REPORT ON NUCLEAR AND RADIATION SAFETY IN UKRAINE FOR 2014

The Report on Nuclear and Radiation Safety in Ukraine in 2015 has been agreed by the editorial board composed of: **Serhii Bozhko**, Chairman of the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU), **Vladimir Berkovsky**, Executive Director of the Radiation Protection Institute, Academy of Technological Sciences of Ukraine, **Ganna Gorashchenkova**, Head of SNRIU Division for International Cooperation and European Integration, **Oleksandr Grygorash**, Deputy Director, SNRIU Directorate on Nuclear Installations Safety, **Anvar Derkach**, Press Secretary of SNRIU Chairman, **Taras Kozulko**, Head of SNRIU Division on Chairman Office, Public Relations and Information Policy, **Olga Kosharna**, member of SNRIU Public Council, **Viktor Kushka**, Head of SNRIU Department on Nuclear Security, **Olga Makarovska**, Advisor to SNRIU Chairman, **Natalia Rybalko**, Deputy Head of SNRIU Department on Radioactive Waste Management Safety, **Ruslana Tripailo**, Deputy Head of SNRIU Department on Radiation Safety, **Nadia Chorna**, Deputy Head of SNRIU Division on Safeguards, **Ihor Shevchenko**, Director of the State Scientific and Technical Center for Nuclear and Radiation Safety.

Dear Readers!

We propose to your attention the Report on Nuclear and Radiation Safety in Ukraine for 2014.

In the past, Ukraine experienced unprecedented times in its history. The events that currently occur in Ukraine have posed new challenges to regional and global safety and security and have questioned the existing norms of international law. Threats to the political independence and territorial integrity of Ukraine have become obvious to the international community, expressing its support as reflected in the UN General Assembly Resolution adopted on 27 March 2014.

The annexation of the Autonomous Republic of Crimea and military actions in eastern Ukraine have led to loss of the SNRIU's regulatory control on certain territories of Ukraine, which was perceived with understanding by the IAEA and other international partners.

The counterterrorist operation in 2014 prompted the public authorities to strengthen the physical protection of fuel & energy enterprises of Ukraine, particularly national nuclear power plants, in order to prevent acts of nuclear terrorism.

The external aggression increased the relevance and need for diversification of nuclear fuel supplies for Ukrainian NPPs and spent fuel management.

Chornobyl NPP decommissioning and Shelter transformation into an environmentally safe system traditionally remain an important area of focus for the SNRIU. A series of international projects are underway on the Chornobyl site, with the common objective to construct the new safe confinement, solve issues related to spent fuel management, and ensure treatment, safe storage and disposal of radioactive waste.

The expansion and strengthening of international relations have become especially significant for Ukraine, including the area of nuclear and radiation safety. In 2014, the SNRIU applied to the Western European Nuclear Regulators Association (WENRA) to give Ukraine full membership instead of an observer status in this organization.

More detailed information on these and other areas of the SNRIU's activities in 2014 can be found in the Report.

Sincerely Yours,

Chairman
State Nuclear Regulatory
Inspectorate of Ukraine **Serhii Bozhko**

<u>**Table of Contents**</u>

1. YEAR 2014 IN DETAILS

January	
29	Review of the working design "Reconstruction of the Main Building of ChNPP Stage II (Units 3, 4) with Strengthening and Sealing of Civil Structures Enclosing the NSC" was completed, compliance with nuclear and radiation safety requirements was verified
31	Transfer to enhanced physical protection of nuclear installations
February	
19.02.14 – 06.03.14	Prohibition of nuclear material transport
March	
23.03.14 - 04.04.14	Ukrainian delegation successfully presented the Report on Compliance with Obligations under the Nuclear Safety Convention at the Sixth Review Meeting of Contracting Parties (Vienna, Austria)
31.03.14 – 02.04.14	NSC eastern part was successfully moved to the holding area. The structure with a total weight of about 12.6 thousand tons was moved during 72 h by 112 m towards the Shelter
April	
9	Serhii Bozhko appointed Chairman of the State Nuclear Regulatory Inspectorate of Ukraine
18	SNRIU Order No. 48 approved the Action Plan on harmonization of NPP safety requirements with WENRA reference levels for reactor safety in the framework of general harmonization of national safety requirements with EU legislation
26	First batch of four packages of conditioned radwaste from the Chornobyl NPP liquid radwaste treatment plant was disposed of in ENSDF
May	
12	First lifting of the NSC western part with a weight above 8300 t
12-13	Ukraine participated in the Second Extraordinary Review Meeting of Contracting Parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Vienna, Austria)
19-23	Workshop on experience exchange in implementation of safeguards with support of the U. S. Department of Energy (Lviv, Ukraine)
June	
2-3	Second lifting of the NSC western part with a total weight above 10,500 t
16	License was issued to the Sevastopol National University of Nuclear Energy and Industry for nuclear installation operation was terminated for violation of Ukrainian regulations
16-18	Ukrainian delegation participated in the annual WWER Regulators Forum (Helsinki, Finland)
26	Annual meeting of the Ukraine–IAEA Safeguards Implementation Review Group (SIRG) was held in Ukraine
July	
1	First Swedish-Norwegian-Ukrainian consultations on the trilateral initiative

	aimed at improving nuclear and radiation safety in Ukraine and declared at the Nuclear Security Summit held in The Hague in March 2014
4	Interdepartmental working group was established to develop the Action Plan on implementation of Council Directive 2013/59/Euratom of 5 December 2.05.2013, laying down basic safety standards for protection against the dangers arising from exposure
18	Ukrainian delegation took part in the meeting of the Assembly of Donors of the European Bank for Reconstruction and Development (London, UK)
21-25	Visit of the SNRIU delegation to the U. S. Nuclear Regulatory Commission, Department of Energy, Department of State
August	
12-13	Participation in the meeting on planning IAEA national technical assistance projects for Ukraine (Vienna, Austria)
13	Cabinet Resolution No. 336 identified national competent bodies for emergency preparedness and response
20	Cabinet Resolution No. 363 approved the Statute of the State Nuclear Regulatory Inspectorate of Ukraine
20	Regulatory document on safety conditions and requirements (licensing terms) for treatment, storage and disposal of radioactive waste was revised
22	With support of the German Government, 250 spent high-level radiation sources were transferred for storage to a specialized enterprise in the Odessa region
September	
4	SNRIU issued an individual permit for strengthening and sealing of existing ChNPP civil structures that serve as NSC enclosure
11	SNRIU Board agreed the Fifth 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
8-12	Training workshop on the physical protection of radioactive waste for SNRIU inspectors with support of the Swedish Radiation Safety Authority SSM (Kyiv, Ukraine)
22-26	Participation of Ukrainian delegation in the 58th Session of the IAEA General Conference (Vienna, Austria)
October	
2	Procedure for training and examination on radiation safety for personnel and officials dealing with activities in the area of nuclear energy was approved
10	Fifth 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 was officially transferred to the IAEA
16-17	First bilateral meeting with the Norwegian Radiation Protection Authority to discuss prospects of cooperation (Oslo, Norway)
23-24	Serhii Bozhko applied with official request for Ukraine to become a full member to WENRA within the plenary meeting
November	
	Third (last) lifting of the western part of the arc with a total weight above 12,560 t to a height of 109 m. Eastern part of the arc moved by 25 m toward the western part.

3-7	Training workshop on the physical protection of radiation sources for SNRIU inspectors with support of the Swedish Radiation Safety Authority SSM (Kyiv, Ukraine)
17	Trilateral Swedish-Norwegian-Ukrainian consultations on implementation of the first projects under the Initiative declared at the Hague Summit in March 2014 (Kyiv, Ukraine)
18	Agreement between the State Nuclear Regulatory Inspectorate of Ukraine and Norwegian Radiation Protection Authority on cooperation in the area of nuclear and radiation safety and statement on cooperation in the field of nuclear safety and security were signed between Ukraine, Norway and Sweden during the official visit of Prime Minister of Norway, E.Solberh, to Ukraine
December	
8	Bilateral consultations with experts of the U.S. Nuclear Regulatory Commission to discuss current status of joint projects and prospective areas of cooperation (Kyiv, Ukraine)
8-12	Training workshop on safety analysis and licensing of spent fuel dry storage facilities with support of the U.S. Nuclear Regulatory Commission (Kyiv, Ukraine)
12	Ukrainian delegation took part in the meeting of the Assembly of Donors of the European Bank for Reconstruction and Development (London, UK)
25	List of radiation sources exempt from licensing was revised and optimized to reduce regulatory pressure on source users
29	SNRIU made a positive decision on further operation of the VVR-M nuclear research reactor of the Nuclear Research Institute until 31 December 2023

2. INTRODUCTION

State regulation of nuclear safety is aimed at ensuring the safety of people, the environment, nuclear facilities and radiation sources as well as physical protection of nuclear installations.

The highest priority for the SNRIU as a central executive body is to protect people and the environment against harmful effects of radiation in the implementation of any activities related to exposure to radiation additional to natural background, including activities at all life stages of a nuclear installation or radioactive waste storage facility, radioactive waste management, radioactive material transport, fabrication and use of radiation sources as well as security and reliable protection of nuclear installations, nuclear material and other radiation sources against unauthorized access and impact.

In order to improve state regulation of nuclear and radiation safety in connection with Ukraine's commitments under the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, the State Nuclear Regulatory Committee of Ukraine was established on 5 December 2000 as a central executive body with special status. Under the optimization of central authorities in 2010, the State Nuclear Regulatory Committee of Ukraine was renamed the State Nuclear Regulatory Inspectorate of Ukraine.

Basis functions of the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU) relating to safety regulation of nuclear energy are to:

- identify safety criteria, requirements and conditions for the use of nuclear energy (*rule-making*);
- issue authorizations and licenses for activities in this area after review of the applicant’s (licensee’s) submittals to confirm compliance with safety requirements (*licensing*);
- conduct state supervision over compliance with legislation, regulations and standards on nuclear and radiation safety and apply sanctions established by law in case of violation (*supervision*).

For proper implementation of these functions, there are the following priority areas in regulation of nuclear and radiation safety in Ukraine:

➢ fulfill the Action Plan on implementation of the Association Agreement between Ukraine, on the one hand, and the European Union, European Atomic Energy Community and their Member States and plans for harmonization of national safety rules and regulations with the WENRA reference levels, including implementation of some legislative acts of the EU:

- Council Directive 2013/59/Euratom of 5 December 2013, laying down basic safety standards for protection against the dangers arising from exposure and cancelling Council Directives 89/618/Euratom, 90/641/Euratom 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom;
- Council Directive 2006/117/Euratom of 20 November 2006, on the supervision and control over shipments of radioactive waste and spent nuclear fuel;
- Council Directive 2014/87/Euratom of 8 July 2014, establishing a Community framework for nuclear safety of nuclear installations.

➢ fulfill the action plan on optimization of state safety regulation of nuclear energy;

➢ ensure regulatory support to:

- Comprehensive (Integrated) Safety Improvement Program for NPPs and safety review of operating power units and nuclear installations, including NPP long-term operation;
- designs of new nuclear installations (CSFSF, ChNPP ISF-2, Neutron Source, KhNPP units 3 and 4);
- projects for diversification of nuclear fuel supplies to Ukraine to ensure energy safety of the State;

➢ promote effectiveness of the state physical and civil protection system in high alert conditions;

- ensure state safety regulation in developing the infrastructure for long-term storage and disposal of radioactive waste, Shelter safety and decommissioning of Chornobyl NPP units 1, 2 and 3;
- implement Ukraine's international obligations related to nuclear weapon non-proliferation, safety and security.

The main challenges to nuclear regulation in Ukraine in 2014 were caused by the external threat: annexation of the Autonomous Republic of Crimea and military operations in Eastern Ukraine. The international community recognized violation of the Budapest Memorandum with respect to Ukraine. This was noted by the UN Secretary General Ban Ki-Moon in his speech at the Nuclear Security Summit held in The Hague on 24 March 2014. He noted that security safeguards were an important condition for Ukraine's joining the Non-Proliferation Treaty (NPT), but their reliability was seriously undermined by the events around Ukraine. The UN Secretary General expressed an opinion that this would have negative consequences for both regional safety and the non-proliferation regime.

Because of external aggression, Ukraine lost regulatory control in the Autonomous Republic of Crimea and some areas in the Donetsk and Luhansk regions. Communication with the Crimean State Inspectorate for Nuclear and Radiation Safety was actually lost in May-June, it was officially transferred to subordination of Russian Federation Rostekhnadzor in September. The Southeast State Inspectorate for Nuclear and Radiation Safety which was located in Donetsk continued its work and was transferred to the city of Zaporizhzhya in December 2014.

In the Autonomous Republic of Crimea, there are nuclear installations such as the IR-100 research reactor of the Sevastopol National University of Nuclear Energy and Industry (SUNEI) and two subcritical assemblies for low enriched and natural uranium. In addition, the Crimea has several enterprises and medical establishments using devices and containers with radiation shielding with depleted uranium and high-level radiation sources in five institutions, mainly oncological centers.

Fortunately, so-called Donetsk People's Republic and Luhansk People's Republic have no nuclear installations but only nuclear material in small amounts as radiation shields in containers for transport and storage of radiation sources and radiotherapy devices in cancer centers and highly radioactive sources.

3. OPTIMIZATION OF REGULATORY ACTIVITY

According to Article 5 of the Law of Ukraine ‘On Nuclear Energy Use and Radiation Safety”, state policy in the area of nuclear energy and radiation protection is exercised, in particular, through optimum national regulation of nuclear and radiation safety, applying a graded approach to safety requirements depending on potential nuclear and radiation hazards peculiar to specific activities at nuclear installations (sources). This is also the case with physical protection.

The graded approach is reflected in the laws of Ukraine, specifically, the Law of Ukraine ‘On Authorizing Activity in Nuclear Energy’ indicates that one of the main authorizing principles is that the graded approach should be applied to different activities and radiation sources, taking into account potential nuclear and radiation hazards (an example is release of radiation sources with minimum potential level of danger from licensing) and the Law of Ukraine ‘On Physical Protection of Nuclear Installations, Nuclear Material, Radioactive Waste and Other Radiation Sources’ states that physical protection of facilities must correspond to potential radiological consequences of illegal actions against them).

These requirements of Ukrainian laws comply with IAEA recommendations. In particular, IAEA General Safety Requirements Part 1, Governmental, Legal and Regulatory Framework for Safety, envisages that national safety policy and strategy are based on a graded approach, taking into account radiological risks, to be considered to establish regulatory requirements, issue permits, conduct inspections and assess facilities and activities. In addition, such requirements in Ukrainian laws comply with EU regulations, such as Council Directive 2013/59/Euratom of 5 December 2013, laying down basic safety standards for protection against the dangers arising from exposure and cancelling Council Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.

The SNRIU applies the optimization principle in state safety regulation. The optimization of state safety regulation in the area of nuclear energy is not regarded as just deregulation, i.e. cancellation or reduction of regulation, but as an attempt to find the optimum level of state regulation considering the graded approach to regulation of various activities with specific facilities (sources) in accordance with their nuclear and radiation hazard. Implementation of the results will in general favorably influence state regulation since SNRIU resources released in state deregulation will focus on enhanced regulation of activities characterized by a high level of nuclear and radiation hazard and, hence, state regulation for the safety of nuclear energy will be optimized.

In order to optimize state regulation for the safety of nuclear energy, draft laws were prepared to amend the law of Ukraine and, in particular, to:

avoid the need to obtain authorization of the state nuclear regulatory authority for the use of land and water bodies located in the controlled area for general use since this regulation is excessive, taking into account that the Law envisages the potential use of lands and water bodies upon agreement with the operating organization with mandatory radiological monitoring of the products;

release radioactive material transport by rail, water and air; reloading (loading, unloading, dispatch) of packages and their transit storage in sea and river ports, airports and railway stations from licensing when the carriers and organizations dealing with the above operations have licenses for shipment of hazardous cargoes, in order to eliminate duplication in licensing;

remove receipt (purchase) and transfer (sale) of radiation sources, including that for supply purposes, from the list of activities related to the use of such sources that are subjected to licensing.

Implementation of these proposals will not decrease the level of nuclear and radiation safety during these activities since they are related only to authorization that does not exclude the application of other state controls to these activities, such as establishment of regulatory criteria and requirements that determine conditions in the area of nuclear energy (rule-making) and state supervision over compliance with legislation, rules and regulations on nuclear and radiation safety and physical protection requirements, including enforcement measures (state supervision). Along with amendment of laws, awareness of the nuclear entities regarding their direct responsibility for nuclear and radiation safety will be increased.

There are also important proposals for laws related to state supervision over nuclear and radiation safety under SNRIU implementation. These proposals include amendments intended to extend some state supervision measures not only to licensees but also to other nuclear entities whose activities are subject to state regulation and are not licensed or are licensed but they still have not become the licensees; and also amendments intended to conduct state supervision over compliance with nuclear and radiation safety requirements in compliance with legislation governing the safety of nuclear energy. Supervision over the use of radiation sources will be exercised in accordance with the Law of Ukraine "On Basic Principles of State Supervision (Control) of Economic Activities". The last proposal is associated with a Law adopted by the Verkhovna Rada (Government) of Ukraine to extend the Law of Ukraine "On Basic Principles of State Supervision (Control) of Economic Activities" in full scope to state supervision over compliance with nuclear and radiation safety requirements, which contradicts international agreement of Ukraine and European Union and IAEA requirements.

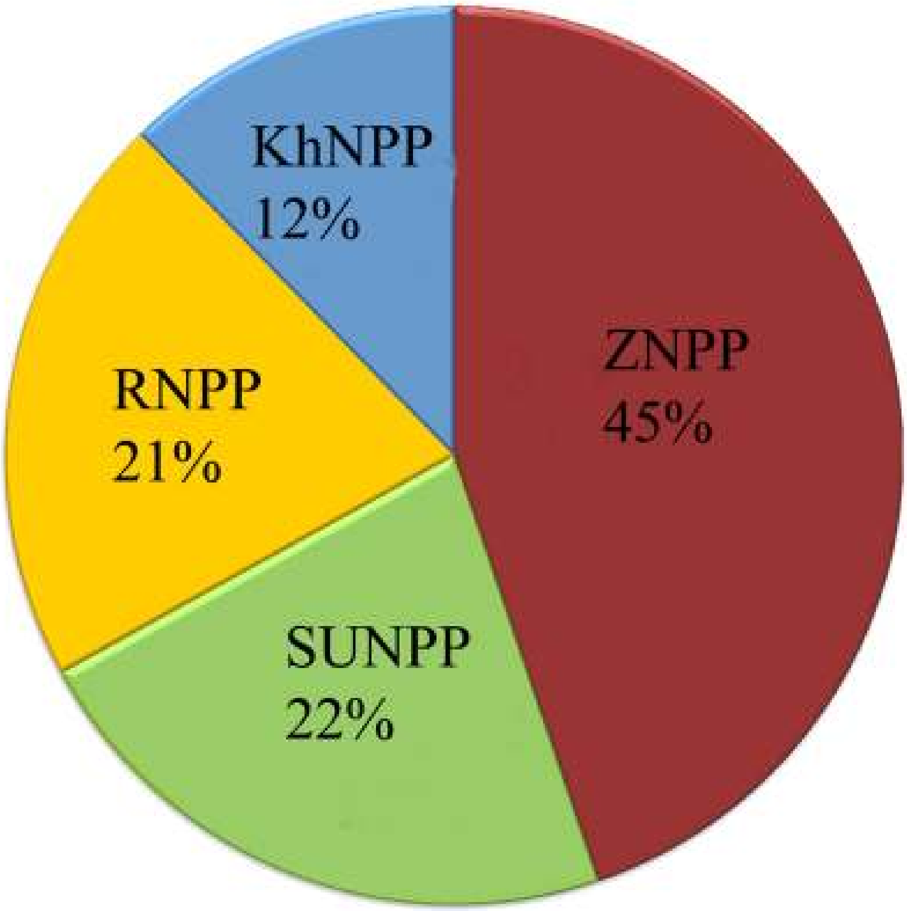
The above measures will allow the SNRIU to focus attention on the most hazardous activities, in view of nuclear and radiation safety, and will reduce the regulatory pressure on economic entities, in line with the state policy being implemented in Ukraine.

4. SAFETY OF NUCLEAR INSTALLATIONS

4.1. NPP Safety Improvement

Ukraine operates 15 power units, ranks the tenth in the world for this indicator and takes the seventh place in the installed capacity. The only operator of all operating nuclear power plants in Ukraine is the National Nuclear Energy Generating Company *Energoatom* The *Energoatom* Company includes four nuclear power plants.

The total installed capacity of operating Ukrainian power units in 2014 is 13,835 MW.



Share of each NPP in nuclear energy production in 2014

Ukraine ensures stable and safe operation of NPPs under the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and the Convention on Nuclear Safety. Safety improvement measures are under implementation at operating nuclear power plants of Ukraine on a systematic basis in compliance with national regulations and standards on nuclear and radiation safety and recommendations of the International Atomic Energy Agency (IAEA), taking into account best international practices.

Peer reviews of WANO[1] and IAEA confirmed operational safety of Ukrainian NPPs and validity of safety upgrades implemented under safety improvement and long-term operation programs.

The safety improvement measures at Ukrainian NPPs are under implementation in compliance with the "Comprehensive (Integrated) Safety Improvement Program for Operating Nuclear Power Units" (C(I)SIP), approved by a Cabinet Resolution in 2011. The C(I)SIP objective is to:

- further improve operational safety of NPP units;
- decrease risks of NPP accidents during natural disasters or other hazards;
- improve the effectiveness in management of design-basis and beyond design-basis accidents at NPPs, minimize their consequences.

The C(I)SIP is based on safety improvement measures of the previous program "Concept for Safety Improvement of Operating Nuclear Power Units" (approved by a Cabinet Resolution in 2005) that were not implemented by the operating organization till the end of the Concept and safety upgrades for Khmelnitsky-2 and Rivne-4 that were implemented during commissioning of these units.

The C(I)SIP also takes into account results and recommendations of the IAEA design safety review mission conducted at all NPPs under the Memorandum of Understanding in the Field of Nuclear Energy between Ukraine and EC.

