DRAFT

UKRAINE

NATIONAL REPORT

On Compliance with Obligations under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

KYIV 2014

FOREWORD

Ukraine signed the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter the Joint Convention) on 29 September 1997 and was one of the first countries to ratify it by the Law of Ukraine on 20 April 2000.

After the Joint Convention came into force, Ukraine became an active participant of all processes and events under the Joint Convention in order to fulfill its tasks. The First, Second, Third and Fourth National Reports of Ukraine were presented to the Contracting Parties of the Joint Convention at Review Meetings. The comments and recommendations of the review processes are incorporated in national action plans in the area of nuclear energy as regards improvement of spent nuclear fuel and radioactive waste management system.

The Fifth National Report has been developed by the State Nuclear Regulatory Inspectorate of Ukraine in full compliance with requirements of the Joint Convention and Guidelines Regarding the Form and Structure of National Reports INFCIRC/604/Ref.3 with amendments, as well as the Summary Report of the Fourth Review Meeting of the Contracting Parties (JC/RM4/04/Rev2).

By submission of National Reports, Ukraine fulfills its obligations according to Article 32 of the Joint Convention.

This Report, like the previous ones, is based on legislative and regulatory documents in force in Ukraine as well as official reports of state executive bodies responsible for the national policy in nuclear energy use and regulation and radioactive waste management as well as operating organizations (operators).

The key objective of this Report is to provide factual information to the Contracting Parties of the Joint Convention and to the public of Ukraine regarding the safety of spent fuel management and the safety of radioactive waste management and actions taken to protect personnel, the public and the environment against hazardous effects of radiation. The Report highlights the progress and changes since the Fourth Review Meeting and identifies prospects and plans for further development and issues to be resolved.

Based on this Report and according to the powers entrusted by the Cabinet of Ministers of Ukraine, the Chairperson of the State Nuclear Regulatory Inspectorate of Ukraine declares the following:

Ukraine adheres to the principle of priority to safety of people and the environment at all stages of spent fuel and radioactive waste management in the area of nuclear energy and radiation safety.

In this regard, *Ukraine completely fulfills its obligations under the Joint Convention,* which is proved by:

- establishment and development of the legislative and regulatory framework of safety in the area of nuclear energy;
- functioning of the state nuclear regulatory authority with relevant competence, which establishes safety requirements and criteria, develops and approves standards and regulations on nuclear and radiation safety, conducts licensing and state supervision and applies legislative sanctions in case of incompliance;
- independence of the state nuclear regulatory authority from other state authorities, establishments, enterprises and officials that deal with nuclear energy and independence from local authorities and public associations;
- safety assessments and reviews of existing and new spent fuel and radioactive waste management facilities and safety improvement measures;

– development of the emergency preparedness and response system;
– full responsibility of the licensee for safety and measures intended to protect people and the environment;
– development of safety culture and implementation of safety self-assessment practices.

The actual data in this Report, except for those specially stated, are provided as of 1 July 2014. The changes that take place by May 2015 will be additionally reported by the Ukrainian Delegation at the Fifth Review Meeting.

Kyiv, September 2014

Sergiy Bozhko

Chairman
State Nuclear Regulatory Inspectorate of Ukraine

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ABBREVIATIONS AND ACRONYMS

CCMEZ	State Specialized Enterprise for Capital Construction Management of the Exclusion Zone
Centralized ISF	Centralized Spent Fuel Storage Facility for RNPP, KhNPP, SUNPP
ChNPP	State Specialized Enterprise *Chornobyl Nuclear Power Plant*
CLTSF	Centralized Long-Term Storage Facility for Radiation Sources
Complex *Vektor*	Industrial Complex *Vektor* for decontamination, transport, treatment and disposal of radioactive waste from the territories contaminated in the Chornobyl catastrophe
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
ENSDF	Engineered Near-Surface Disposal Facility for Solid Radioactive Waste on *Vektor* Site
EPS	Emergency Preparedness System
FS	Feasibility Study
HLW	High-Level Waste
IA PCP	Industrial Association *Prydniprovsk Chemical Plant*
IAEA	International Atomic Energy Agency
ICSRM	Industrial Complex for Solid Radioactive Waste Management at ChNPP
INR NASU	Institute of Nuclear Research, National Academy of Sciences of Ukraine
INSC	European Commission Instrument for Nuclear Safety Cooperation
IRRS	Integrated Regulatory Review Service
ISF	Interim Spent Fuel Storage Facility
KhNPP	Khmelnitsky Nuclear Power Plant
LRSF	Liquid Radioactive Waste Storage Facility
LRTP	Liquid Radioactive Waste Treatment Plant at ChNPP
LRW	Liquid Radioactive Waste
LSRSF	Liquid and Solid Radioactive Waste Storage Facility
MECI	Ministry of Energy and Coal Industry of Ukraine
MENR	Ministry of Environment and Natural Resources of Ukraine
MHU	Ministry of Health of Ukraine
NNEGC *Energoatom*	National Nuclear Utility *Energoatom*
NPP	Nuclear Power Plant
NRU	National Report of Ukraine (on compliance with obligations under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management)
NSC	New Safe Confinement of the Shelter
RICP	Radioactive Waste Interim Confinement Point
RL	Reference Level
RNPP	Rivne Nuclear Power Plant
RS	Radiation Source
RWDP	Radioactive Waste Disposal (Storage) Point
SAR	Safety Analysis Report

SE *Baryer*	State Enterprise *Baryer*
SE *SkhidGZK*	State Enterprise *Eastern Ore Mining and Processing Plant*
SEZA	State Exclusion Zone Management Agency of Ukraine
SF	Spent Fuel
SFA	Spent Fuel Assembly
SFP	Spent Fuel Pool
SIP	Shelter Implementation Plan
SISP	State Interregional Specialized Plant for Radioactive Waste Management of UkrDO *Radon*
SNRIU	State Nuclear Regulatory Inspectorate of Ukraine
SRS	Spent Radiation Sources
SRSF	Solid Radioactive Waste Storage Facility
SRTP	Solid Radioactive Waste Treatment Plant at ChNPP included into ICSRM
SRW	Solid Radioactive Waste
SRW-1, SRW-2	Near-Surface Radioactive Waste Disposal Facilities on *Vektor* Site
SSE	State Specialized Enterprise
SSE CRME	State Specialized Enterprise *Centralized Radioactive Waste Management Enterprise*
SSR	Storage Site for Radwaste Resulting from Decontamination and Sanitary Treatment of Vehicles
SUNEI	Sevastopol National University for Nuclear Energy and Industry
SUNPP	South Ukraine Nuclear Power Plant
TSO	Technical Support Organization
UkrDO *Radon*	Ukrainian State Association *Radon*
USSE	Unified State System for Prevention and Response to Man-Induced and Natural Emergencies
Zaporizhzhya ISF	Dry Spent Fuel Storage Facility at Zaporizhzhya NPP
ZNPP	Zaporizhzhya Nuclear Power Plant

EXECUTIVE SUMMARY

Radioactive Waste Treatment

The Strategy for Radioactive Waste Management in Ukraine[1] has been developed for 50 years. The status of radwaste management in Ukraine was analyzed and best international practices and IAEA and European Union safety standards were taken into account in developing the Strategy.

Specific tasks under the Strategy are performed according to:

- National Target Ecological Program for Radioactive Waste Management[2] to be implemented till 2017;
- National Program for Chornobyl NPP Decommissioning and Shelter Transformation into an Environmentally Safe System[3].

In the period after the Fourth Meeting of Contracting Parties to the Joint Convention, a number of measures were implemented under the Strategy and national programs.

Radioactive Waste Treatment Plants are constructed at operating NPPs in order to minimize it and reach acceptable state for disposal or long-term storage in central storage facilities of the Vektor site:

- significant part of complex equipment has already been supplied, mounting and acceptance test have been performed at Zaporizhzhya and Rivne NPP. Putting of complex lines into trial and commercial operation is planned for 2016;
- inspection of complex and service buildings has been performed at Khmelnitsky and South Ukraine NPPs and designs were developed and submitted for state review;
- safe technologies related to immobilization of salt fusion cake generated in LRW deep evaporation facilities into solid matrix were searched;
- efforts on selecting technology for evaporation bottoms processing without production of salt fusion cake are being performed.

Chornobyl NPP:

- efforts are underway to decommission Units 1, 2, 3, demount systems and equipment of Units No. 1, 2;
- New Safe Confinement of the Shelter is under construction. Design, production, mounting of NSC equipment, systems and elements are in place on the site;
- the temporary storage facility for packages with high-level and long-lived waste has been commissioned at the Industrial Complex for Solid Radioactive Waste Management (ICSRM);
- efforts are underway to commission solid radioactive waste treatment plant within ICSRM;
- efforts to commission the liquid radioactive waste treatment plant (LRTP);
- efforts are taken to mount the line for fragmentation of high-level long-length components to be retrieved from the reactor compartments;
- the plant for manufacture of metal drums and reinforced concrete containers for radioactive waste is under operation.
- additional ChNPP radioactive waste treatment facilities are being designed: a facility for LRW treatment to remove organic compounds and transuranium elements, areas for storage, fragmentation and decontamination of dismantled structures, facilities for release of dismantled materials from regulatory control;

[1] Agreed by Cabinet Resolution No. 990-r of 19 August 2009
[2] Approved by Law of Ukraine No. 516-VI of 17 September 2008
[3] Approved by Law of Ukraine No. 886-VI of 15 January 2009

The Vektor site: (15 km south-west from ChNPP):

- The engineered near-surface disposal facility for ChNPP radwaste packages is under operation;
- Efforts are underway to complete construction of two more near-surface disposal facilities for solid radwaste, SRW-1 and SRW-2, as integral elements of *Vektor* Stage I[4];
- The development of the infrastructure to ensure safe operation of the disposal facilities is under completion;
- A centralized facility for long-term storage of spent radioactive sources is under construction within *Vektor* Stage II[5];
- A special storage facility is being designed in order to provide storage of vitrified high-level reprocessing waste to be returned from Russia. Facilities for long-term storage of high-level and long-lived waste and fuel-containing materials to be retrieved from the Shelter during ChNPP decommissioning, operation and decommissioning of other nuclear facilities are being designed.

In the Chornobyl Exclusion Zone (not considering ChNPP and Vektor sites):

- Measures on radiation monitoring and monitoring of the environment within the Exclusion Zone are taken on a permanent basis according to the agreed procedure;
- near-surface disposal facilities of RWDP *Buriakivka* are under operation;
- the projects are being implemented to upgrade and improve safety of storage facilities, where radwaste was placed in the first years after the Chornobyl accident, namely PWDP *Pidlisnyy*[6] and *ChNPP Stage III*[7];
- Radioactive waste interim confinement points (RICP)[8] are investigated on a permanent basis to find/specify locations of trenches and pits with radwaste. Waste is retrieved from the most hazardous points;

Measures are taken at UkrDO *Radon*:

- convert and reequip specialized plants into facilities for collection and temporary storage of radwaste;
- reassess and improve safety of operating and preserved "historical" storage facilities;
- create new facilities intended for radwaste management;
- renovate container park;
- improve physical protection systems.

Measures are taken to improve radwaste management system, including enhancement of the National Operating Organization on radwaste management at the stage of its long-term storage and disposal, namely SSE *CRME*, in order to ensure conditions for efficient implementation of state policy in radwaste management.

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[4] Vector *Stage I* includes two types of near-surface disposal facilities for low- and intermediate-level short-lived waste resulting from the Chornobyl catastrophe: SRW-1 for radwaste disposal in reinforced concrete containers and SRW-2 for disposal of non-packed and bulky radwaste in modules.

[5] Vector *Stage II* provides for facilities for long-term storage of long-lived and high-level waste; near-surface disposal facilities for low- and intermediate-level short-lived waste; treatment facilities for Chornobyl-origin radwaste and waste generated in the non-nuclear sector.

[6] RWDP *Pidlisnyy* was constructed within priority measures after the Chornobyl catastrophe. From the end of 1986 to the end of 1988, the most hazardous high-level and long-lived waste was located in modules A-1 and B-1 of this RWDP.

[7] RWDP *ChNPP Stage III* was constructed within priority measures after the Chornobyl catastrophe in the partially constructed facility for solid radioactive waste of non-completed ChNPP *Stage III*. From the end of 1986 to the end of 1988, low- and intermediate-level waste was located in the reinforced concrete modules of this facility and bunding was constructed.

[8] RICP includes territories adjacent to ChNPP with total area of 10 ha, where trenches and pits for radwaste confinement were constructed within priority measures after the Chornobyl catastrophe. Estimated number of RICP trenches and pits is from 800 to 1000 pcs., accurate locations of some of them should be specified.

Spent Fuel Management

The Energy Strategy of Ukraine till 2030 (hereinafter called the Energy Strategy of Ukraine), the new revision of which is approved by Resolution of the Government No. 1071 dated 24 July 2013, establishes both design procedure for spent fuel management (transportation of spent fuel for treatment to Russia) and procedure that envisages storage of spent fuel with subsequent approval of the final decision on fuel reprocessing or disposal.

The following efforts are planned:

- transportation of spent fuel from Rivne, Khmelnitsky and South Ukraine NPPs for temporary storage and reprocessing until the Centralized ISF in Ukraine is commissioned;
- safe operation of the dry spent fuel storage facility at Zaporizhzhya NPP;
- construction of the Centralized dry storage facility for spent fuel of WWER-440 and WWER-1000 of operating NPPs and spent fuel of new nuclear units and its safe operation.
- Since Zaporizhzhya ISF Stage I, put into commercial operation in 2004, was filled in accordance with the design (100 containers), ISF Stage II with design capacity of 280 containers was commissioned in December 2011.

The following efforts were taken to construct the Centralized dry storage facility:

- on 4 February 2009, the Feasibility Study for the Centralized spent fuel storage facility (Centralized ISF) was approved by Resolution of the Cabinet of Ministers No. 131-r. It is to be designed to accommodate 16,529 spent fuel assemblies to ensure the storage for 100 years period;
- on 9 February 2012, the Verkhovna Rada of Ukraine approved the Law of Ukraine "On Spent Fuel Management for Siting, Design and Construction of the Centralized Dry Storage Facility for Spent Fuel of Ukrainian NPPs with WWER Reactors". The Law also defines the territory of its location in the Exclusion Zone;
- design and exploration efforts were started to construct the storage facility and access roads.

NNEGC *Energoatom* is the operating organization of the Centralized ISF.

NNEGC *Energoatom* continues efforts on upgrading spent fuel management systems in order to include containers envisaged by the Centralized ISF design into transport flow charts for spent fuel management.

Chornobyl NPP:

- construction of the dry spent interim fuel storage facility ISF-2 is underway at ChNPP;
- measures to upgrade and improve safety of the existing wet interim spent fuel storage facility ISF-1 are taken.

After Fukushima-1 NPP accident in Japan, European Council offered to hold target NPP safety reassessment in European Union member states using stress tests. The operating organization takes the following measures in the area of spent fuel management, considering lessons learnt from Fukushima-1 NPP accident:

- analysis of effect of external extreme natural hazards on reactors, spent fuel pool and reloading of each Ukrainian NPP site;
- additional safety assessment of Zaporizhzhya ISF.

Natural hazards peculiar to the site proposed for the Centralized ISF and their potential impact on its safety were additionally analyzed. The analysis showed that these impacts would not challenge the limits of the Centralized ISF safe operation preliminary identified in the Centralized ISF Feasibility Study.

Information on stress tests at Zaporizhzhya ISF, ChNPP, Centralized ISF and operating NPPs is provided in Subsections B.2.1, G.2.1, G.3.1 and K.3 of the Report.

Section A

A.1. Introduction

The safe management of spent fuel and radioactive waste is one of the most important factors in sustainable development of nuclear energy in the State according to the Energy Strategy of Ukraine till 2030, including applications of nuclear technologies in medicine, science and industry.

Ukraine, as a Contracting Party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter referred to as the Joint Convention), ensures implementation of provisions under the Joint Convention according to its objective and IAEA safety fundamentals.

The existing practice to ensure the safety of spent fuel and radioactive waste management, national strategies, plans and programs for further development of the system for spent fuel and radioactive waste management and major events and changes that took place after the Fourth Meeting of the Contracting Parties to the Joint Convention are highlighted in the relevant sections of this Report.

The Report includes information on the development of the legislative and regulatory system of spent fuel and radioactive waste management, the system for administration of spent fuel and radioactive waste management, emergency preparedness, personnel training, financial resources, quality assurance, decommissioning, international cooperation and improvement of safety in spent fuel and radwaste management.

Annexes to the Report also present:

- the list of existing spent fuel storage facilities and radwaste management facilities, and nuclear facilities being decommissioned;
- inventories of spent fuel and radioactive waste subject to the Joint Convention;
- dynamics of radiation safety indicators;
- the list of regulations approved during the reporting period;
- information on the Shelter safety state, efforts on taking measures to transform it into an environmentally safe system, including construction of the New Safe Confinement;
- data on uranium mining and milling industry.

In the period after submission of the previous National Report, from 2011 to the first half of 2014, the following major events and measures took place:

03 October 2011: SNRIU Board Resolution approved the conclusions of NRS State Review of results of the Target Safety Reassessment (stress test) of ChNPP No. 1-3 and the wet spent fuel storage facility ISF-1;

29 December 2011: NNEGC *Energoatom* issued the Individual Permit to commission Stage II of the dry spent fuel storage facility (termination of construction) at Zaporizhzhya NPP site;

09 February 2012: adoption of the Law of Ukraine "On Spent Fuel Management for Siting, Design and Construction of the Centralized Dry Storage Facility for Spent Fuel of Ukrainian NPPs with WWER Reactors";

18 March 2012: implementation of the project "Closure of RWDP *Pidlisnyy* Disposal Facilities" has been terminated;

03 July 2012: a license was issued to operate the new radwaste container storage facility No. 6 of Dnipropetrovsk SISP;

18 July 2012: a license was issued to construct centralized long-term storage facility for radiation sources within the Vektor site in the Exclusion Zone;

01 August 2012: Resolution of the Cabinet of Ministers of Ukraine No. 529-r approved the revised design of *Vektor* Stage I;

01 August 2012: SNRIU Board Resolution approved the positive conclusions of NRS State Review of "Feasibility Study of Investments for Construction of the Interim Storage Facility for Radioactive Waste returned from Russia after Ukrainian NPP Spent Fuel Reprocessing" (FS);

07-31 August 2012: Ukraine participated in the Extraordinary Meeting under the Convention on Nuclear Safety held in the IAEA headquarters in order to examine taken and planned measures within lessons learnt at Fukushima-1 NPP accident;

01 October 2012: NNEGC *Energoatom* brought into action "Comprehensive Program for Radioactive Waste Management in 2012-2016" unique for operating NPPs;

02 October 2012: approved Conclusion of NRS State Review of SAR of the Centralized Long-Term Storage Facility for Radiation Sources" at construction stage;

23 October 2012: approved project "Closure of *ChNPP Stage III* Disposal Facilities. Revision";

30 November 2012: SNRIU Board Resolution approved the conclusions of NRS State Review of preliminary SAR of ISF-2 rev. 6.1;

07 December 2012: approved project of ISF-2 construction termination;

14 March 2013: approved conclusions of NRS State Review of the working project "Modernization of Production Capacities on Fragmentation of Long-Length Components at ChNPP";

20 February 2013: SNRIU issued a license to ChNPP to perform activity on construction and commissioning of ISF-2;

24 July 2013: Resolution of the Cabinet of Ministers of Ukraine No. 1071 approved the new revision of the Energy Strategy of Ukraine till 2030;

27 November 2013: agreed "Decommissioning Concept for Rivne NPP";

31 December 2013: approved conclusions of NRS State Review of design documentation "Final Closure and Preservation of Chornobyl NPP Units 1, 2, 3";

28 March 2014: issue of an individual permit to commission ChNPP Liquid Radioactive Waste Treatment Plant";

30 March 2014: SNRIU approved "Licensing Plan for Creation of the Centralized ISF";

04 April 2014: the Ministry of Energy and Coal Industry of Ukraine issued an order on laying on NNEGC *Energoatom* functions of the operating organization of Centralized ISF;

12-13 May 2014: Ukraine participated in the Second Extraordinary Meeting under the Convention on Nuclear Safety held in the IAEA headquarters in order to improve procedures of the Examination process for better achieving of the Joint Convention purposes;

23 May 2014: issue of the individual permit to commission go ChNPP Solid Radioactive Waste Treatment Plant.

A.2. Basic Conclusions from the Fourth Review Meeting

At the Fourth Review Meeting, the Contracting Parties noted substantial progress made by Ukraine for the period after the Third Review Meeting. First of all, this includes approval and implementation of the long-term national strategy for radioactive waste management; improvement of radwaste management system through creation of the Special State Authority for Radwaste Management; significant progress on the development of infrastructure for radioactive waste and spent fuel management and on implementation of NSC construction project; implementation of the policy to improve management of radiation sources; including of IRRS-2010 post-mission recommendations into the legislative framework; ensuring transparency of the governmental for spent fuel and radioactive waste management; improvement of public awareness and involvement in decision-making; ensuring efficient international cooperation.

The following was recognized as good practices:

- development of the long-term national strategy for radioactive waste management;
- creation of the national operator for radwaste management at stages of long-term storage and disposal, SSE *CRME*;
- continuous oversight, monitoring, operation and safety improvement of facilities located in the Exclusion Zone;
- participation in innovative EU stress tests and related safety reassessment, which covered NPPs and spent fuel storage facilities, implementation of safety improvement measures defined according to stress tests;
- taking into account the public opinion in the decision-making process;
- successful implementation of projects related to safety improvement of spent radiation sources involving projects of international technical support ("discharge" of irradiation facilities, collection and transportation of spent radiation sources from sites of enterprises in defaults to SISP facilities).

The following challenges were defined for Ukraine:

- terminate construction of the New Safe Confinement of the Shelter;
- construction and modernization of facilities designed for spent fuel and radioactive waste management in the Exclusion Zone;
- enhance competence of the nuclear regulatory authority.

Based on review of the National Report of Ukraine (NRU-2011), the Contracting Parties recommended continuing the following planned measures in the next three-year period:

- continue safety reassessment of the UkrDO *Radon* specialized plants and further re-equipment of SISP according to reassessment results;
- take efforts to terminate construction of ISF-2 at Chornobyl NPP;
- continue upgrading of system for radwaste management generated by NPP operation.

Information on the reached progress on these "Challenges" and recommendations is summed up in Subsection K.1. of the Report.

Besides, NRU-2014 took into account issues common for the Contracting Parties defined in the Final Summary Report of the Fourth Review Meeting (JC/RM4/04/Rev2.), in particular, safety issues related to long-term storage of spent fuel and radioactive waste prior to disposal; consideration of lessons learnt from Fukushima Daiichi NPP accident during implementation of spent fuel management strategies; management of spent radiation sources.

Section B. POLICIES AND PRACTICES (Article 32, Para. 1)

B.1. Policy for Spent Fuel Management

The principles of state policy for spent fuel management are set forth in Article 5 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" (outlined in Subsection B.1 of NRU-2003).

The Energy Strategy of Ukraine till 2030 (hereinafter referred to as the Energy Strategy of Ukraine), the new revision of which is approved by Governmental Resolution No. 1071 dated 24 July 2013, establishes the so-called deferred decision for spent fuel of Ukrainian NPPs, involving long-term (50 years and more) storage of spent fuel and subsequent defining and approval of the final decision on fuel reprocessing or disposal.

Ukrainian NPPs follow both a design procedures for spent fuel management, which is transportation of spent fuel for treatment to Russia, and a procedure envisaging storage of spent fuel with subsequent approval of the final decision on fuel reprocessing or disposal.

The following efforts are planned:

- transportation of spent fuel from Rivne, Khmelnitsky and South Ukraine NPPs to Russia for temporary storage and reprocessing until the Centralized spent fuel storage facility (Centralized ISF) in Ukraine is commissioned;
- safe operation of the dry spent fuel storage facility at Zaporizhzhya NPP;
- construction of the Central dry storage facility for spent fuel of WWER-440 and WWER-1000 of operating NPPs and spent fuel of new nuclear units and its safe operation;
- solving an issue of long-term storage and reprocessing of spent nuclear fuel produced by Westinghouse Electric Sweden AB;
- development of regulatory and procedural issues on return of radioactive waste resulting from Ukrainian NPP spent fuel reprocessing and their approval by Russia;
- development of a Spent Fuel Management Concept to define purposes, strategies and scenarios for spent fuel management, specify key provisions of scientific and technical policy and implementation stages of spent fuel management at Ukrainian NPPs. The Concept should take into account the Energy Strategy of Ukraine till 2030.

Chornobyl NPP:

- terminate construction, ensure commissioning and safe operation of ISF-2 for storage of the full amount of ChNPP spent fuel;
- take measures to upgrade and improve safety of the existing wet interim spent fuel storage facility ISF-1.

B.2. Practices of Spent Fuel Management

Areas for spent fuel management in Ukraine are presented in Subsection B.2 of NRU-2008. Spent fuel management in Ukraine is performed at facilities listed in Annex 1 of this Report. The inventory of spent fuel is presented in Annex 2 of this Report.

B.2.1. Spent Fuel Management at Operating NPPs

Implementation of generation–II fuel was initiated at RNPP unit 2 (in 2010) and RNPP unit 1 (in 2012). Besides, core designs with reduced neutron release were developed. These efforts allowed a reduction of the number of unloaded spent fuel assemblies by 24 pcs for two power units with WWER-440.

At Zaporizhzhya NPP, spent fuel storage racks in spent fuel pools were compacted to increase capacity of ZNPP spent fuel pools.

According to the Comprehensive (Integrated) Safety Upgrade Program for Ukrainian NPPs regarding the management of nuclear fuel including spent fuel, the operating NPP units are to be equipped with mast sipping systems to monitor the integrity of fuel claddings. As of 1 July 2014, mast sipping systems are introduced into commercial operation at RNPP units 1, 2, 3, 4, KhNPP units 1, 2 and SUNPP unit 1.

Trial operation of fuel assemblies produced by Westinghouse Electric Sweden AB is underway at SUNPP unit 3 as part of the Nuclear Fuel Qualification Project. At present, spent fuel of this producer is stored in at-reactor spent fuel pools of SUNPP units 2 and 3. To solve the issue of Westinghouse spent fuel management and diversify suppliers of services related to transportation and reprocessing of Westinghouse spent fuel, NNEGC *Energoatom* is negotiating with the French company *AREVA* regarding the conduct of a study to examine a technology for and cost of spent fuel reprocessing at La Hague plant (France), and management of valuable products and high-level waste coming from reprocessing.

Dry Spent Fuel Storage Facility at ZNPP (Zaporizhzhya ISF)

Starting from 2005, ZNPP spent fuel is unloaded to the Dry Spent Fuel Storage Facility at ZNPP for storage during the period of at least 50 years. As of 01 April 2014, there were 123 containers with 2946 spent fuel assemblies installed at the Zaporizhzhya ISF. The design capacity of Zaporizhzhya ISF is 380 containers, each for 24 SFAs.

Since Zaporizhzhya ISF Stage I, commissioned in 2004, was filled up (100 containers) in accordance with the design, the licensing of Stage II was completed. SNRIU issued an individual permit for commissioning of Zaporizhzhya ISF Stage II, and in January 2012 Stage II designed for 280 containers was put into operation.

To improve storage safety, a remote temperature control system (RTC) was put into commercial operation for Stage I containers. The RTC for Stage II containers is installed in accordance with the design.

Operational records evidence compliance of Zaporizhzhya ISF with safety criteria presented in SAR. The design of Zaporizhzhya ISF was modified, considering operating experience and implementation of components produced in Ukraine. The safety of design modifications was appropriately justified in a number of technical decisions agreed upon by the SNRIU. The ventilated concrete containers and multi-assembly sealed baskets for spent fuel storage are currently manufactured at national enterprises using Ukrainian materials and technologies.

After the accident at Fukushima-1 NPP in Japan, within a focused NPP safety reassessment using stress tests according to the European Council and WENRA proposal, an extraordinary dedicated safety reassessment (stress test) was completed for Zaporizhzhya ISF.

An assessment of Zaporizhzhya ISF vulnerability to external hazards and their combinations that may cause degradation of safety functions and development of severe accidents was completed. The following initiating events were analyzed with regard to nuclear fuel location in the ISF: earthquakes, tornadoes, external flooding (resulting from accidents at hydraulic structures, high waters and precipitations), external fires, extreme high/low temperatures, snow and wind (based on the safety analysis report), and a combination of hazards, such as an earthquake and a resulting flooding caused by the destruction of Dnieper dams.

The additional safety assessment of Zaporizhzhya ISF did not reveal any design safety deficits and additional (not considered by the design) external extreme hazards and their combinations that can challenge safety. Design bases used during the construction ensure high resistance to external extreme hazards.

More details on results of stress tests for the Zaporizhzhya ISF are given in the National Report of Ukraine on Stress Test Results.

Centralized ISF

The Law of Ukraine "On Spent Fuel Management: Siting, Design and Construction of the Centralized Dry Storage Facility for Spent Fuel of Ukrainian NPPs with WWER Reactors" approved on 9 February 2012 establishes the legislative framework for the decision to construct the Centralized ISF and defines its location in the Chornobyl Exclusion Zone.

Preparatory measures are taken at the defined site in the Chornobyl Exclusion Zone in order to start design implementation:

- radiation survey of the site area and of the access railroad area;
- front-end engineering and design are completed for access railroad to the Centralized ISF.

At the same time, the operating organization SE NNEGC *Energoatom* continues its efforts on upgrading of spent fuel management systems at Ukrainian NPPs, to modify design scenarios of SNF management and thus permit the use of containers envisaged by the Centralized ISF design in SNF handling and transportation at NPPs.

Construction of the Centralized ISF will permit to minimize transportation of spent fuel from Ukraine, reduce costs for transportation and correspondingly reduce dependence on the Russian Federation's pricing policy for acceptance, temporary storage and reprocessing of spent fuel.

B.2.2. Spent Fuel Management at Chornobyl NPP

In August 2010, nuclear fuel was completely removed from ChNPP unit 3. Efforts on removal of conditioned spent nuclear fuel from ChNPP unit 2 were terminated in November 2012, and efforts on removal of spent fuel from ChNPP unit 1 were completed in September 2013.

According to the plan, the issue on safe management and storage of damaged spent fuel in ISF-1 will be solved and spent fuel pools of ChNPP unit 1 and 2 will be completely released till the end of 2014.

ISF-1

The Wet Type Spent Nuclear Fuel Storage Facility ISF-1 of ChNPP intended for interim storage of RBMK-1000 spent fuel has been in operation since 1986.

According to the Safety Improvement Plan, the following measures have been taken for ChNPP ISF-1:

– additional ISF-1 safety assessment;

– calculation justification of non-exceeding the maximal temperature of fuel claddings for normal state and design-basis accidents;

– reconstruction of radiation monitoring system of ISF-1 as regards ensuring monitoring of neutron flux density;

– replacing detector of the measuring channel for monitoring of volumetric activity of service water after heat exchangers in spent fuel pools of ISF-1;

– ensuring power supply of ISF-1 essential loads by mobile diesel generator.

As of 01 July 2014, there are 21,231.5 SFAs in storage in the ISF-1 spent fuel pools.

ISF-2

Efforts are continued in the Exclusion Zone on construction of the dry type spent nuclear fuel storage facility ISF-2 intended for preparation for storage and long-term storage (up to 100 years) of ChNPP RBMK reactor spent fuel.

ISF-2 is being constructed with the support of donor countries through EBRD Nuclear Safety Account fund.

Holtec International developed the project to complete ISF-2 construction.

ISF-2 Completion Project received a positive review conclusion and it is approved by ChNPP order.

On 20 December 2013, SNRIU issued a license to perform activity on construction and commissioning of ISF-2.

B.2.3. Spent Fuel Management for Research Reactors

INR NASU Spent Fuel Storage Facility

Spent fuel management at the INR NASU site is described in Subsection B.2.3 of NRU-2011. During 2009-2010, spent fuel from the INR NASU VVR-M research nuclear reactor was transported to the Russian Federation for reprocessing.

As of 01 July 2014, INR NASU has no spent fuel on its site.

SUNEI

The SUNEI has no spent fuel at its site. Should there be any spent fuel, it will be stored in the wet spent fuel reactor pool.

B.3. Policy for Radioactive Waste Management

The major principles of state policy for radioactive waste management are defined by the Law of Ukraine and are presented in Subsection B.3. of NRU-2011.

The state policy for radioactive waste management is implemented in compliance with the Strategy for Radioactive Waste Management in Ukraine, National Target Ecological Program for Radioactive Waste Management, National Program for Chornobyl NPP Decommissioning and Shelter Transformation into an Environmentally Safe System.

The Strategy for Radioactive Waste Management in Ukraine defines major areas and tasks for development of the radioactive waste management system for a 50-year period in Ukraine.

The current strategic option for developing the radioactive waste management system in Ukraine provides for:

- radioactive waste treatment on NPP sites to the state acceptable for disposal or long-term storage in central facilities of the Vektor site;
- collection, conditioning, transport and interim storage of radioactive waste and spent radiation sources generated in medicine, science and industry at UkrDO *Radon* interregional specialized enterprises for radioactive waste management;
- centralized disposal of low- and intermediate-level short-lived waste and long-term storage of long-lived and high-level waste from all Ukrainian generators in facilities on the *Vektor* site;
- disposal of long-lived and high-level waste in a geological repository;
- development of a national organization for radwaste management, including long-term storage and disposal;
- sustainable and adequate funding of radwaste management measures;
- development of the regulatory and legal framework and international cooperation.

The following tasks are underway till 2017 in compliance with the National Target Ecological Program for Radioactive Waste Management:

- improve radioactive waste management system at NPPs;

- reassess safety, reequip and convert the UkrDO *Radon* state interregional specialized plants into sites for radwaste collection and interim storage in containers;

- commission and operate near-surface radioactive waste disposal facilities included in *Vektor* Stage I;

- design and construct facilities for long-term storage of long-lived and high-level waste at *Vektor* Stage II, including vitrified radiation sources to be returned from the Russian Federation after spent fuel reprocessing, other long-lived and high-level waste;

- design radwaste reprocessing facilities at *Vektor* Stage II;

- support ChNPP waste management system, monitoring, modernization and safety improvement of storage facilities for radwaste generated during the first years of Chornobyl accident;

- conduct investigations and research and development to select a site for a geological repository;

- ensure personnel training and professional development;

- improve state system for radwaste accounting and control;

- develop regulatory and legal framework and international cooperation.

The main area of NNEGC *Energoatom* technical policy (the operator of all NPPs except ChNPP) for radioactive waste management is to develop state-of-the-art infrastructure, which should ensure interrelation between all the stages of radwaste management from collection to disposal. According to the National Target Ecological Program for Radioactive Waste Management, NNEGC *Energoatom* developed and implemented the Comprehensive Program for Radioactive Waste Management at NNEGC *Energoatom* in 2012-2016 unique for operating NPPs. The Comprehensive Program is a fundamental document of the operating organization for radwaste management that defines main activities, technical and organizational measures for radwaste management.

The major tasks and measures for the development of the ChNPP radioactive waste management system are established in the National Program for Chornobyl NPP Decommissioning and Shelter Transformation into an Environmentally Safe System.

According to this National Program, the Integrated Radioactive Waste Management Program for ChNPP Decommissioning and Shelter Transformation into an Environmentally Safe System is implemented and kept updated. The Program objective is to develop and ensure functioning of the integrated optimized procedure for radwaste management at ChNPP, taking into account existing facilities for radwaste management and the ones planned to be constructed. The Integrated Radioactive Waste Management Program will ensure management of all waste streams at ChNPP, those accumulated during operation and generated after Chornobyl NPP accident and those generated during decommissioning and efforts taken at the Shelter.

B.4. Radioactive Waste Management Practices

B.4.1. Radioactive Waste Management at Operating NPPs

The list of facilities designed for radwaste management at operating NPPs is given in Subsection 3.1 of Annex 3 to this Report. Information on radwaste stored in storage facilities at operating NPP sites is given in Subsection 4.1 of Annex 4 to this Report.

The on-site management of operational radioactive waste includes collection, transport, treatment and interim storage in design facilities for liquid and solid waste.

Within activities on lifetime extension of operating NPPs, measures are taken to review the technical condition of facilities designed for radwaste management. Activities were completed to review the technical condition of facilities for interim storage of solid and liquid radwaste at

SUNPP-1, which are needed for acceptance of radwaste to be generated during the beyond design-basis operation of the power unit. At present, similar activities are performed at SUNPP-2 and ZNPP.

