



UKRAINE

NATIONAL REPORT

**On Compliance of Ukraine with Obligations
under the Convention on Nuclear Safety**

KYIV 2022

FOREWORD



Ukraine signed the Convention on Nuclear Safety on 20 September 1994 and carried it into effect by the Law of Ukraine "On Ratification of the Convention on Nuclear Safety" on 17 December 1997.

Ukraine took an active part in review of the National Reports of the Contracting Parties, exchange of written questions and comments, as well as discussions over the seven Review Meetings.

This Ninth National Report has been developed in full compliance with the Convention on Nuclear Safety and

Guidelines Regarding National Reports under the Convention on Nuclear Safety (International Atomic Energy Agency, Information Circular INFCIRC/572/Rev. 6, 7 February 2017).

By submitting this National Report, Ukraine completely fulfils its obligations set forth in Article 5 of the Convention on Nuclear Safety.

This Report, as the previous ones, is the result of joint efforts of Ukrainian state authorities responsible for implementation of the state nuclear energy policy and state enterprises (operating organizations):

- National Nuclear Energy Generating Company *Energoatom*;
- State Specialized Enterprise *Chornobyl NPP*.

This Report is based on the legislative and regulatory documents in force in Ukraine and official reports of the central executive bodies implementing the national nuclear energy policy.

The primary objective of this Report is to provide impartial and unbiased information on the safety of nuclear installations and on the measures implemented to enhance safety and protect the public and the environment of Ukraine and to highlight changes and progress in the development of legislative framework and in the nuclear energy sector of Ukraine over the last three years. Based on the information presented in this National Report and in accordance with the authorities granted by the Cabinet of Ministers of Ukraine, the Chairman of the State Nuclear Regulatory Inspectorate of Ukraine declares the following: "Ukraine adheres to the priority of human and environmental protection against the effects of ionizing radiation as one of the basic principles in the state policy for the use of nuclear energy and radiation protection".

Ukraine completely fulfils its obligations under the Convention on Nuclear Safety as confirmed by:

- development of the legislative and regulatory framework to ensure the safe use of nuclear energy;
- establishment of the duly authorized state nuclear regulatory body, which sets safety criteria and requirements, develops and approves regulations and rules on nuclear and radiation safety, and conducts licensing and state oversight;

- independence of the state nuclear regulatory body from any governmental bodies, institutions, and officials dealing with nuclear energy and independence from the local authorities, self-governments, and public associations;
- comprehensive safety assessments of existing nuclear installations and safety improvement measures;
- development of the emergency preparedness and response system;
- full responsibility of the licensee for ensuring safety and taking measures to protect the public and the environment;
- development of safety culture and implementation of safety self-evaluation practices.

The data in this Report, except as otherwise stated, are provided as of June 2022. The changes that may take place by March 2023 will be additionally reported by the delegation of Ukraine at the Joint Eighth and Ninth Review Meeting.

Kyiv, August 2022

Oleh KORIKOV

**Acting Chairman of the State Nuclear
Regulatory Inspectorate of Ukraine – Chief
State Inspector on Nuclear and Radiation
Safety in Ukraine**

TABLE OF CONTENTS

FOREWORD	2
TABLE OF CONTENTS	4
ABBREVIATIONS AND ACRONYMS	6
INTRODUCTION.....	8
SUMMARY	11
COMPLIANCE WITH ARTICLES 6-19	16
ARTICLE 6 Existing Nuclear Installations	16
ARTICLE 7 Legislative and Regulatory Framework	23
7.1 Establishment and regulatory support	23
7.2 National safety requirements and regulations	23
7.3 Nuclear installation licensing system and prohibition of nuclear installation operation without a licence.....	25
7.4 System of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and licensing conditions	25
7.5 Enforcement of applicable regulations and licensing conditions, including suspension, modification or revocation	26
ARTICLE 8 Regulatory Body.....	27
8.1 Establishment of the regulatory body.....	27
8.2 Status of the regulatory body	28
ARTICLE 9 Responsibility of the Licence Holder.....	30
ARTICLE 10 Priority to Safety.....	32
ARTICLE 11 Financial and Human Resources	35
11.1 Financial resources	35
11.2 Human resources	36
ARTICLE 12 Human Factor	38
ARTICLE 13 Quality Assurance	41
ARTICLE 14 Assessment and Verification of Safety	42
14.1 Assessment of safety	42
14.2 Verification of safety.....	43
ARTICLE 15 Radiation Protection	46

ARTICLE 16	Emergency Preparedness.....	49
16.1	Emergency plans and programs	49
16.2	Information of the public and neighbouring states	53
ARTICLE 17	Siting.....	56
ARTICLE 18	Design and Construction	63
ARTICLE 19	Operation	65
ANNEX 1	List of Ukrainian NPPs.....	72
ANNEX 2	Analysis on Implementation of IAEA Recommendations within Safety Improvement Programs	73
ANNEX 3	List of Legislative and Regulatory Documents on Nuclear Energy Use Implemented in 2019-2022.....	78
ANNEX 4	Structure of Energoatom Electricity Tariff	81
ANNEX 5	Dynamics in Licensing of NPP Personnel for 2016-2022	83
ANNEX 6	Radiation Safety and Protection Indicators	84
ANNEX 7	Information on Chornobyl NPP	86
ANNEX 8	Information on the NSC-Shelter.....	99

ABBREVIATIONS AND ACRONYMS

AMP	Ageing Management Program
C(I)SIP	Comprehensive (Integrated) Safety Improvement Program for Nuclear Power Plants
CDF	Core Damage Frequency
ChNPP	Chornobyl Nuclear Power Plant
CPRAC	Center for Prediction of Radiological Accident Consequences
CSFSF	Centralized Spent Fuel Storage Facility for WWER NPPs in Ukraine
DSF	Damaged Spent Fuel
DSFSF	Dry Spent Fuel Storage Facility
DSS	Decision Support System
EBRD	European Bank for Reconstruction and Development
ECCS	Emergency Core Cooling System
EIA	Environmental Impact Assessment
EIC	Emergency Information Center
Energoatom	National Nuclear Energy Generating Company <i>Energoatom</i>
EOP	Emergency Operating Procedure
EU	European Union
Euratom	European Atomic Energy Community
GPET	General Plant Emergency Training involving Energoatom Top Management
HLW	High-Level Waste
IAEA	International Atomic Energy Agency
ICRP	International Commission for Radiological Protection
ICSRM	Industrial Complex for Solid Radioactive Waste Management
IMS	Integrated Management System
ISF	Interim Spent Fuel Storage Facility
KADO	Online Radiological Analysis Software Package
KhNPP	Khmelnysky Nuclear Power Plant
LERF	Large Early Release Frequency
LLW	Low-Level Waste
LRTP	Liquid Radwaste Treatment Plant
MCR	Main Control Room
NEURC	National Energy and Utilities Regulatory Commission
NPP	Nuclear Power Plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRS	Nuclear and Radiation Safety
NSC	New Safe Confinement
NSC SS-1	New Safe Confinement Startup Stage 1
NSC SS-2	New Safe Confinement Startup Stage 2
NSC-Shelter	New Safe Confinement–Shelter System
NSDC	National Security and Defense Council of Ukraine
PSA	Probabilistic Safety Assessment
PSRR	Periodic Safety Review Report
PNPP	Pivdennoukrainsk Nuclear Power Plant
QMS	Quality Management System
Radwaste	Radioactive Waste

RNPP	Rivne Nuclear Power Plant
SAMG	Severe Accident Management Guideline
SAR	Safety Analysis Report
SESU	State Emergency Service of Ukraine
SFA	Spent Fuel Assembly
SFP	Spent Fuel Pool
SG	Steam Generator
SIP	Shelter Implementation Plan
SNRIU	State Nuclear Regulatory Inspectorate of Ukraine
S RTP	Solid Radwaste Treatment Plant
SSE ChNPP	State Specialized Enterprise <i>Chornobyl NPP</i>
SSTC NRS	State Scientific and Technical Center for Nuclear and Radiation Safety
TSF HLW and LIL-LLW	Temporary Storage Facility for High-Level Waste and Low- and Intermediate-Level Waste
USCPS	Unified State Civil Protection System
WANO	World Association of Nuclear Operators
WENRA	West European Nuclear Regulators Association
WWER	Water-Cooled Water-Moderated Power Reactor
ZNPP	Zaporizhzhya Nuclear Power Plant

INTRODUCTION

The last years have been full of events that would influence the assurance of nuclear and radiation safety in our country not only in the near future but would also have long-lasting effects.

The signature of the Ukraine–European Union Association Agreement in 2015 initiated efforts on the implementation of EU nuclear and radiological protection law into the Ukrainian legislation.

In compliance with the implementation plans approved by the Ukrainian Government, the SNRIU made considerable efforts to implement the following EU legislative acts in 2017–2022:

- Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to radiation;
- Council Directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste and spent fuel;
- Council Directive 2014/87/Euratom establishing a Community framework for the nuclear safety of nuclear installations.

On 26 March 2015, the State Nuclear Regulatory Inspectorate of Ukraine became a full member of WENRA, which was the main step in Ukraine’s transfer to EU standards in the regulation of nuclear and radiation safety. The participation in WENRA allows Ukraine to improve national legislation on nuclear and radiation safety in accordance with the WENRA reference levels and to take part in their development/revision. Ukraine is currently the only non-EU country, except for Switzerland and the United Kingdom of Great Britain and Northern Ireland, that became a full WENRA member.

The Report presents information on improvement of the regulatory and legal framework on nuclear and radiation safety in Ukraine.

The efforts are ongoing to improve authorizing procedures in line with international documents and best practices of other countries. A series of draft laws were developed to reduce the regulatory pressure and settle issues caused by the failure to properly address the aspects peculiar to nuclear activities in the deregulation process.

As of 2022, there are 15 WWER units in operation at four NPPs in Ukraine. Three power units of the Chornobyl NPP are under decommissioning. The Chornobyl Shelter is being transformed into an environmentally safe system. The power units and their main characteristics are listed in Annex 1.

Ukraine makes substantial efforts to deal with the following important issues:

- safety upgrading of operating NPPs;
- lifetime extension of operating NPPs based on safety reviews, determination of residual lifetime, implementation of safety upgrades, and ageing management of systems and equipment important to safety;
- diversification of nuclear fuel suppliers for NPPs;
- spent fuel management;
- Chornobyl NPP decommissioning and Shelter transformation into an environmentally safe system.

Implementation of safety improvement measures over the review period was based on C(I)SIP approved by the Cabinet of Ministers of Ukraine by Resolution No. 1270 dated 7 December 2011 and aimed at:

- further enhancing the safety of NPP units;
- minimizing the risks of NPP accidents in case of natural events or other hazards;

- improving the management of design-basis accidents and beyond-design-basis accidents at NPPs and mitigating their consequences.

The C(I)SIP includes the safety improvement measures identified upon safety analyses and IAEA recommendations on the enhancement of design safety of Soviet-design reactors. C(I)SIP was also supplemented with measures to implement recommendations of international experts upon comprehensive safety assessment of Ukrainian NPPs within the Joint EC–IAEA–Ukraine Project and with post-Fukushima measures identified upon the stress tests.

The C(I)SIP measures enhance the operational safety of NPPs in compliance with international standards.

The diversification of nuclear fuel supplies for Ukrainian NPPs, including regulatory support, remains a strategic area. In the reporting period, the SNRIU reviewed a package of the operator’s documents that justify potential extension of trial operation of the Westinghouse nuclear fuel to other Ukrainian NPPs.

As of 1 June 2022, 6 out of the 15 national reactors are operated with Westinghouse fuel within the nuclear fuel diversification program for WWER-1000: 2 PNPP units and 4 ZNPP units. The first reload batch of Westinghouse fuel will be loaded to RNPP Unit 3 in the 2022 refueling outage.

In connection with the Russian aggression against Ukraine, Energoatom made a decision to refuse from the supply of TVEL fuel since February 2022. Measures are currently planned for the gradual transition of the remaining units of Ukrainian NPPs, including WWER-440 units, to Westinghouse fuel.

In 2021, the SNRIU issued licenses to SSE ChNPP for:

- treatment and storage of radioactive waste that exists or is generated in Shelter transformation into an environmentally safe system within NSC-Shelter (License OB 001094);
- operation of the dry spent fuel storage facility (ISF-2).

Chornobyl NPP Units 1-3 are under decommissioning. Since the accident in April 1986, Chornobyl NPP Unit 4 has been referred to as the Shelter.

In ratifying the Convention on Nuclear Safety in 1997, the Verkhovna Rada (Parliament) of Ukraine declared that Article 3 of the Convention would not apply to the Shelter.

General information on activities at Chornobyl NPP Units 1-3 and the Shelter is provided in Annexes 7 and 8 to this Report.

The armed aggression of the Russian Federation against Ukraine that began on 24 February 2022 led to:

- temporary occupation of the Chornobyl NPP site in the period from 24 February 2022 to 31 March 2022;
- hostilities near the ZNPP site (3-4 March 2022) and subsequent temporary occupation of the site and adjacent territory that continues to this day (1 June 2022).

On the night of 4 March 2022, the Russian troops fired shells at the ZNPP site and thus caused an immediate threat to the lives of plant personnel, damage to equipment, buildings, structures and piping, nuclear and radiation hazards or accidents. After the shelling stopped, there was significant damage in one of the training center buildings, reactor compartment building, unit transformer, and household and office buildings and equipment, which did not lead to failure of systems of components important for safety, and damage of the Zaporizhzhia and Pivdenno-Donbas high-voltage lines. On 4 March 2022, the ZNPP was captured by the Russian soldiers.

In the above regard, one of the most priority tasks for the SNRIU is state regulation for the safety of ChNPP and ZNPP in the conditions of their temporary occupation.

The Ukrainian NPPs, as well as any other NPPs worldwide, were not designed for operation in conditions of shelling, bombing or other military operations.

Taking into account the ongoing military activities in eastern and southern Ukraine, the SNRIU, together with relevant ministries and departments, continues efforts on enhancing the physical protection of nuclear installations. At the same time, taking into account regular missile attacks of the Russian Federation on the entire territory of Ukraine, the problem with the safety of nuclear installations under hostilities remains urgent and requires individual comprehensive consideration.