Комплексна (зведена) програма підвищення безпеки енергоблоків АЕС України

[1] WANO is the World Association of Nuclear Operators

Comprehensive (Integrated) Safety Improvement Program for Ukrainian NPPs

Cabinet Safety Improvement Concept (2006-2010)
Comprehensive Safety Improvement Program-2008
IAEA-EU-Ukraine Project
Safety Analysis Reports
Safety-Important Equipment with Expired Life
Equipment Qualification Program
Stress Tests

After the Fukushima accident, the C(I)SIP included additional measures upon extraordinary in-depth safety reassessment for Ukrainian NPPs (stress tests) and additional fire safety measures. Safety improvement measures are among conditions for long-term operation of NPPs. The design-basis lifetime of nine Ukrainian NPP units expires in a period from 2014 to 2020 (see Table 4.1).

Table 4.1. Service Life of NPP Units in Ukraine

NPP	Unit No.	Reactor Type	Expiration of design-basis/long-term operation period
ZNPP	1	WWER-1000/320	23.12.2015
	2	WWER-1000/320	19.02.2016
	3	WWER-1000/320	05.03.2017
	4	WWER-1000/320	04.04.2018
	5	WWER-1000/320	27.05.2020
	6	WWER-1000/320	21.10.2026
SUNPP	1	WWER-1000/302	02.12.2013 / 02.12.2023
	2	WWER-1000/338	12.05.2015
	3	WWER-1000/320	10.02.2020
RNPP	1	WWER-440/213	22.12.2010 / 22.12.2030
	2	WWER-440/213	22.12.2011 / 22.12.2031
	3	WWER-1000/320	11.12.2017
	4	WWER-1000/320	07.06.2035
KhNPP	1	WWER-1000/320	13.12.2018
	2	WWER-1000/320	07.09.2035

In 2014, within C(I)SIP regulatory support, the SNRIU agreed 33 reports on implementation of measures out of the 85 ones planned to be completed in 2014 and 10 reports on measured planned for 2015÷2017. In addition, 15 reports were returned for revision upon review.

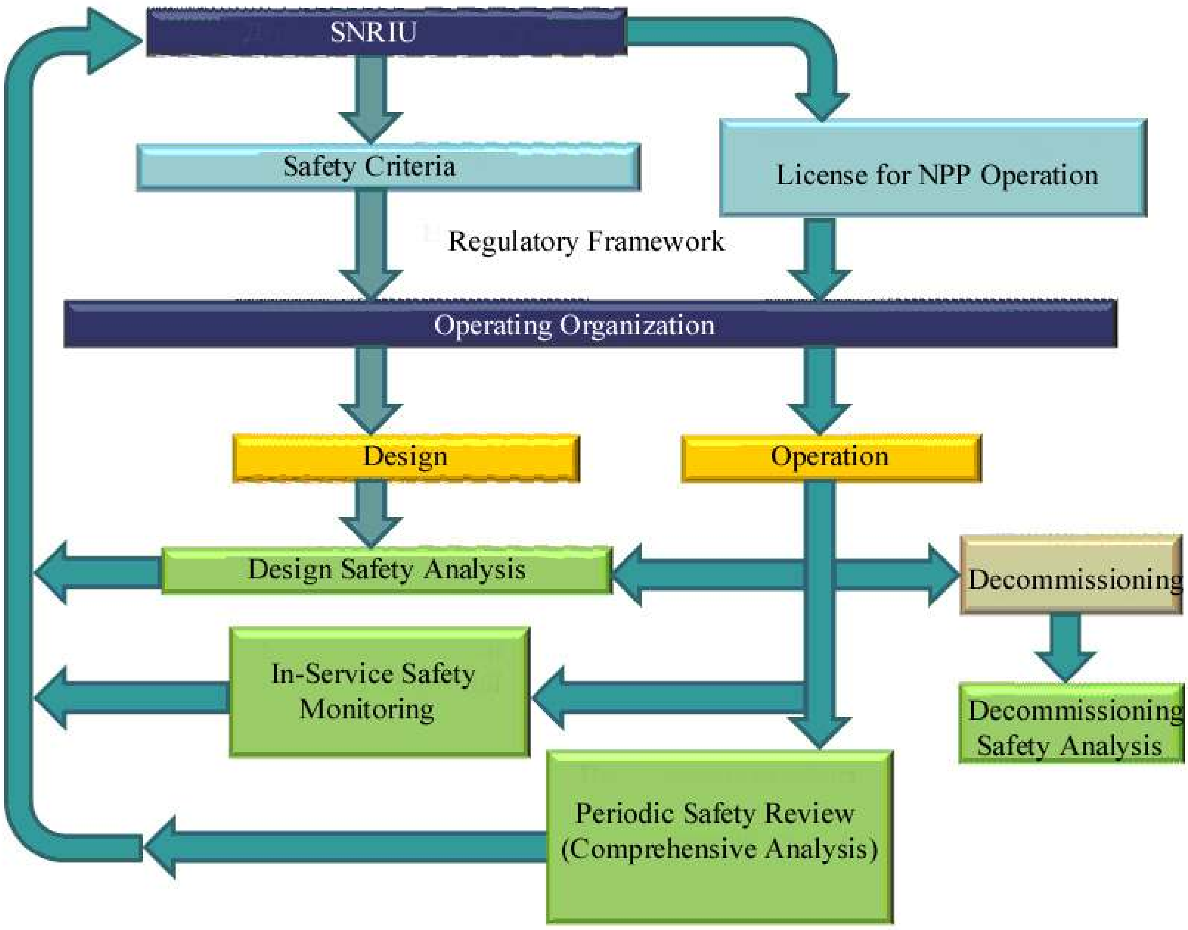
According to C(I)SIP scheduled, the main efforts of the operating organization in 2014 were focused on the development and implementation of measures for SUNPP unit 2 and ZNPP units 1 and 2 within long-term operation activities. The experience in measures taken at the so-called pilot units is further extended to other power units.

Equipment qualification, technical state assessment and emergency response improvement measures are underway at all operating units. The reports are gradually submitted to the SNRIU for regulatory review. It should be noted that instrumented seismic analyses are in their final stage for ZNPP. The results of these seismic analyses and safety margins will be used to establish the seismic level of ZNPP site (similar efforts were completed for SUNPP, introduction of seismic monitoring system is underway for KhNPP and RNPP).

Modifications important to safety of nuclear installations (change in nuclear installation configuration, bringing a nuclear installation into compliance with current regulations and standards, changes in operational documents, modification of the operating organization’s structure) are implemented upon agreement with the SNRIU.

The State Nuclear Regulatory Inspectorate of Ukraine constantly monitors all stages of modifications (concept development, installation and pre-commissioning, introduction into trial and/or commercial operation) through safety assessment of submittals and agreement of appropriate technical decisions, as well as through direct supervision over modifications, introduction of changes to operational documentation and staff training. The results are discussed at open meetings of the SNRIU Board involving all stakeholders, including the public and mass media.

Hence, the Board meeting on 6 February 2014 analyzed the status of NPP safety upgrades completed in 2013 in compliance with the detailed schedule for implementation of C(I)SIP measures developed by the operating organization and agreed by the SNRIU.



Safety Assessment System for NPP Units

During the year, the SNRIU conducted comprehensive inspections of each NPP site, also involving international experts. One of the main tasks is to check implementation of safety improvement measures.

At the beginning of 2013, the SNRIU jointly with the Ministry for Energy and Coal Industry, Ministry of Defense, Ministry for Environment and Natural Resources and State Agency for Exclusion Zone Management developed the National Action Plan upon Stress-Test Results aimed at improving the safety of Ukrainian NPPs.

This document was developed in compliance with the National Action Plan (NAcP) Guidance as directed within the ENSREG Stress test Action Plan.

The National Action Plan upon Stress-Test Results incorporates:

- ENSREG recommendations and proposals set forth in the "Compilation of recommendations and suggestions. Peer review of stress tests performed on European nuclear power plants" in areas such as external extreme hazards, loss of safety functions and management of severe accidents;
- basic issues of the Extraordinary Meeting of the contracting parties to the Convention on Nuclear Safety (August 2012, Vienna, Austria) in areas such as national organizations, emergency preparedness and response and international cooperation.

The draft National Action Plan was presented at the open meeting of the SNRIU Board with involvement of interested ministries/departments/organizations and the public. The National Plan revised to incorporate stakeholder's proposals was submitted by the SNRIU to ENSREG for further joint discussion by all stress-test countries.

The National Plan of Ukraine was positively evaluated by the 'stress-test' countries, recognized as transparent and complying with the structure proposed by ENSREG, and covering all the aspects mentioned in the ENSREG action plan. The National Plan was discussed and approved at an ENSREG public meeting with stakeholders, including non-governmental organizations and mass media.

EU states and neighboring countries that took part in the stress tests (Ukraine and Switzerland) reached agreements for further periodic exchange of information on the implementation of the National Action Plans and transparency and openness of the process.

It is planned to review and discuss the current status of national action plans upon stress tests of the participating countries during the ENSREG workshop in April 2015. In preparation for the ENSREG workshop, the National Action Plan upon Stress-Test Results (2013) was updated to take into account recommendations set forth in the "ENSREG Post-Fukushima National Action Plans Workshop 20÷24 April 2015. Terms of Reference". It should be noted that the number of measured planned for operating NPPs and Chornobyl NPP and the scope of measured remained unchanged in the updated National Action Plan. The updated National Action Plan specified the status of safety upgrades and their schedule.

It should be pointed out that a series of safety upgrades for operating NPPs that require substantial funding were extended in connection with the events that occurred in Ukraine during the last year and with the decision made by the operating organization to shut down power units after expiration of their design-basis life in order to ensure implementation of all safety upgrades at these power units to justify their long-term operation.

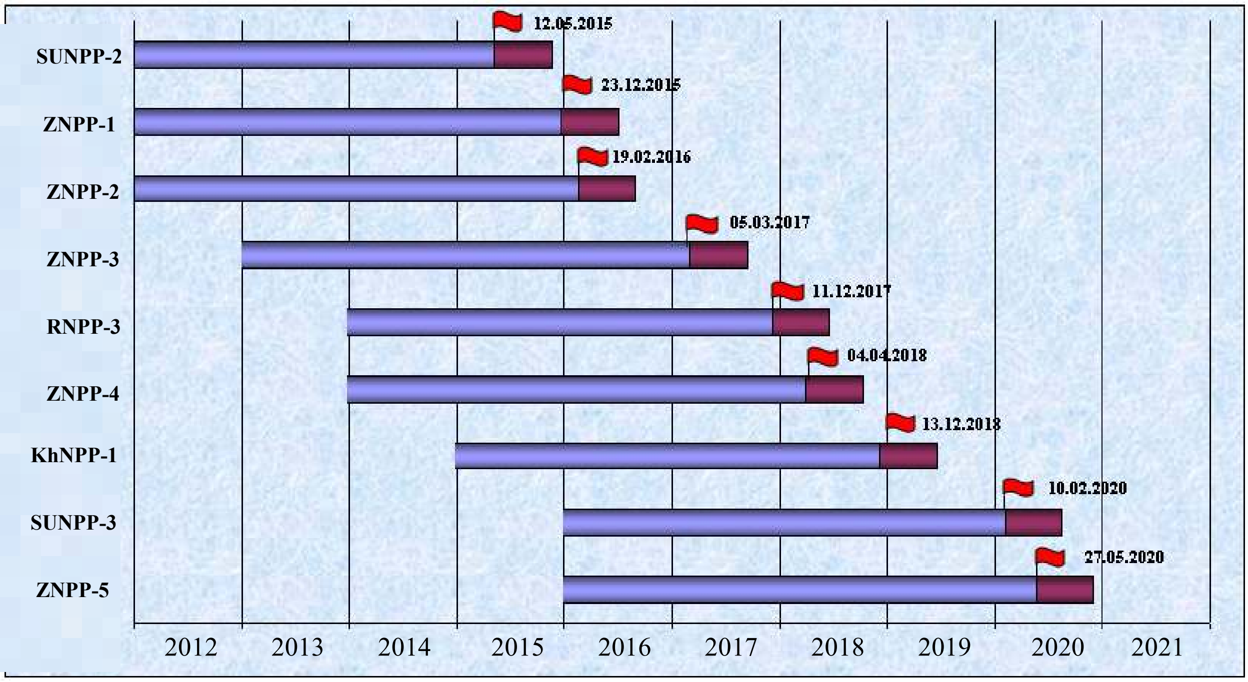
The updated National Action Plan upon Stress-Test Results can be found on the SNRIU official website.

4.2. Safety Review and Long-Term Operation of Nuclear Installations

4.2.1. Safety Review and Long-Term Operation of NPP Units

Most Ukrainian NPPs were commissioned in the 1980s and their 30-year design-basis life is to expire in the near future. The Government of Ukraine decided to continue operation of NPP units as reflected in the "Energy Strategy of Ukraine until 2030" and "Comprehensive Work Program for Long-Term Operation of Nuclear Power Plant Units". The *Energoatom* Company together with the WWER General Designer *Hydropress* revised the schedule for beginning of commercial operation and established the dates for completion of the design-basis life (see Table 4.1).

In a period from 2015 to 2020, the design-basis life of nine NPP units in Ukraine (see the schedule) expires. It will be required to take a decision in 2015, 2017, 2018 and 2020 on life extension of two power units at the same time.



- completion of design-basis life

- last scheduled outage for implementation of long-term operation measures

- period of preparation for long-term operation

In accordance with current legislation, a decision on long-term operation of a power unit is made by the SNRIU based upon conclusions of the state nuclear and regulatory safety review of the periodic safety review repot (PSRR) by amending the license for its operation. Long-term operation may be allowed only if the safety level of the NPP unit is not lower than that established by current regulations and rules on nuclear and radiation safety.

The PSRR is based upon a substantial scope of efforts, in particular, related to:

- assessment of current technical state of components and structures and their lifetime extension;
- elimination of deviations from NRS regulations, rules and standards adopted during the last years;
- implementation of safety upgrades planned under C(I)SIP;
- implementation of measures upon results of NPP operational events and stress tests;
- equipment qualification for harsh environments and seismic events and seismic evaluation of NPP piping, buildings and structures;
- implementation of the ageing management program for NPP components and structures;
- in-depth safety analysis applying deterministic and probabilistic methods;
- enhancement of operational safety through improvement of operational and emergency documentation;
- improvement of the management system to be in compliance with NRS regulations and rules, IAEA recommendations and best international practice;
- improvement of emergency preparedness system.

In accordance with NRS regulations, rules and standards, the PSRR is finalized as individual reports based upon assessment of 14 safety factors:

- plant design;
- current condition of systems and components;
- equipment qualification;
- ageing;
- deterministic safety analysis;
- probabilistic safety assessment;
- internal and external hazard analysis;
- safety performance;
- use of experience from other plants and research findings;
- organization and administration;
- operating procedures;
- human factor;
- emergency preparedness and response;
- environmental impact.

This approach complies with IAEA recommendations and best international practice and allows a comprehensive assessment of the power unit safety to make a sound decision on further operation of the power unit, including long-term operation.

For SUNPP unit 2 and ZNPP units 1 and 2, whose design-basis life expires in 2015÷2016, the operating organization chose the option for preparing for long-term operation in which a power unit is to be shut down after its design-basis life expires and organizational and technical measures are to be taken to continue and recommence operation. The SNRIU agreed long-term operation programs and licensing plans for the above power units. Safety upgrades, equipment qualification and technical condition assessments are underway at these power units. The respective reports are gradually submitted to the SNRIU for state nuclear and radiation safety review.

As of the end of 2014, the SNRIU conducted state nuclear and radiation safety review:

- reports on assessment of all 14 factors in the SUNPP-2 PSRR, among them the reports on eight safety factors were agreed by the SNRIU after the operating organization resolved comments of state NRS review;
- reports on assessment of 12 factors in the ZNPP-1 PSRR, among them the reports on eight safety factors were agreed by the SNRIU after the operating organization resolved comments of state NRS review;
- reports on assessment of 9 factors in the ZNPP-2 PSRR, among them the reports on eight safety factors were agreed by the SNRIU after the operating organization resolved comments of state NRS review.

The safety review of Ukrainian NPPs and preparation for long-term operation undertaken by the operating organization are under strict supervision of the SNRIU.

4.2.2. Safety Review and Long-Term Operation of Nuclear Research Reactor VVR-M of Nuclear Research Institute, National Academy of Sciences of Ukraine

The Nuclear Research Institute (NRI) of the National Academy of Sciences of Ukraine (NASU) operates a nuclear installation including the VVR-M nuclear research reactor and spent fuel storage facility in compliance with License EO No. 000051 for operation for a period until the operational stage expires.

Based on review of the PSRR for VVR-M reactor, current technical condition of systems and components important to safety and inspection findings, the lifetime of the VVR-M nuclear research reactor was limited to 31 December 2013 and conditions for its further operation after 2013 were identified in accordance with decision of the SNRIU Board No. 11 of 21 May 2009.

The possibility and conditions for further VVR-M operation were addressed at the SNRIU Board meeting on 26 December 2013. The Board stated that the justification material submitted by the operating documentation was not sufficient to make a decision on further operation of the research reactor and was to be revised. At the same time, state nuclear and radiation safety review showed that there were no reasons to make a decision on impossibility of further operation of the VVR-M nuclear research reactor.

In this regard, SNRIU Board Resolution No. 25 of 26 December 2013 stated that further operation of the VVR-M reactor would be reconsidered only if the operating organization tool the following measures:

- revise the “Decision on Possibility and Conditions of Further Safe Operation of the VVR-M Nuclear Research Reactor of the NRI NASU No. RE.5-023-13”;
- complete revision of Section 8 “Analysis of Design-Basis and Beyond Design-Basis Accidents at VVR-M Nuclear Research Reactor” of PSRR for NRI VVR-M;
- revise the report on stress tests at VVR-M research reactor of NRI NASU;
- provide new strength analyses for the reactor tank elements and primary piping;
- complete elimination of the defect in primary piping.

During 2014, the SNRIU conducted state nuclear and radiation safety review and agreed all justifications and decisions of the operating organization required by SNRIU Board Resolution No. 25 of 26 December 2013.

In a period from 15 to 16 December 2014, the SNRIU commission conducted comprehensive inspection to verify NRI preparedness for VVR-M operation and found the following:

- NRI submittals for amendment of License EO No. 000051 of 22 May 2002 were complete and reliable and reflected the actual state of affairs;
- NRI was fully capable of VVR-M operation until 31 December 2023.

The final decision to continue VVR-M operation until 31 December 2023 was made at the SNRIU Board meeting on 29 December 2014.

4.3. Implementation of New Nuclear Installation Designs

Ukraine currently implements several designs of new nuclear installations in compliance with nuclear and radiation safety requirements:

- Khmelnitsky NPP units 3 and 4 (see para. 4.3.1.);
- Nuclear Fuel Fabrication Plant (see para. 4.3.2.);
- Neutron Source Based on a Subcritical Assembly Driven by a Linear Electron Accelerator (see para. 4.3.3.);
- Centralized Spent Fuel Storage Facility (see para. 5.3.1.);
- Dry Interim Storage Facility for Spent Fuel at Chornobyl NPP (see para. 5.3.2.).

4.3.1. Construction of Khmelnitsky NPP Units 3 and 4

The construction of KhNPP units 3 and 4 was suspended after the feasibility study for construction of these units was developed and approved by Cabinet Resolution No. 498-r of 4 July 2012 and Verkhovna Rada of Ukraine adopted Law No. 5217-VI of 6 September 2012 “On Siting, Design and Construction of Units 3 and 4 of Khmelnitsky Nuclear Power Plant”.

Taking into account the political relations between Ukraine and the Russian Federation, Energoatom currently considers the construction of these units using the WWER-1000/320 design of **AT Skoda JS a.s.** (Czech Republic).

On 17 October 2014, to ensure compliance of Skoda JS a.s. WWER-1000 with national requirements and rules and to improve technical and economic indicators compared to operating NPPs of Ukraine, Energoatom developed the “Conceptual Decision on Construction of Khmelnitsky NPP Units 3 and 4 and agreed it with the SNRIU, Ministry for Energy and Coal Industry and Ministry for Regional Development, Construction and Housing & Utility Services. According to the Conceptual Decision, additional safety upgrades are to be incorporated in the design of these units:

- use of additional systems to ensure containment integrity (filtered venting system, hydrogen recombiners);
- use of fuel assemblies of alternative supply;
- improvement of electrical part through increase in reliability;
- use of up-to-date instrumentation & control;
- implementation of features envisaged by C(I)SIP and stress tests for Ukrainian NPPs in KhNPP-3 and KhNPP-4 designs;
- use of additional cooling systems for the reactor pressure vessel to prevent potential development of severe accidents involving radioactive releases outside the reactor compartment above regulatory values;
- capabilities for power uprate to 107%.

The *Energoatom* Company currently takes actions to revise the feasibility study and prepare a draft Law to amend Law of Ukraine No. 5217-VI “On Siting, Design and Construction of Units 3 and 4 of Khmelnitsky Nuclear Power Plant”.

4.3.2. Construction of Nuclear Fuel Fabrication Plant

Construction of the Nuclear Fuel Fabrication Plant hardly took place in 2014. There is the following information on construction of the Nuclear Fuel Fabrication Plant as of 31 December 2014.

Creation of a nuclear fuel fabrication plant in Ukraine is envisaged by the State Target Economic Program “Nuclear Fuel of Ukraine”, developed in compliance with the Energy Strategy of Ukraine until 2030 and approved by Cabinet Resolution No. 1004 of 23 September 2009.

Construction of the Nuclear Fuel Fabrication Plant was planned on the territory of the Smolino Village Council in Malovyskiv District of Kirovograd Region in accordance with Cabinet Resolution **No. 437-r of 27 June 2012** “Siting, Design and Construction of the WWER-1000 Nuclear Fuel Fabrication Plant”, which approved the feasibility study for this nuclear installation.

In compliance with legislation, construction of a nuclear fuel fabrication plant (and any other nuclear installation) can be started only under a license issued by the SNRIU for construction and commissioning. In turn, two main conditions for issuing this license is agreement of the preliminary safety analysis report (PSAR) by the SNRIU and approval of the design for this nuclear installation by the Cabinet of Ministers of Ukraine.

The first condition was fulfilled by the operating organization, Private Corporation “Nuclear Fuel Fabrication Plant” (PSAR of the Plant was approved in accordance with SNRIU Board Resolution No. 18 of 4 December 2013), and the second condition still remains to be met, in spite of the positive expert review report on the design documentation “Construction of Nuclear Fuel Fabrication Plant”, No. 00-1085-13/PB, submitted by *Ukrderzhbudekspertiza* on 12 December 2013.