The improvement of a system for operational radioactive waste management at NPPs is aimed to ensure such radwaste treatment as to minimize waste and obtain reprocessing products so as to make the RAW acceptable for disposal or long-term storage in centralized facilities designed and constructed within "Vektor" complex in the Exclusion Zone. For this purpose, the Comprehensive Program for Radioactive Waste Management at SE NNEGC *Energoatom* for 2012-2016 defines main areas of activity and the list of measures designed to improve management of operational radwaste coming from NPPs of SE NNEGC *Energoatom*, in particular:

- upgrading of existing and construction of new facilities for treatment of solid and liquid radioactive waste;
- introduction of efficient and economically reasonable technologies for treatment of solid and liquid radioactive waste;
- construction of complex radwaste treatment lines to condition NPPs waste for long-term storage and disposal in the centralized facilities;
- development and introduction of radwaste characterization (certification) devices and procedures;
- improvement of the containers inventory for radwaste collection, transport, storage and disposal;
- improvement of the radwaste transport system.

Liquid Radwaste Management

Liquid radwaste at NPPs is stored in relevant storage facilities. Liquid radwaste is collected into sealed stainless steel tanks equipped with a system for automated liquid waste level monitoring and alarm in case of leaks. To avoid emergency leakage of liquid radwaste, all tanks are located in concrete rooms lined with stainless steel sheets. The designs of liquid radwaste storages provide for a redundant empty tank to be used in case of damage and repair of other tanks.

To minimize waste volumes, vat residue is evaporated to salt fusion cake using deep evaporation facilities (except South Ukraine NPP). The salt fusion cake is stored in 200-L KRO-200 containers placed into special compartments in solid waste storages.

According to OSPU, the salt fusion cake is classified as liquid radioactive waste and, according to the current legislation, is not subject to direct disposal. To solve the issue of further management of the salt fusion cake, there is a search for safe and economically reasonable technologies for its conditioning to the state acceptable for disposal.

During the reporting period, research and development was performed to select a LRAW treatment technology that prevents generation of the salt fusion cake. According to a comparative analysis, the most appropriate option for conditioning of LRAW of Ukrainian NPPs is the use of direct solidification through cementation.

The Rivne and Khmelnitsky NPPs operate centrifuges to remove the solid fraction (sludge) from floor drains. The dehydrated sludge is stored in containers in solid radioactive waste storage facilities.

Spent filters and sludge are collected and stored in radioactive waste storage facilities in tanks placed in water. Efforts are initiated to select a technology for conditioning of spent filters. The possibility is reviewed to use, at NPPs, a technology for immobilization of spent absorbers and sludges into a nonorganic geopolymeric matrix utilizing mobile facilities.

Solid Radwaste Management

Solid radioactive waste (SRAW) is collected at the sites of their formation, sorted into groups (by gamma dose rate) and transported to SRAW storage facilities for interim storage. At some NPPs low-level waste is conditioned prior to placement for interim storage: preliminary compaction (ZNPP and SUNPP) and incineration (ZNPP). The on-site SRAW storage facilities represent reinforced concrete structures consisting of individual compartments for radwaste depending on activity. The compartments are equipped with a fire alarm system, automated fire-extinguishing system and exhaust ventilation with air purification. Some SRAW storage compartments are additionally equipped with a moisture detection and removal system.

Zaporizhzhya and Rivne NPPs continue to establish (including, within TACIS international assistance projects) systems for solid radioactive waste treatment, including:

- incineration facility, release monitoring system, facilities for fragmentation, supercompaction, radwaste retrieval from existing interim storages and activity measuring (ZNPP);
- facilities for solid radwaste retrieval, sorting and fragmentation, supercompaction, activity measuring for radwaste package characterization, cementation, metal decontamination, oil purification (RNPP).

Construction and mounting activities are underway at RNPP and ZNPP in accordance with approved designs of radioactive waste treatment facilities. New equipment is supplied to NPP sites. Activities are performed at ZNPP to mount an incineration facility and a release monitoring system, acceptance tests are completed for fragmentation and supercompaction facilities. Commissioning of facilities is planned for 2016.

Activities are completed at KhNPP and SUNPP on development of design documentation for radwaste treatment facilities, a state expert review is initiated, measures are taken to inspect buildings, where facilities are to be located.

All facilities will be equipped with systems for radiation monitoring and certification of radwaste packages to be transferred for disposal to the "Vektor" central facilities. The facilities will be provided with systems for radiation monitoring and characterization of radwaste packages. Radwaste packages will be transferred for disposal to the "Vektor" central facilities. The commissioning of the solid radioactive waste treatment facility will ensure reprocessing of SRAW accumulated at NPPs' sites to the state acceptable for disposal, and will permit to release capacities of the existing on-site radwaste storages in view of the NPPs' lifetime extension.

During the reporting period, KTROf-0.28 and KTROf-0.2 containers were designed for conditioned radwaste, after treatment at SRAW treatment facilities, and KT-0,2 containers - for storage of dehydrated sludge.

A concept is defined for a light facility for interim storage of conditioned radwaste in universal protective reinforced concrete containers. Technical Conditions and design documentation are developed for the universal protective reinforced concrete containers for storage and disposal of radwaste, as well as the testing program and methodology. Containers will be used both for radwaste management processes at NPPs and for long-term storage and disposal of solid radwaste in the "Vektor" central facilities.

In order to ensure acceptance/transfer of high-level waste resulting from WWER-440 spent fuel reprocessing in the Russian Federation, a methodology was developed "For Calculation of the Amount of High-Level Waste Returned to Ukraine after Process Storage and Reprocessing of a WWER-440 SFA Batch", requirements were defined for containers and packages for long-term storage of HLRAW returned to Ukraine from the Russian Federation after WWER-440 spent fuel reprocessing. Efforts are continued to agree on the procedure for implementation of the contract provisions related to the return to Ukraine of vitrified radwaste from RNPP WWER-440 spent fuel treatment. Technical Requirements to WWER-440 Spent FA Reprocessing Products to be

Returned to Ukraine and the Procedure for Certification of Containers with Vitrified Radwaste from WWER-440 Spent Fuel Reprocessing are also under agreement.

Spent fuel from NPPs with WWER-1000 reactors (except ZNPP) is transported to the Russian Federation for process storage and treatment. At present, WWER-1000 spent fuel is not reprocessed in the Russian Federation, the processing technology being under refinement. Approval of Technical Requirements to WWER-1000 Spent FA Reprocessing Products to be Returned to Ukraine is underway.

A Facility for long-term storage of vitrified radwaste from spent fuel reprocessing is planned as part of "*Vektor*" complex Phase II.

B.4.2. Radioactive Waste Management at Chornobyl NPP

Detailed information on the existing radwaste management system at the ChNPP is presented in Subsection B.4.2 of NRU-2008.

The list of facilities for ChNPP radwaste management is given in Subsection 3.2 of Annex 3 of this Report. Information on radwaste stored in facilities on the ChNPP site is presented in Subsection 4.2 of Annex 4 of this Report.

Detailed information on the Shelter activity and NSC construction is presented in Annex 9 of this Report.

Developing the management system for Chornobyl radwaste are taken in accordance with the National Program for Chornobyl NPP Decommissioning and Shelter Transformation into an Environmentally Safe System. Such a system should ensure treatment of radwaste accumulated during operation and radwaste that will be generated in Chornobyl NPP decommissioning and Shelter-related activities.

Progress has been made in implementation of projects on construction of facilities for radwaste treatment at ChNPP site in the reporting period.

The interim storage facility for packages with high-level and long-lived radwaste with design storage period during 30 years has been commissioned. The reinforced concrete compartments of the interim storage facility are constructed at upper elevations of the existing building of the ChNPP liquid and solid storage facility.

The interim storage is equipped with a system for transport of radwaste packages in in transport protective reinforced concrete containers, remote equipment for handling and placement of radwaste packages in compartments controlled from a shielded operator room, and systems of video surveillance, exhaust ventilation and radiation monitoring. Radwaste to be stored in this facility will be placed into a double package: 165-L metal drums to be loaded into 200-L metal drums to ensure additional shielding. The storage facility will accept:

- long-lived and high-level radwaste resulting from waste sorting at the solid radwaste treatment plant;
- high-level waste resulting from Shelter-related activities, ISF-2 operation and ChNPP decommissioning.

The storage facility is designed to house 6360 packages with high-level waste and 6784 packages with low- and intermediate-level long-lived waste.

SRTP included in ICSRM is under commissioning. Carry out additional checks and tests of the radwaste sorting system and radwaste characterization, process systems for radwaste treatment (incineration, compaction and cementation). Radwaste treated for disposal is placed in certified 3 m^3 reinforced concrete containers KZ-3 to be transferred for disposal in ENSDF of the Vektor site.

LRTP commissioning is under completion. Commissioning of LRTP will allow ensuring transport, acceptance and reprocessing of liquid radwaste (first of all, evaporation bottoms

accumulated in existing radwaste storage facility). After all process operations of liquid radwaste treatment and characterization of received packages, treatment of other types of liquid radwaste (ion-exchange resins, filter pearlite pulp) will be performed. The treatment technology is based on liquid radwaste cementing and placing of cemented liquid radwaste in 200-L metal drums to be transferred for disposal to ENSDF of the Vektor site. Transport of drums for disposal in ENSDF is underway.

The plant for manufacture of metal drums and containers for ChNPP radwaste is under operation. It has been constructed to ensure the necessary number of KZ-3 reinforced concrete containers and metal drums of different types for ChNPP radwaste management. The plant is located in Slavutych that permits to avoid irradiation of the plant personnel. Certificates of conformity have been gotten for all metal drums which are produced.

Systems and equipment of the line for fragmentation of high-level long-length components are produced and mounted. The main objective of this facility is to perform fragmentation (cutting) of special equipment and elements of the core (long-length components) that are overaged. Long-length components are from 6 to 22 m length and are of 145 mm diameter that requires special equipment and technologies for their treatment during unit decommissioning. The main systems of this facility include hot chamber for cutting of long-length components equipped with special knives, system of video surveillance, system of radiation monitoring and characterization of radwaste packages, system of automated control, ventilation system. The facility is planned to be mounted and operated at unit 2 and later at units 1 and 3. Radwaste resulting from fragmentation of long-length components should be placed in double package: 165-L metal drums to be loaded into 200-L metal drums for storage in the interim storage facility for packages with high-level and long-lived radwaste.

Designing of additional radwaste management facilities has been started:

- facility for removal of organic compounds and transuranium elements from Shelter liquid radwaste;
- areas for storage, fragmentation and decontamination of dismantled structures and equipment;
- facility for release of dismantled materials from regulatory control.

Feasibility Study for Design and Construction of New Additional Facilities for Radioactive Material and Radioactive Waste Management was developed in 2014 and submitted to the regulatory authorities for review in order to improve radwaste management system during ChNPP decommissioning.

B.4.3. Radioactive Waste Management in Exclusion Zone

The list of facilities for management of radioactive waste located in the Exclusion Zone (except ChNPP site) is presented in Subsection 3.3 of Annex 3 of this Report. Data on radwaste disposed of in SSE *CRME* at the Exclusion Zone are given in Subsection 4.4 of Annex 4 of this Report. Data on radwaste stored/confined in the storage facilities of the Exclusion Zone are presented in Subsection 4.5 of Annex 4 of this Report.

The main activity on radwaste management in the Exclusion Zone (except ChNPP site) is performed by SSE *CRME* appointed as the operating organization (operator) for all operating stages and closure of radwaste disposal facilities. The SSE *CRME* also takes specific efforts on radwaste treatment and transport.

The SSE *CRME* deals in the Exclusion Zone with:

- operation of two parallel modules of ENSDF at the Vektor site for disposal of radwaste packages from LRTP and SRTP of ChNPP;
- operation of near-surface disposal facilities of the RWDP *Buriakivka*;

- maintaining and safety improvement of RWDP *Pidlisnyy* and *ChNPP Stage III* constructed during the first years after ChNPP accident;

- maintaining, surveillance, monitoring and liquidation of trenches and pits of RICP;

- operation of the station for decontamination of overalls and individual protection means and the point for decontamination of special vehicles and equipment;

- radwaste transport.

Efforts on design, construction and repair of facilities for radwaste management in the Exclusion Zone (except ChNPP site) are performed by SSE *CCMEZ* appointed as the operating organization (operator) during siting, design and construction of radwaste disposal facilities at the Vektor site and construction of radwaste storage facility.

SSE *CCMEZ* deals in the Exclusion Zone with:

- completion of disposal facilities SRW-1 and SRW-2 within the *Vektor* Stage I with total capacity of 19,200 m^3 and infrastructure facilities to ensure operation of the radwaste disposal facilities (vehicle wash, radiological laboratory, changing rooms etc.);

- construction of the Centralized Long-Term Storage Facility for Radiation Sources within the *Vektor* Stage II (CLTSF).

Efforts on radwaste treatment related to collection and decontamination of radioactive materials and radioactive waste, radwaste transport, radiation dose monitoring and monitoring of the environment in the Exclusion Zone are performed by SSE *Chornobyl Specialized Enterprise*.

RWDP Buriakivka

RWDP *Buriakivka* was commissioned in 1987. RWDP consists of 30 near-surface radwaste disposal facilities (trenches). The main engineering barrier is a compacted clay layer one meter thick to confine radioactive elements from the environment. RWDP *Buriakivka* is one of the main elements to manage large scope of emergency radwaste resulting from the Chornobyl accident. The facility was constructed within priority measures after the Chornobyl catastrophe. Until now, operation of this RWDP ensures disposal of large scope of low-level radwaste resulting from efforts at ChNPP site and contaminated areas of the Exclusion Zone. RWDP *Buriakivka* has practically exhausted its capacities.

During the reporting period, safety of RWDP Buriakivka was reassessed under INSC Project U4.01/08-B with the support of EC. Taking into account the safety reassessment, possible decisions on RWDP reconstruction are examined in order to increase capacities on low-level radwaste disposal.

ENSDF

The Engineered Near-Surface Disposal Facility (ENSDF) for solid radwaste was constructed on the Vektor site within ICSRM for disposal of radwaste packages from ChNPP LRTP and SRTP. The design capacity of the disposal facility is 50,210 m^3. ENSDF consists of two parallel sections, each with eleven reinforced concrete compartments (modules). The disposal facility is equipped with the central drainage gallery, two mobile frame structures with bridge cranes for filling of modules, radiation monitoring system and system of environmental monitoring. Within the disposal facility operation, measures are taken to ensure functioning of the central drainage gallery under the disposal facility and monitor state of building structures in modules. State-of-the-art procedures are investigated and implemented for ENSDF safety reassessment in order to increase the number of radwaste suppliers and update radwaste acceptance criteria for this disposal facility. Placing of ChNPP radwaste packages in ENSDF was started on 26 April 2014.

RWDP and RICP

RWDP *Pidlisnyy* was constructed within priority measures after the Chornobyl accident. From the end of 1986 to the end of 1988, the most hazardous high-level and long-lived radwaste had been placed in modules A-1 and B-1 of this RWDP. On 18 March 2012, the project "Closure of RWDP *Pidlisnyy*" aimed at stabilization and safety improvement of this facility has been completed. Efforts under the project were started in the end of 2011. Process covers over RWDP modules, new bunding around the perimeter of modules, new water removal drainage system, eight additional observation wells for monitoring groundwater were constructed. They will ensure protection against degradation and support of confining functions of RWDP *Pidlisnyy* engineering barriers and will improve the monitoring system efficiency.

RWDP *ChNPP Stage III* was constructed within priority measures after the Chornobyl accident in the partially constructed facility for solid radioactive waste of non-completed ChNPP Stage III. From the end of 1986 to the end of 1988, low- and intermediate-level radwaste was located in the reinforced concrete modules of this facility and bunding was constructed. Over the years, the bunding has been degraded and required measures for repair and maintenance on the permanent basis. As of today, the project "Closure of RWDP ChNPP Stage III" is agreed and is under implementation in order to stabilize and improve safety of this facility. The project envisages construction of additional engineered barriers (new multi-layer upper protective screen over existing modules with radwaste), modernized drainage system and monitoring system, improvement of the facility infrastructure (access ways, physical protection system etc.).

RICP includes territories adjacent to ChNPP with total area of 10 ha, where trenches and pits for radwaste confinement were constructed within priority measures after the Chornobyl catastrophe. Mostly, such radwaste means radioactively contaminated building structures, household items, upper layer of soil etc. Nine RICP are located in the Exclusion Zone: Yaniv Station, Naftobaza, Pischane Plato, Rudyy Lis, Stara Budbaza, Prypiat, Kopachi, Chystohalivka with total area of 10 ha, where trenches and pits with radwaste are located. Estimated quantity of RICP trenches and pits is from 800 to 1000 pcs., accurate location of some of them should be specified. The RICP territories in the Exclusion Zone are continuously investigated, trenches and pits are maintained in a safe state. The objective of investigations is to search and specify locations of trenches and pits with radwaste, specify inventory and activity of placed radwaste. Efforts on investigation, safety assessment and remediation of these territories are planned within INSC Project U4.01/10-D.

SSE *CRME* performs efforts on retrieval and redisposal of radwaste from RICP trenches and pits that can have the most negative impact on the personnel of the Exclusion Zone and the environment. Starting from 2012, 8,342.8 m^3 radwaste with total activity of 0.67 TBq were transferred for disposal to RWDP *Buriakivka* from trenches and pits of Nova Budbaza within locations for construction of ISF-2 and NSC, and RICP Naftobaza, where seasonal floodings are observed.

RWDP and RICP in the Exclusion Zone and existing solid radwaste disposal facility at ChNPP are the elements of management system with large amounts of emergency ChNPP radwaste. At present, these facilities ensure confinement and isolation of radwaste from release into the environment. Though they require measures on maintenance, monitoring, surveillance, stabilization, safety improvement, remediation, safety reassessment etc. such measures are one of the main constituents of the Strategy for Radioactive Waste Management in Ukraine and the National Target Ecological Program for Radioactive Waste Management. International cooperation with EC and IAEA is involved for their implementation.

CLTSF

CLTSF is a key element to create a system for safety management of spent radiation sources in Ukraine (see Section J of this Report). This facility should ensure centralized placing of spent

radiation sources that are currently stored at UkrDO *Radon* SISPs and used in medicine, science and industry. The design of the facility foresees capacities for acceptance, processing, sorting, identification, conditioning and packaging of spent sources and placing for long-term storage according to the type of activity (α-, β-, γ-, n-emitting). General amount of spent radiation sources planned to be accepted is 500,000 pcs. The project is implemented with the support of the Department of Energy and Climate Change of the Great Britain. During the reporting period, main buildings and structures of the facility were constructed, equipment of process systems, radiation monitoring systems and ventilation systems was produced and purchased. Significant progress on construction of the storage facility is planned till the end of 2014.

Facilities for long-term storage of radwaste included into Vektor Stage II

According to the Strategy for Radioactive Waste Management in Ukraine and the National Target Ecological Program for Radioactive Waste Management, design of new facilities for long-term storage of radwaste as part of Vektor *Stage II* is underway in order to improve the radwaste management system in Ukraine:

- facilities for long-term storage of vitrified radwaste to be returned from the Russian Federation after WWER-440 spent fuel reprocessing. On 01 August 2012, the SNRIU Board Resolution approved the positive conclusions of NRS State Review of "Feasibility Study of Investments for Construction of the Interim Storage Facility for Radioactive Waste Returned from Russia after Ukrainian NPP Spent Fuel Reprocessing". The next design stage includes development and approval of the facility design;
- facility for long-term storage of high-level radwaste and facility for long-term storage of long-lived radwaste. High-level and long-lived radwaste that should be stored in these facilities would be generated during efforts on retrieval of radwaste and fuel-containing materials from the Shelter, ChNPP decommissioning and during NPP operation.

Facilities for long-term storage will ensure long-term storage (100 years) of the relevant radwaste prior to its disposal in the geological repository.

International cooperation with EC under INSC Project U4.01/12-A is planned to design facilities for long-term storage of radwaste as part of *Vektor* Stage II.

B.4.4. Radioactive Waste Management at UkrDO *Radon*

Radioactive waste originating from the use of radiation sources in medicine, science, different fields of industry in the relevant Ukrainian regions are collected and managed for interim storage by six State Interregional Specialized Plants for Radioactive Waste Management (SISP) of UkrDO *Radon*: Kyiv SISP, Kharkiv SISP, Dnipropetrovsk SISP, Odessa SISP, Lviv SISP and Donetsk SISP.

The list of radwaste facilities located on UkrDO *Radon* SISP sites is presented in Subsection 3.4 of Annex 3 to this Report. Data on radwaste and spent radiation sources located in UkrDO *Radon* SISP facilities are presented in Subsection 4.6 of Annex 4.6 to this Report. Spent radiation sources are the main type of radwaste managed by SISPs.

SISPs are responsible for the following:

- operate facilities for solid radwaste storage in containers;
- maintain, check and monitor conserved radwaste disposal facilities that were filled during the previous period (to 1996);
- collect, condition and transport radwaste to the relevant facilities;

- operation of decontamination stations for overalls, clothes, and individual protection means.

Containers with radwaste and spent radiation sources are stored in hangar-type storage facilities. These buildings were constructed at SISP sites in the 1990s after making decision on SISP transfer to the radwaste storage technology.

Conserved radwaste disposal facilities filled to 1996 are a system of near-surface reinforced concrete module-type facilities with the capacity of 200 m^3. They were constructed according to standard designs in the 1960s–1970s. SISPs are responsible for maintenance, monitoring and safety reassessment to make decisions on the safety state of each facility, periods during which these facilities can ensure reliable radwaste isolation, process decisions on radwaste retrieval and liquidation of facilities.

Some of these module-type facilities at Lviv SISP and Kharkiv SISP, which are remained unfilled, are placed under hangar covers and are operated as modules for temporary storage of radwaste in containers.

There are also borehole facilities on SISP sites for spent radiation sources. They represent deep stainless steel tanks with a wavy reception tube for lowering of RS capsules. According to a regulatory decision, spent radiation sources are no longer placed into the borehole facilities. The safety reassessment should be performed and process decisions should be made on the retrieval of spent radiation sources located in these facilities.

According to conditions of SISP licenses, SISP started the safety reassessment of radwaste facilities on their sites. The safety reassessment is performed for both facilities operated under the technology of temporary container storage of radwaste and spent radiation sources and conserved "historical" facilities that were operated in the previous period (see Subsection H.2.2 of this Report). Based on the reassessment, the time frame while facilities can be considered safe will be justified and decisions on radwaste removal will be planned. At present, radwaste is planned to be retrieved from Kyiv SISP facilities No. 5, 6, 7. The retrieval project is developed and is under consideration. Design decisions are made on sorting of radwaste and its placing in protective containers that would ensure further safe storage of retrieved radwaste prior to reprocessing and disposal at the Vektor site.

New state-of-the-art facilities for radwaste management, radwaste reprocessing and conditioning are designed to be constructed within some SISPs to improve safety of radwaste management.

On 03 July 2013, the new module-type storage facility for radwaste and spent radiation sources was commissioned in Dnipropetrovsk SISP to increase capacity of this SISP and improve safety of spent RS storage. The storage facility was constructed with investments provided within the technical cooperation with the USA. Dnipropetrovsk SISP provides services to one industrial region in Ukraine, where a lot of radiation sources are used. A large quantity of radiation sources were retrieved and transferred to this SISP from enterprises in defaults remained after the USSR under projects "Decommissioning of Irradiation Facilities and Safe Storage of Radiation Sources" (BMU/GRS, Germany) and "Improving Security of Spent Radiation Sources in Ukraine" (the USA).

At Kharkiv SISP, the special facility (Packet) for remote reloading of spent radiation sources from transport container to storage container has been commissioned in 2011.

In 2013, Kharkiv SISP started experimental efforts on testing technology for decontamination of tubing contaminated by natural radionuclides.

In 2014, the mobile complex of technical means for safe discharge of spent radiation sources from BGI and E biological protective units was completed and prepared for operation. The mobile complex is a facility for management of radwaste that are spent gamma radiation sources. The complex operation is envisaged at SISP sites for discharge of spent radiation sources

and their placing into the protective container. This procedure will allow reducing the scope of such radwaste, improving safety of storage and increasing efficiency of its transport to CLTSF after commissioning. Development and producing of the mobile complex and special packaging set for placing and transport of spent radiation sources are performed within cooperation with the French Atomic Energy Commission.

The Kyiv SISP conducts maintenance, radiation monitoring and control of storage sites for radwaste resulting from decontamination and sanitary treatment of vehicles (SSR) after the Chornobyl accident, which are located outside the Exclusion Zone in the Kyiv, Zhytomyr and Chernihiv Regions. These facilities require decisions to be made and accepted on their liquidation.

B.4.5. Management of Radioactive Waste from Research Reactors

Data on radwaste stored at research reactor sites are presented in Subsection 4.3 of Annex 4 to this Report.

Information on the management of radwaste from SUNEI RR-100 (Sevastopol) and INR NASU VVR-M (Kyiv) research reactors is provided in Subsection B.4.5 of NRU-2008. No changes in the radwaste management systems at these facilities were effected in the reporting period.

B.5. Criteria Used to Identify and Categorize Radioactive Waste

Detailed information on the radwaste classification system used in Ukraine is provided in Subsection B.5 of NRU-2005 and NRU-2011.

Taking into account new IAEA Safety Standard GSG-1 Classification of Radioactive Waste, international experience, IRRS-2008 and IRRS-2010 recommendations, Ukraine initiated revision and improvement of the radwaste classification system. This is aimed at implementing the radwaste classification system in accordance with waste ultimate disposal technique. Within EC Instrument for Cooperation INSC, Project U4.01/08-C "Improvement of the radwaste classification system in Ukraine" was implemented during 2010-2012. Efforts are continued to implement recommendations under this project into the national regulatory and legal system.

The existing classification of radwaste is used during the transition period prior to implementation of the new classification system for needs of facilities under operation. Besides, research and investigations on further development of radwaste disposal system, development of disposal concepts are performed considering proposals to improve radwaste classification under Project U4.01/08-C.

Section C. SCOPE OF APPLICATION (Article 3)

Spent fuel and radwaste management in Ukraine is considered according to Article 2 of the Joint Convention.

Ukraine has no facilities for spent fuel reprocessing.

Ukraine deals with uranium ore mining and processing resulting in uranium ore waste stored in tailing pits of the SE *SkhidGZK* and former IA PCP. According to the Radiation Safety Standards of Ukraine, waste from uranium mining industry, as well as waste resulting from mining of other minerals, is considered as technology-enhanced naturally occurring radioactive material and is not declared by Ukraine as radwaste. In line with recommendations of the First and Third Review Meetings of the Contracting Parties to the Joint Convention, information on uranium milling waste is provided in Annex 10 to this Report.

Ukraine does not pursue any military or defense programs that would result in the generation of spent fuel or radwaste. However, there are four radwaste disposal sites that remained from the former activities of the USSR Army and are kept by the Ministry of Defense and State Border Guard Service of Ukraine. The Strategy for Radioactive Waste Management in Ukraine and National Target Ecological Program for Radioactive Waste Management envisage safety measures for these facilities to keep them in a safe state, carry out safety reassessment and plan subsequent liquidation.

Ukraine applies requirements of the Joint Convention to ensure the safety of radwaste originating from former defense programs, if this radwaste has been transferred for management under civil programs.

Section D. INVENTORIES AND LISTS (Article 32, Para. 2)

D.1. List of Spent Fuel Management Facilities Subject to the Joint Convention, Their Location, Main Purpose and Essential Features

Spent fuel is generated in Ukraine at operating NPPs and research reactors.

Ukrainian NPPs currently operate WWER-1000 (13 units) and WWER-440 (2 units) reactors. Systems for spent fuel management include handling equipment for loading and unloading of reactors and transport containers and spent fuel pools.

ZNPP operates a dry interim storage facility for WWER-1000 spent fuel designed for 380 storage containers, each containing 24 SFAs. All ZNPP units are equipped with handling equipment for loading and unloading of storage containers.

ChNPP RBMK-1000 spent fuel is stored in the spent fuel pools of units 1, 2 and ISF-1.

As of 01 July 2014, the list of spent fuel management facilities is presented in Annex 1 of the Report.

D.2. Inventory of Spent Fuel Subject to the Joint Convention

As required by the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", spent fuel is accounted for under the state system for accounting and control of nuclear materials. The inventory of spent fuel as of 01 July 2014 is presented in Annex 2 to this Report.

D.3. List of Radioactive Waste Management Facilities Subject to the Joint Convention, Their Location, Main Purpose and Essential Features

A general description of radwaste management facilities existing in Ukraine is provided inSubsection B.4.1 - 4.5 of this Report.

A list of radwaste management facilities as of 1 July 2014 is provided in Annex 3 to this Report.

D.4. Inventory of Radioactive Waste Subject to the Joint Convention

The system for state accounting of radwaste and control of its transportation consists of two main elements: the State Register of Radwaste and State Cadaster of Storages and Sites for Temporary Radwaste Storage.

SEZA, as a state authority for radwaste management, arranges and coordinates state accounting of radwaste and storage facilities and carries out state inventories of radwaste. UkrDO *Radon*, which includes the Chief Information and Analytical Center for Radwaste State Accounting System and Regional Centers for Radwaste Accounting, is responsible for the State Register and State Cadaster. State inventory of radwaste is taken every three years. The first state inventory was taken in 1999-2000, the second in 2003, the third in 2007, the fourth in 2010 and the fifth in 2013.

Radwaste inventories as of 01 July 2014 are presented in Annex 4 to this Report.

D.4.1. List of Radioactive Waste in Temporary Storage at Nuclear Facilities and Research Reactors

Subsections 4.1–4.3 of Annex 4 to this Report contain data on radwaste accumulated in storages located at sites of NNEGC *Energoatom* NPPs, ChNPP and research reactors as of 1 July 2014.

D.4.2. List of Radioactive Waste That Has Been Disposed

Subsection 4.4 of Annex 4 to this Report contains information on radwaste disposed of in near-surface radwaste disposal facilities of the RWDP *Buriakivka* and ENSDF of the Vektor site as of 1 July 2014.

D.4.3. List of Radioactive Waste Resulting from Past Practices

Subsection 4.5 of Annex 4 to this Report contain data on radwaste originating from the Chornobyl accident (stored in SSE CRME facilities).

Subsection 4.6 of Annex 4 to this Report contain data on radwaste originating from the use of RS by industrial enterprises, research, scientific and medical institutions, liquidation of radwaste storages of the Ministry of Defense (stored at UkrDO *Radon* facilities) as of 1 July 2014.

D.5. List of Nuclear Facilities under Decommissioning and the Status of Decommissioning Activities at Those Facilities

The list of ChNPP nuclear facilities being decommissioned is provided in Annex 5 to this Report.

Section E. LEGISLATIVE AND REGULATORY SYSTEM

E.1. Implementing Measures (Article 18)

Nuclear safety requirements and regulations in Ukraine are established by laws, resolutions of the Cabinet of Ministers and regulatory documents of central executive authorities. The system of nuclear legislation also includes international treaties of Ukraine, whose obligatory nature is appropriately acknowledged and which constitute an integral part of national legislation.

Regulatory requirements are developed by the SNRIU on a systematic basis through analysis of the existing regulatory framework, taking into account IAEA safety standards, EC legislation, recommendations of the West European Nuclear Regulators' Association and regulatory experience of other member states.

The main priorities to develop the national regulatory and legal system during the reporting period include:

- implementation of recommendations and suggestions of IRRS-2008 mission and IRRS-2010 follow-up mission based on the Action Plan to Implement Recommendations and Suggestions of the IAEA Mission "Integrated Regulatory Review" (IRRS) approved by Cabinet Resolution No. 751-r dated 26 September 2013;
- implementation of IAEA requirements and safety standards, EC Directives, WENRA recommendations;
- implementation of strategic objectives for nuclear development according to the Strategy for Radioactive Waste Management and Energy Strategy.

Among others, regarding radwaste and spent nuclear fuel management, the following regulations are under development/revision:

- requirements and conditions (licensing conditions) for enterprises that provide radioactive waste management activity regarding disposal, processing and storage (considering Council Directive 2011/70/EUROATOM and SF-1);
- general safety requirements for disposal of radioactive waste (based on SSR-5);
- general safety requirements for processing of radioactive waste (based on GSR Part 5);
- updated requirements for nuclear fuel management at NPPs covering unloading, storage, transportation within the NPP site;
- requirements for the list of documents provided by operator for applying for the license for the activity on the nuclear facility lifecycle stages;
- requirements for NORM waste management;
- requirements for safety waste management from uranium mining and milling industry.

There are regulations under development based on the new IAEA Safety Guides:

- updated requirements for the structure and content of SAR for disposal facility (based on SSG-23);
- updated requirements for the structure and content of SAR for radioactive waste processing facility (based on GSG-3);
- updated requirements for the structure and content of SAR for radioactive waste storage facility (based on GSG-3);
- requirements for safety assessment and monitoring program for geological repository (based on SSG-23) etc.

E.2. Legislative and Regulatory Framework (Article 19)

E.2.1. National Safety Requirements and Radiation Safety Regulations

The list of nuclear regulations made valid during the period from 2011 to the first six month of 2014 is presented in Annex 6 of this Report.

E.2.2. Licensing System for Spent Fuel and Radioactive Waste Management

The major legal and organizational issues of licensing system are set up in the Law of Ukraine "On Authorizing Activity in the Sphere of Nuclear Energy Use".

The purpose of licensing system in the field of nuclear energy use and accordingly for spent fuel and radwaste management was described in Subsection E.2.2 of NRU-2008.

The list of activities that require receiving license and permission is set in the Law of Ukraine "On Authorizing Activity in the Sphere of Nuclear Energy Use".

The license is required to provide following activities related to spent fuel and radwaste management activities:

- operator's activity on the particular stages of lifecycle of nuclear facility (including spent fuel storage facility): construction and commissioning of the facility, operation of the facility, decommissioning of the facility;
- operator's activity on the particular stages of lifecycle of radwaste disposal facility related to construction of the disposal facility, operation of the disposal facility, closure of the disposal facility;
- activity of operator's officials in charge of management and organizational decisions for ensuring nuclear and radiation safety;
- activity of radwaste treatment and storage enterprises related to radwaste processing facility operation and decommissioning; radwaste storage facility construction, operation and decommissioning, other radwaste management activity;
- activity on radioactive material transportation.

Individual permission is required for the operator to take certain efforts during specific stage of nuclear facility or radwaste disposal facility lifecycle. These efforts are listed in each license.

The list of documents to be submitted by the licensee to support its license application for each type of activity is defined in regulations.

E.2.3. System of Prohibition to Operate a Spent Fuel or Radioactive Waste Management Facility without a License

The legislative provisions regarding the prohibition to operate a spent fuel or radwaste management facility indicated in Subsection E.2.3 of NRU-2008 has not changed.

E.2.4. System of Institutional and Regulatory Control and Documentation and Reporting

The safety and quality assurance in the area of spent fuel and radioactive waste management is controlled at three levels by:

I) the contractor performing peculiar activities;

II) the individual appointed by the licensee who is independent of the contractor (institutional control);

III) SNRIU state inspectors (regulatory control).

The licensee's self-assessment and institutional control independent of the contractor is a

necessary condition to obtain a license for spent fuel and radioactive waste management.

Regulatory control involves state supervision over compliance with nuclear and radiation safety requirements for spent fuel and radioactive waste management. State supervision in the area of nuclear energy is performed by the SNRIU and its territorial bodies (State Nuclear Safety Inspectorates) pursuant to Article 25 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and according to the "Procedure for State Oversight of Compliance with Nuclear and Radiation Safety Requirements" No. 824 dated 13 November 2013.

State oversight adheres to the following principles:

- priority to ensure nuclear and radiation safety;
- openness, transparency, planned and systemic nature of state oversight measures;
- adequacy and impartiality of requirements by state inspectors;
- compliance of enforcement measures and scope of financial sanctions with nature of revealed inconsistencies and level of their impact on nuclear and radiation safety;
- planning and taking state oversight measures, considering level of the potential hazard of facilities subjected to state oversight (risk-informed approach), degree of risk based on nuclear activity;
- taking enforcement measures to prevent offenses;
- inadmissibility of any interference of any authorities, officials and employees, the public and associations into state oversight measures, except cases envisaged by the law.

State supervision includes three basic components:

- current safety assessment – SNRIU review of licensee submittals periodically issued to confirm compliance with safety requirements;
- inspection – inspection efforts and measures and observation of compliance with prescriptions issued to reveal, eliminate and prevent violations. Inspections are divided into checks (to check the licensees' performance) and surveys (to audit the applicant prior to granting a license or an authorization for a practice, activity, or operation under the license);
- enforcement – sanctions that may be imposed on the licensee based on findings of safety assessment and/or inspection in order to eliminate current and prevent future violations and encourage licensee personnel to improve safety culture.

