REPORT ON NUCLEAR AND RADIATION SAFETY IN UKRAINE FOR 2017


MAP
UKRAINIAN NPPs
Rivne NPP
Khmelnitsky NPP
State Nuclear Regulatory Inspectorate of Ukraine
www.snrc.gov.ua
South Ukraine NPP
Zaporizhzhya NPP
13 WWER-1000 UNITS
2 WWER-440 UNITS

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Dear Readers!

Nuclear and radiation safety has always been and will remain important for Ukraine. The country operates 15 NPP units. Three units at ChNPP are under decommissioning in the exclusion zone and Unit 4, along with the Shelter and the New Safe Confinement, is being transformed into an environmentally safe system. We have a series of facilities for the management of spent fuel, radioactive waste, and radiation sources. We use radiation technologies in industry, medicine, science, and other areas.

The nuclear regulator's task is to ensure that all these facilities are safe and do not pose a threat for the public or the environment. The SNRIU uses three main instruments for this purpose: law-making, licensing, and oversight.

The year of 2017 was rich in advances. The SNRIU's active participation allowed the general radiation safety rules for the use of radiation sources in medicine to be approved and harmonized with the EU legislation and IAEA standards. This will significantly improve the radiation protection of patients and medical personnel in Ukraine in the future.

Nuclear fuel diversification and the country's energy independence have improved in Ukraine. The SNRIU's license issued to the operator for construction and commissioning of the centralized spent fuel storage facility in the Chornobyl exclusion zone was a significant advance in this area. The CSFSF construction is of continued importance for Ukraine since it will allow spent fuel to be stored in safe conditions using the up-to-date world technologies and significant financial resources to be saved for spent fuel storage and reprocessing in the future.

Ukrainian NPPs produce about 55% of electricity. NPPs are an important component of the country's fuel and energy system. The SNRIU continuously monitors the implementation of the Comprehensive (Integrated) Safety Improvement Program for Nuclear Power Plants in Ukraine. In 2017, the SNRIU made a decision on long-term operation of Zaporizhzhya NPP Unit 3 until 5 March 2027. Long-term operation is a worldwide practice and Ukraine has successful experience in this area.

Two large-scale projects in the Chornobyl exclusion zone regulated by the SNRIU crossed the finish line. They are related to commissioning of the New Safe Confinement and dry spent fuel storage facility. The significance of these projects for Ukraine can hardly be underestimated. NSC commissioning will enable moving to the next stage, such as creation of an infrastructure to dismantle unstable structures inside the Shelter and retrieve fuel-containing materials and radwaste for further management, including disposal.

The presentation of the Seventh National Report on the fulfillment of Ukraine's obligations under the Convention on Nuclear Safety by the Ukrainian delegation was also of great importance. This event was held in Vienna at the IAEA headquarters. The world community confirmed once again the adequate nuclear safety level in Ukraine under this event and noted many achievements in nuclear and radiation safety, including successful harmonization of the national legislation with EU standards.

The year of 2017 was actually full of events: it saw many challenges and many victories. The SNRIU team fulfilled its duties with dignity and provided regulatory support to the projects important to Ukraine’s safety. I know that we will continue our mission properly in 2018, as we understand that we shall ensure nuclear and radiation safety in Ukraine.

Sincerely,

Hryhorii Plachkov
SNRIU Chairman

2. YEAR 2017 IN DETAILS

January	
25	Resolution No. 39 of the Cabinet of Ministers of Ukraine "Some Issues on Optimization of Territorial Bodies of the State Nuclear Regulatory Inspectorate" was adopted at Governmental meeting.
February	
8	The Verkhovna Rada Committee on Fuel and Energy System, Nuclear Policy, and Nuclear Safety as the main committee recommended the Verkhovna Rada of Ukraine to adopt, in the first reading, the draft Law of Ukraine "On Amendments to Certain Laws of Ukraine on Nuclear Energy Use" (reg. No. 5550 of 16 December 2016) developed to implement 2013/59/Euratom Directive.
16	The public report of SNRIU Chairman on the results of nuclear and radiation safety regulation in 2016 and the identification of first-priority areas of activities for 2017 was presented.
23	A decision was approved on ZNPP Unit 3 operation in shutdown state to take necessary administrative and technical measures to ensure its long-term operation.
	The draft Law "On Amendments to Certain Laws of Ukraine on Nuclear Energy Use" (reg. No. 5550) was addressed at the meeting of the Verkhovna Rada Committee on European Integration.
March	
15	The draft Law "On Amendments to Certain Laws of Ukraine on Nuclear Energy Use" (reg. No. 5703) was addressed at the meeting of the Verkhovna Rada Committee on Fuel and Energy System, Nuclear Policy, and Nuclear Safety.
April	
27.03.2017 – 07.04.2017	The National Report of Ukraine on the fulfillment of obligations under the Convention on Nuclear Safety was presented during the Seventh Review Meeting of the Contracting Parties to the Convention (Vienna, Austria).
May	
5	SNRIU Order No. 136 of 13 April 2017 on approval of the "General Requirements for Aging Management of NPP Components and Structures and Long-Term Operation" was registered in the Ministry of Justice under No. 578/30446; amendments were made to the "General Requirements for NPP Long-term Operation Based on Periodic Safety Review" approved by SNRIU Order No. 181 of 26 November 2004 are registered in the Ministry of Justice of Ukraine under No. 1587/10186 of 15 December 2004.
17	License No. OB 000891 issued to Lviv SISP for radioactive waste treatment and storage was renewed.
18	The "General Safety Rules for Medical Radiation Sources" approved by

	Order of the SNRIU and Ministry of Health No. 51/151 of 16 February 2017 were registered in the Ministry of Justice under No. 636/30504.
June	
21-22	The SNRIU ensured Ukraine's participated in the ConvEx-3 international exercise, involving full activation of the Information and Emergency Center under a conditional severe accident scenario at Paks NPP (Hungary) in cooperation with the State Emergency Service of Ukraine and other authorized central executive bodies.
27	The safety analysis report for the project "Construction of Intermediate Storage Facility for Vitrified High-Level Radioactive Waste Returned from the Russian Federation after Reprocessing of Spent Nuclear Fuel from Ukrainian NPPs" was subjected to state NRS review, which provided positive conclusions.
29	The SNRIU issued a license to Energoatom for the construction and commissioning of the centralized spent fuel storage facility.
July	
10	Taking into account positive conclusions of the state NRS review of safety justification documents, the SNRIU agreed loading of the first batches of Westinghouse fuel assemblies the cores of Zaporizhzhya NPP Units 1, 3 and 4.
21	License No. OB 001050 issued to CRME for reprocessing and storage of radioactive waste was renewed.
August	
02	Acting Chairman of the State Nuclear Regulatory Inspectorate of Ukraine Borys Stoliarchuk signed the Agreement for renewal of arrangements between the SNRIU and the U.S. Nuclear Regulatory Commission on technical information exchange and cooperation in the field of nuclear safety.
22	The "General Safety Provisions for Predisposal Management of Radioactive Waste" approved by SNRIU Order No. 279 of 1 August 2017 were registered in the Ministry of Justice under No. 1045/30913.
September	
01	The Association Agreement between Ukraine on the one hand and the European Union, European Atomic Energy Community and their member states on the other hand entered into force and was ratified by the Law of Ukraine of 16 September 2014.
	The SNRIU provided positive conclusions of state NRS review related to the projects on closure of filled storage facilities No. 21 and No. 30 at Buryakivka RWDS.
05–06	The SNRIU took part in the joint Ukrainian-American training exercises on response to a state-level emergency associated with a radiation accident at Zaporizhzhya NPP.
20	The "Requirements for NPP Periodic Safety Review" approved by SNRIU Order No. 313 of 30 August 2017 were registered in the Ministry of

	Justice under No. 1158/31026.
28	The Sixth National Report of Ukraine on the fulfillment of obligations under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was approved at the SNRIU Board meeting.
25-29	The 39th meeting of WENRA working group on radwaste management and decommissioning was held in Kyiv.
October	
4-5	Joint emergency response training was held at Rivne NPP (Energoatom, SNRIU, territorial and local authorities) to exercise a general accident caused by an emergency meteorological situation at the NPP site that led to failure of the main and backup power supply system at Rivne NPP Unit 3 and failure of the reactor cooling systems.
13	License No. OB 000891 issued to Lviv SISP for treatment and storage of radioactive waste was renewed; this license was extended to an additional radwaste management facility - a mobile unit with equipment for safe removal of disused radiation sources from shielding blocks of BGI and E type.
17	The "Procedure for Training of Young Experts at the State Nuclear Regulatory Inspectorate of Ukraine" registered in the Ministry of Justice of Ukraine under No. 1324/31192 on 30 October 2017 was approved by SNRIU Order No. 380.
24	Public hearings were held in the city of Energodar (Zaporizhzhya region) on long-term operation at Zaporizhzhya NPP Unit 3. 212 people participated in the hearings.
25	Resolution of the Cabinet of Ministers of Ukraine No. 1106 approved the "Action Plan for the Implementation of the Association Agreement between Ukraine on the one hand and the European Union, European Atomic Energy Community and their member states on the other hand". The updated implementation plan, which envisages the update of measures and their deadlines, was put in force on 17 March 2018.
02.10.2017-01.11.2017	Public hearings were held on long-term operation at Zaporizhzhya NPP Unit 3.
November	
02	SNRIU Order No. 372 of 12 October 2017 "On Amending Some Regulations and Recognizing the Order on Radioactive Waste Management to Be Invalid" was registered in the Ministry of Justice under No. 1340/31208.
03	A decision was made on long-term operation of Zaporizhzhya NPP Unit 3 until 5 March 2027.
08	The "Radiation Safety Rules of Using Radiation Sources in Brachytherapy" approved by Order of the SNRIU and the Ministry of Health No. 316/998 of 31 August 2017 was registered in the Ministry of Justice under No. 1362/31230.
09	The construction of the centralized spent fuel storage facility in the town

	of Buryakivka in the Chornobyl exclusion zone was started.
17	The SNRIU published information stating that "the situation with Ru-106 confirmed the capability of modern radiation monitoring systems to immediately reveal even insignificant changes in radiological conditions" related to the analysis of Ru-106 isotope spread in the atmosphere in Ukraine and Europe.
24	Individual Permit No. OD 00000953/003/24 for closure of filled radwaste disposal facility (trench) No. 21 at Buryakivka RWDS was issued under License No. 000953 dated 20 April 2011 for operation of radwaste disposal facilities.
30	At the meeting of the SNRIU Board: - a decision was made to operate Rivne NPP Unit 3 in shutdown state with full fuel unloading for the period of required administrative and technical measures implemented by Energoatom to enable its long-term operation; - the completeness and quality of investigations of operational events at Ukrainian NPPs and the causes that increased the number of operational events at Ukrainian NPPs were analyzed; - a decision was made to approve the "National Report for the First Topical Peer Review on Aging Management" under preparation for the international peer review on nuclear facility safety (implementation of 2014/87/Euratom Council Directive).
December	
19	SNRIU Order No. 443 of 1 December 2017 "On Approval of the Requirements for Making Risk-Informed Decisions on NPP Safety" was registered in the Ministry of Justice under No. 1535/31403.
27	The Cabinet of Ministers of Ukraine approved the draft Law "On Amendments to Certain Laws of Ukraine on Nuclear Energy Use" at the meeting.
	The Cabinet of Ministers of Ukraine approved a resolution on amending resolutions of the Cabinet of Ministers of Ukraine No. 440 of 6 May 2001 and No. 591 of 1 June 2011 on the procedure for charging fees for the implementation of licensing procedures in the field of nuclear energy.
28	The SNRIU renewed License No. EO 000953 issued to CRME for operation of radwaste disposal facilities prior to completion of the operating stage of the Buryakivka RWDS radwaste disposal facilities.

3. SAFETY OF NUCLEAR INSTALLATIONS

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

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

In 2017, NPPs produced 85.8 billion kW*h of electricity, constituting 55.2% of the total electricity production in Ukraine. The NPP installed capacity factor was 70.6% in 2017.

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 NPPs 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 at all Ukrainian nuclear power units.

3.1. NPP Safety Improvement

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 the Cabinet of Ministers of Ukraine in 2011. In 2015, the Cabinet of Ministers of Ukraine extended C(I)SIP by 2020. The C(I)SIP objective is to:

[1] WANO is the World Association of Nuclear Operators

- 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 and minimize their consequences.

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

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 in the areas of nuclear safety.

Comprehensive (Integrated) Safety Improvement Program for Ukrainian NPPs

After the Fukushima accident, the program included additional measures upon extraordinary in-depth safety reassessment for Ukrainian NPPs (stress tests) and additional fire safety measures. Implementation of the safety improvement measures under the program promotes necessary conditions to make decisions on long-term operation of NPP units.

The design-basis lifetime of six Ukrainian NPP units expires in a period from 2017 to 2020 (see Table 3.1).

Table 3.1. Data on Ukrainian NPP Units

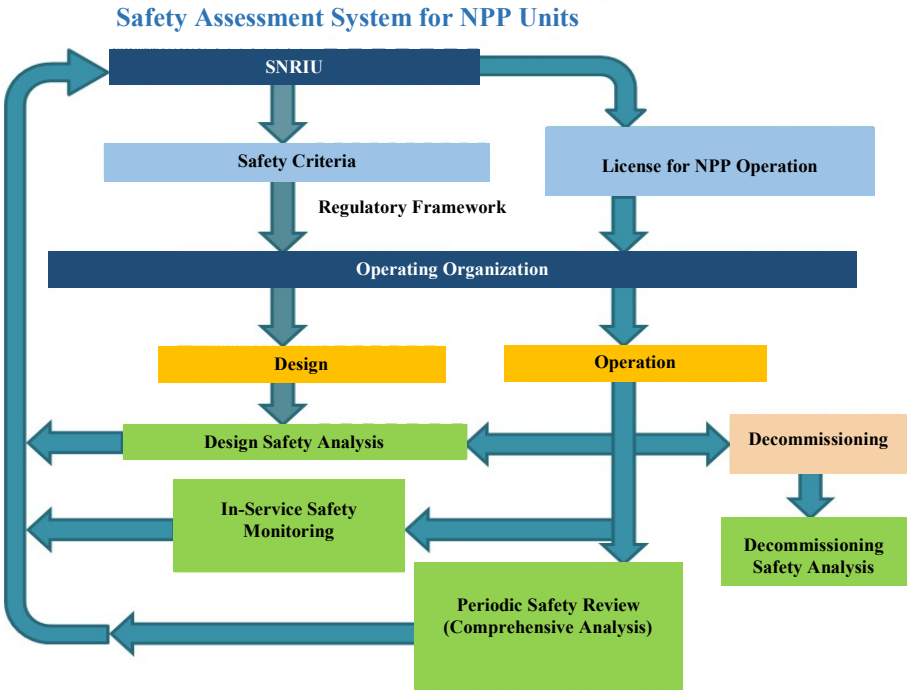
NPP	Unit No.	Reactor Type	Expiration of design-basis/long-term operation period
ZNPP	1	WWER-1000/320	23.12.2015/23.12.2025
	2	WWER-1000/320	19.02.2016/19.12.2026
	3	WWER-1000/320	05.03.2017/05.03.2027
	4	WWER-1000/320	04.04.2018
	5	WWER-1000/320	27.05.2020
	6	WWER-1000/320	21.10.2026
SUNPP	1	WWER-1000/302	02.12.2013/02.12.2023
	2	WWER-1000/338	12.05.2015/31.12.2025
	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 2017, within C(I)SIP regulatory support, SNRIU agreed 62 reports on implementation of safety measures out of 79 planned for 2017.

According to C(I)SIP schedules, the main efforts of the operating organization in 2017 were focused on the development and implementation of measures for Zaporizhzhya Units 3 and 4, Rivne Unit 3 and Khmelnitsky Unit 1 within long-term operation activities. The experience in measures taken at the so-called pilot units is further extended to other operating power units.

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 SNRIU.

SNRIU constantly monitors all stages of modifications (concept development, installation and pre-commissioning, introduction into trial and/or commercial operation) through safety assessment of safety 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.



During the year, SNRIU conducted comprehensive inspections of each NPP site, international experts being involved as well. One of the main tasks is to verify implementation of safety improvement measures.

At the beginning of 2013, SNRIU jointly with the Ministry for Energy and Coal Industry, Ministry of Defense, Ministry for Environment and Natural Resources and State Agency of Ukraine on 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 Stress Test Action Plan of the European Nuclear Safety Regulators Group (ENSREG).

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;
- main topics 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.

At the end of 2017, the National Action Plan upon Stress-Test Results was updated once again to take into account the status and schedule for implementation of safety measures. The number and scope of planned measures remained unchanged.

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

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

Thirty-year design-basis life is established for Ukrainian NPPs. Eleven power units were commissioned in the 1980s–1990s. The Government of Ukraine decided to continue operation of NPP units as reflected in the "Energy Strategy of Ukraine until 2035" and

Energoatom “Comprehensive Work Program for Long-Term Operation of Nuclear Power Plant Units”.

In accordance with current legislation, a decision on long-term operation of a power unit is made by the SNRIU based upon conclusions of state nuclear and regulatory safety review of the periodic safety review report (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 condition of power unit 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 the Fukushima 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 practices;
- improvement of the emergency preparedness system.

In accordance with NRS regulations, rules and standards, the PSRR is finalized as individual reports based upon evaluation 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 practices 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 Zaporizhzhya NPP Units 1, 2, and 3 and Rivne NPP Unit 3 with WWER-1000/320 reactors, whose design-basis life expired in 2016–2017, Energoatom chose the “second option” for their lifetime extension such as: “shutdown of the power unit after its design-basis life expires and implementation of organizational and technical measures to continue and

recommence operation". For each of these power units, the SNRIU agreed long-term operation programs and licensing plans, in compliance with which Energoatom conducts respective activities and submits associated reports to the SNRIU.