4.3.3. Construction of Neutron Source Based on Subcritical Assembly Driven by Linear Electron Accelerator

The Neutron Source Based on a Subcritical Assembly Driven by a Linear Electron Accelerator (Neutron Source) is being constructed on premises of the National Scientific Center “Kharkiv Institute of Physics and Technology” (KIPT) in accordance with the agreement reached at the Washington Security Summit and outlined in the Joint Statement of the Presidents of Ukraine and USA in April 2010 and Memorandum of Understanding between the Government of Ukraine and the Government of the United States of America on nuclear safety cooperation signed on 26 September 2011. The Neutron Source is under construction with support of the U.S. Argonne National Laboratory.

The Neutron Source is intended for scientific study and applied research in the fields of nuclear physics, radiation material science, biology, chemistry and production of medical radioisotopes. The Neutron Source was described in detail in the “Report on Nuclear and Radiation Safety in Ukraine for 2012”.

This nuclear installation is created under SNRIU License EO No. 001018 for construction and commissioning issued on 10 October 2013.

According to the License, the KIPT operating organization took efforts to construct the Neutron Source during 2013÷2014 as well as to develop and agree working documentation (technical specifications for equipment important to safety) with the SNRIU.

As of 1 January 2015, the SNRIU preliminary agreed 36 documents out of the 78 reviewed.

The Neutron Source is expected to be commissioned in the third quarter of 2015.

4.4. NPP Operational Events

Accounting and analysis of NPP operational events are an integral part of the operating experience feedback system, which in turn is a contributor to NPP safe operation.

Ten operational events occurred at operating Ukrainian NPPs in 2014. They include:

- 4 events at ZNPP;
- 3 events at RNPP;
- 2 events at KhNPP;
- 1 event at SUNPP.

Figure 4.4.1 presents the distribution of operational events at Ukrainian NPPs from 2000 to 2014 and shows that the number of events in 2014 slightly decreased as compared to the previous year.

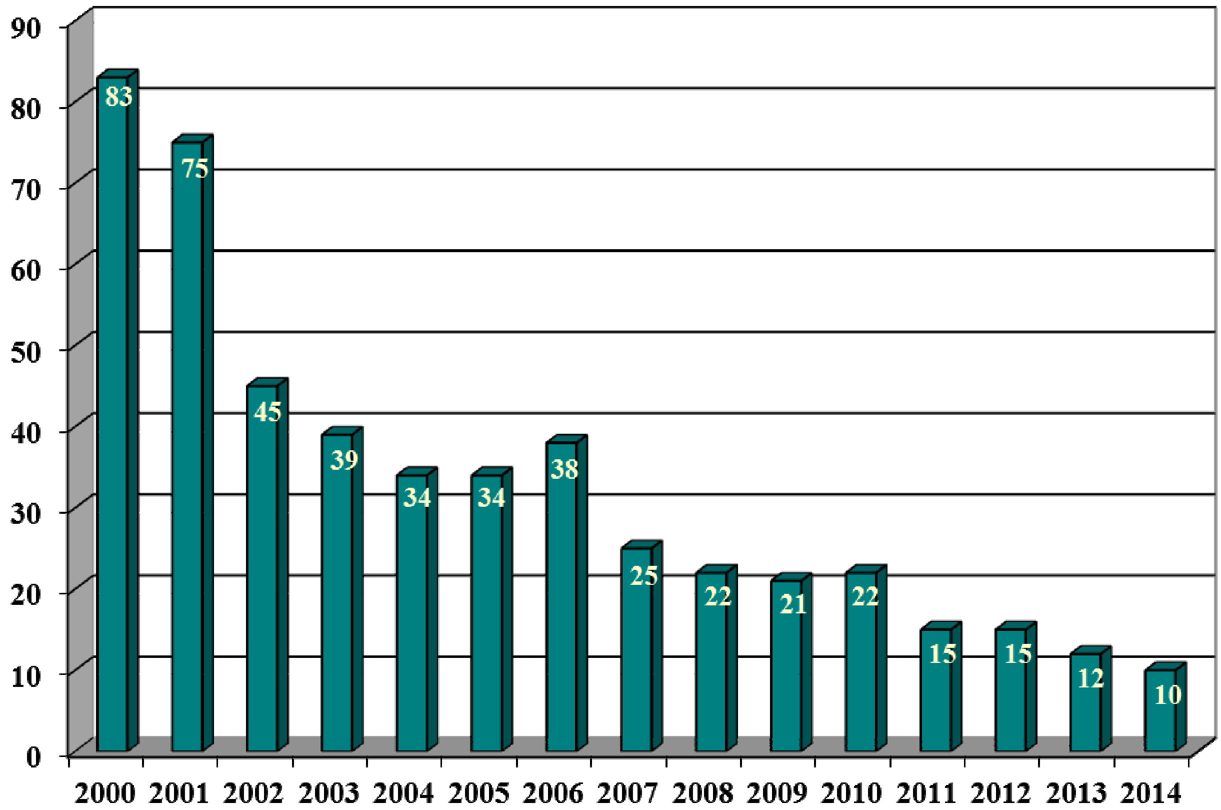


Figure 4.4.1. Number of operational events at Ukrainian NPPs in 2000÷2014

Figure 4.4.2 presents distribution of events by NPP sites in 2000÷2014.

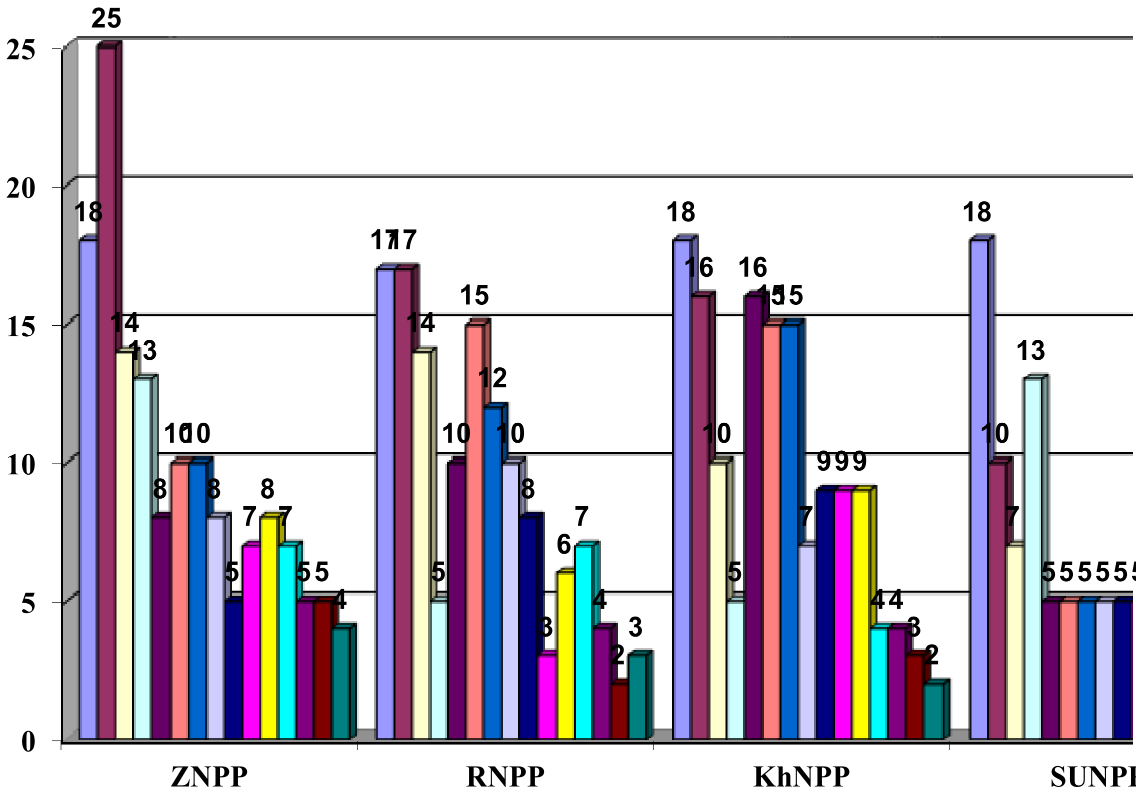


Figure 4.4.2. Distribution of events by NPP sites in 2000÷2014

The number of operational events decreased at ZNPP and SUNPP, has not changed for KhNPP and increased at ZNPP compared to the previous year.

All power units under commercial operation are divided into two groups according to reactor types: WWER-1000 (13 units) and WWER-440 (2 units).

According to INES (Annex 4), the worldwide instrument developed to inform the public on significance of nuclear and radiological events for safety, Ukraine had no events higher than “below scale/level 0” (insignificant for safety) in 2014.

Depending on features and consequences, NPP operational events in 2014 included the following:

- reactor shutdown with scram, preventive protection, power limiter – 20 % (2 events);
- power unit disconnection from the grid by emergency automatics, turbine and turbine generator protection – 20% (2 events);
- failure of group A and B equipment and piping important to safety and safety class 1 and 2 components – 20% (2 events);
- power decrease by 25% Nel and higher from the previous level – 30% (3 events);
- actuation of any safety system or safety system train in standby – 10% (1 event).

During an NPP operational event, there is deviation from normal operation (abnormal event) that can be caused by equipment failure, external impact, human error or procedural drawbacks. Figure 4.4.3 presents the distribution according to systems that failed or were affected during abnormal events.

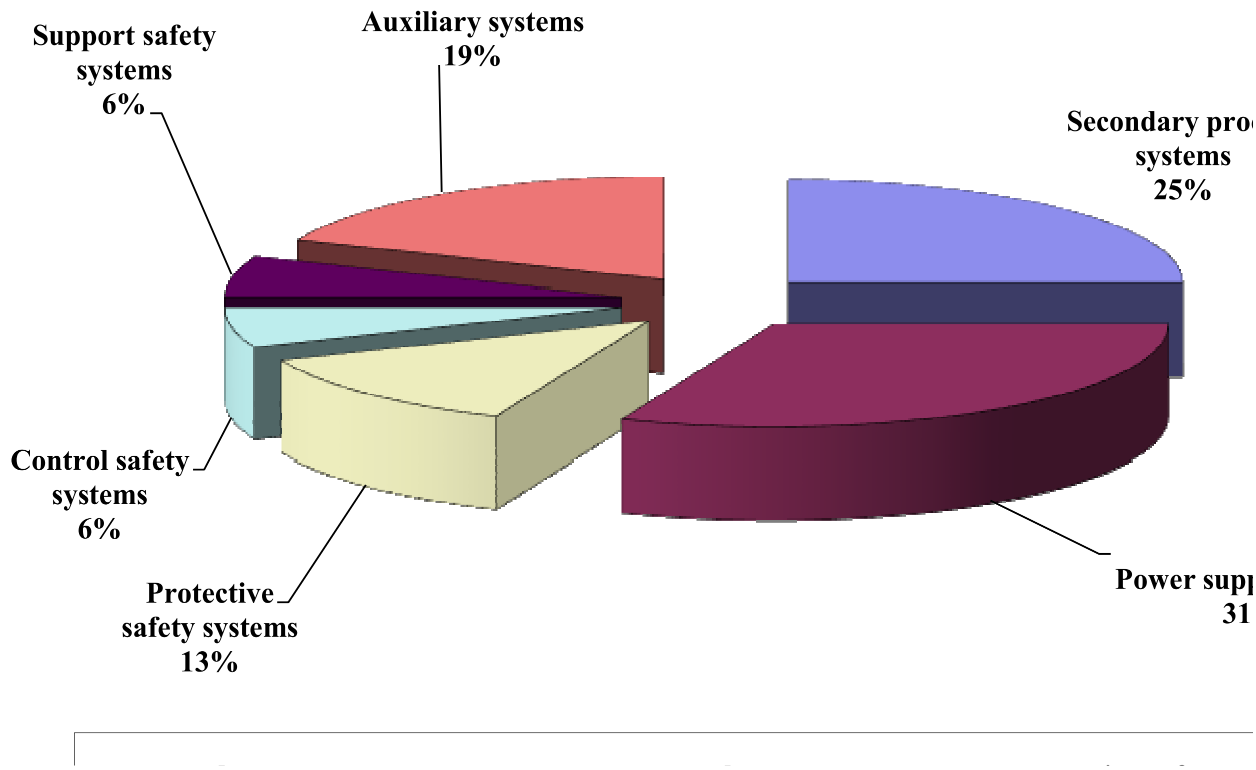


Figure 4.4.3. Distribution according to systems that failed or were affected during abnormal events

The following systems failed the most in 2014:

– power supply systems;
– secondary process systems.

Figure 4.4.4 presents the distribution of root causes of abnormal events in 2008÷2014.

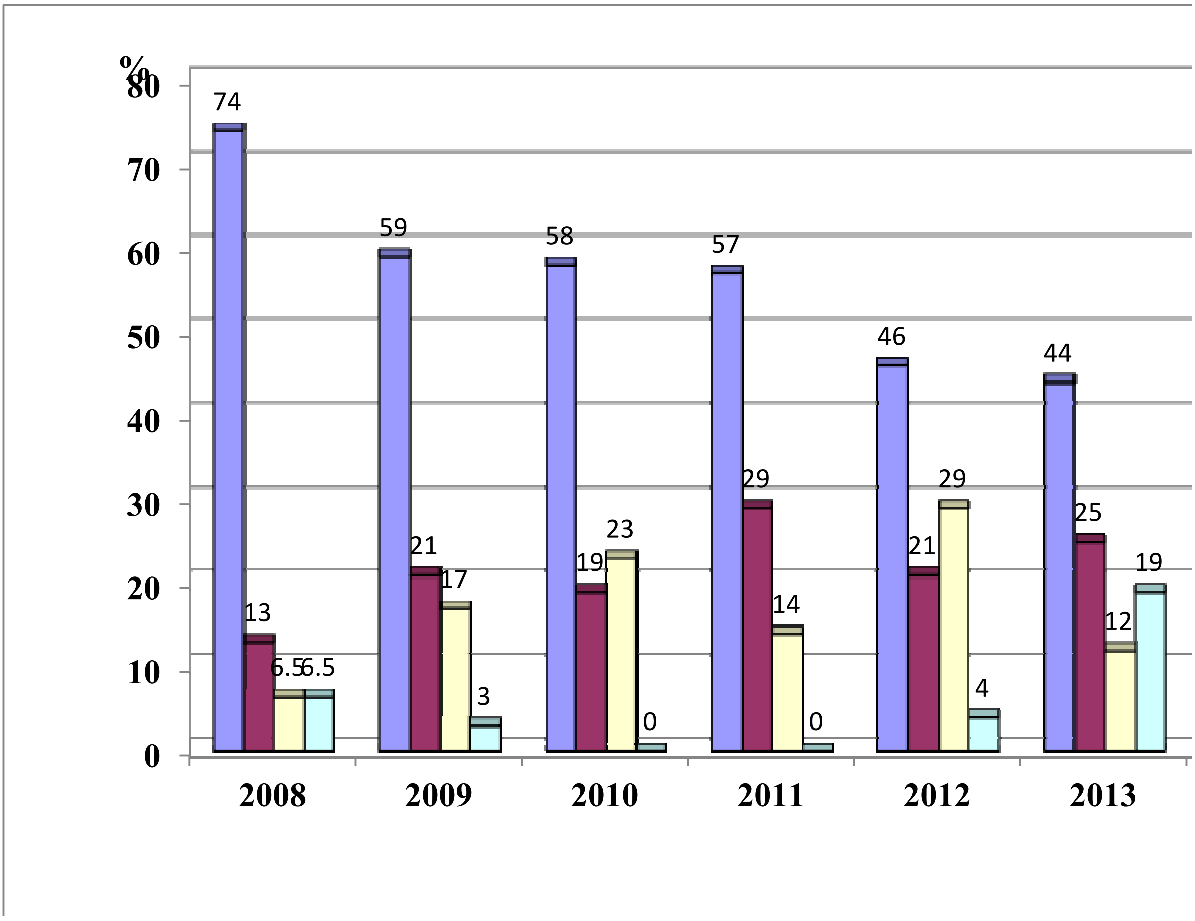


Figure 4.4.4. Distribution of root causes of abnormal events

As a rule, causes related to equipment failures make the greatest contribution (37.5 %). The share of root causes related to personnel increased in the last year.

The root causes related to equipment mainly occurred due to:

- design drawbacks;
- fabrication drawbacks.

4.5. Releases, Discharges and Exposure Doses

NPP environmental impact is assessed through analysis of radiological and non-radiological factors. Impact of NPP radiological factors is assessed from data on airborne releases and water discharges into the environment, doses of NPP personnel and radiological state of environmental objects in the NPP location area.

The main criterion for assessing of radiological impact is doses of personnel and the public.

Radiation safety involves compliance with permissible limits of radiation impact on personnel, the public and the environment established in safety regulations, rules and standards. Radiation protection is a series of radiation health & safety, design & engineering and technical & and organizational measures aimed at ensuring radiation safety.

NPP radiation protection includes a series of protective barriers on the path of radionuclides toward the environment. The values of airborne releases and water discharges from NPP characterize the state of protective barriers.

Effectiveness of radiation protection at Energoatom NPPs is assessed by the following parameters of radiation safety:

- airborne release per 1000 MW of installed capacity;
- water discharge of radionuclides per 1000 MW of installed capacity;
- indexes of radioactive releases and discharges to the environment.

Table 4.5.1. Dose limit quotas

Source	Dose limit quota for all dose pathways from releases		Discharges: dose limit quota for critical water use		Total dose limit quota for individual enterprise	
	%	μSv	%	μSv	%	μSv
NPP, nuclear steam power plant, heat-supply NPP	4	40	1	10	8	80
RWDS, uranium mines	2	20	1	10	4	40
RT plants	10	100	5	50	20	200
Other sources, reference industrial source	4	40	1	10	8	80

4.5.1 Radioactive Airborne Releases to Atmosphere

The levels of NPP airborne releases to the atmosphere are determined upon:

- continuous monitoring of inert radioactive gases, long-lived aerosols and iodine radionuclides in NPP ventilation stacks by automated airborne release systems and regular automated radiation monitoring equipment;
- gamma spectrometry of aerosol samples deposited on filters taken from NPP ventilation stacks;
- gamma spectrometry of gas and aerosol fractions of radioactive iodine taken from NPP ventilation stacks.

There are limits for radioactive releases and reference levels (RLs) for airborne releases to the environment approved for each NPP. The reference levels and limits for airborne releases of inert radioactive gases, long-lived nuclides or iodine radionuclides to the environment were not exceeded in 2014.

RNPP and KhNPP mastered the guidance for a facility for monitoring of airborne tritium releases to the environments through NPP ventilation stacks and accepted it into commercial operation. The contribution of this radioisotope to the total release indicator was ~ 58% at RNPP and ~ 36% at KhNPP.

The airborne releases from operating NPPs were much lower than limits established for each NPP in 2014.

Therefore, the total indexes of airborne radioactive releases from NPPs to the environment remain stably low and change vary insignificantly, being no more than one percent of permissible limits.

4.5.2. Radioactive Discharges to External Water Bodies

Radioactive discharges of radionuclides from nuclear power plants to external water bodies (cooling ponds) are mainly formed by residual waters from chemical demineralization tanks and blowdown essential spray ponds.

Radioactive discharges to the cooling pond are mainly formed by residual waters from radiation monitoring tanks, water treatment tanks and blowdown of essential service water supply systems.

RNPP has a process water treatment system for cooling of turbine condensers (cooling towers instead of cooling pond) which is different from other NPPs. Hence, the volume of total discharges 137Cs per 1000 MW installed capacity at RNPP to the environment are much higher than at other NPPs because of continuous blowdown of the cooling tower basin.

Radioactive discharges at SUNPP are monitored and accounted in dump of residual waters from spray ponds and cooling towers to the NPP cooling pond.

Spray pond waters and residual waters are discharged into the KhNPP cooling pond. The main contribution to discharges is made by blowdown of spray ponds.

The total indexes for radioactive water discharges for the reporting period for all reliably recorded radionuclides (3H, 137Cs, 134Cs, 60Co, 54Mn, 90Sr) were as follows: 1.6% for ZNPP, 0.55% RNPP, 4.45% for SUNPP and 0.27% for KhNPP.

It should be noted that the “Permissible Radioactive Water Discharges from NPP to the Environment” for ZNPP and KhNPP were revised in 2013, their numerical values changes. This circumstance explains substantial improvement in the discharge index at KhNPP in 2013.

Radioactive water discharges to open ponds were not exceeded at any Energoatom NPP for 2014.

discharge indexes, %

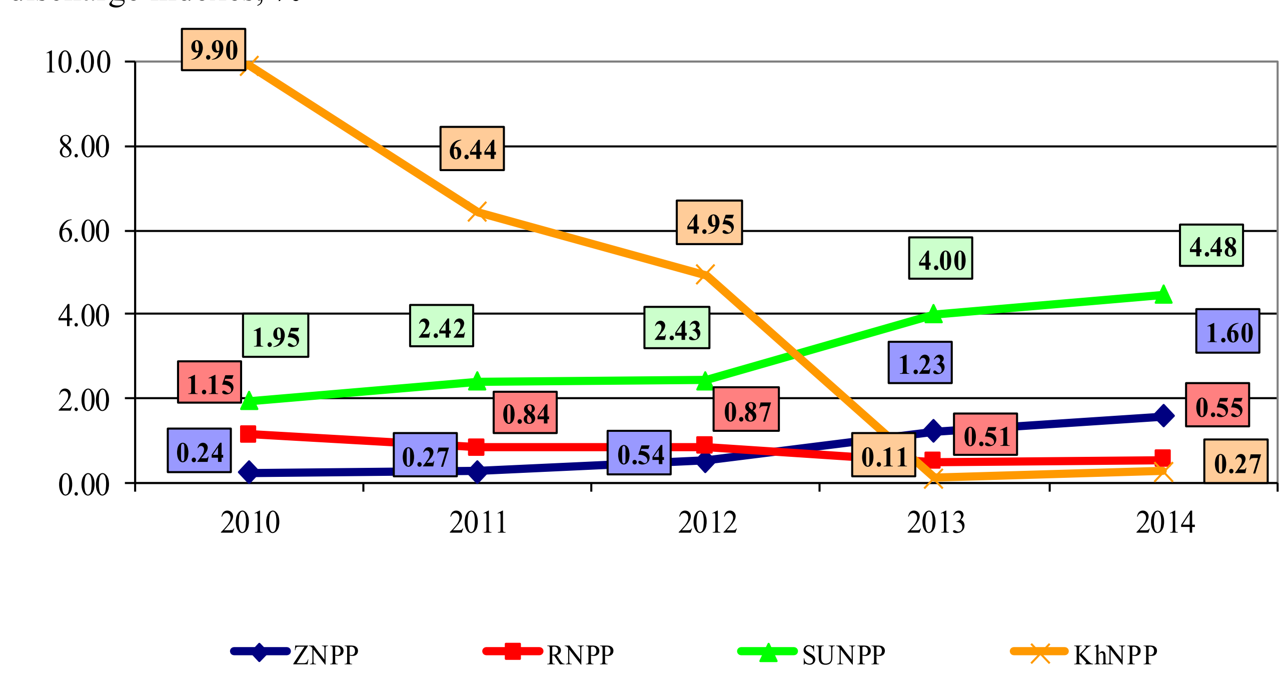


Figure. 4.5.1. Total indexes of radioactive water discharges for NPPs in 2010÷2014

4.5.3. Results of Personnel Dose Monitoring

4.5.3.1 Personnel External Doses

In the reporting year, individual external doses of ZNPP, RNPP and SUNPP personnel were measured with the RADOS dose measurement system with RE-2000 readers and thermoluminescent dosimeters (with MCP-N gamma and beta detectors and MCP-6,7 neutron detector) and with Harshaw 8814/0110 thermoluminescent dosimeters at KhNPP.