The SNRIU performs state oversight on the basis of annual and monthly plans. If scheduled checks or review of reports reveal safety deficits, unscheduled or response inspections are conducted.

Legislation establishes requirements for the licensees to submit periodic safety reports on facilities and activities to the regulatory authority. Requirements on the periodicity and contents of safety reports are set forth in licenses and relevant regulations.

The licensees are informed of inspection and review finding. Information on results of regulatory control is provided in annual reports on nuclear and radiation safety in Ukraine and periodically placed on the SNRIU official website.

E.2.5. Enforcement of Applicable Regulations and Terms of Licenses

According to Article 17-1 of the Law of Ukraine "On Authorizing Activity in the Sphere of Nuclear Energy", entities dealing with nuclear energy are responsible for:

- activities in the area of nuclear energy for which a license and/or another authorization and registration are required under the above Law, without these documents or registration, penalty is imposed in the amount from 500 to 50,000 nontaxable incomes;
- failure to comply or properly comply with terms of a license and/or another authorization, in this case, penalty is imposed in the amount from one to 100,000 nontaxable incomes.

The decision to impose penalties in accordance with part 1 of this article is made by the chief state inspector for nuclear and radiation safety or his deputy based on the record of incompliance with this Law issued by an inspector of the SNRIU or a territorial body. The costs used to pay penalties are allocated to the State Budget of Ukraine.

Pursuant to Presidential Decree No. 403/2011 dated 6 April 2011, the SNRIU:

- takes, within its power, enforcement actions against legal entities and individuals if they violate legislation and fail to comply with authorizing documents, standards and rules on nuclear and radiation safety or requirements for physical protection of nuclear facilities, nuclear material, radioactive waste and other radiation sources;
- monitors temporary storage of radioactive waste by their generators beyond the period established by special licensing terms. If the established period expires, radioactive waste owners have to pay to the Fund for Radioactive Waste Management, as envisaged by the Tax Code of Ukraine;
- sends mandatory orders (prescriptions) to eliminate violations and drawbacks in the area of nuclear energy to licensees, their officials, heads of central and local executive authorities and local governments; submits notices on inaptitude of individuals to the held position to licensees and owners or heads of enterprises, establishments or organizations;
- applies, in accordance with established procedure, financial sanctions to enterprises, establishments and organizations and other entities if they violate legislation or terms of authorizations;
- calls to account, in a proper legal manner, individuals guilty of incompliance with authorizations, standards and regulations on nuclear and radiation safety, physical protection requirements;
- restricts, suspends and terminates operation of enterprises, establishments and organizations, nuclear facilities, radioactive waste management facilities and facilities with radiation sources, if requirements for nuclear and radiation safety are not met or cannot be complied with;
- submits certificates of incompliance with requirements for nuclear and radiation safety and physical protection of radioactive waste and other radiation sources established by laws and other regulations to law-enforcement bodies.

Procedures and criteria for imposing sanctions and their amount are established in:

– Code on Administrative Violations of Ukraine;
– Procedure for State Safety Oversight in the Area of Nuclear Energy;
– Guidelines on Prosecution of Administrative Violations in the Area of Nuclear and Radiation Safety;
– document of the SNRIU quality management system "Guideline on Supervision, H-P3".

The SNRIU refrains from imposing sanctions on licensees that report on their own detection and elimination of incompliance with safety requirements before this caused failure to comply with operating procedures or led to emergencies or accidents. The SNRIU supports the licensee management system that relies on high safety culture principles and pursues the policy of decrease in regulatory burden on licensees that adhere to these principles.

The statistics of sanctions is provided, in particular, in annual reports on nuclear and radiation safety in Ukraine.

E.2.6. Allocation of Responsibilities for Bodies Involved in Different Stages of Spent Fuel and Radioactive Waste Management

According to the principles of state policy in the area of nuclear energy established in Article 5 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", Ukraine separates state control in the areas of nuclear energy and state control in radwaste disposal and long-term storage.

The State Exclusion Zone Management Agency (SEZA) is entrusted with functions of state management in the area of radwaste management at the stages of long-term storage and disposal and with implementation of the state policy for radwaste management. To perform its functions, the SEZA deals with state management of specialized radwaste management enterprises at ChNPP in decommissioning of ChNPP units 1-3 and Shelter transformation into an environmentally safe system.

The SEZA efforts in the central executive system are coordinated by the Minister of Ecology and Natural Resources of Ukraine.

The Ministry of Energy and Coal Industry of Ukraine (MECI) is in charge of the establishment and implementation of state policy for fuel and energy, including nuclear energy.

The MECI exercises state management over the operating organizations of acting NPPs (NNEGC *Energoatom*) and nuclear research facilities.

The MECI arranges and coordinates the safe management of spent fuel and radioactive waste during operation of nuclear facilities until radwaste is transferred to specialized radwaste management enterprises for long-term storage or disposal.

In compliance with the main principles of state policy for radwaste management identified in Subsection B.3, the radwaste generators are responsible for management of waste before its transfer to specialized radwaste management enterprises. Radwaste disposal by radwaste generators is prohibited.

In compliance with the main principles of state policy for radwaste management identified in Subsection B.3 of NRU-2011, the radwaste generators are responsible for management of waste before its transfer to specialized radwaste management enterprises. Radwaste disposal by radwaste generators is prohibited.

Waste generators are currently operating organizations of nuclear facilities: NNEGC *Energoatom* for operating NPPs, INR NASU (Kyiv) and SUNEI (Sevastopol) for research reactors, State Specialized Enterprise ChNPP for the Chornobyl NPP and enterprises and organizations that use radionuclide sources.

The SSE CRME is the national operating organization for radwaste management at the stages of long-term storage and disposal. Radwaste generated at enterprises that use radiation sources and research reactors is collected and temporarily stored by UkrDO *Radon* SISPs, the SSE CRME being the main enterprise of the UkrDO *Radon*.

E.3. Regulatory Body (Article 20)

The State Nuclear Regulatory Committee of Ukraine was established according to Presidential Decree No. 1303 dated 5 December 2000. In 2010, the State Nuclear Regulatory Committee of Ukraine together with its territorial bodies was renamed as the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU). Since 2006 there have been eight territorial bodies in the SNRIU structure. They are called State Inspectorates of Nuclear and Radiation Safety that perform licensing of activity related to RS use, oversight of radiation safety during RS use and radwaste management directly in regions.

It was concluded during the IRRS-2008 and follow-up IRRS-2010 missions that SNRIU was effectively regulating nuclear and radiation safety, was de facto an independent regulatory body and tool effective actions towards achieving transparency and communication with the public, Government and Parliament.

According to the "Statute of the State Nuclear Regulatory Inspectorate of Ukraine" approved by Presidential Decree No. 403 dated 6 April 2011, the SNRIU performs functions of the state nuclear regulatory authority and establishes and maintains the legislative and regulatory framework in compliance with Article 19 of the Joint Convention. The SNRIU has appropriate power, competence and resources to perform its functions and fulfill commitments in compliance with Article 20 of the Joint Convention.

The Ministry of Health participates in state radiation safety supervision, and its competence includes the development and implementation of radiation safety standards, authorization of practices involving radioactive material and other radiation sources and state supervision under health and safety legislation. The Ministry of Environment participates in the regulation of environmental radiation protection.

According to paragraph 2 of Article 20 of the Joint Convention, the SNRIU, in state regulation of nuclear and radiation safety, is independent of central executive authorities, enterprises and institutions that manage the use of nuclear energy and spent fuel and radioactive waste.

The SNRIU quality management system was developed to function in compliance with ISO 9001:2008 Quality Management Systems - Requirements. The compliance of the system is periodically verified by auditors that are certified internationally. According to results of the recertification audit of the management system carried out in July 2014, it was confirmed that quality of the management system is in compliance with requirements of ISO 9001:2008, stating the SNRIU efficiently meets its functions and duties of the state regulatory authority in the sphere of nuclear energy use.

Section F. OTHER GENERAL SAFETY PROVISIONS

F.1. Responsibility of the License Holder (Article 21)

According to Article 32 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", the licensee is fully responsible for radiation and physical protection and safety of nuclear facilities, radwaste management facilities and radiation sources independently of activities and responsibilities of suppliers and state nuclear regulatory authorities.

Specific responsibilities of the licensee are established in Articles 32 and 33 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and Article 11 of the Law of Ukraine "On Radioactive Waste Management", specifically:

– the licensee shall submit annual radiation safety analysis reports to the regulatory body and ensure that radwaste generation be as low as practically achievable;

– in the event of an accident, the licensee shall keep records and predict radioactive releases beyond the nuclear installation or spent fuel or radwaste management facility and appropriately inform about this respective bodies and organizations;

– the operating organization shall appropriately submit timely and complete information on operational events at nuclear installations or radwaste disposal facilities;

– the licensee shall be responsible for informing the public, national authorities and public organizations on nuclear safety and radiation protection.

The licensee's responsibilities are also established in special terms of licenses and individual authorizations. If the licensee is deprived of the license or authorization, it is still responsible for the safety of its facilities until they are transferred to other entities or a new license or authorization is granted.

The licensee takes measures to protect personnel and the public in case of an accident at a nuclear facility or radwaste management facility.

The SNRIU checks whether the licensee has necessary documentation, organizational structure and resources to maintain a proper safety level.

F.2. Human and Financial Resources (Article 22)

F.2.1. Qualified Staff Needed for Safety-Related Activities during the Operating Lifetime of a Spent Fuel and Radioactive Waste Management Facility

According to Article 32 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", the licensee establishes requirements on qualification of personnel depending on their responsibility for the safety of nuclear facilities and radwaste management facilities, their monitoring, and proper operation of safety-related equipment.

The licensee improves skills of its personnel that perform licensed activities on a permanent basis and admits them to work after appropriate training and examination. The licensee develops procedures for examinations on nuclear and radiation safety for managers and personnel and agrees them with the SNRIU.

Compliance with personnel qualification requirements is monitored under state supervision over enterprises that deal with spent fuel and radioactive waste management.

The training and professional development system in the area of spent fuel and radwaste management, which is described in previous NRUs, was further improved in the reporting period. This system is based on the systematic training approach that is recognized universally and recommended by the IAEA. Systematic training of personnel aimed at promoting safety culture and ensuring the required qualification and constant readiness to perform professional duties is a

key element of the licensee's activities related to nuclear and radiation safety of spent fuel and radioactive waste management facilities.

The training system operates in cooperation with scientific organizations, enterprises, state control and regulatory bodies and other educational systems to ensure adequate training, retraining and professional development of personnel in order to maintain knowledge, skills and professional attitude.

The development of NPP training centers, serving as a basis for personnel training is underway. The centers are provided with skilled trainers. Training tools are under improvement. The NPP training centers employ simulators.

Under the INSC U4.1/08D project within cooperation with the European Commission related to a comparative analysis of the personnel training and monitoring systems in the area of radwaste management at Ukrainian NPPs and practices at West European NPPs, the "Program for Training and Professional Development of Personnel Involved in Radioactive Waste Management" was developed to support training of personnel of different categories on radwaste management and preparation of individual and group programs for initial training and further professional development.

F.2.2. Financial Resources to Support the Safety of Facilities for Spent Fuel and Radioactive Waste Management during Their Operating Lifetime and for Decommissioning

According to Article 32 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", the licensee shall have financial, material and other resources to keep safety at the level accepted by safety standards and regulations and requirements of the license or authorization.

According to Article 33 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", the operating organization (NNEGC *Energoatom*) shall include costs for spent fuel storage, radwaste treatment and disposal and decommissioning of nuclear facilities into the electricity production cost.

The Law of Ukraine "On Settlement of Nuclear Safety Issues" defines a legal and administrative basis for funding of termination and decommissioning of nuclear facilities. This law states that a special account shall be opened at the State Treasury of Ukraine to accumulate decommissioning funds.

The Law of Ukraine "On Radioactive Waste Management" establishes a legal framework for the establishment and use of the State Fund for Radioactive Waste Management. The fund is a part of the special fund under the State Budget of Ukraine and is replenished through ecological taxes paid by enterprises responsible for radwaste generation and temporary storage beyond the established period. Therefore, one of the fundamental principles used in international practice, "who contaminates, must pay", has been implemented.

Besides replenishment of the State Budget, these tax liabilities will encourage the radwaste generators to transfer waste to specialized radwaste management enterprises in a timely manner and avoid waste accumulation in situ and will improve radiation safety in the State.

The Tax Code of Ukraine determines appropriate environmental tax rates depending on the amount and activity of radwaste. This tax shall be paid by operating NPPs, other nuclear facilities and radiation source users.

As part of its financial obligations, NNEGC *Energoatom*, being the primary payer to the State Fund for Radioactive Waste Management, has been paying tax for radwaste generation (including already accumulated waste) since 2009. Such a tax is provided in tariffs for supply of electricity and general of thermal energy at NPPs. NNEGC *Energoatom* allocated **2,741 mln. UAH** to the Fund for Radioactive Waste Management (environmental tax) from 2009 to 1 July 2014.

Pursuant to Article 4 of the Law of Ukraine "On Radioactive Waste Management", budget programs for management of Chornobyl-origin radwaste and the National Target Ecological Program for Radioactive Waste Management are funded from the State Fund for Radioactive Waste Management.

Financial resources to support the safety of spent fuel and radioactive waste management facilities during their operating lifetime.

Spent fuel and radioactive waste management at operating NPP sites is funded from costs included into the electric and thermal energy rate. Moreover, to improve the infrastructure for radwaste management at NPPs, resources of international cooperation are involved. The systems for solid radwaste treatment are being constructed at the Zaporizhzhya and Rivne NPPs under EC technical cooperation projects.

The management of spent fuel and radwaste from research reactors during operation (including future decommissioning) is funded from the State Budget.

Radwaste management at the UkrDO *Radon* SISPs (operation and future decommissioning) is funded from costs paid by enterprises that transfer radwaste to SISPs for storage on a contractual basis and from the State Budget. With implementation of the financial mechanism for the State Fund for Radioactive Waste Management, the safe operation of SISP facilities and their conversion and re-equipment within the National Target Ecological Program for Radioactive Waste Management shall be supported from a special fund under the State Budget through allocations to the State Fund for Radioactive Waste Management.

The SSE *CRME*'s activities related to operation and safety assurance of radwaste management facilities in the Exclusion Zone are financed from a special fund within the State Budget through the State Fund for Radioactive Waste Management according to annual work programs. International technical assistance is also involved.

Financial resources to support the safety of spent fuel and radioactive waste management facilities during decommissioning

The reliable and safe operation of spent fuel and radioactive waste management facilities and radwaste collection, sorting, characterization and transfer for disposal at the ChNPP are supported from the State Budget of Ukraine under annual ChNPP work programs. The Law of Ukraine "On Radioactive Waste Management" with changes introduced in 2010 establishes that the management of Chornobyl-originating waste is funded from the State Fund for Radioactive Waste Management. To improve the system of ChNPP spent fuel and radioactive waste management, resources of international technical cooperation are involved. The construction of the ISF-2 and LRTP is funded from the EBRD Nuclear Safety Account, and the ICSRM facilities have been constructed and almost finally commissioned within the TACIS program.

The costs to support termination and decommissioning of operating NPPs are allocated to a special fund within the State Budget of Ukraine and enter to an appropriate account as a financial reserve for NPP decommissioning. As of 1 January 2014, the special fund of the State Budget contains a financial reserve of 1,890.07 mln. UAH.

According to Article 10 of the Law of Ukraine "On Settlement of Nuclear Safety Issues", the financial reserve is used exclusively to fund the development of a decommissioning project, operation termination measures and decommissioning of a nuclear facility under the project.

Issues regarding the use of the Fund for Radioactive Waste Management and financial reserve for decommissioning (Decommissioning Fund)

The experience in implementation of the mechanisms for accumulation and use of the Fund for Radioactive Waste Management and Decommissioning Fund has revealed the need for

improvement of the procedure for using financial resources from these Funds, including their protection against misuse.

Cabinet Resolution No. 21 of 22 January 2014 established a Supervisory board for the control over the use and investment of financial reserve funds intended for decommissioning of operating nuclear power plants. The supervisory board competencies include:

1) review and agreement of annual action plans for termination of operation and decommissioning of NPP units submitted by the operating organization (operator);

2) control over the proper use of funds and investment of financial reserve;

3) review and agreement of the operator's annual plans for investment of financial reserve;

4) agreement of the operator's proposals on deposit of financial reserve funds in securities issued by the State;

5) obtaining of annual information from the operator on the use of financial reserve.

F.2.3. Financial Provision for Appropriate Institutional Control and Monitoring Arrangements for the Period Following the Closure of a Radwaste Disposal Facility

The institutional control and supervision of disposal facilities for SSE *CRME* radwaste in the post-closure period will be funded from a dedicated fund of the State Budget through the State Fund for Radioactive Waste Management.

The control of preserved UkrDO *Radon* SISPs is funded from a dedicated fund of the State Budget through the State Fund for Radioactive Waste Management.

F.3. Quality Assurance (Article 23)

According to the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", safety assurance is a set of measures that are planned and systematically implemented to reach confidence that the activities comply with safety standards and regulations.

In order to bring the national regulatory framework into compliance with the best world practices and new IAEA requirements, in particular, those established in GS-R-3 "The Management System for Facilities and Activities" and GS-G-3.x Series, the SNRIU developed the "General Requirements for the Management System in the Area of Nuclear Energy" and "Requirements for the Management System of the Operating Organization (Operator)" in 2012. These regulations implement the principles of integrated management system and propose the licensees to apply a process approach instead of the functional design approach to quality management.

The operating organizations that deal with spent fuel and radwaste management, NNEGC *Energoatom*, ChNPP, SSE *CRME*, CCMEZ, and UkrDO *Radon* SISPs bring their quality management systems (quality) systems into compliance with these regulations and ISO 9000 standards.

The NNEGC *Energoatom* took considerable efforts to establish an integrated management system in its *Atomenergomash* and *Atomremontservis* enterprises as well as in the *Energoatom* Directorate. The TÜV NORD CERT certification body issued certificates of compliance with ISO 9001:2008 "Quality Management Systems. Requirements" and ISO 14001:2004 "Environmental Management Systems. Requirements with Guidance for Use". All certified departments of the NNEGC *Energoatom* successfully passed audits within specified time.

The NNEGC *Energoatom* management system is described in the General Guidance for the NNEGC *Energoatom* Integrated Management System and developed in similar guidance documents of its enterprises. The NNEGC *Energoatom* keeps its policy updated on a permanent

basis, giving the highest priority to nuclear and radiation. The operator always identifies ways for achieving the set objectives.

In order to coordinate activities to maintain a high level of safety culture, the NNEGC *Energoatom* established a safety culture board. Safety culture audits are periodically conducted at the NNEGC *Energoatom*, involving a number of quality management aspects.

Basic elements of the ChNPP management system are as follows:

– working quality board, the main collegiate body for making managerial decisions on quality assurance;

– functional processes that cover basic ChNPP activities, including those intended to ensure nuclear, radiation, environmental and other safety. Proper monitoring and measurement methods are applied to all process to allow their efficient management: analyze the progress of each process, record deviations and make decisions to develop corrective and preventive actions when necessary and feasible;

– quality programs that are primarily developed and implemented for safety-relevant processes and activities and that demonstrate how the management system is applied to a specific case, project or contract;

– independent assessment of the management system and its components to determine the effectiveness of processes, compliance with safety and quality requirements, possibility to improve the management system;

– audits of suppliers' management systems, primary suppliers of safety-related systems, to confirm their capability to ensure compliance of the products with established requirements.

The SSE *CRME* management system is described in the "Guidance on the Management System (Quality Guidance) of the Enterprise", which determines the policy and objectives of radiation safety at all stages of radwaste management, inculcation of safety and security culture and effective performance of the tasks and functions of the SSE *CRME* as the operating organization dealing with radwaste management during storage and disposal and having the exclusive right for disposal of all radwaste types. The management system is continuously improved through self-assessments, analysis of the main processes described in the management system, internal and external audits and implementation of corrective and preventive actions in case of incompliance.

There are appropriate quality management systems at UkrDO *Radon* SISPs developed to ensure safety of licensed activities. The quality management systems take into account all required processes that influence radiation safety, identify basic functions in quality assurance, reflect authorities and responsibilities, include necessary provisions, guidelines and procedures and contain internal mechanisms for continuous improvement of the quality management system and, hence, for safety enhancement, effectiveness and efficiency of licensed radwaste management activities.

F.4. Operational Radiation Protection (Article 24)

F.4.1. Radiation Protection of Workers and Public

Regulatory control over limitation of radiation exposure for personnel, the public and the environment in Ukraine is ensured by laws, standards and rules, such as the Law of Ukraine "On Human Protection against Ionizing Radiation", "Radiation Safety Standards of Ukraine" (NRBU-97), including supplement "Radiation Protection against Potential Exposure Sources" (NRBU-97/D-2000), "Basic Sanitary Rules for Radiation Safety of Ukraine" (OSPU-2005), health and safety standards "Levels for Exemption of Radioactive Material from Regulatory Control" (2010).

These regulations, in particular, establish regulatory values to limit routine and potential exposure for personnel and the public.

The Radiation Safety Standards of Ukraine (NRBU-97), which are mandatory, establish the following dose limits:

Table F.4.1. Dose Limits ($mSv \cdot year^{-1}$)

	Category of exposed individuals		
	A [a) b)]	B [a)]	C [a)]
DL_E (effective dose limit)	20 [c)]	2	1
External equivalent dose limits:			
- DL_{lens} (for lens)	150	15	15
- DL_{skin} (for skin)	500	50	50
- DL_{extrim} (for hands and feet)	500	50	-

Notes:

[a)] dose distribution during a calendar year is not regulated;

[b)] limitations of NRBU-97 para. 5.6 apply to women of childbearing age (to 45) and pregnant women;

[c)] average for any five consecutive years but not more than 50 mSv in a single year.

The following regulatory values are established for spent fuel and radioactive waste management:

1. Limits for planned exposure during practices – dose limits and derived permissible and reference levels. These regulatory values are based on the concept of annual effective dose limitation.

2. Limits for potential exposure during practices – reference levels of doses and probabilities of critical events. These regulatory values are based on the concept of potential exposure risk limitation: 2×10^{-4} $year^{-1}$ for personnel and 2×10^{-5} $year^{-1}$ for the public. Accordingly, for critical events (CEs) that lead to potential exposure for a small group of people, the following reference levels to limit potential exposure are established:

- for personnel – CE probability is no higher than 1×10^{-2} $year^{-1}$ with effective dose no more than 100 mSv and no higher than 2×10^{-4} $year^{-1}$ with effective dose more than 100 mSv;
- for the public – CE probability is no higher than 1×10^{-2} $year^{-1}$ with effective dose no more than 50 mSv and no higher than 2×10^{-5} $year^{-1}$ with effective dose no more than 50 mSv.

3. Limits for exposure during accidents.

Exposure for the main personnel involved in emergency measures is limited by the above dose limits for routine exposure. Given proper informing and voluntary agreement of personnel, it is permitted to increase the effective dose to 100 mSv and increase the equivalent dose to 500 mSv in exceptional (specifically defined) cases and in cases when measures are required to save people's lives.

In order to ensure radiation protection of the public, dose limit quotas are established for exposure from releases and discharges: they are 80 μSv/year for nuclear installations and 40 μSv/year for radwaste management facilities in operation. Based on the dose limit quota for each individual facility, permissible releases and discharges are determined, which are not allowed to be exceeded in normal operation.

Radiation exposure for the public is limited through countermeasures taken in compliance with intervention levels and derived action levels. Intervention levels are determined in terms of averted dose due to countermeasures. NRBU-97 established criteria (intervention levels and

action levels) to make decisions on justification or unconditional justification of emergency, urgent or long-term countermeasures. For example, averted dose of 50 mSv for the whole body is the lower justification boundary and averted dose of 500 mSv is the level of unconditional justification for evacuation countermeasure.

4. Regulatory values for exposure to people from radwaste disposed of in near-surface facilities following 300 years after closure include limitation of:

– annual effective dose of 0.01 mSv for routine exposure;

– reference level of 1 $mSv \cdot year^{-1}$ for potential exposure.

Upon a separate regulatory decision, the level of potential exposure may be increased to 50 $mSv \cdot year^{-1}$ provided that additional measures are taken to reduce the risk of potential exposure.

F.4.1.1. Application of the ALARA Principle

The legislation of Ukraine determines optimization as one of the main principles of radiation protection. The optimization principle obliges the licensee to keep both individual and collective exposure of personnel and the public and the probability of critical events and associated potential doses as low as reasonably achievable, social and economic factors being taken into account.

There are the following key instruments for optimization of radiation protection in Ukraine:

– application of reference levels (RLs) to decrease exposure for personnel and releases and discharges (they are RLs for exposure of personnel to radiation, releases and discharges, RLs for radiation conditions in production rooms and on site, RLs for contamination of equipment, process media etc.). Reference levels shall not exceed 70% of permissible levels and shall be as low as practically achievable;

– application of administrative technological levels (investigation levels) below RLs for additional monitoring of equipment process modes;

– improvement of radiation monitoring systems, including monitoring types, scopes and procedures, instrumentation, methodologies, metrological support and software;

– implementation of administrative and technical measures for collective and individual protection of personnel, reduction of releases and discharges, prevention of critical events and decrease of exposure, releases and discharges in case of critical events;

– planning of radiation-related hazardous activities;

– minimization of radwaste generation;

– implementation of the training system;

– implementation of the quality system for radiation protection.

Reference levels are established by the licensee based on the achieved level of radiation safety and shall be decreased as safety improves. The SNRIU makes sure that RLs are established at the level close to that of similar practices and that RLs are observed. In particular, any case of RL incompliance is investigated by the licensee, and the respective report and corrective measures are considered by the SNRIU.

Application of the optimization principle allows the plants to keep individual doses to personnel as low as reasonably achievable, gradually decrease the collective dose and ensure that plant releases and discharges be no more than percentage of permissible levels (see Annex 8 to this Report).

The licensee's compliance with the optimization principle is verified during regulatory supervision, through analysis of annual reports on nuclear and radiation safety and during periodic revisions of reference levels and regulatory values for radiation dose control and monitoring.

There are dose registries at each NPP in Ukraine to evaluate the effectiveness of the optimization principle.

According to recommendations of the IRRS-2008 Mission, the optimization principle was applied at the UkrDO *Radon* SISPs to establish RLs for individual annual doses for personnel. The reference levels of individual annual dose for category A personnel are 4-5 mSv for these enterprises.

F 4.1.2. Observation of Basic Dose Limits

Dose limitation is one of the main principles of radiation protection and safety in Ukraine.

According to radiation dose monitoring at facilities for spent fuel and radioactive waste management, the following conclusions can be made for 2011-2014:

– annual limits of individual equivalent doses for personnel of categories A and B were not exceeded in the reporting period;

– permissible airborne radionuclide concentrations in working areas were not exceeded at any enterprise;

– radiation safety of category C individuals (public) living around the respective enterprises complied with standards and rules in force according to radiation monitoring.

The dynamics of average individual doses for personnel of operating Ukrainian NPPs, ChNPP and SSE *CRME* is shown in Figures L.8.1, L.8.2 and L.8.3 of Annex 8 to this Report.

The average individual doses for personnel of operating NPPs in 2011-2013 were from 0.29 mSv/person per year (KhNPP, 2013) to 1.10 mSv/person per year (SUNPP, 2013).

Collective doses for personnel involved in spent fuel storage at the Zaporizhzhya ISF are shown in Figure L.8.4 of Annex 8 to this Report.

Ukraine keeps registers of doses for personnel of NPPs, specialized radwaste management enterprises, Exclusion Zone facilities and for medical staff.

F.4.1.3. Prevention of Unplanned and Uncontrolled Releases of Radioactive Materials into the Environment

To prevent unplanned and uncontrolled releases and discharges of radioactive materials into the environment, control and monitoring devices are used at spent fuel and radwaste management facilities. Procedures for radiation monitoring and for calibration, maintenance and repair of instrumentation are in place.

Routine radiation and environmental monitoring is conducted at NPP sites, including the 30-km area, in the Chornobyl Exclusion Zone, including its radwaste management facilities, on the SISP territory and adjacent controlled areas and in observation areas. Threshold dose rate detectors are installed around each NPP site within a 30-km radius.

Procedures for radiation dose control and monitoring are agreed by regulatory authorities, Ministry of Health and SNRIU, and are periodically revised to take into account operating experience, improvement of monitoring instrumentation and changes in the regulatory and legal framework.

F.4.2. Limitation of Discharges and Releases

The Radiation Safety Standards of Ukraine establish dose limit quotas for the public from releases and discharges, which are 80 μSv/year for nuclear facilities and radwaste treatment facilities and 40 μSv/year for radwaste disposal facilities in the operational period. These quotas

are used as the basis for determining, for each facility, permissible releases and discharges that must not be exceeded in normal operation.

There is a multilevel system for limitation of releases and discharges at each NPP:

Level 1: administration of each NPP establishes administrative technological levels for releases and discharges, so-called investigation levels (see Subsection F.4.1.1). Incompliance with these levels is investigated by an NPP commission and, if necessary, corrective measures are taken.

Level 2: RLs are established that reflect the level of radiation safety achieved at NPP. The RLs are necessarily agreed by the regulatory authorities. If they are exceeded, NPP administration conducts investigation and submits its results to the regulatory authorities to make an appropriate decision.

Level 3: permissible levels of releases and discharges are established using the dose limit quotas that must not be exceeded in normal operation.

According to radiation monitoring, RLs of releases and discharges at operating nuclear facilities, including spent fuel storage facilities and radwaste management facilities, were not exceeded in the reporting period.

The dynamics of releases and discharges at operating NPPs in the reporting period is shown in Figures L.8.5-L.8.12 and at the Chornobyl NPP in Figures L.8.13-L.8.14 of Annex 8 to this Report.

F.4.3. Corrective Measures to Control Unplanned or Uncontrolled Release of Radioactive Materials into the Environment and Mitigation of Its Effects

The protection of personnel and the public against unplanned or uncontrolled release of radioactive materials is governed by Articles 7 and 8 of the Law of Ukraine "On Human Protection against Ionizing Radiation" and Radiation Safety Standards of Ukraine.

The principles of justification, limitation and optimization are used for intervention in case of uncontrolled or unplanned radioactive release. Intervention levels and action levels for countermeasures are determined as quantitative criteria; unjustified, justified and conditionally justified intervention is defined; and intervention termination procedure is established (see also Subsection F.4.1 of this Report).

The Unified State Civil Protection System (USCPS) is in place in Ukraine to protect personnel and the public in case of unplanned or uncontrolled release of radioactive materials to the environment. The USCPS includes a system of emergency preparedness and response in case of nuclear and radiation accidents. The system and associated measures are described in Subsection F.5.

F.5. Emergency Preparedness (Article 25)

F.5.1. On-site and Off-site Emergency Plans. Testing of Emergency Plans

The system of emergency preparedness and response in case of nuclear and radiation accidents is an integral part of the Unified State Civil Protection System (USCPS). Detailed information on the structure, objectives and functions of the USCPS is provided in NRU-2003-2011.

Improvement of the system continued in the reporting period.

The new Code of Civil Protection of Ukraine entered into force in July 2013. Cabinet Resolution No. 11 of 9 January 2014 approved new Provisions on the Unified State Civil

Protection System. According to these Provisions, the SNRIU is responsible for managing the establishment and operation of the functional subsystem "Safety of Nuclear Power Facilities".

NPP Emergency Preparedness

The functional subsystem "Safety of Nuclear Power Facilities" operates at national, regional and facility levels.

Facility-level activities are carried out by the on-site State Nuclear Safety Inspectorates and regional-level activities are carried out by State Regional Nuclear Safety Inspectorates.

At the national level, the SNRIU Information and Emergency Center (IEC) is the key element of the subsystem. When the IEC is activated, the most experienced experts of SNRIU and TSO are involved in its activities.

In routine operation, the IEC keeps 24-hour duty and on-line communication with Ukrainian NP, analyzes and records information on NPP operational events to be introduced into a computer database. Summary reports on the status of Ukrainian NPPs and information on NPP operational events are placed on the SNRIU website www.snrcu.gov.ua.

The main IEC systems include reliable supply, telephone communication recording and automated notification systems and a system for real-time transfer and display of plant process and radiological parameters through the NNEGC *Energoatom* emergency center.

A backup automated workplace for the operator of the data transfer and display system between NPPs and SNRIU IEC was created in 2013, and training for IEC personnel was organized including special exercises for the IEC Data Analysis Group.

During 2012-2013, the RODOS decision support system was implemented at the SNRIU IEC under a European Commission project to manage off-site emergencies for ZNPP and RNPP, and administrators and users of the system were trained.

After implementation of the Unified System for Information Exchange in Incidents and Emergencies (USIE) in 2013, created by the IAEA for emergency response under the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, IEC personnel action procedures were revised and the user interface in the database "Notification of IAEA and States of Nuclear and Radiation" was modified.

Requirements for the emergency plans at any facilities that deal with practices involving nuclear and radiation technologies, including spent fuel and radioactive waste management facilities, are established in the Radiation Safety Standards of Ukraine and Plan of Response to Radiation Accidents. Requirements of the above regulations regarding emergency response comply with IAEA recommendations. In particular, emergency planning takes into account radiation hazard categories of facilities (categories I-V) and classification of radiation accidents (general, on-site, industrial etc.).

In the reporting period, the NNEGC *Energoatom* revised the Standard Emergency Plan for Ukrainian NPPs and Emergency Response Plan of NNEGC *Energoatom* Directorate under the safety upgrade package for Ukrainian NPPs to improve response to emergencies at NPPs and ensure their emergency preparedness. The "Basic Provisions on the NNEGC *Energoatom* System for Preparedness for and Response to Accidents and Emergencies at Ukrainian NPPs" was revised. This is the main document that establishes principles for the emergency preparedness system, identifies its objectives, tasks, structure, functions and allocation of responsibilities and authorities between NNEGC *Energoatom* departments and officials for emergency planning, preparedness and response and interaction with external organizations and enterprises.

The Emergency Plans for Rivne, South Ukraine and Khmelnitsky NPPs and for the VVR-M research reactor of INR NASU were revised in 2013.

The Radiation Safety Standards of Ukraine (NRBU-97) require emergency training of

operating personnel involved in emergency measures.

The operating organization conducts full-scale general plant emergency training every three years at each NPP in accordance with the "Schedule for General Plant Emergency Training jointly with the NNEGC *Energoatom* Directorate and with Participation of Representatives from Relevant Ministries and Departments and Local Executive Bodies", developed by the NNEGC *Energoatom* for the period from 2009 to 2018 and agreed by the SNRIU.

Pursuant to this schedule, the operating organization participates in State-level emergency training every five years conducted by the State Emergency Service of Ukraine in accordance with the "Plan of Response to Radiation Accidents".

If the operating organization has insufficient resources, interaction and involvement of the USCPS functional subsystems are envisaged at State level.

Actions and interaction between management bodies and forces and means involved in the prevention or mitigation of emergencies at Ukrainian NPPs (including additional external resources) are governed in compliance with the procedure established in the "Plan of Response to Emergencies of State Level".

ChNPP Emergency Preparedness

ChNPP performed the main measures planned for civil protection and emergency preparedness training. Theoretical training (on relevant subjects), emergency training of plant personnel, training of emergency crews and individual training are the main types of training for ChNPP personnel to test response to accidents and emergencies.

Emergency crews and teams were established at ChNPP. Emergency exercises are conducted in accordance with:

– schedule for training of emergency crews and teams in emergencies;

– schedule for general plant-specific and unit-specific emergency and fire drills with ChNPP operating personnel.

General plant training upon civil protection signals is conducted twice a year.

To comply with legislative and regulatory documents and tasks of the emergency preparedness and response system, ChNPP developed the "ChNPP Plan of Response to Accidents and Emergencies" (32P-S) and the 'Plan of Measures and Actions in Case of Accidents during Radioactive Material Transport' (1PL-S). The "Emergency Plan for the Liquid Radioactive Waste Treatment Plant" and "Emergency Plan for the Industrial Complex for Solid Radioactive Waste Management" were implemented in 2014 for commissioning of the ChNPP LRTP and SRTP.

To implement measures to improve protection of personnel and the territory against emergencies, prevent potential emergencies and ensure actual preparedness for response both in peaceful and crisis times, ChNPP developed the "Plan on Basic Civil Protection Measures at ChNPP".

Emergency Preparedness of Research Reactors

Emergency plans and procedures for personnel in the event of an accident are in place at SUNEI IR-100 and INR NASU VVR-M research reactors. In case of an accident, specially trained emergency crews are alerted. Emergency planning takes into account hazard category II assigned to these reactors. Full-scale emergency training is periodically conducted involving SNRIU representatives.