SUMMARY

This Report covers the following main aspects that were addressed in the previous National Report of Ukraine and require further consideration:

- improving the system of NRS regulations (para. 7.2.1 of this Report);
- implementing measures for training and professional development of the state nuclear regulatory body's staff (ARTICLE 8 Section of this Report);
- proceeding with NPP safety improvement measures (ARTICLE 6 Section of this Report);
- updating Safety Analysis Reports to incorporate completed activities (ARTICLE 6 Section and ARTICLE 14 Section, para. 14.1, of this Report);
- commissioning CSFSF (ARTICLE 17 Section, para. 17.4, of this Report);
- proceeding with in-depth safety analysis of NPPs (ARTICLE 14 Section, para. 14.1, of this Report).

This Report also takes into account findings of the Seventh Review Meeting of the Contracting Parties regarding further provision of information on issues that are of interest for all Parties to the Convention on Nuclear Safety, considering the Report of the IAEA Secretariat to the Contracting Parties 'Synopsis of the Relevant IAEA Requirement Statements Reflecting the Issues Addressed by Articles 6 to 19 of the Convention on Nuclear Safety' (Synopsis).

This Report does not provide any information on the Synopsis-related matters that was included in the previous Reports that Ukraine submitted to the Parties.

Compliance with the Vienna Declaration on Nuclear Safety

The Vienna Declaration on Nuclear Safety was adopted at the Diplomatic Conference on 9 February 2015. The Vienna Declaration on Nuclear Safety sets forth principles to be met by the Contracting Parties in implementing the objectives of the Convention on Nuclear Safety to prevent accidents and mitigate radiological consequences.

Principle 1: nuclear power plants are to be designed, sited and constructed in consistency with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off-site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions.

Ukraine is making efforts to improve the system of national regulations and incorporate to the extent possible the principles of the Vienna Declaration and IAEA and WENRA recommendations.

To implement the objective of preventing accidents, the following basic measures are considered in the design and safety verification of existing NPP units:

- all natural and man-induced site-specific hazards are to be addressed at the design stage, by conducting special analyses to justify the characteristics of these hazards and consider combinations of external hazards using a conservative approach. For the most significant hazards, justified margins are to be accounted for in safety assessments (seismic events, floods, tornados);
- qualification of NPP equipment for harsh environments and seismic hazards is to be confirmed and seismic resistance of NPP systems and components (SSE) is to be confirmed and increased;
- defense-in-depth including five levels with specific measures at each of the levels is to be ensured;

- design-basis accidents are to be prevented and accident management measures are to be implemented through: safety systems designed in different redundant trains using the train independence principle and measures to prevent potential common-cause failures using the diversity and physical separation principles;
- design extension conditions are to be considered in the design process, which requires considering of a number of failures and ensuring the proper level of safety. Practical elimination of an accident involving core damage at high pressure is one of the required conditions;
- based on analysis of existing design features and operating experience for existing NPPs, C(I)SIP was developed and is under implementation, including, inter alia, measures to prevent accidents and mitigate their consequences.

Technical criteria and standards are used to mitigate consequences of potential radiological accidents:

- national regulations that establish NRS requirements primarily focus on preventing radiological impacts on personnel, the public, and the environment that would exceed the criteria defined in national regulations;
- the above-stated principles for the design of systems incorporate requirements for systems that ensure confinement of radioactive substances within established boundaries and integrity of these systems (implementation of containment overpressure protection systems in case of beyond-design-basis accidents, hydrogen safety measures, etc.);
- technical decisions and organizational measures are taken to prevent severe accidents and mitigate their consequences including accidents involving plant blackout, failure of heat removal to the ultimate heat sink, and their combinations. The prevention or mitigation of these initiating events requires the use of special systems or equipment that are to be as independent of other design-basis systems as possible;
- human actions in the event of occurrence and development of beyond-design-basis (as well as severe) accidents are identified in special operating documents (EOPs, SAMGs) that have been developed and verified for each Ukrainian NPP unit;
- special measures for protection of personnel, the public, and the environment in emergencies and accidents have been developed for each Ukrainian NPP. The measures have been implemented considering interaction of respective state structures.

Principle 2: comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements aimed at meeting the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.

The current national requirements and regulatory principles on NRS for existing NPPs are aimed at complying with safety objectives and principles that fully meet principle 2 in the process for NPP safety verification.

If some safety issues were not addressed in the design, construction, commissioning, or operation, activities are conducted on a permanent basis to bring the NPP units into compliance with new regulatory requirements. These activities are also carried out in periodic safety verification of Ukrainian NPPs.

When a new regulatory document on NRS is implemented, the operator, in compliance with legislative requirements, shall develop a plan for bringing the operating

power units into line with the new regulatory document upon analysis of compliance with the new regulation and agree the plan with the SNRIU.

The safety measures under C(I)SIP are also implemented to ensure that the Ukrainian NPPs are brought into compliance with the new NRS regulatory requirements and the principles set forth in the Vienna Declaration on Nuclear Safety (see ARTICLE 6 Section of this Report).

The most important aspects in implementing the principles of the Vienna Declaration for existing NPPs include activities (planned and completed) to take the following measures at Ukrainian NPPs:

- containment protection in the event of accidents by introducing hydrogen control and removal systems, containment filtered venting systems, and other measures;
- emergency power supply from independent mobile diesel generators;
- heat removal from the reactor core and SFP when this function cannot be performed by design systems, using mobile pumps for makeup of SG and SFP;
- SAMGs (for full and low power levels) containing human actions for various severe accident scenarios developed and implemented for all NPPs.

National requirements and regulations in force govern the scope and timeframes for periodic safety reviews of existing Ukrainian NPPs. Specific requirements for periodic safety reviews, whose results are finalized in PSRRs (see para. 14.1 of this Report), are established in the following regulations:

- General Safety Provisions for Nuclear Power Plants;
- Requirements for Safety Assessment of Nuclear Power Plants;
- General Requirements for Ageing Management of Components and Structures and Long-Term Operation of NPP Units.

The regulation "Requirements for Periodic Safety Review of Nuclear Power Plants" was approved in 2017. This regulation incorporates Ukrainian experience in periodic safety reviews and international experience presented, in particular, in relevant IAEA standards.

Pursuant to the above regulations:

- periodic safety review of power units is carried out every 10 years (or upon SNRIU request). The review findings serve as a basis for PSRR development;
- periodic safety review is based on a comprehensive analysis of safety factors to justify the potential, period, and conditions for further operation of power units;
- measures are identified and justified upon safety review to be implemented to maintain the required safety level for each safety factor.

Principle 3: national requirements and regulations for addressing this objective throughout the lifetime of nuclear power plants are to take into account the relevant IAEA Safety Standards and, as appropriate, other good practices as identified inter alia in the Review Meetings of the Convention on Nuclear Safety.

The Ukrainian NRS regulations in force comply with current IAEA standards. In addition, the NRS regulatory framework is under continuous improvement (see paras. 7.2.1 and 8.1 of this Report). In the framework of these activities:

- a number of regulations that were developed and introduced in the Soviet era are being replaced;
- a number of regulations are being improved to incorporate NPP operating experience;
- regulations are under improvement to incorporate provisions of updated IAEA standards and EU directives.

Compliance with the IAEA Safeguards Agreement

According to Article III of the Treaty on the Nonproliferation of Nuclear Weapons (NPT) joined by Ukraine in 1994, IAEA Agreement on the Application of NPT Safeguards (INFCIRC/550) was signed (21 September 1995) and ratified (Law of Ukraine No. 737/97-VR dated 17 December 1997). According to this Agreement, Ukraine has a system of comprehensive safeguards that has been used in the world for non-nuclear countries for more than 40 years, and before the Russian invasion of Ukraine on 24 February 2022, all obligations were fulfilled by Ukraine in accordance with the commitments made.

The events in Iraq and North Korea in the early 1990s showed serious shortcomings of the existing safeguards system, as it prevented the Agency from detecting not declared hidden nuclear activities. Therefore, IAEA improved the safeguards system and developed an Additional Protocol in 1997 that significantly expanded the Agency's ability to detect undeclared nuclear materials and activities granting IAEA greater rights of access to information, nuclear facilities and other locations of material. The Additional Protocol to the Agreement between Ukraine and IAEA on the Application of NPT Safeguards was ratified by the Law of Ukraine No. 3092-IV/16 dated 16 November 2005. In accordance with the requirements of the Additional Protocol, Ukraine declares all its nuclear activities to the Agency from plans for research and development in the area of NFC, information on the production of dual-use goods, export of materials and equipment related to nuclear activities, and to the information on decommissioned facilities. In addition, Ukraine provides IAEA inspectors with access to all sites where the presence of nuclear material is declared. The state executive body responsible for implementing the Additional Protocol is SNRIU, which, in accordance with the Provisions on the State Nuclear Regulatory Inspectorate of Ukraine, coordinates measures to implement the Agreement between Ukraine and IAEA on the Application of NPT Safeguards.

The following tasks were accomplished under the IAEA Safeguards Agreement and its Additional Protocol:

- for all areas of balance of nuclear materials at NPPs of Ukraine, documents developed jointly with IAEA came into force: Applications to Installations. Deliverables, as well as information provided by the Additional Protocol, are sent to SNRIU within the established timeframes. IAEA inspectors receive information on nuclear materials from NPPs to the extent envisaged by the Safeguards Agreement and the Additional Protocol;
- at all NPPs and CSFSF site, there are persons responsible for accounting and control of nuclear materials and compliance with the terms of the Safeguards Agreement. During IAEA inspections, they accompany IAEA inspectors around the NPP territory and rooms, prepare documents necessary for inspections;
- IAEA has installed remote monitoring systems at each NPP unit and at the CSFSF site, which allows provision of information to the IAEA. The design of surveillance systems provides the transmission of a signal from video cameras installed at NPPs to the IAEA headquarters in Vienna using the global network.

Prior to the military aggression against Ukraine, according to the results of the IAEA inspections, no violations of international law were recorded.

As a result of the Russian invasion, hostilities and occupation of the ZNPP, Chernobyl, and CSFSF sites and the entire territory of the exclusion zone, where radioactive waste management facilities are also located, by the occupiers, at present:

- there are significant risks in the management of nuclear and radioactive materials;

- it is impossible to fulfill obligations to the extent stipulated by the Safeguards Agreement and the Additional Protocol, namely: to guarantee the timely transmission of information on the location and movement of nuclear materials, as well as to ensure the conduct of IAEA inspections at captured facilities.

At the international level, urgent issues of the application of IAEA safeguards under the conditions of any country's aggression need to be resolved.

COMPLIANCE WITH ARTICLES 6-19

ARTICLE 6 Existing Nuclear Installations

Each Contracting Party should take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible.

When necessary in the context of this Convention, the Contracting Party should ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shutdown may take into account the whole energy context and possible alternatives as well as the social, environmental, and economic impact.

After shutdown of the last ChNPP unit, Ukraine operates only WWER-type nuclear power plants.

Ukrainian NPPs operate WWER reactors including 11 WWER-1000/V-320 power units, one WWER-1000/V-302 unit, one WWER-1000/V-338 unit, and two WWER-440/V-213 units (nuclear installations are listed in Annex 1).

Currently, Ukraine ranks 10th in the world in terms of the number of power units and 7th in terms of installed capacity, which is 13 835 MW.

Since 4 March 2022, due to the Russian military aggression against Ukraine, 6 power units of the Zaporizhzhya NPP, as well as the dry spent fuel storage facility, are located in the temporarily occupied territory.

Despite the conditions of temporary occupation, ZNPP is an integral entity of the Energoatom operator. Power units are operated within the licenses issued to the operator in accordance with the procedure established by law for activities at life stage “operation of a nuclear facility” and other permits. Training, retraining and skill improvement of personnel is provided in accordance with the license to train personnel for the operation of a nuclear facility.

The share of electricity generated at NPPs in the total power production in Ukraine remains high: above 50% in 2018 and above 55% in 2021.

Since the 1980s, the operator has been implementing measures under safety improvement programs to enhance NPP safety. Major safety improvement programs currently in effect are listed in Annex 2.

After the Chernobyl catastrophe, safety improvement programs were developed to be implemented at Ukrainian NPPs. They included measures to bring the power units into compliance with the requirements of new safety regulations, rules, and standards, IAEA recommendations on safety improvement, operating experience, measures identified by safety analyses, and the operator’s commitments on safety enhancement to international organizations. Based on analysis of operating experience, safety assessment, and additional IAEA recommendations, these programs were supplemented with individual measures.

The Comprehensive (Integrated) Safety Improvement Program that was approved by the Government in 2011 is currently under way.

The C(I)SIP objective is to:

- bring the designs of operating NPPs into compliance with up-to-date national and international safety standards;
- prevent accidents in the event of natural disasters or other hazards and mitigate their consequences;

- improve the management of design-basis and beyond-design-basis accidents at NPPs and minimize their consequences.

C(I)SIP passed state regulatory review in 2010 and was agreed by the SNRIU upon positive review results. In addition, C(I)SIP was additionally reviewed (within INSC Project UK/RA/07 Subtask 6.2) by the RISKAUDIT international expert organization. The RISKAUDIT experts confirmed in their statement that all IAEA recommendations provided previously were incorporated in C(I)SIP.

As recommended by the National Report of Ukraine on Stress-Test Results and its peer review, Energoatom developed additional safety improvement measures that were included in the C(I)SIP.

To implement C(I)SIP, the operator ensured planning and funding, continuously monitored program progress, organized reporting (annual, quarterly, and monthly for each measure), and developed and keeps a database on program implementation status.

The C(I)SIP implementation progress is continuously supervised by the SNRIU, Ministry of Energy of Ukraine, SESU, and Cabinet of Ministers of Ukraine.

All C(I)SIP measures were to be implemented in 2012-2017. However, because of objective reasons, the program was extended until 2023.

In 2022, due to the introduction of martial law in Ukraine associated with the Russian military aggression against Ukraine, force majeure circumstances arose that made it impossible to fulfill the C(I)SIP until 2023.

In particular, a significant damage of industrial enterprises and infrastructure, disruption of logistics, reduction in the number of personnel of design, construction, installation and commissioning organizations due to forced evacuation led to the impossibility of fulfilling obligations under concluded contracts for the supply of necessary equipment, materials, cable products and other goods, as well as failure to perform activities and render services.

C(I)SIP measures of a capital nature are implemented, as a rule, at a shutdown power unit during the scheduled outage. Due to the reduction in scheduled outage duration in 2022, taking into account the damage of the energy infrastructure in the south and east of the country, ZNPP capture by the invaders, which led to a temporary suspension of the operation of a part of the nuclear power units, the number of previously planned C(I)SIP measures in 2022 was reduced.