In addition, for prompt monitoring of external doses, NPPs used DMC-2000S electron dosimeters (MGPI, France) in 2014.

Table 4.5.2 shows administrative process levels for individual doses of NPP personnel and reference levels of annual collective doses for two groups of personnel whose individual dose exceeds 6 mSv/y (RL6) and 15 mSv/y (RL15).

Table 4.5.2. Administrative process (administrative) levels for individual effective doses of NPP personnel and reference levels for annual collective doses of NPP personnel with individual doses higher than 6 mSv/y (RL6) and 15 mSv/y (RL15)

Plant	Administrative process levels for individual doses of personnel		Reference levels for annual collective doses of personnel	
	Personnel, mSv/y	Women to 45 years of age, mSv	RL6	RL15
ZNPP	15.0 (18.5*)	-	4.50	1.80
RNPP	15.0 (19.0*)	1.90 (for 2 months)	3.60	0.83
SUNPP	15.0	1.40 (for 2 months)	3.30	0.41
KhNPP	15.0 (18.0*)	1.40 (for 2 months)	1.60	0.32

** - for personnel involved in hazardous radiological work*

Table 4.5.3 provides distribution of individual doses and collective and average doses of Energoatom NPP personnel and temporary duty staff for 2014.

Table 4.5.3. Distribution of individual effective external doses of NPP personnel (with temporary duty staff), collective and average individual doses for 2014

NPP	Number of persons monitored	Doses for 2014							
		<1	1-2	2-6	6- 10	10-15	15-50	Collective, man-mSv	Average individual, mSv/y
ZNPP	4806	4182	277	299	47	1	0	2154.29	0.448
incl. temp. staff	637	586	36	15	0	0	0	160.20	0.251
RNPP	3732	3221	232	250	23	6	0	1712.64	0.459
incl. temp. staff	629	555	39	35	0	0	0	208.84	0.332
SUNPP	3080	2511	231	291	36	11	0	1978.26	0.642
incl.	676	549	57	45	15	10	0	532.19	0.787

temp. staff									
KhNPP	2800	2315	271	205	9	0	0	1454.58	0.519
incl. temp. staff	700	634	34	32	0	0	0	207.62	0.297
Energoatom	14418	12229	1011	1045	115	18	0	7299.77	0.506

Table 4.5.3 shows that none member of personnel or temporary duty staff at NPP received an individual effective dose in the range 15-20 mSv, which is close to the limit for individual effective dose (20 mSv).

In recent years, there is positive dynamics of decrease in the annual collective doses of personnel per one unit at Energoatom NPPs.

General trends in changes of absolute values of collective doses for NPP personnel and their contribution to the total dose for Energoatom NPPs for the recent decade are presented in Figure 4.5.3.

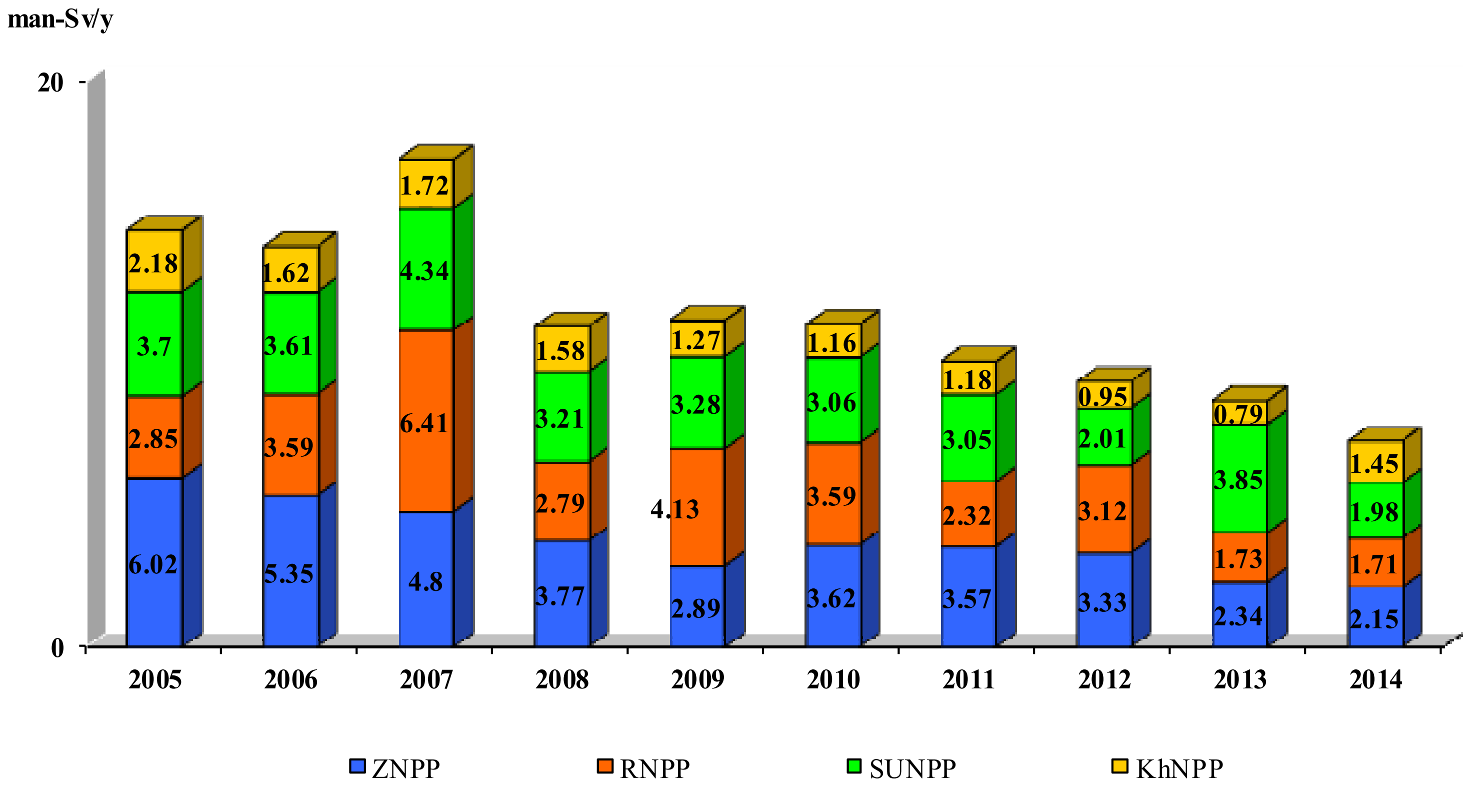


Figure. 4.5.3. Collective doses for NPP personnel (including temporary duty staff) for 2005 - 2014

The total collective dose for personnel of operating NPPs in 2014 was 7.300 man-Sv, which is 1.408 man-Sv lower than in 2013, when the total collective dose of personnel was 8.708 man-Sv. It should be pointed out that the total annual collective dose of NPP personnel has decreased in recent years starting from 2008 and was the lowest in 2014.

4.5.3.2. Personnel Internal Doses

According to NRBU-97, permissible levels of radionuclide inhalation are established for category A personnel, while instrumentation used at NPPs determines the content of radionuclides in critical human organs. Internal exposure was monitored by direct measurement of radionuclide activity in human body (critical organ) using human radiation spectrometers based on scintillation and semiconductor detectors with subsequent conversion of the results into expected effective dose.

Permissible levels of individual annual inhalation of radionuclides established by NRBU-97 for category A personnel are 400 kBq/y for ^{131}I, 200 kBq/y for ^{60}Co, 100 kBq/y for ^{137}Cs and 200 kBq/y for ^{134}Cs.

Content of ^{137}Cs and ^{60}Co radionuclides in human body and lungs and of ^{131}I in thyroid gland was monitored at all NPPs.

Table 4.5.4 shows distribution of individual internal doses and collective internal dose of NPP personnel in 2014.

Table 4.5.4. Distribution of individual doses and collective internal doses of NPP personnel in 2014

NPP	Number of monitored persons	Number of persons with dose received in 2014 (mSv)		Collective dose, man-mSv
		< 1	> 1	
ZNPP	7621 (2211)	15	0	1.08
RNPP	4950 (667)	4	0	< 1.00
SUNPP	3447 (994)	3	0	1.21
KhNPP	2933(695)	14	0	1.45
Energoatom	18951(4567)	36	0	4.24

( ) - Staff of other organizations*

The collective annual internal dose of ZNPP personnel in 2014 was 1.08 man-mSv, which is the same as in 2013.

Based on monitoring of internal radionuclide content in critical organs of RNPP personnel, all individual internal doses were lower than 0.25 mSv. The maximum internal dose in this personnel group was 0.22 mSv.

The annual collective dose of SUNPP personnel in 2014 increased as compared with 2013 and was 1.45 man-mSv (0.66 man-mSv in 2013). 80% in this value was the dose of maintenance staff engaged in work with reactor equipment during scheduled outages.

The annual collective internal dose of KhNPP personnel was 1.45 man-mSv (0.71 man-mSv in 2013).

5. NUCLEAR FUEL MANAGEMENT

5.1. Nuclear Fuel Transport

On the territory of Ukraine, there is transport of fresh and spent nuclear fuel of Ukrainian NPPs and transit transfers of fuel between the Russian Federation and East European Countries – Slovakia, Hungary and Bulgaria. Transport is undertaken in compliance with a number of intergovernmental agreements on cooperation in nuclear material transport, particularly between the governments of the following countries:

- Ukraine, Russian Federation (1996);
- Ukraine, Russian Federation, Bulgaria (2006);
- Ukraine, Russian Federation, Slovakia (2010);
- Ukraine, Russian Federation, Hungary (2012).

The agreements identify basic legal and organizational principles of cooperation in nuclear material transport – competent authorities involved in implementation of the agreements, international documents used in the transport of nuclear materials, procedure for cargo escort, physical protection and security issues, reloading points, guard change points, responsibility for loss of cargo, civil liability for nuclear damage, mitigation of accident consequences and procedure for notification about transport.

Legislation also identified cases when transit of nuclear materials and radioactive waste cannot be undertaken: in cases of potential threats related to military actions, armed conflicts, civil war, uprisings, political or civil unrest, strikes, acts of terrorism; in cases of force majeure including natural phenomena, which are exceptional, inevitable and unpredictable; during events of national importance in Ukraine (national holidays, international cultural and sports events, etc.).

In view of the events in early 2014, the SNRIU introduced a ban on the transport of nuclear materials for the period from 19 February to 6 March 2014.

The SNRIU granted 19 authorizations in 2014 for the transport of nuclear fuel of Ukrainian NPPs and 9 permits for transit of nuclear fuel of Slovakian, Hungarian and Bulgarian NPPs.

To ensure physical protection during nuclear fuel transport, measures are taken to provide information security and protection of shipments by the National Guard throughout the route of spent fuel transport through Ukraine.

Spent fuel is transported by rail in special cars and in transport packaging sets that are able to withstand transportation accidents. Although the transport of spent nuclear fuel is potentially dangerous because of the extremely high-active content of containers, there have been no transportation accidents in history that would have resulted in radioactive release from containers or violation of nuclear safety requirements.

5.2. Westinghouse Nuclear Fuel

In order to diversify the supply of nuclear fuel and avoid dependence on the monopoly supplier, Energoatom has taken measures since 2000 on the development, delivery and qualification of an alternative supplier of nuclear fuel, compatible with Russian-design fuel. These measures are taken within the Implementing Agreement between the Government of Ukraine and the Government of the United States of America on “Nuclear Fuel Qualification Project for Ukraine” signed on 5 June 2000.

In preparation for the implementation of the Qualification Project, the Core Design Center was established on the premises of KIPT, to which Westinghouse transferred technologies for design of nuclear fuel and reactor cores and guidance for safety analysis. Experts of the center successfully passed training and internship in the USA.

In the first phase of the Qualification Project in 2005–2009, trial operation of six fuel assemblies manufactured by Westinghouse (FA-W) was conducted at SUNPP unit 3. In addition, the computer system for the in-core monitoring system was assembled and put into operation.

Since March 2010, in the framework of the second phase of the Qualification Project, trial operation of the reload batch consisting of FA-W was started.

On 30 March 2008, a contract for supply of nuclear fuel for annual reloading of three WWER-1000 units in 2011 ÷ 2015 was signed between Energoatom and Westinghouse Electric Sweden AB (Västerås, Sweden).

In 2011 ÷ 2012, under the contract and with potential extension of the FA-W pilot operation, four batches of nuclear fuel were supplied; two of them were loaded into the reactor cores of SUNPP units 2 and 3 in 2011.

In 2012, during scheduled outage, issues occurred during reloading of mixed cores at SUNPP units 2 and 3, which were caused by design features of fuel assemblies from both suppliers (TVEL and Westinghouse) that formed the core, namely:

- FA-W with damaged spacer grids were revealed;
- reactor cores could not be loaded as planned.

In this connection, extension of Westinghouse fuel operation under the contract was terminated. Beginning from 2013, FA-W operation continued only in the SUNPP-3 core. According to the work program for FA-W trial operation, all fuel assemblies in the core were subjected to visual examination and integrity check using regular instrumentation of the power unit during each scheduled outage. Part of FA-W was inspected in more detail with use of the inspection and maintenance test bench supplied by Westinghouse.

At the end of 2014, four-year operating cycle expired for a number of FA-W, i.e., the full cycle envisaged by design documentation. Inspection of these fuel assemblies, including integrity check, revealed no issues.

Therefore, it can be noted that no loss of integrity was revealed during operation of Westinghouse fuel during 2010÷2014, in spite of the damage of spacer grids during handling operations.

After the events in 2012, in order to recommence FA-W trial operation, Energoatom and Westinghouse, upon agreement with the SNRIU, identified a series of measures, including required upgrades to fuel design.

In 2013÷2014, Westinghouse upgraded the fuel assembly design and conducted comprehensive testing of the upgraded robust assemblies (FA-WR).

Licensing of the upgraded assemblies was started in parallel. For this purpose, Energoatom and Westinghouse developed a package of justification documents, which was strictly required by Ukrainian regulations, and submitted it to the SNRIU for review. The first stage of this processes completed with an authorization issued by the SNRIU for loading of batch consisting of 42 FA-WR into the SUNPP-3 core in 2015.

In August 2014, the Energoatom commission, with an SNRIU representative, confirmed that Westinghouse Electric Sweden AB would ensure the required quality of products to be supplied to Ukrainian NPPs within the audit of quality control system of this company and acceptance of the FA-WR batch for SUNPP-3. As of the end of 2014, the reload batch was supplied to the SUNPP site and passed acceptance inspection, which revealed no issues that would prevent FA-WR loading into the SUNPP-3 core.

5.3. Spent Nuclear Fuel Management Facilities

Spent nuclear fuel (SNF) generated during electricity production in nuclear reactors is an important component of the NPP process cycle.

The period for which nuclear fuel is used in the reactors is determined by allowable burnup. After planned burn up is reached, nuclear fuel is unloaded from the reactor and is considered spent fuel since it cannot be used directly to produce electricity.

After unloading from the core, SNF is placed into spent fuel pools (SFP). SNF is cooled down in these pools for a time period needed to decrease residual heat resulting from radioactive decay of fission products to allowable values. When SNF is stored in SNP for a limited time, spent fuel assemblies (SFAs) are to be removed from the NPP unit and sent for storage (disposal) or processing. This is done because the capacity of NPP SFPs is limited and they must always have free volume for nuclear fuel unloading from the core or periodic inspections of the WWER reactor pressure vessel and internals.

At the same time, factors that are determined by specific features of SNF are to be taken into account in its management: high radioactivity and presence of valuable elements in SNF (uranium, plutonium, germanium, erbium, palladium, zirconium etc.), which can be used prospectively, including that in other nuclear cycles (nuclear fuel for fast neutron reactors, MOX fuel for light-water reactors).

The state of nuclear energy all over the world shows that, given the current development of technologies, one cannot make ultimate conclusions on economic feasibility of SNF reprocessing or disposal, i.e., on the final stage in the nuclear fuel cycle (NFC). In this regard, Ukraine, like most countries with developed nuclear energy, accepted the so-called deferred decision, providing for long-term SNF storage. The deferred decision allows the State to make a decision on the final NFC stage later, to benefit from the development of global technological and national economic feasibility.

Ukraine currently operates two interim storage facilities for spent fuel: wet storage facility for SNF – ISF-1 at the Chornobyl NPP – and dry storage facility for SNF – DSFSF at the Zaporizhzhya NPP.

In addition, two other storage facilities are under construction in Ukraine: dry interim spent fuel storage facility – ISF-2 at the Chornobyl NPP – and centralized storage facility for SNF of national WWER NPPs – CSFSF.

5.3.1. Management of WWER Spent Nuclear Fuel

The ZNPP was the first plant that had to deal with a lack of space in SFP for SNF. To solve this issue, ZNPP started implementation of DSFSF in 1996.

The DSFSF design is based on the licensed and proven spent fuel storage technology of Duke Engineering & Services (USA). SNF is stored in the following way: 24 fuel assemblies with low decay heat (<1 kW) after five-year cooling in SFP are placed into a special canister, which is filled with helium (inert gas with high thermal conductivity) and sealed, then the canister is placed into a ventilated concrete storage cask (VSC). The storage facility is designed to accommodate 380 VSC, which may contain 9000 assemblies with SNF.

The first stage of DSFSF for 100 VSC was commissioned in 2001 and the second stage, for 280 VSC, at the end of 2011.

Figure 5.3.1. Zaporizhzhya NPP DSFSF

As of 1 January 2015, there are 124 VSC on the DSFSF site.

SNF from the Rivne, Khmelnitsky and South Ukraine NPPs is currently transported to the Russian Federation. WWER-1000 spent fuel is sent for storage and WWER-440 spent fuel (RNPP-1, 2) for reprocessing.

To implement the “Action Plan for 2006-2010 for Implementation of the Energy Strategy of Ukraine until 2030” (approved by Cabinet Resolution No. 427 of 27 July 2006), Energoatom concluded a contract with U.S. Holtec International for construction of a centralized storage facility in Ukraine to accept SNF from the Rivne, Khmelnitsky and South Ukraine NPPs employing the dry storage technology proven at the Zaporizhzhya NPP.

In compliance with legislative requirements, Energoatom developed the “Feasibility Study for Investments into Construction of Centralized Storage Facility for Spent Nuclear Fuel (CSFSF) of National WWER Nuclear Power Plants”. The Feasibility Study was approved by Cabinet Resolution No. 131-r of 4 February 2009 after comprehensive regulatory review.

The Feasibility Study proved that long-term SNF storage in Ukraine was economically sound as compared to fuel transfer to the Russian Federation and justified the construction of one centralized spent fuel storage facility as compared to any other spent fuel storage options.

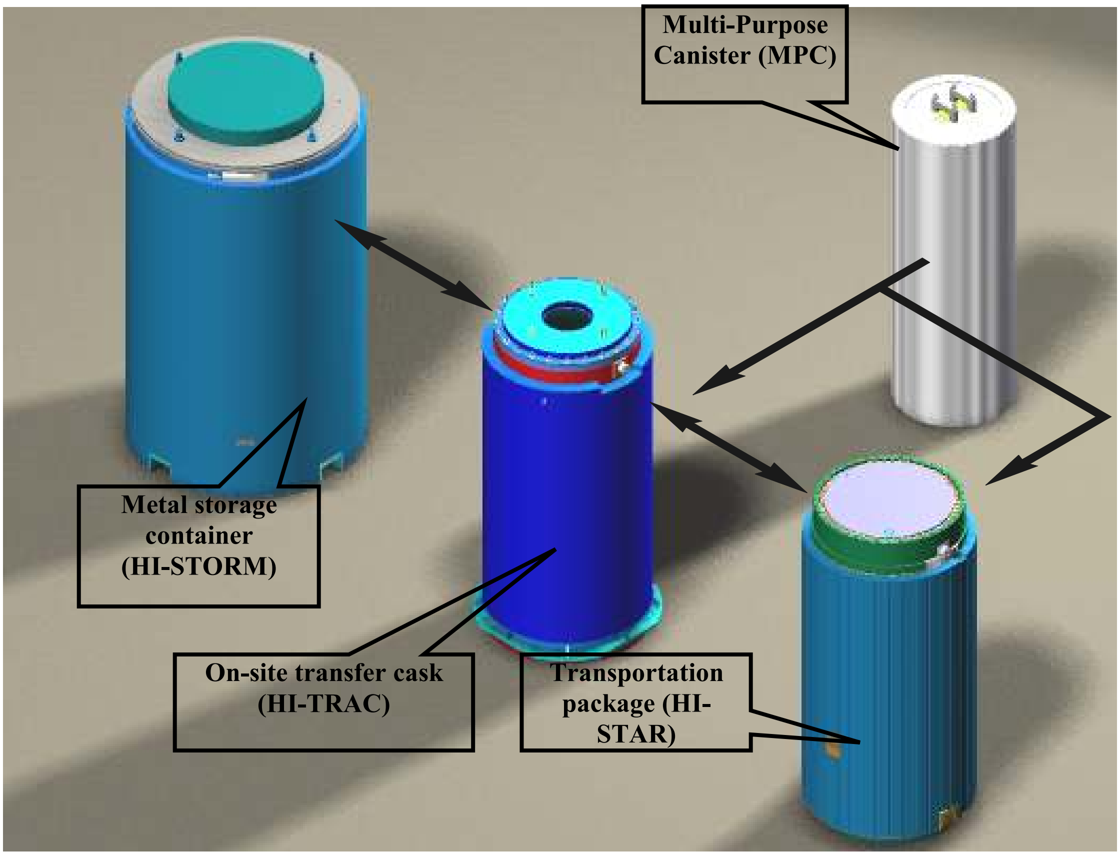


Figure. 5.3.2. CSFSF main equipment

It is planned to store 12,500 WWER-1000 SFAs and WWER-440 4000 SFAs for 100 years in CSFSF.