Emergency Preparedness of UkrDO Radon Plants

Plans of response to radiation accidents are in place at the specialized radwaste management enterprises: SSE *CRME* and UkrDO *Radon* SISPs. Emergency planning takes into account hazard

category III of these enterprises. Emergency crews have been trained. Emergency personnel are provided with an emergency medical kit, sanitary treatment means, overalls, individual protection means and radiation monitoring devices. Technical state of equipment used in response to a radiation accident is tested in accordance with an agreed schedule. Personnel involved in emergency crews are systematically trained and take part in scheduled exercises in accordance with the "Plan of Organizational and Technical Measures on Theoretical and Practical Training". Emergency exercises are conducted to check adequacy of time available for response, completeness of emergency procedures and effectiveness of notification systems. Emergency response to an accident in the Exclusion Zone is also tested during training at the SSE *CRME*.

According to the governmental 'Procedure for Interaction between Executive Bodies and Legal Entities Dealing with Nuclear Energy in Case of Illicit Trafficking of Radioactive Materials', the UkrDO *Radon* SISPs are involved in emergency actions of competent authorities for mitigation of emergencies and accidents associated with the detection of orphan sources and radioactive materials in illicit trafficking. There is a database to record these accidents, including their classification, mitigation measures, causes and effects for the public and environment.

29 October 2011: the emergency team of the Lviv SISP was on duty during the grand opening of the *Arena Lviv* stadium;

04-07 October 2011: experts of the Odessa SISP took part in training on interaction between executive bodies in detecting radioactive materials at checkpoints at the national frontier. The training was conducted by the State Environmental Inspectorate of Ukraine at the checkpoint for maritime transport Illichivsk in the Odessa region;

30-31 August 2011: experts of the Donetsk SISP took part in training on interaction between executive bodies in detecting radioactive materials at checkpoints at the national frontier. The training was conducted by the State Environmental Inspectorate of Ukraine at the checkpoint for rail service in the Ilovaisk station of the Donetsk region;

24-26 April 2012: experts of the Lviv SISP took part in command post exercises with control units and territorial subsystems of the USCPS in Lviv region to train actions in case of a threat and actual man-caused and natural emergencies;

30 May 2013: the coordination team of the Antiterrorist Center at the Security Service Department in Lviv region organized scheduled command post exercises at the Lviv SISP to gain experience and skills in preparing for and conducting antiterrorist operations at facilities with increased hazard and to train common actions to check the preparedness of antiterrorist forces and capabilities for their effective use and test preventive, operational, organizational and other measures;

20 June 2013: the coordination team of the Antiterrorist Center at the Security Service Department in Kharkiv region conducted joint scheduled exercises under the Boomerang code name at the Kharkiv SISP. The exercises were attended by 400 persons and about 80 pieces of equipment and one airplane.

Summary on Training at UkrDO *Radon* in 2010-2013

Year of training	the following exercises were conducted with participation and organization of SEZA:						
	jointly with Security Service of Ukraine	jointly with Ministry of Emergencies	jointly with SNRIU	UkrDO *Radon*	training EURO-2012	jointly with U.S. Oak Ridge National Laboratory	jointly with Ministry of Internal Affairs

2010		2	1	8			2
2011		5		8			
2012		4		4	4	1	1
2013	2	1		3		2	
	2	**12**	**1**	**23**	**4**	**3**	**3**
TOTAL: 48							

F.5.2. Preparation and Testing of Emergency Plans in Ukraine Considering Probability of a Radiological Emergency at a Spent Fuel or Radioactive Waste Management Facility in the Vicinity of Its Territory

The Plan of Response to Radiation Accidents requires scheduled training at all USCPS levels to check consistency of the emergency plans of enterprises with those of other USCPS structural units and to test personnel actions in accidents.

Full-scale general plant emergency exercises are periodically conducted to prepare NPP personnel to act in emergency conditions, improve their knowledge and skills on accident confinement and mitigation and test emergency preparedness plans.

Under the short-term measures identified in the "Action Plan for Special Targeted Safety Reassessment and Further Safety Improvement of Units 1–3 and ISF-1 Considering the Events at Fukushima-1", extraordinary check of emergency preparedness and training were organized at NPPs. In 2011, ChNPP conducted full-scale training and exercises based on the stress-test scenario involving multiple failures of regular systems and equipment under natural hazards. During this training, ISF-1 makeup was restored within 30 min by directing the ISF-1 leaks to the spent fuel pool compartments without treatment ('small ring'). In the reporting period, the ChNPP also conducted training to ensure continued readiness of ChNPP personnel to act during radiation accidents on the scenarios involving ChNPP personnel evacuation using individual protection means and personnel evacuation from buildings and structures to railroad transport.

Scheduled general plant emergency exercises were conducted at South Ukraine NPP and Zaporizhzhya NPP in 2013 and at Khmelnitsky NPP in 2013. General plant emergency training is planned for Rivne NPP in November 2014.

Upon the training and exercises, corrective actions were developed to improve the relevant emergency preparedness systems of the USCPS in case of a threat or actual radiation accident.

During the training, the SNRIU IEC was activated, and experts of the on-site State Nuclear Safety Inspectorates participated in exercises at NPPs.

In the reporting period, the on-site State Nuclear Safety Inspectorates took part in emergency training at relevant NPPs for regulatory assessment of personnel actions and NPP emergency response systems as a whole. They took part in 237 emergency exercises in 2012, including 31 general plant exercises, in 161 emergency exercises in 2013, including 32 general plant exercises, and in 85 emergency exercises at relevant NPPs from the beginning of 2014, including 6 general plant exercises.

Resources of the emergency response system may be used for response to emergencies in other countries in case of a radiation threat for the territory of Ukraine.

Detailed information on the SNRIU's activities as a competent national body and point of contact under the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and international treaties with other countries that provide for mutual early notification and further information exchange in case of a nuclear accident or radiological emergency is given in NRU-2005.

Ukraine has entered into 14 intergovernmental treaties with other countries for early notification and subsequent data exchange in the event of a nuclear accident or radiological emergency. These treaties have been concluded with Sweden, Turkey, Belarus, Slovakia, Hungary, Finland, Norway, Poland, Germany, Austria, Bulgaria, Latvia, Romania and Russia (signed in December 2013).

To implement these treaties, communication with national points of contact in these countries was regularly tested in 2011-2013 and was also additionally tested with Poland, Latvia and Hungary during IEC emergency exercises.

The SNRIU took part in the ConvEx-1a and 1b exercises conducted by the IAEA to test communication between the IAEA's Incident and Emergency Center and competent organizations and to test actions with competent national points of contact under the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and in in the ConvEx-2a and 2b exercises to check how national competent bodies fill in the notification forms and to test inquiry and assistance mechanisms.

The SNRIU also took part in the IAEA ConvEx-1c exercises in 2013 to check access of the administrators of the Unified System for Information Exchange in Incidents and Accidents to the USIE website.

In November 2013, Ukraine took part in the international full-scale ConvEx-3 exercises conducted by the IAEA on the scenario of conventional explosions of dirty bombs in Morocco, with a threat of transboundary and transnational effects. The SNRIU IEC was partially activated and duty departments of the State Emergency Service of Ukraine were involved for 24-hour operation. Upon results of the international full-scale ConvEx-3 exercises, a plan of corrective actions was developed to improve the SNRIU emergency preparedness and response system.

F.6. Decommissioning (Article 26)

Decommissioning of ChNPP Units

As noted in NRU-2008, the ChNPP developed a Detailed Decommissioning Plan in 2008.

The ChNPP deals with decommissioning of Chornobyl NPP units 1-3 in compliance with License series EO No. 000040 issued by the SNRIU by successive implementation of the following decommissioning stages:

- termination of operation;
- final shutdoun and preservation;
- safe enclosure storage;
- dismantling.

The decommissioning license covers:

- power units 1, 2, 3;
- interim storage facilities for liquid and solid radwaste;
- other plant facilities: auxiliary, electrical and hydraulic structures, cooling pool.

The Chornobyl NPP currently removes nuclear fuel from units 1-3 under the operation termination stage. See Subsection B 2.2 of this Report.

Taking into account that all spent fuel was removed from ChNPP-3 in 2010, the operator made a decision to change the status of ChNPP-3 from a nuclear installation to a radwaste management facility on 8 December 2012 upon agreement with the SNRIU (in accordance with the definition in para. J) of Article 2 of the Joint Convention).

The license establishes requirements for obtaining individual written authorizations from the SNRIU:

– for each subsequent decommissioning stage;

– for specific activities or operations related to design, construction, commissioning and operation of radwaste management facilities and for measures to remove spent and fresh fuel and liquid and solid radwaste accumulated during Chornobyl NPP operation from the existing facilities.

Accordingly, the Chornobyl NPP shall obtain a written authorization from the SNRIU for final shutdown and preservation. In the framework of arrangements for obtaining an authorization, the design documentation "Final Shutdown and Preservation of ChNPP Units 1-3" was given a favorable conclusion of the regulatory review, and the SAR for final shutdown and preservation is currently under review.

The ChNPP site also houses unit 4 destroyed in the beyond-design basis accident (Shelter), which is a nuclear hazardous facility and temporary storage of uncontrolled radwaste. The measures taken at the Shelter are intended for its transformation into an environmentally safe system. Information on Shelter-related activities is provided in Annex 9 to this Report.

Decommissioning Plans for Operating NPPs in Ukraine

It was pointed out in NRU-2011 that the design-basis operating period of SUNPP-1 would expire in December 2012.

Based on state review on nuclear and radiation safety for the Periodic Safety Review Report for SUNPP-1 and comprehensive inspection, the lifetime of SUNPP-1 was extended to 2 December 2023.

Efforts are currently underway to justify long-term operation of the following power units:

– SUNPP-2, WWER-1000/338, lifetime expires in May 2015;

– ZNPP-1, WWER-1000/320, lifetime expires in December 2015;

– ZNPP-2, WWER-1000/320, lifetime expires in February 2016.

The design lifetimes of other WWER-1000 units expire in 2017-2035.

The Law of Ukraine "On Settlement of Nuclear Safety Issues" requires the following documents to be developed for decommissioning of nuclear facilities:

– decommissioning concepts;

– decommissioning projects.

The NNEGC *Energoatom* "Decommissioning Concept for Operating Nuclear Power Plants of Ukraine" was revised in the reporting period to justify and increase allocations to the Decommissioning Fund in connection with commissioning of new units and long-term operation of existing ones.

Based on the branch Decommissioning Concept, decommissioning concepts for the South Ukraine, Zaporizhzhya, Khmelnitsky and Rivne NPPs were developed and agreed with the SNRIU.

The Decommissioning Concepts for South Ukraine, Rivne and Zaporizhzhya NPPs were revised in 2012-2014.

Decommissioning Plans for Research Nuclear Reactors in Ukraine

To comply with the license for operation of the VVR-M research reactor, the INR NASU developed the "Program for Decommissioning of the VVR-M Research Reactor". The SNRIU agreed the Program in 2009 after state review on nuclear and radiation safety.

To comply with the license for operation of the RD-100 research reactor, the SUNEI developed the "Concept for Decommissioning of the SUNEI IR-100 Research Reactor", which was under SNRIU review. The SNRIU agreed the concept in 2012 upon state review on nuclear and radiation safety.

Decommissioning Plans for Radwaste Management Facilities - Radwaste Treatment and Storage Facilities

According to the regulations "Requirements for the Structure and Contents of the Safety Analysis Report for Radwaste Treatment Facilities" and "Requirements for the Structure and Contents of the Safety Analysis Report for Radioactive Waste Storage Facilities", the safety analysis reports for these facilities contain sections devoted to decommissioning.

The current safety analysis reports on the retrieval facility and solid radwaste treatment plant and interim storage facility for high-level and low- and intermediate-level long-lived radwaste of the ICSRM and liquid radwaste treatment plant at the ChNPP contain sections on decommissioning of these facilities.

F.6.1. Qualified Staff and Adequate Financial Resources for Decommissioning

As was mentioned in Subsection F.6 of this Report, the only operating organization in Ukraine – ChNPP – has a license for nuclear facility decommissioning. One of the license conditions was to develop and introduce an effective management system to implement planned activities in a timely and high-quality manner.

The ChNPP presently continues optimization of the enterprise management system taking into account experience in practices, international experience in decommissioning and recommendations of IAEA experts. The management system is primarily optimized to ensure effective planning and successive implementation of projects and activities during decommissioning of ChNPP units 1-3 and Shelter transformation into an environmentally safe system, including their coordination and monitoring.

The ChNPP is currently provided with the necessary number of skilled personnel for spent fuel and radioactive waste management (as of 1 April 2011, ChNPP industrial personnel constituted 2626 persons) including:

- 53.5% with higher education;
- 18.2% with incomplete higher education;
- 67.9% with 10-year record of service.

Training of ChNPP personnel is aimed at improving the occupational quality of the enterprise. Continuous professional development is one the major principles that promote high qualification and skills of the ChNPP personnel. There is a functional training center at the enterprise.

Information on funding of Chornobyl NPP decommissioning is provided in Subsection F.2.2 of this Report. The same section also informs how the NNEGC *Energoatom* ensures a financial reserve for future decommissioning of operating NPPs (decommissioning fund).

F.6.2. Operational Radiation Protection, Minimization of Discharges and Unplanned and Uncontrolled Releases during Decommissioning

According to regulations, the operating organization must adapt the radiation protection program to new conditions before the beginning of decommissioning activities. During decommissioning, radiation monitoring of individual doses and radiation monitoring of the environment must be ensured. Radiation and individual dose monitoring at the stages of termination and decommissioning is conducted in accordance with the Radiation Monitoring Procedure that establishes requirements for the scope and periodicity of monitoring using stationary automatic systems, individual and movable devices and laboratory methods.

The ChNPP established limits for radiation dangerous factors including:

- reference levels of radiation safety for personnel;

– technological levels of radiation factors for separate areas of the territory and rooms.

Reference levels of radiation safety determine:

– effective doses of external and internal exposure;
– exposure dose rate and radioactive contamination of surfaces in the working area;
– radiation contamination of air and drinking water;
– radioactive releases and discharges.

The reference levels are established as low as is practically achievable, taking into account controlled parameters in normal operation, and do not exceed 70% of the respective permissible levels.

The technological levels of radiation factors for separate areas of the territory and rooms are used for their zoning to optimize exposure of personnel at work. These technological levels establish average annual parameters:

– gamma dose rate;
– beta radiation flux density;
– airborne concentrations of alpha and beta long-lived radionuclides.

Permissible levels for releases are established in the document "Permissible Airborne Radioactive Releases at the Chornobyl NPP". Permissible levels for discharges are established in the document "Permissible Radioactive Water Discharges at the Chornobyl NPP".

Permissible radioactive releases to the atmosphere and discharges to water bodies are based on the dose limit quota for the ChNPP, specifically: 40 μSv/year for inhalation intake (for all dose pathways) and 10 mSv/year for ingestion intake (due to critical water use). The reference levels for radionuclide discharge with sewage waters and atmospheric releases are no more than 70% of the permissible levels.

In the reporting period, there were no discharges to open water bodies. Radioactive discharges to the cooling pool were associated only with washout of residual accident-related contamination and went through the industrial storm water drainage, radionuclide volume concentration being monitored.

The dynamics of airborne atmospheric releases and water discharges to the cooling pool is shown in Figures L.8.11–L.8.12 of Annex 8 to this Report.

Analysis of individual doses of ChNPP personnel involved in the stage of operation termination (see Subsection F.4.1.2 of this Report) demonstrates that most of them receive individual doses lower than 10 mSv/year. The average individual doses of personnel were 1.39-4.23 mSv/year in 2005-2010.

Analysis of ChNPP annual radiation safety reports shows that reference levels were not exceeded in the reporting period.

F.6.3. Emergency Preparedness

The ChNPP implements necessary measures to ensure emergency preparedness. For this purpose, the following documents were developed and implemented:

- ChNPP Plan of Response to Accidents and Emergencies, 32P-S;
- Provisions on Plant Commission of Emergencies, 33P-S;
- Provisions on ChNPP Emergency Crews, 11P-S;
- Provisions on Information Transfer, 22P-S;
- Provisions on ChNPP Evacuation Commission, 86P-S;
- Procedure for Use of the Computer-Aided System for Automated Notification of ChNPP Management, 61E-S.

Emergency crews and teams were formed at the ChNPP. Personnel of the ChNPP and emergency crews and teams are provided with respiratory protection means. The ChNPP emergency kit includes skin protection means, special emergency rescue equipment, equipment for emergency recovery measures on process lines, dosimeters and chemical survey devices, equipment and tools needed to mitigate emergencies at ChNPP facilities.

Experts of the emergency preparedness and response department annually check the preparedness of Chornobyl NPP personnel to act in emergencies. Exercises and training are also conducted for ChNPP personnel to correctly use skin and respiratory protection means and test evacuation routes to protective structures.

Interaction and coordination with forces of the USSE regional subsystem are tested during training and exercises.

Emergency training is conducted on the basis of schedules approved by the ChNPP. Plant-level training on personnel's response to civil defense signals is organized twice a year.

The preparedness of departments, emergency crews and teams in case of emergencies is checked during plant-level "safety days".

At the Chornobyl NPP, there are three protective structures with self-contained power supply and ventilation systems that are kept ready to shelter personnel. An emergency center operates in protective building 1 (under Administrative and Office Building-1).

F.6.4. Records of Information Important to Decommissioning

Records of Information Important to Decommissioning for ChNPP Units 1, 2, 3

The project on the "Information Support System for Decommissioning of the Chornobyl NPP" is financed under IAEA international assistance. The project scope includes design, supply, assembly, testing and commissioning of the system, personnel training, supply of spare parts and/or consumables and warranty service of equipment and software needed for the decommissioning information support system.

Records of Information Important to Decommissioning for Ukrainian NPPs Operated by NNEGC Energoatom

According to the *Energoatom* Enterprise Standard "NPP Decommissioning. Information Support System. Structure and Procedure for Collection, Processing and Storage of Information", the South Ukraine NPP has implemented an automated system to support comprehensive engineering radiation inspection (ASS CERI) of power units. The system is intended to:

– collect and organize information on radiation contamination of equipment, piping, rooms, structures of buildings and power units and NPP territory adjacent to the power units obtained during their comprehensive engineering and radiation inspection;

– store design and operational documentation.

The Rivne and Zaporizhzhya NPPs started preparations for comprehensive engineering radiation inspection of units 1, 2 and creation of ASS CERI.

It should be also noted that the *Energoatom* also started creation of an information support system for decommissioning of WWER NPPs.

Section G. SAFETY OF SPENT FUEL MANAGEMENT

G.1. General Safety Requirements (Article 4)

The Ukrainian legislation provides for compulsory licensing of operating organizations during construction and commissioning, operation and decommissioning of facilities for spent fuel management.

General safety requirements at all stages of spent fuel management are established in the Laws of Ukraine "On Nuclear Energy Use and Radiation Safety" and "On Authorization Activity in the Field of Nuclear Energy".

Requirements and rules for spent fuel management are established by regulations that cover spent fuel management at NPP sites, research reactors and interim spent fuel storage facilities, specifically:

– General Safety Provisions for Nuclear Power Plants;
– Nuclear Safety Rules for Pressurized Water Reactor Nuclear Power Plants;
– General Safety Provisions for Design, Construction and Operation of Research Reactors;
– Nuclear Safety Rules for Research Reactors;
– Safety Rules for Nuclear Fuel Storage and Transport at Nuclear Facilities;
– Basic Safety Provisions for Dry Interim Spent Fuel Storage Facilities;
– Requirements for Modifications of Nuclear Facilities and Procedure for Their Safety Assessment.

Following the Fukushima NPP accident, the regulatory and legal framework is undergoing improvement as part of the "Action Plan for Extraordinary Targeted Safety Assessment and Further Safety Improvement of NPP Units Considering Events at Fukushima Daiichi NPP" approved by the SNRIU Board dated 19 May 2011.

G.1.1. Criticality and Residual Heat Removal

According to the requirements of the above regulations, the effective neutron multiplication factor for spent fuel management activities shall not exceed 0.95 in normal operation and design-basis accidents, which is to be ensured by appropriate features of the facilities. During spent fuel storage, subcriticality is ensured by limitation of the fuel assembly layout pitch; fuel burnup control (if burnup is used as a parameter in nuclear safety substantiation); use of heterogeneous or homogenous absorbers and control of absorption capacity; monitoring of the cooling media, its condition and composition in dry storage facilities; monitoring of process parameters of spent fuel management systems. According to the document "Basic Safety Provisions for Dry Interim Spent Fuel Storage Facilities", subcriticality in dry spent fuel interim storage facilities shall be mainly ensured by the geometry of spent fuel location.

The design of spent fuel management systems provides for residual heat removal and for appropriate chemical composition of the media in which SNF is stored, to prevent increase of fuel cladding temperature and uncontrolled corrosion rate beyond the permitted design values for normal operation and design-basis accidents. Thus, for facilities where spent fuel is stored in water (reactor cooling pools of ChNPP units 1, 2, 3 and ISF-1), devices and systems are in place to provide water supply, treatment and cooling, ventilation, monitoring of radioactivity, temperature, level, chemical composition of water and, if necessary, of hydrogen concentration.

G.1.2. Minimization of Radioactive Waste Generation

In the reporting period, the requirements for minimization of radwaste generation associated with spent fuel management have not changed (see Subsection G.1.2 of NRU-2003). Pursuant to the "Basic Safety Provisions for Dry Spent Fuel Interim Storage Facilities", the operating organization develops and implements the radwaste management program to identify measures for minimization of radwaste generation and safety assurance during collection, sorting, treatment, storage and transfer of radwaste for disposal or long-term storage.

G.1.3. Interdependencies between Different Steps in Spent Fuel Management

The interdependencies between different steps in spent fuel management are taken into account starting from the very design of fresh nuclear fuel. The technical specifications for supply of fresh nuclear fuel contain requirements for spent fuel storage in cooling pools, permissible temperature of fuel claddings in spent fuel storage, etc. Two options are currently implemented:

–transfer of ZNPP spent fuel from reactor ponds to the dry spent fuel storage facility operated at ZNPP;

– transport of spent fuel from the RNPP, KhNPP and SUNPP to Russian enterprises for technological storage and reprocessing and subsequent return of the resulting high-level waste to Ukraine.

In the reporting period, the requirements to consideration of interdependencies between different steps of spent fuel management have not changed.

G.1.4. Radiation Protection of Personnel, Public and Environment

The radiation protection system of Ukraine is described in Subsection F.4 of this Report.

G.1.5. Biological, Chemical and Other Risks

Biological, chemical and other risks that can be associated with spent fuel management shall be taken into account in safety assessment of spent fuel management facilities. Information on such risks is provided according to the "Recommendations on the Structure and Contents of the Safety Analysis Report for Spent Fuel Storage Facilities".

Biological, chemical and other risks are evaluated within state comprehensive review.

G.1.6. Avoiding Predictable Negative Impacts on Future Generations More Severe Than on the Current Generation

Protection of future generations is considered in the safety analysis reports for spent fuel management facilities, which should demonstrate that protection of the public and personnel in the future will not be minor to that at the beginning of operation. If necessary, processes inside the containment and degradation of fuel elements and spent fuel storage components are inspected during operation to ensure timely corrective measures are taken (if needed).

G.1.7. Avoiding Undue Burdens on Future Generations

The policy of avoiding undue burdens on future generations in Ukraine is implemented through:

–establishment of efficient quality management systems for operators at all lifetime stages of nuclear facilities, and within state authorities for nuclear and radiation safety regulation;

–improvement and development of regulations in the field of nuclear and radiation safety;

–building of high safety culture with strict compliance with standards and rules on nuclear and radiation safety among the present generation dealing with siting, design, commissioning and operation of nuclear facilities and radwaste disposal storages;

–introduction of methodologies ensuring long-term safety of radwaste disposal facilities for the entire period of potential danger.

In the context of reducing of the financial burden on future generations, it has become relevant to ensure timely preparation of operators for decommissioning of nuclear facilities such as spent fuel storage facilities.

This issue is currently resolved by implementation of the Law of Ukraine "On Settlement of Nuclear Safety Issues" (see Subsection F 2.2 of this Report), in particular, by:

– planning of future decommissioning, starting from the very design of a nuclear facility;

– development of decommissioning concepts, starting from licenses for construction of nuclear facilities, including their periodical revisions to take into account improvement of the regulatory and legal framework, development of science and technologies and to address incidents (accidents) that occurred during operation;

– timely development of decommissioning projects based on decommissioning concepts for nuclear facilities;

– timely establishment of a decommissioning fund designed for accumulation of funds during operation to finance measures envisaged by the decommissioning plan for a nuclear facility;

– arrangement for and ensuring, during the entire life cycle of a nuclear facility, collection, processing, recording and storage of information on the facility that may substantially impact the decommissioning process (databases (archive)) etc.

G.2. Existing Facilities and Past Practices

Spent fuel in Ukraine is managed at facilities listed in Annex 1 to this Report.

Information on operation of the existing spent fuel management facilities is provided in Subsections B.2.1. - B.2.3 of this Report.

G.2.1. Safety of Existing Facilities

The safety of existing spent fuel management facilities is ensured by current technical regulations, design decisions, technical specifications, operating and maintenance procedures, technical decisions and quality assurance procedures.

All spent fuel management facilities are designed to have surveillance and monitoring systems.

The automated radiation monitoring system *Koltso* and a network of observation wells to monitor underground and ground waters are in operation in the territories around the Zaporizhzhya ISF. Radiation parameters at the site and adjacent territory around the storage facility are monitored at time intervals established in radiation monitoring procedures. The results are analyzed and compared with reference levels. Quarterly and summary annual safety reports on Zaporizhzhya ISF safety performance indicators are submitted to the SNRIU.

As noted in previous NRUs, safety reassessment of Ukrainian NPPs did not reveal any fundamental drawbacks that would require modernization of the spent fuel management systems at operating NPPs.

The reactor cores of Ukrainian NPPs are reloaded in a timely manner and regulations that require vacant capacities in the cooling pools for complete accident core unloading are met owing to the efficient operation of the Zaporizhzhya ISF and compliance with the schedule for spent fuel transport for reprocessing to specialized enterprises of the Russian Federation.

Based on the analysis of the Fukushima-1 accident and its consequences, and in order to properly address the lessons learned from the accident, the Chornobyl NPP implemented the "Action Plan for Special Targeted Safety Reassessment and Further Safety Improvement of Units 1–3 and ISF-1 Considering the Events at Fukushima-1" (hereinafter referred to as the ChNPP Action Plan), which was agreed upon at an open meeting of the SNRIU Board.

On 03 October 2011, a conclusion of the State NRS Review of the results of a targeted safety reassessment (stress-test) for units 1-3 and ISF-1 was approved by the Ordinance of the SNRIU Board. The "Plan of ISF-1 Safety Improvement" was amended based on the safety reassessment results.

Nuclear fuel was completely removed from unit-3 in August 2010. According to Decision "On Recognizing ChNPP-3 (Nuclear Facility released from Nuclear Fuel) as a Radioactive Waste Management Facility" No. 03-OSE dated 12 November 2012, inventory No. VTS-48 dated 14 December 2012, starting from 08 December 2012 the nuclear facility "ChNPP-3" was assigned a status of radioactive waste management facility.

Activities on ChNPP-2 release from conditioned nuclear fuel was completed in November 2012, ChNPP-1 was released in September 2013. Damaged NF in spent fuel pool of these units is stored in special canisters of different configurations produced by SSE ChNPP.

It is expected that the issue on safe management and storage of damaged nuclear fuel in ISF-1 will be solved, and spent fuel pools of ChNPP-1, 2 will be completely released by the end of 2014.

The information on performed safety substantiations is presented below.

No	Place of spent fuel storage	Performed safety assessment activities
1	Spent fuel reactor pool of Unit-1.	"Safety Assessment Report of ChNPP Systems and Components related to Spent Nuclear Fuel and Radioactive Waste Management"
		"Report on Nuclear Safety Substantiation of Spent Fuel Reactor Pools of Unit-1, 2 Considering Spent Fuel Burnup"
2	Spent fuel reactor pool of Unit-2.	"ChNPP-2 Safety Assessment Report for Lifetime Extension"
		"Report on Nuclear Safety Substantiation of Spent Fuel Reactor Pools of Unit-1, 2 Considering Spent Fuel Burnup"
3	ISF-1	"Safety Analysis Report of Interim Storage Facility (ISF-1)"

G.3. Siting for Proposed Facilities (Article 6)

G.3.1. Evaluation of Site-Related Factors Likely to Affect the Safety of the Facility during Its Operating Lifetime

In the reporting period, the requirements for Zaporizhzhya ISF site-related factors that can affect safety of the facility during its service life have not changed. The information provided in Subsection G.3.1 of NRU-2003, NRU-2005, NRU-2008, and NRU-2011 is relevant at present.

The development of EIA, which is a part of the Feasibility Study for construction of the centralized spent fuel storage facility for Ukrainian NPPs with WWER reactors (Centralized ISF), takes into account evaluation of site-related factors that can affect the safety of the Centralized ISF. After the accident at the Fukushima-1 NPP in Japan, natural hazards peculiar to the site, recommended for the Centralized ISF, and their potential impact on its safety were additionally analyzed. The analysis showed that these impacts would not challenge the limits of the Centralized ISF safe operation preliminary identified in the Centralized ISF Feasibility Study.

To evaluate factors of the Chornobyl ISF-2, which is under construction within a 10-km Exclusion Zone, a feasibility study for siting of ISF-2 was developed. In addition, the "Preliminary Safety Analysis Report for ISF-2 (PSAR)" and "Environmental Impact Assessment of the Chornobyl NPP ISF-2" were prepared. These documents analyze natural and man-induced conditions on the ISF-2 construction site.

Based on the feasibility study and its supporting materials, and based on conclusions of state experts reviews thereof, the most suitable site for ISF-2 (of the four candidate sites) was selected, which was approved by Cabinet Resolution No. 1963 of 25 October 1999.

Additional seismic studies were conducted in 2005 at the Chornobyl NPP site. The results were taken into account during a revision of ISF-2 PSAR as recommended by the SNRIU.

G.3.2. Evaluation of Likely Safety Impact of the Facility on Individuals, Society and the Environment

According to Article 51 of the Law of Ukraine "On Environmental Protection", economic and other projects shall include environmental and human health impact assessment (EIA). Requirements for the EIA structure and contents are established in the State Construction Standards of Ukraine "Composition and Contents of the Environmental Impact Assessment (EIA) for Design and Construction of Enterprises, Buildings and Structures. Basic Design Rules".

According to the Law of Ukraine "On Ecological Review", design documentation on spent fuel management facilities is subject to state ecological review, including EIA as part of this design documentation.

As required by the State Construction Standards of Ukraine, EIA includes Statement of Ecological Consequences, which contains the final EIA results. The Statement is a legal document that sets forth ecological consequences and guarantees that measures are taken to ensure environmental safety over the entire period of a planned activity. The Statement shall be made public through mass media and submitted to local authorities for subsequent oversight.

NRU-2011, item G.3.2 includes the information on "Statement of Ecological Consequences Resulting from Construction and Operation of the Centralized Spent Fuel Storage Facility for the Rivne, Khmelnitsky and South Ukraine NPPs Operated by NNEGC *Energoatom* and Centralized ISF Feasibility Study".

Assessment of ISF-2 impact on the public, personnel, and environment is given in the EIA under ISF-2 project.

G.3.3. Informing the Public of the Facility Safety

Public hearings on nuclear energy use and radiation safety are envisaged in the valid Legislation. Their procedure is established by the Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Procedure of the Public Hearings on Nuclear Energy Use and Radiation Safety" No. 1122 of 18 June 1998.

The stages that were and continue to be implemented by the operating organization regarding interactions with the public on the centralized ISF development are presented in NRU-2011, Subsection G 3.3.

To inform the public of the ChNPP ISF-2 safety:

– information on ISF-2 is regularly published in mass media in Slavutych and broadcast on the local TV channel;

– lectures and visits to the Chornobyl NPP and ISF-2 are arranged for inhabitants of Slavutych and populated centers adjacent to the 30-km Exclusion Zone;

– on 06 March 2014, the SNRIU invited open dedicated public discussions on the progress of implementation of ISF-2 with the participation of representatives from SSE ChNPP, Holtec International, SSTC NRS, the public and mass media.

G.3.4. Consultations with Neighbouring States

In the reporting period, requirements to procedures for consultation with neighboring states have not changed. The information on the Centralized ISF provided in Subsection G.3.4 of NRU-2003, NRU-2005, NRU-2008 and NRU-2011 is still relevant.

Other states made no requests regarding general information on ISF-2 to assess probable safety impact of this facility in their territory.

G.4. Design and Construction of Facilities (Article 7)

G.4.1. Limiting Possible Radiological Impacts of Spent Fuel Management Facilities

In the reporting period, requirements to limitation of possible radiological impacts of spent fuel management facilities have not changed (see Subsection G.4.1 of NRU–2003, NRU–2005, NRU–2008, and NRU-2011).

G.4.2. Concept Plans and Technical Provisions for Decommissioning of Spent Fuel Management Facilities

Requirements to development of conceptual decommissioning plans for nuclear facilities including spent fuel storages are defined in the Law of Ukraine "On Settlement of Nuclear Safety Issues". According to this Law, the operating organization shall develop a conceptual plan of decommissioning (concept) and then use it as a basis for a decommissioning project for a nuclear facility.

In compliance with the procedure for review and approval of the decommissioning project for a nuclear facility, the decommissioning project is developed by the operating organization no later than 18 months prior to the termination of operation of a nuclear facility – expiry of the license for operation – and is submitted for state review. Provided all findings of the state reviews foreseen by Ukrainian legislation for investment programs and construction projects are favorable and all necessary agreements of state regulatory and control authorities are obtained, the decommissioning project is submitted to the Cabinet of Ministers of Ukraine for review and approval six months before the termination of operation of a nuclear facility.

Requirements concerning future decommissioning of nuclear facilities, including spent fuel storage facilities, beginning from the design stage, are stated in Article 42 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and in the regulation "Basic Safety Provisions for Dry Interim Spent Fuel Storage Facilities".

In accordance with the abovementioned regulation, the operating organization shall prepare for future decommissioning during different lifecycle stages of the Zaporizhzhya ISF. In addition, the operating organization shall, over the entire lifecycle of the dry storage facility, collect, process, record and save data on the Zaporizhzhya ISF needed to develop documentation for its decommissioning.

Hence, decommissioning issues for nuclear facilities, including spent fuel storage facilities, are a part of documentation submitted to justify safety at each licensing stage in compliance with the "Recommendations for the Structure and Content of the Safety Analysis Report for Spent Fuel Storage Facilities".

Regarding the development of conceptual decommissioning plans for spent fuel storage facilities in Ukraine:

1. for the dry storage facility, Zaporizhzhya ISF, the operator has developed and agreed:
   - Program for Spent Fuel Storage Facility Unloading and Decommissioning;
   - Program for Management of Spent Fuel after Reaching the Maximum Storage Period in Zaporizhzhya Spent Fuel Storage Facility.
2. for the Centralized ISF, the approved Feasibility Study for construction of the centralized ISF particularly includes a General Decommissioning Plan (Vol. 1, Part 3) with the main objectives to:
   - determine decommissioning principles;
   - determine decommissioning approaches;
   - determine main approaches to the decommissioning strategy;
   - evaluate foreseeable types and amounts of radwaste;
   - identify potential areas for radwaste management.
3. For the ChNPP ISF-1, according to the license conditions for operation of ISF-1, the decommissioning concept for ISF-1 was developed.

Moreover, Section 13 "Decommissioning" of the ISF-1 Safety Analysis Report describes the ISF-1 general decommissioning concept and considers several decommissioning options. The final decommissioning option will be selected at the final stage of ISF-1 operation.

4. For the dry spent fuel storage facility (ISF-2), Preliminary Safety Analysis Report describes the ISF-2 general decommissioning concept and considers several decommissioning options. The final decommissioning option will be selected at the final stage of ISF-2 operation.

G.4.3. Verification of Technologies Used in the Design by Experience, Testing or Analysis

During this reporting period, the requirements to verification of technologies used in the design by experience, testing or analysis have not been changed (see Subsection G.4.3 of NRU-2011).

G.5. Safety Assessment of Facilities (Article 8)

G.5.1. Safety Assessment and Environmental Assessment

During this reporting period, the requirements to safety assessment and environmental review have not been changed (see Subsection G.5.1 of NRU-2011).

During this reporting period, the operating organization developed a preliminary safety analysis report (PSAR) for ISF-2 that obtained a positive conclusion of the state expert review of nuclear and radiation safety.