Therefore, Energoatom, on its own initiative, is working to extend the program until 2025. The Draft Resolution of the Cabinet of Ministers of Ukraine on Amending Resolution of the Cabinet of Ministers of Ukraine No. 1270 “On Approval of the Comprehensive (Integrated) Safety Improvement Program for NPPs” dated 7 December 2011 is being agreed with the central executive bodies of Ukraine.

1. Implementation of the IAEA recommendations related to resolution of safety issues determined in IAEA reports.

The following reports were developed after the Chernobyl accident: Safety Issues and Their Ranking for WWER-1000 Model 320 Nuclear Power Plants (IAEA-EBP-WWER-05), Safety Issues and Their Ranking for Small Series WWER-1000 Nuclear Power Plants (IAEA-EBP-WWER-14), and Safety Issues and Their Ranking for WWER-440 Model 213 (IAEA-EBP-WWER-03).

The above IAEA recommendations have been implemented for all WWER-440/213 and WWER-1000/302, 338 units and are in the final implementation stage at WWER-1000/320 units. To resolve the safety issues identified in the above reports, the operator implemented a significant number of safety upgrades. In particular, they included measures on improvement of control rod insertion reliability (RC2), reactor pressure vessel

embrittlement and monitoring (CI1), application of non-destructive testing (visual, ultrasonic, eddy current) (CI2), elimination of ECCS sump screen blocking and replacement of primary equipment insulation at all reactors (S5), replacement of steam generator pilot-operated relief valves at all V-320 power units (S9), replacement of storage batteries and uninterruptible power supply sources with expired lifetime at all power units (EI5), backup of the reactor protection system (I&C5), fire prevention (IH2), qualification of equipment for V-302/338 units etc.

2. Measures identified in the final report on comprehensive evaluation of Ukrainian power units for compliance with IAEA international standards.

The evaluation was carried out within the Joint EC–IAEA–Ukraine Project (2007-2010).

The Joint Project was initiated within the Memorandum of Understanding on Cooperation in the Field of Energy between the European Union and Ukraine signed on 1 December 2005. In the framework of this project, IAEA experts conducted 14 missions at all Ukrainian NPPs in 2008-2009 to carry out a unique (in scope) comprehensive evaluation of Ukrainian NPPs with IAEA standards. The evaluation covered the following areas:

- plant design safety;
- plant operational safety;
- radwaste management and decommissioning;
- regulatory aspects.

62 international experts from 23 countries and international organizations and 32 IAEA experts took part in the project. The experts confirmed that compliance with IAEA requirements was ensured in all areas. Incomplete compliance was found only for five aspects: equipment qualification, severe accident analysis and SAMG development, design seismic resistance, completion of SAR development, and post-accident monitoring. The final report pointed out that all these issues were successfully resolved within the current safety improvement program. The incompliance has been fully resolved for three areas (severe accident analysis and SAMG development, completion of SAR development, and post-accident monitoring), and activities are being completed in two areas (equipment qualification and design seismic resistance).

3. Measures developed upon stress tests after the Fukushima-Daiichi accident.

After the Fukushima-Daiichi accident, Energoatom conducted extraordinary targeted safety assessment of Ukrainian NPPs (stress tests) in line with the decisions adopted by the NSDC at the meeting of 8 April 2011 and were enacted by Presidential Decree No. 585/2011 dated 12 May 2011.

Based on the stress tests, a list of measures for prevention of severe accidents similar to that at the Fukushima-Daiichi NPP was compiled. These measures are to be implemented as a necessary condition for NPP long-term operation and are intended to:

- ensure resistance to an earthquake for equipment, piping, buildings and structures required for critical safety functions: provide reactor safe shutdown and keep the reactor in safe condition, ensure heat removal from the reactor core and spent fuel pool, and prevent radioactive releases to the environment;
- ensure performance of equipment important to safety in harsh environments;
- implement containment filtered venting systems at WWER-1000 NPPs for forced steam and gas release from the containment;

- implement measures to ensure emergency makeup of steam generators (reactor secondary system cooldown) and SFPs in plant blackout conditions and/or loss of ultimate heat sink and ensure emergency supply of essential service water;
- implement severe accident management guidelines addressing possible severe fuel damage both in the core and in the spent fuel pool and symptom-based EOPs for low-power operation.

These measures were included into the National Action Plan upon Stress-Test Results, which was approved by SNRIU Board Resolution No. 8 dated 5 March 2013. The National Action Plan was developed by the SNRIU and presented at the ENSREG working meeting in Brussels on 22-26 April 2013. Ukraine presented a report on implementation of the updated National Action Plan in Brussels in April 2015.

The number and scope of measures did not change in the National Action Plan updated in 2017 and 2021. The current state and deadlines of the measures were specified.

The C(I)SIP was supplemented with a series of post-Fukushima measures: measures for heat removal from nuclear fuel in severe accidents (measures to ensure makeup of steam generators and SFP and operability of essential service water systems in dewatering of spray ponds) and for emergency power supply in blackout conditions using mobile diesel generators. The C(I)SIP also included measures for qualification for harsh environments of components that can be involved in severe accident management for primary circuit makeup in accidents with loss of power supply and/or ultimate heat sink, for in-vessel melt retention, etc.

Energatom carries out a series of measures to improve NPP seismic resistance:

- equipment qualification has been completed (for all power units except for ZNPP Unit 6);
- robustness of equipment and structures under potential seismic hazards has been confirmed (completed in full scope for PNPP-1–3 and ZNPP-1–5 and without on-line seismic monitoring results for ZNPP-6, RNPP-1–4 and KhNPP-1–2);
- seismic surveys and introduction of continuous seismic monitoring at NPP sites have been completed (for all NPP sites).

To implement additional safety improvement measures upon stress-test results and to ensure a uniform engineering approach, Energatom developed appropriate industrial conceptual decisions and agreed them with the SNRIU. These decisions deal with the strategy of blackout accident mitigation using mobile diesel generators, mobile pumping units, and motor pumps for each reactor design at Ukrainian NPPs (V-213, V-302/338, V-320). Mobile equipment has been introduced at all power units except for ZNPP Unit 6 and PNPP Unit 3 (completed in the scope of the first stage – nonstationary connection).

As of 1 June 2022, the general implementation status is as follows: 210 (88%) out of the 238 post-Fukushima measures have been completed under C(I)SIP; 3 measures that have been physically implemented are to be completed in 2022, 7 measures in 2023, 3 measures in 2024, and remaining 15 measures in 2025. All post-Fukushima measures are to be completed by 2025.

In addition, a series of measures to upgrade the emergency response system are ongoing at NPPs:

- system for prompt radiological analysis in the NPP location area has been implemented;
- NPP radiation safety departments have been additionally equipped with mobile laboratories for radiological monitoring and individual dose monitoring;

- additional measures on uninterrupted operation of communications within NPP sites and communications between NPPs and the SNRIU and Energoatom emergency centers are being implemented;
- mobile power sources are being provided;
- for national-level accidents or accidents associated with transboundary radionuclide transfer, development of the innovative interagency RODOS-Ukraine real-time decision support system (DSS) based on the European RODOS system was completed within the European Commission Instrument for Nuclear Safety Cooperation (INSC) in Ukraine in June 2016; Energoatom introduced RODOS DSS into commercial operation by Order No. 87 of 26 January 2017 (as part of the national RODOS-Ukraine system).

Detailed information on the resolution of safety issues and compliance with international obligations of Ukraine on implementation of safety improvement measures is provided in Annex 2 of this Report.

The safety level of Ukrainian NPPs is high, as confirmed by the results of safety improvement measures.

The SARs developed for all Ukrainian NPPs (detailed information is provided in ARTICLE 14 Section) and agreed by the SNRIU allow the following conclusions:

- power units are operated in a safe manner. The submittals prove that the requirements for reactor safety imposed by the design, scientific and technical documents and international practices are adequately fulfilled;
- the operator analyzed deviations from current regulatory requirements and identified appropriate compensatory actions to allow operation of power units within design limits without their shutdown for eliminating the deviations;
- implementation of safety upgrades already resulted in decrease in CDF and LERF for all NPP units.

The positive conclusions of SARs on the safety of Ukrainian NPPs agree with expert findings from international safety evaluation missions at Ukrainian NPPs within international cooperation (OSART, SALTO, PROSPER, WANO missions).

Implementation of safety improvement measures is a precondition for NPP long-term operation. The decisions on further safe long-operation of power units were and are made by the SNRIU on the basis of state NRS review of PSRR, implementation of safety improvement measures, and comprehensive inspection of the power units.

For most power units whose design-basis life expired in 2013–2021, Energoatom selected the ‘second option’ of long-term operation in accordance with requirements of SNRIU regulation NP 306.2.210-2017 "General Requirements for Ageing Management of Components and Structures and Long-Term Operation of NPP Units": power unit is shut down after expiration of its design-basis life and organizational and technical measures to continue lifetime and proceed to long-term operation are implemented.

The ‘first option’ was chosen only for PNPP Unit 3: implementation of organizational and technical measures to continue lifetime and proceed to long-term operation throughout the design-basis life indicated in the license for nuclear installation operation.

From 2019 to 2021, the SNRIU made decisions on long-term operation of ZNPP Unit 5, KhNPP Unit 1 and PNPP Unit 3. Based on state NRS review of PSRRs for these power units and public hearings, the SNRIU accepted that safety of long-term operation of the power units at determined power levels was justified and reissued the licenses for nuclear installation operation.

As of 1 June 2022, the SNRIU made decisions on long-term operation of 12 out of the 15 operating NPP units (the design life of the remaining units (KhNPP-2, RNPP-4 and

ZNPP-6) has not yet expired). Based on state NRS review of PSRRs for these power units and public hearings, the SNRIU accepted that safety of long-term operation of the power units at determined power levels was justified and reissued the licenses for nuclear installation operation.

The required condition for long-term operation of an NPP unit is to develop and implement AMP.

Aging management at operating Ukrainian NPPs is organized on a systematic basis according to the adapted "plan–do–check–act" Deming cycle.

AMP and a list of components and structures subject to ageing management have been developed for each NPP unit and agreed by the SNRIU.

In accordance with the IAEA recommendations (IGALL project), all NPPs have developed AMPs for individual components and structures (reactor pressure vessel, head closure assembly, internals, support elements, etc.).

Basic requirements for technological aging were developed with the use of national and international experience and were included into the following Energoatom document (standard): SOU NAEK 141:2017 "Ageing Management of NPP Components and Structures".

As part of the periodic safety review, aging effects on the safety of NPP units are assessed. The assessment results are presented in the report on analysis of the 'Ageing' safety factor (safety factor 4) included in PSRR for each power unit.

The effectiveness of AMPs is assessed annually by the operator in compliance with the established criteria and evaluated by the regulatory body. In addition, AMPs are evaluated by international experts. Such evaluation was carried out within the Pre-SALTO mission at PNPP-3 in 2018. The IAEA experts recognized the development of the "Book of Operational Defects in WWER NPP Steam Generator Heat-Exchange Tubes" as a good practice. They also additionally recommended to extend this practice to all WWER NPPs operating the same type of steam generators.

Within the European integration process, Ukraine takes measures aimed at implementing EU legislation into the national regulatory and legislative framework.

Council Directive 2014/87/Euratom dated 8 July 2014, establishing a Community framework for the nuclear safety of nuclear installations (Council Directive 2014/87/Euratom), is one of the EU directives to be implemented in the Ukrainian legislation. In compliance with Article 8e of this Directive, each EU Member State shall take place in topical peer reviews in specific technical safety areas. The first topical peer review in the area of ageing management took place in 2017 and covered NPP units and research reactors with power over 1 MW (that were in operation as of 31 December 2017 or in construction as of 31 December 2016).

The objective of the first topical peer review was to exchange information between the participating countries on ageing management of components and structures of nuclear installations, identify good practices and common issues, and develop an action plan for improvement of the regulatory and legislative framework and practices in this area. Ageing management of the reactor pressure vessel, underground pipework, civil structures and electrical cables was addressed.

Results from the analysis of ageing management issues in Ukraine were set forth in the "National Report on the First Topical Peer Review on Ageing Management" and approved by SNRIU Board Resolution in November 2017. The report is placed on the ENSREG website at <http://www.ensreg.eu/sites/default/files/attachments/ukraine.pdf>. According to the analysis of ageing management in Ukraine presented in the Report, the following can be stated:

- the existing regulatory and legislative framework of Ukraine regarding ageing management requirements complies with IAEA and WENRA recommendations and documents. This was confirmed by independent reviews carried out by western experts within international projects;
- the ageing management activities are carried out on a regular basis and appropriately recorded in electronic databases;
- the ageing management approach relies on the understanding of ageing effects and prediction of degradation of components and structures;
- the AMP development and implementation are a necessary condition to proceed with power unit long-term operation.

Thus, the measures implemented by the operating in the reporting period ensure implementation of Ukraine's international obligations on safety improvement of operating Ukrainian NPPs.

The completed efforts ensure that Ukrainian NPPs can be operated in a safe manner over their design-basis and long-term lifetime.

Therefore, Ukraine complies with the provisions of Convention Article 6.

ARTICLE 7 Legislative and Regulatory Framework

Each Contracting Part shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

The legislative and regulatory framework shall provide for:

7.1 Establishment and regulatory support

The Ukrainian nuclear safety legislation governs all relations associated with the use of nuclear energy and assurance of nuclear and radiation safety.

The Law of Ukraine "On Nuclear Energy Use and Radiation Safety" is a fundamental document in this area, which was adopted in 1995 and further amended and supplemented. The document establishes the priority of human safety and environmental protection. The Law identifies the main tasks of nuclear legislation, principles of state nuclear policy, rights and obligations of citizens in the use of nuclear energy and competences of state management bodies in nuclear energy use and radiation safety and provides for state regulation of safety in the use of nuclear energy.

7.2 National safety requirements and regulations

As mentioned in the previous National Reports, the legislative framework and regulatory control system in the field of nuclear energy fully embrace all safety principles and provisions of Article 7 of the Convention on Nuclear Safety.

In the reporting period, improvement of the nuclear regulatory and legislative framework continued, taking account of NRS state regulation and practices in Ukraine and experience of advanced countries considering scientific and technical achievements, international standards, as well as EU documents and documents and recommendations of the IAEA and other international safety organizations. Analysis for compliance with the updated WENRA reference levels was carried out. Findings of the analysis were considered in the development/revision of regulatory documents.