9 February 2012, Verkhovna Rada of Ukraine made a decision on CSFSF siting in the exclusion zone and its design and construction by adopting Law of Ukraine No. 4383-VI "On Management of Spent Nuclear Fuel in Siting, Design and Construction of Centralized Storage Facility for Spent Nuclear Fuel of National WWER Nuclear Power Plants".

30 March 2012. The SNRIU agreed the "Licensing Plan for CSFSF Construction" developed by Energoatom.

30 April 2013. The SNRIU agreed the Energoatom document "Statement of Work on Upgrading the Technology of Spent Nuclear Fuel Unloading from WWER-1000 (M V-320) for Transfer to CSFSF".

23 April 2014. Cabinet Resolution No. 399-r authorized Energoatom to develop a land utilization project and to allocate lands with a total area of 45.2 ha, located between the former villages of Stara Krasnitsa, Buryakivka, Chistogalivka and Stechanka of the Kyiv region in the exclusion zone affected by the Chornobyl area, to transfer them subsequently to Energoatom for permanent use with change of their purpose for the construction of CSFSF and access railway.

5.3.2. Management of RBMK Spent Nuclear Fuel

The RBMK design envisaged the following sequence of SNF management:

– after operation in the reactor, fuel was to be reloaded into SFPs to be cooled down for at least 1.5 years to reduce radioactivity and decay heat;
– after storage in SFP, RBMK was to be sent for a wet spent fuel storage facility.

As of 1 January 2015, there are 21,284 FAs on the Chornobyl NPP site. Among them:

- 21,231.5 SFAs stored in ISF-1 SFP;
- 32 damaged fuel assemblies stored in unit 1 SFP;
- 20.5 damaged fuel assemblies stored in unit 2 SFP.

ChNPP unit 3 has no SNF and further use of its SFP for SNF is not envisaged. In this connection, on 7 December 2012, the SNRIU agreed the SSE ChNPP decision "On Recognition of Power Unit 3 as Radioactive Waste Management Facility". Therefore, since ChNPP unit 3 has been regarded as a radwaste management facility since 8 December 2012.

There is no fresh nuclear fuel on the ChNPP site.

ISF-1 is operated under SNRIU License EO No. 000859 for operation of the nuclear installation – spent fuel storage facility of 25 June 2008.

Figure. 5.3.3. ChNPP ISF-1

The operating organization SSE Chornobyl NPP currently makes efforts to implement:

- Action Plan to Improve ISF-1 Safety, agreed by the SNRIU on 24 June 2008;
- Action Plan to Improve Safety of SSE ChNPP Nuclear Installations, agreed by the SNRIU on 12 December 2011;
- Action Plan for Stabilization, Transfer and Storage of Special Canisters with Damaged Spent Nuclear Fuel, agreed by the SNRIU on 25 March 2014 (in accordance with this Action Plan, it planned to transfer and store damaged fuel assemblies from unit 1 and 2 SFPs to ISF-1 SFP in 2015).

At the same time, the ISF-1 lifetime determined upon safety review conducted in 2011 expires at the end of 2025. Therefore, a new dry interim storage facility (ISF-2) is under construction to ensure long-term safe storage of all SNF on the ChNPP site.

Figure. 5.3.4. Storage of canisters with spent nuclear fuel in ISF-1

ISF-2 is constructed under SNRIU License EO No. 001002 for construction and commissioning of the nuclear installation (interim spent fuel storage facility (ISF-2)) of 20 February 2013.

The ISF-2 design provides for the following sequence of SNF management:

1. First SNF will get into the facility for spent fuel treatment before storage, where each spent fuel assembly will be cut into two parts (bundles) and each bundle will be placed into a fuel cartridge.

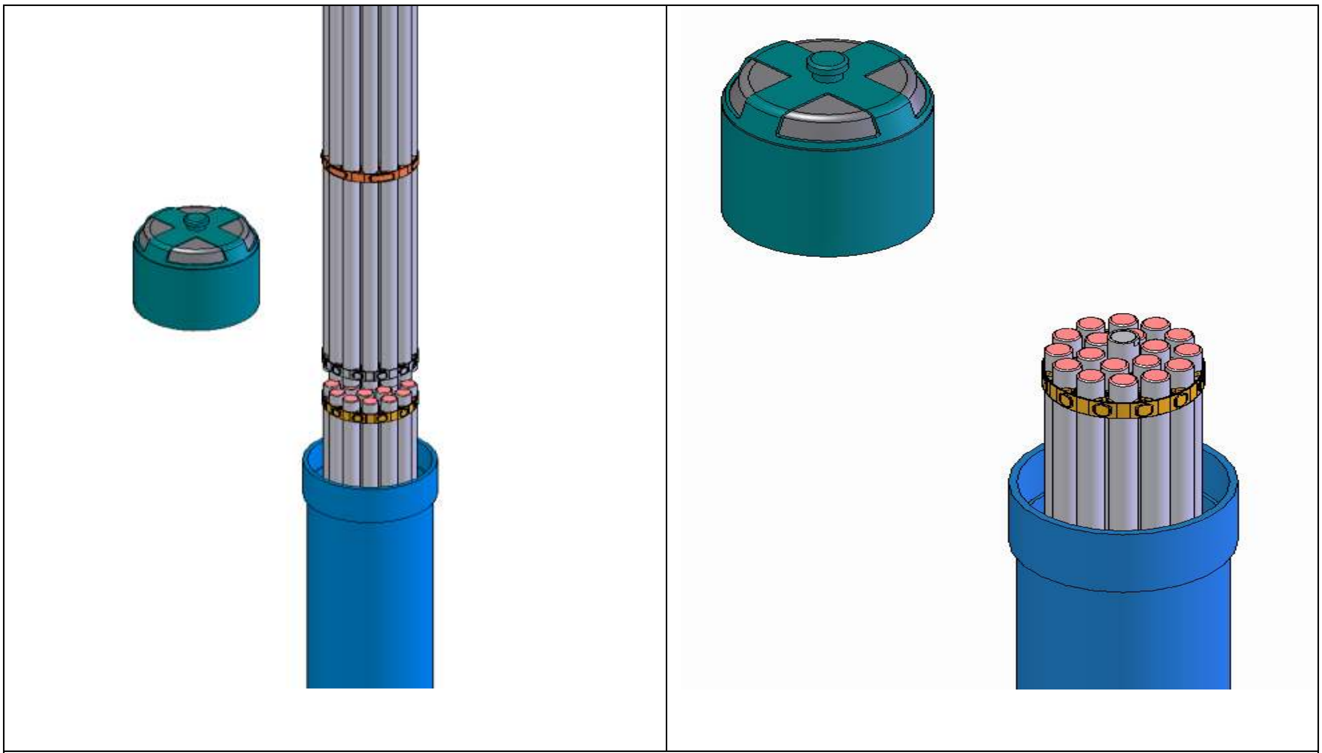


Figure. 5.3.5. Fuel cartridge

2. Then the cartridges will be placed into stainless-steel double-walled dry shielded canisters (DSC), each containing 186 bundles.

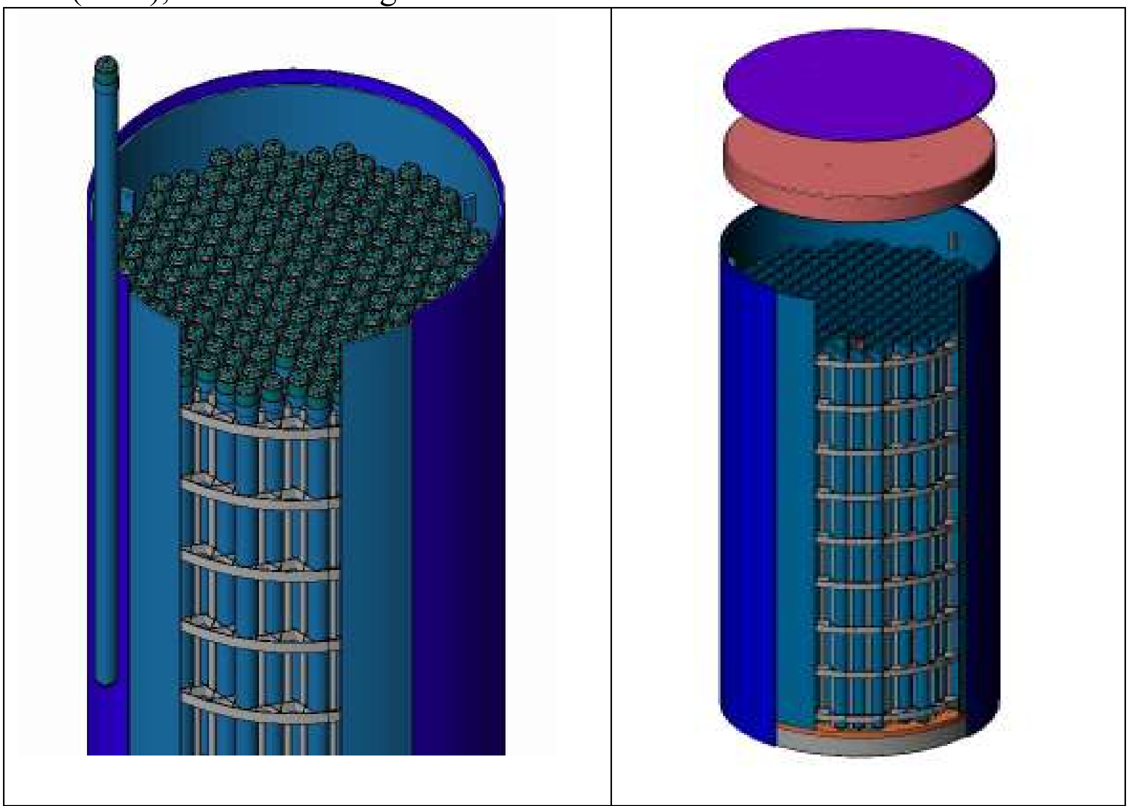


Figure. 5.3.6. Dry double-walled shielded cask

3. After filling with fuel cartridges with SFA bundles, DSCs will be transported to a special facility for complete spent fuel drying and filling of the canister with inert gas helium.

4. After drying, helium filling and integrity check, DSCs with SNF will be sent to the spent fuel storage area, where they will be placed into concrete storage modules (CSMs).

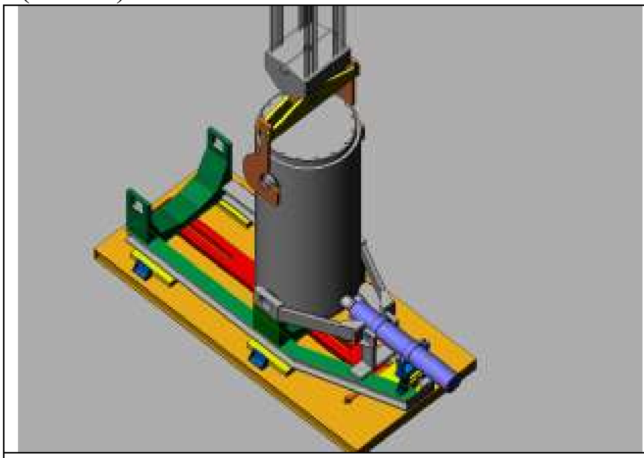
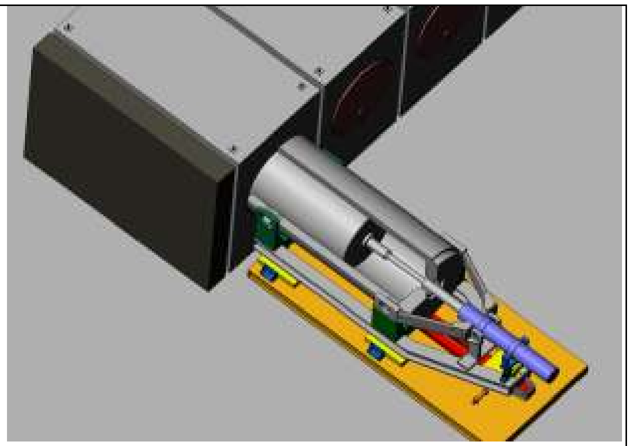
	

Figure 5.3.7. Placement of dry double-walled shielded canister with spent fuel onto transport carrier for transfer to spent fuel storage area	*Figure 5.3.8. Placement of dry double-walled shielded canister with spent fuel into concrete storage module*

5. DSCs with SNF will be stored in CSMs for 100 years.

Moreover, the ISF-2 design provides for:
- potential removal of DSC form CSM for technical inspection and repacking (if needed);
- equipment for management of damaged SNF.

During 2014, the SSE Chornobyl NPP continued the developed and agreement of a package of technical specifications and design documentation on systems and equipment important to safety. According to the ISF-2 design, it is required to develop:
- 42 technical specifications for equipment important to safety, 27 specifications were preliminary agreed by the SNRIU as of 1 January 2015;
- 7 technical specifications for system important to safety, all of them were preliminary agreed by the SNRIU as of 1 January 2015;
- 49 acceptance inspection programs for equipment and systems, 2 of them were agreed by the SNRIU as of 1 January 2015.

Commissioning of ISF-2 is planned for the fourth quarter of 2016.

6. SAFETY IN MANAGEMENT OF RADIATION SOURCES

Management of radiation sources in each area of national economy has its specifics and requires human protection against ionizing radiation. Radiation protection of people and the environment in use of radiation sources is a priority for state regulation of nuclear and radiation safety.

State safety regulation of radiation sources is exercised by establishing legislative requirements and safety criteria, authorization (licensing of activities with radiation sources and their state registration), supervisory activity and application of enforcement actions if regulations and standards on radiation safety are not met.

For reference. Radiation sources are physical objects, except for nuclear installations, that contain radioactive substances or technical devices that create or can create ionizing radiation in certain conditions.

The SNRIU and State Nuclear and Radiation Safety Inspectorates conduct regulatory control over activities of 4167 entities using radiation sources. Among them, 2481 entities use radiation sources that are not exempt from licensing and have appropriate licenses. The other entities use radiation sources with low potential hazard and ensure only their state registration in the State Register of Radiation Sources as an authorizing procedure established by law.

One of the state regulatory principles is to apply a graded approach to different activities with radiation sources considering their potential hazard, in particular:

1) Radiation sources with low potential hazard are exempt from regulatory control. The levels and procedure for exemption from regulatory control are identified in Cabinet Resolution No. 1174 of 16 November 2011 and SNRIU Order No. 84 of 1 July 2010;

2) Radiation sources with relatively low potential hazard are subject only to state registration (i.e., they are exempt from licensing) according to the procedure approved by Cabinet Resolution No. 1718 of 16 November 2000. The list of radiation sources whose use is exempt from licensing is approved by SNRIU Order No. 138 of 3 December 2013. Criteria applied to exempt radiation sources from licensing are approved by Cabinet Resolution No. 1174 of 16 November 2011;

3) Activities with radiation sources with medium and high potential hazard are mandatory licensed according to the procedure established in the Law of Ukraine “On Authorizing Procedure in Nuclear Energy”.

If radiation source safety is not ensured or safety culture in society does not correspond to the level of potential source hazard, useful properties of ionizing radiation turn out to be harmful consequences of radiological accidents for people.

As of December 2014, 4167 entities use 28,728 radiation sources, including 11,784 radionuclide sources and 16,944 radiation generators.

The highest number of nuclear entities is concentrated in the North part, including Kyiv and Kyiv, Cherkassy, Vinnitsa, Zhitomir and Chernihiv regions. Regarding the entities that use radiation sources, their number is almost 30% higher than in the North Part of Ukraine, such as South-Eastern (Donets, Luhansk and Zaporizhzhya regions) and Eastern (Kharkiv, Sumy and Poltava regions). In the North part and Autonomous Republic of Crimea, a part of their territory being a recreation area of Ukraine, radiation sources are mainly used by medical establishments. Most of these entities are medical establishment applying X-ray apparatus for diagnosis.

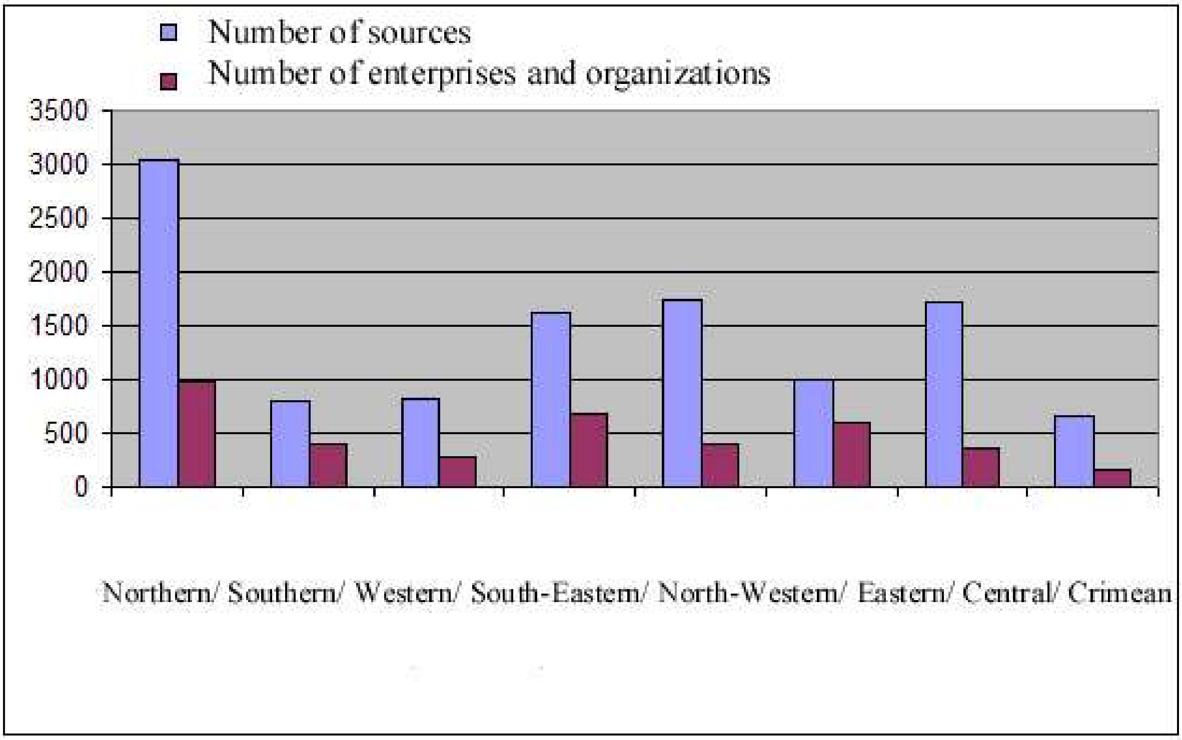


Figure. 6.1. Number of radiation sources

24,582 sources have been registered, including 9,654 radionuclide sources and 14,928 radiation generators.

In 2014: 1237 new sources were registered and 480 sources were reregistered for new owners in the State Register of Radiation Sources; 1005 sources were removed from record (713 sources were transferred to specialized radwaste management enterprises, 11 were transferred from Ukraine and 281 generating device was put out of operation); service life of 1447 sources was extended.

The number of radiation sources registered in regions is shown in the table below:

Location, region	Radionuclide sources, pcs.	Radiation generators, pcs.	Total, pcs.
Northern State Inspectorate	2560	3449	6009
Eastern State Inspectorate	1515	2 332	3847
Central State Inspectorate	1291	1450	2741
South-Eastern State Inspectorate	1602	2526	4128
North-Western State Inspectorate	477	1238	1715
Western State Inspectorate	384	1730	2114
Southern State Inspectorate	1571	1304	2875
Autonomous Republic of Crimea	277	870	1147

Ukraine does not produces radionuclide sources. In 2014, 166 radionuclide sources were imported to Ukraine (30% fewer as compared with 2013). The main producers of radionuclide sources imported to Ukraine in 2014 were enterprises in Poland, Russia, Belarus, Germany, Netherlands and USA. The following Ukrainian enterprises supplied these radiation sources: *Izotop* Enterprise, Kyiv; *ShimUkraine* Ltd, Kyiv; VATEK Ltd., *Impuls* Foreign-Trade Ltd.; Schlumberger Services Ukraine Ltd., Kyiv; *Khartron* Company, Kharkiv.

The distribution of the main users of radionuclide sources in 2014 was as follows: medical applications – 18.1%; industrial application, customs and other controls – 80.1%; research institutions and other organizations – 1.8%.

As of December 2014, Ukraine uses 2240 sources with a life more than 35 years, including: 23 sources produced in the 1950s and 173 sources produced in the 1960s.

In 2014, open radiation sources based on Tc-99m for medical applications with a total activity of 4151.33 GBq were imported to Ukraine.

For medical institutions of Ukraine, I-131, I-125, P-32, Sr-89 and Sm-153 sources were provided with radio pharmaceuticals with the following total activity:

	2014	**For comparison**	
		2013	**2012**
I-131	1192.138 GBq	2049.08 GBq	1548.0016 GBq
I-125	966.75668 MBq	16,452.246 MBq	1780.082 MBq
P-32	8391.97 MBq	7816.879 MBq	13,003.46 MBq
C-14	-	-	37.00 MBq
H-3	-	9.25 MBq	9.25 MBq
Sr-89	4500 MBq	1050 MBq	8735.00 MBq
Sm-153	198 MBq	24,036 MBq	8020.00 MBq
S-35	-	-	86.00 MBq

In 2014, 193 X-ray units were produced in Ukraine, including: 60 for Ukraine and 133 were transferred aboard.

In 2014, the following equipment was imported to Ukraine: 10 computer tomography systems, 1 mobile surgical system, 1 densitometer, 4 mobile X-ray units, 2 X-ray mammography systems, 8 portable X-ray apparatus, 2 X-ray television introscopes, and other X-ray devices for various purposes for medical institutions.

In addition, 281 generating devices were taken out of service in such a way as to make their recovery impossible.