The conclusion of the state expert review of nuclear and radiation safety regarding the construction design and safety justification documents for ChNPP ISF-2 demonstrated that the

selected technology for spent fuel storage is appropriate with respect to nuclear and radiation safety and is compliant with the policy for interim spent fuel storage accepted in Ukraine. The nuclear and radiation safety principles applied in development of the design meet the national regulatory and legal acts and approaches to safety.

G.5.2. Safety Reassessment during Construction and Commissioning

During this reporting period, the requirements for safety reassessment during construction and commissioning have not changed (see Subsection G.5.2 of NRU-2011).

The ChNPP obtained a license for "Nuclear Facility Construction and Commissioning (Spent Fuel Storage Facility ISF-2)" No. 001002 on 20 February 2013.

The interim SAR to be submitted to the SNRIU to obtain a license for commissioning within this license should include evidence that the safety level of the constructed ISF is compliant with the design safety level, and safety justification for any changes, amendments and corrections to the design incorporated during ISF construction, pre-start up reviews and tests. The operating organization will further add the final SAR incorporating results of commissioning to the application for obtaining a license for ISF operation. It will be submitted to further expert review at this stage.

G.6. Operation of Facilities (Article 9)

G.6.1. Licensing of Facility Operation

In the reporting period, the licensing procedure for operation of facilities has not changed (see Subsection G.6.1 of NRU-2011).

G.6.2. Defining and Revising Operational Limits and Conditions

Information on the establishment and revision of operational limits and conditions for nuclear facilities is provided in Subsection G.6.2 of NRU-2003. According to the requirements of the "Basic Safety Provisions for Interim Dry Spent Fuel Storage Facilities", the design shall define operational limits and conditions to be revised by the operating organization with the periodicity established by the SNRIU.

Ukraine currently operates Zaporizhzhya ISF for WWER-1000 fuel at the Zaporizhzhya NPP and ISF-1 at the Chornobyl NPP.

The first safety reassessment of the Zaporizhzhya ISF was carried out in 2006. Based on the results, the "Safety Analysis Report for the Zaporizhzhya Dry Spent Fuel Storage Facility. Revision 3.01.1" was approved in March 2006. In 2014, preparation for periodic safety review of Zaporizhzhya ISF was started, an in-depth analysis of ZNPP ISF will be performed as part of it to consider research results.

In 2011, safety review was performed for ISF-1, and Safety Analysis Report was developed based on its results. This SAR obtained positive conclusion of the state expert review of nuclear and radiation safety.

ISF-1 safety review considering the revised scheme for damaged fuel storage in ISF-1 is planned to be completed by 31 December 2014.

G.6.3. Operating Procedures

The information on ISF operating procedures is presented in Subsection G.6.3 of NRU-2011.

G.6.4. Engineering and Technical Support of Operations

Information on engineering and technical support in ISF operation is presented in Subsection G.6.4 of NRU-2011

In particular, the priority areas of scientific, engineering, and technical support in spent fuel management are:

- scientific and technical support of research efforts undertaken by the RIAR (Russian Federation) on "Experimental and Calculation Study of WWER-1000 Spent Fuel Behavior on a Short-Term Basis during Dry Storage for 50 Years";
- development of a technology for producing of concrete and resilient materials with titanium hydride admixtures with a high hydrogen content based on a technology developed by IPMS of the NASU involving RDIB experts;

The cooperation between the SE NNEGC *Energoatom* and institutes of the National Academy of Sciences of Ukraine, for example, may yield the following results:

- development of a new neutron shielding material based on titanium hydrides and obtaining of two Ukrainian Patents No. 56381 "Neutron Shielding Titanium Hydride" and No. 56382 "High-Hydrogen Zirconium Hydride Neutron Moderator".

The NNEGC *Energoatom* maintains permanent liaisons with Russian organizations that were involved in NPP design and still provide engineering support to operating facilities.

In order to examine dry storage conditions of WWER-1000 spent fuel, NNEGC *Energoatom* developed and implemented the long-term "Work Program to Examine Spent Fuel Storage Conditions". The program is aimed at obtaining results to confirm either adequacy or excessive conservatism of restrictions imposed on the operation of Zaporizhzhya ISF, safety requirements being properly met.

G.6.5. Reporting of Safety-Significant Incidents to the Regulatory Body

In this reporting period, the procedure for reporting to the regulatory body on incidents important to safety have not been changed (see Subsection G.6.5 of NRU-2011).

In particular, a valid regulatory document NP 306.2.100-2004 (Regulation) "Procedure for Investigation and Reporting of Operational Events at Nuclear Power Plants" defines the following procedure for informing the regulatory body on incidents (operational events), related to falling and/or damage of fuel assemblies, fuel elements, absorber rods during handling operations with dry and spent nuclear fuel (P01, P02, P06 categories):

1. NPP Shift Supervisor or an official instructed by him shall inform the SNRIU duty officer and Head of the on-site State Nuclear and Radiation Safety Inspectorate on an incident (operational event) by telephone immediately (for P01, P02) or within one hour (for P06) after detection of an incident (operational event).
2. Preliminary notification of an incident signed by the NPP Chief Engineer and the Head of NPP On-site State Nuclear and Radiation Safety Inspectorate is transferred via telephone or electronic network to the regulatory body and its Department on Safety Analysis of Nuclear Facilities.

3. If needed, a supplementary (detailed) notification signed by the mentioned persons is sent to the same address as a preliminary notification within five days.

SE NNEGC *Energoatom* unconditionally fulfills these requirements.

A nuclear facility monitoring group consisting of five people who work according to the general schedule (day and night duty) was formed within the "Emergency Technical Center" by NNEGC *Energoatom* to improve the emergency preparedness system considering SNRIU proposals on improvement of emergency preparedness service and crisis response in emergency situations and modes, and to provide additional monitoring of nuclear facilities according to the Ordinance of NNEGC *Energoatom* No. 989 of 22 November 2011.

The main functions of this group are:

- interaction (information exchange) with the state authorities and other organizations responsible for decision-making, implementation of emergency response plans in crisis and emergency situations and accidents at nuclear facilities;
- monitoring of NPP parameters on a regular basis to define critical safety functions, checking compliance with limits and conditions of reactor safe operation and preparedness of safety system trains;
- informational support to departmental oversight services and appropriate services of the state governmental authorities related to functioning of equipment important to NPP safety and its specified parameters and states;
- participation in emergency exercises and training using all communication systems, equipment, involving personnel and using procedures the group is responsible for;
- maintaining constant preparedness of the equipment and communication systems designed for the use in crisis and emergency modes, testing and inspection of these including checking of communications with foreign partners established in compliance with the requirements of international conventions and treaties;
- maintaining a computerized database in crisis centers of Ukraine and other countries.

The emergency planning system envisages state and facility level checks of emergency preparedness through emergency exercises and training.

Measures are taken to inform the public, state establishments and international organizations.

G.6.6. Analysis of Relevant Operating Records

The data on analysis of relevant operating records is presented in Subsection G.6.6 of NRU-2011.

G.6.7. Decommissioning Plans

The information on legislative requirements of Ukraine on decommissioning of nuclear facilities, such as spent fuel storage facilities, and on the development of decommissioning plans is provided in Subsection G.4.2 of this Report.

G.7. Disposal of Spent Fuel (Article 10)

As stated in Subsection B.1 of this Report, the Energy Strategy of Ukraine till 2030 established the so-called deferred decision for spent fuel management, which includes long-term storage (50 years and more) and subsequent definition and approval of the final decision on spent fuel reprocessing or disposal.

According to Task 3 of the National Target Ecological Program for Radioactive Waste Management, design of a facility for long-term storage of high-level waste generated from reprocessing of spent fuel from Ukrainian NPPs in the Russian Federation has been started as part of *Vektor* Phase II.

There are plans to create a geological repository for final disposal of high-level and long-lived waste, including waste resulting from spent fuel reprocessing in accordance with the Strategy for Radioactive Waste Management in Ukraine.

Section H. SAFETY OF RADIOACTIVE WASTE MANAGEMENT

H.1. General Safety Requirements (Article 11)

General safety requirements for all stages of radwaste management are established in legislative and regulatory documents identified in Subsection H.1 of NRU-2008. Annex 6 to this Report indicates regulations implemented in the period from 2011 to 01 July 2014.

The licensees' compliance with safety requirements is confirmed by safety assessments of radwaste management facilities and radwaste management activities (safety assessment of facilities and activities) and analysis of annual reports on compliance with radiation safety requirements during operation and state oversight.

According to the regulatory requirements, the licensee conducts periodic safety reassessment taking into account experience in activities.

H.1.1. Criticality and Removal of Residual Heat

According to the radwaste classification established in the "Basic Sanitary Rules for Radiation Safety of Ukraine", the category of high-level waste is divided into two subcategories:

- "low-temperature" HLW whose specific heat release in temporary storage or disposal does not exceed 2 kW/m^3;
- "heat-releasing" HLW whose specific heat release is 2 and more kW/m^3.

In compliance with the regulatory document "Requirements for Packages for Long-Term Storage and Disposal of High-Level Waste Resulting from Spent Fuel Reprocessing":

- requirements for HLW packages limit the heat release of a radwaste package so that its physical, chemical and mechanical characteristics remain stable over the design lifetime of the facility;
- requirements for the waste limit the content of fissile materials in the HLW form so that criticality in a radwaste package is prevented. To justify that a package is subcritical, the presence and amount of the following radionuclides shall be taken into account:

Radionuclide	Chemical symbol
Uranium	U-232, U-234, U-235, U-236
Neptunium	Np-237
Plutonium	Pu-238, Pu-239, Pu-240, Pu-241, Pu-242
Americium	Am-241, Am-242m, Am-243
Curium	Cm-243, Cm-244, Cm-245

According to the Resolution of the Ministry of Energy and Coal Industry of Ukraine No. 485 of 04 July 2012, a regulatory document "Requirements for Containers and Packages for Long-Term Storage of HLW Returned to Ukraine after Reprocessing of WWER-440 Spent Fuel in the Russian Federation" was put into force. They establish that:

- specific heat release of the HLW forms returned to Ukraine must not exceed 2 kW/m^3;

- concentrations of fissile radionuclides must be determined by laboratory measurements and criticality calculations must take into account possible inhomogeneous distribution of these radionuclides in a package.

The heat release of HLW packages shall be considered in design of facilities for long-term storage.

H.1.2. Minimization of Radioactive Waste Generation

Basic provisions of the legislation to minimize radioactive waste generation are presented in Subsection H.1.2 of NRU-2011.

"Comprehensive Program for Radioactive Waste Management in NNEGC Energoatom for 2012-2016" is a fundamental document of the operating organization on radioactive waste management specifying main spheres of activity, technical and organizational measures on radioactive waste management, particularly: minimization of radioactive waste generation, improvement of NPP operating radioactive waste management systems, and construction of radioactive waste treatment plant.

Sources and scope of generation of radioactive media, LRW, SRW in normal operation and scheduled repair were analyzed to minimize radioactive waste generation at NPP during the reporting period.

Resulting from the analysis of sources and scope of generated radioactive media, LRW, SRW at NPP, measures were developed to minimize LRW generation such as spent fuel pool leakage elimination, changing modes for filter regeneration in special water treatment facilities, liquid radioactive medium flow separation, application of up-to-date decontamination technologies for equipment, rooms and personnel individual protection means, monitoring and account of floor drain ingress from NPP compartments etc.

The most efficient measures to minimize solid waste amounts transferred to temporary storages include improvement of work planning in strict access area (limit entering of packaging materials, collection and sorting of clean or contaminated metal cuttings), reuse of insulating material, decontamination and reuse of contaminated equipment and materials, etc.

Reference levels for generation and transfer of solid and liquid radwaste to plant storages have been developed and approved at each NPP, including the Chornobyl NPP. These levels are periodically revised to consider decrease of their dependence on the actual amounts of radwaste generation due to measures aimed at minimizing radioactive waste generation in NNEGC *Energoatom* and at ChNPP.

The administrative and technical measures taken under the Comprehensive Program have resulted in a clear tendency toward decrease in the annual generation and accumulation of radwaste.

The ChNPP administrative and technical measures to minimize radwaste generation to the extent possible include:

– decontamination and release of contaminated equipment dismounted during decommissioning from regulatory control;

– operation of a site for temporary storage of process materials that are generated during the Shelter transformation into an environmentally safe system and may be reused in NSC construction.

The specialized radwaste management enterprises in the Chornobyl exclusion area operate facilities for decontamination of metal items and equipment. As a result, some their part is released from regulatory control and amounts of radwaste subject to disposal are reduced.

H.1.3. Interdependencies among Different Steps of Radioactive Waste Management

Requirements on interdependencies among different steps in radwaste management are determined in a number of regulations. The main regulations are indicated in Subsection H.1.3 of NRU-2008.

Strategic areas and practical measures for interdependencies among different steps of radwaste management are described in Subsections B.3, B.4.1 - B.4.4 of this Report. The main measures include creation and implementation of an integral infrastructure of radioactive waste management in Ukraine.

The regulatory and legal support is being continued including development and implementation of radioactive waste classification system depending on their disposal. See Subsection B 5 of this Report.

NNEGC *Energoatom* put in force:

- SOU YaEK 1.037:2013 "Short-lived Low-and intermediate Level Waste at NPP. Requirements for End Product" to ensure waste acceptance for disposal in centralized radwaste facilities on the *Vektor* site.
- requirements for containers and packages for long-term storage of HLW returned to Ukraine after WWER-440 spent fuel reprocessing in the Russian Federation.

Preliminary radioactive waste acceptance criteria in form of spent radiation sources to the centralized long-term storage facility for radiation sources were developed within implementation of CLTSF construction project.

H.1.4. Effective Protection of Individuals, Society and the Environment

The radiation protection system for personnel, the public and the environment and radiation protection measures taken in Ukraine during radwaste management are described in Subsection F.4 of this Report.

H.1.5. Biological, Chemical and Other Risks

The contents of biological, chemical, toxic, inflammable or explosive substances in radwaste shall be taken into account to determine the methods and technologies for waste sorting, preliminary treatment and processing. The adverse impact of these substances at further stages of radwaste management, storage and disposal, must be prevented.

According to regulations:

- radwaste containing chemical substances must be treated to neutralize them completely and avoid their presence in a radwaste package;
- explosive or inflammable radwaste must be transferred into a safe state in situ;
- combustible radwaste must be transferred into a noncombustible state;
- amount of organic and biological substances and complexing agents in radwaste is limited to minimize degradation in engineering barriers of the storage/disposal facility and failure of the structural stability of a radwaste package;
- toxic radwaste is not accepted for disposal.

The permissible content of hazardous substances in a radwaste package is evaluated during safety assessment of a radwaste storage/disposal facility based on calculations of the cumulative effects of radiation and other hazardous factors on human health.

H.1.6. Avoiding Reasonably Predictable Impacts on Future Generations Greater Than Those for Current Generation

According to the main principles of state policy for nuclear energy use identified in Article 5 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", no activity in the area of nuclear energy may bring greater detriment to future generations than that accepted for the present generation.

The implementation of this principle becomes especially important for disposal and long-term (more than 50 years) radwaste storage since the life of such facilities is greater than the life of one generation. Hence, reliable waste isolation from the environment during its disposal and long-term storage is one of the principles of state policy for radwaste management in compliance with Article 3 of the Law of Ukraine "On Radioactive Waste Management".

Reliable isolation of radwaste is provided by a system of multiple natural and engineering barriers that shall ensure safety over the period while waste remains potentially dangerous, taking into account possible external natural and man-induced hazards, and is demonstrated in safety justification of radioactive waste storage facilities.

Safety assessment of radwaste storage/disposal facilities should provide evidence that radiation impacts on the public are not exceeded in the long-term post-closure period according to radiation safety standards. In compliance with regulatory requirements, safety assessment of facilities for radwaste disposal and long-term storage is carried out for the operational and post-closure periods.

According to the regulatory documents, radiation protection of future generations is considered adequate during disposal (taking into account uncertainties of estimates for times far into the future) if estimated risks for human health range from 5E-7 to 5E-5 per year. The risk of 5E-7 per year is regarded as the target value used in optimization of radiation protection. If the estimated risk exceeds 1E-6 but is lower than 5E-5 per year, radiation protection is considered sufficient.

In addition, the probability of inadvertent human intrusion into a storage/disposal facility must be decreased through proper selection of the storage/disposal site and measures of active and passive institutional control and storage of records on the storage/disposal facility.

H.1.7. Avoiding Undue Burdens on Future Generations

Radioactive waste shall be managed to avoid imposing responsibility for safety on future generations.

Regarding radwaste disposal, this is ensured by passive safety control of the disposal system after completion of the active institutional control period. This means that characteristics of the barriers shall be such that safety of the disposal facility does not rely on monitoring, oversight, preventive or corrective actions after completion of the active institutional control and the need for active control is minimum.

Centralized disposal and long-term storage of radwaste in Ukraine will be arranged on the *Vektor* site in the Exclusion Zone. Hence, necessary measures and duration of active and passive institutional control of facilities for radwaste disposal and long-term storage will be determined taking into account safety assessment of total radiation impact of radioactive waste management facilities at the *Vektor* site and all existing and planned facilities at this site.

At the same time, layout of RWDP *Buriakivka* at the distance of one kilometer from the *Vektor* site should be also considered. Safety assessment of RWDP *Buriakivka* is currently based on an assumption that limited access and inhabitation around RWDP *Buriakivka* (strict access

area) will be established in the longer term. Specific dimensions of this area will be specified considering impact assessment of RWDP *Buriakivka* and the *Vektor* site for a long period.

Reliable data storage on all radioactive waste disposal facilities at the territory of current Exclusion Zone related to assessment results of their total impact, decisions on dimensions and life of the strict access area is important.

Regarding radwaste treatment storage facilities, regulations require that projects of future decommissioning be developed in the design stage to be periodically revised to incorporate advanced technologies and means.

In order to decrease financial burdens on future generations, a financial mechanism should function for the State Fund for Radioactive Waste Management, according to which radwaste generators pay appropriate taxes during their activities to contribute to the development of an appropriate infrastructure for radwaste management. Financial provisions for radwaste management are considered in detail in Subsections F 2.2 and F 2.3 of this Report.

H.2. Existing Facilities and Past Practices (Article 12)

List of the existing radwaste management facilities as of 01 July 2014 is presented in Annex 3 to this Report. Information on operation of the existing radwaste management facilities is provided in Subsections B.4.1 – B.4.5.

List of radwaste resulting from past practices is provided in Subsection D.4.3 of this Report.

H.2.1. Safety of Existing Facilities

The safety of existing radwaste management facilities is ensured and monitored in compliance with technical specifications and procedures for operation and maintenance, procedures for radiation monitoring and environmental monitoring, emergency response plans and quality assurance procedures.

All facilities are designed to be equipped with radiation monitoring systems, and observation boreholes to monitor underground and ground waters are arranged around the radwaste facilities. Radiation performance indicators of facilities and the environment are monitored with the periodicity and are compared with the established reference levels.

Personnel are provided with adequate individual protection means and are subject to individual dose monitoring.

In compliance with the "Requirements for Periodicity and Content of Reports Submitted by the Licensees in the Sphere of Nuclear Energy Use", the Licensees provide the regulatory authority with quarterly and annual reports on radiation safety of radwaste management facilities, which contain data on results of individual dose and radiation monitoring, compliance with reference levels, analysis of incompliance with reference levels and safety improvement measures.

All radwaste management facilities are also equipped with engineered safety features such as systems for fire alarm and fire-fighting, ventilation and air purification, active drainage, moisture detection and removal, leakage and water level monitoring (for liquid radwaste storage facilities), redundant tanks, etc. The radwaste treatment facilities include systems for control and monitoring of radwaste treatment processes.

All amendments in design and operating documentation, upgrading, modernization and major repairs that may affect safety are subject to state review on nuclear and radiation safety.

H.2.2. Past Practices

The past practices identified in the previous National Reports of Ukraine and in the current Report include:

- management of large scope of radwaste associated with mitigation of the Chornobyl catastrophe and Shelter-related activities, radwaste placement on *Pidlisnyy* and *ChNPP Stage III* RWDP, RICP and storage sites for radwaste resulting from decontamination and sanitary treatment of vehicles outside the Exclusion Zone in Kyiv, Zhytomyr and Chernihiv regions;
- activities associated with disposal of radwaste in the non-nuclear sector resulting from various uses of radionuclide sources in medicine, science and industry in UkrDO *Radon* SISPs prior to the decision to convert the SISPs into sites for radwaste collection and temporary storage (1996);
- activities of the UkrDO *Radon* associated with liquidation of the *Makariv* radwaste disposal facility resulting from past Soviet Union military programs and placement of this radwaste into radwaste disposal facilities of the Kyiv SISP in 2000.

Information on this radwaste is provided in Subsections 4.5 and 4.6 of Annex 4 to this Report.

Information on Shelter-related activities is provided in Annex 9 to this Report.

Information on current activity related to radwaste storage/disposal facilities is provided in Subsections B .4.3, B. 4.4 of this Report.

Decisions on further management of radwaste placed in preserved facilities of the UkrDO *Radon* SISPs and on RWDP and RICP in the Exclusion Zone shall be made after their safety reassessment.

In accordance with special terms of SNRIU licenses, SISPs carry out safety reassessment of their radwaste facilities, including preserved historical disposal facilities. Safety assessment of such disposal facilities shall also justify their long-term safety. The results of safety reassessment will be used for measures in compliance with tasks under the National Target Ecological Program for Radioactive Waste Management associated with radwaste retrieval from preserved facilities and transfer to centralized facilities on the *Vektor* site. Appropriate subsequence and certain terms should be specified to take measures for SISP considering the term within which certain radwaste disposal facilities will perform their confining functions. The SNRIU in cooperation with European and Ukrainian TSOs developed under INSC U3.01/08 the "Guidance on Safety Reassessment of Existing Radwaste Disposal Facilities and Criteria for Decision making on Further Activities at These Facilities" recommended to the Licensees in safety reassessment. Safety reassessment shall take into account data on the designs of facilities taking into account modernizations or upgrades; data on radionuclide composition, activity and other characteristics of radwaste placed in the storage/disposal facilities; data on site characteristics (hydrogeological, metrological, seismic, demographic, etc.); data on events and external and natural hazards observed during the lifetime of facilities that could affect their safety; results from radiation monitoring and environmental monitoring during operation of the storage/disposal facilities.

Prior to making decisions on further management of long-lived and high level radwaste in RWDP *Pidlisnyy*, RWDP *ChNPP Stage III*, the designs for their stabilization and safety improvement are implemented. The operating organization SSE *CRME* envisages long-term safety assessment of these radwaste disposal facilities considering project implementation for safety improvement to substantiate terms of further possible radwaste storage in these disposal facilities; engineering barriers improvement; radwaste clearance or release and its location in new disposal facilities.

Regarding radwaste placed in RICP of the Exclusion Zone, decisions on additional intervention measures taken to decrease their hazard (retrieval, re-disposal, stabilization,

preservation, etc.) will be made after investigation of radwaste pits and trenches on the RICP territory, and safety reassessment. Appropriate measures will be taken under INSC U4.01/10-D.

H.3. Siting of Proposed Facilities (Article 13)

According to the Strategy for Radioactive Waste Management in Ukraine, new facilities for treatment and temporary storage of radwaste are to be constructed on sites of operating NPPs, ChNPP, UkrDO *Radon* SISPs and *Vektor*. The safety assessment of these facilities, in accordance with the structure and content of the safety analysis report for radwaste treatment and storage facilities, shall include analysis of factors associated with site location (meteorological, geological, hydrological, seismic, technology-related and social and economic factors) that affect the safety of the facility during construction, operation and decommissioning. Since these factors were also used in the site selection process, safety assessments may use data from the safety analysis report for existing facilities at the sites of which new radwaste management facilities are under construction.

Regarding siting of radwaste disposal facilities, the regulation "Requirements for Siting for a Radioactive Waste Disposal Facility" states that a site is considered acceptable for a disposal facility if its safety assessment has proved that the disposal system is capable of confining and/or isolating radwaste from the accessible environment over the period while waste remains potentially hazardous, in compliance with radiation safety requirements and criteria.

Consideration shall be given to site characteristics that:

- ensure radionuclide isolation from accessible environment;
- may influence the rate of transport and accumulation of radioactive substances in the environment;
- ensure protection of engineering barriers against external events and processes.

External natural and technology-related events and processes that may affect the safety of the disposal system during operation, closure and in the post-closure period are also considered.

The requirements are used to select new sites and reassess the safety of facilities located on previously selected sites, including the sites of *Vektor*, *Buriakivka* and *Radon* enterprises.

According to the Law of Ukraine "On Decision Making Procedure for Siting, Design and Construction of Nuclear Facilities and Radioactive Waste Management Facilities of National Importance", a decision on siting and design of a radwaste disposal facility is made by the Verkhovna Rada of Ukraine through adoption of a relevant law. The Verkhovna Rada makes this decision only if the site for a disposal facility is agreed by the local executive authorities and local governments following a consultative referendum involving the public and public hearings.

H.4. Design and Construction of Facilities (Article 14)

According to Article 24 of the Law of Ukraine "On Radioactive Waste Management", radwaste management facilities are designed in compliance with current standards and regulations using technologies proven by experience, testing or analysis. The design of a radwaste disposal facility must rely on safety assessment for the operational period and long-term post-closure period.

Compliance of the design decisions on a radwaste management facility with standards and rules on radiation safety is assessed during the state review of such designs. The state review of the designs for radwaste management facilities necessarily includes state review on nuclear and radiation safety and state ecological review. The state review on nuclear and radiation safety is conducted by the SNRIU involving technical support organizations. The state review on nuclear and radiation safety of the designs involves national and international technical support

organizations in the framework of international cooperation with the SNRIU and EC, EBRD and countries with developed nuclear energy. The state ecological review is conducted by the Ministry of Ecology and Natural Resources of Ukraine.

In making a decision to issue a license for construction of a radwaste storage or disposal facility, one of the main documents is a favorable conclusion of the state review of the design, taking into account state review on nuclear and radiation safety and state ecological review.

Compliance of design decisions with requirements of nuclear and radiation safety for new radwaste management facilities was confirmed by state review on nuclear and radiation safety: LRTP, SRTP, temporary storage of high-level long-lived waste, the line for fragmentation of high-level long-length components, on the *Vektor* site – ENSDF, SRW-1 and SRW-2, centralized facility for long-term storage of spent radioactive sources; and on sites of operating NPPs – ICSRM.

If the design of radwaste management facility is significantly amended and corrected, it should be submitted repeatedly for the state review and review on nuclear and radiation safety.

In 2011, the state review related to corrections made in the *Vektor* Stage I design was carried out that included the review on nuclear and radiation safety. The project was approved by the Resolution of the Cabinet of Ministers of Ukraine No. 529-r of 01 August 2012.

In 2013, the state review on nuclear and radiation safety (as part of the state review) of "Feasibility Study of Investments for Construction of the Interim Storage Facility for Radioactive Waste returned from Russia after Ukrainian NPP Spent Fuel Reprocessing" (FS) and of project "Closure of *ChNPP Stage III* Disposal Facilities. Revision" was carried out.

In construction of the centralized disposal facility for spent radiation sources, the state review on nuclear and radiation safety of technical specifications for basic process systems of the disposal facility is carried out.

H.5. Assessment of Safety of Facilities (Article 15)

Safety assessment of a radwaste management facility is finalized into a safety analysis report (SAR). Requirements for the SAR structure and contents are established in relevant regulations. SARs are developed and gradually updated at all life stages of facilities: from siting and design to operation and closure. The SAR for a radwaste disposal facility for the post-operational period is revised to incorporate operating experience and data of environmental monitoring and to include additional safety justification for the post-closure period.

Assessment of long-term safety of a radwaste disposal facility includes estimates of radiological impact of the disposal facility on human and the environment for different scenarios and comparison of these estimates with established safety criteria. It must be ensured that consequences of:

- normal evolution scenarios (on-site natural processes and degradation of engineering barriers of the disposal facility) do not exceed the quota of annual effective dose limit established by radiation safety standards;
- alternative scenarios (unlikely natural destructive events that affect confining and isolating functions of the disposal system in the post-closure period) do not exceed 1 mSv/year;
- scenarios of inadvertent intrusion into the disposal facility upon completion of institutional control do not exceed 50 mSv/year.

For radwaste disposal facilities located on the *Vektor* site (SRW-1, SRW-2), updated versions of safety assessments shall be prepared prior to the beginning of operation.

According to the license conditions for ENSDF operation, the operating organization SSE *CRME* should reassess the disposal facility safety considering existing characteristics of received ChNPP radwaste packages. After commissioning of LRTP and SRTP equipped by advanced

spectrometric equipment, characterization of radwaste packages will be performed depending on radionuclide composition and specific activity. This will enable obtaining of more detailed data on ChNPP radwaste characteristics than those based on which ENSDF safety assessment was carried out. Resulting from this, radwaste acceptance criteria for disposal will be revised to decrease conservatism.

In addition, considering the recommendations of IRRS-2008 and IRRS-2010 Missions, total radiation impact of radwaste management facilities to be located at the *Vektor* site for a long period should be assessed to implement the National Target Ecological Program for Radioactive Waste Management.

The SNRIU in cooperation with European and Ukrainian TSOs developed under INSC U3.01/08 the "Guidance on Assessment of Total Impact of the *Vektor* Site with Several Facilities for Radwaste Processing, Storage and Disposal". This Guidance is recommended to the operating organization SSE *CRME* for such reassessment.

For radwaste treatment facilities on the ChNPP site (LRTP, ICSRM, line for fragmentation of high-level long-length components), the final SARs will be developed taking into account commissioning activities (cold and hot tests).

Considering implementation of construction and mounting activities, testing of the systems and equipment of the centralized storage facility for spent radiation sources, the final SAR for this storage facility will be developed.

H.6. Operation of Facilities (Article 16)

H.6.1 License to Operate Radioactive Waste Management Facilities

Information on the licensing system for spent fuel and radioactive waste management is provided in Subsection E 2.2 of this Report.

The regulation "Safety Conditions and Requirements (Licensing Terms) for Radwaste Treatment, Storage and Disposal" established general licensing conditions and requirements to be met by licensees of enterprises that deal with radwaste treatment and storage and operating organizations of radwaste disposal facilities. The applicant's submittals to obtain a license for operation of a radwaste management facility mandatory include:

- conclusion of the state review on project of radwaste management facility;
- act of preparedness of constructed facility;
- safety analysis report developed taking into account all design changes and modifications made during construction and results of individual and comprehensive tests of systems and equipment of the facility;
- technical specifications for operation;
- radiation monitoring program;
- waste acceptance criteria for the treatment, storage or disposal facility;
- quality assurance program;
- information on personnel qualification;
- emergency plan;
- documents confirming compliance with requirements for radwaste physical protection.

H.6.2 Definition and Revision of Operational Limits and Conditions

The SAR on the radwaste management facility and technical specifications for operation include a detailed list of activities related to operation of a facility depending on its purpose, waste acceptance, internal transport, treatment processes, procedure for radwaste placement for

storage or disposal, radwaste accounting, decontamination of equipment and tools for radwaste management, acceptance inspection of radwaste packages (for treatment facilities). The SAR also justifies operational limits and conditions for process systems and equipment, radiation monitoring systems and systems of storage or disposal barriers. Taking into account commissioning activities, operational experience or experience in facility safety reassessment, decisions may be taken to improve safety of the facilities by correction of operational limits and conditions, modifications and reconstructions. The documents on changes in operational limits and conditions, modification, reconstruction, and major repair are subject to the state review on nuclear and radiation safety.

H.6.3 Operating and Maintenance Procedures

According to the regulation "Safety Conditions and Requirements (Licensing Terms) for Radwaste Treatment, Storage and Disposal", the licensee deals with radwaste treatment, storage and disposal using equipment, premises and technical specifications, information on which is provided in safety assessment documents submitted to obtain the license. The licensee, within its quality system, develops operating procedures and rules needed to ensure processes, operations on maintenance, radiation monitoring and emergency measures.

H.6.4 Engineering and Technical Support

Information on engineering and technical support during operation of radwaste management facilities is provided in Subsection H.6.4 of NRU-2003.

Engineering support during investigation, assessment, scientific, research and design activities on sitting for a geological repository for disposal of long-lived and high-level waste is provided by the Institute of Environmental Geochemistry and Science and Engineering Center for Radiological Field Investigations of the National Academy of Sciences of Ukraine.

H.6.5 Radioactive Waste Characterization and Sorting Procedures

Radwaste management facilities constructed on the sites of operating NPPs and ChNPP (see Subsections B 4.1, 4.2) are designed to be equipped with radwaste sorting and characterization systems using modern dosimetric and spectrometric instrumentation. Therefore, radwaste characteristics important for disposal will be determined: radionuclide composition and specific activity of each radionuclide. Sorting will take into account radwaste acceptance to the appropriate option of further treatment – incineration, compaction and cementation.

Considering characteristics of liquid radwaste to be treated at the LRTP, the ChNPP determines the composition of the LRTP final product to comply with acceptance criteria for disposal in the ENSDF.

During commissioning of ChNPP SRTP, additional tests of the radwaste sorting system are performed. The specific features of the sorting system are associated with the characteristics of radwaste accumulated at the ChNPP, one part of waste generated from operation and the other from the Chornobyl accident. This radwaste has different radionuclide composition, which was not determined during waste loading into the ChNPP solid waste storage because appropriate equipment was missing at that time (to 2003).

CLTSF on the Vektor site provides for identification and sorting of spent sources and their placement in containers according to the type of radiation and half-life and further storage of containers with radiation sources of different types in separate storage compartments, marking of

containers according to radionuclide half-life in order to optimize RS management after retrieval of RS packages from the storage facility after termination of storage period.

Equipment is supplied and guidelines are developed for the Central Analytical Laboratory for Radwaste Characterization of SSE *Chornobyl Specialized Enterprise* and the Mobile Laboratory Complex of SSE *CRME* under INSC Project U4.01/08-B in order to improve infrastructure for radwaste treatment in the Exclusion Zone. The Central Analytical Laboratory is designed for characterization of all types on radwaste in the Exclusion Zone and for checking compliance of radwaste characteristics and radwaste packages to be transferred for disposal in the centralized facilities of the Vektor site. The Mobile Laboratory Complex among other functions designed for field conditions is planned to be used during surveys of RICP territories to reveal locations of trenches and pits.

H.6.6 Reporting of Incidents Significant to Safety to the Regulatory Body

According to the regulation "Safety Conditions and Requirements (Licensing Terms) for Radwaste Treatment, Storage and Disposal", in case of any situation or circumstance that caused incompliance with radiation safety standards and rules or in case of a radiation accident, the licensee:

- notifies the regulatory authority and territorial body of the Ministry of Health of Ukraine within an hour;
- starts actions to eliminate incompliance or, in case of an accident, measures under emergency plans;
- conducts official investigation of causes and circumstances that caused incompliance or accidents and submits the investigation report to the SNRIU.

In the reporting period, there were no incidents or accidents during radwaste management activities.

H.7. Institutional Measures after Closure (Article 17)

While designing any disposal facility, the operating organization shall determine measures for storage of archives and for placement of relevant data and limitations on maps stored by relevant state authorities. According to Article 21 of the Law of Ukraine "On Radioactive Waste Management", the responsibility for storage of documentation that characterizes the facility lies with the state control body for radwaste management and local state executive authority.

Institutional control after closure of a radwaste disposal facility includes active and passive institutional control. Active institutional control covers monitoring, maintenance, inspection of integrity of barriers and, if necessary, recovery activities and prevention of access to the territory of the disposal facility. A program for post-operational monitoring of the disposal facility shall be developed to ensure monitoring of protective properties of disposal barriers and timely detection of radionuclide transport beyond the facility in order to take, if needed, corrective actions and repairs. To prevent unauthorized access to the territory of the disposal facility, warning signs and fences may be used during active institutional control.

Passive control provides for restrictions on economic activities within the disposal site and storage of information on the disposal facility.

To arrange active administrative control during closure of a radwaste disposal site, the operating organization shall obtain a separate SNRIU authorization.

The decision on duration of administrative control (passive and active) of the Vektor site after closure and its radwaste disposal facilities will be made according to results of assessment of

total radiation impact of radwaste management facilities planned to be constructed at the Vektor site during the long-term period.

There are no radwaste disposal facilities in Ukraine that would pass the closure stage.

Section I. TRANSBOUNDARY MOVEMENT (Article 27)

Ukraine does not undertake nor is involved in transboundary radwaste movement.

Transboundary movement of spent fuel takes place from Ukrainian NPPs to the Russian Federation and includes transit of spent fuel from Bulgaria Kozloduy NPP and Hungarian Paks NPP to the Russian Federation through the territory of Ukraine.