The results of these activities serve as the basis for PSRR submitted to the SNRIU for consideration and NRS regulatory review.

3.2.2. Long-Term Operation of Zaporizhzhya NPP Unit 3

In the framework of long-term operation of ZNPP Unit 3, the SNRIU agreed all technical decisions on lifetime extension of equipment, piping, and civil structures of the power unit and agreed results of the following activities in full scope:

- equipment qualification for harsh environments and seismic impacts;
- assurance of seismic resistance of equipment, piping and structures.

The results of the above activities served as the basis for PSRR of Zaporizhzhya NPP Unit 3, which passed state NRS review.

On 24 October 2017, the SNRIU with the participation of Energoatom held public hearings in Energodar, the satellite town of Zaporizhzhya NPP, on long-term operation of Zaporizhzhya NPP Unit 3.

The event was attended by authorized representatives of the SNRIU and SSTC NRS, Energoatom, Zaporizhzhya NPP, representatives of public organizations and local mass media, city and village councils, as well as residents of the settlements in the Zaporizhzhya NPP supervision area: Nikopol, Kamyanka-Dniprovska, Velyka Bilozerka, Velyka Znamyanka, Novodniprovka, Energodar, and Zaporizhzhya. 212 people in total were registered to participate in the public hearings.

The Chairman of the SNRIU Public Council was appointed as secretary and moderator of the public hearings.

The following clarifications were provided during the public hearings on Zaporizhzhya NPP Unit 3:

- regulatory and legal framework for long-term operation;
- grounds for long-term operation;
- technical condition assessment of equipment and buildings;
- safety improvement measures;
- results from review of the Periodic Safety Review Report and inspection;
- environmental impact;
- emergency preparedness;
- social and economic aspects, etc.

The open meeting of the SNRIU Board on 3 November 2017 was held to discuss the topic “On Long-Term Operation of Zaporizhzhya Unit 3 Based on Periodic Safety Review”.

The meeting was attended by Board members and SNRIU and SSTC NRS staff, Energoatom executive staff, authorized representatives of the Ministry for Energy and Coal Industry and Ministry for Environment and Natural Resources, representatives of Verkhovna Rada Committees, EBRD, public organizations, and mass media.

Positive findings of the NRS regulatory review for the Periodic Safety Review Report and comprehensive inspection at Zaporizhzhya Unit 3 convinced the SNRIU Board that safe operation of Zaporizhzhya NPP Unit 3 was justified until 5 March 2027.

Based on review of the Energoatom Application in connection with long-term operation of Zaporizhzhya Unit 3 at rated power levels after expiration of its design lifetime, the SNRIU issued a license for operation of Zaporizhzhya NPP Unit 3 on 3 November 2017.

Серія АА ЛІЦЕНЗІЯ № 001637

№ ЕО 001062

ДЕРЖАВНА ІНСПЕКЦІЯ ЯДЕРНОГО РЕГУЛЮВАННЯ УКРАЇНИ

Ідентифікаційний код 21721086

Видана експлуатуючій організації - Державному підприємству «Національна атомна енергогенеруюча компанія «Енергоатом» Україна, 01032, м. Київ, вул. Назарівська, 3

(найменування, місцезнаходження юридичної особи або прізвище, ім'я та по батькові громадянина-підприємця, місце проживання)

Ідентифікаційний код юридичної особи 24584661

На право провадження діяльності на етапі життєвого циклу «експлуатація ядерної установки енергоблока № 3 ВП «Запорізька АЕС»

(вид діяльності)

Місце здійснення діяльності 71500, Запорізька область, м. Енергодар, межі майданчика ВП «Запорізька АЕС» відповідно до генерального плану №ГС-512-347/11-308 ГП

(межі майданчика ядерної установки або сховища для зберігання РАВ)

Технологічний комплекс у складі енергоблока № 3, об'єктів та будівель, що технологічно з ним пов'язані, відповідно до генерального плану майданчика ВП «Запорізька АЕС» №ГС 512-347/11-308 ГП

(перелік основних об'єктів та споруд, що входять у технологічний комплекс ядерної установки або сховища для зберігання радіоактивних відходів)

Перелік документів, на підставі яких прийнято рішення про видачу ліцензії - згідно з розділом 1

Перелік посадових осіб, до службових обов'язків яких належить здійснення організаційно-розпорядчих функцій, пов'язаних з забезпеченням ядерної та радіаційної безпеки, фізичного захисту ядерних установок, радіоактивних відходів, інших джерел іонізуючого випромінювання - згідно з розділом 2

Умови провадження діяльності - згідно з розділом 3

Перелік видів робіт або операцій виконання яких здійснюється після видачі окремих дозволів органом державного регулювання ядерної та радіаційної безпеки згідно з пунктом 3.4.6

Дата видачі 03 листопада 2017 року

Строк дії ліцензії до до видачі ліцензії на провадження діяльності на етапі життєвого циклу «зняття з експлуатації ядерної установки енергоблока № 3 Запорізької АЕС»

Голова (посада) (підпис) Г. Плачков (ініціали та прізвище)

М.П.

Сторінка 1 з 6

3.2.3. Measures to Prepare NPP Units for Long-Term Operation and Their Safety Review

During 2017, efforts for preparation of Zaporizhzhya Unit 4, Rivne NPP Unit 3, Khmelnitsky NPP Unit 1, and South Ukraine NPP Unit 3 for long-term operation were continued in compliance with the Programs for Preparation of NPP Units for Long-Term Operation and the Licensing Plan for Long-Term Operation of NPPs, which were agreed by the SNRIU.

The SNRIU approved 11 working programs for technical condition assessment and 28 technical decisions for long-term operation of equipment, piping and structures of Zaporizhzhya NPP Unit 4.

Lifetime extension of components and structures, equipment qualification, and seismic resistance verification for equipment, piping, buildings and structures at Zaporizhzhya NPP Unit 3 are ongoing.

The SNRIU approved all working programs for technical condition assessment of components and structures of Rivne NPP Unit 3, as well as technical decisions on their lifetime extension.

Equipment qualification for harsh environments and seismic impacts was completed. The assessment of seismic resistance of equipment and piping is under performance.

The SNRIU approved one working program for technical condition assessment and two technical decisions for lifetime extension of equipment, piping and structures of Khmelnitsky NPP Unit 1.

Lifetime extension of components and structures, equipment qualification, and seismic resistance verification for equipment, piping, buildings and structures at Khmelnitsky NPP Unit 1 are ongoing.

The SNRIU approved one working program for technical condition assessment of components and structures of South Ukraine NPP Unit 3 and one technical decision for lifetime extension of equipment, piping and structures of the power unit.

Lifetime extension of components and structures, equipment qualification, and seismic resistance verification for equipment, piping, buildings and structures are ongoing.

In addition, as of the end of 2017, within periodic safety review of NPP units, the SNRIU:

1) conducted state nuclear and radiation safety review and confirmed that review comments were completely incorporated for 11 of the 15 reports included in the Zaporizhzhya Unit 4 PSRR (safety factors: plant design, 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);

2) conducted state nuclear and radiation safety review of all 15 reports included in the Rivne NPP Unit 3 PSRR and confirmed that review comments were completely incorporated for 13 of the 15 PSRR reports (safety factors: plant design, 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). Taking into account that lifetime extension measures were not implemented in full scope at Rivne NPP Unit 3, the SNRIU Board resolved to amend the license for operation of RNPP Unit 3 on 30 November 2017. Hence, upon completion of the design-basis lifetime of the power unit (11 December 2017), the reactor is operated in shutdown state with all fuel being completely removed to the spent fuel pool and the operating organization implements planned organizational and technical measures to promote the decision on long-term operation of the power unit at full power levels.

According to the Plan for implementing Council Directive 2014/87/Euratom, international peer review on ageing management at nuclear installations upon ENSREG decision is planned. The objective of this peer review is to exchange information between member states on ageing management of structures, systems and components of nuclear facilities, learn best practices and common issues, and develop an action plan for improvement of the regulatory and legal framework and activities in this area.

Considering the mentioned above, the SNRIU with the participation of Energoatom and SSTC NRS developed the “National Report on the First Topical Peer Review on Aging Management” in 2017.

This National Report confirmed, among other things, that the regulatory and legal framework in Ukraine regarding requirements for aging management complies with the IAEA and WENRA safety documents and recommendations and that aging management in Ukraine is provided on a systematic basis and is appropriately documented with entry of data into electronic databases.

In addition, good practices were identified for improving aging management in the National Report.

The "National Report on the First Topical Peer Review on Ageing Management" was approved by the SNRIU Order of 30 November 2017 and published at SNRIU and ENSREG official websites at the end of 2017.

It is planned to establish an expert group including SNRIU and SSTC NRS experts in 2018 to perform further activities related to the peer review of the National Reports on Aging Management in the European Union countries, the Kingdom of Norway, the Swiss Confederation and Ukraine.

3.3. NPP Operational Events (2000-2017)

Operating experience feedback is one of the key methods to ensure and further improve operational safety of NPPs, which includes recording and analysis of operational events and implementation of corrective measures to mitigate the causes and prevent the recurrence of events.

NPP operational events are among the most important indicators of operational safety.

In 2017, 16 operational events occurred at 15 WWER units in commercial operation in Ukraine. There have been no events at the Chornobyl NPP since 2014.

Figure 3.3.1 shows the number of operational events at Ukrainian NPPs (without the Chornobyl NPP) from 2000 to 2017.

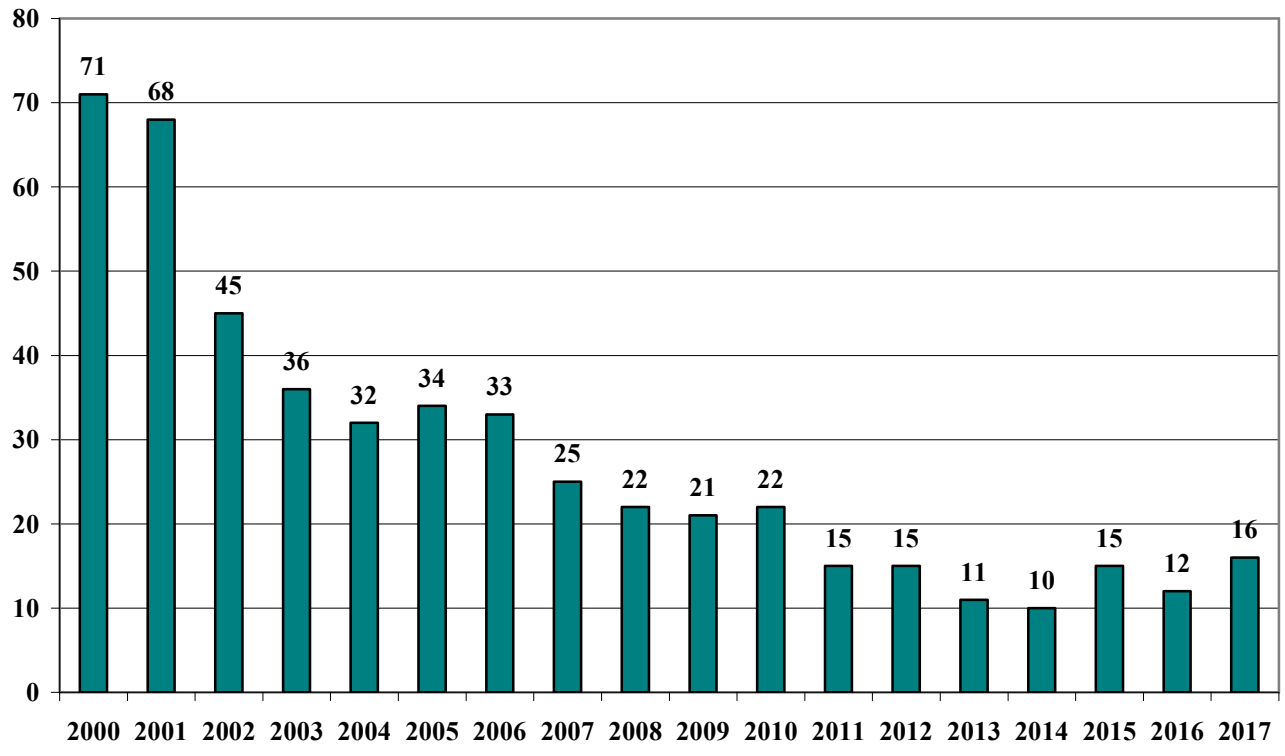


Fig. 3.3.1. Number of operational events at Ukrainian NPPs in 2010-2017

The distribution of operational events by NPP sites in 2017 is as follows:

- 6 events at ZNPP (6 power units);
- 2 events at KhNPP (2 power units);
- 3 events at SUNPP (3 power units);
- 5 events at RNPP (4 power units).

Figure 3.3.2 shows the distribution of operational events by NPP sites in 2000-2017.

As compared to the previous year, the number of events has not changed at the Zaporizhzhya NPP, increased fivefold at the Rivne NPP (and is maximum for this site for the last six years), decreased at the South Ukraine NPP, and increased twofold at the Khmelnitsky NPP.

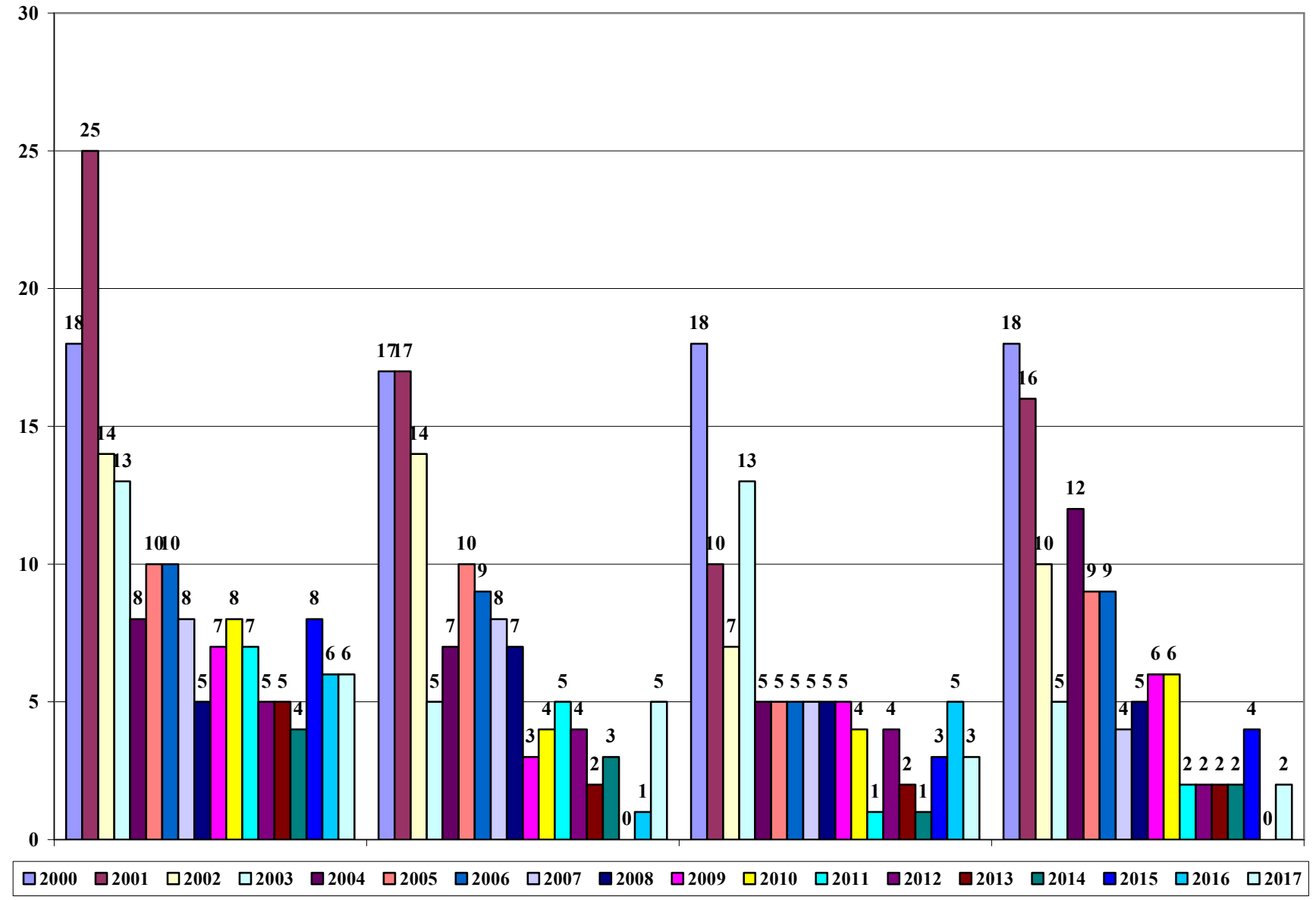


Fig. 3.3.2. Distribution of events by NPP sites in 2000-2017

According to INES, the international instrument developed to inform the public on safety significance of nuclear and radiological events, all NPP events were classified as “below scale/level 0” (insignificant for safety) in 2017. Figure 3.3.3 shows the number of operational events at Ukrainian NPPs in 2000-2017 classified on the INES scale.