In 2014, response to 14 radiological accidents and other events associated with loss of control over radiation sources was ensured; in particular, 10 of these events happed in the South-Eastern region:

2 January: at Metallurgical Plant *Azovstal* (Mariupol, Donetsk region), a railroad car with metal scrap that arrived from the Sumy station of the Southern Railway from *Uktrans Consulting* Ltd. (cargo owner was *Poseidon Trade* Ltd., Kyiv) was arrested during acceptance radiological inspection. After radiological inspection, the contaminated fragment was transported to the Donetsk SISP storage for temporary placement. Gamma exposure dose rate at a distance of 0.1 m from the tube was 10.0 μSv/y and specific activity of ^{226}Ra was $4.9 x 10^4$ Bq/kg.

23 January: at the control point at the state border of Ukraine in the Donetsk airport, the regular YANTAR-2P radiological monitoring system actuated in customs control of Istanbul–Donetsk Flight No. 453. After radiological monitoring, the suspicious material was transferred to the Donetsk SISP storage for temporary placement. Specific activity of

^{226}Ra was $2.9x10^4$ Bq/kg and exposure dose rate at a distance of 0.1 m from the radioactive material was up to 3 μSv/y.

12 February: three gamma flow detectors of Gammarid-192/120 type were found during scheduled inspection of the State Enterprise *Skyper*. One of the devices was equipped with a cesium-137 source. The other device and shielded container had no radiation sources. The State Enterprise *Skyper* does not currently work, and the industrial buildings belong to *Mariupolstalkonstruktsiya* Ltd. Information on the inspection was submitted to the Department of the Security Service of Ukraine in Donetsk region and to the Mayor of Donetsk for making an appropriate decision.

18 March: in the town of Vilnyansk in Zaporizhzhya region, radioactive material was revealed in a private house, with signs of smuggling from the Russian Federation to Ukraine.

27 March: at *Hamadey* Tobacco Company (83047, Donetsk, 2-2A Andropov St.), a radioisotope device with a radionuclide source (strontium-90) with activity of 925 MBq was revealed. According to personnel, the device arrived in a parcel with equipment from the Great Britain.

15 April: at Metallurgical Plant *Azovstal* (Mariupol, Donetsk region), railroad car No. 68750918 with metal scrap that arrived from the Akhtyrka station of the Southern Railroad from Energy Industry Ltd. (74 Rivne St., the village of Strumivka, Lutsk district, Volyn region) was arrested during acceptance radiological inspection. After radiological inspection, the contaminated fragment was transferred to the Donetsk SISP storage for temporary placement. Gamma exposure dose rate at a distance of 0.1 m from the tube was 2.5 μSv/y and specific activity of ^{226}Ra was $1.4x10^4$ Bq/kg.

9 May: at Metallurgical Plant *Azovstal* (Mariupol, Donetsk region), railroad car No. 60503174 with metal scrap that arrived from the Khriplin station of the Lviv Railroad was arrested during acceptance radiological inspection. The owner was MEGA-MET Ltd. (Donetsk, 4 Ovtanyan St.). Personnel of the Donetsk SISP removed fragments of metal tubes 168 kg in weight from the metal scrap, contaminated with radioactive material (226Ra isotope).

12 October: at the Mariupol Metallurgical Plant (Mariupol, Donetsk region), railroad car No. 68824002 with metal scrap arrived from the Talalaivka station of Chernigiv region was arrested during acceptance radiological inspection. The carbo owner was METAL-KOM Ltd. (Chernigiv, 27-A Ripkinska St.). Personnel of the Donetsk SISP removed 37 fragments of metal pipes 420 in weight contaminated with radioactive material from the metal scrap. Gamma exposure dose rate inside some fragments was 2.5 μGy/h and beta-particle flux was 300 β-part./min×cm^2.

17 October: at Metallurgical Plant *Azovstal* (Mariupol, Donetsk region), railroad car No. 67702514 with metal scrap that arrived from the Kalmius station in Donetsk Railroad was arrested during acceptance radiological inspection. The consignor was ALFAMET Ltd. (Donetsk, 2a Rozdolna St.). Donetsk SISP personnel removed the contaminated fragments.

3 December: at Zaporizhhzya Metallurgical Plant Zaporizhstal (Zaporizhzya), a railroad car with metal scarp arrived from the Shostka station of the Kyiv Railroad was arrested during acceptance radiological inspection. The consignor was *Ukr-Trans-Invest* Ltd. (Kyiv region, Kyiv-Svyatoshin district, the town of Vyshneve). Ferrous metal fragments were removed – 14 tubes with a total weight of 190 kg, contaminated with radioactive material. Gamma exposure dose rate on the surface of tubes was 30.0 μSv/y and beta-particle flux was 220 β-part./min×cm^2.

6.1. Management of Radioactive Waste Resulting from Use of Radiation Sources

Same management of radiation sources at the end of their life cycle is an important condition to eliminate the risk of their lost and transfer to places acceptable to the public. Spent radiation sources even after expiration of their service life remain hazardous because they contain radioactive material, which may seriously affect human health in case of its spreading or inadvertent use. Spent radiation sources are transferred to the category of radioactive waste and further managed in compliance with safety requirements for radwaste treatment at state specialized plants of the Ukrainian State Association *Radon*.

There are six interregional specialized plants (SISPs) for radwaste management in Ukraine: Kyiv, Kharkiv, Dnipropetrovsk, Odessa and Donetsk SISPs. The specialized plants deal with collection, transport and safe storage of spent radiation sources and radwaste in devoted facilities for waste container-type storage prior to transfer of spent radiation sources to the centralized facility for long-term storage of spent sources being constructed at the *Vektor* site in the exclusion zone.

At the same time, there are waste storages on sites of the specialized plants that were constructed, commissioned and filled in the Soviet era, without compliance with all safety requirements to be met today. Permanent measures are taken to maintain, keep in safe stage, monitor and control these storages. They are currently regarded as 'historical' ones, and plans and measures for their further liquidation and reclamation are to be based on safety review, taking into account modern international approaches to management of legacy sites. For this purpose, with support of the European Commission, the regulatory body's recommendations "Guideline for Safety Review of Existing Radwaste Storge Facilities and Criteria for Making Decisions on Further Actions at These Facilities" were developed within the Instrument for Nuclear Safety Cooperation (INSC). The specialized plants conduct safety reviews in compliance with the licenses issued by the SNRIU and with account of this Guideline.

Figure 6.1. Storage at Khakriv SISP for radwaste container-type storage

The specialized plants are also involved into actions of competent authorities to mitigate emergencies when orphan radiation sources are found or illicit trafficking of radiation sources is revealed. All these radiation sources are sent to storages of the specialized plants for their safe and monitored storage.

For the entire service period of SISPs, a great quantity of radiation sources and radwaste has been accumulated. The relevant data are provided in Table 6.1.

Table 6.1. Quantities of spent radiation sources and radwaste

Radon SISP	Number of spent radiation sources, psc.	Activity, Bq	Amount of solid radwaste, m^3	Activity, Bq
Donetsk SISP	*220318*	*8.64E+14*	*531*	*7.49E+14*
Kyiv SISP	*93656*	*1.25E+15*	*2094*	*6.04E+15*
Lviv SISP	*96383*	*2.55E+14*	*695*	*6.53E+12*
Odesa SISP	*20134*	*2.61E+16*	*474*	*5.25E+14*
Kharkiv SISP	*109237*	*1.54E+14*	*2070*	*6.8E+12*
TOTAL	***539728***	***2.86E+16***	***5864***	***7.28E+15***

In connection with the counterterrorist operation in the Donetsk region, the Donetsk SISP turned out to be located on the territory that is currently out of Ukrainian control and its operation was terminated by a decision of the control body in the area of radwaste management. Since Donetsk SISP transported only small batches of radwaste to the Kharkiv or Dnipropetrovsk SISPs, no radwaste that could pose a serious threat was located on its territory. At the same time, the plant infrastructure was damaged and will require recovery actions. Until termination of military actions, the function of the Donetsk SISP on the territories under Ukrainian control were transferred to the Dnipropetrovsk SISP.

7. ACTIVITIES IN EXCLUSION ZONE

7.1. Chornobyl NPP Decommissioning

The Chornobyl NPP is decommissioned and associated projects are implemented under License No. 000040, Series EO, issued by the SNRIU on 22 March 2002.

ChNPP is planning to transfer to the next decommissioning stage – final closure and safe storage. In 2014, the SNRIU conducted state nuclear and radiation safety review of the design documentation “Final Closure and Safe Storage of Chornobyl NPP Units 1, 2, 3” as part of the design review. The draft Cabinet Resolution “On Approval of the Construction Design on Final Closure and Safe Storage of Chornobyl NPP Units 1, 2, 3” was agreed. The SNRIU considers the ChNPP application and documentation package submitted to obtain an individual written authorization to proceed with the final closure and safe storage of ChNPP units 1, 2 and 3.

Putting the Chornobyl NPP cooling pond out of operation

The cooling pond is a process water body constructed by creating an artificial dam on the floodplain area of the Prypyat river, separating the cooling pond from the Prypyat river in order to provide the necessary volume of service water for cooling of ChNPP systems in power unit operation. After the 1986 accident, the cooling pond became contaminated. Upon termination of ChNPP operation, water use from the pond substantially reduced.

In 2014, the SNRIU agreed the “Feasibility Study for Putting the Cooling Pond out of Operation”.

At the same time, insufficient funding does not allow to put the cooling pond out of operation in the planned scope, and water level decreases because of inoperable makeup pumps. In this connection, the SNRIU imposed conditions for taking measures on radiological monitoring of the cooling pond before it is put out of operation taking into account its actual characteristics.

ChNPP is provided with service water in accordance with the agreed design “Service Water Supply System. Service Water Source (Service Water Pond) with Pump Makeup Station”.

Facilities for radwaste management at ChNPP

At the ChNPP site, within international technical assistance projects, a number of radwaste management facilities have been constructed and are being commissioned. Commissioning of these facilities will allow treatment of radwaste that has been accumulated and is being generated to make it suitable for safe storage.

Liquid Radioactive Waste Treatment Plant (LRTP) is designed for treatment of liquid radwaste accumulated in liquid waste storages and in liquid and solid waste storages as well as liquid radwaste to be generated in decommissioning.

The LRTP building and main equipment were constructed even before. However, analysis of the LRTP design carried out in 2009 with involvement of KIEP revealed a number of drawbacks in the design, and appropriate changes and upgrades were introduced.

On 28 March 2014, the SNRIU issued individual authorization No. 000040/5 OD for LRTP commissioning. Upon completion of basic commissioning efforts, individual permit No. 000040/7 OD was issued for LRTP operation on 11 December 2014.

State nuclear and radiation safety reviews were conducted for the Final Safety Analysis Report on LRTP, Technical Specifications on Radioactive Waste Package of the Liquid Radioactive Waste Treatment Plant (200-liter drum), Rev. 2 and a number of other operational documents.

Industrial Complex for Solid Radioactive Waste Management (ICSRM) on the ChNPP site combines a series of radwaste management facilities*. Construction of the ICSRM facilities has been completed, and they are being commissioned.

In order to test and ensure performance of all systems, including equipment for radwaste sorting and characterization, three stages are envisaged for commissioning of the **Solid Radwaste Retrieval Facility** (SRRF) and **Solid Radwaste Treatment Plant** (SRTP): stage 1 – radwaste testing in sealed packages with predetermined characteristics, stage 2 – testing with "open" radwaste with known characteristics, stage 3 – testing of radwaste retrieved from compartments of the solid waste storage facility. The SNRIU issued individual authorization No. 000040/6 for stage 2.

Radwaste will be accepted and placed for storage in compartments of the temporary storage for low- and intermediate-level long-lived and high-level waste after commissioning of the solid radwaste treatment plant.

***Temporary storage facility for low- and intermediate-level long-lived and high-level waste** is designed for intermediate (30 years) storage of long-lived and high-level waste to be generated n sorting at the solid radwaste treatment plant and in preparation for the Shelter New Safe Confinement. This storage facility was created by reconstruction and re-equipment of the room located at upper levels of the ChNPP liquid and solid storage which has not been in operation to date;*

***SRRF** – facility for retrieval of solid radwaste from the existing ChNPP solid waste storage and transfer of waste for treatment to SRTP;*

***SRTP** – solid radwaste treatment plant for sorting of solid waste of all categories and treatment (fragmentation, incineration, pressing, cementation) of low- and intermediate-level short-lived solid waste retrieved from the solid radwaste storage and waste resulting from ChNPP decommissioning and Shelter transformation into an environmentally safe system. SRTP also envisages packing of long-lived and high-level waste that will result from sorting and transport of these packages to temporary storage.*

Modernization of production facilities for cutting of long waste

Under the TACIS project for modernization of production facilities for cutting of long waste at the Chornobyl NPP, construction of a facility was started for cutting long waste removed from reactor rooms during decommissioning of ChNPP units 1, 2 and 3 according to the agreed working design. The facility is to be assembled at unit 2 and then moved to units 1 and 3. The main function of the facility is fragmentation (cutting) of long elements of the reactor core with expired life. The long elements are peculiar in that they are from 6 to 22 m in length and 145 mm in diameter, which requires special equipment and management technologies in power unit decommissioning.

In 2014, the project was terminated as the AMEC company, project performer, stopped its activities. The Licensing Plan for the project on modernization of production facilities for cutting of long waste is not complied with. Further prospects for implementation of the project as well as schedule for commissioning of the facility will depend on a decision of the European Commission regarding allocation of additional funding to complete the effort.

Design and research have been started for creation of **additional facilities** for ChNPP radwaste management:

- facility for removal of organics and transuranium elements from Shelter liquid radwaste;

- sections for sorting, fragmentation and decontamination of dismantled structures and equipment;

- facility for removal of dismantled materials from regulatory control.

For further development of the radwaste management system for ChNPP decommissioning, ChNPP developed the “Feasibility Study for Justification of Creation and Siting of Additional Facilities for Management of Radioactive Waste and Radioactive Material in 2014 and submitted it to the regulatory authorities for review.

Existing radwaste management facilities

Radioactive waste accumulated during Chornobyl NPP decommissioning, mitigation of the 1986 accident and waste generated in decommissioning of units 1, 2 and 3 and Shelter transformation into an environmentally safe system are stored in existing radwaste storages on the ChNPP site, such as solid waste storage and liquid and solid waste storage, or are transferred for disposal to *Buryakivka* RWDS.

The liquid waste storage system consists of the following storages interconnected with special piping for liquid waste pumping:

- liquid radwaste storage designed for 26,000 m^3, including five reception tanks for 5000 m^3 and two reception tanks for 500 m^3 made of corrosion-resistance steel;
- liquid and storage radwaste storage, which is operated only for liquid waste storage and is designed for 12,000 $м^3$, including 12 reception tanks for 1000 m^3, made of corrosion-resistance steel;
- storage for spent radioactive oil, consisting of two tanks for 72 m^3 each.

During 2014, 22.06 m^3 of liquid waste generated and was sent for storage at ChNPP including: 12.5 m^3 of evaporation bottoms; 3.66 m^3 of spent ion-exchange resins; 5.90 m^3 of pearlite pulp. As a total, 13,504.70 m^3 of evaporation bottoms, 4,082.36 m^3 of spent ion-exchange resins, 2290.03 m^3 of pearlite pump and 144.75 m^3 of contaminated oil-fuel mixture were accumulated in the liquid waste storages at the end of 2014.

Low- and intermediate-level solid waste generated during decommissioning and Shelter transformation into an environmentally safe system is transferred for disposal to *Buryakivka* RWDS. During 2014, 4146.40 m^3 (5805.40 t) of low-level waste and 13.80 m^3 (15.50 t) of intermediate-level waste were transferred to *Buryakivka* RWDS.

High-level waste is collected into special containers (KTZV-0.2) and placed into the temporary storage for solid high-level waste arranged in the former fresh nuclear fuel storage building. During 2014, 0.03 m^3 (0.012 t) of solid high-level waste generated and was transferred for storage. As a total, this storage houses 3.783 m^3 of high-level and long-lived waste, with activity of 8.59 TBq.

7.2. Construction of Shelter New Safe Confinement

According to the Sate Program for Chornobyl NPP Decommissioning and Shelter Transformation into an Environmentally Safe System, approved by Law of Ukraine No. 886-VI of 15 January 2009, measures taken at the Shelter are qualified as its transformation into an environmentally safe system.

The Shelter is transformed through successive development and implementation of individual plans, projects and program. The most comprehensive among them is the Shelter Implementation Plan (SIP), international technical assistance project.

The main SIP design is creation of the new safe confinement for the Shelter (NSC).

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.

The confinement represents an arch structure with operating period of 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 NSC SC-2 design decisions are under development.

The contractor for design, construction and commissioning of NSC SC-1 is the French Consortium Novarka including VINCI Construction Grands Projets and Bouygues Travaux Publics. Other foreign companies and Ukrainian design, scientific and construction organizations are involved as subcontractors.

Consortium Novarka implements NSC SC-1 through individual projects combined in 6 licensing packages (LP). Preparatory work under projects developed within licensing packages LP1-LP4 have been completed. Licensing package LP4 – dismantling of ventilation stack VT-2 – was removed from the scope of Novarka activities and implemented by Corporation *Ukrtransbud*.

The main physical efforts are implemented within the following licensing packages:

- LP-5: Project – the main structure and systems of the main cranes;
- LP-6: Project – protective structure with process life support systems and necessary infrastructure.

  Authorizations to proceed with the above licensing packages were issued by the SNRIU to SSE ChNPP on 18 November 2011 (for LP-5) and 22 April 2013 (for LP-6) after nuclear and radiation safety review of the design documentation.

For reference. *The NSC arc is assembled on a dedicated site to the west of the Shelter (at a distance more than 200 m) to reduce negative effect from the Shelter on personnel during work. The site is a free-access area.*

According to the design, the eastern part of the arc was moved to the holding area after mounting; after completion of assembling, the two parts will be combined. Then the combined NSC arc will be moved and installed into the design position above the Shelter.

Successful lifting (jacking) of the eastern part of the arc in three stages was important for NSC SC-1 construction during 2012-2013:

- first lifting at a height about 53 m in November 2012;

- second lifting to a level of 85 m in June 2013;

- third jacking to a level of 109 m took several steps and was completed in Ocrober 2013.

During 2014, the following important efforts on NSC were completed at ChNPP in accordance with the documents agreed by the SNRIU:

- in a period from 31 March to 2 April 2014, the NSC eastern part was successfully moved to the holding area – the structure with a total weight of ≈ 12.6 thousand tons was moved for 72 h by 112 m toward the Shelter;
- in May, August and November 2014, the first, second and third (last) lifting of the NSC western part was done;
- at the end of November 2014, the NSC eastern part was moved back to the western part; the distance between the edges of metal structures of both arc parts is 1.35 m.

In the reporting period, ChNPP installed metal structures of the western part of the arc, mounted ventilation system air ducts, arranged external and internal cladding of NSC arc, took efforts on construction of a process building and auxiliary structures, installed electric devices, access gateways for fire brigades, etc.

In 2014, SNRIU performed safety assessment of documents in the framework of regulatory assistance to construction of the NSC first startup complex of the Shelter (NSC SC-1):

- review of nuclear and radiation safety of updated safety assessment reports for the first startup complex of the New Safe Confinement and new ventilation pipe of ChNPP Stage 2 (NVP);
- technical assessment and regulatory decisions on seven projects for taking activities and three packages of operating documentation related to NSC construction;
- review and agreed terms of reference for the development of the NSC integrated management system.

Regarding the sidewalls of NSC, they will consist of existing and newly built structures. Strengthening and sealing of existing building structures that perform the function of NSC protective circuit are not included into the scope of the Consortium Novarca.

Developing of the project on strengthening of existing structures is financed from the Chornobyl Shelter Fund (CSF). The efforts on the project development are completed. The project developer is KSK Consortium (Kyiv Institute *Energoproject*, Research Construction Institute, NPP Operation Support Institute).

At the end of 2014, SNRIU completed review of the working project "Reconstruction of ChNPP Stage 2 Main Building (Units 3 and 4) with Strengthening and Sealing of Building Structures Functioning as NSC Protective Circuit" and acknowledged the project to be in general compliance with nuclear and radiation safety requirements.

On 31 March 2014, the expert report of the *Derzhbudekspertiza* for this project has been issued.

On 4 September 2014, SNRIU issued an individual permit of series OD No. 000033/9 to perform activities on strengthening and sealing of existing building structures in the framework of ChNPP Stage 2, since they function as a protective circuit of the New Safe Confinement.

As it is highlighted at the meetings of CSF Donor-Countries Assembly, physical activities on strengthening of existing structures have to be done at the expense of Ukraine. Timely financial support is needed to avoid delays in NSC project.

On 15 May 2014, the Verkhovna Rada of Ukraine ratified the Agreement on Increasing Contribution to the Chornobyl Shelter Fund (CSF). Ukraine confirmed its readiness to make an additional contribution to CSF in the amount of 63.4 million USD.

It is envisaged that these funds will be primarily forwarded to implementation of the above project.

In preparation for implementation of the NSC second startup complex, namely development of infrastructure for dismantling of unstable structures of the Shelter, ChNPP report on reassessment of the Shelter unstable structures to be early dismantled has been reviewed and provided with comments. Besides, two methodologies developed for implementation of the stated report have been developed.

7.3. Radioactive Waste Management Facilities in Exclusion Zone

The Chornobyl exclusion zone is the territory of Ukraine contaminated by radionuclides after the Chornobyl disaster and from which the population was evacuated during the first years after the accident.

At present, the exclusion zone is an important part of the whole branch of nuclear energy use in Ukraine. According to national strategic and program documents, key components of the infrastructure for ensuring the final stage of activities in nuclear energy use, radwaste and SNF management, safe storage and disposal, are planned to be created in the territory of the exclusion zone.

Creating of such an infrastructure is a condition without which it is impossible to ensure energy security of the state, further improvement of national nuclear and energy sector, use radiation technologies in the economy, science and medicine, meet international principles of ensuring safety and security commitments under the Joint Convention of the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Safety of the final stage of activities in nuclear energy use is the priority in European countries, USA, Canada and other countries using radiation and nuclear technologies.

Information on existing and newly built spent nuclear fuel management facilities in the territory of the exclusion zone is presented in Section 5 "Nuclear Fuel Management".

Creation of a set of radioactive waste management facilities in the exclusion zone in the framework of improving radioactive waste management system of Ukraine includes:

- radioactive waste management facilities at the Vektor site, which have to ensure final stage of radwaste management (centralized disposal and long-term storage) of all Ukrainian producers, and processing of some types of radioactive waste of the exclusion zone and small producers;
- radioactive waste management facilities at ChNPP site;
- siting of the geological repository.