Therefore, Ukraine does not send spent fuel for storage or disposal to the south of latitude 60 (paragraph 2 of Article 27 of the Joint Convention).

Transboundary movement of spent fuel takes place in accordance with intergovernmental agreements on transport of nuclear material:

- between Russia and Ukraine of 1996;
- between Russia, Bulgaria and Ukraine of 2006;
- between Ukraine, Russia and Hungary of 2013.

To comply with paragraph 1i) of Article 27 of the Joint Convention, the SNRIU uses an authorization procedure for each spent fuel transport according to the Procedure for Authorization of International Transport of Radioactive Material approved by Cabinet Resolution No. 1196 "Some Issues of Radioactive Material Transport" of 3 October 2007.

As one of the conditions to obtain an authorization, the Russian consignee (operator) shall have a permit for spent fuel import issued by the authorized state body of the Russian Federation to confirm the consent of the state of destination. Preliminary notification on transboundary movement takes place according to a contract under which the Ukrainian operator shall notify the Russian operator no later than seven days before spent fuel departure.

Transboundary movement of spent fuel from Kozloduy and Paks NPPs through the territory of Ukraine, as a state of transit, takes place by railroad in compliance with the "Agreement on International Goods Transport by Rail" of 1951, which is mandatory for railroads, consignors and consignees of Ukraine, Bulgaria and Russian Federation.

Section J. DISUSED SEALED SOURCES (Article 28)

The main amount of spent radioactive sources is placed in the facilities of the UkrDO *Radon* SISPs for safe and secure storage. Information on the UkrDO *Radon* SISPs and plans and measures to ensure and improve the operational safety of facilities for storage of radwaste and spent sources is provided in Subsections B.4.4, H2.2 and K.1 of this Report. Data on radiation sources transferred into the category of radwaste and stored at UkrDO *Radon* SISPs are provided in Subsection 4.6.2 of Annex 4 to this Report.

The NNEGC *Energoatom* transferred disused radiation sources to UkrDO *Radon* SISPs from 2011 to 2013 as follows:

- 118 spent radiation sources from Zaporizhzhya NPP to Dnipropetrovsk SISP;
- 38 spent radiation sources from South Ukraine NPP to Dnipropetrovsk SISP;
- 350 spent radiation sources from Rivne NPP to Lviv SISP;
- 19 spent radiation sources from Khmelnitsky NPP to Kyiv SISP;
- 228 spent reference radiation sources from the Emergency Technical Center to Kyiv SISP.

The safety in management of radiation sources prior to their transfer to specialized radwaste management enterprises is ensured by:

- licensing of manufacture, use and storage of radiation sources;
- supervision over compliance with safety standards and rules and licensing terms for use of radiation sources;
- functioning of the State Register of Radiation Sources;
- implementation of tax liabilities within the Tax Code of Ukraine for RS users to pay taxes for temporary storage of sources after expiry of their lifetime to encourage the enterprises to transfer spent RS to specialized radwaste management enterprises in a timely manner.

At the same time, there are enterprises, organizations and establishments that used RS in industrial and research activities but now cannot ensure proper monitoring of their RS because of change in activity or bankruptcy and cannot transfer RS to specialized enterprises because of lack of funding.

These issues are resolved under the State Program for the Safety of Spent High-Level Radiation Sources in Storage, approved by the Government of Ukraine in August 2006. The Program addresses, among other things, management of spent radiation sources that were fabricated to 1990 for use in X-ray, measurement and diagnosis units and devices and were not transferred to specialized enterprises because of bankruptcy or financial failure of the owners or other reasons. The first stage of the Program covered registration of spent high-level RS and investigation of RS storage places and conditions, which served as a basis for identifying priorities of actions on conditioning, containerization or unloading of facilities with spent RS.

The Program is further implemented by involvement of resources under international technical assistance provided on a bilateral basis between the Great Britain, Germany, France, the USA, and other donor countries within the nonproliferation initiatives.

The CLTSF is the main project to improve the SRS management system, which is under constructed on the *Vektor* site under support of the Great Britain (see also Subsection B.4.3 of this Report).

With support of the French Atomic Energy Commission, a mobile technical system was developed to discharge gamma-SRS from shielding blocks to be used at UkrDO *Radon* SISPs and a special packaging for transport of these SRS.

Under the Treaty between the Federal Ministry for Environment, Nature Conservation and Reactor Safety (BMU) and Company for Installations and Reactor Safety (GRS) of Germany for contribution to G8/GP to ensure removal and safe storage of unprotected radiation sources in Ukraine, the project "Decommissioning of Irradiation Facilities and Safe Storage of Radiation

Sources" is continued. Within this project, radiation sources of bankrupt enterprises are retrieved and transported for further safe storage.

In the framework of the project, 13,394 radiation sources with the total activity of 1.18E+15 Bq were retrieved from enterprises in different regions of Ukraine and their containerization and safe storage in SISP radwaste facilities were provided. List-4 for spent radiation sources of these enterprises is being prepared.

US international technical assistance to Ukraine is continued under the project intended to improve the security of spent radiation sources in Ukraine. Efforts to remove 250 SRS of GIK-7-4 type from the gamma unit "Sterilization–III" of the Gemoplast Company with a total activity of 4.34E+14 Bq are underway in 2014.

Considering paragraph 24 of the Summary Report of the Second Review Meeting of the Contracting Parties to the Joint Convention (May 2006) and consistently following the Guidance on the Import and Export of Radioactive Sources of the Code of Conduct on the Safety and Security of Radioactive Sources, the Government of Ukraine resolved the following: the import of radiation sources that belong to category 1 in compliance with IAEA Safety Standard RS-G-1.9 "Categorization of Radioactive Sources" to the territory of Ukraine will be authorized on condition that these sources are returned after their use to the consignor (manufacturer) as stated in the contract for import. The Procedure for Authorization of International Transport of Radioactive Material was appropriately modified in 2007. This standard is also confirmed in the technical specifications for sealed radiation sources approved by Cabinet Resolution No. 1382 of 5 December 2007.

Section K. GENERAL EFFORTS TO IMPROVE SAFETY

K.1. Measures Taken to Solve Issues Defined as Challenges and Suggestions According to the Fourth Review Meeting

Upon the Fourth Review Meeting of the Contracting Parties, the following challenges were identified for Ukraine:

1. Completion of the New Safe Confinement for the ChNPP Shelter.

Information on the progress in NSC construction is provided in Annex 9 to this Report.

2. Construction and upgrading of radwaste and spent fuel management facilities in the Exclusion Zone.

Information on the construction and upgrading of radwaste management facilities in the Exclusion Zone is provided in Subsection B 4.3 of this Report. Information on the construction and upgrading of spent fuel management facilities in the Exclusion Zone is provided in Subsections B 2.1 and B 2.2 of this Report.

3. Enhancement of competencies of the nuclear regulatory body.

Information on the regulatory body is provided in Subsection E.3 of this Report.

Upon the Fourth Review Meeting of the Contracting Parties, the following suggestions were identified for Ukraine:

1. Safety reassessment of the UkrDO *Radon* SISPs and their subsequent re-equipment based on the results.

Information on radwaste management, safety reassessment of storages and safety improvement measures for conversion and re-equipment of UkrDO *Radon* SISPs is provided in Subsections B 4.4 and H 2.2 of this Report.

2. Completion of ISF-2.

ISF-2 is the key element for ChNPP decommissioning. The construction of ISF-2 has been resumed. Information on the progress of this project is provided in Subsection B 2.2 of this Report.

3. Improvement of the system for managing radwaste resulting from operation of NPPs.

Information on measures for improvement of the system for managing radwaste from operating NPPs is provided in Subsections B.4.1 and H.1.2 of this Report.

K.2. Major Challenges Related to Spent Fuel and Radioactive Waste Management in Ukraine and Ways of Their Solution

The key element in the radwaste management system in Ukraine is construction of radwaste management facilities on the *Vektor* site to support the final stage of waste management – disposal and long-term storage – and treatment of some waste types from the Exclusion Zone and minor waste generators.

An important element in the system for managing spent fuel from operating NPPs is to create a centralized ISF in the Exclusion Zone.

It is also important to complete construction of the New Safe Confinement for the Shelter above the destroyed Chornobyl unit 4.

In this connection, the major challenges for Ukraine related to spent fuel and radwaste management are as follows:

1. Creation of spent fuel and radwaste management facilities in the Exclusion Zone including:

- design and construction of a Centralized ISF;

- design and construction of a storage facility for vitrified HLW resulting from reprocessing of WWER-440 spent fuel to be returned from the Russian Federation.

2. Completion of the New Safe Confinement for the ChNPP Shelter.

K.3. Improvement of Safety in Spent Fuel and Radioactive Waste Management Considering Lessons Learnt from Fukushima-1 Accident

In June 2011, Ukraine joined the European stress-test initiative for NPPs in European Union member states and neighboring countries (Declaration on Stress Tests). The stress tests for Ukrainian NPPs were conducted in accordance with the methodology agreed by the European Commission and ENSREG (13 May 2011, Declaration of ENSREG, Annex 1 "EU Stress-Test Specifications". The following facilities were subject to stress tests:

- ZNPP units 1-6 (WWER-1000/320) and dry spent fuel storage facility on the Zaporizhzhya site;
- RNPP units 1, 2 (WWER-440/213) and units 3, 4 (WWER-1000/320);
- SUNPP unit 1 (WWER-1000/302), unit 2 (WWER-1000/338) and unit 3 (WWER-1000/320);
- KhNPP units 1, 2 (WWER-1000/320);
- ChNPP units 1-3 (spent fuel pools) and ChNPP ISF-1.

The National Action Plan upon Stress-Test Results was developed for the operating organizations to implement safety upgrades determined in stress tests, ensure effective SNRIU supervision and implement recommendations of the stress-test peer review for Ukrainian NPPs.

To monitor implementation of safety improvement measures identified upon stress tests and peer review results for Ukrainian NPPs, the SNRIU Board held an open meeting on 20 November 2012. Following the Board meeting, additional safety improvement measures related to severe accident management were determined to take into account peer review recommendations.

In order to improve effectiveness of personnel actions in case of accidents at SFPs, emergency procedures and severe accident management guidelines are under development. A spent fuel pool consists of a metallic shell placed in reinforced-concrete enclosing structures to ensure its protection against external events. Personnel actions in case of accidents at SFPs are considered in the development and justification of SFP emergency operating procedures and severe accident management guidelines. Mobile diesel generators for SFP makeup are envisaged under the detailed emergency strategy for long-term station blackout.

Upon stress-test results, additional measures are planned for SFP makeup at WWER-440 and WWER-1000 units from mobile pumps in case of station blackout.

The measure for spent fuel pool makeup and cooling in station blackout was implemented at SUNPP-1 in 2013.

In connection with implementation of second-generation fuel, the SNRIU allowed RNPP-1,2 to use uncompact upper racks in the spent fuel pool for temporary storage of spent fuel based on partial filling of the upper racks and placement of fuel followers.

The criticality analysis of Rivne-1, 2 spent fuel pools with upper removable racks and lower Skoda compacted fuel storage racks confirmed that subcriticality was not ensured without absorbers in case of complete filling of the upper racks.

It is planned to take measures to replace the existing upper racks for spent fuel storage by Skoda compacted racks that comply with national requirements for the effective neutron multiplication factor to be not higher than 0.95 in normal operation and design-basis accidents provided that all spent assemblies are placed in stainless-steel absorption hexagonal tubes (cells) with 1.14-1.25% boron, which are the basis for fuel storage racks. The replacement of racks at unit 2 is to be completed by the end of 2015 and at unit 1 in 2016.

In order to consider the ENSREG stress-test recommendations and manage large amounts of post-accident radwaste within the National Action Plan upon Stress-Test Results, it is planned to analyze potential volumes of radioactive water by the end of 2016, the productivity of the existing evaporation system, the number of drums for evaporation bottoms and storage places (creation of additional reserve if necessary) and assess the adequacy of water activity monitoring means and measures to prevent contamination of groundwater etc. After the analysis and assessment, recommendations and, if necessary, conceptual technical decisions on management of large volumes of radioactive water will be developed.

K.4. Measures to Ensure Openness and Transparency of Activities on Compliance with Obligations under the Joint Convention

All NRUs and reports upon IRRS-2008 and IRRS-2010 (follow-up) missions are open for the public at the official SNRIU website www.snrc.gov.ua.

BASIC CONCLUSIONS

Since the Joint Convention entered into force on 18 June 2001, Ukraine has become an active participant of all processes and events under the Joint Convention in order to fulfill its tasks. The First, Second, Third and Fourth National Reports of Ukraine were presented to the Contracting Parties of the Joint Convention at review meetings. The comments and recommendations of the review meetings serve as a basis for preparing and implementing national plans for the development of nuclear energy and the improvement of spent fuel and radwaste management system. The Report provides factual information to the Contracting Parties of the Joint Convention and to the public of Ukraine on the safety of spent fuel management and on the safety of radioactive waste management and actions taken to protect personnel, the public and the environment against hazardous effects of radiation. The Report highlights the progress and changes since the Fourth Review Meeting and identifies prospects for further development and issues to be resolved.

The Report demonstrates that Ukraine fulfills its obligations under the Joint Convention. This is confirmed by a detailed description of measures to ensure the safety of spent fuel and radioactive waste management developed under the Strategy for Radioactive Waste Management in Ukraine and implemented in the framework of State and branch programs. The Strategy, programs and regulatory requirements for spent fuel and radioactive waste management are based on safety principles harmonized with EC directives and IAEA recommendations and incorporate the best international practices.

Ukraine has an effective legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management and a state system for management and regulation of nuclear energy use and radwaste management. The role and independence of the SNRIU as a state competent regulatory body for nuclear and radiation safety are enhanced through legislative status, competence and required resources, compliance with quality procedures for regulatory activity and international technical cooperation.

In the sphere of spent fuel and radwaste management, Ukraine is an active participant of international cooperation under the EC, IAEA, EBRD, G-7 and bilateral cooperation projects.

Section L. ANNEXES
Annex 1. List of Spent Fuel Management Facilities as of 01 July 2014

Facility	Location	Purpose	Status
Spent fuel pool of unit 1 at Zaporizhzhya NPP	ZNPP 71500, Energodar Zaporizhzhya Region	Temporary storage to reduce decay heat	In operation
Spent fuel pool of unit 2 at Zaporizhzhya NPP	„	„	In operation
Spent fuel pool of unit 3 at Zaporizhzhya NPP	„	„	In operation
Spent fuel pool of unit 4 at Zaporizhzhya NPP	„	„	In operation
Spent fuel pool of unit 5 at Zaporizhzhya NPP	„	„	In operation
Spent fuel pool of unit 6 at Zaporizhzhya NPP	„	„	In operation
Zaporizhzhya NPP ISF, Stage 1	„	Interim storage of spent fuel	In operation since 2001
Zaporizhzhya NPP ISF, Stage 2	„	Interim storage of spent fuel	In operation since 2012
Spent fuel pool of unit 1 at Khmelnitsky NPP	KhNPP 30100, Neteshin Khmelnitsky Region	Temporary storage to reduce decay heat	In operation
Spent fuel pool of unit 2 at Khmelnitsky NPP	„	„	In operation
Spent fuel pool of unit 1 at Rivne NPP	RNPP 34400, Kuznetsovsk Rivne Region	Temporary storage to reduce decay heat	In operation
Spent fuel pool of unit 2 at Rivne NPP	„	„	In operation
Spent fuel pool of unit 3 at Rivne NPP	„	„	In operation
Spent fuel pool of unit 4 at Rivne NPP	„	„	In operation
Spent fuel pool of unit 1 at South Ukraine NPP	SUNPP 55000, Yuzhnoukrainsk Mykolaiv Region	Temporary storage to reduce decay heat	In operation
Spent fuel pool of unit 2 at South Ukraine NPP	„	„	In operation
Spent fuel pool of unit 3 at South Ukraine NPP	„	„	In operation
Spent fuel pools of unit 1 at Chornobyl NPP	ChNPP 07100, Slavutych, Kyiv Region	Temporary storage to reduce decay heat	Termination of operation
Spent fuel pools of unit 2 at Chornobyl NPP	„	„	Termination of operation
ISF-1 of Chornobyl NPP	„	Temporary storage to reduce decay heat	In operation
ISF-2 of Chornobyl NPP	„	Long-term spent fuel storage (to 100 years)	Construction resumed
Spent fuel storage of the	INR NASU	Temporary storage to	In operation

Facility	Location	Purpose	Status
research reactor VVR-M, SFP-1	03680, Kyiv 47 Nauki Avenue	reduce decay heat	
Spent fuel storage of the research reactor VVR-M, SFP-2	„	„	In operation
Spent fuel storage of the research reactor IR-100	SUNEI 99033, Sevastopol Gollandia Village 7 Kurchatova St.	Temporary storage to reduce decay heat	In operation
Centralized spent fuel storage facility		Interim spent fuel storage	Site selection

Annex 2. Inventory of Spent Fuel as of 01 July 2014

Material	Location	Number of SFAs	Weight of heavy metal, t
SFAs of reactor WWER-1000	KhNPP Unit EC	437	174.65
SFAs of reactor WWER-1000	KhNPP Unit 2	419	171.90
SFAs of reactor WWER-440	RNPP Units 1, 2	1135	128.39
SFAs of reactor WWER-1000	RNPP Unit 3	507	201.25
SFAs of reactor WWER-1000	RNPP Unit 4	456	183.03
SFAs of reactor WWER-1000	SUNPP Unit 1	312	124.53
SFAs of reactor WWER-1000	SUNPP Unit 2	264	110.95
SFAs of reactor WWER-1000	SUNPP Unit 3	429	167.98
SFAs of reactor WWER-1000	ZNPP Unit 1	313	126.52
SFAs of reactor WWER-1000	ZNPP Unit 2	274	111.92
SFAs of reactor WWER-1000	ZNPP Unit 3	326	133.25
SFAs of reactor WWER-1000	ZNPP Unit 4	321	130.90
SFAs of reactor WWER-1000	ZNPP Unit 5	308	125.75
SFAs of reactor WWER-1000	ZNPP Unit 6	310	124.99
SFAs of reactor WWER-1000	ZNPP ISF	2946	1143.12
SFAs of reactor RBMK-1000	ChNPP Unit 1	32	3.546
SFAs of reactor RBMK-1000	ChNPP Unit 2	20.5	2.310
SFAs of reactor RBMK-1000	ChNPP ISF-1	21231.5	2390.255
SFAs of research reactor VVR-M	INR NASU	0	0
SFAs of research reactor IR-100	SUNEI	0 *	0

* The amount of nuclear fuel loaded into IR-100 during commissioning is sufficient for its operation until the expiry of the design service life

Annex 3. List of Radioactive Waste Management Facilities as of 01 July 2014

3.1. List of Radioactive Waste Management Facilities at Operating NPPs

Facility	Location	Purpose	Design capacity	Year of commissioning
UGU-1-500	ZNPP	Deep evaporation of vat residue	500 dm^3/h	1987
UGU-1-500	ZNPP	Deep evaporation of vat residue	500 dm^3/h	2000
UGU-1-500	KhNPP	Deep evaporation of vat residue	500 dm^3/h	1990
UGU-1-500	RNPP	Deep evaporation of vat residue	500 dm^3/h	2004
UGU-1-500	RNPP	Deep evaporation of vat residue	500 dm^3/h	2007
Incineration facility	KhNPP	Incineration of radioactive oil	5 dm^3/h	1994
Centrifuge	KhNPP	Treatment of floor drains	1-10 m^3/h	2011
Bitumization facility*	RNPP	Bitumization of liquid radwaste	150 dm^3/h	1995
Centrifuge	RNPP	Treatment of floor drains	1.5-7 m^3/h	2004
Incineration facility	ZNPP	Incineration of low-level waste	40 kg/h – solid radwaste 12 kg/h – liquid radwaste	1992
Compaction facility VRN-500	ZNPP	Minimization of low-level solid radwaste	P = 500 kN Volume reduction factor = 4	1991
Compaction facility C-26	SUNPP	Minimization of low-level radwaste	P = 2000 kN Volume reduction factor = 4	1997
Interim unit for liquid radwaste storage in special building 1	ZNPP	Acceptance and storage of liquid radwaste	3800 m^3	1984
Interim unit for liquid radwaste storage in special building 2	ZNPP	Acceptance and storage of liquid radwaste	1000 m^3	1987
Storage unit for solid radwaste in special building 1	ZNPP	Acceptance and storage of solid radwaste	5910 m^3	1984
Storage unit for solid radwaste in special building 2	ZNPP	Acceptance and storage of solid radwaste	1906.7 m^3	1989
Storage unit for solid radwaste in processing building (storage unit)	ZNPP	Acceptance and storage of solid radwaste	11174 m^3	1986
Storage unit for liquid radwaste in special building 1	RNPP	Acceptance and storage of liquid radwaste	4590 m^3	1981
Storage unit for liquid radwaste in special building 2	RNPP	Acceptance and storage of liquid radwaste	3800 m^3	1986

Facility	Location	Purpose	Design capacity	Year of commissioning
Storage unit as part of a reactor shop of power units 1 and 2	RNPP	Storage of high-level solid waste	84.2 m^3	1981
Storage unit for solid radwaste in special building 1	RNPP	Acceptance and storage of solid radwaste	4180 m^3	1981
Storage unit for solid radwaste in special building 2	RNPP	Acceptance and storage of solid radwaste	6042 m^3	1986
Storage unit for solid radwaste in the building for radwaste processing	RNPP	Acceptance and storage of solid radwaste	7756 m^3	2001
Liquid radwaste storage facility (LRSF-1)	KhNPP	Acceptance and storage of liquid radwaste	800 m^3	1987
Liquid radwaste storage facility (LRSF-2)	KhNPP	Acceptance and storage of liquid radwaste	2250 m^3	1987
Site "BB-Cube"	KhNPP	Storage of liquid radwaste (containers with salt fusion cake)	240 m^3	1997
Storage unit of the solid radwaste storage facility	KhNPP	Storage of liquid radwaste (containers with salt fusion cake)	7183 m^3	2002
Solid radwaste storage unit of the special building	KhNPP	Acceptance and storage of solid radwaste	6368.1 m^3	1987
Liquid radwaste storage facility No. 1	SUNPP	Acceptance and storage of liquid radwaste	2121 m^3	1982
Liquid radwaste storage facility No. 2	SUNPP	Acceptance and storage of liquid radwaste	1969 m^3	1987
Liquid radwaste storage facility No. 3	SUNPP	Acceptance and storage of liquid radwaste	760 m^3	1989
Low-level waste storage unit	SUNPP	Acceptance and storage of solid radwaste	12000 m^3	1982
Solid radwaste storage unit No. 1	SUNPP	Acceptance and storage of solid radwaste	1250 m^3	1982
Solid radwaste storage unit No. 2	SUNPP	Acceptance and storage of solid radwaste	3053 m^3	1989
Solid radwaste storage unit No. 3	SUNPP	Acceptance and storage of solid radwaste	10811 m^3	2002

* preserved in 2002

3.2. List of Radioactive Waste Management Facilities at Chornobyl NPP

Facility	Location	Purpose	Year of commissioning
Solid radwaste storage facility (SRSF)	ChNPP site	Temporary storage of solid radwaste in operation and decommissioning of power units	1978 Acceptance of solid radwaste terminated on 9 May 2003
Liquid radwaste storage facility (LRSF)	ChNPP site	Temporary storage of liquid radwaste in operation and decommissioning of power units	1977
Liquid and solid radwaste storage facility (LSRSF)	ChNPP site	Temporary storage of liquid radwaste in operation and decommissioning of power units	1981 Storage compartments for solid radwaste were not operated. Within ICSRM project, compartments for solid radwaste were upgraded and temporary storage for high-level waste and low- and intermediate-level long-lived waste was created
Temporary storage facility for high-level and low- and intermediate-level long-lived waste	ChNPP site	Temporary storage of packages with high-level waste and low- and intermediate-level long-lived waste	2010 LSRSF at upper elevations within ICSRM project
Temporary storage facility for solid high-level waste	ChNPP site	Temporary storage of solid high-level waste	2004
Temporary storage for spent radioactive oil	ChNPP site	Temporary storage of spent radioactive oil	1999
Liquid radwaste treatment plant	ChNPP site	Management of liquid radwaste accumulated during ChNPP operation and radwaste to be generated during ChNPP decommissioning and SIP	Commissioning in 2012

Facility	Location	Purpose	Year of commissioning
Solid radwaste retrieval facility Solid radwaste treatment plant within ICSRM	ChNPP site	Management of solid radwaste accumulated during ChNPP operation and radwaste to be generated during ChNPP decommissioning and implementation of SIP	Commissioning in 2012

3.3. List of Radioactive Waste Management Facilities in the Exclusion Zone

Facility	Enterprise/ location	Purpose	Design capacity (for radwaste storages)	Year of commissioning	State
ENSDF	SSE CRME/ *Vektor* complex	Disposal of SRW packages	50,210 m^3	2009	Operation
Buriakivka RWDP	SSE CRME/ Exclusion Zone	SRW disposal	690,000 m^3	1987	Operation
Pidlisnyy RWDP	SSE CRME/ Exclusion Zone	Storage of accident radwaste	*	1986	Stabilized, monitoring, maintenance
ChNPP Stage III RWDP	SSE CRME/ Exclusion Zone	Storage of accident radwaste	*	1986	Stabilization, monitoring, maintenance
RICP	SSE CRME/ Exclusion Zone	Storage of accident radwaste	*	1986-1987	Survey, monitoring, maintenance
Decontamination facility	SSE CRME/ Exclusion Zone Leliv	Decontamination of radwaste, vehicles		1987	Operation
Station for decontamination of individual protection means and overalls	SSE CRME/ Exclusion Zone Prypiat	Decontamination of individual protection means and overalls		1986	Operation
Decontamination facility No. 1	Chornobyl Specialized Plant/ Exclusion Zone	Radwaste decontamination		1987	Preserved in 2012

Decontamination facility No. 2 (Dibrova)	Chornobyl Specialized Plant/ Exclusion Zone	Radwaste decontamination		1987	Preserved in 2007
Vektor Stage I, SRW-1, SRW-2	CCMEZ/ *Vektor* complex	SRW disposal	19,200 m^3	2015	Construction
CLTSF	CCMEZ/ *Vektor* complex	SRS processing and storage	500,000 pcs.	2015	Construction

* design documentation is missing.

3.4. List of Radioactive Waste Management Facilities at UkrDO *Radon* SISPs

Enterprise/ Location	Basic activity	Design capacity	Year of commissioning	Name	State
Dnipropetrovsk SISP 23-km Dnipropetrovsk–Zaporizhzhya highway	Transport, processing, storage of radwaste	Solid radwaste – 450.0 m^3	1961	SRW 1	Preserved
			1982	SRW 2 BRW 5	In operation, radwaste is not accepted
			1963	SRW 1	
		Solid radwaste – 700 m^3	2007	Hangar storage 2	In operation (container storage)
		Storage of spent radiation sources – 50 kg-eqv. Ra	1979	SRS 3	In operation, radwaste is not accepted
		Liquid radwaste – 200.0 m^3	1965	LRW 4	In operation, radwaste is not accepted
Kyiv SISP Kyiv 1 Komunalna St.	Transport, processing, storage of radwaste	Solid radwaste – 1800.0 m^3	1985	SRW 5-6	Preserved
			1975	SRW 7	
			1971	SRW 8	
			1967	SRW 9-10	
		Hangar with containers – 328.0 m^3	1995	Hangar storage 2	In operation (container storage)
		Container – 10.5 m^3	1995	Container storage 18	In operation, radwaste is not accepted
		Spent radiation sources – 120 kg-eqv. Ra	1992	SRS 1-5	Radwaste is not accepted
			1978	SRS 6	Preserved
		Liquid radwaste – 600.0 m^3	1985	LRW 12-13	Radwaste is not accepted
			1968	LRW 14	In operation

	Monitoring of storages for decontamination waste in the Kyiv, Zhytomyr and Chernihiv regions	Solid radwaste – 36090.0 m^3*	1987-1995 (mitigation of Chornobyl accident consequences)		Not operated (monitoring and maintenance)
Lviv SISP Yavoriv District Lviv Region	Transport, processing, storage of radwaste	Solid radwaste – 1140.0 m^3	1989	SRW 1 SRW 2,5-8 in hangar storage	Preserved In operation (container storage)
			1989	BRW 3, 4 Biological radwaste	Radwaste is not accepted
		Liquid radwaste – 200.0 m^3	1962	LRW	Not operated, empty
		Spent radiation sources – 80 kg-eqv. Ra	1979 1989	SRS SRS 1	Not operated, filled
			1989	SRS 2	Radwaste is not accepted
Odessa SISP 75-km Odessa–Kyiv highway	Transport, processing, storage of radwaste	Solid radwaste – 583.0 m^3	1962	SRW 1-6 Hangar storage SRW 7-11	Preserved In operation
		Liquid radwaste – 400.0 m^3	1963	LRW 1 LRW 2	In operation, radwaste is not accepted Not operated, empty
		Spent radiation sources – 50 kg-eqv. Ra	1968	SRS 13	Radwaste is not accepted
		Solid radwaste (container) - 74 m^3	2001	Containers 14 14a (18) 14b (21), 17, 22, hangar storage	In operation
		Spent radiation sources 'RITEG'	2003	SRS 'RITEG' 15	Radwaste is not accepted
Kharkiv SISP Derhachiv District Kharkiv Region	Transport, processing, storage of radwaste	Solid radwaste – 2384.6 m^3	1962 1991	SRW 1-13, hangar storage SRW 18-20	In operation (container storage) Preserved
		Liquid radwaste – 1000.0 m^3	1962	LRW 21 LRW 22-25	In operation Redundant
		Spent radiation sources – 60 kg-eqv. Ra	1962, 1991 1991	SRS 15, 16 SRS 17	Radwaste is not accepted
		Tubing storage – 750 t	1996	NKT 30	In operation (retrieval of tubing), waste is not accepted.
		Facility 'Packet'	2011	SRW 14	In operation

		Experimental decontamination of tubing	2013	Experimental section for decontamination of tubing	Experimental work

Note: * design capacity is indicated for facilities in the Chernihiv Region and is absent for other facilities;
** design documentation is absent.

Annex 4. Inventory of Radioactive Waste as of 01 July 2014

4.1. Information on Radioactive Waste Stored at Sites of Operating NPPs

Material	Location	Volume, m^3	Activity, Bq	Main radionuclides
Filtering materials	KhNPP	169.8	6.28E+11[1]	^{134}Cs-8%, ^{137}Cs-91%, ^{60}Co-1%[1]
Vat residue	KhNPP	350.4	4.56E+12[2]	^{134}Cs-28%, ^{137}Cs-71%, ^{60}Co-1%[2]
Dehydrated sludge	KhNPP	21.4	5.1E+10	^{134}Cs-20%, ^{137}Cs-61%, ^{60}Co-19%
Salt fusion cake	KhNPP	1012.4	3.54E+13	^{134}Cs-7%, ^{137}Cs-92%, ^{60}Co-1%
Low-level solid radwaste	KhNPP	4950.8	-[3]	^{134}Cs, ^{137}Cs, ^{60}Co, ^{58}Co, ^{54}Mn, ^{110m}Ag
Intermediate-level solid radwaste	KhNPP	120.8	-[3]	^{134}Cs, ^{137}Cs, ^{60}Co
High-level solid radwaste	KhNPP	9.82	-[3]	-[3]
Filtering materials	ZNPP	350	1.33E+13[1]	^{134}Cs-10.1%, ^{137}Cs-59.9%, ^{60}Co-24.5%, ^{58}Co-0.5%, ^{54}Mn-2.6%, ^{124}Sb-0.1%, ^{122}Sb-1.5%, ^{110m}Ag-0.6%[1]
Vat residue	ZNPP	2927	7.48E+12[2]	^{134}Cs-10.4%, ^{137}Cs-41.6%, ^{60}Co-40.0%, ^{58}Co-0.8%, ^{54}Mn-2.5%, ^{124}Sb-2.9%, ^{122}Sb-1.4%, ^{110m}Ag-0.4%[2]
Salt fusion cake	ZNPP	4444.4	6.40E+13	^{134}Cs-22%,^{137}Cs-71%, ^{60}Co-7%
Low-level solid radwaste	ZNPP	7923.6	1.03E+12[4]	^{134}Cs, ^{137}Cs, ^{60}Co,^{54}Mn
Intermediate-level solid radwaste	ZNPP	753.5	6.93E+11[4]	^{134}Cs, ^{137}Cs, ^{60}Co,^{54}Mn
High-level solid radwaste	ZNPP	96.42	-[3]	-[3]
Filtering materials	SUNPP	409	5.07E+10[1]	^{134}Cs-28%, ^{137}Cs-69%, ^{60} Co-2%, ^{54}Mn-1%[1]
Vat residue	SUNPP	2902	8.80E+13[2]	^{134}Cs-11%, ^{137}Cs-80%, ^{60} Co-7%, ^{58}Co-1.0% ^{54}Mn-1%[2]
Low-level solid radwaste	SUNPP	16613.9	-[3]	^{58}Co,^{134}Cs, ^{137}Cs, ^{60}Co,^{54}Mn
Intermediate-level solid radwaste	SUNPP	595	-[3]	^{34}Cs, ^{137}Cs, ^{60}Co,^{54}Mn
High-level solid radwaste	SUNPP	15.1	-[3]	-[3]
Filtering materials	RNPP	562.45	4.53E+12[1]	^{134}Cs-13%, ^{137}Cs-86%, ^{60}Co-1%[1]
Vat residue	RNPP	3259	2.98E+13[2]	^{134}Cs-14%, ^{137}Cs-84%, ^{60} Co-2%[2]
Salt fusion cake	RNPP	2166.6	1.81E+14	^{134}Cs, ^{137}Cs, ^{60} Co
Dehydrated sludge	RNPP	11.0	1.45E+11	^{134}Cs, ^{137}Cs, ^{60} Co
Bituminous compound	RNPP	147.8	1.46E+13	^{134}Cs, ^{137}Cs, ^{60} Co
Low-level solid radwaste	RNPP	6935	-[3]	^{134}Cs, ^{137}Cs, ^{60}Co, ^{58}Co,^{54}Mn
Intermediate-level solid radwaste	RNPP	340.4	-[3]	^{58}Co, ^{137}Cs, ^{60}Co,^{54}Mn
High-level solid	RNPP	75.32	-[3]	-[3]

radwaste				

[1] - average total activity and radionuclide composition of surface samples taken from tanks with spent filtering materials
[2] - average total activity and radionuclide composition of vat residue
[3] - specific activity and radionuclide composition of solid radwaste accumulated in storage facilities since the beginning of power unit operation will be determined during solid radwaste retrieval, and solid radwaste total activity will be evaluated
[4] - tentative data obtained by calculation.

4.2. Information on Radioactive Waste in Storage at Chornobyl NPP Site

Radwaste material	Location	Volume, m^3	Mass, t	Activity, Bq	Main radionuclides
Low-level solid radwaste	SRSF	1069.00	-	1.1E+11	Mixture of radionuclides*: Cs, Sr, Co, Pu, Am
Intermediate-level solid radwaste	SRSF	926.50	-	4.11E+12	-//-
High-level solid radwaste	SRSF	506.93	-	1.2816E+14	-//-
High-level solid radwaste	Temporary storage for solid high-level waste	3.973	-	8.62E+12	^{137}Cs, ^{134}Cs, ^{60}Co, ^{94}Nb, ^{154}Eu, ^{152}Eu, ^{241}Am, ^{90}Sr, ^{241}Pu, ^{63}Ni, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{3}H, ^{14}C
Evaporation bottoms	LRSF	9672.50	-	2.75E+14	^{137}Cs, ^{134}Cs, ^{60}Co, ^{90}Sr
Ion-exchange resins	LRSF	2827.06	-	1.68E+12	^{137}Cs, ^{60}Co, ^{90}Sr, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{243}Am
Pulp	LRSF	1622.98	-	2.91E+12	^{137}Cs, ^{134}Cs, ^{60}Co, ^{90}Sr, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am
Evaporation bottoms	LSRSF	3892.00	-	1.08E+14	^{137}Cs, ^{134}Cs, ^{60}Co, ^{90}Sr
Ion-exchange resins	LSRSF	1255.30	-	5.60E+11	^{137}Cs, ^{134}Cs, ^{60}Co, ^{90}Sr, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am
Pulp	LSRSF	662.80	-	9.5E+11	^{137}Cs, ^{134}Cs, ^{60}Co, ^{90}Sr, ^{241}Am
Spent radioactive oil	Temporary storage	104.80	-	2.71E+07	^{137}Cs

* - nuclide composition of radwaste during facility loading was not determined because respective tools and guidelines were missing.