An important event in 2020 was the adoption of the Law of Ukraine "On Amendment of Some Laws of Ukraine in the Area of Nuclear Energy" on May 19 by the Verkhovna Rada of Ukraine. The amendments made to the Laws of Ukraine "On Basic Principles of State Oversight (Control) in the Sphere of Economic Activities" and "On Licensing of Economic Activities" provide that these laws do not apply to oversight over compliance with safety requirements for nuclear energy use and licensing of activities in nuclear energy use that ensures the independence of the nuclear regulatory body of Ukraine in the implementation of licensing and oversight.

In order to improve the terminology in nuclear energy use, taking into account EU law, as well as to bring some provisions of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" in line with EU legislation, legislative standards and, taking into account the practice of applying the Law, draft Law of Ukraine "On Amendment of the Law of Ukraine on Nuclear Energy Use and Radiation Safety" was developed. On 20 August 2021, the draft law was registered in the Verkhovna Rada under No. 5860.

To govern the issue of authorizing documents in the area of nuclear energy and radiation safety and implement provisions of EU regulations, in particular those relating to the optimization of authorizing activity in nuclear energy and the improvement of procedure for issue of authoring documents for the use of nuclear energy, the draft Law of Ukraine "On Amendment of the Law of Ukraine on Licensing Activity in Nuclear Energy"

was prepared. The draft Law was registered in the Verkhovna Rada on 3 December 2021 under No. 6425.

The system of nuclear legislation includes regulatory acts of the Cabinet of Ministers to establish mechanisms for implementing laws and conducting nuclear energy activities (without technical aspects).

Regulations and rules on NRS are an important part of the nuclear safety legislation. These documents establish criteria, requirements and conditions for safe use of nuclear energy in all associated areas (safety of nuclear installations, particularly NPPs, safety of radioactive waste management facilities, safety of radiation sources, physical protection, safety of radioactive material transport etc.).

The SNRIU regulations are registered in the Ministry of Justice of Ukraine in compliance with the established procedure and officially published and are binding for entities to which these regulations apply.

Basic legislative and regulatory acts in the area of nuclear energy that came into force in 2019 - 2022 are listed in Annex 3.

In connection with the signature of the Association Agreement between Ukraine, of the one side, and the European Union, European Atomic Energy Community and their member states, of the other side, and its ratification by the Verkhovna Rada of Ukraine and the European Parliament on 16 September 2014, the SNRIU activated the adaptation of Ukrainian legislation to EU nuclear safety laws.

The issues related to cooperation of Ukraine and EU in the field of nuclear safety are envisaged by the Agreement in Article 342 and Annex XXVII (nuclear energy section).

Annex XXVII to the Association Agreement between Ukraine and EU was amended by Association Council resolution. These amendments were approved by the Verkhovna Rada of Ukraine on 6 June 2019. These amendments are aimed at updating the EU acquis to be implemented.

To implement Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation, the SNRIU:

- developed draft Law "On Amendment of Some Laws of Ukraine in the Area of Nuclear Energy". This draft Law was adopted by the Verkhovna Rada by No. 107-IX on 18 September 2019. The Law regulates NRS issues such as reduction in risks of long-term exposure to radon products and radiation protection in medical exposure, improves state regulation of uranium ore mining and processing activities and introduces licensing for uranium ore mining;
- developed draft Law "On Amendment of the Law of Ukraine on Nuclear Energy Use and Radiation Safety Regarding Radiation Protection Expert", which was submitted for review to the Verkhovna Rada of Ukraine (registered by No. 3869 of 16 July 2020) after agreement with interested executive bodies and approval by the Government.

In addition, for implementing Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation, the Cabinet of Ministers of Ukraine adopted Resolution No. 1141 of 18 November 2020 "Some Issues in Establishing a Unified State System for Control and Accounting of Individual Doses" (aimed at creating a unified state system for control and accounting of individual radiation doses in Ukraine in line with the basic principles of radiation protection set forth in the Directive).

To implement Council Directive 2006/117/Euratom on the supervision and control over shipments of radioactive waste and spent fuel, the SNRIU developed the Procedure

for Issuing Permits for International Shipments of Radioactive Materials, intended to determine procedure for agreement of radwaste and spent fuel transfer between Ukraine and EU member states, which was approved by Cabinet Resolution No. 759 of 21 August 2019.

In addition, SNRIU Order No. 320 of 4 August 2020 approved Standard Document Forms, which is a required mechanical for applying the agreement procedure envisaged by Cabinet Resolution No. 759 of 21 August 2019 "On Amendment of the Procedure for Issuing Permits for International Shipments of Radioactive Materials".

The SNRIU also works on the implementation of Council Directive 2014/87/Euratom dated 8 July 2014, which amends the Community framework for nuclear safety of nuclear installations.

7.3 Nuclear installation licensing system and prohibition of nuclear installation operation without a license

At the legislative level, the nuclear installation licensing system is governed by the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and the Law "On Licensing Activity in Nuclear Energy".

Article 26 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" prohibits legal entities or individuals to conduct any activity related to the use of nuclear installations or radiation sources without a properly granted permit (license).

Pursuant to the Law of Ukraine "On Licensing Activity in Nuclear Energy", the operators have licenses covering all necessary life stages of their nuclear installations.

In connection with the military aggression of the Russian Federation against Ukraine, Decree of the President of Ukraine No. 64 "On the Introduction of Martial Law in Ukraine" dated 24 February 2022 introduced martial law in Ukraine from 05:30 on 24 February 2022, which has now been extended.

In the above regard, the Government adopted a number of regulations that:

- terminated the provision of administrative services to entities for the duration of martial law;
- extended automatically the validity of existing licenses and permits for the period of martial law and three months from the date of its termination or cancellation.

However, to ensure the availability of services and for convenience of entities, SNRIU continued rendering services to entities in case they applied in regions where there were no active hostilities.

7.4 System of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and licensing conditions

In compliance with the Convention on Nuclear Safety, a state system for NRS regulation was established and is maintained in Ukraine.

The legislative principles underlying the system of regulatory oversight and safety assessment of nuclear installations remained unchanged over the reporting period.

Under Article 5 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", oversight activity is considered to be among the fundamental cornerstones of the national policy in nuclear energy use and radiation protection.

In accordance with Articles 22, 24 and 25 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", state regulation of nuclear energy use provides for supervision over compliance with NRS regulations and standards and terms of authorization granted to entities using nuclear energy, including enforcement measures (oversight).

Under Article 15 of the Law of Ukraine "On Licensing Activity in Nuclear Energy", the nuclear regulatory body supervises compliance with license conditions by conducting regulatory inspections and nuclear safety reviews of the reporting documents submitted by the operator.

In connection with the introduction of martial law, which was mentioned in para. 7.2.2, and the Governmental decision to stop scheduled and unplanned state oversight (control) measures for the period of martial law, the SNRIU suspended the implementation of scheduled measures on state oversight for compliance with NRS requirements.

7.5 Enforcement of applicable regulations and licensing conditions, including suspension, modification or revocation

Under Article 24 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", the state nuclear regulatory body is empowered to supervise compliance with regulations and standards on NRS as well as licensing conditions. In case of incompliance, the regulatory body may apply administrative sanctions to personnel and officials of enterprises, institutions and organizations. Article 25 of the Law determines the rights of state inspectors regarding their responsibilities and application of enforcement measures towards individuals who fail to comply with legislation, regulations and standards on NRS and licensing conditions.

Article 81 of the Law determines the types of violations for which personnel and officials of nuclear installations and enterprises, institutions and organizations dealing with any other nuclear energy activity, as well as citizens, are brought to disciplinary, civil (except for civil liability for nuclear damage), criminal and administrative responsibility. Article 17-1 of the Law of Ukraine "On Licensing Activity in Nuclear Energy" sets penalties that may be imposed on entities engaged in nuclear energy activities if they fail to fulfil completely or partially conditions of the licenses and other permits and if they conduct activities without a license. The Code of Ukraine on Administrative Violations defines penalties that may be applied to officials and personnel that do not comply with NRS legislation.

Article 16 of the Law of Ukraine "On Licensing Activity in Nuclear Energy" considers incompliance with licensing conditions to be a reason for suspension and cancellation of the operator's license, depending on the life stage of a nuclear installation.

Oversight of nuclear and radiation safety directly at NPP sites is conducted by the on-site Nuclear Safety Inspectorates.

Therefore, Ukraine complies with the provisions of Convention Article 7.

ARTICLE 8 Regulatory Body

8.1 Establishment of the regulatory body

Each Contracting Party shall establish or designate a regulatory body for nuclear safety entrusted with the implementation of the legislative and regulatory framework and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

The main functions of the nuclear regulatory body as determined by the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management are entrusted to the State Nuclear Regulatory Inspectorate of Ukraine, which acts in compliance with the "Statute of the State Nuclear Regulatory Inspectorate of Ukraine" approved by Cabinet Resolution No. 363 of 20 August 2014.

The SNRIU Board is working on a permanent basis to develop recommendations on significant issues and most essential areas of NRS regulation.

To address issues related to NRS regulation, nuclear security and accounting and control of nuclear materials and prepare proposals for resolving these issues, a State Regulatory Control Commission was established in the SNRIU as a collegial advisory body.

To prepare proposals for making decisions to issue, refuse to issue, amend, renew, refuse to amend or renew, terminate, revoke and resume licenses in the field of nuclear energy, a Licensing Commission was established in the SNRIU.

Advisory and consultative functions in the SNRIU decision-making process in nuclear energy are exercised also by the Public Council.

The Public Council was established to ensure that the public is involved in administration of state affairs, exercise public supervision of the SNRIU activities and promote effective interaction of the SNRIU with the public, taking into consideration public opinion in the formulation and implementation of state policy.

The SNRIU has a state technical safety organization – SSTC NRS – providing analytical, scientific, expert, technical, engineering, informational, advisory and methodological support to the state nuclear regulatory body.

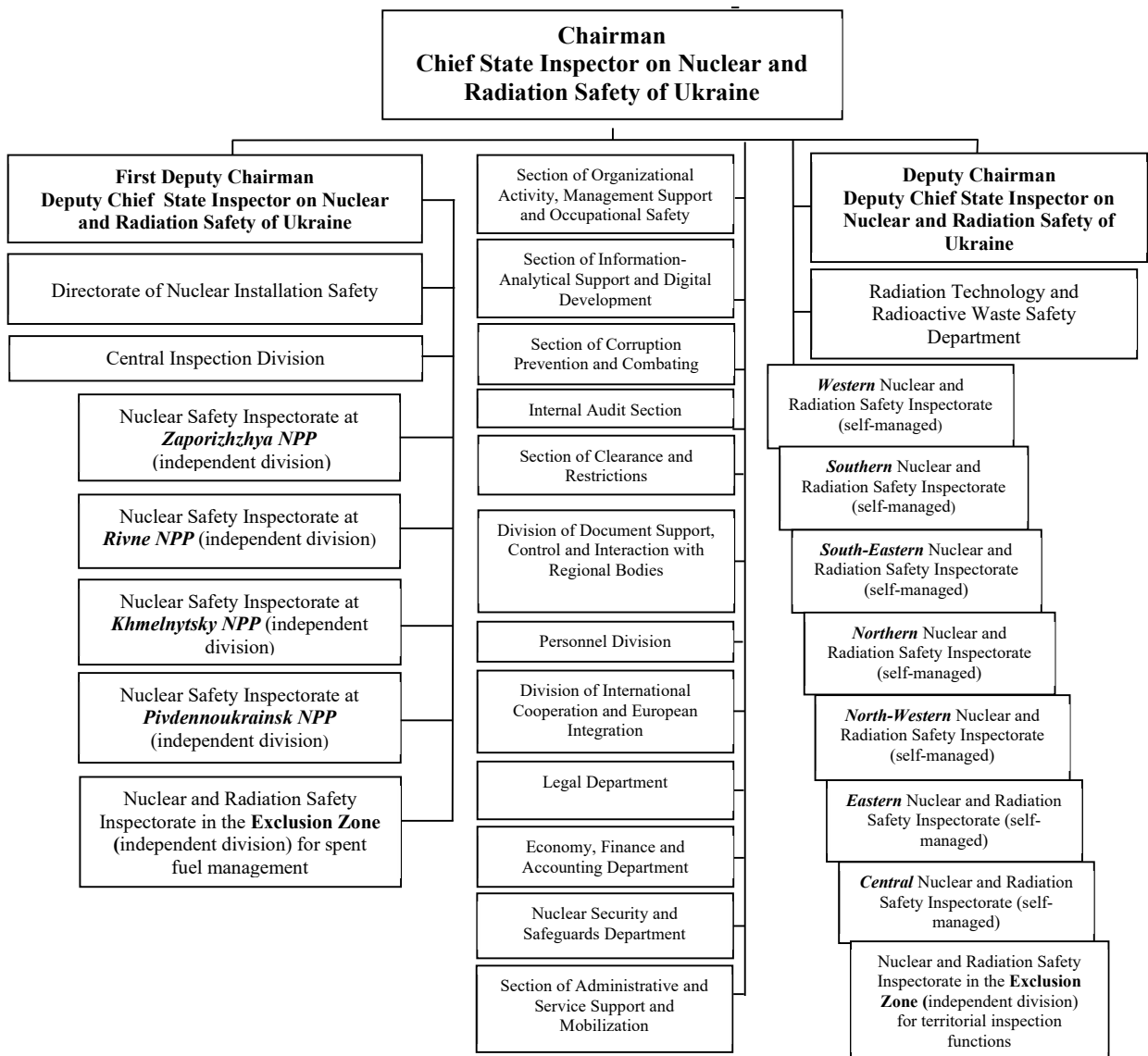
The SNRIU issues annual reports on nuclear and radiation safety in Ukraine. The annual report highlights implementation of the national policy in peaceful use of nuclear energy and compliance with NRS requirements in Ukraine. The annual report is published in Ukrainian and English and posted at the SNRIU official website www.snriu.gov.ua.

SNRIU Ordinance No. 13 of 28 November 2019 approved the Policy Statement of the State Nuclear Regulatory Inspectorate of Ukraine for 2019-2024, which outlines the position, mission, strategy and fundamental principles of state NRS regulation and is published on the SNRIU website.

Since 2008, a quality management system has been in force at the SNRIU.

Within the certification procedure, annual internal and external audits are conducted in all areas of activities, working parameters are monitored on a permanent basis and measures are taken to improve the results at the SNRIU.