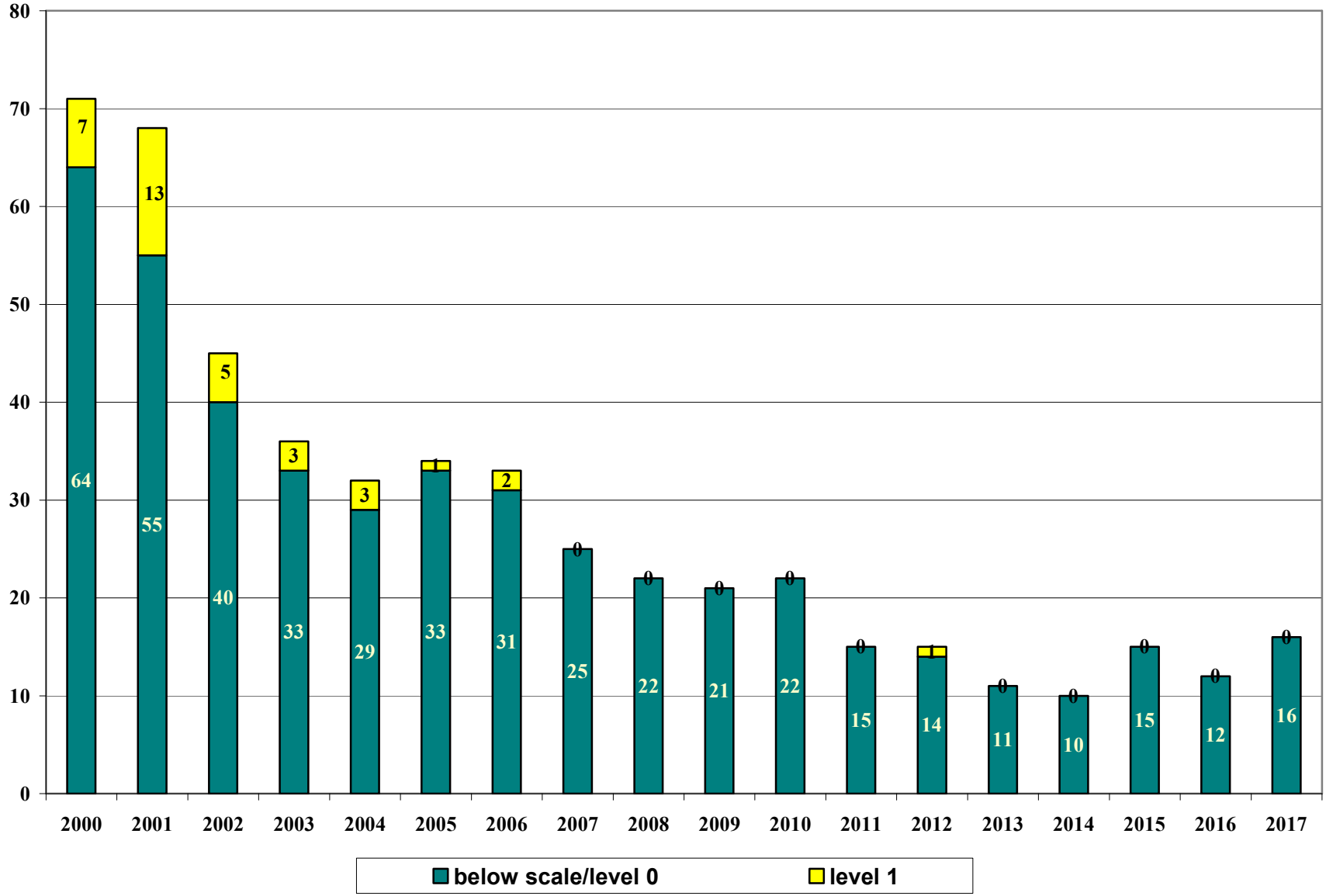


Fig. 3.3.3. Distribution of operational events at Ukrainian NPPs classified on the INES scale in 2000-2017

In 2017, there were no events that caused overexposure of personnel, radioactive releases to the environment, or violation of safe operation limits and conditions. Neither were there events associated with unavailability of systems important to safety or events that caused drop and/or damage of fuel assemblies and fuel rods.

Depending on features and consequences, NPP operational events are categorized in compliance with the "Provisions on the Procedure for Investigation and Recording of Operational Events at Nuclear Power Plants". Figure 3.3.4 shows the distribution of operational events in 2017 depending on their category.

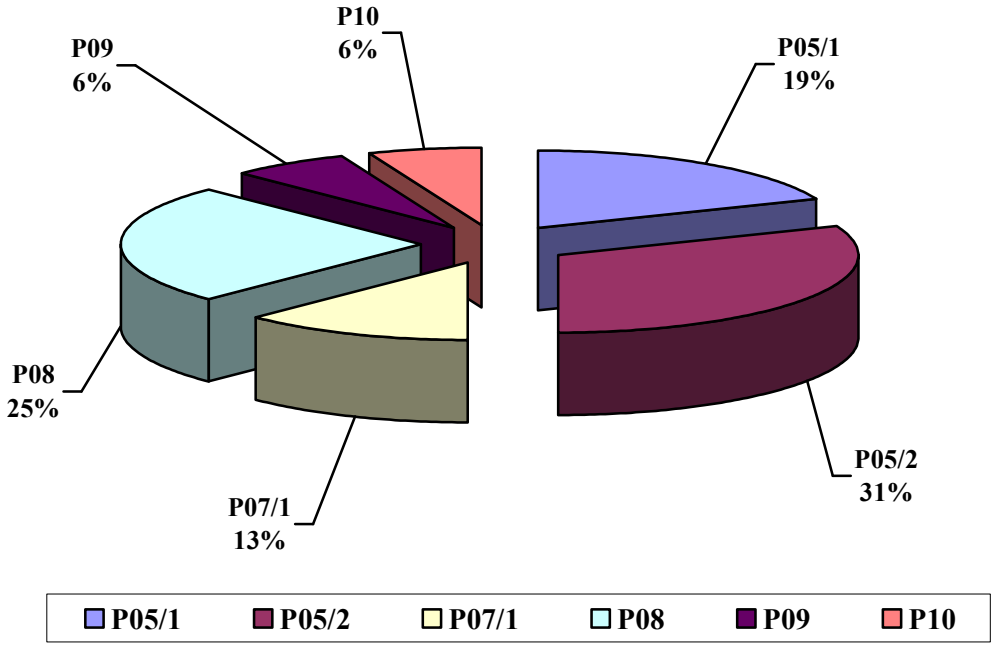


Fig. 3.3.4. Distribution of operational events by categories

The categories of events that occurred in 2017 are as follows:

- P05/1 (reactor shutdown with scram, preventive protection, power limiter);
- P05/2 (power unit disconnection from the grid by emergency automatics);
- P07/1 (failures of equipment and piping important to safety that belong to groups A and B, components of safety classes 1 and 2, control rod(s) with the derive mechanism);
- P08 (power decrease by 25% N_{ELECTR});
- P09 (actuation of any safety system or safety system train in standby in any reactor operating state that has not led to incidents of categories P05, P07/1, P07/2 and P08);
- P10 (unavailability of a safety system train over a period that does not exceed that allowed in the Technical Specifications on Safe Operation).

NPP operational events are accompanied by deviation from normal operation (abnormal event) that can be caused by equipment failure, external hazard, human error or procedural drawbacks.

Figure 3.3.4 presents the distribution according to systems that failed or were affected during abnormal events in 2017.

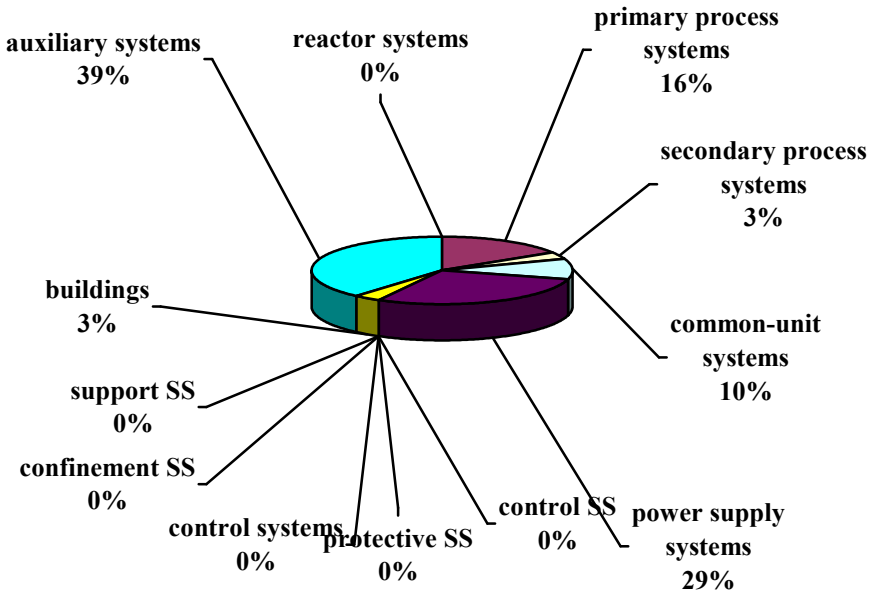


Fig. 3.3.5. Distribution by systems failed or affected in abnormal events

In 2017, the greatest number of events and deviations (39%) occurred at auxiliary systems supporting operation of the main systems and 16% of failures occurred at primary process systems of the reactor compartment. Common-unit process systems (circulation water systems) failed in 10% of cases. One failure occurred at secondary process systems of the turbine compartment and one failure occurred at structures.

In 2017, 34 abnormal occurrences were identified in the investigation of events and deviations at the power units. These occurrences are distributed as follows:

- mechanical damage – 12 occurrences;
- faults in electrical design – 12 occurrences;
- human errors – 6 occurrences;
- not determined – 2 occurrences;
- faults in instrumentation & control – 1 occurrence;
- hydraulic impacts – 1 occurrence.

The investigation of 16 operational events that happened at Ukrainian NPPs in 2017 identified root causes of abnormal occurrences that were divided into three main groups:

- root causes associated with equipment;
- root causes associated with documentation;
- root causes associated with personnel and management system.

In addition, there was an individual group including events and deviations whose root causes were not established in the investigation. In 2017, 39 root causes were identified in the investigation of events and deviations. Figure 3.3.6 shows the contribution of each group of root causes in 2008-2017.

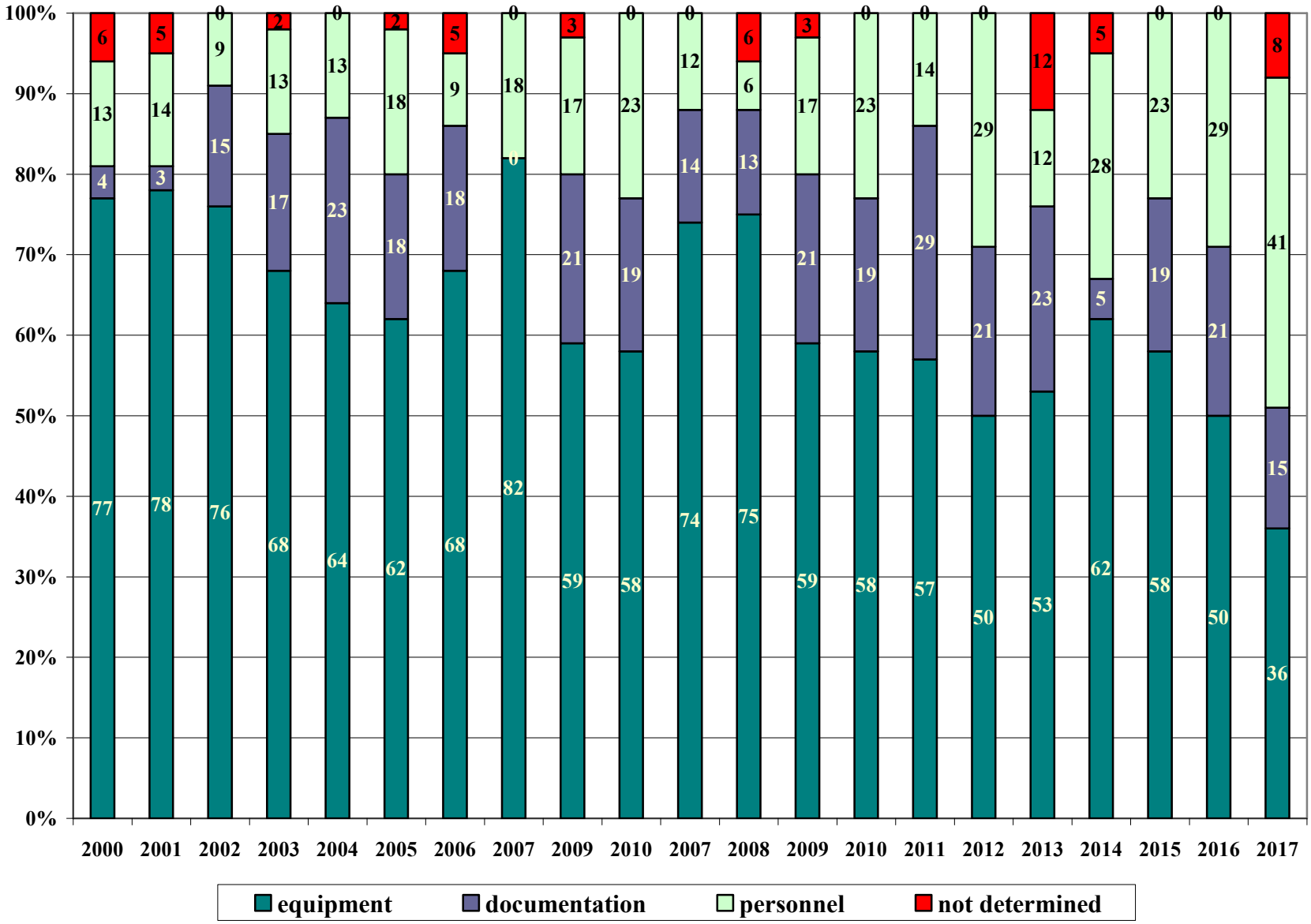


Fig. 3.3.6. Distribution of root causes of abnormal events in 2000-2017

4. IMPLEMENTATION STATUS OF NEW BUILT PROJECTS

Several new nuclear facilities are currently under construction in Ukraine:

- Neutron source based on a subcritical assembly driven by a linear electron accelerator;
- Centralized spent fuel storage facility (see para. 5.2.1.);
- Dry spent fuel storage facility at Chornobyl NPP (see para. 5.2.2.).

4.1. 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 under construction at the National Scientific Center 'Kharkiv Institute of Physics and Technology' (KIPT) in accordance with the agreements of the Washington Summit set forth in the Joint Statement of the Presidents of Ukraine and the United States in April 2010 and the Memorandum of Understanding between the Government of Ukraine and the Government of the United States of America on Cooperation in Nuclear Safety signed on 26 September 2011. The neutron source project is implemented under support of the Argonne National Laboratory, USA.

The neutron source is intended for scientific and applied studies in the field of nuclear physics, radiation materials science, biology, chemistry and production of medical radioisotopes. A general description of the neutron source was provided in detail in the Report on Nuclear and Radiation Safety in Ukraine for 2012.

This nuclear facility is constructed in compliance with License EO No. 001018 for construction and commissioning of the neutron source, which was issued by SNRIU to the operating organization in 2013.

In accordance with the above license, KIPT, as the operating organization, performed installation and construction activities and developed technical specifications for equipment important to safety, as well as operational documentation for the neutron source, and agreed them with SNRIU during 2013-2017.

In addition, in compliance with the license, the operating organization has to obtain three individual permits for:

- first delivery of nuclear fuel for the neutron source to the KIPT industrial site;
- initial subcriticality of the neutron source;
- trial commercial operation of the neutron source.

As of 31 December 2017, SNRIU did not receive any application from KIPT to obtain these individual permits.

In July 2017, the SNRIU approved the forecast work schedule for initial subcriticality of the neutron source.

Based on conclusions of the Licensing Commission of Officials finalized in minutes No. 0251-0254 of 18 August 2017, it was decided to:

- renew the license issued to three officials to perform administrative functions related to nuclear and radiation safety;

- refuse to renew the license issued to I. M. Karnaukhov occupying the position of Deputy Director of the Research Complex "Accelerating Nuclear Systems" with the right to replace the administrative head of the operator.

The Interdepartmental Council for general management and coordination of commissioning and further operation of the neutron source was established according to Resolution of the Cabinet of Ministers No. 1021 of 20 December 2017 to facilitate

coordination of executive bodies and the National Academy of Sciences in commissioning and further operation of the neutron source, as well as to identify the ways, mechanisms and methods to resolve the arising issues.

5. NUCLEAR FUEL MANAGEMENT

5.1. Diversification of Nuclear Fuel Supply

Implementation of Westinghouse fuel was started in 2000 in the framework of 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. The project objective was to develop, deliver and qualify alternative nuclear fuel compatible with the Russian-design one for Ukrainian NPPs.

The implementation of Westinghouse fuel assemblies (FA-W) as any new nuclear fuel modification for Ukrainian NPPs is clearly governed by nuclear and radiation safety regulations. These documents specify successive steps to be implemented by the operator and carefully analyzed and controlled by the SNRIU from a conceptual decision on new fuel implementation to its introduction into commercial operation.

The compliance of the Ukrainian legal framework for nuclear and radiation safety with the IAEA safety standards including the licensing procedures for new fuel was confirmed in implementing the EC-IAEA-Ukraine Joint Project on Safety Evaluation of Ukrainian NPPs in 2007-2010.

In the first phase of the Qualification Project in 2005–2009, trial operation of six pilot Westinghouse fuel assemblies was conducted at SUNPP Unit 3 during four fuel campaigns. Since March 2010, in the framework of the second phase of the Qualification Project, trial operation of the reload batch consisting of 42 FA-W was started.

In 2011-2012, under the contract for nuclear fuel supply between Energoatom and Westinghouse Electric Sweden AB (Västerås, Sweden), considering approaches to the extension of FA-W trial operation, four nuclear fuel batches were supplied, two of which were loaded into the core of SUNPP Units 2 and 3 during scheduled outage in 2011.