Besides, there are urgent safety issues related to facilities intended for management of emergency Chornobyl origin radwaste generated during the first years of ChNPP accident elimination, and which became elements of system for treatment with large volumes of emergency radwaste. These facilities still to some extent provide confinement and isolation of radwaste from spreading into the environment. However, they require implementation of measures on maintenance, stabilization, safety improvement, monitoring, survey, remediation, safety reassessment.

Vektor Complex

The Vektor site is located in the territory of the exclusion zone at a distance of 11 km in the south-western direction from Chornobyl NPP. The Vektor complex is a set of facilities for decontamination, transport, processing and disposal of radioactive waste. Construction of the complex started in March 1998.

State Specialized Enterprise "Centralized Radioactive Waste Management Enterprise" (SSE CRME) is the operating organization (operator) of the radioactive waste management facilities of the Vektor complex.

Vektor Stage 1 is aimed at disposal of radioactive waste resulting from ChNPP accident. Stage 1 startup complex includes disposal facility for radwaste in reinforced concrete containers (**SRW-1**) and module disposal facility for unpacked and large radioactive waste in bulk (**SRW-2**) with the general capacity of 19 200 m^3 and required infrastructure.

Construction of near-surface disposal facilities of two types: **SRW-1** for radwaste disposal in metal-concrete containers, **SRW-2** for disposal of unpackaged and bulky radwaste with general capacity of 19 200 m^3, as well as equipping the required infrastructure, which ensures operation of the facility, is in progress. Unfortunately, completion of the construction was significantly delayed, all the facilities under construction since 1995 were at the final construction stage already in 2010 (preparedness is more than 90%). However, in the last four years, activities within this uncompleted construction were not conducted at all. The issue on SRW-1, SRW-2 safety assessment using current methodologies is not solved. This shows significant drawbacks in the radwaste management system. At the same time, in the situation when almost all the capacities of *Buryakivka* RWDS are exhausted the absence of new disposal facilities for low-level radwaste can result in blocking activities on ChNPP decommissioning, at the Shelter, in the exclusion zone. Capacities of Ukrainian NPPs for radwaste disposal are not developed.

Figure 7.3.1. Vektor site: near-surface radwaste disposal facilities (SRW-2, SRW-1, ENSDF) and infrastructure

Engineered near-surface disposal facility (ENSDF) with the capacity of 50 210 m^3 for disposal of ChNPP radwaste packages is already operated at Vektor site. The disposal facility consists of two parallel sections each having 11 metal-concrete compartments (modules). The facility is equipped with the central drainage gallery, two movable framed structures with traveling cranes to fill modules, radiation control and environment monitoring system.

Placement of radwaste packages from ChNPP liquid radwaste treatment plant in ENSDF started on 26 April 2014.

Possibility to accept radwaste packages in ENSDF from other suppliers (except ChNPP), in particular, Rivne NPP, Kharkiv SISP is under analysis. The SNRIU agreed relevant Technical Decisions and Acceptance Criteria.

It is planned to perform safety review taking into account practical experience gained during operation and radwaste package characteristics.

Figure 7.3.2. Loading of the first radwaste package lot in ENSDF

In compliance with the feasibility study for Vektor Stage 2 approved by Resolution of the Cabinet No. 1605-r dated 23 December 2009, Vektor Stage 2 envisages constructing a complex of radwaste management facilities:

– storage facilities for high-level and long-lived radwaste including facilities for long-term storage of vitrified waste returning from the Russian Federation after processing of SNF from Ukrainian NPPs;

– centralized facility for long-term storage of spent high-level radiation sources;

– centralized near-surface disposal facilities for radwaste generated during operation of Ukrainian NPPs and accumulated at Radon sites;

– treatment plants for radwaste from ChNPP and Radon sites.

Under assistance of the UK Department of Energy and Climate Change, draft project on construction of centralized long-term storage facility for spent radiation sources **(CLTSF)** is actively implemented. This facility currently has no analogues in the world and is a key element to improve the entire system of spent radiation source management in Ukraine. It should ensure centralized location for more than 500000 pcs. of spent radiation sources of different types and structures, which are now accumulated at Radon sites, as well as after use in medicine, science and industry.

Figure 7.3.3. Centralized long-term storage facility for spent high-level radiation sources

The main CLTSF systems ensuring the cycle on spent source processing (acceptance, sorting, and conditioning), location for long-term storage, and facility operation safety include: hot cells, glove box, encapsulation system, storage sections, radiation monitoring system, ventilation system. The SNRIU agreed technical documentation for components and equipment of these most important systems that confirms high safety standards of their production and functioning. In 2014, construction and mounting activities at the facility were completed; testing and adjustment of the systems were initiated. CLTSF commissioning should be terminated in 2015.

Designing of **long-term radwaste storage facilities** was initiated (with the storage term of over 30 years).

"Feasibility Study of Investment for Interim Storage of Vitrified High-Level Radwaste Returning from the Russian Federation after Processing of Spent Nuclear Fuel from Ukrainian NPPs" for WWER-440 SNF is developed. The SNRIU presented positive conclusion of the feasibility study state review and agreed Draft Resolution of the Cabinet on its approval. The following design stage is development and approval of the disposal facility design. Return of vitrified high-level radwaste to Ukraine is expected in 2018.

Within the projects of the Instrument for Nuclear Safety Cooperation (INSC), it is planned to design long-term storage facilities for high-level and long-lived radwaste before their disposal in geological repository. Generation of such radwaste is expected during removal of radwaste and fuel containing materials from the Shelter, ChNPP decommissioning, operation and decommissioning of other nuclear facilities.

Besides, within INSC, it is planned to design a comprehensive processing facility for radwaste from ChNPP and minor manufacturers, which comprises, in particular, incineration, pressing, and cementation installations.

Radwaste management facilities within exclusion zone territory

The facilities for disposal and confinement of the great amount of radwaste resulted from ChNPP accident were arranged starting from 1986 up to 1987 at implementation of the urgent measures on ChNPP accident elimination. These are the following radwaste disposal sites - *Buryakivka* RWDS, *Pidlisny* RWDS, ChNPP Stage 3 RWDS and radwaste interim confinement points (RICP).

The Ukrainian State Corporation Radon - national operating organization (Operator) for radwaste management at the stage of radwaste long-term storage and disposal - carries out operation of these facilities and implementation of safety support measures considering conditions of licenses issued by the SNRIU, certain permissions, approved designs and technical decisions.

***Buryakivka* RWDS** is under operation since 1987. *Buryakivka* RWDS consists of 30 near-surface radwaste disposal facilities (trenches). The specially arranged clay shield of 1 miter thickness is the main engineered barrier that ensures confinement of radionuclides. Starting from the beginning of *Buryakivka* RWDS operation the total amount of ChNPP origin radwaste disposed in *Buryakivka* RWDS disposal facilities (trenches) makes approximately 683.1 thousands of m^3 of radwaste with total activity of $2.54x10^{15}$ Bq.

Buryakivka RWDS is one of the main elements of radwaste management system, designed for the management of the great amount of the radwaste resulted from ChNPP accident, constructed in the framework of implementation of urgent accident elimination measures. Up to now, the operation of this RWDS disposal facilities ensures disposal of the great amount of low-level radwaste generated as a result of works at ChNPP site and as a result of activity at contaminated territories of the exclusion zone. The current capacity of *Buryakivka* RWDS is almost exhausted, in 2014 the last of 30 disposal facilities was filled up.

The *Buryakivka* RWDS safety reassessment was carried out in 2013-2014 with the assistance of the European Commission in order to take possible decisions on its reconstruction (extension) and on corresponding nuclear and radiation safety review. In this direction the vital is to intensify efforts on the development and making of certain design decisions considering the requirements for this facility safety ensuring in the long-term perspective – 500 years and more, and for its location in the exclusion zone.

Besides, the specially equipped *Buryakivka* RWDS site includes technical equipment used at ChNPP accident elimination. In 2014, Radon performed dismantling, fragmentation and release from the regulatory control of this technical equipment in compliance with technical decisions approved by the SNRIU.

The *Pidlisny* RWDS* and ChNPP Stage 3 RWDS ** undergo maintenance and safety improvement. The radwaste resulted from ChNPP accident, disposed at these facilities, were classified as high-level long-lived radwaste that should be disposed in geological repository. Therefore, these RWDS are not considered as disposal facilities. It is necessary to ensure stabilization, degradation protection and confining functions of existing engineered barriers up to the moment when it will be possible to withdraw and redispose the radwaste in geological repository.

With this purpose, the agreed project “Closure of *Pidlisny* RWDS disposal facilities” was implemented in 2011-2012, also the service cover over modules, new banking, water removal system were constructed and 8 additional inspection wells were arranged.

At the same time, the implementation of the agreed project “Closure of ChNPP Stage 3 RWDS disposal facilities”, that envisages construction of additional engineered barriers (new multilayer protection shield over existing modules with radwaste), of upgraded drain system and monitoring system and improvement of the facility infrastructure (access and drive ways, physical protection system, etc.), was stopped due to the lack of financing.

The additional survey and development of RWDS safety reassessment methodology were started in the framework of INSC and with the assistance of the European Commission in order to substantiate RWDS safety margin considering stabilization and safety improvement measures.

** Pidlisny RWDS was constructed in the framework of implementation of the urgent measures on ChNPP accident elimination. In 1986-1988 Modules A-1, B-1 of this RWDS contained the most hazardous high-level and long-lived radwaste resulted from the accident (fuel containing materials, radioactive graphite, etc., that were released from the reactor in the process of accident).*

*** ChNPP Stage 3 RWDS was arranged in the framework of implementation of the urgent measures on ChNPP accident elimination in partially constructed solid radwaste storage facility of unfinished ChNPP Stage III. In 1986-1988, the reinforced concrete modules of this facility contained low and intermediate-level radwaste resulted from the accident. Through the years appears the degradation of the upper banking, arranged in hurry, what requires constant maintenance.*

The works on survey of RICP*** area in the exclusion zone are carried out, also the trenches and pits are maintained in the safe state. The works on survey of RICP area with the use of Mobile Laboratory Complex, works on safety assessment and rehabilitation of these areas started in 2014 with the assistance of the European Commission in the framework of INSC. The survey and safety assessment goal is to find and clarify the location of trenches and pit with radwaste, to clarify composition and activity of the radwaste, to take decisions on dismantling (or preservation) of trenches and on subsequent rehabilitation of the territory.

The works on withdrawal and redisposal of the radwaste from RICP trenches and pits, that can have most negative effect on personnel of the exclusion zone and environment, are carried out. For the period of 2012, 8342,8 m^3 of the radwaste with total activity of 0,67 TBq were transferred for disposal in *Buryakivka* RWDS from of *Nova Budbasa* RICP trenches and pits located at construction site of ISF-2 and NSC, and also from *Naftobasa* RICP characterized with seasonal flooding.

**** RICP (radwaste interim confinement points) – territories adjacent to ChNPP with total area of about 10 ha at which, in the framework of implementation of urgent measures on elimination of ChNPP accident, the trenches and pits for radwaste confinement were arranged. In general, such radwaste represent building structures, household stuff, top soil, etc., contaminated, as a result of the emergency release.*

Nine RICPs are located at the territory of the exclusion zone: "Yanov Station", "Naftobasa", "Pischane Plato", "Rudyy Lis", "Stara Budbasa", "Nova Budbasa", "Pripyat", "Kopachi", "Chistohalivka" with total area of about 10 ha which territory include trenches and pit with radwaste. The assessed quantity of RICP trenches and pits makes from 800 up to 1000, the exact location places of some of them should be clarified.

8. INTERNATIONAL ACTIVITY

SNRIU international cooperation is an integral part of developing the national system of nuclear and radiation safety regulation to achieve world standards on nuclear and radiation safety in Ukraine.

SNRIU implements a range of intergovernmental and interdepartmental agreements in the sphere of nuclear and radiation safety with both world's leading countries operating NPPs, and countries, which recently started the implementation of nuclear energy programs.

During many years of activity of the Ukrainian regulatory body, an efficient partnership has been developed with the regulatory authorities of the United States, Germany, France, Finland, Sweden, and cooperation with Norway is under development.

Multilateral treaty mechanisms and tools in which Ukraine is engaged, including its membership in the international organizations, are of great importance among the variety of areas of the international cooperation.

The world's leading organization aimed at achieving the widest nuclear energy use for peaceful purposes in the countries of the world is the International Atomic Energy Agency (IAEA). The IAEA is an international intergovernmental organization of the UN system. Ukraine is a state-founder of the IAEA and supports the Agency since its founding in 1957. Ukraine shares the statutory objectives of the Agency and supports the IAEA to ensure nuclear energy use for peaceful purposes.

Ukraine is a party of important international tools of the Agency such as the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, the Convention on Assistance in Case of Nuclear or Radiological Emergency, the Convention on Early Notification of a Nuclear Accident, the Convention on Physical Protection of Nuclear Materials, and Vienna Convention on Civil Liability for Nuclear Damage, etc.

Thus, under the Convention on Nuclear Safety, the Sixth Review Meeting of member countries has been carried out from March 24 to April 4, 2014 in Vienna (the Republic of Austria) aimed at reviewing the national reports on obligations under this Convention. The National Report of Ukraine prepared by SNRIU jointly with the Ministry of Energy and Coal Industry of Ukraine, the State Agency of Ukraine for Exclusion Zone Management, and *Energoatom* was presented during the meeting. Resulting from the Report, a number of comments was made for Ukraine to be considered during the next review cycle; the results of their consideration should be reported during the Seventh Review Meeting.

On May 12-13, 2014, in the city of Vienna (the Republic of Austria), the second extraordinary meeting of the member countries of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (hereinafter - the Joint Convention) was held, and on May 14-15, 2014, the first inception meeting on preparation to the Fifth Meeting on obligations under the Joint Convention was carried out. The objective of this extraordinary meeting was consideration of amendments to the Rules of the Procedure and Financial Rules of the Joint Convention (INFCIRC/602/Rev.4), Guidelines on the Review Process, and Guidelines on Form and Structure of the National Reports (INFCIRC/603/Rev.5 and INFCIRC /604/Rev.2 respectively). Within the Fifth Review Cycle of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, the State Nuclear Regulatory Inspectorate of Ukraine jointly with the State Agency of Ukraine for

Exclusion Zone Management, Chornobyl NPP, and *Energoatom* prepared the Fifth National Report of Ukraine on the implementation of obligations under the Joint Convention, which was posted on the closed web portal of the Joint Convention.

In 2014, continued fruitful cooperation of SNRIU with the IAEA Secretariat related to implementation of the National Projects of the Technical Cooperation Program for 2014-2015 was provided. In 2014, four new project proposals for the cooperation projects for the period of 2016-2017 were developed and submitted to the IAEA. These new projects are aimed at strengthening of regulatory capabilities in the sphere of the state review, ChNPP decommissioning, radioactive waste management, establishment of the National Center of Biological Dosimetry, etc.

In response to temporary annexation of the territory of the Autonomous Republic of Crimea by the Russian Federation, and under the Resolution of the UN General Assembly of 27 March 2014 "The territorial Integrity of Ukraine” (A/Res/68/262), the SNRIU worked out a package of proposals on amending the existing international conventions and agreements such as the Agreement between Ukraine and the International Atomic Energy Agency on Safeguards related to the Treaty on the Non-Proliferation of Nuclear Weapons, the Convention on Physical Protection of Nuclear Material and Nuclear Facilities, and the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management. The proposals were sent through official channels for consideration to the IAEA management.

Figure 8.1. Report of Serhii Bozhko, SNRIU Chairman, at the 58th IAEA General Conference

During the 58th IAEA General Conference held on 22-26 September 2014 in Vienna (Austria), SNRIU Chairman had a number of officials meetings with IAEA Director General Yukiya Amano and Deputies of IAEA Director General, official delegates of European countries and USA to support Ukraine in proposed amendments to international documents.

During the Hague Nuclear Security Summit in 2014, Sweden and Norway stated that they were going to initiate trilateral cooperation in Ukraine in the field of nuclear safety and security as a response to new challenges posed not only before Ukraine but also world community. The Initiative was developed in 2014 through a number of high-level meetings, which resulted in agreement of four projects intended to ensure safety and security of Ukrainian NPPs, upgrades of the physical protection system and other NPP infrastructure, enhancement of regulatory supervision and control of nuclear safety and security, enhancement of inspection capabilities and improvement of legislation. Under the trilateral initiative, the trilateral statement of cooperation in the field of nuclear safety was signed between Ukraine, Norway and Sweden on 18 November 2014 in Kyiv (during visit of the Prime Minister of Norway, E. Solberg). The parties agreed to report on the implementation of joint projects during the next Nuclear Security Summit in the USA in 2016.

Figure 8.2. Signature of trilateral statement of cooperation in the field of nuclear safety and security between Ukraine, Norway and Sweden

In 2014, SNRIU initiated cooperation with the Norwegian Radiation Protection Agency (NRPA). Thus, Draft Agreement between SNRIU and NRPA on cooperation in the field of nuclear and radiation safety was agreed during the first consultations in October 2014 in Oslo. This Agreement was signed during the visit of Prime Minister of the Kingdom of Norway E.Solberg to Ukraine on 18 November 2014. At the same time three projects of cooperation for 2015-2016 were agreed by SNRIU and NRPA based on the meeting results. They envisage development of regulatory requirements for radioactive waste management safety before disposal and during final disposal, support to SNRCU in developing regulations on radiation protection in medicine and enhancement of the institutional control over uranium mining and processing facilities.

The program of bilateral cooperation with the Swedish Radiation Safety Authority (SSM) in 2014 included successful implementation of joint bilateral projects aimed at improving the regulatory framework for long-term operation of Ukrainian NPP units, supporting development of SNRIU information technologies, in particular development of website on nuclear safety and non-proliferation Uatom.org., supporting the system for accounting and control of nuclear material. In September and November 2014, SSM arranged two training courses in the George Kuzmycz Training Center within the personnel development program for SNRIU inspectors on physical protection of nuclear facilities, nuclear material and other radiation sources.

In 2014, cooperation with the United States became more active. A number of meetings with the management of the US Nuclear Regulatory Commission, US Department of Energy and State Department was held during the visit of SNRIU delegation to the USA in July. The US party expressed its full support to Ukraine and agreed a number of project proposals of SNRIU on cooperation. Thus, during the meeting in Kiev in December 2014, US NRC confirmed allocation of additional assistance to implement four new projects, among which the most important is to provide support to SNRIU in moving the state inspectors of the South-Eastern Inspection from Donetsk and Lugansk to Zaporizhzhya.

Figure 8.8. At the meeting between U.S. NRC and SNRIU Chairpersons

In 2014, the project on cooperation with the US Department of Energy was intensively implemented. It was aimed at improving security of radiation sources in Ukraine. Under the project for SNRIU, activities on establishing the main monitoring center to observe security in using radiation sources in medical institutions of Ukraine were performed.

International non-governmental organizations and associations achieve a special authority in implementing the international cooperation on nuclear and radiation safety. WENRA (Western European Nuclear Regulators Association) goes ahead among the leading European non-governmental organizations. It was established in 1999 on a voluntary basis by the regulatory bodies of EU Member States and Switzerland to develop common standards of nuclear and radiation safety in EU and establish assessment criteria of the regulatory sphere in the countries planning to join EU. Since 2009, Ukraine is an associate member of WENRA.

WENRA was founded in 1999 as an association of senior management (heads) of the Western European regulatory authorities of the countries having at least one nuclear facility under construction, operation or decommissioning. In 2003, the list of WENRA member states was extended due to membership of new countries in the European Union.

Today, WENRA Association includes: Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Italy, Lithuania, Netherlands, Romania, Slovenia, Slovakia, Spain, Sweden, Switzerland, and the United Kingdom. Ukraine, Austria, Norway, Poland, and the Russian Federation are included to WENRA Association as observer countries.

The main WENRA tasks are to:

- develop and improve methods of independent safety assessment of nuclear installations based upon their in-depth knowledge;
- development of general approaches related to nuclear safety and its regulation as well as support to harmonization of requirements in practices.

To implement the above tasks, two WENRA work groups were established in 2002; one of the them is the work group on radioactive waste management and decommissioning (WGWD).

The objective of this work group is to develop the so-called safety reference levels (SRLs) and subsequent analysis of national legislation and development of National Action Plans to harmonize regulations of WENRA member states with the SRLs. The main documents for the development of SRLs are IAEA safety standards and experience in activities in the field of radwaste management and decommissioning.

Ukraine recognizes the importance of international cooperation between regulatory authorities for harmonization of regulatory requirements on NPP safety, safety in management of spent nuclear fuel and radioactive waste and NPP decommissioning and took an active part in WENRA plenary sessions and work groups. In October 2014, SNRIU Chairman officially applied to WENRA for Ukraine to acquire full membership. Announcement of the decision about WENRA membership is on the agenda of the spring plenary session in 2015 to be held in Geneva (Switzerland).

In order to ensure harmonization of Ukrainian regulatory requirements on decommissioning with the WENRA reference levels, SNRIU Order No. 174 of 11 November 2014 approved the “Schedule for Harmonization of Ukrainian Regulatory Requirements with WENRA Safety Reference Levels”.

Self-evaluation of Ukrainian regulations on decommissioning has started to verify their compliance with WENRA safety reference levels.

The WENRA safety reference levels on radioactive waste management are taken into account by the SNRIU in development of new regulations on general provisions on radwaste management, particularly for waste disposal and pre-disposal management.

Annex 1

VIOLATION OF BUDAPEST MEMORANDUM

In late February 2014, Russian troops invaded the Autonomous Republic of Crimea, thus cynically violating their obligations specified in the Budapest Memorandum. The paradox lied in the fact that the territorial integrity of Ukraine was violated by the guarantor of this territorial integrity, moreover, the aggression was made by the state possessing nuclear weapons.

The international community has recognized violation of the Budapest Memorandum provisions with respect to Ukraine. This was stated by UN Secretary General Ban Ki-Moon in his speech at the Nuclear Security Summit held in The Hague on March 24, 2014. He noted that security safeguards were an important condition for Ukraine's joining to the Non-Proliferation Treaty (NPT), but their reliability was seriously undermined by events around Ukraine. The UN Secretary General expressed the view that this will have negative consequences for both regional safety and the whole non-proliferation regime. Non-compliance with the Budapest memorandum conditions formed a dangerous precedent in the world nuclear safety system.