4.3. Information on Radioactive Waste in Storage at Sites of Research Reactors

INR NASU

Material	Location	Volume, m^3	Mass, t	Specific activity, Bq/L (Bq/kg)	Main radionuclides
Intermediate-level solid radwaste	Storages 8, 9, 10, 11, 12	- *	7.053	$1.51x10^7$	^{137}Cs, ^{60}Co
Low-level liquid radwaste	Sewer tanks 1	280.3	- *	$1.62x10^4$	^{137}Cs, ^{141}Ce, ^{60}Co
	Sewer tanks 2	204.1	- *	$7.30x10^4$	^{137}Cs, ^{60}Co
	Sewer tanks 3	7.3	- *	$1.41x10^2$	^{137}Cs, ^{60}Co

SUNEI

Material	Location	Volume, m^3	Mass, t	Activity, Bq	Main radionuclides
Intermediate-level solid	Storage 8	-	-	-	-

waste					
Low-level solid waste	Storage 8	-	-	-	-
Low-level liquid waste	Storage 3	2.1	- *	4.0E+5	^{137}Cs, ^{90}Sr+, ^{90}Y

* - activity and radionuclide composition are not determined because appropriate guidelines and/or equipment are missing

Note: all solid radwaste of SUNEI IR-100 was transferred for storage to the Odessa SISP on 27 April 2011.

4.4. Information on Radioactive Waste Disposed of at SSE CRME

Waste state	Waste category	Location	Mass , t	Volume m^3	Activity, Bq	Main nuclides
Solid radwaste	Low- and intermediate-level solid radwaste	*Buriakivka* RWDP	1,275,011	636,000	2.51E+15	Mixture of nuclides Cs, Sr, Eu, Pu, Am
Radwaste packages	Low-level solid waste	ENSDF	0.4143	0.8	6.2215E+10	^{90}Sr, ^{137}Cs, ^{135}Cs, ^{134}Cs, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, ^{241}Pu, ^{241}Am, ^{242}Am

4.5. Information on Chornobyl-Origin Radioactive Waste Stored at SSE CRME (evaluation)

Waste state	Waste category	Location	Mass, t	Volume, m^3	Activity, Bq
Solid radwaste	High-level, long-lived	*Pidlisnyy* RWDP	* 7920	* 3960	2.59E+15
	Low- and intermediate-level	*ChNPP Stage III* RWDP	41,900	26,200	3.40E+14
		Nova Budbaza RICP	41,570	27,710	7.59E+09
		Stara Budbaza RICP	62,550	40,140	4.04E+10
		Naftobaza RICP	180,600	102,300	3.47E+13
		Pischane Plato RICP	91,534	57,288	5.97E+12
		Yaniv Station RICP	15,000	30,000	3.70E+13
		Rudyy Lis RICP	250,000	500,000	3.74E+14
		Prypiat RICP	11,000	16,000	2.59E+13
		Kopachi RICP	90,000	110,000	3.33E+13
		Chystohalivka RICP	150,000	160,000	3.70E+12
Total:			956,154	1,080,638	3.45E+15

Note:

* - The amount of waste is indicated. However, according to the inventory of 1989 and taking into account materials used to stabilize radwaste in *Pidlisnyy* RWDP modules (concrete slurry, sand and gravel mixture) that have induced activity and also belong to radioactive waste, the total amount of radwaste in the modules is 22.0 thousand tons and 11.0 thousand m^3, respectively.

4.6. Information on Radioactive Waste and Spent Sources in Storage at UkrDO *Radon* SISPs

4.6.1. Information on Radioactive Waste Stored at UkrDO *Radon* SISPs

Waste material	Location	Volume *, m^3	Mass*, t	Activity**, Bq	Main radionuclides
Low- and intermediate-level solid radwaste	Kyiv SISP	2088	2801.4	4.84E+15	Cs-137, Ra-226, C-14, H-3,Th-232
	Dnipropetrovsk SISP	573	925.1	6.11E+11	Cs-137, Pu-239, Ra-226, U-238+U-235
	Donetsk SISP	2.9	1.7	2.10E+09	Cs-137, Ra-226
	Odessa SISP	523	332.5	5.10E+14	Cs-137, Kr-85, Ra-226, U-238+U-235
	Lviv SISP	695	738.3***	6.77E+12	C-14, H-3, U-238+U-235
	Kharkiv SISP	2097	2136	7.69E+12	H-3, Cs-137, Tc-99, Ra-226
Low- and intermediate-level liquid radwaste	Kyiv SISP	484	-	1.17E+13	H-3, C-14
	Dnipropetrovsk SISP	124	-	1.77E+10	H-3
	Odessa SISP	183	-	1.10E+11	C-14, H-3, Cs-137
	Kharkiv SISP	2	-	8.58E+06	Cs-137
Tubing contaminated by technology-enhanced naturally-occurring sources	Kharkiv SISP	812	780.2	2.72E+08	Ra-226

Note:

* - mass and volume of solid radwaste take into account shielding of spent sources

** - activity takes into account decay of radionuclides

*** - mass of solid radwaste takes into account material used for layer-by-layer cementation of facilities

4.6.2. Information on Spent Radiation Sources Stored at UkrDO *Radon* SISPs

Waste material	Location	Number, pcs.	Activity**, Bq	Main radionuclides
Spent sealed radiation sources placed in well-type storages	Kyiv SISP	5805	1.82E+14	Cs-137, Co-60, Pu-239
	Dnipropetrovsk SISP	8131	1.18E+14	Cs-137, Am-241, Co-60,
	Odessa SISP	10916	1.70 E+13	Cs-137, Pu-239, Co-60
	Lviv SISP	7083	7.28E+13	Cs-137, Co-60, Sr90+Y90
	Kharkiv SISP	15348	9.43E+13	Cs-137, Co-60, Am-241
Spent sealed radiation sources in shielding	Kyiv SISP	99,221	1.18E+15	H-3, Cs-137, Co-60, Pu-239,
	Dnipropetrovsk SISP	219,982	8.79E+14	Am-241, Cs-137, Co-60, Sr90+Y90
	Odessa SISP	1	6.11E+10	Cs-137
	Lviv SISP	44,157	1.96E+14	Cs-137, Sr90+Y90
	Kharkiv SISP	104,420	3.02E+14	Cs-137, H-3, Am-241
	Kyiv SISP	103,857	3.84E+14	H-3, Cs-137, Co-60
Spent sealed high-power radiation sources (RITEG)	Odessa SISP	15	2.60E+16	Sr90+Y90

Annex 5. List of ChNPP Nuclear Facilities in Decommissioning

Power unit	Location	Reactor type	Date of shutdown
No. 1	ChNPP site	RBMK-1000 (modified RBM-K2)	30 November 1996
No. 2	ChNPP site	RBMK-1000 (modified RBM-K2)	11 October 1991
No. 3	ChNPP site	RBMK-1000 (modified RBM-K7)	15 December 2000

Annex 6. Ukrainian Regulations on Nuclear and Radiation Safety Adopted in the Reporting Period

LAWS OF UKRAINE

1. Law of Ukraine No. 4175-VI of 20 December 2011 "On Amendment of the Law of Ukraine *On Nuclear Energy Use and Radiation Safety* to Complete the List of Nuclear Installations".
2. Law of Ukraine No. 654-VII of 23 October 2013 "On Ratification of the Agreement between the Cabinet of Ministers of Ukraine, the Government of the Russian Federation and the Government of Hungary on Transport of Nuclear Material between the Russian Federation and Hungary through the Territory of Ukraine".
3. Law of Ukraine No. 3255-VI of 20 April 2011 "On Ratification of the Agreement between the Cabinet of Ministers of Ukraine, the Government of the Slovak Republic on Transport of Nuclear Material between the Russian Federation and Slovak Republic through the Territory of Ukraine".

DECREES OF THE PRESIDENT OF UKRAINE

1. Presidential Decree No. 585/2011 of 12 May 2011 "On Decision of the National Security and Defense Council of Ukraine of 8 April 2011 On Improvement of Operational Safety *of Nuclear Power Plants of Ukraine*".
2. Presidential Decree No. 600/2012 of 16 October 2012 "On Decision of the National Security and Defense Council of Ukraine of 16 October 2012 *On New Revision of the Design Threat to Nuclear Installations, Nuclear Material, Radioactive Waste and Other Radiation Sources in Ukraine*".

RESOLUTIONS OF THE CABINET OF MINISTERS OF UKRAINE

1. Cabinet Resolution No. 591 of 1 June 2011 "On Approval of a List of Paid Administrative Services Provided by the State Nuclear Regulatory Inspectorate and Its Territorial Bodies and Size of Payment for Their Provision and Recognition as Invalid, Size of Payment for Authorizing Procedures in Nuclear Energy".
2. Cabinet Resolution No. 790 of 20 July 2011 "On Approval of the Form of License in the Sphere of Nuclear Energy and Its Description".
3. Cabinet Resolution No. 1174 of 16 November 2011 "On Approval of Criteria for Exemption of Radiation Source Use from Licensing".
4. Cabinet Resolution No. 1276 of 30 November 2011 "On Amendment of the List of Central Executive Bodies, Other State Bodies Responsible for Obligations under Participation of Ukraine in International Organizations".
5. Cabinet Resolution No. 1270 of 7 December 2011 "On Approval of the Comprehensive (Integrated) Safety Improvement Program for Nuclear Power Plants".
6. Cabinet Resolution No. 1337 of 21 December 2011 "On Approval of the Procedure for State Physical Protection System".
7. Cabinet Resolution No. 263 of 21 March 2012 "On Approval of Provisions on the State System for Professional Training, Retraining and Skill Improvement of Experts in Physical Protection, Accounting and Control of Nuclear Material".

8. Cabinet Resolution No. 1099 of 24 October 2012 "On Amendment of Some Cabinet Resolutions" (new revision of the Technical Specifications for packaging for radwaste storage and disposal).

9. Cabinet Resolution No. 339 of 15 May 2013 "On Implementation of Article 85 of the Law of Ukraine *On Restoration of the Debtor's Solvency or Declaration of Bankruptcy*".

10. Cabinet Resolution No. 598 of 24 July 2013 "On Approval of the State Plan for Interaction between Central and Local Executive Bodies in the Event of Sabotage at Nuclear Installations, Nuclear Material and Other Radiation Sources during Their Use, Storage or Transport as well as in Radioactive Waste Management".

11. Cabinet Resolution No. 393 of 27 May 2013 "On Establishment of the Interdepartmental Commission for Creation of the Nuclear Facility *Neutron Source Based on a Subcritical Assembly Driven by a Linear Electron Accelerator*".

12. Cabinet Resolution No. 639 of 28 August 2013 "On Amendment of Some Cabinet Resolutions on Payment for Authorizing Procedures in the Sphere of Nuclear Energy".

13. Cabinet Resolution No. 824 of 13 November 2013 "On Approval of the Procedure for State Supervision over Compliance with Nuclear and Radiation Safety Requirements".

14. Cabinet Resolution No. 736-r of 3 August 2011 "On Approval of the Action Plan to Ensure Openness and Accessibility of Information Associated with Nuclear Energy Use and Improvement of Nuclear Safety Culture".

15. Cabinet Resolution No. 684-r of 4 September 2013 "On Approval of Comprehensive Plan of Measures on Implementation of the New Revision of the Design Threat to Nuclear Installations, Nuclear Material, Radioactive Waste and Other Radiation Sources of Ukraine".

16. Cabinet Resolution No. 751-r of 26 September 2013 "On Amendment of the Action Plan for Implementation of Recommendations and Suggestions of the IAEA IRRS Mission".

REGULATIONS

1. Order No. 39 of 20 April 2011 "On Amendment of the Procedure for Investigation and Recording of Operational Events at Nuclear Power Plants".

2. Order No. 121 of 12 August 2011 "On Approval of the Procedure for Preparation and Submission of Requests for Public Information Administered by the State Nuclear Regulatory Inspectorate of Ukraine".

3. Order Form No. 122 of 16 August 2011 "On Approval of Forms of Documents for Proceedings in Case of Administrative Violations in the Sphere of Nuclear and Radiation Safety".

4. Order No. 133 of 20 September 2011 "On Amendment of the General Safety Provisions for Nuclear Power Plants".

5. Order No. 142 of 11 October 2011 "On Approval of Provisions on State Regional Nuclear Safety Inspectorates of the SNRIU".

6. Order of the Ministry of Health No. 153/766 of 7 November 2011 "On Approval of Requirements for Determining the Sizes and Boundaries of Observation Areas of Nuclear Power Plants".

7. Order No. 154 of 8 November 2011 "On Approval of the Procedure for Emergency Iodine Prophylaxis Measures for the Population of Ukraine in Case of a Radiation Accident".

8. Order No. 177 of 5 December 2011 "On Approval of Requirements for Limited Access and Access Monitoring and Control".

9. Order No. 176 of 5 December 2011 "On Approval of Engineered Physical Protection Features for Nuclear Installations, Nuclear Material, Radioactive Waste and Other Radiation Sources".

10. Order No. 183 of 12 December 2011 "On Amendment of the Procedure for Application of Nuclear Weapon Non-proliferation Safeguards".

11. Order No. 190 of 19 December 2011 "On Approval of General Requirements for the Management System in the Use of Nuclear Energy".

12. Order No. 193 of 27 December 2011 "On Approval of the Procedure for Free Primary Legal Assistance in the State Nuclear Regulatory Inspectorate of Ukraine".

13. Order No. 195 of 28 December 2011 "On Approval of Conditions and Procedure for Issuing Licenses for Activities of Operating Organization Officials".

14. Order No. 8 of 16 January 2012 "On Approval of the Procedure for Issuing Authorizations for Use of Land and Water Bodies Located in the Controlled Area of Nuclear Installations, Radioactive Waste Management Facilities, Uranium Plants".

15. Order No. 51 of 2 March 2012 "On Approval of Requirements for the Management System of the Operating Organization (Operator)".

16. Order No. 56 of 12 March 2012 "On Approval of the General Safety Provisions for Nuclear Subcritical Facility".

17. Order No. 84 of 9 April 2012 "On Approval of Requirements for Safety Assessment of the Nuclear Material Accounting and Control System".

18. Order No. 153 of 6 August 2012 "On Approval of Provisions for the List and Requirements for the Structure and Contents of Documents Submitted to Obtain a License for Individual Activities in the Use of Nuclear Energy".

19. Order No. 188 of 18 October 2012 "On Approval of the Procedure for Training and Examination on Nuclear and Radiation Safety for Operating Organization (Operator) Personnel and Legal Entities Subcontracted by Operating Organizations".

20. Order No. 238 of 17 December 2012 "On Approval of the List of Radiation Hazardous Facilities in Ukraine Covered by the Developed Design Threat".

21. Order No. 256 of 28 December 2012 "On Approval of the Procedure for Cases of Legislation Violation and Application of Sanctions to Entities Dealing with Nuclear Energy".

22. Order No. 64-od of 14 June 2013 "On Approval of the Procedure for the Formation and Keeping of the Unified Register of Licenses Issued for Nuclear Energy Activities".

23. Order No. 76 of 25 June 2013 "On Approval of the Procedure for the Development of Security Culture of Nuclear Installations and Radioactive Waste Management Facilities and Other Radiation Sources and Instructions on Assessment of Security Culture of Nuclear Installations, Radioactive Waste Management Facilities and Other Radiation Sources".

24. Order No. 83 of 5 August 2013 "On Approval of Radiation Safety Rules for Electron Accelerators"

25. Order No. 88 of 9 August 2013 "On Approval of Provisions on Departmental Incentive Awards of the State Nuclear Regulatory Inspectorate of Ukraine".

26. Order No. 117 of 21 October 2013 "On Approval of Changes to the Rules for Nuclear Material Accounting and Control".

27. Order No. 136 of 28 November 2013 "On Approval of the Procedure for Exemption of Nuclear Power Plant Sites from Regulatory Control after Completion of Decommissioning Activities".

28. Order No. 138 of 3 December 2013 "On Approval of the List of Radiation Sources Whose Use is Exempt from Licensing".

29. Order No. 149 of 30 December 2013 "On Approval of Changes to Provisions on the List and Requirements for the Structure and Contents of Documents Submitted to Obtain a License for Individual Activities in Nuclear Energy".

Annex 7. National and International Safety Reports for the Reporting Period

1. National Report of Ukraine on Compliance with the Obligations of the Convention on Nuclear Safety (2014).
2. National Report of Ukraine "25 Years from the Chornobyl Catastrophe. Future Safety" (2011).
3. National Report on Technology-Related and Natural Safety in Ukraine in 2011.
4. National Report on Technology-Related and Natural Safety in Ukraine in 2012.
5. National Report on Technology-Related and Natural Safety in Ukraine in 2013.
6. Annual Report on Nuclear and Radiation Safety in Ukraine for 2011.
7. Annual Report on Nuclear and Radiation Safety in Ukraine for 2012.

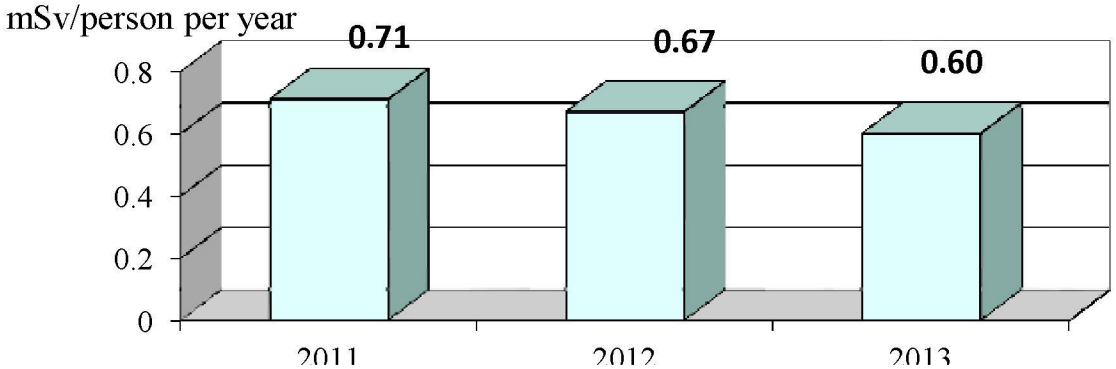

Figure L.8.1. Average Annual Individual Doses for Personnel of NNEGC *Energoatom* (mSv/person per year)

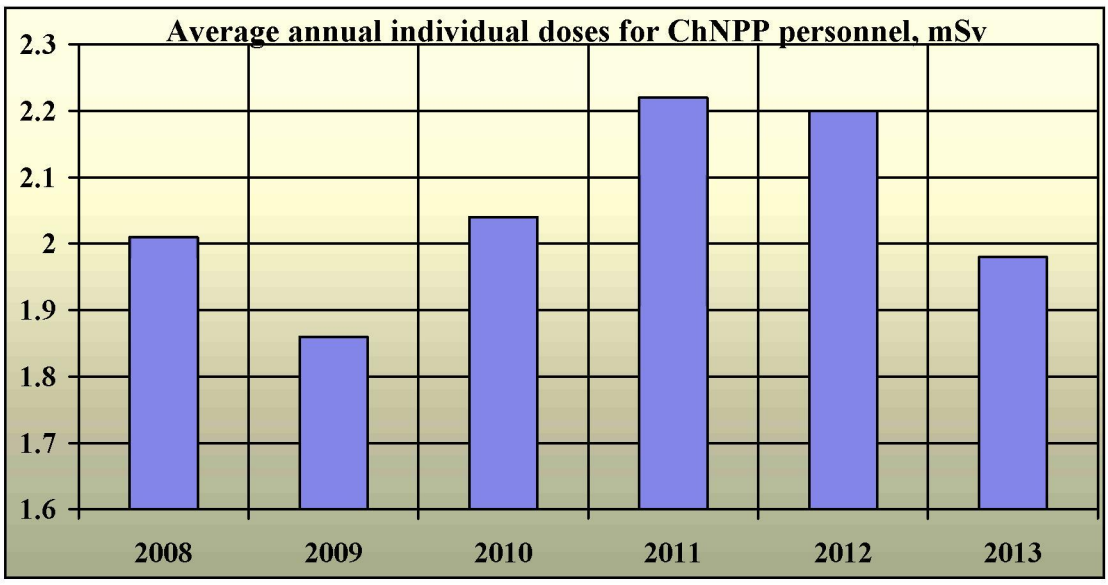

Figure L.8.2. Average Annual Individual Doses for ChNPP Personnel (mSv/person per year)

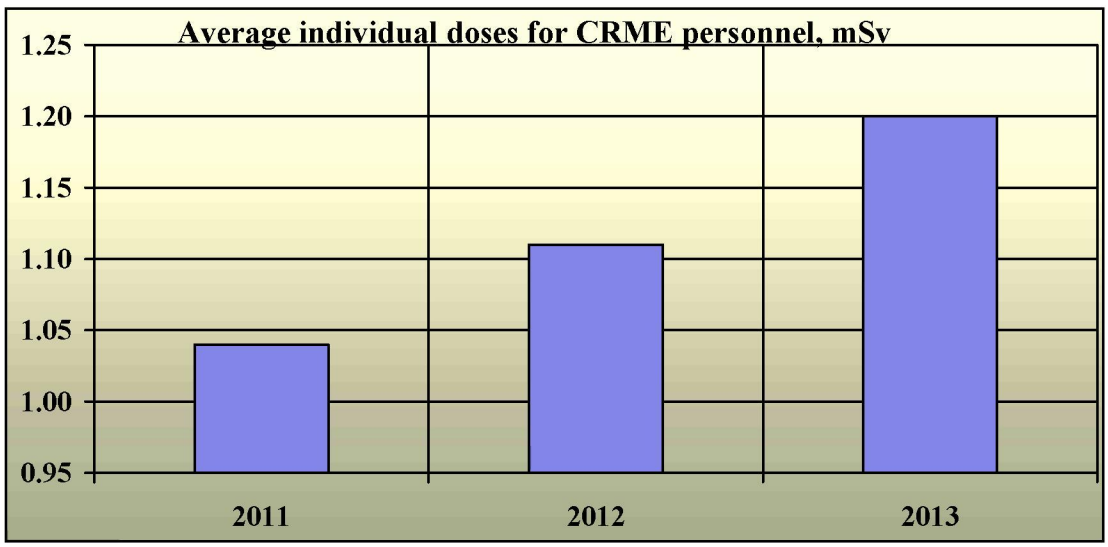

Figure L.8.3. Average Annual Individual Doses for CRME Personnel (mSv/person per year)

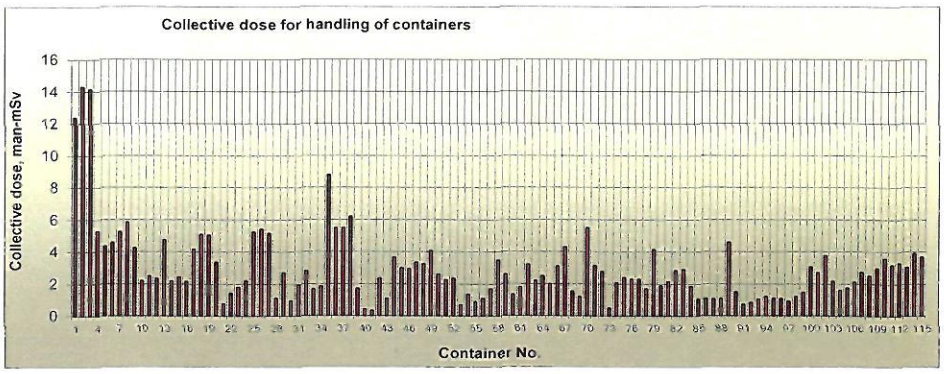

Figure L.8.4. Collective Dose for Zaporizhzhya NPP Personnel in All Handling Operations with Containers for Spent Fuel Storage

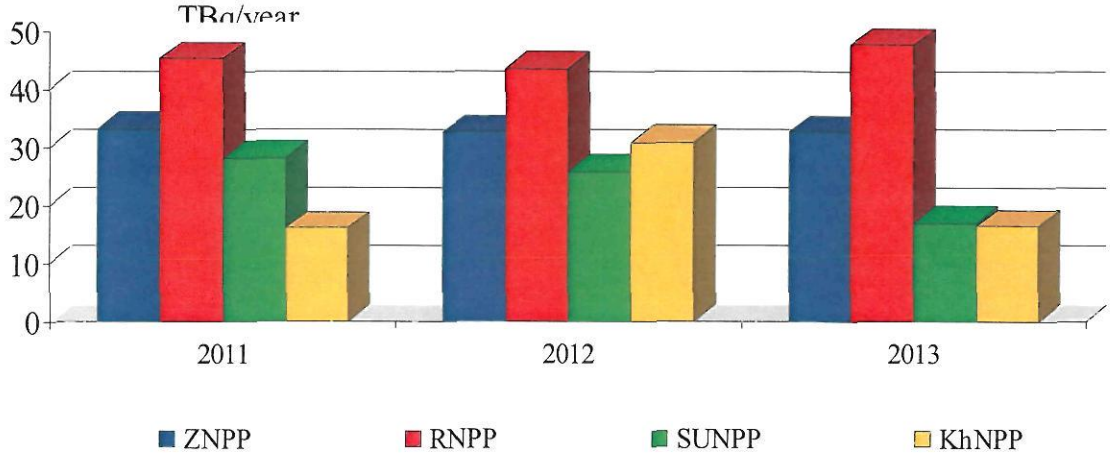

Figure L.8.5. Releases of Inert Radioactive Gases from Ukrainian NPPs

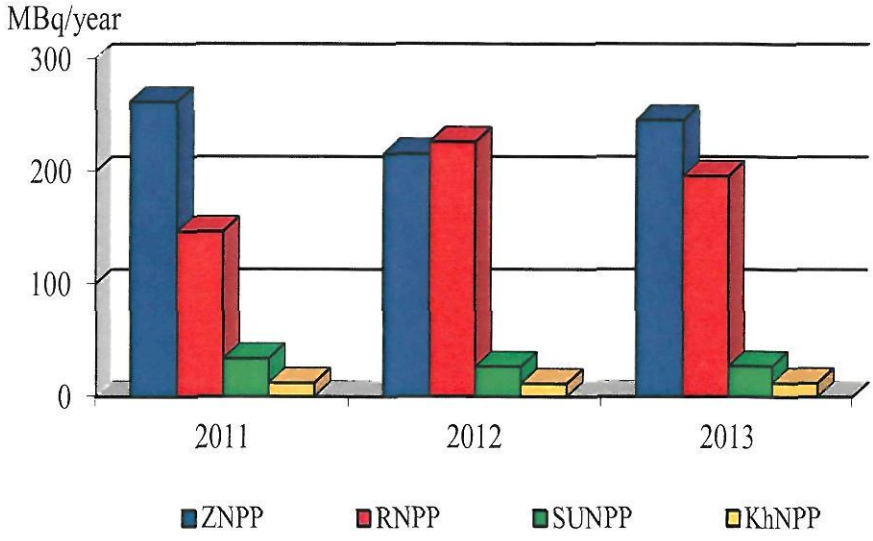

Figure L.8.6. Releases of Long-Lived Radionuclides from Ukrainian NPPs

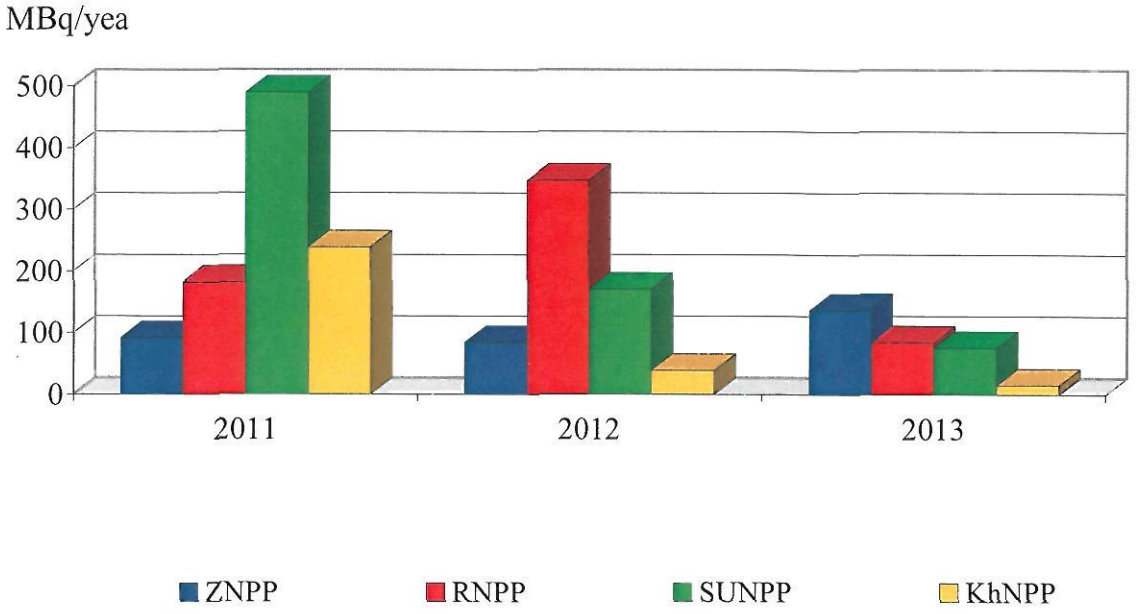

Figure L.8.7. Releases of Radioactive Iodine from Ukrainian NPPs

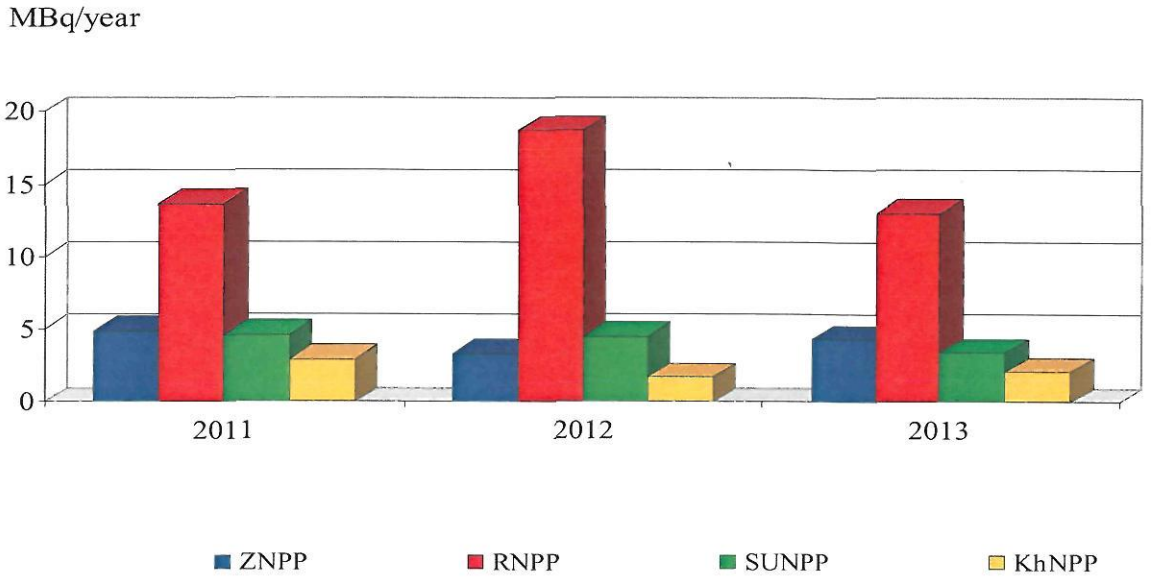

Figure L.8.8. Releases of Cs-137 from Ukrainian NPPs

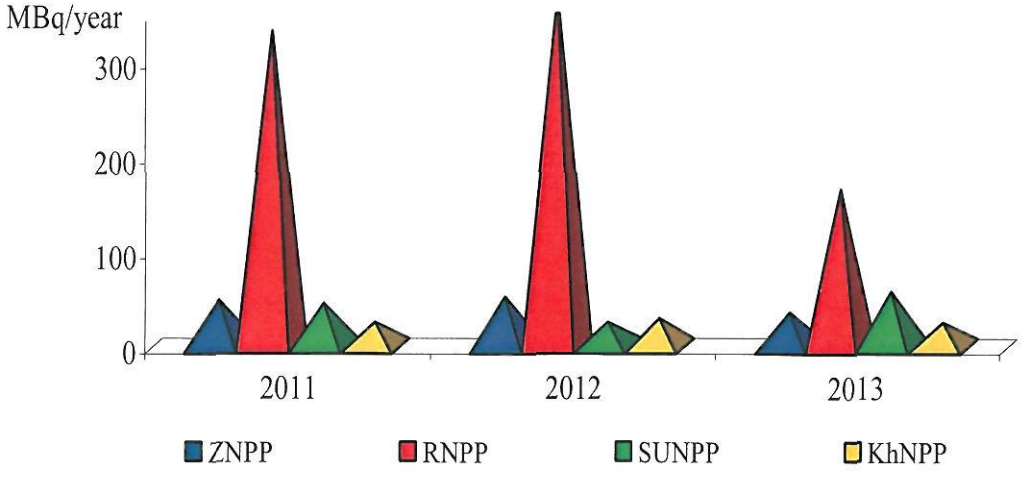

Figure L.8.9. Releases of Cs-137 from Ukrainian NPPs

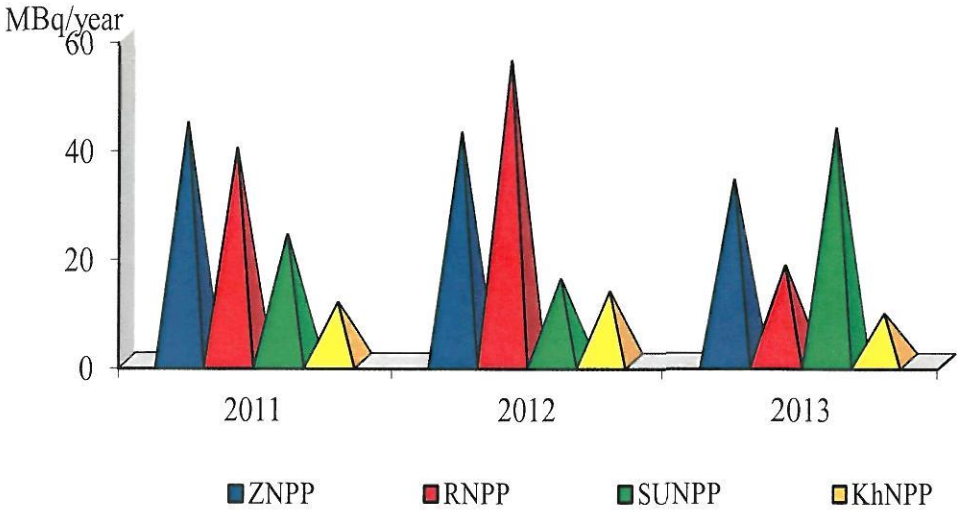

Figure L.8.10. Releases of Cs-134 from Ukrainian NPPs

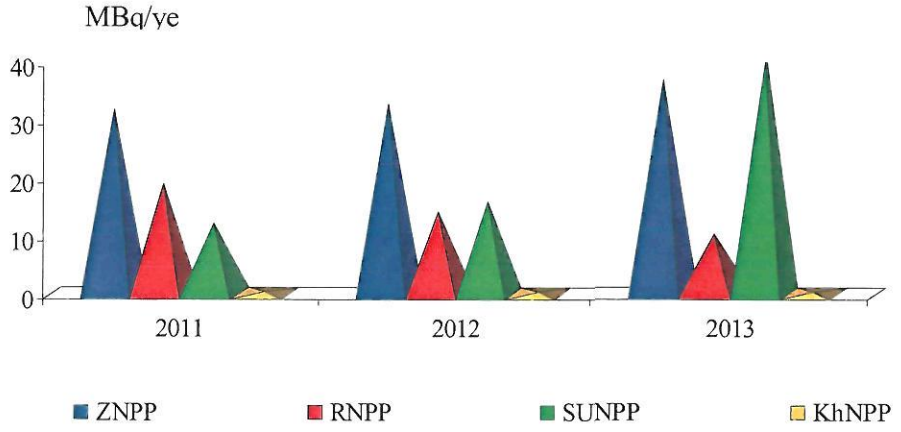

Figure L.8.11. Releases of Co-60 from Ukrainian NPPs

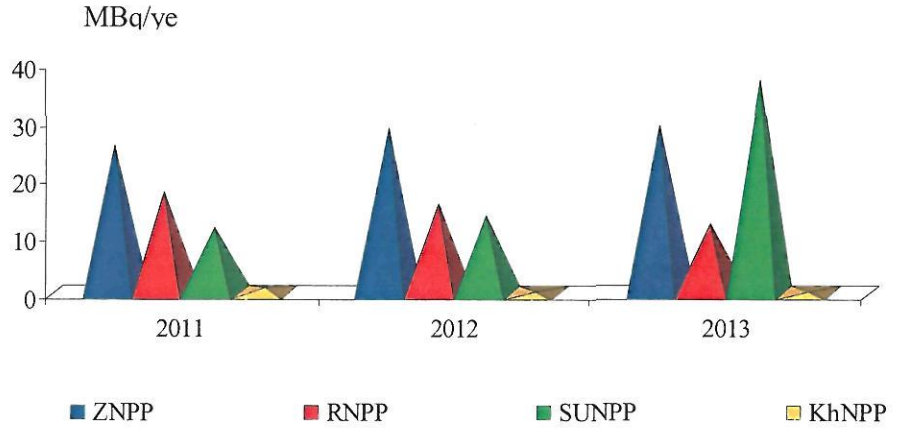

Figure L.8.12. Releases of Mn-54 from Ukrainian NPPs

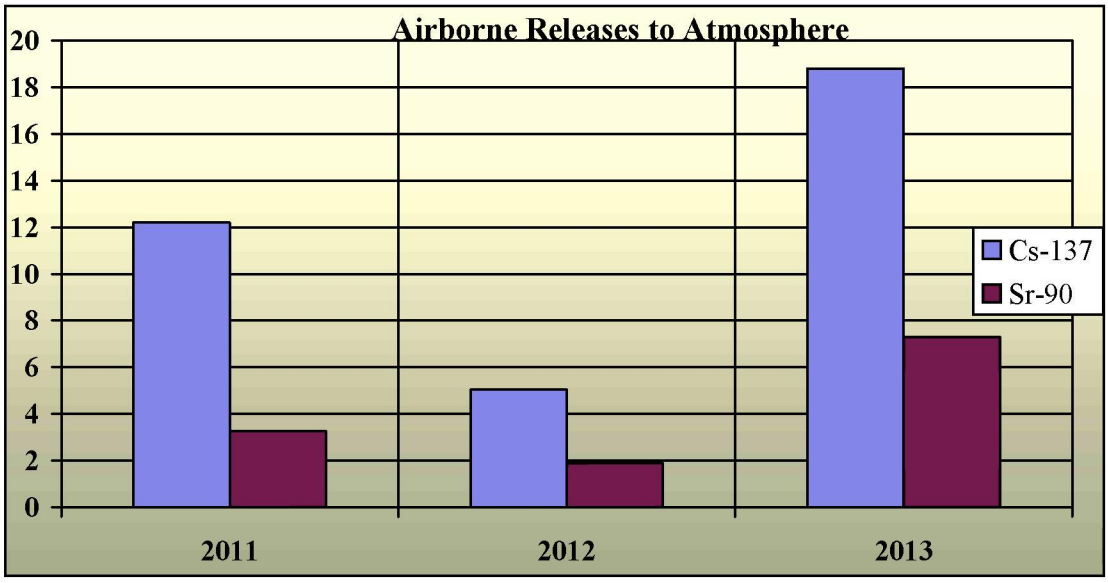

Figure L.8.13. ChNPP Releases to Atmosphere (kBq)