Some difficulties with fuel loading into the mixed core occurred during the refueling outage in 2012 at SUNPP Units 2 and 3, which were caused by peculiarities of the fuel assemblies of both manufacturers (TVEL Company and Westinghouse Electric Company).

In this regard, further extension of Westinghouse fuel operation under the contract was suspended. FA-W operation continued only in the core at SUNPP Unit 3.

FA-W operated in core were inspected visually and checked for leaks during each scheduled outage in accordance with the program for trial and commercial operation of Westinghouse FA-W at Unit 3 (for the period of trial and commercial operation). In particular, this concerned FAs of the 4th year of operation; that is, FAs that were in operation during the whole cycle envisaged in the design documentation for them and unloaded for storage to the spent fuel pool.

The obtained results approved the absence of comments on FA -W.

Thus, it can be noted that no case of unsealing of these fuel assemblies was revealed during the operation of the refueling batch with Westinghouse fuel during 2010-2014 in spite of the cases of damage to structural components in FA-W.

Energoatom and Westinghouse in coordination with the SNRIU addressed a range of measures including necessary modifications of the fuel assembly design after the events in 2012 in order to recommence FA-W trial operation.

Westinghouse took a full range of measures on the modified assemblies (FA-WR) in laboratory conditions. The Safety Analysis Report on the use of the modified assemblies was developed and subjected to state NRS review.

FA-WR were put into trial operation at SUNPP Unit 3 according to the established procedure based on activities performed in 2015. As of today, FA-WR are also operated at SUNPP Units 2, 3, and ZNPP Units 1, 3, 4, 5 under the extension of trial operation.

No preconditions for abnormal operation were identified during FA-WR operation in 2015-2017.

5.2. Spent Nuclear Fuel Management Facilities

Spent nuclear fuel (SNF) generated in the production of electricity by nuclear reactors is one of the important components in the NPP process cycle.

The period of nuclear fuel use in the reactors is determined by the allowed burnup of fissile isotopes. After the planned burnup has been reached, nuclear fuel is unloaded from the reactor and is regarded as spent fuel since it cannot be directly used for energy production.

After unloading from the reactor core, SNF is loaded to spent fuel pools (SFPs). In these pools, SNF is cooled down for the period necessary to reduce energy release caused by radioactive decay of fissile products to the allowable values. After SNF cooling in spent fuel pools for a limited period, spent fuel assemblies (SFAs) are to be removed from the NPP unit and sent for storage (disposal) or processing. This is because the capacity of NPP SFPs is limited and there must always be free volume for unloading of nuclear fuel from the reactor core or periodic inspections of the WWER reactor pressure vessel and internals.

At the same time, in SNF management, it is necessary to consider factors determined by specific features of this material: high radioactivity level and valuable components (uranium, plutonium, germanium, erbium, palladium, zirconium, etc.) that may be used in future, including that in other nuclear cycles (nuclear fuel for fast-neutron reactors, MOX fuel for light-water reactors). Taking into account the above mentioned, SNF does not belong to radioactive waste.

The state of nuclear energy in the world shows that ultimate conclusions on the economic feasibility of SNF processing or disposal, i.e. the final stage of nuclear fuel cycle, cannot be made with the current level of technologies. In this regard, Ukraine, like most of the countries developing nuclear energy, made the so-called “deferred decision” envisaging long-term storage of spent nuclear fuel. This “deferred decision” allows the decision on the final stage of nuclear fuel cycle to be made later, taking into account the development of technologies in the world and economic benefits for the state.

Currently, two facilities for spent nuclear fuel interim storage are operated in Ukraine: wet spent fuel storage facility – ISF-1 at the Chornobyl NPP – and dry spent fuel storage facility – DSFSF at the Zaporizhzhya NPP.

In addition, two more storage facilities are under construction in Ukraine: dry storage facility – ISF-2 at ChNPP – and centralized storage facility for WWER spent fuel from national NPPs – CSFSF.

5.2.1. Management of WWER Spent Nuclear Fuel

The Zaporizhzhya NPP was the first to face the lack of free space in NPP SFPs. In 1996, the Zaporizhzhya NPP launched the DSFSF project to solve this issue.

The Zaporizhzhya DSFSF was designed using the licensed and appropriately proven technology for spent nuclear fuel storage by Duke Engineering & Services (USA). The spent fuel storage principle is as follows: after being cooled down for five years in SFP, 24 assemblies with low energy release (<1 kW) are placed in a special basket filled with helium (inert gas with high thermal conductivity) and sealed and then the basket is placed in a concrete ventilated storage cask (VSC). The storage facility is designed for 380 VSCs, which can house 9000 assemblies with SNF.

Zaporizhzhya NPP Stage 1 with a capacity of 100 VSCs was commissioned in 2001 and Stage 2 with a capacity of 280 VSCs was commissioned at the end of 2011.

Zaporizhzhya DSFSF

As of 1 January 2018, 145 ventilated concrete casks were located at the Zaporizhzhya DSFSF site.

During 2017, the SNRIU reviewed and agreed four technical decisions “On the Content of Multiplace Sealed Baskets Loaded with Spent Nuclear Fuel”.

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

To fulfil the “Action Plan for 2006-2010 on Implementing the Energy Strategy of Ukraine until 2030” (approved by Cabinet Resolution No. 427 of 27 July 2006), the Energoatom Company concluded a contract with the U.S. Holtec International Company for the construction of a centralized storage facility for spent fuel from the Rivne, Khmelnitsky and South Ukraine NPPs based on the dry storage technology already proven at the Zaporizhzhya NPP.

In accordance with legislative requirements, the Energoatom operating organization developed the “Feasibility Study of Investments in the Construction of a Centralized Storage Facility for WWER Spent Nuclear Fuel (CSFSF) of Ukrainian NPPs”, approved by Cabinet Resolution No. 131-r of 4 February 2009 after a comprehensive state review.

This feasibility study proved economic feasibility of long-term spent fuel storage in Ukraine compared to its transport to the Russian Federation for reprocessing and justified construction of one centralized storage facility against any other options of SNF storage.

It is planned to store 12500 WWER-1000 SFAs and 4000 WWER-440 SFAs for 100 years in the CSFSF.

On 9 February 2012, the Verkhovna Rada of Ukraine adopted a decision on siting the CSFSF in the exclusion zone and its design and construction with Law of Ukraine No. 4383-VI “On Spent Nuclear Fuel Management as Regards Siting, Design and Construction of a Centralized Storage Facility for WWER Spent Fuel of Ukrainian NPPs”.

On 30 April 2013, the SNRIU agreed the "Technical Specifications for Modifying the Technology of Spent Fuel Transfer from WWER-1000 Power Unit (320) to the CSFSF" developed by Energoatom.

On 23 April 2014, according to Cabinet Resolution No. 399-r, Energoatom obtained a permit to develop a land management plan for allocation of lands with a total area of 45.2 hectares located between the former villages of Stara Krasnytsia, Buryakivka, Chystogalivka and Stechanka of the Kyiv region in the exclusion zone, affected by radioactive contamination in the Chornobyl catastrophe, and for transfer of these lands for permanent use with change of their intended purpose for construction of the CSFSF and access railroad.

On 22 July 2015, the SNRIU agreed the updated "Licensing Plan for Construction of a Centralized Spent Fuel Storage Facility" (PN-D.0.46.527-15) developed to supersede PN-D.0.46.527-11.

On 23 July 2015, the SNRIU agreed proposals of the operating organization on composition and content of the Explanatory Note "Project for Construction of the Centralized Storage Facility for WWER Spent Nuclear Fuel of Ukrainian NPPs" and provided recommendations on the CSFSF design.

On 12 October 2015, according to Energoatom Order No. 926, a Steering Committee was established for implementing the Holtec technology for spent fuel management at RNPP, KhNPP, and SUNPP. It included representatives of SNRIU and SSTC NRS.

On 5 October 2016, according to Cabinet Resolution No. 721-r, a land area of 45.2 ha was removed from permanent use of the State Agency of Ukraine on Exclusion Zone Management and transferred it to Energoatom for CSFSF construction and operation.

On 3 November 2016, SNRIU Board Order No. 8 agreed the conclusions of the state nuclear and radiation safety review for CSFSF PSAR.

On 7 December 2016, Energoatom registered declaration for the beginning of preparatory activities No. IU030163421149.

On 7 June 2017, Cabinet Resolution No. 380-r approved the project "Construction of Centralized Storage Facility for Spent Fuel from Domestic Nuclear Power Plants with WWER Reactors".

On 29 June 2017, the SNRIU issued license No. EO 001060 to Energoatom for construction and commissioning of the nuclear facility (centralized storage facility for spent fuel of Ukrainian WWER NPPs (CSFSF)).

On 09 November 2017, official events were conducted in Buryakivka village (exclusion zone) on the occasion of CSFSF construction initiation.

In addition, during 2016, the SNRIU:

- reviewed 15 packages of technical specifications for equipment important to safety and, upon review results, sent preliminary comments to Energoatom;
- preliminary agreed three technical specifications (TS) upon state nuclear and radiation safety review;

- reviewed and sent preliminary comments on three programs on factory acceptance testing;
- reviewed a number of technical decisions on implementation of the Holtec technology relating to preparation of spent nuclear fuel at Ukrainian NPP units for storage at CSFSF;
- participated in Steering Committee meetings for implementing the Holtec technology for spent fuel management at RNPP, KhNPP, and SUNPP.

5.2.2. Management of RBMK Spent Nuclear Fuel

The following procedure for SNF management was envisaged by the RBMK design:

– after use in the reactor, nuclear fuel was transferred to spent fuel pools where it was cooled down for at least 1.5 years to reduce radioactivity and decay heat;
– after cooling in SFP, RBMK fuel was transferred to a wet spent fuel storage facility.

As of 1 January 2018, all ChNPP SNF consisting of 21284 spent fuel assemblies (SFA) is stored in the ISF-1 cooling pool.

No SNF is present at ChNPP Units 1, 2, 3 and no further use of SFPs at these units is envisaged.

No fresh nuclear fuel is present at the ChNPP site.

ISF-1 is operated in compliance with SNRIU License EO No. 000859 for operation of the spent nuclear fuel storage facility of 25 June 2008.

Chornobyl NPP ISF-1

Currently, the Chornobyl NPP operating organization implements:

– Action Plan on ISF-1 Safety Improvement, agreed by the SNRIU on 24 June 2008;
– Action Plan on Safety Improvement of ChNPP Nuclear Facilities, agreed by the SNRIU on 12 December 2011.

ISF-1 room with the cooling pool canyon with damaged SNF

At the same time, the ISF-2 lifetime determined by the safety review performed in 2011 expires by the end of 2025. Therefore, in order to ensure safe long-term storage of all spent fuel at the ChNPP site, a new dry storage facility (ISF-2) is under construction.

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

The algorithm of SNF management envisaged by the ISF-2 design is detailed in the Report on Nuclear and Radiation Safety for 2014.

During 2016, the Chornobyl NPP continued development and agreement of technical specifications (TS) and design documentation for systems and equipment important to safety according to the established procedure.

As of 1 January 2018, according to ISF-2 Licensing Plan, the SNRIU:

1. Preliminarily agreed:
   - 7 TS for systems important to safety out of the seven developed according to the design;

- 41 TS for equipment important to safety out of the 41 developed according to the design and one TS for equipment whose impact on safety is not defined (table for damaged SNF handling).

2. Agreed 33 testing programs for equipment important to safety out of the 33 planned (factory acceptance tests are not envisaged for 8 equipment pieces and individual tests will be carried out instead of them at the ISF-2 site);

3. Participated in 33 factory acceptance tests of equipment important to safety out of the 33 planned and two factory acceptance tests of systems.

4. Finally agreed two TS for equipment important to safety out of the 41 developed according to the design.

5. Ten programs (from twelve envisaged) on comprehensive testing of systems important to safety and process systems were agreed.

On 1 August 2017, ChNPP SISP started cold testing of ISF-2 in accordance with the Integrated Testing Program for ISF-2 with Dummy Fuel Assemblies.

On 22 December 2017, the SNRIU amended License No. EO 001002 for construction and commissioning of the nuclear facility (spent fuel storage facility ISF-2). In accordance with the amendments, this license was extended until issuing the license for operation of the nuclear facility.

6. SAFETY IN USE OF RADIATION SOURCES

6.1. Improvement of Radiation Protection in Medical Exposure, Practices of Regulating Safety of Radiation Sources and Conceptual Changes and Prospects

The State Nuclear Regulatory Inspectorate of Ukraine is a central executive body that implements state policy, since 1995, on the safety of nuclear energy use by establishing legislative and regulatory requirements, issuing permits, conducting inspections and applying sanctions.

Today, in Ukraine, the requirements for safety regulation of radiation sources are more deregulated and liberal than required by international standards and EU legislation. This was stated during the international review of the state regulation system of Ukraine in 2008. In particular, international experts from the IRRS mission specified[2] that we should be very careful when exempting activities related to medical exposure from licensing.

This is also shown by Council Directive 2013/59/Euratom of 5 December 2013 establishing basic safety standards for protection against hazard resulting from radiation. This allows EU members to select independently the process of licensing or registering certain activities in nuclear energy use but requires the use of licensing exclusively, in particular, regarding the use of radioactive materials for medical or veterinary diagnosis, treatment or biomedical research (Articles 28, 88).

The area of medical using radiation sources for diagnostic and therapeutic purposes requires reforms and changes the most in order to bring it into compliance with new Council Directive 2013/59/Euratom. This branch is still guided by departmental orders of the Ministry of Health of the 1990s[3], although in the world since 1991, the radiation protection system has been fundamentally changed twice.

At the same time, it is the medicine where most radiation sources are used (70% of the total), including with the highest potential hazard level (category 1 radiation sources). Medical radiation requires radiation protection not only for personnel (more than 10 thousand people working with sources) but also for patients: about 80 thousand people undergo treatment annually; about 20 million people per year are diagnosed.

International practice shows that the greatest number of radiation accidents with severe consequences arises precisely under medical application of radiation sources.

Unfortunately, in Ukraine until now, any radiation accident in medicine is automatically secret.

In addition, in most medical institutions, exposure procedure is not justified, absorbed dose is not controlled. Inadvertent or erroneous exposure occurs because of most therapeutic procedures, the received radiation dose differs from the dose prescribed by physician. Unfortunately, computer systems of dose planning are available only in 32 radiotherapy departments; at the same time, in 21 departments (40%), planning and calculation of absorbed doses is still performed manually, without involving medical physicists. Planning and calculation of doses by hand may (and very often leads to) reduce the exposure dose of the tumor and adjacent organs by more or less than 5%. This approach

[2]Report "Integrated Review of Regulatory Activities (IRRS), 9-20 June 2008

[3]Order of the Ministry of Health dated 28 November 1997 "On Improvement of the Radiation Diagnostics and Radiation Therapy Service"; Order of the Ministry of Health No. 295 of 18 July 2001 "On Establishment of the System for Control and Monitoring of Individual Doses to the Public in Radiological Medical Procedures"; Radiation Safety Standards of Ukraine (NRBU-97); Basic Health and Radiation Safety Rules of Ukraine (OSPU-2005).

makes the treatment ineffective, causes radiation damage of adjacent organs, tumor recurrence and radiation complications during exposure.

The absence of any information from medical institutions on inadvertent or erroneous medical exposure confirms the fact that cases of inadvertent or erroneous exposure are not recorded in medicine, not analyzed and corrective measures are not implemented.

In most cases, all of the above-mentioned measures are slowly implemented only under the pressure of the SNRIU and its territorial bodies by issuing prescriptions and establishing licensing conditions.

Radiation protection level of the public during medical exposure in Ukraine is low and today, there are no levers to stimulate this level increase except licensing of activities on using radiation sources.

In order to improve the situation, medical institutions should analyze the present realities in this area and, if necessary improve the state of radiation safety and patient protection. Radiation doses for patients should be measured in diagnostic procedures, as well as dose rate for therapeutic procedures. Medical institutions should provide continuous monitoring of dose forming parameters, maintenance, and repair of diagnostic and therapeutic equipment. At the same time, it is necessary to improve skills of medical personnel on radiation safety issues; provide personal protection means for patients and doctors.

In 2017, first regulatory documents were approved based on new international safety standards and EU legislation. In particular, General Radiation Safety Rules of Using Radiation Sources in Medicine and Radiation Safety Rules of Using Radiation Sources in Brachytherapy were approved by joint orders of the SNRIU and the Ministry of Health.

These regulatory documents are aimed at increasing radiation protection in medical exposure: establish the values for diagnostic reference levels of exposure, requirements and mechanisms to ensure control over exposure doses of patients, methods and means to optimize radiation protection, justify procedures for diagnostic medical exposure. In addition, regulatory documents establish current safety criteria for radiation sources including new radiation technologies implemented in Ukraine.

Meeting the requirements of these regulatory documents is controlled by SNRIU territorial subdivisions: inspections on nuclear and radiation safety. The SNRIU will continue activities on increasing radiation protection in medicine next year.

6.2. State System for Accounting and Control of Radiation Sources in Ukraine

The State System for Accounting and Control of Radiation Sources implemented in Ukraine is an effective tool of regulatory control and meets the requirements of international safety standards (IAEA) and EU legislation, which define the need to establish relevant registers.

