact. But this case has highlighted once more the vital need to develop interagency regulation intended to regulate unambiguously the notification process of the public and international organisations in case of accidents related to nuclear materials and other sources of ionising radiation.

7.6 Nuclear material safeguards system

International safeguard system is the system designed for control over nuclear material to prevent the use of nuclear materials for nuclear weapon creation. Safeguards are the important component of the world-wide system on preventing the spread of nuclear weapons.

In 1993 Ukraine, having signed the *Agreement between Ukraine and the International Atomic Energy Agency for the application of safeguards to all nuclear material in all peaceful nuclear activities of Ukraine* (INFCIRC/462) committed itself to control the inventory amount and location of nuclear materials within its territory border. Acting in pursuance to the said agreement Ukraine made obligation to transfer notifications about nuclear materials to the IAEA.

For the recent years in order to fulfil obligations Ukraine is in process of establishment of Accountancy and Control System of Nuclear Material. Mainly the System is purposed to collect and transfer to relevant information the IAEA. It should be noted that fulfilment of these obligations is the point of honour of Ukraine standing in the international environment. Having transferring a complete and trustworthy information about nuclear materials to international agencies and giving opportunity for international inspections in Ukraine we demonstrate the striving for integration with the world community.

In January 1998 the above mentioned Agreement lost its validity due to putting in force of *Agreement between Ukraine and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons* (INCIRC/550).

Since August 1, 1998 supplementary provisions to the Agreement have been put in force. According to requirements of the supplementary provisions the IAEA receives initial list of nuclear material inventory at the Ukrainian enterprises as of January 1, 1998.

According to the current control regime there were 79 permits to conduct export and import submitted to the State Service on Export Control. Notifications about nuclear material export-import were sent to the IAEA. Activities to inspect discrepancies found in lists, submitted to the IAEA, regarding nuclear fuel accountancy units imported by Ukraine.

There were 88 inspections conducted by the IAEA experts in Ukraine (including 5 inspections with participation of specialist of NRA's *Nuclear Fuel Licensing Cycle Department* to check inventory amount of nuclear materials in MBA of the Ukrainian facilities). In order to facilitate inspections aimed to check observance of requirements of the State System of Accountancy and Control of Nuclear Materials, the Minister issued Order #85 of June 15 1998 to commission the *Main State Inspectorate of Nuclear Safety* to discharge functions of accountancy and control of nuclear materials.

Conclusion

Analysis of nuclear and radiation safety status for 1998 performs the basis to conclude:

- In 1998 activities on promoting Conception of state safety regulation and nuclear industry management in Ukraine were underway. The Conception set the priority of safety for the public and environment. The gained experience of the current Laws is subject to a thorough and comprehensive analysis which will serve the framework for defining ways and directions to upgrade the legislative basis on nuclear and radiation safety.
- Under conditions of financial cutback status of nuclear and radiation safety at NPPs is in stable acceptable level. Ukraine meets commitments made in respect to ratification of the Convention of Nuclear Safety. Planned performance of works on periodical safety assessment of power units under operation, development of Safety Analysis Reports, the Quality Assurance Program enhancement, NPP full-scope simulator create a sound prerequisites for further on upgrading of NPP safety. Unfortunately, the pressing problems related to replacement of equipment and technical basis improvement are still remained to be solved. This situation calls forth a repetition of same type equipment failure.
- For radioactive waste management - the key efforts are exerted to minimise radioactive waste volumes and reprocessing to reduce disposal quantities. In 1998 Radioactive Waste Management Programs were developed and approved. The works on their implementation have been commenced.
- Completion of “Comprehensive Program for nuclear fuel cycle development in Ukraine” intended to settle the problem of spent nuclear fuel is in the midst of completion. Implementation of the mentioned program will build up a framework for establishment of national infrastructure for spent nuclear fuel management, remove a dependency on either spent nuclear fuel shipment out of the country and payment for reprocessing services or unexpected political decisions. These actions would considerably reduce expenses for spent nuclear fuel management.
- In 1998 activities has been commenced to start implementation of Plan of measures to convert the “Shelter” facility into environmentally safety system (SIP).
- Monitoring of radioecology and radiation status at the Chernobyl Exclusion zone are kept running. A number of radioactive waste disposal points are in operation accordingly. Analysis of the Exclusion zone status in 1998 reports about stability in status of reference parameters.
- Operation of research reactors was suspended in 1993-94 upon requirements of NRA of MEPNS. Operating organisations keep running activities to implement measures necessary to receive permit of NRA to operate the reactors. Implementation of a range of necessary measures and submission of safety demonstrating document was followed by granting Kiev Nuclear Research Institute with temporary permit for operation of the research reactor. Sevastopol Nuclear Energy Institute continues the process of bringing the reactor in line with requirements to norms and rules of nuclear and radiation safety.
- A number of problems concerning radioactive waste management resulted from the use of sources of ionising radiation are still pending. Due to financial problems the measures developed by “Radon” enterprise are implemented partially.
- Ukraine meets commitments to establish effective physical protection system intended to prevent man-caused accidents and catastrophes that could a result of unauthorised actions against nuclear facility and nuclear materials. A number of measures with the purpose to resolve some drawbacks and upgrade physical protection level of nuclear facility and nuclear material in Ukraine have been developed and implemented.

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* The list of legislative acts, international treaties and agreements, regulatory documents Decrees of the Cabinet of Ministers, and regulations in the field of nuclear and radiation safety (put in force in 1998), is attached in Appendix B.