Organizational Structure of the State Nuclear Regulatory Inspectorate of Ukraine



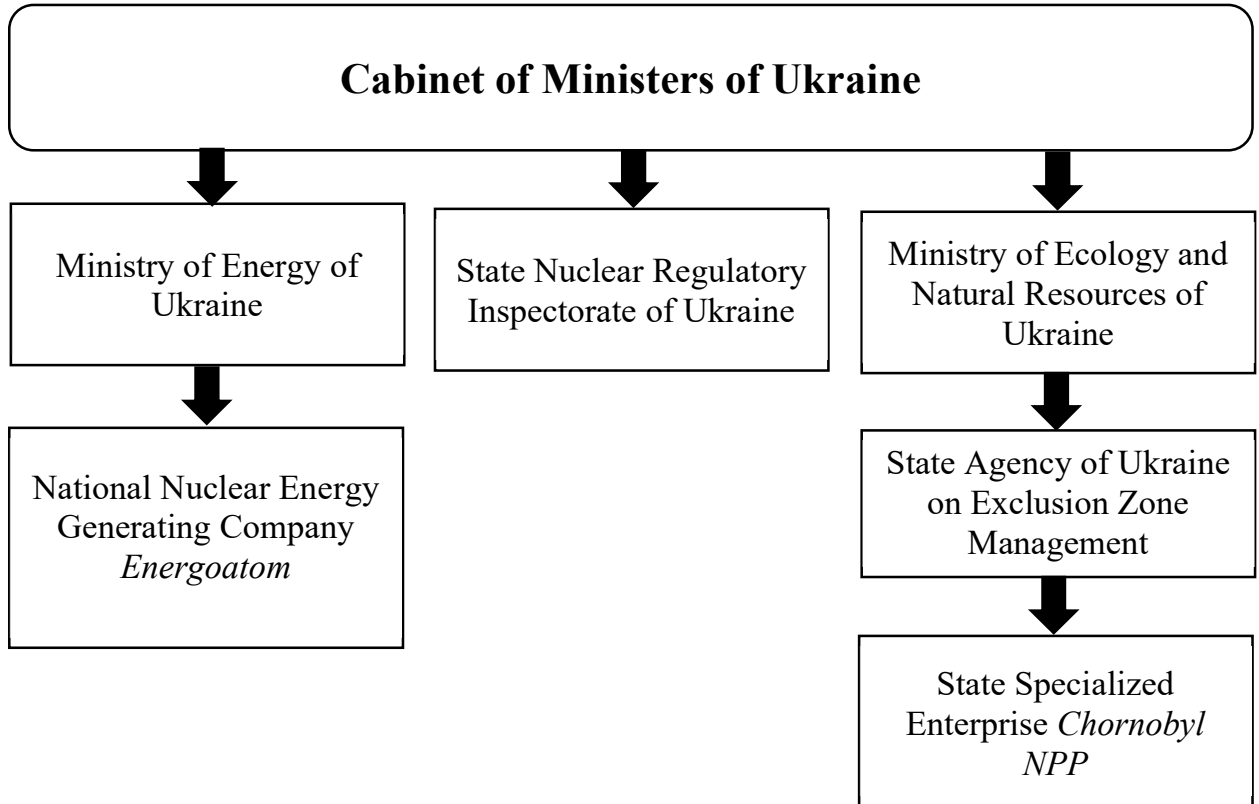
8.2 Status of the regulatory body

Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or use of nuclear energy.

The national legislation of Ukraine clearly specifies and distinguishes functions of the regulatory body and functions of any other bodies or organizations dealing with nuclear energy use. At the legislative level, this is governed by Articles 21, 23 and 24 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety". At the sub-legislative level, this is governed by powers of the executive bodies established in their statutes and determined by the Cabinet of Ministers of Ukraine.

The Law of Ukraine "On Licensing Activity in Nuclear Energy" states that any bodies, officers, officials, members of the public and their associations shall not be allowed to interfere with resolution of the issues that fall within the SNRIU authorities unless otherwise provided by law.

In addition, the Verkhovna Rada of Ukraine adopted the Law of Ukraine "On Amendment of Some Laws of Ukraine in the Area of Nuclear Energy" on 19 May 2020. The amendments made to the Laws of Ukraine "On Basic Principles of State Oversight (Control) in the Sphere of Economic Activities" and "On Licensing of Economic Activities" provide that these laws do not apply to oversight of compliance with safety requirements for nuclear energy use and licensing of activities in nuclear energy use that ensures the independence of the nuclear regulatory body of Ukraine in the implementation of licensing and oversight.



Therefore, Ukraine complies with the provisions of Convention Article 8.

ARTICLE 9 Responsibility of the License Holder

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant license and shall take the appropriate steps to ensure that such license holder meets its responsibility.

Laws of Ukraine establish a legally binding framework, allocating responsibilities for the safety of nuclear installations.

Under Article 26 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", the use of nuclear installations in Ukraine shall be subject to licensing. The operating organization (operator) shall obtain licenses for activities at individual life stages of its nuclear installations. Article 32 of the Law states that the licensee is fully responsible for radiation protection and safety of the nuclear installation. Article 33 of this Law determines specific obligations of the operator.

There are two operators in the nuclear power sector of Ukraine, namely: Energoatom and Chornobyl NPP.

Energoatom has licenses granted by the SNRIU for operation of Pivdennoukrainsk NPP Units 1–3, Rivne NPP Units 1–4, Khmelnytsky NPP Units 1 and 2, and Zaporizhzhya NPP Units 1–6 (including operation of DSFSF on the ZNPP site). A license was also granted on 29 June 2017 for construction and commissioning of the nuclear installation (centralized spent fuel storage facility for WWER spent fuel from national NPPs (CSFSF)).

Under the licenses for operation of NPP units, ZNPP DSFSF and construction and commissioning of CSFSF, Energoatom obtains individual permits for activities and operations identified in the licenses, in particular: start-up of power units after refueling outages, first reactor startup after long-term operation measures, commissioning of new infrastructure facilities included in the technological system, testing of the power unit, facilities, systems and components important to safety that are not envisaged by technical specifications and operating procedures for the reactor and its systems and components etc.

ChNPP has licenses granted by the SNRIU for:

- decommissioning of Chornobyl NPP Units 1, 2, 3;
- operation of the NSC–Shelter;
- operation of the wet spent fuel storage facility – ISF-1;
- operation of the dry interim spent fuel storage facility – ISF-2.

According to the license for Chornobyl NPP decommissioning, ChNPP shall obtain individual permits to proceed with the next decommissioning stage of an individual nuclear installation and to conduct specific activities or operations at the decommissioning stages, which involve design, construction, commissioning and operation of radioactive waste management facilities as well as measures to remove spent and fresh fuel, solid and liquid operational radioactive waste of ChNPP from the existing facilities (detailed information is presented in Annex 7 to this Report).

As license holders, Energoatom and ChNPP are fully responsible for the safety of their nuclear installations.

Pursuant to the obligations imposed by Ukrainian legislation on operators, Energoatom, as the operator of the operating Ukrainian NPPs:

- ensured nuclear and radiation safety (ARTICLE 6 and ARTICLE 14 Sections of this Report);
- developed and implemented measures to improve the safety of nuclear installations (ARTICLE 6 Section of this Report);

- informed on the operational events at nuclear installations in a timely and comprehensive manner, investigated the events and implemented corrective actions (para. 16.2 of this Report);
- secured financial coverage of liability for nuclear damage as required by Ukrainian legislation (ARTICLE 11 Section of this Report);
- established requirements for staff qualification (skills and knowledge) depending on responsibilities for safety of the nuclear installation and provided staff training (ARTICLE 11 Section of this Report);
- ensured radiation protection of personnel, the public and the environment (ARTICLE 15 Section of this Report).

Starting with review of the license application and throughout the licensee's operations, the SNRIU monitors and verifies the licensee for compliance with the established requirements. In particular, the regulatory body verifies whether the nuclear installation complies with established requirements, whether financial, material and other resources are available and the organizational structure is in place and whether the system for staff training and retraining is available as mandatory conditions for granting a license to the operator for a specific life stage of the nuclear installation.

In the reporting period, the Ukrainian operators fully complied with their obligations to ensure safety of their nuclear energy operations.

In compliance with legislation in force, the operators fully implement and comply with the obligations and license terms (individual permits) concerning the safety of licensed nuclear energy activities.

Implementation of the obligations and terms of licenses (individual permits) concerning the safety of licensed activities is under continuous regulatory oversight.

Therefore, Ukraine fully complied with the provisions of Convention Article 9 as of 23 February 2022.

After the Russia's military aggression and occupation of the ZNPP site on 4 March 2022:

- Energoatom ensures the fulfillment of obligations and conditions of licenses (individual permits) in a limited scope regarding the safety of authorized activities at the ZNPP site;
- SNRIU conducts regulatory control of the ZNPP site in a limited (remote) mode.

ARTICLE 10 Priority to Safety

Each Contracting Party shall take appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

The priority to safety in design and operation of nuclear installations, which is established in the Law of Ukraine "On Nuclear Energy Use and Radiation Safety", is the basic principle of the state nuclear energy policy.

In the reporting period, all legal nuclear entities adhered, within their authorities, to legislative policy principles set forth in Ukrainian laws. This and previous Reports of Ukraine describe the implementation of national policy principles regulating the issues covered by the Convention on Nuclear Safety.

In December 1997, the Verkhovna Rada of Ukraine ratified the Convention on Nuclear Safety. The Law on ratification explicitly reads that "... Confirming its adherence to the principles of nuclear safety culture and promoting their implementation, the Verkhovna Rada of Ukraine has approved a responsible decision on ratifying the Convention on Nuclear Safety".

In 2003, the Law on Principles of National Security of Ukraine came into force. This law determines nuclear and radiation safety as one of the areas and an integral part of Ukraine's national security.

Assurance of safety safeguards, reliability of nuclear power and implementation of relevant international commitments of Ukraine are priorities for the executive authorities. The state of nuclear and radiation safety was regularly reviewed by the Cabinet of Ministers and the National Security and Defense Council of Ukraine at their meetings. NPP safety issues are addressed at the meetings of the SNRIU Boards and Boards of the Ministries concerned, and at the interdepartmental commissions' meetings.

In the reporting period, SNRIU reports on nuclear and radiation safety in Ukraine were regularly developed according to the established procedure for the Verkhovna Rada, President and Cabinet of Ministers of Ukraine.

Pursuant to NP 306.1.190-2012 "General Requirements for the Management System for Activities in the Use of Nuclear Energy", the operator's policy, objectives and management system shall ensure that priority is given to compliance with safety requirements over economic, technical, scientific and other objectives and that constant and systematic monitoring of compliance with safety requirements is conducted.

In accordance with the approved and published Energoatom Nuclear Safety Policy Statement, safety assurance has priority over economic, technical, scientific and other objectives. The operator's highest priority is to improve and maintain the achieved safety level of operating NPPs. The principle according to which each of the operator's staff members is responsible for safety and quality of their activities is adhered to at all levels.

Since 2002, International Conferences 'Safety Culture at Ukrainian NPPs' have been conducted by Energoatom every two years.

Safety Days are regularly held at NPPs at two levels (departments and plant as a whole) to introduce the safety culture principles, reveal operational occurrences and deviations from the requirements of applicable standards and regulations, technical specifications, operating procedures and operational documentation. NPP Safety Days are held according to the annual schedule, which is an integral part of the annual schedule for human resource development.

The Safety Day agenda can be adjusted, if necessary, to take account of the supervisory recommendations and events that occurred at NPP.

The Safety Days contribute to implementing the safety culture principles, enhancing nuclear and radiation safety, strengthening the control exercised by subdivision managers and plant administration over fulfilment of the requirements.

The management's statements were developed and brought to the attention of NPP staff, determining the priorities assigned to NPP activities on safety and quality assurance.

Programs on production culture assurance and improvement, as well as occupational safety and fire safety programs, were elaborated and introduced at NPPs; long-term planning of safety culture-related activities is also provided.

Job descriptions of all-level managers responsible for nuclear and radiation safety determine the obligations related to fostering the safety culture of their subordinated staff.

Production Culture Days are held across all Energoatom NPPs.

The Safety Culture course is a compulsory element of the position-specific training and retraining programs for all NPP industrial and operational personnel. Training covers all safety culture aspects for operational personnel of all categories.

Energoatom developed complete packages of training courses covering the following topics:

- Fundamentals and Basic Characteristics of Safety Culture;
- Role of Human Factor in Safety Culture;
- Quality Assurance;
- Safety Management.

Safety culture elements were incorporated into the training courses conducted at full-scope simulators, laboratories and workshops.

For implementing the principles of transparency and accessibility of information on nuclear energy use, specific public relations departments and information centers were established at all NPPs and Energoatom Headquarters to provide the public with explicit information on the environmental radiation situation. NPPs and their information centers organize guided tours for citizens to get them acquainted with NPP operation. Each NPP issues a plant newspaper and has radio broadcasting and telecasting offices and its website.

NPPs prepare annual reports on the assessment of operational safety and technical condition of power units and reports on radiation safety and radiation protection at NPPs. Energoatom summarizes the NPP reports to develop the final report on assessment of operational safety and technical condition and the report on radiation safety and radiation protection at NPPs, which are submitted to the regulatory and governing state bodies of Ukraine.

Therefore, Ukraine fully complied with the provisions of Convention Article 10 as of 23 February 2022.

At the same time, after the start of the military aggression of the Russian Federation and occupation of the ZNPP site on 4 March 2022, the implementation of a policy in which priority is given to nuclear safety is much more complicated. In connection with the temporary occupation of the ZNPP site, the following challenging issues arose:

- critical situation with the supply of spare parts and consumables to ZNPP for maintenance, modernization and other activities within long-term operation;
- critical situation with the supply of fuel and lubricants, chemicals, etc. to ZNPP
- deterioration of the moral and psychological condition of ZNPP personnel due to the pressure of invaders, which can increase the probability of errors or making erroneous decisions by these personnel;
- non-compliance with the ZNPP physical protection mode;

- significant deterioration in communication and coordination of actions with other organizations and institutions, which complicates significantly meeting fire safety requirements and reduces effectiveness of emergency response measures;
- unstable operation of the system for remote transmission of data on safety indicators;
- loss of the possibility to implement regulatory control measures directly at the ZNPP site.

ARTICLE 11 Financial and Human Resources

11.1 Financial resources

Each Contracting Party shall take appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.