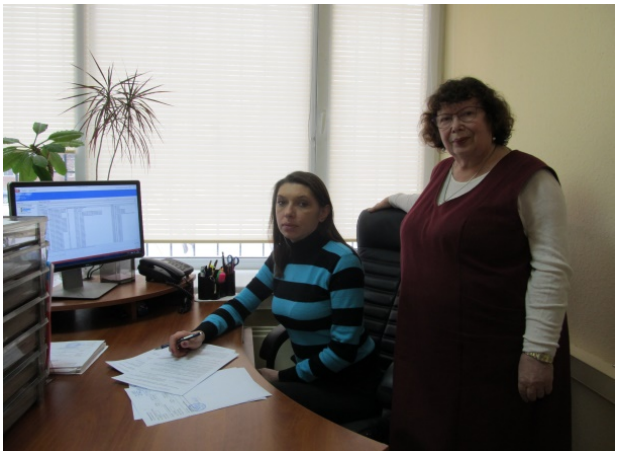
The purpose of the State Register of Radiation Sources in Ukraine is not only to keep accounting data; first, it is a tool of the regulatory body to assess radiation safety at a certain facility using radiation sources.

The decision to establish the State Register of Radiation Sources was made by the Government of Ukraine in 1997. In 2007, according to the results of interdepartmental commission work, the register was put into force.

The automated system for registering radiation sources was developed on the basis of RAIS developed by the IAEA by its adaptation to the requirements of national legislation. Moreover, the procedure for interaction of the register with the State Customs Service was implemented, the procedure for using the register was adopted, and a number of other documents necessary for functioning of the system were developed.

All radiation sources not exempted from regulatory control are subject to registration in the State Register of Radiation Sources. The established levels of exemption from regulatory control by total and specific activity meet the recommended IAEA levels.

Currently, the register functions in Isotop Ukrainian State Production Enterprise as a separate subdivision Main Register Center (MRC) and relevant regional centers. MRC personnel register radiation sources, provide methodological assistance when organizing the state inventory, and assess adequacy and quality of inventory documents. After that, they submit reports to the SNRIU on the activities performed.



As of 31 December 2017, the number of sources registered and operated or stored is **23854** radiation sources, including **8719** radionuclide sources and **15135** non-radionuclide installations generating radiation.

Number of registered radiation sources in 2017

	Registered in total, Pcs.	including	
		Radionuclide	Radiation generators
RC (Kyiv)	529	231	298
RC (Dnipro)	102	38	64
RC (Zaporizhzhya)	114	33	81
RC (Kharkiv)	154	49	105
RC (Rivne)	54	10	44
RC (Odesa)	122	50	72
RC (Ivano-Frankivsk)	147	54	93
RC (Simferopol)	-	-	-
Total	1 222	465	757

During 2017, 441 radiation sources were transferred to new owners. 632 disused radionuclide radiation sources were deregistered and 310 non-radionuclide installations were decommissioned.

In 2017, lifetime was extended for **1580** radionuclide sources of the Institute of Metrology, Kyivoblstandartmetrologiia State Enterprise, Promisotop LLC, Chornobyl SISP and Isotop Service LLC having the license to use radiation sources as regards implementing such activities. At the same time, control over the owners of radiation sources with expired life is implemented with the help of register information.

Registration fee in 2017 was 160 UAH for a radionuclide source; 112 UAH for a non-radionuclide installation generating radiation.

Functioning of the Register, maintaining adequacy and quality of its information is one of the main SNRIU tasks. Consequently, Register functioning is an important component in preventing the use of radiation sources with malicious intent and preventing radiation accidents.

Металевий контейнер циліндричної форми з маркуванням «Радіоактивно»

Трос з синтетичних волокон в поліетиленовому пакеті

At the same time, the State Register of Radiation Sources is an effective tool to search radiation source owners when revealing radiation sources in illicit trafficking.

7. RADIOACTIVE WASTE MANAGEMENT

7.1. Management of Radioactive Waste Generated at Ukrainian NPPs

The production of electricity at NPPs is accompanied by the generation of radioactive waste in technological processes, maintenance, and regular operations.

The safety of radioactive waste management at NPPs is one of the conditions of NPP operational safety and is ensured by compliance with legislation and licensing terms and implementation of measures under Energoatom's Comprehensive Program for Radioactive Waste Management for 2017-2021 intended to:

- construct and commission complex lines for radwaste treatment to prepare NPP waste for transfer for long-term storage/disposal to centralized facilities at the Vektor site in the exclusion zone;
- implement efficient and economically feasible technologies for treatment of solid and liquid radwaste;
- upgrade existing and construct new facilities for treatment of solid and liquid radwaste;
- develop a system for radwaste characterization;
- improve the fleet of containers for radwaste collection, transport, storage and disposal;
- develop and implement a transport and handling procedure for NPP radwaste transport to specialized enterprises for radwaste management;
- justify criteria for transfer/acceptance for long-term storage and/or disposal of NPP radwaste in Vector facilities.

The management of NPP radwaste on operating NPP sites includes radwaste collection, sorting, transport, treatment and interim storage in on-site storage facilities for liquid and solid waste.

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

Solid radwaste is collected in situ, sorted into groups (by gamma dose rate) and transported for interim storage to solid radwaste storage facilities (SRSF). The on-site SRSF represent reinforced concrete structures including individual compartments for solid radwaste depending on activity. The compartments are equipped with a fire alarm system, automated fire-extinguishing system and exhaust ventilation with air purification.

The main principles for NPP radwaste management are to minimize waste generation and consider interrelation between all stages: from generation to disposal.

The Strategy for Radioactive Waste Management in Ukraine, approved by a Cabinet Resolution, and the National Target Environmental Program for Radioactive Waste Management, approved by a Law of Ukraine, envisage the removal and treatment of radwaste accumulated at NPP during operation by developing an infrastructure for radwaste characterization, conditioning and packing into the form suitable for further waste transport and storage and/or final disposal.

The release of free volumes in on-site radwaste storage facilities is a necessary condition for NPP long-term operation.

In 2017, Energoatom completed construction and started testing of equipment in industrial systems for management of radioactive waste that has accumulated in the operational period and will be generated in long-term operation, in future, in decommissioning of Rivne and Zaporizhzhya NPPs.

The SNRIU provided regulatory review and agreement of comprehensive testing programs and appropriate technical decisions on introduction into trial operation:

RNPP radwaste treatment system including process facilities for:

solid radwaste retrieval from SRSF compartments;
solid radwaste sorting and fragmentation;
solid radwaste supercompaction;
solid radwaste cementation;
solid radwaste activity measurement;
metal decontamination;
spent oil processing;

ZNPP radwaste treatment system including process facilities for:

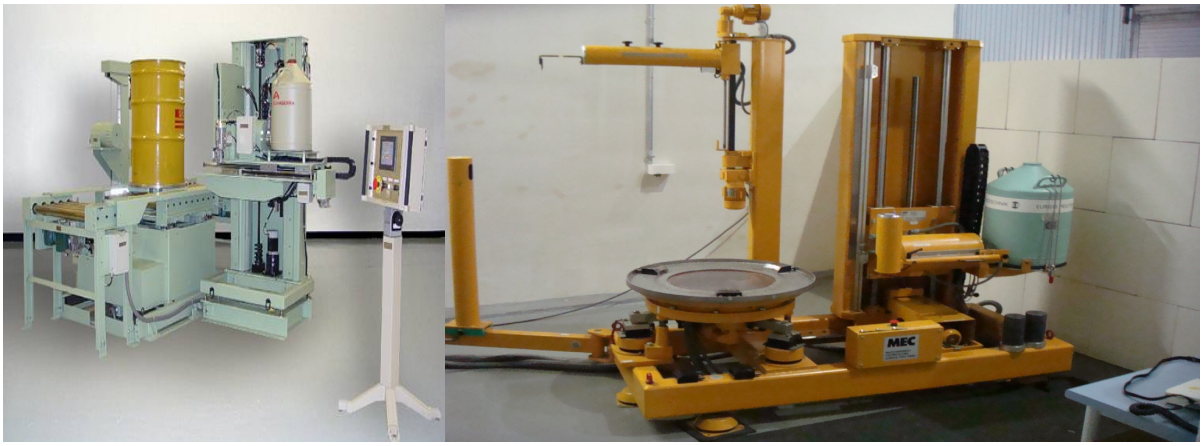
incineration;
solid radwaste fragmentation;
supercompaction;
radwaste categorization.

The incineration facility is intended to process solid radwaste and oil at 1100 °C .

The system to monitor releases from the incineration facility ensures continuous measurement of airborne activity, periodic sampling to measure activity by laboratory methods and continuous measurement of CO, SO_2, NO, NO_2, HCl, and O_2 concentration in flue gases. The incineration facility was tested on dummy radwaste.

The pressing facility (supercompactor) is intended to reduce the volume of solid radwaste, including, containers for solid radwaste. The compaction force is 1500 t and volume reduction factor is 3.5.

The fragmentation facility is located in a special caisson and is intended to reduce the size of solid waste, first of all metal waste.



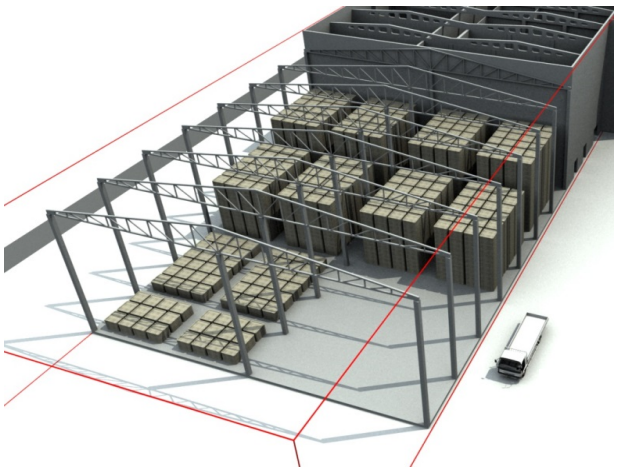
The activity measurement facility (radwaste categorization facility) is intended for characterization of containers with radwaste and preparation of certificates for radwaste packages.

In addition, to improve the radwaste management system, ZNPP is going to introduce the following infrastructure facilities:

- radwaste retrieval facility;
- metal decontamination area;
- light facility for radwaste container storage.

Using a special facility, solid radwaste is retrieved from storage cells and primarily fragmented to facilitate further treatment.

The light storage facility is intended for on-site interim storage of radwaste treatment products in certified containers of UZZZh type prior to transfer to specialized radwaste management enterprises for final disposal.



The development of a system for radwaste treatment is envisaged for KhNPP in 2017-2021 and at SUNPP in 2019-2023.

According to the Agreement between the Government of Ukraine and the Government of the Russian Federation on Scientific, Technical and Economic Cooperation in the Field of Nuclear Energy of 14 January 1993 and the contractual obligations of Energoatom Company, spent fuel of WWER reactors is transferred for technological storage and reprocessing to the enterprises in the Russian Federation (Industrial Association *Mayak* and Mining and Chemical Plant). Spent fuel reprocessing products shall be returned to Ukraine according to the terms and within timeframes defined by contractual documents.

The amount of vitrified high-level waste to be returned to Ukraine is calculated according to the "Methodology for Calculating the Amount of High-Level Waste Returned to Ukraine after Technological Storage and Reprocessing of WWER-440 SFA Batch" (SOU-N YaEK 1.027:2010).

Technical specifications for vitrified high-level waste resulting from WWER-440 spent fuel reprocessing, certification procedure, and quality assurance program are currently revised to incorporate SNRIU comments.

The feasibility study for construction of the interim storage facility for vitrified radwaste returned from the Russian Federation after reprocessing of spent nuclear fuel from Ukrainian NPPs was approved by order of the State Agency of Ukraine on Exclusion Zone Management in 2016. The design of this storage facility received positive conclusions of state review and was approved by order of the State Agency of Ukraine on Exclusion Zone Management in 2017.

Construction of a facility for long-term (up to 100 years) storage of vitrified high-level waste resulting from reprocessing of WWER-440 spent fuel on the Vektor site is envisaged by Task 3 of the National Targeted Environmental Program for Radioactive Waste Management but has not been started yet.

Spent fuel of WWER-1000 NPPs, except for ZNPP, is transported to the Russian Federation for technological storage and reprocessing. WWER-1000 spent fuel is not reprocessed in the Russian Federation since the reprocessing technology is only under testing. The technical specifications for WWER-1000 spent fuel reprocessing products and methodology for calculating the amount and activity of WWER-1000 spent fuel reprocessing products to be returned to Ukraine are under agreement.

7.2. Management of Radioactive Waste in Exclusion Zone

A key element in developing the radioactive waste management system in Ukraine is construction of a series of radioactive waste management facilities in the exclusion zone, including:

- radioactive waste management facilities at the Vektor site intended for the final stage of radwaste management (centralized disposal and long-term storage) of all waste producers in Ukraine as well as processing of some types of radioactive waste from the exclusion zone and minor waste producers;
- construction of radioactive waste management facilities at the ChNPP site;
- surveys of sites for a geological repository.

According to the Strategy for Radioactive Waste Management[4] and the National Target Environmental Program for Radioactive Waste Management[5], the primary tasks and measures aimed at developing the radwaste management system in the exclusion zone envisage the following:

- commissioning and operation of near-surface radwaste disposal facilities of Vektor Stage 1[6] and engineered near-surface radwaste disposal facility (ENSDF)[7] constructed for disposal of radioactive waste packages from Chornobyl NPP at the Vektor site;

[4] Approved by Cabinet Resolution No. 990-r of 19 August 2009.
[5] Approved by Law of Ukraine No. 516-VI of 17 September 2008.
[6] Vektor Stage 1 incudes near-surface disposal facilities for low- and intermediate-level radwaste resulting from the Chornobyl disaster of two types: SRW-1 is a facility for disposal of radioactive waste in reinforced concrete containers, SRW-2 is a module-type disposal facility for unpacked large-size radioactive waste.
[7] ENSDF was constructed in 2009 under ChNPP ICSRM project for disposal of radioactive waste packages from ChNPP LRTP and SRTP with a capacity of 50 210 m^3 for radioactive waste packages, which consists of two parallel sections, each of them has 11 reinforced concrete modules, central drainage gallery and two movable frame structures with bridge cranes.

- design and construction of pre-disposal long-term storage facilities (over 30 years) for long-lived high-level radioactive waste in geological repository within Vektor Stage 2[8] including vitrified radwaste resulting from spent fuel reprocessing to be returned from the Russian Federation, spent radiation sources and other long-lived high-level radioactive waste;

- design and construction of treatment plants for radwaste from the exclusion zone and minor waste producers within Vektor Stage 2;

- maintenance of the existing management facilities for Chornobyl-origin radioactive waste constructed during the first years of Chornobyl accident mitigation: Buryakivka RWDS[9], Pidlisny RWDS[10], ChNPP Stage III RWDS[11], and RICS[12] including their monitoring, upgrade, stabilization, safety improvement, inspection, safety review, remediation;

- surveys and research & development for siting a geological repository for long-lived high-level radioactive waste.

Implementation status

1. Completion of radioactive waste disposal facilities SRW-1 and SRW-2 and other facilities of the Vektor site was stopped in 2010 and was not resumed as of the end of 2017.

2. ENSDF is under operation. Since the beginning of operation, ENSDF accepted four radwaste packages (200-liter drums) for disposal from the Chornobyl NPP liquid radwaste treatment plant and 191 radwaste packages from Kharkiv SISP.

3. Operation of the centralized long-term storage facility for spent radiation sources (CLTSF[13]) is ongoing, which includes CLTSF hot tests using spent radiation sources. During hot tests, protective properties of facility structures shall be confirmed and the treatment process for disused radiation sources, operating procedures, interaction between suppliers of radwaste in the form of spent radiation sources, and accounting and control system for such radioactive waste over the entire technological process from acceptance from suppliers to placement of packages for long-term storage and management of secondary radioactive waste shall be verified.

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[8] Vektor Stage 2 includes long-term storage facilities for long-lived high-level radioactive waste; near-surface disposal facilities for low- and intermediate-level short-lived radioactive waste; treatment plants for Chornobyl radwaste and radwaste generated in non-nuclear sector. The Vektor Stage 2 Feasibility Study was approved by Cabinet Resolution No. 1605-r of 23 December 2009.

[9] Buryakivka RWDS is one of the main components of the management system for large amounts of accident-related radwaste that was constructed in 1987 under the emergency measures aimed at Chornobyl accident mitigation. Buryakivka provides, up to now, the disposal of a large amount of low-level radioactive waste generated during the activities performed at ChNPP site and on the contaminated territories in the exclusion zone.

[10] Pidlisny RWDS was constructed under the emergency measures aimed at Chornobyl accident mitigation. A-1, B-1 modules in this RWDS in 1986-1988 included the most hazardous high-level long-lived accident-related radioactive waste (fuel-containing materials, radioactive graphite, etc., that were thrown from the reactor during the accident).

[11] ChNPP Stage III RWDS was constructed under the emergency measures aimed at Chornobyl accident mitigation in uncompleted storage facility for radioactive waste of uncompleted ChNPP Stage 3. The reinforced concrete modules in this facility in 1986-1988 contained low- and intermediate-level accident-related waste. Over the years, there are processes of degradation of the hastily constructed dumping, which requires constant repair and maintenance.

[12] RICS are territories adjacent to ChNPP with a total area of about 10 hectares on which trenches and pits for radwaste confinement were constructed during the emergency measures aimed at Chornobyl accident mitigation. Such radwaste are mainly building structures, household items, upper layer of the soil, etc., contaminated in emergency release. There were from 800 to 1000 RICS trenches and pits.

[13] The Great Britain and the EC supported CLTSF construction. CLTSF operation includes acceptance, processing (conditioning) of radioactive waste in form of spent radiation sources of different types and categories and location of packages containing such radwaste according to radiation type for long-term storage during 50 years.

Within CLTSF hot tests in 2017, the SNRIU reviewed and agreed technical decisions for management of spent radiation sources of different types (neutron, military, beta-emitting, etc.) and documents on the development of system for nuclear material accounting and control.