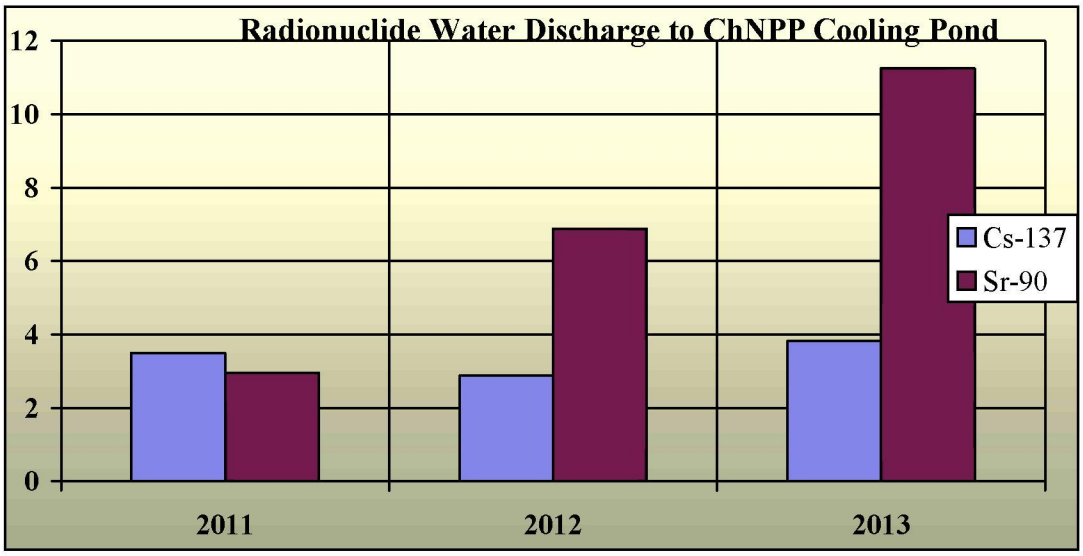

Figure L.8.14. Radioactive Water Discharges to ChNPP Cooling Pond, GBq

Integrity Monitoring of Radwaste Storage Facilities on the ChNPP Site (Observation Wells)

Contamination of groundwater is monitored using observation boreholes of the monitoring system for radwaste storage facilities on the ChNPP site. The maximum activity concentration of radionuclides determined with this monitoring is shown in Figures L 8.15- L 8.20.

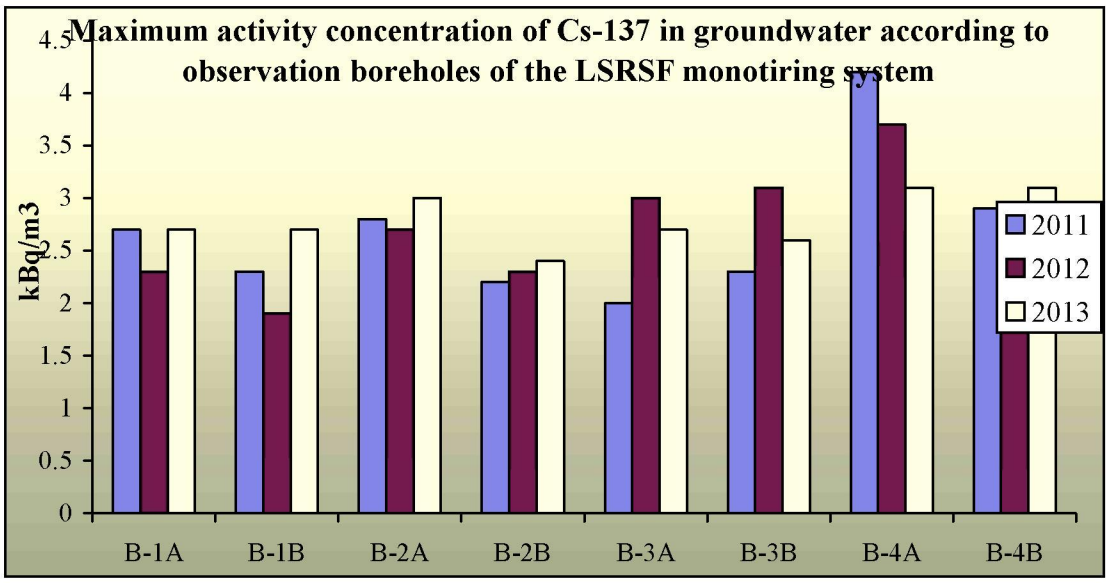

Figure L.8.15. Maximum Activity Concentration of Cs-137 in Groundwater According to Observation Boreholes of the LSRSF Monitoring System

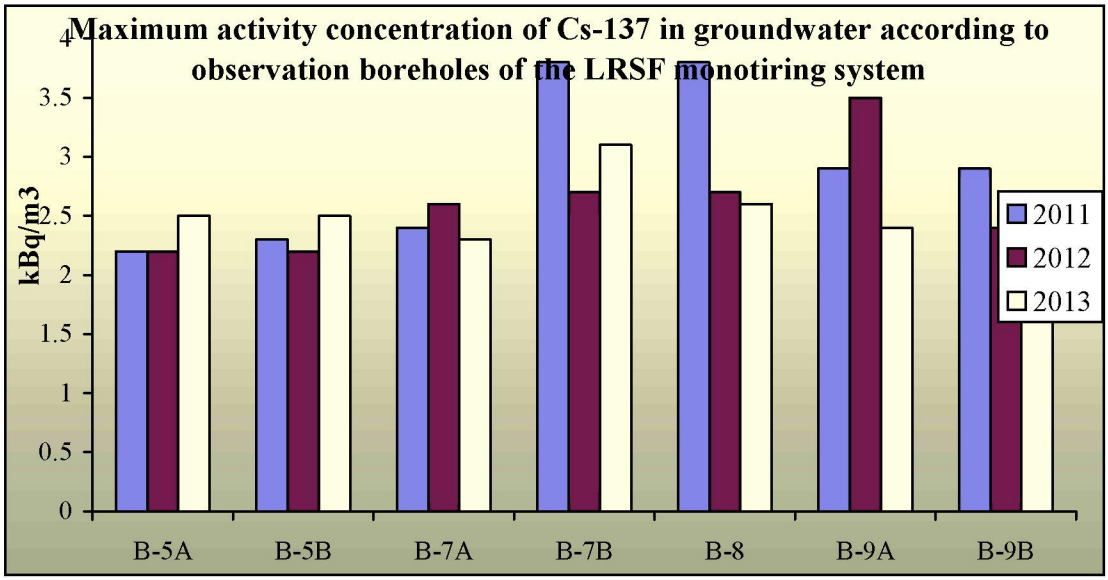

Figure L.8.16. Maximum Activity Concentration of Cs-137 in Groundwater According to Observation Boreholes of the LRSF Monitoring System

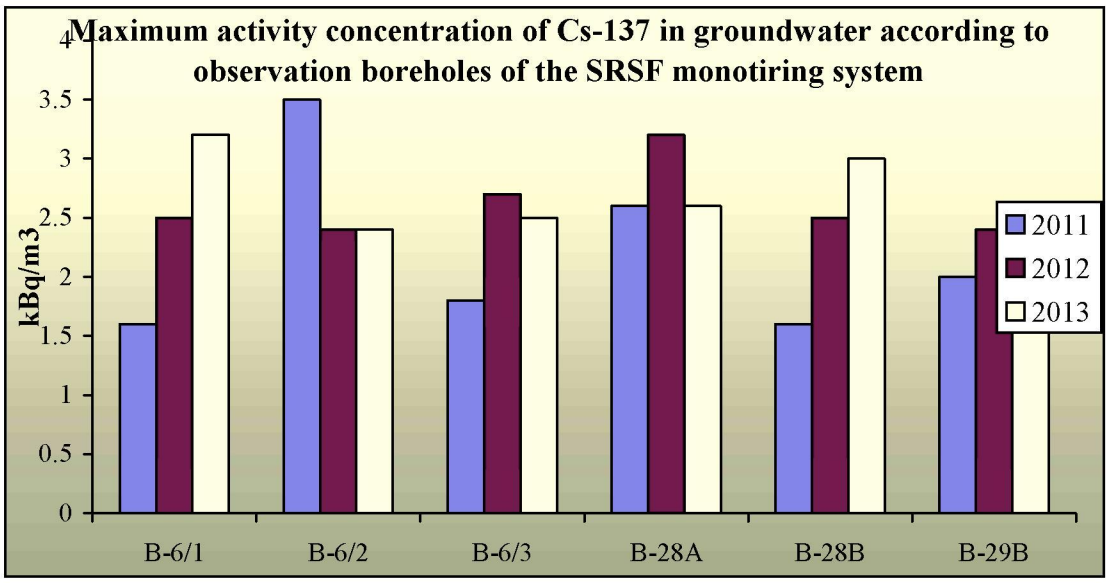

Figure L.8.17. Maximum Activity Concentration of Cs-137 in Groundwater According to Observation Boreholes of the SRSF Monitoring System

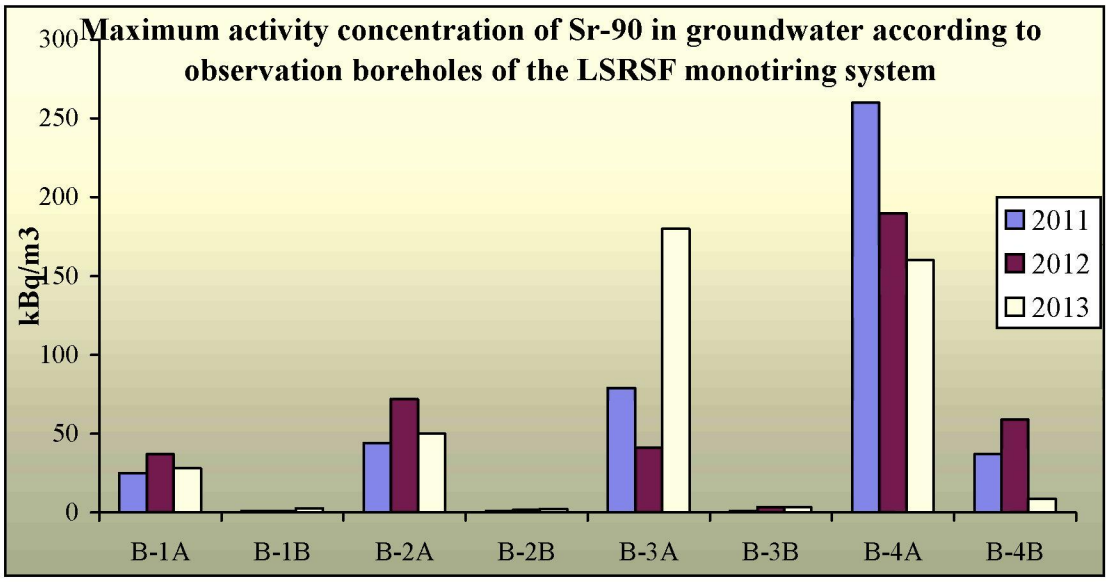

Figure L.8.18. Maximum Activity Concentration of Sr-90 in Groundwater According to Observation Boreholes of the LSRSF Monitoring System

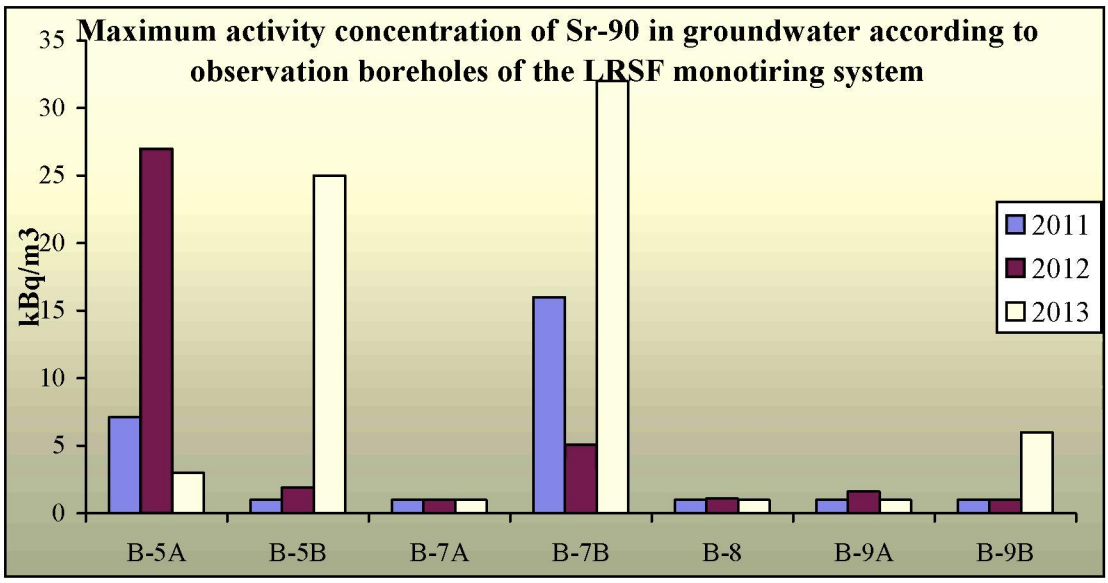

Figure L.8.19. Maximum Activity Concentration of Sr-90 in Groundwater According to Observation Boreholes of the LRSF Monitoring System

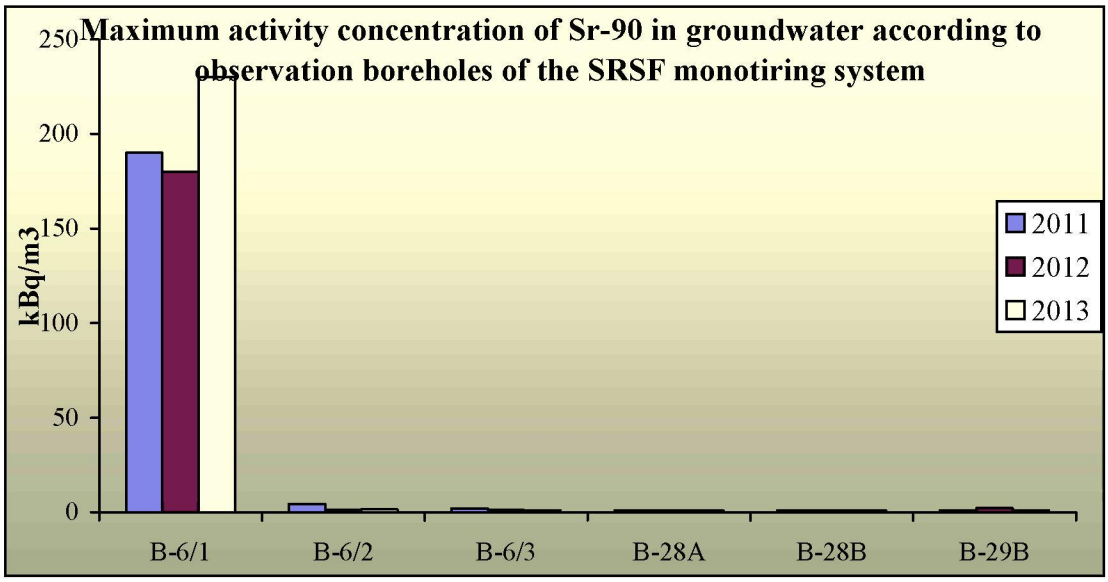

Figure L.8.20. Maximum Activity Concentration of Sr-90 in Groundwater According to Observation Boreholes of the SRSF Monitoring System

Annex 9. Shelter

1. General Information

The accident that occurred at Chornobyl unit 4 on 26 April 1986 became the largest and severest catastrophe in the history of nuclear energy. The explosion destroyed the reactor core, protective barriers and safety systems. The destruction of unit 4 and the magnitude of consequences were such that the accident was evaluated as level 7 on the International Nuclear Events Scale (INES).

To isolate the destroyed reactor within the shortest possible period (from May to November 1986), ChNPP unit 4 was preserved and a protective structure was built around it.

The preservation of the destroyed unit 4 was intended to decrease its environmental impact and protect the ruined reactor from external effects.

The East European Leading Research and Design Institute for Energy Technologies (Saint Petersburg) was the general designer of the Shelter. The design was elaborated and modified during construction.

Along with construction, great efforts were made to decontaminate the territory, which decreased the exposure dose rate on the ChNPP site.

The Shelter is the ChNPP destroyed unit 4 that lost its functions. Emergency measures were taken at unit 4 to mitigate consequences of the accident, and activities are continued to monitor its state and nuclear and radiation safety.

The Shelter is not a facility created in compliance with regulations and rules or standards for siting, design, commissioning, operation and decommissioning of nuclear facilities (or radioactive waste storage facilities). The current state of the Shelter does not and cannot comply with safety standards and rules in force in the area of nuclear energy and general industrial safety requirements.

Some part of structures constructed in 1986 rests on destroyed components of the ChNPP unit 4 building, whose strength could not be assessed because of complex radiation conditions and obstructions. After use of remote concreting methods, concrete masses spread over coverings of the building and overloaded them. Remote assembling in some cases did not ensure tight fitting of structures and reliable connection with supports.

According to the Law of Ukraine "On Ratification of the Convention on Nuclear Safety", the Shelter is not subject to this Convention because of its unique nature resulting from the global consequences of the Chornobyl catastrophe and because of impossibility to reach a high safety level at the Shelter in compliance with the Convention.

All nuclear and radioactive materials in the Shelter are radioactive waste. In compliance with the Radiation Safety Standards of Ukraine, the Shelter, in its current state, is qualified as a place for surface storage of uncontrolled radwaste (temporary storage of uncontrolled radwaste in the stage of stabilization and reconstruction).

The accident-related radwaste, representing open radiation sources that are located in the Shelter in great amounts without reliable protective barriers, poses a high current and potential hazard for personnel, the public (including future generations) and the environment. The main task of all Shelter-related activities is to control these sources and protect individuals and the environment against their radiological impact.

2. Shelter Operating License

Shelter-related activities are conducted under a license issued by the SNRIU. The license establishes the scope and conditions of the authorized activity and provides for Shelter

transformation into an environmentally safe system, in particular, in the framework of the international Shelter Implementation Plan (SIP).

According to this license, any activity at the Shelter is intended to protect personnel, the public and the environment against the impact of radioactive materials located in the Shelter or on its site. Any activity at the Shelter for another purpose is prohibited.

The license will remain valid until the Shelter new safe confinement is completed. The license determines a list of officials charged with organizational and administrative functions associated with nuclear and radiation safety, Shelter physical protection, nuclear material and radioactive waste located at the Shelter.

The license identifies 23 conditions for Shelter operation.

The ChNPP has currently implemented all special terms of the license and deals with general terms of activities. In particular, the licensee:

- submits semiannual and annual reports on Shelter safety;
- ensures storage of all records on accounting of radwaste removed outside the Shelter;
- ensures physical protection of nuclear and radioactive material against unauthorized actions in compliance with current legislation;
- during any activities that affect Shelter safety, develops, justifies and approves relevant technical decisions that become valid after their agreement with the SNRIU;
- conducts certain activities or operations (determined by license terms) for Shelter transformation into an environmentally safe system under individual authorizations issued by the SNRIU.

During 2011-2013, the SNRIU issued eight individual written authorizations in compliance with the license for important activities on construction, installation/dismantling, commissioning and operation of facilities on the Shelter site.

Compliance with the license and individual authorizations is monitored by the SNRIU in the framework of state supervision.

Shelter-related activities are carried out in accordance with technical specifications. This document governs activities related to Shelter structures and systems (components) that are accepted in operation, including maintenance, repair, modernization and other operations to protect personnel, the public and the environment against radiological hazards associated with the Shelter.

3. Shelter Transformation into Environmentally Safe System

Shelter transformation into an environmentally system requires substantial financial and material resources and international assistance to solve this widespread problem.

An important step to solve the Shelter safety problem is Ukraine's interaction with G8 States and European Commission.

The international program for Shelter transformation into an environmentally safe system, Shelter Implementation Plan (SIP), was developed under joint efforts of governments and experts of these countries during 1997.

The SIP is funded through contributions to the Chornobyl Shelter Fund, which is administered by the European Bank for Reconstruction and Development.

The Shelter Implementation Plan includes 22 tasks governed by five safety objectives:

– decrease the probability of Shelter collapse (stabilization of structures);

– mitigate consequences of collapse;

– improve nuclear safety;

– increase safety of personnel and the environment;

– implement the strategy of long-term measures on Shelter transformation into an environmentally safe system.

Shelter transformation into an environmentally system (SIP tasks and projects) is structured into the following main areas:

– develop safety programs and plans;
– create an infrastructure for projects;
– stabilize the Shelter;
– equip the Shelter with systems;
– construct the new safe confinement (NSC);
– develop the strategy for removal of fuel-containing materials (FCM).

Systems for organizational, methodological and technical measures for safe implementation of SIP projects were introduced under safety programs and plans. The radiation protection program, radioactive waste management program and emergency plan were developed. The last two documents constitute part of general plant documents.

The creation of an additional infrastructure is needed for safe implementation of SIP projects. The main completed projects include a changing room for 1430 places, an air lock at Shelter elevation +5.8, a site for temporary storage of process materials and external engineering communications and auxiliary structures.

An important element of the additional infrastructure included construction of a special working platform (site) for assembling the New Safe Confinement for the Shelter. To decrease the negative Shelter effect on personnel, this platform was constructed in the west from the Shelter at a distance more than 200 meters. After planned safety measures were completed, the site was given the status of 'free' access zone. This status allows personnel to get access to the platform according to simplified procedures, perform activities with minimum use of individual protection means and increase their effectiveness.

Seven emergency stabilization measures on Shelter structures were implemented during 2005-2008. These structures were the most unreliable and hazardous in terms of consequences from potential collapse. The main objective of Shelter stabilization is to decrease the risk of collapse involving potential large release of radioactive dust to the atmosphere.

After completion of these measures, the ChNPP developed the "Summary Executive Report on Stabilization Measures (Safety Assessment Report)" to analyze the stabilization measures and the reliability of the Shelter as a whole and provide recommendations on further Shelter operation.

It was concluded that the safety of Shelter structures substantially increased although its level did not fully comply with regulatory requirements. The safety level can be considered acceptable for a period no more than 15 years from the date of official completion of activities (29 October 2008).

The new safe confinement for the Shelter shall be constructed within this period, and the most unstable Shelter structures shall be dismantled after its commissioning.

Equipment of the Shelter with systems includes the following projects:

- modernized dust suppression system (MDSS) – the project has been completed, MDSS is in routine operation;
- additional system for operating radiation monitoring of Shelter personnel (ASORM) – the project has been completed, the system is in routine operation;
- integrated automated monitoring system (IAMS) – pilot commercial operation is underway, acceptance tests are to be conducted;
- modernized physical protection system – the system is in routine operation;
- fire protection system (FPS) – the system is in routine operation.

The Shelter new safe confinement (NSC) is the main SIP project.

The confinement is a protective structure including process equipment for retrieval of fuel-containing materials from the destroyed ChNPP unit 4, radwaste management and other systems

and is intended to transform this unit into an environmentally safe system and ensure the safety of personnel, the public and the environment.

According to the design decisions, the NSC represents an arch structure with the following dimensions: bay – 257 m, width – 150 m and height – 108 m. The envisaged operating period of the NSC is 100 years.

The NSC project is divided into two startup complexes (SC):

- NSC SC-1 – protective structure with process life support systems and necessary infrastructure;
- NSC SC-2 – infrastructure for dismantling of unstable Shelter structures.

NSC SC-1 is currently under implementation and preparations for the development of NSC SC-2 design decisions are underway.

The design documentation on NSC SC-1 passed state reviews, including reviews on nuclear and radiation safety, and was properly approved.

NSC SC-1 is implemented through individual projects combined in 6 licensing packages (LP).

Preparations for NSC SC-1 have been completed under the LP1-LP3 licensing packages: the territory has been prepared and cleared for construction, foundations for NSC installation and transport zones have been created and the working platform for assembling NSC structures has been constructed and accepted in operation.

The confinement construction activities are carried out within the LP5-LP6 licensing packages: NSC foundations in the main zone are under construction, NSC structures are being assembled, the process building included in NSC is under construction, life support systems and facilities and confinement infrastructure are being created.

According to design decisions, the assembled eastern part of the NSC arch with a total weight more than 12,000 t was moved to the 'expectation' zone toward the Shelter to a distance of 112 meters. After the western arch part is assembled, both parts will be joined. Then the entire arch will be moved and installed into its design position above the Shelter.

The existing ventilation stack of ChNPP Stage II (VS-2) interfered prevented the future establishment of the NSC into its designed position. This ventilation stack was finally dismantled in November 2013 under the LP4 licensing package.

The dismantling work was preceded by construction and commissioning of a new ventilation stack of ChNPP Stage II in October 2013, which is intended to perform functions of VS-2 and constructed not to impede NSC structures.

Monitoring of fuel-containing materials (FCM) inside the Shelter and their retrieval for further controlled storage are an important task of Shelter transformation into an environmentally safe system. The "Strategy for Management of FCM and Radioactive Waste at the Shelter. Plan for Further Actions" was developed within the SIP. To determine the final strategy for FCM management, additional measures on FCM monitoring shall be developed and implemented and their funding sources shall be defined.

4. Abnormal Event on 12 February 2013

On 12 February 2013, an abnormal event happened at ChNPP and involved collapse of wall panels and roof of the ChNPP unit 4 turbine hall above unattended rooms. The total area of collapse constituted about 600 m^2. There were no victims.

The investigation commissions and IAEA missions concluded that the roof collapsed due to the following causes: ageing and damage of turbine hall roof and deaerator stack over time after the 1986 accident, non-uniform distribution of loads on structures, water leakage through the

roof leading to corrosion of roof metallic structures, absence of full-scale monitoring of technical state of structures, due to difficult access to bearing structures, high doses for personnel etc.

The SNRIU analyzed and classified the abnormal event involving partial collapse of the roof and wall panels of ChNPP unit 4 as INES level 1.

ChNPP took emergency actions to avoid potential negative effects of this incident and developed the "Plan of Measures to Decrease Consequences of Roof Collapse and Decrease Potential Risks for Existing Structures and Personnel", which was agreed by the SNRIU.

To avoid spread of radioactive dust through the damaged roof, ChNPP implemented measures on dust suppression inside the turbine hall and took other actions: pumped out additional water that got into the turbine hall with precipitations, dismantled and removed damaged, unstable structures etc.

The Chornobyl NPP developed the project "Recovery of the Enclosing Structure of ChNPP Unit 4 at Axes 46-52 in Rows A-B", which was subjected to comprehensive state review and properly agreed.

As of 14 August 2014, most activities under the above project have been completed and the leaky place has been repaired.

5. Shelter Radioactive Waste Management

According to evaluations, there is radwaste with the following basic characteristics inside the Shelter and on its site:

No.	Radwaste type (storage place)	Physical state	Activity category	Amount, m^3	Total activity, TBq	Nuclide composition, %
1.	Solid radwaste[1] located in the Shelter and on its site that formed during the accident and mitigation measures	Fresh and spent fuel assemblies, lava-like fuel-containing materials, dust, metallic equipment and assembling structures etc.	Solid radwaste of all categories	630,000 – 665,000	5.21E+5	Mixture of radionuclides typical of spent nuclear fuel from the core (uranium, cesium, strontium, cobalt, transuranium elements – plutonium, americium etc.)
2.	Post-accident waste[1] located inside the Shelter (uncontrolled leakages and water accumulations in rooms of block B)	Water accumulations and leakages (including sediments in water accumulations)	Liquid radwaste of all categories	~ 500	~ 59.3	Mixture of post-accident radionuclides: cesium, strontium, plutonium, uranium etc.

Notes:

[1] Data in the table are tentative and based on research work conducted at the Shelter
[2] Amount of liquid radwaste changes annually depending on the intensity of precipitations getting into the Shelter

Solid and liquid radwaste is generated during Shelter routine activities and transformation into an environmentally safe system.

Radwaste management at the Shelter is part of radwaste management at the ChNPP.

Solid radwaste (soil, scrap metal, mixed construction waste, spent individual protection means) is mainly generated during routine activities to maintain the Shelter in a safe state and during SIP projects.

This solid radwaste is mainly of low and intermediate level, and sometimes high-level waste is revealed. Strontium-90, cesium-137, cesium-134 and transuranium elements are the main nuclides that contribute to contamination. Shelter solid radwaste is managed in compliance with ChNPP documents in force. Low- and intermediate-level waste is collected, sorted (if needed, large radwaste is fragmented) and transferred to the *Buriakivka* RWDP or stored in temporary storage facilities on the ChNPP site. Solid radwaste is transported to the *Buriakivka* RWDP in accordance with waste acceptance criteria for this facility. High-level radwaste is collected and fragmented using equipment for remote solid waste treatment and is transported to the temporary storage of high-level waste on the ChNPP site.

Shelter liquid radwaste results from decontamination of rooms, equipment and tools, dust suppression, operation of changing rooms, and natural factors such as penetration of precipitations through non-tight places in Shelter structures and moisture condensation.

Liquid radwaste, including that of the Shelter, is collected through the ChNPP piping system.

There are liquid radwaste accumulations inside the Shelter that result from uncontrolled water leakages and dust suppression activities.

The radionuclide and chemical composition of this liquid radwaste depends on location. The radionuclide composition of water in Shelter rooms includes Cs^{134}, Cs^{137}, Sr^{90}, $Pu^{239-240}$, Am^{241} and organic and film-forming compounds.

The main tasks to improve the existing system for Shelter liquid radwaste management are:

– collection of waters from block B and the block of reactor compartment auxiliary systems) and their treatment;

– rapid determination of α-activity of liquid radwaste prior to transfer to the ChNPP chemical department for further treatment;

– removal of transuranium elements, organic and film-forming compounds from liquid radwaste.

ChNPP has developed a statement of work for designing a facility for treatment of Shelter waters and liquid radwaste to remove transuranium elements and organic compounds and has submitted it to the European Commission for review and tender procedures.

To solve issues associated with Shelter liquid radwaste management, the ChNPP developed the "Conceptual Technical Decision on Liquid Radwaste Management and Shelter Transformation into an Environmentally Safe System" in 2006 and agreed it with the SNRIU. To comply with this decision, the ChNPP developed a plan of measures and implemented them partially.

6. Regulatory Authority's Documents for Shelter Activities

The SNRIU, in its Shelter-related activities, is governed by the Laws of Ukraine, Cabinet resolutions and ordinances and regulations in the area of nuclear energy.

To explain the policy for state regulation of nuclear and radiation safety of the Shelter, the regulatory authority approved the "Statement on the Policy for Regulation of Nuclear and Radiation Safety of the Chornobyl Shelter" in 1998. It determined the main principles of nuclear and radiation safety during Shelter transformation into an environmentally safe system, specifically:

– management principles;

– radiation protection;
– radwaste management;
– general technical principles.

In 2001, the SNRIU developed "Requirements for the Structure and Contents of the Safety Analysis Report for Projects of the Shelter Implementation Plan". According to this document, the ChNPP develops safety analysis reports on projects submitted to the nuclear regulatory authority with the documentation package to obtain an authorization for specific activities or operations at the Shelter.

The Interagency Regulatory Task Force is functioning for coordination of regulatory authorities' activities in licensing of Shelter operations and ChNPP decommissioning to ensure consistent activities of different regulatory authorities involved in the SIP. The Interagency Regulatory Task Force includes, besides the SNRIU, representatives of state authorities for construction, environment, health protection, fire safety and industrial safety.

During 2005-2006, the SNRIU developed, with involvement of foreign experts, the "Fundamental Safety Principles under the Shelter Implementation Plan" and "Guideline on Using Safety Fundamentals during Regulatory Activity under the Shelter Implementation Plan".

In October 2010, the regulation "Conditions and Procedure for Issuing Individual Written Authorizations for Activities or Operations on Shelter Transformation into an Environmentally Safe System" developed by the SNRIU was put in force. This document identifies activities or operations to be conducted under individual authorizations at the Shelter and establishes conditions and procedure for issuing, amending, rejecting, terminating and cancelling authorizations for activities or operations on Shelter transformation into an environmentally safe system.

Annex 10. Uranium Mining and Milling Waste

Operating period	Tailing pit	Area, ha	Volume of tailing, mln. t / mln. m^3	Total activity, 10^{12} Bq	Uranium content, mg/kg
Tailing pits of SE *SkhidGZK*					
1959-1970	Scherbakivska (old basin)	614.9	7.640/7.119	79.318	5 - 10
1979 – till present	Scherbakivska (new basin)		30.576/27.902	317.414	6 - 8
1964 – till June 1990 1991-1996 (occasionally)	Iron ore quarry	55.0	15.94/12.40	93.300	10
IA PCP tailing pits registered on SE *Baryer* Books					
1949- 1954	Western	4.0	0.77/0.35	180	700
1951 - 1954	Central Yar	2.4	0.22/0.10	104	630
1956- 1990	South Eastern	3.6	0.33/0.15	67	22
1968- 1983	Sukhachivske Section 1	90.6	19.0/8.60	710	80
1983-till present	Sukhachivske Section 2	70.0	9.60/5.50	270	80
1960- 1991	Base C	34.0	0.3/0.10	440	1000
1954- 1968	Dniprovske	73.0	12.0/5.84	1400	230
1982	Blast Furnace 6	0.2	0.04/0.02	11	-
1965- 1990	Lanthanum Fraction	0.06	0.007/0.003	0.86	-