According to Article 32 of the Law of Ukraine “On Nuclear Energy Use and Radiation Safety”, the license holder shall have financial, material and other resources, an appropriate organizational structure and personnel to maintain the level of safety defined by safety regulations, rules and standards and licensing requirements. The license holder shall have financial capabilities to indemnify damages caused by accidents that may occur in the use of nuclear energy through its own funds or funds of insurance companies (organizations).

Payments for the supplied electricity versus its cost were 97.57% in 2017, 100% in 2018 and 98.48% in 2019. The slight fluctuations in the payments in 2017 and 2019 are associated with decrease in the level of payments in the Wholesale Electricity Market of Ukraine for the final consumers.

A fixed tariff is used for the electricity that Energoatom NPPs delivers to Energorynok (Energy Market). Decisions on the tariff amount, as well as breakdown of costs for electricity production, are approved by NEURC.

Since 1 July 2019, Energoatom sells and buys electrical energy in accordance with the Law of Ukraine "On the Electricity Market", which is close to European standards.

The state has ceased to be the only buyer and seller of electricity, the market has transferred to a competitive mechanism that provides the sale of electricity both through organized electronic tenders and under bilateral agreements between producers and consumers, suppliers.

The price for Energoatom electricity is currently formed in various market segments in accordance with the concluded contracts or conducted tenders, taking into account special obligations in accordance with Resolution of the Cabinet of Ministers No. 483 of 5 June 2019.

For improving the safety of nuclear installations, ensuring effective and reliable operation of power industry and enhancing the safety of Ukrainian NPPs to the level that meets recognized international standards of nuclear safety and environmental protection, Energoatom is implementing C(I)SIP. The estimated cost of C(I)SIP implementation approximates 1,861 mln EUR, including 1,201 mln EUR provided by Energoatom and the rest from the EBRD/Euratom loan.

Under the Memorandum of Understanding on Cooperation in the Field of Energy between the European Union and Ukraine, the EBRD/Euratom, on the one side, and the Ministry of Fuel and Energy of Ukraine and Energoatom, on the other side, made a decision on funding the Program from the EBRD/Euratom loan.

Law of Ukraine No. 1868-IV "On Settlement of Nuclear Safety Issues" dated 24 June 2004 and Cabinet Resolution No. 594 dated 27 April 2006 provided for establishing, accumulating and using a financial reserve for nuclear installation decommissioning. Ukraine is a Contracting Party to the Vienna Convention on Civil Liability for Nuclear Damage dated 1963 (as prescribed by the Law of Ukraine "On Accession of Ukraine to the Vienna Convention on Civil Liability for Nuclear Damage" dated 12 July 1996).

The insurance coverage of Energoatom civil liability for nuclear damage has been provided since 2004. Annually, Energoatom enters into an agreement with an insurance

company that is duly authorized by member companies of the Nuclear Insurance Pool of Ukraine.

11.2 Human resources

Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

The NPP personnel training system is in place and fully operates in Ukraine. This system is based on the IAEA-recommended systematic approach to training and experience acquired by leading IAEA member states in staff training.

The staff training system operates in interaction with research organizations, enterprises, state administrative and regulatory bodies and other educational systems to provide each staff member with high-standard training, retraining and skill improvement, which are aimed at acquiring and maintaining the knowledge and sustaining skills and qualifications necessary for safe operation of NPPs.

The SNRIU licenses the training of NPP staff according to regulation "Rules for Licensing the Training of Staff for Operation of Nuclear Installations" NP 306.2.104-2004. The SNRIU also licenses officials according to "Conditions and Procedure for Licensing the Activities of Operating Organization Officials" NP 306.1.180-2012 and operational personnel in accordance with "Rules for Licensing of Personnel for Direct Control of NPP Reactors" NP 306.2.103-2004.

Energoatom developed and introduced "Provisions for Staff Development Activities of the National Nuclear Energy Generating Company Energoatom" PL-K.0.07.005-17, incorporating state-of-the-art international experience in the area of NPP staff training. The document also defines principles based on which the safety culture of the staff is developed through systematic staff management to maintain the required proficiency level and keep the staff continuously ready to fulfil their professional duties, which is crucial for nuclear and radiation safety of NPPs and especially for protection and integrity of defense-in-depth barriers.

The effectiveness of the staff training system is clearly demonstrated by a steady trend towards improving the staff availability factor.

Energoatom has training centers in place at all nuclear power plants and at the AtomRemontServis Enterprise. All centers have appropriate licenses and permits issued by state regulatory bodies to train staff of different categories.

Forming a basis for the training system, the training centers of NPPs continue developing. The structure and staff list for the training centers were developed taking account of NPP-specific features. The NPP training centers are staffed with skilled and knowledgeable instructors. The technical training materials are continuously improved.

At present, the NPP training centers use eight full-scale simulators, namely: full-scale simulators for WWER-1000 at KhNPP-1, ZNPP-1, 3, 5, RNPP-3 and PNPP-1, 3 and a full-scale simulator for WWER-440 at RNPP-2, along with simulators for emergency control rooms at KhNPP-1, ZNPP-3, 5, PNPP-1, 3 and RNPP-2, 3. The full-scale simulators are upgraded on a regular basis to maintain configuration in compliance with prototype power units, to extend the scope and accuracy in modelling of processes and systems and develop modules of beyond design-basis and severe accidents. Besides, the training of staff involves multifunctional and local simulators and computer training systems.

Significant attention is paid to training and professional development of maintenance staff. The training center for Energoatom maintenance staff was established on the

premises of the ZNPP training center with participation of the European Commission. The center has full-scale equipment of one WWER-1000 loop, including the reactor, steam generator, reactor coolant pump, pressurizer, main coolant piping, etc. Besides, the center has a reloading machine, main handling equipment, internals inspection cavities, and spent fuel pool. There are equipment and systems for reactor assembly/disassembly and fuel reloading and a test bench of control rod drive mechanisms. The center was commissioned in 2018.

Staff training is based on training methodologies and guidelines developed in accordance with the Energoatom standard "Requirements for Training Materials". The development of training materials is a precondition for obtaining a license for staff training.

However, the ZNPP training center was severely damaged by the shelling by Russian soldiers on 4 March 2022. The Russian soldiers prevented fire extinguishing for a long time, and the ZNPP training center was extensively damaged.

Moreover, because of the ZNPP temporary occupation by the Russian troops, the NPP training center is not available for training and advanced training of personnel from other Ukrainian NPPs and experts of other institutions and organizations.

The staff to be licensed are trained using individual training programs based on standard programs agreed by the SNRIU.

Annex 5 to this Report shows dynamics in the number of licensed plant experts and information on NPP staff training.

All Ukrainian NPPs are fully provided with trained and skilled staff.

Therefore, Ukraine complies with the provisions of Convention Article 11.

ARTICLE 12 Human Factor

Each Contracting Party shall take appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

In 2012, Ukraine revised regulatory requirements for the management system and human factor. New regulatory requirements are in full compliance with IAEA requirements GS-R-3 "Safety Requirements. Management Systems for Facilities and Activities", comply with recommending documents GS-G-3.x and WENRA reference levels.

State regulation of nuclear and radiation safety envisages requirements for safety culture, professional training, creation of a training system and examination of knowledge on nuclear and radiation safety. Licenses are issued to train certain categories of plant experts and license personnel who control the nuclear reactor and top managers whose duties include administrative functions associated with the assurance of nuclear and radiation safety. State oversight of compliance with legal requirements and regulatory framework, as well as conditions of issued licenses, shall be performed. Special verifications are conducted to check compliance with regulatory requirements with regard to the human factor, and the regulatory body interacts with licensees to eliminate drawbacks and maintain safety culture.

The Energoatom staff management policy is set forth in the Energoatom Policy Statement and is focused on professional and psychological awareness of personnel recognizing safety assurance as a first priority and inherent need of each employee, leading to self-consciousness, responsibility and self-control in all activities that are important for NPP operational safety.

Recognizing the role of human factor in NPP safety assurance, the Energoatom management declares that priority is to be given not only to search and punishment but also to detection, resolution and prevention of issues and non-conformances related to human factors.

To prevent and avoid any influence of human factors that may cause NPP operational events if psychophysical state or proficiency level of the staff do not meet the safety requirements, Energoatom employs the system of operating experience feedback in personnel training at NPP training centers.

With due regard to the human factor, the effectiveness of training systems for Ukrainian NPP staff is assessed as follows:

- analysis of reports on events that describe abnormal occurrences related to human errors;
- audits of NPP training centers by SNRIU experts to verify whether licenses can be granted for position-specific training of staff;
- analysis of reports on casualties due to drawbacks in training.

To assess the operational personnel's technical proficiency to operate a power unit under different operating modes, the operational personnel availability factor is calculated. Erroneous actions that caused occurrences during transients and wrong actions or omissions of the operational personnel are taken into account.

The licensed personnel (shift supervisors and MCR operators) are certified by NPP commissions headed by NPP chief engineers. The rest of operational personnel are certified by commissions headed by deputy chief engineers or heads of NPP departments. Personnel's knowledge is assessed as prescribed in the relevant regulations.

Upon completion of training, a post-training knowledge test is conducted by NPP training centers. If results of the post-training test are positive, the trainee is sent for further knowledge verification by the commission.

The following additional certification procedures are envisaged for the staff whose training is subject to licensing:

- preparation for knowledge verification by the NPP central commission, during which previously gained knowledge and skills are refreshed, requirements, rules and standards on NPP safety and operation are specified. Based on the results of pre-training tests, trainees gradually and successively refresh the topics of individual programs through their self-training and by means of interviews and consultations with instructors;
- drills using a full-scale simulator.

Proficiency and skills of the trainees are tested to check their ability to control production process from MCR in:

- normal operation;
- abnormal operation;
- emergencies.

Teamwork capabilities are checked as well.

Final post-training tests to check knowledge and skills are administered by deputy chief engineers. They verify if the knowledge obtained by trainees is sufficient for self-guided work and if trainees are prepared for knowledge verification.

Test results are incorporated into records and along with other documents are handed over to the central knowledge verification commission.

In case the test results are not satisfactory, extra time is provided for further preparation.

The knowledge level is verified by the commission headed by the NPP chief engineer with a state inspector as a representative of the on-site State Nuclear Safety Inspectorate.

Upon successful knowledge verification by the commission, as well as shadow training and exercises, a package of documents for granting a license is prepared and sent to the SNRIU for further review. If results of the review are positive, the SNRIU issues a license for nuclear installation operation with the NPP units being specified.

Personnel are prepared for emergency mitigation, accident management and prevention of event recurrence in NPP operation through:

- emergency exercises in training for individual position-specific training programs;
- emergency exercises for shift operational personnel;
- full-scale simulator training for operational personnel under skill improvement program;
- full-scale training on mitigation of beyond design basis.

In 2021, the SNRIU developed and introduced the regulation "Requirements for Emergency Documents for Nuclear Power Plants", approved by SNRIU Order No. 290 of 27 May 2021, to establish requirements for NPP emergency documents.

Symptom-based EOPs and SAMGs have been implemented at all NPPs for all operational states.

To minimize effects of the human factor, the following administrative arrangements are implemented, namely:

- individuals are permitted to work at a nuclear installation and with nuclear materials only following special examination and training;
- psychophysical state of the operational personnel is checked annually;

- all staff's health is monitored annually and operational personnel are subject to mandatory medical examination before shifts;
- staffing, staff training and safety culture improvement are controlled at the intradepartmental level;
- as prescribed in the staff development schedule, general-plant and unit emergency response and fire protection exercises are held annually for operational personnel, including individual training with administrative and technical staff.

Therefore, Ukraine complies with the provisions of Convention Article 12.

ARTICLE 13 Quality Assurance

Each Contracting Party shall take appropriate steps to ensure that quality assurance programs are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

The Energoatom management system combines (integrates) regulatory requirements for nuclear safety, environmental protection, occupational safety, fire safety, etc. needed to achieve objectives of the organization. The management system covers management of equipment, operation of equipment for the production of electric and thermal power, modification, maintenance, repairs, reconstruction and upgrade of NPP equipment, development, design and production of special equipment, devices and instrumentation, engineering and technical support, management of human resources, safety management (nuclear safety, radiation safety, occupational safety, fire safety, environmental protection, physical protection) and actions in accidents and emergencies, engineering support and major construction, management of material and technical resources, management of finances, economy, and purchase and sale of electricity on the electricity market.

Requirements of the integrated management system (IMS) applied in Energoatom activities take into account the approach based on the classification (grading) established in regulations. The issues of safety take priority over economic, technical, scientific and other objectives of activities.

Energoatom's IMS complies with the requirements of international standards ISO 9001 (for quality control systems), ISO 14001 (for environmental management system) and ISO 45001 (for health protection and occupational safety management system), which has been ascertained by TÜV NORD CERT certificates.

In order to identify the areas for improvement and ascertain the actual status of compliance with the above requirements, Energoatom conducts internal audits of IMS processes. The audits are conducted in the areas such as NPP equipment operation support, management of maintenance, safety assurance, upgrading, modernization, and long-term operation, acceptance and incoming inspection, equipment and material procurement management, management of emergencies, emergency preparedness, environmental management, etc.

In addition, Energoatom performs scheduled internal inspections of compliance with rules, regulations and standards on nuclear safety, fire safety and occupational safety. The inspections also cover measuring laboratories and metrological services, as well as emergency preparedness, plant physical protection, financial and economic activities.

To make sure that vendors/manufacturers can ensure that their products conform to the prescribed requirements, the operator carries out audits of the vendors that provide products for NPP systems important to safety.

Great attention is paid to providing NPPs with highly-skilled personnel to ensure a high level of operational safety for nuclear installations. Personnel are trained and retrained on a regular basis. The training is based on a graded approach reasoning from the roles and functions of employees: managerial staff, quality assurance officers and other specialists.

Therefore, Ukraine complies with the provisions of Convention Article 13.

ARTICLE 14 Assessment and Verification of Safety

14.1 Assessment of safety

Each Contracting Party shall take appropriate steps to ensure that comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information and reviewed under the authority of the regulatory body.

Operation of nuclear installations envisages their detailed and comprehensive safety analysis taking into account design features and operating practices. Ukrainian laws and other regulations require safety assessments and safety reviews.

The operator's safety assessment of operating power units is aimed at developing and keeping updated the main safety justification document, SAR, which presents both comprehensive safety assessment and technical and administrative measures to ensure safety.

Safety assessment and verification represent a continuous process and require the safety analyses to be detailed and their procedures to be improved continuously to take account of the best world practices and actual events that occurred or might occur at nuclear installations.