Centralized long-term storage facility for disused radiation sources (CLTSF)

Area for storage of disused radiation sources at CLTSF

In 2017, License No. OB 001050 issued to CRME for radwaste treatment and storage was amended to extend its period of validity and supplemented with additional conditions for CLTSF hot tests.

4. In the framework of state comprehensive review, the project **"Construction of Interim Storage Facility for Vitrified High-Level Radioactive Waste Returned from the Russian Federation after Reprocessing of Spent Nuclear Fuel from Ukrainian**

NPPs" and the respective Safety Analysis Report were subjected to NRS review. The review resulted in positive conclusions on nuclear and radiation safety.

5. Within the operation of disposal facilities (trenches) for radwaste at Buryakivka RWDS, CRME was closing and sealing trench No. 21 and completed the sealing of trench No. 30 as of the end of 2017.

Closure of Buryakivka RWDS trenches

To expand production capacities of Buryakivka RWDS, CRME developed and submitted project "Construction of 21A Buryakivka RWDS Disposal Facility", which envisages construction of an additional disposal facility (trench), for state review.

In 2017, License No. EO 000953 issued to CRME for operation of radwaste disposal facilities was extended.

License No. EO 000953 provides for operation of the following facilities:

- sealed radwaste disposal facilities or Buryakivka RWDS and all facilities located on their site and technologically related to them (regular activities to ensure safety);
- facilities to which accident-origin radwaste from Pidlisny and ChNPP State III RWDS was transferred during mitigation of the Chornobyl accident in 1986 (regular activities to ensure safety, safety improvement measures in compliance with agreed projects);
- radwaste interim confinement sites (RICS) (regular activities to ensure safety, safety improvement measures, radwaste re-disposal taking into account technical decisions agreed by SNRIU, taking into account safety assessments and priorities).

6. In the course of industrial project INSC U4.01/10D and regulatory project INSC U3.01/10 (UK/TS/46) involving European experts and applying current safety assessment methodologies, safety assessment of Pidlisny RWDS and ChNPP Stage III RWDS was performed. This assessment confirmed that, taking into account the implemented safety improvement and stabilization projects, these facilities ensure safe radwaste storage. At the same time, it is necessary to continue enhanced institutional control involving measures for ageing management and monitoring of facilities to confirm the reliability of the measures completed.

The SNRIU reviewed and, taking into account state review conclusions, agreed the "Technical Decision on Additional Survey of Pidlisny RWDS" and "Program for Study of Radioactive Waste Characteristics in Pidlisny RWDS Module A-1" developed by CRME.

Pidlisny RWDS modules A-1 and B-1 after safety improvement project

In the long term, the issue related to retrieval of radwaste from these RWDS and its redisposal in appropriate disposal facilities should be solved. Preparation for radwaste retrieval from these RWDS is part of the long-term measures to be implemented stage by stage after the development of retrieval, handling and disposal technologies for this waste.

7. Under industrial project INSC-U4.01/10D, RWDS and radwaste pits and trenches located on RICS territories were surveyed. RICS safety assessments were performed in compliance with the approach agreed with the SNRIU. These assessments were used to rank RICS according to their potential hazard and identify and optimize further remediation measures, which may include complete or partial waste retrieval from individual facilities, creation of additional barriers, monitoring, etc.

The main conclusions of the RICS safety assessments indicate that:

- RICS are associated with radiological risks that require measures to reduce them in the long term;
- for most RICS, institutional control for about 500 years within a certain restricted territory in the exclusion zone (approximately within 10 kilometers) is sufficient to ensure radiation protection;
- after a 500-year institutional control period, most restrictions can be removed;
- assessment of some scenarios (for example, fires, tornadoes) shows that appropriate emergency preparedness measures can significantly reduce the radiological impact of such events on personnel and the public beyond the exclusion zone;
- retrieval of radioactive waste from certain RICS pits/trenches (and contaminated upper soil layer) can be justified in terms of safety improvement for personnel and visitors of the exclusion zone and reduction of the collective dose.

7.3. Management of Radioactive Waste on Ukrainian Territory (Including Legacy Radioactive Waste)

Safe storage of radiation sources or their disposal at the end of lifetime is an important condition for their safe use in order to avoid their loss or access of the public

since disused radiation sources remain hazardous as they contain radioactive material that can cause significant damage to human health in case of distribution or inadvertent use.

Disused radiation sources are declared as radioactive waste and become the state property. Their further management is implemented in accordance with the safety requirements for radioactive waste management of the state specialized enterprises on radioactive waste management of the Radon Ukrainian State Corporation (Radon USC).

Currently there are Kyiv, Kharkiv, Dnipropetrovsk, Lviv, Odessa State Interregional Specialized Plants (SISPs) in the Ukrainian territory.

These enterprises, in the territories of their assigned service areas, ensure collection, transport and safe placement of radioactive waste in storage/disposal facilities specially designed for this. At the same time, SISPs operate stations for decontamination of underwear, special clothes and personal protective means of medical and research institutions and enterprises.

Radwaste storage in SISP containers

Since capacities for radwaste management of the abovementioned enterprises were established in the Soviet times in the 60-70s of the 20th century, the National Program for Radwaste Management provided a number of measures to re-equip SISPs. At the same time, measures are envisaged to retrieve radioactive waste from old facilities and re-dispose it in the centralized disposal facilities at the Vektor site in the Exclusion Zone. This will allow liquidation of old radioactive waste disposal facilities that do not meet current safety requirements and potential hazard of radionuclides spread in the environment. In each case, such decisions should be made on the basis of a safety review performed by specialized enterprises in accordance with the conditions of licenses issued by the SNRIU.

In 2017, in order to ensure radioactive waste supply in the form of disused radiation sources from specialized plants to CLTSF in compliance with the acceptance criteria established for this facility, in particular during hot tests, relevant amendments were made in the licenses of the Kharkiv SISP No. OB000949, Dnipropetrovsk SISP No. OB000948, Kyiv SISP No. OB00959, Lviv SISP No. OB000891, Odessa SISP No. OB000893 for radioactive waste processing and storage.

Licensing documents were considered and assessed on amending license No. OB000891 of the Lviv SISP for processing and storage of radioactive waste as regards extending the validity period for this license and extending license application for additional

facility: mobile unit with equipment for safe removal of disused radiation sources from shielding blocks of BGI and E type.

Specialized enterprises are also involved in urgent actions of competent authorities on mitigation of emergencies associated with revealing abandoned radiation sources or illicit trafficking of radiation sources. All these radiation sources are transferred to storage/disposal facilities of specialized enterprises where their safe and controlled storage, as well as localization from entry into the environment and places accessible for the public is provided.

Legacy Radioactive Waste

Legacy radwaste in Ukraine includes the following:

- radwaste disposed in Soviet times at radwaste management facilities of Radon state interregional specialized plants;
- radwaste placed on the decontamination waste storage sites and vehicle sanitary treatment sites (DWSS/VSTS), resulting from mitigation of the Chornobyl accident and located outside the exclusion zone in the Kyiv, Zhytomyr and Chernihiv regions;
- radwaste resulting from military programs of the former USSR.

The Kyiv SISP provides maintenance, radiation monitoring and control of DWSS/VSTS. These facilities need additional examination, safety assessment, making and implementing decisions on their remediation.

In 2017, SNRIU considered documents on the preliminary safety assessment of DWSS/VSTS and preparation of recommendations on the methodologies to remediate DWSS/VSTS and pilot facility “Pisky-1 Decontamination Waste Disposal Facility”.

In summer 2017, the State Nuclear Regulatory Inspectorate received a message that unauthorized land activities were carried out in the place of legacy disposal of radioactively contaminated materials in 1988 near Kropyvnytskyi in the region of Veselivske deposit. In the place of disposal, materials resulting from mitigation of the consequences of the radiation accident in the territory of the Kirovogradbud trust related to depressurization of the radiation source with cesium-137 were disposed. This facility is an environmentally hazardous inheritance from the times of the former USSR regarding which administrative control was actually lost.

The prompt response at the level of the Kropyvnytskyi city council involving law enforcement agencies, Kirovograd Regional Laboratory Center of the Ministry of Health of Ukraine, Dnipropetrovsk SISP, SEZA, SNRIU, and SSTC NRS allowed localization of the situation and prevention of further emergency development. A number of archival documents were found on the amount and activity of disposed materials.

Currently, remediation of this facility and its site is coordinated by the State Agency of Ukraine on Exclusion Zone Management as a state administrative body in radioactive waste management. The SNRIU involving expert resources under INSC UK/TS/56 prepares a special regulatory decision taking into account international standards and directives on the procedure for actions and decision making on remediation of identified facility territory. The current situation in terms of planning radiation protection and remediation measures may be referred to existing exposure situations in accordance with the updated International Basic Safety Standards (IAEA publication: GSR, Part 3, BSS) and EURATOM Directive 2013/59.

7.4. Chornobyl NPP Decommissioning

Chornobyl NPP Units 1-3 are decommissioned by the State Specialized Enterprise "Chornobyl NPP" (ChNPP) in accordance with License No. EO 000040 issued for nuclear facility operation on 22 March 2002.

In November 2017, ChNPP submitted the application to SNRIU to renew License No. EO 000040. The renewal of License No. EO 000040 is associated with special conditions established in the license to be fulfilled by ChNPP, namely:

- Chornobyl NPP operational termination stage was completed;
- individual permit No. OD 000040 was obtained for final closure and safe storage of Chornobyl NPP Units 1, 2 and 3;
- all spent nuclear fuel, including damaged one, was removed from Units 1, 2, 3 to the spent fuel storage facility (ISF-1);
- measures on the heat supply system for ChNPP facilities were developed and implemented.

Based on preliminary analysis of the application package, the SNRIU accepted it for review. State nuclear and radiation safety review was arranged for the Chornobyl NPP Decommissioning Program revised by ChNPP. The document package submitted by ChNPP is under review and evaluation.

During 2017, the SNRIU supervised ChNPP activities on implementation of the final closure and safe storage (FCSS) stage for Chornobyl NPP Units 1, 2 and 3 in compliance with individual permit No. OD 000040/8 issued within License No. EO 000040.

In October 2017, the SNRIU conducted scheduled inspection of ChNPP. The inspection showed that ChNPP in general ensured safety of activities envisaged for the FCSS stage.

Nuclear fuel was removed from ChNPP Units 1, 2, 3 in 2016. Upon ChNPP request, the SNRIU reviewed and agreed a number of procedural and technical documents and amendments to them, which relate to safety assurance in further Chornobyl NPP operation and area associated with change in the status of ChNPP Units 1, 2, 3.

In the framework of supervision over ChNPP's compliance with special conditions of the above-mentioned individual permit, the SNRIU reviewed ChNPP's report on implementation of the "Program on Final Closure and Safe Storage of ChNPP Units 1, 2 and 3 for 2017" (FCSS Program). Analysis of the report showed that the measures envisaged by the FCSS Program were not performed in full scope and in a timely manner. In particular, there were deviations from the schedule for implementation of individual startup packages (SP) at the stage of final closure and safe storage, which are specified in the Program on Final Closure and Safe Storage of Chornobyl NPP Units 1, 2 and 3.

Particular attention should be paid to the implementation of SP-2 "Dismantling and Processing of Fuel Channels and Control Rod Channels", which is one of the most important activities for ChNPP at the FCSS stage. The implementation of SP-2 (beginning of activities, duration, sequence of activities, periods for dismantling of fuel channels, control and protection channels, casing of fuel channels etc.) directly depends on the technical project for the line for cutting long-length waste (LCLW). The LCLW is intended for cutting special items to be dismantled under SP-2 and special long-length items resulting from operation of the power unit. The LCLW project has been suspended. Implementation

of the LCLW project is under SNRIU supervision.

The timely implementation of individual SPs at the FCSS stage in general also depends on the presence of radwaste management infrastructure (radwaste storage and disposal facilities, commissioning and operation of existing facilities, design of new radwaste management facilities at the Chornobyl NPP, etc.) and infrastructure for management of contaminated materials and equipment.

In the reporting year, the ChNPP technical decision "On Temporary Location of Dismantled Equipment (Contaminated Equipment and Materials) in Head Pool of Stage I (HP-1)" was reviewed and agreed.

At the same time, problems associated with the disposal of large-size waste remained during 2017 since the radwaste disposal facilities at Buryakivka RWDS were filled. In the reporting year, the SNRIU attracted ChNPP attention to the need to construct additional interim radioactive waste storage facilities at the ChNPP site using rooms and buildings that are emptied during decommissioning and accelerate the beginning of operation of radioactive waste treatment facilities at the ChNPP site.

At the end of 2017, ChNPP submitted the "Conceptual Decision on Procedure for Handling of Dismantled Equipment at ChNPP" and technical decisions developed in compliance with this conceptual decision to the SNRIU.

These documents discuss ChNPP approaches and methods for the arrangement of temporary storage of contaminated equipment and materials in buildings, structures and rooms of buildings and structures emptied during ChNPP decommissioning.

The SNRIU arranged state nuclear and radiation safety review of the above-mentioned documents.

In the decommissioning process, a great volume of equipment and its components that are subject to release from regulatory control is dismantled.

With involvement of Riskaudit and SSTC NRS, the SNRIU conducts review of the design documents "Development of Facility for Release of Materials from Regulatory Control at ChNPP" submitted by ChNPP and developed under industrial project INSC U4.01/11E.

Radioactive Waste Management Facilities at Chornobyl NPP

Radioactive waste accumulated during Chornobyl NPP operation and accident mitigation in 1986 and generated during decommissioning of power units 1, 2 and 3 and Shelter transformation into an environmentally safe system is stored in radioactive waste storage facilities at the Chornobyl NPP site: solid radwaste storage facility, liquid radwaste storage facility, solid and liquid radwaste storage facility, or is transferred for disposal to Buryakivka RWDS disposal facilities.

In 2017, 1.05 m^3 of liquid radwaste was generated at Chornobyl NPP and sent for temporary storage (filter perlite pulp). As of the end of 2017, 13580.90 m^3 of evaporation bottoms, 4109.47 m^3 of spent ion-exchange resins, 2295.88 m^3 of filter perlite pulp, and 145.31 m^3 of contaminated oil-fuel mixture were accumulated in liquid radioactive waste storage facilities.

Low- and intermediate-level solid waste generated during decommissioning and Shelter transformation into an environmentally safe system was transferred to Buryakivka RWDS facilities for disposal. During 2017, 7000.0 m^3 (9264.45 t) of low-level radioactive waste was transferred to Buryakivka RWDS.

High-level waste is collected into special containers (KTZV-0.2) and placed into the interim storage facility for solid high-level waste arranged in the former fresh nuclear fuel storage building. During 2017, 0.5 m^3 (0.18 t) of mixed solid high-level waste was generated and transferred for storage.

A series of radioactive waste management facilities have been constructed and are being commissioned at the ChNPP site under international technical assistance projects. Commissioning of these facilities will allow processing of the accumulated and generated radwaste to bring it to the state acceptable 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.

According to individual permit OD No. 000040/7 issued on 11 December 2014 for operation of the liquid radwaste treatment plant (LRTP), the operation is possible only after obtaining a certificate of completed facility. To obtain the certificate, the Chornobyl NPP has to reconstruct the fire-fighting and lighting protection systems and provide thermal insulation for external walls of the plant. To issue the certificate, the SNRIU reviewed and agreed the project "Chornobyl NPP. Liquid Radioactive Waste Treatment Plant (Revision)" in 2017. ChNPP carried out activities envisaged by the project.

The SNRIU also reviewed and agreed changes to the "Technical Specifications on Operation of the Chornobyl NPP Liquid Radioactive Waste Treatment Plant".

In 2017, liquid radwaste was not treated at LRTP, but equipment and systems were maintained in operable state.

Industrial Complex for Solid Radioactive Waste Management (ICSRM) on the ChNPP site combines a series of radwaste management facilities[14]. Construction of the ICSRM facilities has been completed, and they are being commissioned.

[14] **Interim 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 in sorting at the solid radwaste treatment plant and in preparation for construction of 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 is designed for retrieval of solid radwaste from the existing ChNPP solid waste storage and transfer of waste for treatment to SRTP;

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

In the framework of ICSRM commissioning, the SNRIU reviewed and agreed:

– changes to the "Program for ICSRM Commissioning" and "Working Program for Second Stage of ICSRM Hot Tests";

– revised "Decision on Safe Management of Radioactive Waste Packages not Complying with Acceptance Criteria for Disposal in ENSDF";

– "Methodology for Taking Samples from Light Compartments of Solid Radioactive Waste Storage Facility (Building 85)" (regarding characterization of solid radwaste in the upper layer of light compartments).

The SNRIU also reviewed and agreed the "Decision on Transfer of Containers with Bituminous Compound from RNPP for Disposal in ENSDF of CRME Including Immobilization at ChNPP Facilities" (ICSRM) upon Energoatom request.

7.5. Shelter Transformation into Environmentally Safe System

During 2017, the SNRIU implemented its priority activities such as safety assessment and licensing for the construction of the first startup package of the New Safe Confinement (NSC SP-1).

The Shelter is transformed into an environmentally safe system through subsequent development and implementation of individual plans, projects and programs.

One of the main Shelter projects is the construction of the New Safe Confinement (NSC).

NSC project implementation is envisaged within two startup packages (NSC SPs):

– NSC SP-1 is a protective structure with process life support systems and necessary infrastructure;

– NSC SP-2 is an infrastructure for dismantling of unstable Shelter structures.

The design lifetime of the NSC is 100 years.

The first startup package of the New Safe Confinement (NSC SP-1) is currently under implementation; the contractor for NSC design, construction and commissioning is French Novarka Consortium.