For immediate and coordinated resolving issues in the field of nuclear non-proliferation safeguards, physical protection of nuclear materials and facilities, nuclear and radiation safety on the temporarily occupied territory of the Crimea, SNRIU formed a temporary working group by Order No. 50 dated 24 April 2014, powers of this working group were extended also to the anti-terrorist operation areas by Order No.144 dated 03 October 2014. SNRIU also developed proposals to the Cabinet of Ministers of Ukraine to establish the Interagency Working Group (IWG) for resolving the issues on security and nuclear non-proliferation safeguards on the temporarily occupied territory of Crimea.

Such nuclear facilities as nuclear research reactor IR-100 of Sevastopol National University of Nuclear Energy and Industry (SNUYaEiP) and two subcritical assemblies for low enriched and natural uranium are located on the territory of Crimea. At the time of annexation, reactor was shut down. Security of the facility was provided by the security forces of the Internal Troops of the Ministry for Internal Affairs of Ukraine, 3042 troop unit formed of locals who under pressure began to come over to the RF side. Control over the object was completely lost in May. Moreover, in the Crimea there are several enterprises and medical institutions, which use equipment and containers with radiation protection of depleted uranium and high-level radiation sources (5 institutions, mainly oncological clinics).

SNRIU tried to keep the situation in the Crimea under control and perform its duties in nuclear security and nuclear non-proliferation safeguards on the temporarily occupied territory for the following several months. First of all, under the instruction, our territorial subdivision, the Crimean State Inspection, conducted urgent unscheduled inspection of physical protection, accounting and control of nuclear materials at the facilities listed above and physical protection at facilities using radioactive sources. Communication with the Crimean State Inspection on Nuclear and Radiation Safety was actually lost in May-June and in September it officially passed to the control of the Russian Rostekhnadzor. Any report on physical inventory of nuclear material for 2014 was not received from the licensees located in the Crimea.

South-Easter State Inspection on Nuclear and Radiation Safety located in Donetsk continued its work and in December 2014, it was transferred to Zaporizhzhya. As for licensees located in the Donetsk and Lugansk regions, the reports were received almost from each of them. In the area of so-called Lugansk People's Republic and Donetsk People's Republic there are no nuclear facilities, only small amount of nuclear materials in the form of radiation protection of containers for transportation and storage of radiation sources and X-ray equipment in oncological clinics, as well as high-level radiation sources.

SNRIU activity on implementing the international agreements, due to which it is a competent authority, comes to the forefront. Consequently, on 26 March 2014, a special report pursuant to implementing Art. 68 of the Safeguards Agreement in connection with the Non-Proliferation Treaty ratified by Law of Ukraine No.737/97-VR dated 17 December 1997 was sent to the IAEA Secretariat. The report informed that Ukraine lost control over nuclear materials and facilities located on the Crimean territory, which meant the impossibility to fulfil the international obligations by Ukraine in full scope due to occupation of the part of Ukrainian territory by the Russian Federation.

Since March 2014, the SNRIU actively cooperates with the Ministry of Foreign Affairs and the Permanent Mission of Ukraine to the International Organizations in Vienna providing expert technical assistance and making joint solutions. In a letter to the Ministry of Foreign Affairs, SNRIU expressed its consent to proposed spread of the note of MFA of Ukraine No. 413/23-190-703 dated 22 March 2014 among the IAEA member states. At the same time, opinion of the Agency Secretariat on the need to comply with the IAEA Statute and current international standards in the application of IAEA safeguards was supported.

According to Art. 5 of the Convention on Physical Protection of Nuclear Material and Nuclear Facilities ratified by Ordinance of the Verkhovna Rada of Ukraine No. 3182-12 dated 05 May 1993, in case of receiving the information on any transfer, use or change of nuclear materials or if real risk of such actions occurred, Ukraine should inform IAEA and/or its member states. This information was provided to the Ministry of Foreign Affairs of Ukraine to further inform the IAEA.

On 27 March 2014, the UN General Assembly adopted Resolution 68/262 "The Territorial Integrity of Ukraine". One hundred of states voted for this Resolution.

In addition, according to the proposal, the National Security and Defence Council of Ukraine and the Permanent Mission sent a letter to the IAEA Director General on arranging a special IAEA inspection of the Crimean nuclear facilities. On 7 April 2014, a meeting was held of the Permanent Representative of Ukraine I.Prokopchuk and IAEA Director General Yu.Amano to discuss Ukraine's initiative on sending a special IAEA inspection to the Crimea. During this meeting, Mr. Amano specified that although Ukraine has lost control over nuclear materials on the peninsula, it has not violated its international obligations. He confirmed that IAEA will continue to apply nuclear non-proliferation safeguards in Ukraine based on the fact that the Autonomous Republic of Crimea is an integral part of Ukraine.

In practice, it turned out that the situation with the annexation of the Ukrainian territory was not regulated legally in the international documents on nuclear safety, physical protection of nuclear materials and facilities, as well as nuclear non-proliferation safeguards. SNRIU also developed proposals on amending the international agreements, which were submitted to the IAEA member states for consideration.

Meeting of IAEA Director General Yukiya Amano and SNRIU Chairman Serhii Bozhko

In the letter dated 22 September 2014, IAEA informed Ukraine on the extension of applying safeguards in compliance with its Statute and international law. This was confirmed during the meeting of the Ukrainian delegation and Mr. Yukiya Amano, IAEA Director General, under the 58th IAEA General Conference. Since the beginning of the Crimea occupation and anti-terrorist operation, IAEA inspections in these regions were not carried out.

Annex 2

SITUATION IN DONETSK AND LUHANSK REGIONS

On 14 April 2014, Decree of the President of Ukraine No. 405/2014 “On the Decision of the National Security and Defense Council of Ukraine dated 13 April 2014 “On Urgent Measures to Overcome the Terrorist Threat and Preserve Territorial Integrity of Ukraine” came into force.

Since June 2014, continuous battles have been conducted at some territories of the Donetsk and Luhansk Regions occupied by illegal armed groups using mortars, heavy cannon artillery, multiple launch rocket systems and small arms. Terrorists took under control large territories located under the South-Eastern State Inspectorate area of responsibility, including regional centers, namely Donetsk and Luhansk. These areas are the largest in Ukraine in the number of industrial coal, metallurgical, chemical and mining enterprises that belong to the economy branches with increased risk, since they can apply sealed radionuclide radiation sources. 65 facilities applying radiation sources (including eight institutions with category I high-level radiation sources of activity over 1000 Curie) remained without state regulatory control of nuclear and radiation safety by Ukraine.

However, employees of the South-Eastern State Inspectorate stayed at their working places and continued implementation of the state policy of Ukraine aimed at ensuring nuclear and radiation safety for almost seven months in 2014 (from June to December) in the face of conducted anti-terrorist operation and military actions. The analysis of radiation safety ensured by facilities using radiation sources (information received from licensee annual reports, communication with responsible individuals, indirect data, etc.) showed its significant degradation. This particularly applies to storage and physical protection of radiation sources. For example, the South-Eastern State Inspectorate has official data on at least two facts of destroyed sealed radionuclide radiation sources used in the international automobile checkpoints across the state border of Ukraine “Izvaryne” (device for detecting smuggle completed by radiation source with barium-133) and in PJSC “Aircompany Constanta” (radioisotope ice detector RIO-3A completed by radiation source with strontium-90+yttrium-90).

Automobile checkpoint "Izvaryne"

RIO-3A was installed in the aircraft Yak-40 UR-MMK, which landed in the Donetsk International Airport, and was under fire and burned completely increasing the risk of radioactive contamination of the environment.

Donetsk International Airport

Destroyed airplane

According to unofficial data, currently 15 radiation sources with strontium-90+yttrium-90, which were part of the radioisotope ice detectors RIO-3A used for monitoring aircraft icing and stored in separate rooms of the Luhansk International Airport and Luhansk Aircraft Repair Plant, are destroyed.

Luhansk International Airport

Luhansk Aircraft Repair Plant

RIO-3A Ice Detectors

Military actions lead to flooding of three coal mines of Donbass using radionuclide radiation sources due to damage of power supply systems. Currently the situation cannot be tracked.

Unfortunately, there is no information on radiation safety at two major coal enterprises of Donbass (Donetsk Coal Energy Company and SE Luhanskvuhillia), which combine 15 coal mines located in the territory not controlled by Ukraine. These mines use the total of 142 radiation sources (maximum rated activity of a single source reaches

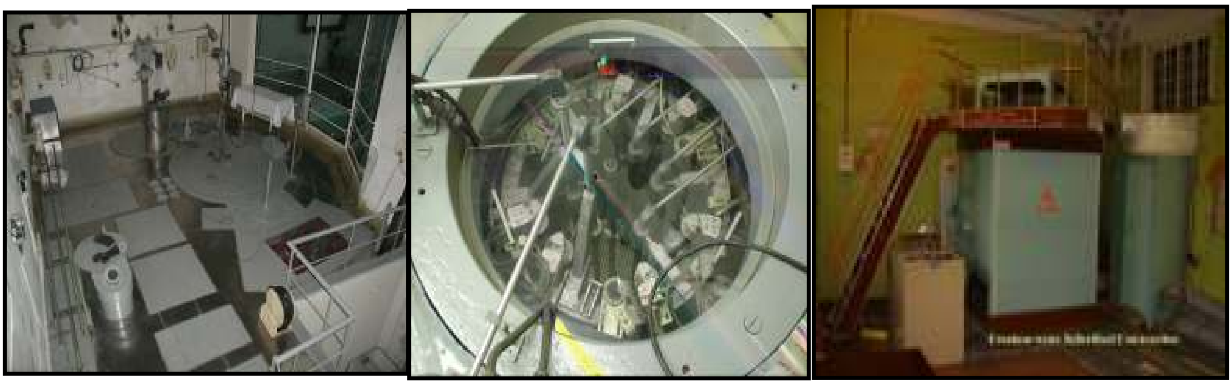
2.35×10^{11} Bq). There is no information on the state of preserved radioactive waste storage facility located in the territory of the Donetsk State Plant of Chemical Products, which experienced a powerful explosion in the end of 2014.

Besides, three licensees informed the South-Eastern State Inspectorate on the impossibility to ensure physical protection of radiation sources due to seizure of facilities by armed groups of so-called Donetsk People's Republic and Luhansk People's Republic.

NUCLEAR INSTALLATIONS IN AUTONOMOUS REPUBLIC OF CRIMEA

The following nuclear installations are located in the Autonomous Republic of Crimea (hereinafter called the Crimea):

1. Research reactor DR-100 with thermal power of 200 kW, physical start-up of which was performed on 18 April 1967;
2. Physical test facility (critical assembly) located in massive of DR-100 reactor biological protection. The facility was commissioned in 1974;
3. Subcritical uranium-water assembly (hereinafter called SUWA) located in the educational building of the university. The facility was commissioned in 1964.



General view of DR-100, critical assembly, SUWA correspondently

The same fuel elements with 10% enrichment of uranium-235 are used in the reactor and critical assembly cores. SUWA uses nuclear fuel with 0,7% enrichment of U-235.

DR-100 protection control system was updated in 1977.

All the above mentioned nuclear installations are operated by the Sevastopol National University of Nuclear Energy and Industry (hereinafter called SUNEI) according to SNRIU license of series EO No. 000131 dated 24 June 2003 on a right to perform activity “operation of nuclear installations” (hereinafter called License EO 000131).

In view of the fact that the design and engineering documentation did not define design operational lifetime for DR-100, its lifetime was extended (the last extension took place in 2007) based on assessment of the technical state of critical components, namely control and protection system, reactor tank, cable lines and switching devices of systems important to safety.

General view of DR-100

According to technical decisions agreed with SNRIU, lifetime of critical components was justified to 31 December 2012.

At the beginning of 2012, upon the expiration of justified lifetime of critical components, SNRIU obliged the operating organization to perform safety review of DR-100 and submit periodical safety review report (hereinafter called PSRR) in order to define new terms and conditions for DR-100 safe operation.

Since the stated requirement has not been performed within the established deadline, SNRIU sent a letter to SUNEI on 29 December 2012 with the **requirement** to operate DR-100 only in a shutdown mode from 01 January 2013 in accordance with requirements of operating documents, and the **prohibition** to perform any activity at the reactor facility related to “preparation for start-up” and “start-up” of the research nuclear reactor till the SNRIU final decision on possibilities and conditions of further safe operation of DR-100 according to results of nuclear and radiation safety state review.

General view of DR-100

During 2013-2014, SUNEI successfully continued efforts on justification of further DR-100 safe operation and PSRR revision in accordance with comments of state review of nuclear and radiation safety. In particular, in September 2014, SNRIU informed SUNEI about the absence of comments on two sections of PSRR: "Arrangement and management of DR-100 operation" and "Impact of DR-100 nuclear facility operation on the environment".

Unfortunately, efforts of PSRR revision have not been completed due to annexation of the Crimea by the Russian Federation.

SUWA, following completion of SNRIU requirements regarding replacement of polypropylene shell pipes for dural pipes envisaged by the design, since 2012 has been actively involved into training and research activities, modeling and experimental study of neutron processes in uranium-water lattices of uranium-water assembly in presence of the external source.

In April-June 2014, after annexation of the Crimea by the Russian Federation, SNRIU performed the following efforts in accordance with prescribed obligations:

On 01 April 2014 and 04 April 2014, in order to implement provisions of Article 5 of the Convention on the Physical Protection of Nuclear Material and Nuclear Facilities ratified by Order of the Verkhovna Rada of Ukraine No. 3182-12 dated 05 May 1993 regarding informing of IAEA and/or member states in case of receiving any information on any transfer, use or change of nuclear material, or in case of real hazard of such an action (which exactly took place on the territory of the temporary occupied Crimea), SNRIU submitted the relevant information to the Ministry of Foreign Affairs of Ukraine for further informing of IAEA;

On 24 April 2014, in order to ensure prompt and coordinated solution of challenging issues in area of nuclear weapons non-proliferation safeguards, physical protection of nuclear materials and facilities, nuclear and radiation safety, SNRIU created temporary working group led by the Deputy Chairman;

On 21 May 2014, SNRIU submitted an appeal to SUNEI with the requirement for immediate correction of incompliance with regulations and rules of nuclear and radiation safety and physical protection, and unconditional compliance with the License EO No. 000131;

On 05 June 2014, SNRIU informed the management of the operating organization on unscheduled target inspection of SUNEI regarding the absence of any response to the previous appeal, but the latter has not confirmed its preparedness within the established deadline;

On 16 June 2014, taking into account absence of any response of the licensee to the request of the regulatory authority and failure to implement any corrective measures, SNRIU **terminated** License EO 000131 in accordance with the established procedure and informed the licensee by letter with stated terms of the license renewal;

As of 01 January 2015, none of the conditions stated for renewal of License EO 000131 have not been met.

It should be noted that issue on SUNEI nuclear facilities is under control of IAEA, which during numerous meetings and consultation confirmed that it finds radioactive materials and nuclear installation located in the Crimea and Sevastopol the property of Ukraine.

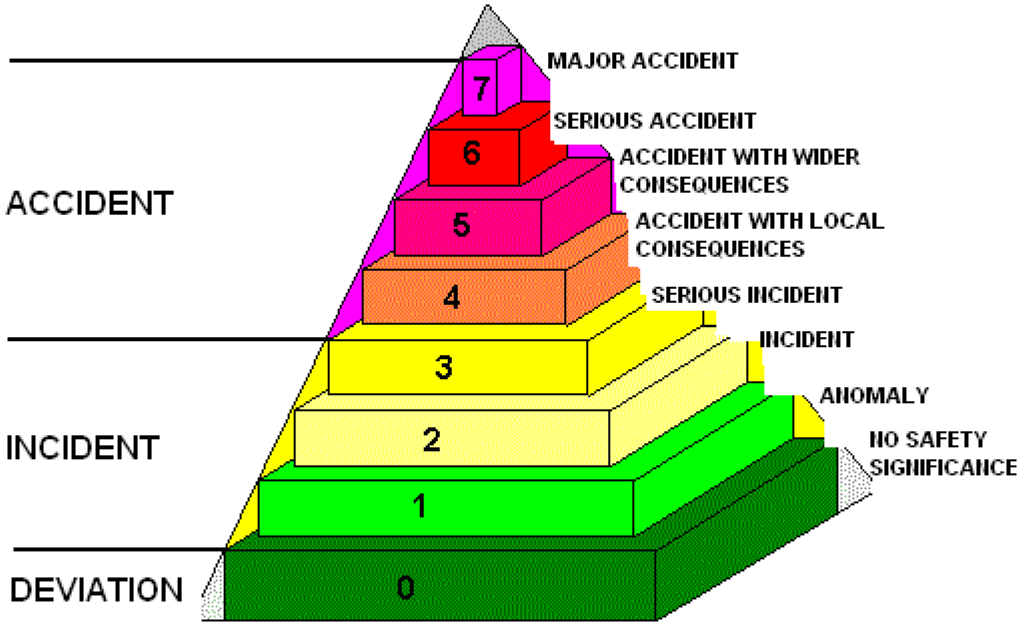
INTERNATIONAL NUCLEAR AND RADIOLOGICAL EVENT SCALE

The International Nuclear and Radiological Event Scale (INES) is a worldwide tool for communicating to the public in a consistent way the safety significance of nuclear and radiological events.

The INES explains the significance of events from a range of activities, including industrial and medical use of radiation sources, operations at nuclear facilities and transport of radioactive material.

The INES was developed by the IAEA in 1988 and introduced in 1990 to rank events at NPPs. It was extended with time to apply to all civil nuclear installations. By 2006, it was adapted to meet the needs for communicating all significant events associated with the transport, storage and use of radioactive material and radiation sources.

Events are classified on the scale at seven levels: levels 1–3 are called 'incidents' and levels 4–7 'accidents'. The scale is designed so that the severity of an event is about ten times greater at each increasing level. Events without safety significance are called 'deviations' and are classified below scale/level 0.



The INES classifies nuclear and radiological accidents and incidents by considering three areas of impact:

People and the Environment considers the radiation doses to people close to the location of the event and the widespread, unplanned release of radioactive material from an installation.

Radiological Barriers and Control covers events without any direct impact on people or the environment and only applies inside major facilities. It covers unplanned high radiation levels and spread of significant quantities of radioactive materials confined within the installation.

Defense-in-Depth also covers events without any direct impact on people or the environment, but for which the range of measures put in place to prevent accident did not function as intended.

Examples of Events at Nuclear Installations

	People and Environment	Radiological Barriers and Control	Defense-in-Depth
Level 7 Major accident	*Chernobyl accident, 1986* *Fukushima-Daiichi accident (Japan), 2011* – severe consequences for public health and the environment. External release of a significant fraction of reactor core inventory.		
Level 6 Serious accident	*Kyshtum, Russia, 1957* – significant release of radioactive material to the environment from explosion of a high-activity waste tank.		
Level 5 Accident with wider consequences	*Windscale Pile, UK, 1957* – release of radioactive material to the environment following a fire in the reactor core	*Three Mile Island, USA, 1979* – severe damage to the reactor core	
Level 4 Accident with local consequences	*Tokaimura, Japan, 1999* – fatal overexposure of workers following a criticality event at a nuclear facility.	*Saint Laurent des Faux, France, 1980* – melting of one fuel channel in the reactor with no off-site release.	
Level 3 Serious incident	No examples.	*Sellafield, UK, 2005 – release of large quantity of radioactive material contained within the installation.*	*Vandellos, Spain, 1989* – near accident caused by a fire resulting in loss of safety systems at the nuclear power plant.
Level 2 Incident	*Atucha, Argentina, 2005* – overexposure of a worker at a power reactor exceeding the annual limit.	*Cadarache, France, 1993* – spread of contamination to an area not expected by design.	*Forskmark, Sweden, 2006* – degraded safety functions for common-cause failure in the emergency power supply system at the nuclear power plant.
Level 1 Anomaly			Breach of operating limits at a nuclear facility.

Examples of Events Involving Radiation Sources and Transport

	People and Environment	Defense-in-Depth
Level 7 Major accident		
Level 6 Serious accident		
Level 5 Accident with wider consequences	*Goiânia, Brazil, 1987* – four people died and six received doses of a few grays from an abandoned and ruptured highly radioactive Gs-137 source.	
Level 4 Accident with local consequences	*Fleurus, Belgium, 2006* – severe health effects for a worker of a commercial irradiation facility as a result of high doses of radiation.	
Level 3 Serious incident	*Yanango, Peru, 1999* – incident with radiography source resulting in severe radiation burns.	*Ikitelli, Turkey, 1999* – loss of a highly radioactive Co-60 source
Level 2 Incident	*USA, 2005* – overexposure of a radiographer exceeding the annual limit of radiation workers.	*France, 1995* – failure of access control systems at an accelerator facility. .
Level 1 Anomaly		Theft of a moisture-density gauge.

List of Abbreviations

C(I)SIP	–	Comprehensive (Integrated) Safety Improvement Program
ChNPP	–	Chornobyl NPP
CSFSF	–	Centralized Storage Facility for Spent Nuclear Fuel
DSFSF	–	Dry Storage Facility for Spent Nuclear Fuel
EC	–	European Commission
Energoatom	–	National Nuclear Energy Generating Company *Energoatom*
ENSDF	–	Engineered Near-Surface Disposal Facility for Solid Radioactive Waste at *Vektor* site
ENSREG	–	European Nuclear Safety Regulatory Group
EU	–	European Union
IAEA	–	International Atomic Energy Agency
ICSRM	–	Industrial Complex for Solid Radioactive Waste Management
INES	–	International Nuclear and Radiological Even Scale
ISF	–	Interim Storage Facility for Spent Nuclear Fuel
KhNPP	–	Khmelnitsky NPP
LRTP	–	Liquid Radioactive Waste Treatment Plant
NPP	–	Nuclear Power Plant
NRBU	–	Radiation Safety Standards of Ukraine
NRS	–	Nuclear and Radiation Safety
NSC	–	New Safe Confinement
Radon	–	Ukrainian State Association *Radon*
Radwaste	–	Radioactive Waste
RBMK	–	High-Power Channel-Type Reactor
RNPP	–	Rivne NPP
RWDS	–	Radioactive Waste Disposal Site
SAR	–	Safety Analysis Report
SFA	–	Spent Fuel Assembly
SFP	–	Spent Fuel Pool
SIP	–	Shelter Implementation Plan
SISP	–	State Interregional Specialized Plant
SNF	–	Spent Nuclear Fuel
SNRIU	–	State Nuclear Regulatory Inspectorate of Ukraine
SRW	–	Solid Radioactive Waste
SSE	–	State Specialized Enterprise
SUNPP	–	South Ukraine NPP
VSC	–	Ventilated Storage Cask
WWER	–	Water-Cooled Water-Moderated Power Reactor
ZNPP	–	Zaporizhzhya NPP