Safety analysis efforts that complied with the then effective legal NRS framework and IAEA recommendations were started in Ukraine in the 1990s and included development of SARs initially for pilot units (RNPP-1, PNPP-1, ZNPP-5) and afterwards for the other power units. Safety analysis for NPPs was subjected to great attention of the international organizations (IAEA, STUK, GRS, IRSN, etc.) under international projects.

At present, SARs have been developed for all Ukrainian NPPs and include both deterministic and probabilistic safety assessments.

Results of safety analysis confirm that safety of Ukrainian NPPs meets requirements of Ukrainian NRS regulations, rules and standards.

Currently, Energoatom's activities on SAR are generally intended to keep them updated and eliminate some restrictions of the previous safety analyses.

In particular, according to the regulation "Requirements for Safety Assessment of Nuclear Power Plants", which became effective in October 2010, the operator continues development of the probabilistic safety assessment of levels 1 and 2 including a full range of initiating events for all normal states of the reactor and spent fuel pool. These efforts are under way to cover all operating NPPs under the C(I)SIP.

As of 1 June 2022, such analyses have been performed for all operating Ukrainian NPP units.

The implementation of living PSA procedures at NPPs was started in 2010 to keep updated the probabilistic models of NPP units developed within SARs with the purpose of applying risk-informed approaches. Such efforts were also planned under the C(I)SIP. To date, living PSAs have been implemented at all units of Ukrainian NPPs. In 2017, an industry standard was developed by the operator, agreed by the regulatory body and implemented. The industry standard is a guideline on the development, implementation and update of living PSAs. According to the standard, Ukrainian NPPs are carrying out activities on the current and full update of PSAs.

In 2014, SAMGs for the reactor and spent fuel pool were implemented at pilot units such as PNPP-1, ZNPP-1 and RNPP-1. In 2015-2016, SAMGs for reactor shutdown states and SFPs were implemented for pilot PNPP-1, ZNPP-1 and RNPP-1.

Within the C(I)SIP, measures were implemented to develop EOPs for accidents in low power and shutdown (refueling outage) states. Severe accident management guidelines for full power and shutdown states were developed and implemented for all NPP units.

The developed SAMGs take into account upgrades focusing on the severe accident management strategies involving mobile power supply sources and pump units.

The adaptation of SAMGs to all other units of Ukrainian NPPs was completed in 2017.

The Program for Analyzing Phenomena of Severe Accidents was implemented in 2016. It defines further organizational and technical measures to:

- validate and improve the computer models for severe accident analysis (including purchase of new codes);
- validate and improve the computer models for severe accident analysis (including purchase of new codes).

In 2017, Energoatom purchased the ANSYS computer code and conducted personnel training. In 2018, the first stage of negotiations with the U.S. Nuclear Regulatory Commission took place for participation in the CSARP program and provision of the MELCOR 2.x computer code. Currently, efforts are ongoing to analyze in detail the potential for criticality in the severe accident progression and for in-vessel and ex-vessel phenomena of severe accidents using the MELCOR 1.8.5 computer code.

As prescribed by nuclear law and national safety requirements and regulations, the operator shall periodically, at least every 10 years, perform periodic safety review for NPP units and report its results to the regulatory body.

As of 1 June 2022, in the framework of long-term operation measures at Ukrainian NPPs, the operator developed PSRRs for RNPP-1-3, ZNPP-1-5, KhNPP-1 and PNPP-1,3 to justify the safety of their long-term operation. Besides, a scheduled periodic safety review not related to long-term operation was performed for ZNPP-6, RNPP-4 and KhNPP-2.

In 2017, new regulatory document “Requirements for Periodic Safety Review for Nuclear Power Plants” was put in force. The regulation was developed by the SNRIU taking into account IAEA SSG-25 “Periodic Safety Review for Nuclear Power Plants” and national experience in periodic safety reviews of NPP units. Upon agreement with the regulatory body, the operator identified ZNPP Unit 6 as the pilot one. The scheduled safety review of this power unit will have to be performed in accordance with the new regulation. In 2021, the operator’s standard “Requirements for the Structure and Contents of Periodic Safety Review Reports for Nuclear Power Plants. Methodological Guidance” was developed. This document specifies requirements of the above regulatory document on the PSRR development, structure and contents.

14.2 Verification of safety

Verification by analyses, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

Since the previous Report, the nuclear installations have been verified for compliance with NRS requirements, standards and rules.

Regulatory oversight is exercised by on-site State Nuclear Safety Inspectorates and state inspectors of the SNRIU Headquarters. The inspector activities are governed by applicable regulations, special programs and inspection schedules. The experts of dedicated divisions of the SNRIU and resident State Nuclear Safety Inspectorates are involved in comprehensive inspections.

Pursuant to requirements of the General Safety Provisions for Nuclear Power Plants, NP 306.2.141-2008, the operator ensures that the NPP safety is permanently monitored. To this end, an institutional control service was established and operates at Energoatom.

The mission of the institutional control service is to monitor Energoatom departments for compliance with requirements, standards and rules on nuclear, radiation and technical safety along with requirements for environmental protection, license terms and operational documents.

Each NPP has an institutional control service whose mission includes regular (daily) monitoring of operating states, condition of equipment and systems important to safety and their compliance with requirements of operational documents and NRS regulations, standards and rules.

Pursuant to NP 306.2.145-2008 “Nuclear Safety Rules for Nuclear Power Plants with Pressurized Water Reactors”, each NPP conducts internal nuclear safety inspections and submits the inspection certificates to the SNRIU.

According to the approved program, the operator conducts internal nuclear safety inspections at least every two years and regularly verifies radiological and environmental protection on a regular basis.

Based on the inspections, measures are identified to eliminate the revealed shortcomings, as required.

NPP systems and components important to safety undergo inspections for compliance with design characteristics in commissioning, after maintenance, and periodically throughout the NPP service life.

The nuclear installation design provides for diagnostics (testing) of systems and components important to safety. In-service maintenance is conducted in compliance with conditions and limits of safe operation established in technical specifications for safe operation and justified in SAR.

Specific measures on testing and inspection and their scopes and frequencies are determined in the technical specifications, special programs and procedures applied at NPPs. In compliance with these documents, the operator conducts:

- inspections and testing of equipment and process systems;
- monitoring of the design life of major equipment;
- regular nondestructive testing of equipment and piping metal and welds;
- assessment of fuel cladding integrity;
- primary and secondary water chemistry control;
- checks of reactor cooling system integrity;
- monitoring of radioactive releases and discharges and radiological conditions in

the NPP control area and observation area,

and other monitoring actions as prescribed by special programs and procedures.

Upon maintenance, the systems and equipment are checked for operability and compliance with design characteristics, with inspection results being recorded.

To limit degradation of structures, systems and components important to safety (as a result of ageing, wear, corrosion, erosion, fatigue and other mechanisms) and support their in-service operability and reliability, Energoatom developed and performs programs on equipment ageing management, equipment qualification and long-term operation of power

units and the C(I)SIP and developed and implemented a comprehensive integrated program for improvement of operational effectiveness and reliability of Energoatom NPPs.

The legislative and regulatory framework was established in Ukraine to allow a comprehensive and systematic safety assessment throughout the life stages of nuclear installations.

Therefore, Ukraine complies with the provisions of Convention Article 14.

ARTICLE 15 Radiation Protection

Each Contracting Party shall take the appropriate measures to ensure that in all operational states the radiation exposure to the personnel and the population caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

The Law of Ukraine "On Human Protection Against Ionizing Radiation" aimed at protecting the human life, health and property against negative effects of ionizing radiation prescribes practical steps to implement provisions of the basic Law "On Nuclear Energy Use and Radiation Safety" and establishes the main dose limits for personnel and the public. This Law also outlines the scope of authorities and obligations of state bodies responsible for radiation protection.

In 2001, 2009 and 2012, the Law of Ukraine "On Human Protection against Ionizing Radiation" was amended to bring its provisions into full compliance with the ICRP recommendations.

The regulatory document "Radiation Safety Standards of Ukraine" (NRBU-97) and its Supplement "Radiological Protection against Potential Radiation Sources" (NRBU-97/D-2000) were developed to specify the main provisions of the Law of Ukraine "On Human Protection against Ionizing Radiation". They are based on accumulated international experience, reflect up-to-date approaches towards law-making and radiation protection and take into account IAEA and ICRP recommendations.

NRBU-97 determines the basic principles of radiation protection applied to practices and intervention situations and establish radiation and health and safety regulations, in particular, effective dose limits for category A (personnel) (no more than 50 mSv for an individual year and 20 mSv/year on average for any consecutive five years) and category B (2 mSv/year) and for category C (the public) (1 mSv/year), as well as limits for equivalent external doses for the eye lens, skin, hands and feet that comply with recommendations of ICRP Publication 60.

NRBU-97/D-2000 complements and extends NRBU-97, including requirements for radiological health and safety regulation of potential radiation sources.

The basic principles of radiation protection and the ALARA (optimization) principle are implemented in Ukraine through the development and introduction of regulatory standards and rules and through the development and introduction of appropriate operational procedures. The ALARA principle implementation includes a series of organizational and technical measures. These organizational and technical measures are implemented at Ukrainian NPPs with the purpose of reducing individual and collective doses of personnel, minimizing releases and improving radiological monitoring systems.

In connection with closure of the Health and Epidemiological Service of Ukraine, Cabinet Resolution No. 348 of 29 March 2017 entrusted the State Service of Ukraine on Food Safety and Consumer Protection with the tasks and functions of the state policy in the sphere of health and epidemiological welfare of the public and control (oversight) of compliance with health and safety legislation.

The functions relating to the monitoring of doses at workplaces and doses of employees are within the competence of the State Labor Service of Ukraine.

The effectiveness of radiation protection measures is evaluated from collective and individual doses, dynamics in their changes, and levels of releases and discharges from the nuclear installation.

Figure 1 (Annex 6) shows the dynamics of collective doses for Ukrainian NPP personnel for a period from 2009 to 2021. The dynamics of personnel collective doses reflects the exposure levels depending on the scope of radiologically hazardous activities in refueling outage.

Figure 2 (Annex 6) shows the distribution of individual doses for personnel of Ukrainian NPPs over a period from 2016 to 2021. The diagram shows that individual doses to the majority of individuals monitored at all Ukrainian NPPs (more than 80% of personnel) are below 1 mSv. In 2016-2018, no individuals were registered at Ukrainian NPPs to have a dose higher than 20 mSv/year. In 2019, one KhNPP employee was recorded to receive a dose above 20 mSv. The dose received by the employee does not exceed the limit of the individual annual effective dose and the limit of the dose on average for the last 5 years (50 mSv and 20 mSv, respectively) established by NRB-97.

Figure 3 (Annex 6) shows the dynamics in the total radioactive airborne releases to the environment for Energoatom NPPs from 2009 to 2021.

The actual releases recorded by the regular radiation monitoring systems at Ukrainian NPPs are much lower than permissible levels established taking into account appropriate dose limit quotas for individuals from the public.

The total indicators (percentage of actual release to permissible one) of airborne releases to the environment for the main nuclides (inert radioactive gases, iodine radionuclides and long-lived nuclides: ^{137}Cs , ^{134}Cs , ^{60}Co , ^{54}Mn , ^{90}Sr) in 2018 reached 0.85% at ZNPP (including 0.71% for tritium), 0.78% at RNPP (including 0.61% for tritium), 0.18% at PNPP (including 0.08% for tritium) and 0.11% at KhNPP (including 0.04% for tritium).

Figure 3 (Annex 6) shows that the release indicators over a period from 2009 to 2021 were below 1%, except for PNPP in 2021. Higher release indicators at ZNPP and PNPP in 2018 were connected with a technique introduced at the plants to measure and monitor the tritium releases through the ventilation stacks. The tritium releases have been controlled at RNPP since 2007 and at KhNPP-2 since 2010.

Since the 3rd quarter of 2021, control of ^{14}C in releases has been introduced at PNPP. This led to an increase in the release indicator at PNPP in 2021 to 4.05%, while the ^{14}C release indicator is 3.84%. Hence, the actual total indicator of monitored reference radionuclides remains at the previous level.

The total indicators (ratio of actual discharges to permissible ones) of water discharges to the environment for the main nuclides (^{137}Cs , ^{134}Cs , ^{60}Co , ^{54}Mn , ^{90}Sr , ^3H) in 2018 reached 2.13% at ZNPP, 0.50% at RNPP, 1.57% at PNPP and 0.14% at KhNPP and have not significantly changes in recent years. Figure 4 (Annex 6) shows the dynamics in the total indicators of radioactive releases to the environment at Energoatom NPPs for a period from 2009 to 2021. There were no substantial changes in the total discharge indicator for 2019–2021 as compared to 2018 at NPPs. The maximum discharge indicator for 2019–2021 did not exceed 2.35% of the permissible discharge.

The environment in the nuclear installation control areas is monitored by regular radiation monitoring systems in accordance with current regulations on radiation monitoring at each NPP. These regulations prescribe the scope, frequency, and methods of monitoring.

Every year in the control and observation areas, several thousand samples are taken for further research. They characterize radiation state of the surface air layer, surface water, components of terrestrial and aquatic ecosystems.

The analysis of samples in the surface atmospheric air layer in the areas where the NPP is located indicates that radionuclide content is mainly determined by ^{137}Cs , ^{60}Co and ^{90}Sr radionuclides.

In 2018, the radioactive content of atmospheric air in the ZNPP location area was $1.1\text{--}1.6\ \mu\text{Bq}/\text{m}^3$ for ^{137}Cs and $< 0.01\ \mu\text{Bq}/\text{m}^3$ for ^{90}Sr . At RNPP, the content of ^{137}Cs radionuclide in atmospheric air varied from 3.9 to $7.1\ \mu\text{Bq}/\text{m}^3$. At PNPP, the registered radioactive content of atmospheric air was $< 1.4\ \mu\text{Bq}/\text{m}^3$ for ^{137}Cs , and varied from 0.2 to $1.3\ \mu\text{Bq}/\text{m}^3$ for ^{90}Sr . At KhNPP, the content of radioactive materials in atmospheric air varied from 1.9 to $11.9\ \mu\text{Bq}/\text{m}^3$ for ^{137}Cs and from 0.2 to $3.0\ \mu\text{Bq}/\text{m}^3$ for ^{90}Sr .