In November 2016, the NSC arch was moved into its design position above the Shelter.

Although the confinement still was not commissioned, radiation monitoring in 2017 showed that installation of the arch into the design position positively influenced the radiological conditions on the ChNPP site. According to ChNPP, the dose rate decreased by 2 to 5 times on average based on measurements of gamma dose rates in different areas of the Chornobyl NPP site.

Airborne releases through leaky places in the Shelter reduced as well. The arch completely prevented the direct impact of solar rays and wind, which caused air flows inside the facility and carried out radioactive aerosols outside. The total volume of releases reduced by several times.

The arch also excluded penetration of atmospheric precipitations into the Shelter, which that was previously the main degradation factor for Shelter structures along with snow and wind loads, and decreased transfer of radioactive substances both inside and outside the Shelter.

For comparison, the amount of contaminated water pumped from the Shelter in 2017 was lower by two to four times than in the previous years.

During 2017, ChNPP and Novarka continued activities that were envisaged previously by design decisions agreed by the SNRIU.

On the NSC installation site and Shelter local area, the radiation monitoring ventilation, gas treatment and conditioning, power supply, fire safety, physical protection and access control, integrated monitoring and control, and internal transport systems were installed; arch hinged supports were covered with concrete; sealing membranes were installed; sealing anchors were assembled and installed, etc.

The process and other auxiliary buildings were constructed, including electrical device building, fire-fighting pump stations, and access air lock for fire units. NSC internal and external areas were equipped, including installation of piping for fire and service and drinking water supply, construction of roads and pavements in the Shelter local area, etc.

The construction of NSC end walls was completed and the apertures above the deaerator stack, turbine hall, block B, and auxiliary structures of the reactor compartment were closed (roof was arranged).

Control boards for the NSC main crane system were installed and connected in the main control room.

In the reporting year, the SNRIU carried out safety assessment of the documents under regulatory support in construction of NSC SP-1:

- the following documents were subjected to state nuclear and radiation safety review and were agreed:
    - revised parts of the project for the new safe confinement first startup package (NSC SP-1) related to installation of a foam fire-extinguishing system for the turbine hall roof and deaerator stack, change in NSC arch weight and NSC foundation sizes;
    - project of activities. Installation of sealing anchors on the existing Shelter structures (block B) along axis 39. SIP-N-TM-22-B2032-WEP-003-04;
    - working project “Cementation of Soil in the Foundation of the NSC Process Building and Auxiliary Facilities (Revision)”;
    - revised annexes to the technical decision “On Extension of the Strict Access Area with Special Conditions for Personnel Access to the Process Building Construction Territory”;
    - technical decision on temporary storage of solid radwaste in ChNPP Unit 4 (Shelter) turbine hall rooms outside the NSC fencing;
    - technical decision on decommissioning of the SSMS-DAU008-LDP205 instrumentation channel of the civil engineering structure monitoring system, included into the Shelter integrated automated control system;
- the following documents were subjected to technical assessment and were agreed:
    - analysis of amendments in the Shelter operating procedure associated with NSC commissioning;
    - documents on the ventilation system for the NSC annular space;
- the following documents were reviewed and agreed:
    - document “Static and Dynamic Tests of the Main Crane System”;
    - justification of long-term acceptability of storm water discharge from the arch installation platform to the relief;
    - measures intended to demonstrate the acceptability of annular space leak-tightness for performance of NSC safety functions.

Concerning the NSC second startup package (NSC SP-2), which is the infrastructure for dismantling of Shelter unstable structures, the NSC SP-2 working project was not developed in 2017 because of the lack and uncertainty of funds.

In the framework of preparation for NSC commissioning and in compliance with the "Plan of Measures on Stage-by-Stage Integration of the Shelter and NSC Safety Analyses with the Implementation of NSC SP-1" agreed by the SNRIU, ChNPP started development of the final safety analysis report for the project "Startup Package-1 (SP-1). Protective Structure with Process Life-Supporting Systems and Required Infrastructure".

Upon ChNPP request, the SNRIU, with involvement of SSTC NRS, conducts preliminary review and provides comments on individual chapters of the document.

According to the Novarka forecast schedule, the project was expected to be completed in November 2017.

At the regular meeting of the Assembly of Contributors to the Chornobyl Shelter Fund and the Assembly of Donors to the Nuclear Safety Account held in London in December 2017, the deadline for completion of the activities was postponed to May 2018 in view of the high levels of radiation in the work areas, which requires additional time for their implementation.

8. PHYSICAL PROTECTION

8.1. Measures to Improve Effectiveness of State Physical Protection System

Oversight activities

During January 2017, the SNRIU conducted one inspection of the Energoatom as regards inspection of the physical protection system of the Centralized Spent Fuel Storage Facility (CSFSF), as well as four state inspections of the physical protection system at Rivne NPP, Khmelnitsky NPP, South Ukraine NPP, and Zaporizhzhya NPP.

Within implementation of the Initiative for Global Threat Reduction and Improvement of Radiation Source Protection, surveys were conducted, after which the decision was made to modernize engineering and technical equipment of physical protection systems of 20 institutions. After modernization completion, they were accepted into trial operation.

In order to prevent the threat of sabotage, theft and other illicit actions by internal offenders the following was considered:

- interaction plans in case of sabotage for 7 enterprises;
- 2 plans of physical protection;
- 117 lists of employee positions (requiring a special permit to perform special activities). 27 of 117 were returned for revision;
- special authorization was also provided for 22 heads of enterprises of private ownership.

In 2017, a package of documents for a special inspection of 21 inspectors of the SNRIU and regional inspections was drawn up, permit was provided to 21 persons.

Licensees submitted 85 certificates on defining physical protection level of nuclear facilities, nuclear materials, radioactive waste, and other radiation sources to the SNRIU, 22 of them were returned for revision.

Regulatory activities

In order to bring regulatory documents into compliance with the Ukrainian legislation, Revision 1 of Draft Cabinet Resolution “On Amending Cabinet Resolutions No. 1471 of 25 December and No. 625 of 26 April 2003” was developed.

Authorizing activities

In order to meet the requirements of Article 45 of the Law of Ukraine “On Nuclear Energy Use and Radiation Safety” one permit was issued to use land and water bodies located in the control area of a nuclear facility, radioactive waste management facility, uranium facility. Two permits were amended.

In compliance with Article 15 of the Law of Ukraine “On Physical Protection of Nuclear Facilities, Nuclear Materials, Radioactive Waste, other Radiation Sources”, a state review of physical protection of 10 working projects for establishing (or modernization) of physical protection systems of nuclear facilities was performed.

International activities

Within the Information Exchange with IAEA Database on incidents and illicit trafficking of nuclear and other radioactive materials, 37 informational messages were sent about the cases of revealing illicit trafficking of radioactive materials in Ukraine.

Under IAEA assistance, SNRIU personnel participated in the workshop on actions at site of the crime with the use of radioactive substances. In addition, under IAEA auspices, a practical training was conducted for representatives of central executive bodies on nuclear and radiation safety during major public events, in particular preparations for Eurovision 2017. The SNRIU experts also took part in the training.

Moreover, in 2017, SNRIU personnel participated in two trainings organized by the Interpol Headquarters on combating illicit transfer of radioactive materials across the state border of Ukraine; and in Navigator-2 operation, which was conducted to combat illicit trafficking of firearms, ammunition, explosives, precursors, as well as chemical, biological and radioactive materials through the Ukrainian-Moldovan state border.

The SNRIU also participated in the XI and XII meetings of the IAEA Nuclear Security Guidance Committee (NSGC).

8.2. Project to Improve Security of Radiation Sources

The project for security improvement of radiation sources was initiated in 2004. Since then, technical modernization of physical protection system for more than 80 institutions was conducted in the country; assistance was provided in withdrawal of more than 500 high-level radiation sources; a number of workshops and training was held in this area.

Today, the activities are underway on implementing radiation awareness and crisis response training courses in the educational institutions of the National Police of Ukraine for the cases of unauthorized actions on radiation sources.

Central Monitoring Station (CMS) with the service of regular duty officers is established and functions under the SNRIU. Currently, 25 objects are connected with CMS.

During the year, inspections were conducted and projects for technical modernization of physical protection systems for 14 domestic facilities were developed. Three of them are at the stage of modernization. It is planned to perform surveys to make a decision of modernization of another 17 facilities in the future.

The Monitoring Station is also established at the Vektor Complex (Chornobyl Exclusion Zone) to which all operating RWDS of Radon USC (five institutions) are connected.

A positive decision is expected on establishing a safety monitoring station for radiation source transport at the Isotop State Production Enterprise, which focuses on transport of 90% of radiation sources in Ukraine.

8.3. Project for Comprehensive Training and Exercises to Ensure Preparedness of Response Forces

The project was launched in Ukraine in 2016. During 2017, a full-scale training of response forces and techniques in case of sabotage was planned and conducted at the Khmelnitsky NPP, emergency response measures were practiced.

In addition, during the year, tactic and special training was conducted at the sites of Khmelnitsky NPP, Rivne NPP, South-Ukraine NPP and Zaporizhzhya NPP. The participants exercised interaction elements of the defense and guard forces during counter sabotage and counter terrorism response, as well as during nuclear material transport.

8.4. Detection of Radioactive Materials in Illicit Trafficking

During 2017, SNRIU State Inspections on Nuclear and Radiation Safety together with the relevant structures of other central executive authorities in Ukraine continued activities aimed at revealing illicit trafficking of radioactive materials beyond regulatory control.

Thirty-seven information reports on the cases of revealed illicit trafficking of radioactive materials in Ukraine in 2017 were submitted within the exchange of information with the IAEA Incident and Trafficking Database (ITDB). The reports were sent seven

times in a standard information form (nuclear materials – 2, radiation sources – 5) and thirty times in a package information form (used since 2012 for the cases of withdrawal of: scrap metal contaminated with naturally occurring radionuclides, items with naturally occurring radionuclides: aviation watches, compasses, altimeters, etc.). In 2016, the total figure was 33 cases (29 in a package form). In 2015, the total figure was 22 and 18 correspondently.

In February 2017, the law enforcement agencies detained a group of people in Kyiv, who transported Gammarid gamma flaw detector with a protective shell of depleted uranium in their car.

Therefore, two cases of illicit trafficking of radioactively contaminated scrap metal were detected at the Azovstal Iron and Steel Works in incoming radiation inspection.

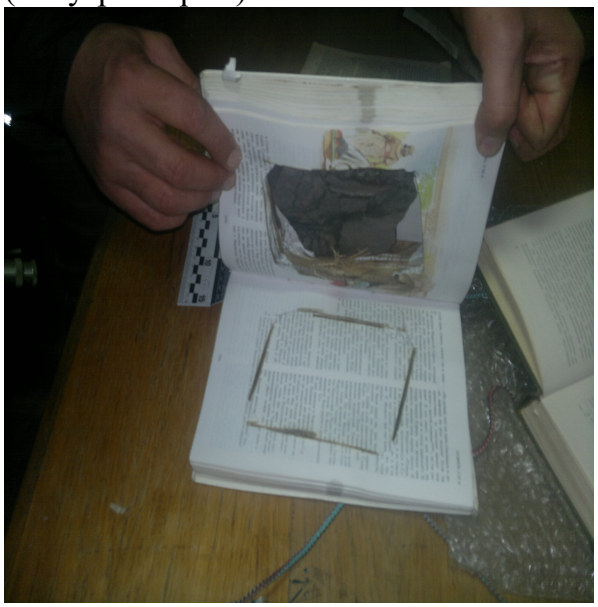
In June 2017, an attempt of carrying of an altimeter and a thermometer out of Ukraine was detected at the Boryspil Airport.

In August 2017, Gammarid 192/120 radioisotope device with increased level of gamma radiation was revealed in the Solomiansky district of Kyiv on the territory of a private estate. Equivalent dose rate on the surface of the device exceeded the reference

levels approved by the chief medical doctor of Kyiv and agreed with the chief state doctor of Ukraine.

The cases of revealing radiation sources in scrap metal accepted at the iron and steel works continue. Thus, RIO-3 radioisotope icing sensor containing strontium-90+yttrium-90 was revealed at the Azovstal Iron and Steel Works in late September during the incoming radiation inspection. Besides, a part of metal pipe with a significant excess of established standards was withdrawn in Kherson port from a batch of scrap metal that was to be sent to Turkey.

The citizens of Ukraine continue to send abroad using Ukrposhta mail different items like watches, altimeters, etc., containing radium 226 salts and whose equivalent dose rate significantly exceeds the established limits. There was a sample of rock that was put into a niche carved in the Children's Bible in one of the mail package. Such items are withdrawn and transferred for further safe storage to specialized plants of the USC Radon. Similar gifts with exceeded amount of radium 226 were also withdrawn in Lviv and Kyiv airports (Boryspil airport).



According to Resolution of the Cabinet of Ministers of Ukraine No. 813 dated 02 June 2003 "On Approved Procedure for the Interaction of Executive Authorities and Nuclear Entities in Case of Illicit Trafficking of Radioactive Materials", revealed hazardous items were withdrawn and transported to the state specialized plants of the USC Radon for further storage.

9. EMERGENCY PREPAREDNESS AND RESPONSE

Emergency preparedness and response are one of the tem fundamental safety principles in the sphere of nuclear energy use. The purpose of preparedness for response is to ensure:

efficient response measures at event scene and, if necessary, at local, regional, national and international levels;

minimization of radiation risks for anticipated incidents;

taking of measures to mitigate consequences of any incidents.

The SNRIU ensures support to continuous preparedness for response of its own system of communication and information exchange with the licensees, executive authorities, international organizations and competent authorities of other countries, as well as equipment and personnel of the Information and Emergency Center.

Requirements are established for NPP emergency centers, for personnel training and response procedures through approval of emergency plans, review of safety assessment reports, inspections and surveys, examinations and regulatory assessment of licensee training, etc., within state regulation of safe nuclear energy use.

The project "Modernization of SNRIU Information and Emergency Center" was implemented in 2017 under support of the U.S. Defense Threat Reduction Agency within the initiative "Global Partnership against the Spread of Weapons and Materials of Mass Destruction". The project was aimed at the implementation of telecommunications and communications of SNRIU Information and Emergency Center with the emergency centers of NPPs and ChNPP, improvement of power supply systems, upgrade computer hardware and software for response purposes.

In pursuance of the Convention on Early Notification of a Nuclear Accident, the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and relevant intergovernmental bilateral agreements with other countries, Ukraine participated in five IAEA ConvEx trainings in 2017. On 21-22 June, Ukraine participated in international training of ConvEx-3 format on the scenario of a severe accident at Paks NPP (Hungary) with the full activation of the Information and Emergency Center (IEC), involvement of ministries and agencies that are responsible for response to emergencies with the threat of transboundary radiation effect. International training of such a scale on the conditional scenario of emergencies at several NPP units was conducted for the first time in real time and weather conditions.

The participation in these training gave an opportunity to check interagency interaction procedures, ability to respond to nuclear incidents at national and international levels, ensure the fulfillment of Ukraine's obligations to international conventions, as well as:

the ability of the automated systems for radiation situation control at NPPs, Exclusion Zone, Ukrainian Hydrometeorological Center to switch to the emergency mode of tracking changes in radiation characteristics of the air over the country in the threat of transboundary effect;

efficiency of notification and information exchange procedures at interagency, state and international levels;

efficiency of processing the input information on the event progression and its use for the assessment, prediction and development of agreed proposals for making decisions on response and protection;

verification of atmospheric transport models made using the RODOS system.

According to results of Ukraine's participation in these trainings, the Annual National Program under the auspices of the NATO-Ukraine Commission for 2018 was completed with the task "to develop the national plan of response to a nuclear and radiological emergency, including those which may occur in other countries and have a transboundary effect on Ukraine or the security of its citizens, taking into account the results of international trainings, practical experience and recommendations of NATO member states and IAEA safety standards".

Joint Ukrainian and U.S. command and staff training on response to state-level emergency related to a conditional radiation accident at NPP was held in September 2017. The SESU in cooperation with other executive authorities and territorial subsystems of the Unified State System for Civil Defense checked interagency response procedures and the ability of officials to make decisions to coordinate measures of emergency response and protection of the public in the case of a radiation accident.

NPP emergency training held together with the Energoatom at Rivne NPP in October 2017.

The training purpose was to check and exercise interaction between personnel of RNPP, departments of the Energoatom, the SNRIU, territorial and local authorities to minimize consequences of a conditional accident, take measures on putting nuclear facilities in a safe controlled state, assess and predict progression of the situation to protect personnel and the public. The SNRIU IEC was activated to ensure information exchange with the IAEA, SESU, RNPP Nuclear Safety Inspection and North-Western Inspection on Nuclear and Radiation Safety, to analyze operating data on the state of nuclear facilities and modeling of processes, as well as progression of events on site of a conditionally emergency NPP. In particular, this included prediction of ways and distances of radioactive contamination transport and dose characteristics using JRODOS system based on actual weather data provided to the SNRIU by the Ukrainian Hydrometeorological Center.

The common emergency training at RNPP was supervised by international experts: representatives of regulatory nuclear and radiation safety authorities of Poland, Norway and Belarus.

In October 2017, with the NATO support, Ukraine carried out command and staff training on the protection of critical energy infrastructure and response to threats to its stable functioning at the national level. The event was arranged by the Ministry of Energy and Coal Industry of Ukraine, National Institute for Strategic Studies and NATO Energy Security Center of Excellence (Vilnius). The training purpose was to check procedures for interaction of different systems of response to combined threats and emergencies.

The concept for the creation of the state system for protection of critical infrastructure was approved by Resolution of the Cabinet of Ministers of Ukraine No. 1009-r dated 06 December 2017.

In cooperation with the SESU, there was an update of data in the IAEA RANET on the potential and opportunities of Ukraine to provide specialized assistance at the request of

other countries within the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

According to the analysis of information messages on incidents that occurred in other countries that are submitted within the international information system INES-NEWS and the unified system for information exchange in incidents and emergencies (USIE), the SNRIU informed the public and the mass media through the disclosure of information on events of the public interest on the official website.

In particular, an exchange of information with the IAEA on the results of measuring of the artificial isotope ruthenium-106 during September-October 2017 in the surface layer of atmospheric air in Ukraine using the data of the radiation monitoring systems of the NPPs (Energoatom), observation points of the Ukrainian Hydrometeorological Center (SESU), SAEZ, Institute for Safety Problems of Nuclear Power Plants (NAS of Ukraine) and State and State Space Agency of Ukraine.

The situation with ruthenium-106 demonstrated the ability of up-to-date radiation monitoring systems to promptly identify even minor changes in background radiation indicators in the environment. It also confirmed the need and the importance of support and further improvement of the mechanisms of international information exchange for timely identification and assessment of the emergency release magnitude.

10. INTERNATIONAL COOPERATION

International cooperation is an inseparable part of the SNRIU activities. International events that took place in 2017 were aimed at the development of an independent nuclear and radiation safety regulation system in Ukraine and its integration into the European space. During the year, the cooperation developed actively both in bilateral and multilateral formats, in particular through the interaction with international organizations and associations, as well as fulfillment of obligations under the international agreements to which Ukraine is a party.

10.1. Cooperation with European Institutions

Currently, cooperation with the European Union (EU) and its bodies and institutions has the highest priority in the SNRIU international activities. In this context, the **European Commission** is the main partner of the SNRIU. Cooperation with the European Commission is performed within the Instrument for Nuclear Safety Cooperation INSC. The ongoing INSC projects cover areas such as safety improvement of nuclear power plants, strengthening of the regulatory authority and technical support organizations, mitigation of Chornobyl accident consequences, radioactive waste and spent nuclear fuel management, adaptation of the national laws to EU legislation.

In particular, the implementation of two INSC projects continued in 2017:

- "Assistance to State Nuclear Regulatory Inspectorate of Ukraine (SNRIU) in Regulation on Safe Radioactive Waste Management and Harmonization of Regulatory Requirements with WENRA Reactor Safety Reference Levels" (UK/TS/46 and UK/RA/09 Components of U3.01/10 Project correspondently).
- "Safe Radioactive Waste Management at Vektor Industrial Complex in the Chornobyl Exclusion Zone, Licensing of New Subcritical Facility – Neutron Source Based on an Electron Accelerator-Driven Subcritical Assembly, and Oversight and Assessment of Nuclear and Radiation Safety in Terms of the Licensee Management System and Human Factor" (UK/TS/48, 49, 50 Components of U3.01/12 Project correspondently).

The implementation of a new INSC Project "Strengthening of State Nuclear Regulatory Inspectorate of Ukraine Capabilities Relevant for the Regulation of Nuclear Activities and in Licensing and Severe Accident Management of Nuclear Installations" U3.01/14-15 (UK/TS/51-57) which includes seven components and which will be performed during 2018-2020 started in December 2017.

In 2017, SNRIU continued active participation in the European Commission's project for the Republic of Belarus to provide support and assistance in strengthening the capabilities of the Belarusian regulatory authority in licensing and oversight for construction of a nuclear power plant.

In 2017, the SNRIU continued cooperation with the **Western European Nuclear Regulators Association (WENRA)**. SNRIU representatives took active part in two WENRA working groups: Reactor Harmonization Working Group (RHWG) and Working Group on Waste and Decommissioning (WGWD).

The Ukrainian side arranged the 39th meeting of the Working Group on Waste and Decommissioning (WGWD), which took place from 25 to 29 September 2017 in Kyiv.

Besides, SNRIU experts have joined WENRA Working Group on the development of safety reference levels for research reactors (WGRR) since 2017.

In 2017, the SNRIU actively cooperated with the **European Nuclear Safety Regulators Group (ENSREG)**. According to decision made on 34th meeting of ENSREG, all member states shall submit updated national action plans upon stress test results for their further discussion. Though Ukraine is not ENSREG member, it took active part in stress tests as a partner country. In 2017, the SNRIU created a working group to arrange review of the National Action Plan, which included representatives of the SNRIU, State Scientific and Technical Center for Nuclear and Radiation Safety, Energoatom Company, Chornobyl NPP. The active cooperation at national level resulted in the development and agreement of the updated National Action Plan of Ukraine upon stress test results, which officially has been submitted to ENSREG Secretariat.

In 2017, the process for carrying out the First Topical Peer Review on Ageing Management to comply with requirements of Council Directive 2014/87EURATOM started under the auspices of ENSREG. Ukraine actively participated in the First Topical Peer Review. Experts from the SNRIU, State Scientific and Technical Center for Nuclear and Radiation Safety, Energoatom Company and Institute for Nuclear Research of the NAS of Ukraine developed the National Report on the First Topical Peer Review on Ageing Management, which was approved by the SNRIU Board on 30 November 2017. Then, the National Report has been published on SNRIU official website and submitted to ENSREG. Preparation for the participation in the inspection process within the First Peer Review started in December 2017.

10.2. Compliance with Obligations under International Conventions

The **Seventh Review Meeting** of the Contracting Parties to the **Convention on Nuclear Safety** was held from 27 March to 7 April 2017 at the IAEA Headquarters in Vienna.

As of March 2017, 80 states are the Contracting Parties to the Convention on Nuclear Safety: 79 states and one regional organization – Euratom. Thirty-two Contracting Parties out of 80 Contracting Parties have operating nuclear power plants. Two more Contracting Parties are in the process of NPP construction and 46 states do not have NPPs. The Convention on Nuclear Safety was signed by Ukraine on 20 September 1994, ratified by the Law of Ukraine on 17 December 1997 and came into force on 7 July 1998. The Ukrainian delegations also participated in the First (1999), Second (2002), Third (2005), Fourth (2008), Fifth (2011) and Sixth (2014) Review Meetings. The Contracting Parties defined seven groups of states during the organizational meeting that was held in October 2015. Each group included states, which have nuclear energy programs of different volumes, and states, which do not have energy reactors, but some of them do have plans or intentions to develop a nuclear energy program.

On the random basis regarding states that do not operate NPPs, seven group of countries were formed. Ukraine joined the seventh group of countries, which also included the following: Australia, Croatia, India, Ireland, Mali, Netherlands, Peru, Sri Lanka and Switzerland.

According to the agenda of the seventh group of countries, on 30 March 2017, the Ukrainian delegation presented the Seventh National Report on Compliance of Ukraine with Obligations under the Convention of Nuclear Safety and gave reasoned and complete answers to questions from representatives of other countries.

The Seventh National Report has been developed in full compliance with requirements of the Convention on Nuclear Safety, Guidelines Regarding National Reports

(INFCIRC/572/Rev.6) and taking into account recommendations of the Final Report of the Sixth Review Meeting.

According to the established procedure, in August 2016, the National Report of Ukraine was published on the Convention website for review by other countries. The National Report of Ukraine received 196 written questions from 22 Contracting Parties to the Convention. The above is a clear indication that the Contracting Parties to the Convention are highly interested in Ukraine. The most questions were received from Switzerland, Belarus, Russian Federation, Canada and Germany.

The National Report presentation focused mainly on the current situation in the industry, harmonization of the Ukrainian laws with EU Directives and reference levels of the Western European Nuclear Regulator's Association (WENRA), project on the qualification of Westinghouse fuel for Ukrainian NPPs, project on the construction of the Centralized Spent Fuel Storage Facility (CSFSF) for Ukrainian NPP units, successful construction of the New Safe Confinement above ChNPP-4 and its movement in the design position, Comprehensive (Integrated) Safety Improvement Program for Ukrainian NPPs, implementation of measures aimed at compliance of the Vienna Declaration on Nuclear Safety (VDNS). Besides, the presentation included the report of Ukraine on fulfilment of challenges and proposals defined according to the results of the Sixth Review Meeting.

Having completed the presentation, representatives of other countries asked questions on the independence of the nuclear regulatory authority of Ukraine; personnel and financial resources of the nuclear regulatory authority; harmonization of the Ukrainian nuclear legislation with Council Directives and WENRA reference levels; long-term operation of South Ukraine Units 1 and 2, Zaporizhzhya NPP Units 1 and 2; status of the Comprehensive (Integrated) Safety Improvement Program for Ukrainian NPPs; status of CSFSF construction for Ukrainian NPPs; participation of the operating organization (Energoatom Company) and the regulatory authority (SNRIU) in international peer reviews.

The Report was discussed in a business and constructive environment. Based on review results, the managers of the group and representatives of the Contracting Parties included into the group made positive conclusions on the commitment of obligations to the Convention on Nuclear Safety by Ukraine.

During the Sixth Review Meeting on the Convention on Nuclear Safety, Ukraine faced four challenges and four suggestions:

Challenges:

1. Fulfilment of C(I)SIP measures by the end of 2017;
2. SAMG development (severe accident management guidelines) for pilot power units and distribution for non-pilot units for low power operation and reactor shutdown;
3. Completion of safety review reports for seven units;
4. Supply of spare parts and avoiding of operator's personnel distraction from fulfilment of their duties.

Suggestions:

5. Assess results of development of periodic safety review reports for RNPP-1, 2 and SUNPP-1 and use them during the development of following reports;
6. Consider possibility to attract funds of the European Union for the construction of the Centralized Spent Fuel Storage Facility in the Exclusion Zone;
7. During the discussion, there were comments on approaches to WWER-440 safety. It was suggested to consider containment venting taking into account countries operating such reactors;

8. It was proposed to provide information on the training of operator's personnel during the Seventh Review Meeting.

According to the presented Seventh National Report, the group acknowledged that three challenges out of four and three suggestions out of four were successfully completed. In addition, the group defined two more challenges on the conversion of the State Nuclear Regulatory Inspectorate of Ukraine into Commission that performs regulation in the sphere of nuclear and radiation safety. The conversion shall be held based on the special Law in order to strengthen independence of the nuclear regulator, to provide it with sufficient financial and human resources, improve transparency in the performance of functions and to implement Council Directives and WENRA reference levels into the national legislation. There was a proposal during the meeting to invite IRRS mission to Ukraine in 2020.

The participants also noted achievements of Ukraine since the Sixth Review Meeting, in particular:

- Ukraine's efforts on the harmonization of nuclear and radiation safety laws with EU legislation, reaching of full membership in WENRA and active participation in its activity, as well as participation in the topical peer reviews of the EU;
- reaching of significant progress in the diversification of nuclear fuel supplies and nuclear fuel reliability improvement;
- successful transport of spent nuclear fuel (including the damaged) from spent nuclear fuels of ChNPP-1-3 to the wet spent fuel storage facility (ISF-1);
- completion of New Safe Confinement movement above ChNPP-4 sarcophagus.

Therefore, in 2017, Ukraine confirmed its obligations under the Convention on Nuclear Safety, which was recognized by the Contracting Parties during the presentation and review of the Seventh National Report of Ukraine and which was reflected in the summary documents of the meeting.

The Sixth Review cycle within the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management started in 2017. In accordance with the obligations, the SNRIU developed the Sixth National Report of Ukraine, which was approved by the SNRIU Board and published on a secured website of the Joint Convention on 23 October 2017.

10.3. Participation in Programs and Projects of International Atomic Energy Agency (IAEA)

In 2017, four national projects within the Technical Cooperation Program of the International Atomic Energy Agency for 2016-2017 were implemented. The Integrated Nuclear Security Support Plan (INSSP) for Ukraine was implemented.

Ukrainian experts made a significant contribution into the improvement of IAEA safety standards through the active work in the Nuclear Safety Standards Committee (NUSSC), Radiation Safety Standards Committee (RASSC), Waste Safety Standards Committee (WASSC) and Nuclear Security Standard Committee (NSGC).

The SNRIU actively cooperated and exchanged information with the IAEA Illicit Trafficking Database.

Systemic update of the Ukrainian profile of IAEA Radiation Safety Information Management System (RASIMS) and National Nuclear Safety Knowledge Platform (NNSRG) was ensured in 2017.

SNRIU representative participated in the Standing Advisory Group on Safeguards Implementation (SAGSI) for the IAEA Director General.

On 02-03 May 2017, the 24th Annual Forum of the State Nuclear Safety Authorities of the Countries Operating WWER Type Reactors (WWER Regulators Forum) was held in Isfahan (Islamic Republic of Iran). Representatives of Belarus, Bulgaria, India, Iran, People's Republic of China, Russian Federation, Slovakia, Hungary, Ukraine, Finland, Czech Republic, representatives of GRS (Germany) and IAEA participated in the WWER Regulators Forum. The Forum objective was to exchange information on the state regulation of nuclear and radiation safety of NPPs with WWER. In particular, specific attention was focused on NPP equipment ageing management.

Besides, the Working Groups established within the WWER Regulators Forum presented their activities, namely:

- Working Group on Reactor Physics Analysis;
- Ageing Management Working Group;
- PSA Working Group.

10.4. Bilateral Cooperation Programs

The SNRIU together with the SSTC NRS and the **Norwegian Radiation Protection Agency (NRPA)** implemented the following projects in 2017 to continue cooperation initiated in 2014:

1. Development of High-Level Regulatory Documents for Decommissioning Safety of Nuclear Facilities;
2. Development of Guideline for Assessment of Safety Culture and Human and Organizational Factors in Operating Experience Analysis;
3. Requirements for the Structure and Contents of Emergency Documents;
4. Enhancing Emergency Preparedness and Response in Ukraine;
5. Ukrainian Regulation on Radiation Protection in the Use of Radiation Sources;
6. Ukrainian Regulatory Threat Assessment 2017;
7. Revision of the Regulatory Document "Rules for Nuclear and Radiation Safety in Transport of Radioactive Materials".

Within the development of the Report on "Ukrainian Regulatory Threat Assessment 2017", the Road Map was defined for bilateral cooperation for 2018-2020, according to which new projects will be launched.

During 2017, the SNRIU actively cooperated in the area of nuclear and radiation safety with the **Swedish Radiation Safety Authority (SSM)** under the Agreement between the State Nuclear Regulatory Inspectorate of Ukraine and the Swedish Radiation Safety Authority on cooperation in the field of nuclear and radiation safety.

The following projects were implemented:

- Information support to the State Nuclear Regulatory Inspectorate of Ukraine, development and filling of the independent web resource on nuclear safety, radiation protection and nuclear non-proliferation - www.Uatom.org;
- Upgrade of applied software for the information system of the State Register of Radiation Sources;
- Technical support to the SNRIU in keeping the database on nuclear material accounting (STAR).

In 2017, there was active cooperation with the **United States of America**. On 1 August 2017, the Agreement on the Renewal of the Understanding between the State Nuclear Regulatory Inspectorate of Ukraine and the United States Nuclear Regulatory Commission on the Exchange of Technical Information and Cooperation in the Field of Nuclear Safety dated 12 April 2006 and with Amendment to it of 21 September 2011 was signed.

The implementation of WBS 1.01 Project "Technical Support to the State Nuclear Regulatory Inspectorate of Ukraine" and implementation of provisions of the agreements on CAMP and CSARP computer codes were ensured within the cooperation with the **U.S. Nuclear Regulatory Commission**.

In response to project proposals submitted by the SNRIU within the Global Partnership initiative, the implementation of two projects continued in 2017 under the **U.S. Department of Energy** Defense Threat Reduction Program on interagency command training on response to emergencies, nuclear terrorism and modernization of SNRIU Information and Emergency Center.

In 2017, the cooperation with the **U.S. Department of Energy** continued under the Executive Agreement between the State Nuclear Regulatory Committee of Ukraine and the U.S. Department of Energy on Cooperation to Improve the Safety of Radiation Sources Used in Ukraine since 23 June 2006. The project was implemented on the improvement of radiation sources security, the purpose of which is to prevent unauthorized use of radiation sources in Ukraine.

The access control systems were installed in SNRIU rooms (9/11 Arsenalna Street and 3 Verkhovna Rada Blvd) at the expense of the U.S. Department of Energy. Besides, the Central Monitoring Station with duty officer service was created in the SNRIU.

List of Abbreviations

C(I)SIP	–	Comprehensive (Integrated) Safety Improvement Program for Nuclear Power Plants
ChNPP	–	Chornobyl Nuclear Power Plant
CRME	–	Centralized Radioactive Waste Management Enterprise
CSFSF	–	Centralized Spent Fuel Storage Facility
DSFSF	–	Dry Spent Fuel Storage Facility
IAEA	–	International Atomic Energy Agency
ICSRM	–	Industrial Complex for Solid Radioactive Waste Management
IEC	–	Information and Emergency Center
INES	–	International Nuclear and Radiological Event Scale
ISF	–	Interim Spent Fuel Storage Facility
KhNPP	–	Khmelnitsky Nuclear Power Plant
LRTP	–	Liquid Radioactive Waste Treatment Plant
NPP	–	Nuclear Power Plant
NRS	–	Nuclear and Radiation Safety
NSC	–	New Safe Confinement
PSRR	–	Periodic Safety Review Report
Radwaste	–	Radioactive Waste
RNPP	–	Rivne Nuclear Power Plant
RWDS	–	Radioactive Waste Disposal Site
SFA	–	Spent Fuel Assembly
SISP	–	State Interregional Specialized Plant
SNF	–	Spent Nuclear Fuel
SP	–	Startup Package
SUNPP	–	South Ukraine Nuclear Power Plant
VSC	–	Ventilated Storage Cask
WWER	–	Water-Cooled Water-Moderated Power Reactor
ZNPP	–	Zaporizhzhya Nuclear Power Plant