In 2021, in the NPP location area, the content of radioactive substances in the atmospheric air was as follows:

- ZNPP: ^{137}Cs – $1.3 \div 2.5\ \mu\text{Bq}/\text{m}^3$; ^{90}Sr – $< 0.03\ \mu\text{Bq}/\text{m}^3$; ^{60}Co – $< 1.2\ \mu\text{Bq}/\text{m}^3$;
- RNPP: ^{137}Cs – $2.96 \div 7.48\ \mu\text{Bq}/\text{m}^3$; ^{60}Co – $< 0.4\ \mu\text{Bq}/\text{m}^3$;
- PNPP: ^{137}Cs – $< 0.54 \div 2.3\ \mu\text{Bq}/\text{m}^3$; ^{90}Sr – $0.43 \div 1.27\ \mu\text{Bq}/\text{m}^3$; ^{60}Co – $< 0.73\ \mu\text{Bq}/\text{m}^3$;
- KhNPP: ^{137}Cs – $0.37 \div 2.41\ \mu\text{Bq}/\text{m}^3$; ^{90}Sr – $0,076 \div 0.46\ \mu\text{Bq}/\text{m}^3$; ^{60}Co – $< 0.18\ \mu\text{Bq}/\text{m}^3$.

The analysis of water samples from surface water bodies in the NPP location areas indicates that radionuclide content is mainly determined by ^{137}Cs , ^{60}Co , ^{90}Sr and ^3H radionuclides, and the maximum values of radionuclide content were:

- ZNPP: ^{137}Cs – $< 6.6\ \text{Bq}/\text{m}^3$; ^{90}Sr – $20.0\ \text{Bq}/\text{m}^3$; ^{60}Co – $< 21.0\ \text{Bq}/\text{m}^3$; ^3H – $340\ \text{kBq}/\text{m}^3$;
- RNPP: ^{137}Cs – $1.73\ \text{Bq}/\text{m}^3$; ^{60}Co – $< 1.4\ \text{Bq}/\text{m}^3$; ^3H – $64\ \text{kBq}/\text{m}^3$;
- PNPP: ^{137}Cs – $1.97\ \text{Bq}/\text{m}^3$; ^{60}Co – $83.0\ \text{Bq}/\text{m}^3$; ^{90}Sr – $15.0\ \text{Bq}/\text{m}^3$; ^3H – $281.0\ \text{kBq}/\text{m}^3$;
- KhNPP: ^{137}Cs – $12.3\ \text{Bq}/\text{m}^3$; ^{90}Sr – $9.99\ \text{Bq}/\text{m}^3$; ^{60}Co – $< 14.0\ \text{Bq}/\text{m}^3$; ^3H – $98.0\ \text{Bq}/\text{m}^3$.

In 2021, in the NPP location area, the content of ^{137}Cs in the surface soil layer was not more than: $0.4\ \text{kBq}/\text{m}^2$ at ZNPP, $2.64\ \text{kBq}/\text{m}^2$ at RNPP, $0.269\ \text{kBq}/\text{m}^2$ at PNPP and $0.454\ \text{kBq}/\text{m}^2$ at KhNPP. In the RNPP location area, heterogeneous contamination of the surface soil layer with ^{137}Cs radionuclide of Chernobyl origin is observed. The content of ^{60}Co and ^{90}Sr radionuclides in the surface soil layer is fixed at a level less than the minimum measured activity.

In general, the radiological condition of the surface air layer, surface water and surface soil layer for all NPPs is significantly lower than the permissible values for these radionuclides and are at the zero background level.

Therefore, Ukraine complies with the provisions of Convention Article 15.

ARTICLE 16 Emergency Preparedness

16.1 Emergency plans and programs

Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.

In Ukraine, measures for preparedness and response to emergencies of any origin (natural, man-made, including radiation and nuclear) are integrated into the Unified State Civil Protection System (USCPS).

The structure, tasks, performance, requirements for planning protective measures and other aspects are determined by the Code of Civil Protection of Ukraine No. 5403-VI of 2 October 2012 and the Provisions on the Unified State Civil Protection System approved by Resolution of the Cabinet of Ministers of Ukraine No. 11 dated 9 January 2014.

The main USCPS tasks according to the Code and Provisions are as follows:

- ensure preparedness of central and local executive bodies for preventing and responding to emergencies;
- project and assess social and economic consequences of emergencies;
- determine the needs in logistics, human resources, financial resources;
- accumulate and store resources;
- notify the public about the threat and occurrence of emergencies;
- protect the public, conduct emergency rescue operations, take measures for social protection;
- train the public how to behave and act in case of emergencies, etc.

USCPS is managed by the Cabinet of Ministers of Ukraine, while interaction is coordinated and arranged by the State Emergency Service of Ukraine. The main structural components of USCPS are functional and territorial subsystems.

The Provisions on the USCPS Functional Subsystem of Nuclear and Radiation Safety were approved by SNRIU Order No. 57 dated 14 February 2020 and registered in the Ministry of Justice of Ukraine on 13 April 2020 under No. 340/34623.

The functional subsystem includes SNRIU, economic entities related to the area of its management, nuclear entities and civil protection forces subordinate to them.

The SNRIU emergency preparedness system is described in document VL-D.0.03.089-18 “Basic Provisions to Organize the SNRIU Preparedness and Response System for Accidents and Emergencies at Ukrainian NPPs”.

Emergency planning is implemented in accordance with the radiation hazard categories for facilities (categories I-V), taking into account the risk assessment results and requirements of IAEA GSR Part 7 “Preparedness and Response for a Nuclear or Radiological Emergency. General Safety Requirements”.

In accordance with NP 306.2.141-2008 “General Safety Provisions for Nuclear Power Plants” approved by SNRIU Order No. 162 of 19 November 2007 and registered in the Ministry of Justice of Ukraine on 25 January 2008 under No. 56/14747 (as amended according to SNRIU Order No. 133 of 20 September 2011):

- prior to the delivery of nuclear fuel to NPPs, an NPP emergency plan and emergency response plan of the operator are developed, agreed and approved in accordance with legislation. The plans are based on the initial data presented in the NPP design and in SAR.

The actions of the operator (licensee) in case of a nuclear or radiological emergency are established by the Standard Emergency Plan for Ukrainian NPPs, Emergency Response Plan of Energoatom Headquarters, and emergency plans of each NPP.

The NPP Emergency Plan defines the NPP emergency organizational structure, distribution of responsibilities and duties for emergency response, composition of emergency response means and external organizations involved in emergency response, establishes the procedure for NPP to implement emergency response measures and support emergency preparedness, and contains comprehensive reference and explanatory information.

The Emergency Response Plan of Energoatom Headquarters was developed in accordance with the requirements of NP 306.2.141-2008 in order to:

- coordinate actions of the affected NPP's management, Energoatom Headquarters and Energoatom separated entities;
- mobilize resources of the operator and provide assistance to NPPs;
- provide interaction of the Energoatom Headquarters with the state management body for nuclear energy use, specially authorized central executive body for civil protection, state nuclear regulatory body, and other central executive bodies.

The Standard Emergency Plan for Ukrainian NPPs establishes the procedure for development, agreement, approval, amendment and revision of NPP emergency plans, as well as uniform requirements for their structure and contents.

The NPP Emergency Plans and Emergency Response Plans of Energoatom Headquarters are interconnected and coordinated.

The efficiency and consistency of the Emergency Plans of Energoatom Headquarters and NPPs and measures identified in them are systematically verified in emergency exercises of different levels and in scheduled annual comprehensive inspections of NPPs and separated entities that shall ensure and implement emergency measures in case of a threat and/or occurrence of nuclear or radiological accidents and man-made and natural emergencies.

To train NPP emergency personnel, whose responsibilities include implementing measures for emergency preparedness and response (civil protection) in a nuclear or radiological emergency, to improve their knowledge and skills in the mitigation of accident or emergency consequences, the following emergency exercises are conducted:

- general plant emergency training involving Energoatom top management (GPET) is emergency exercises on the NPP site jointly with the Energoatom Headquarters and separated entities involving external organizations and agencies to verify the capabilities of interaction (every three years at each NPP in accordance with the "Schedule of General Plant Emergency Training together with Energoatom Headquarters Involving Representatives of Ministries and Institutions, and Representatives of Local Executive Bodies" developed by Energoatom for 2018–2029 and agreed with the SNRIU);
- general plant emergency training is energy exercises on the NPP site to train interaction with local and territorial bodies of the State Emergency Service, Ministry of Internal Affairs, local executive authorities (by agreement), which should participate in the mitigation of an emergency or accident at an NPP (carried out annually, except for the years when the GPET is held)
- training of emergency teams (civil protection groups) (every six months).

Emergency training for personnel whose responsibilities include making decisions and performing actions for the operational management and maintenance of power

equipment of power plants (with the involvement of personnel implementing emergency preparedness and response/civil protection measures) are divided into the following types:

1) by method of conduct:

- by procedures;
- with conditional actions on equipment that is in operation;
- with real actions on the equipment put out of operation;
- using technical training means;
- combined.

2) depending on the place of conduct, amount of equipment and operational and operational and production personnel involved:

- operator;
- intersystem;
- system;
- network or regional (in the electrical networks of the main electrical networks and power supply organizations, as well as their structural subdivisions);
- general plant (unit, shop, area);
- facility (area or substation).

3) by other features:

- scheduled (ordinary) and extraordinary;
- group and individual;
- combined with fire prevention training.

Energoatom develops and implements emergency training programs to work out personnel actions in emergencies. The programs are formed in such a way as to ensure annual verification of all elements of the NPP emergency plan and emergency response plan of Energoatom during training.

In the course of training, the adequacy and interconnection of emergency plans are checked, actions are worked out for a coordinated prompt response of administrative bodies, forces and means of the USCPS functional and territorial subsystems, the public and territories at all levels - facility, local, regional and national.

The training results are carefully analyzed, on their basis, relevant corrective measures are planned and implemented. SNRIU approve these measures and control their implementation.

The arrangement and implementation of emergency measures for the public in the event of radiological accidents are governed by the Exemplary Radiological Accident Response Plan for Territorial Subsystems of the Unified State Civil Protection System Whose Territory Belongs Fully or Partially to the NPP Observation Area, approved by Ordinance No. 339 of the Ministry of Health of Ukraine on 6 May 2008.

The territorial plan determines the main measures to organize and conduct the mitigation of radiation accident consequences ensuring the minimum life support needs for the public affected by the accident, membership of the necessary forces and content of means, material, financial and other resources, establishes the allocation of responsibilities and procedure for the actions of administration bodies and forces of the territorial subsystem of the unified state civil protection system for the implementation of these measures.

Training of emergency personnel to act in case of accidents is provided by the following:

- current system for professional training of NPP personnel and maintenance of the required level of their qualification;
- systematic emergency exercises;

- briefings and knowledge tests on emergency preparedness and response, civil protection.

The NPP structure provides training centers equipped with technical training means, including full-scale simulators necessary for training, skill improvement and retraining of NPP personnel, staffed by emergency preparedness and response instructors.

NPP personnel undergo on-the-job training and in training centers using simulators, knowledge tests before being allowed to work independently, as well as periodic skill improvement in accordance with the requirements of standards, regulations and rules on NRS. During training, skill improvement and retraining of personnel, special attention is paid to working out their actions during accidents, obtaining practical skills to control the reactor, power unit and NPP as a whole. Personnel training is carried out taking into account operating experience, awareness of the consequences of possible personnel errors for NPP safety.

The general requirements for emergency training in separate subdivisions of the Company are established by the Methodology for the Preparation, Organization and Conduct of Emergency Training in Separate Subdivisions of Energoatom, developed and approved by Energoatom in accordance with the Procedure for Organization and Conduct Special and Facility Exercises and Training on Civil Protection approved by SNRIU Order dated 28 November 2019 and registered in the Ministry of Justice of Ukraine on 16 January 2020 under No. 46/34329.

In GPET, personnel actions in emergency conditions are worked out and adequacy and effectiveness of the NPP emergency plan and emergency response plans at the level of the Company Headquarters are checked in terms of interaction with external bodies, institutions and organizations. According to Energoatom decision, for individual GPET, it may be additionally planned to exercise other emergency response measures

Maintaining an appropriate level of personnel emergency preparedness is ensured by the system for information exchange on abnormal events and organization of feedback on NPP operating experience.

GPET and comprehensive inspections of the state of emergency preparedness and response, civil protection and technological safety of Energoatom separate subdivisions in 2020 depended on the rate of acute respiratory disease COVID-19 caused by the SARS-CoV-2 coronavirus, on the development of the epidemic situation in the regions of location and directly at NPPs, and a remote format of interaction was used.

Thus, RNPP in 2020 using multimedia course "Special Training of Personnel Included in the RNPP Emergency Groups and Teams. 052-65-MMK-NTTs", a theoretical training was conducted for personnel of emergency groups (teams), as well as a self-check of the state of emergency preparedness and response, civil protection and technological safety was performed.

On 9-10 June 2021, a scheduled GPET was carried out at PNPP according to the scenario of a conditional general accident at PNPP accompanied by a complete NPP blackout, failure of Unit No. 2 all diesel generators and primary to secondary coolant leak with BRU-A opening (steam dump valve to the atmosphere) of the Unit No. 3 emergency steam generator.

On 17–18 November 2021, ZNPP exercised actions under a severe accident scenario with core melting and long-term extra-vessel phase with the operation of the pressure relief system from under the containment. The ZNPP training confirmed the effect of introducing the severe accident module using the full-scale simulator of Unit No. 1 to achieve a realistic reflection of severe accident phenomena, improve training of the MCR operational personnel on actions using a set of emergency documents.

Training practically shown the ability of Energoatom and NPPs to implement and use additional technical and organizational measures for improving the stability of Ukrainian NPP units under extreme natural and other influences in the context of the events occurred at the Fukushima Daiichi.

The military aggression of the Russian Federation, which started as a full-scale invasion on 24 February 2022 throughout the territory of Ukraine and the introduction of martial law in Ukraine by Decree of the President of Ukraine No. 64/2002 of 24 February 2022 changed the plans for GPET at KhNPP, which was scheduled for 1 June 2022 in accordance with Energoatom Order No. 01-1209-n dated 16 December 2022.

Energoatom Order No. 01-201-n dated 7 April 2022 proposed KhNPP (under agreement with SNRIU) instead of the general plant emergency training jointly with the Energoatom Headquarters to conduct the general plant emergency training at the KhNPP site by 2 October, involving local executive bodies, administration bodies and forces of the State Emergency Service of Ukraine, as well as with the participation of the Nuclear Safety Inspectorate at KhNPP.

Taking into account the extremely difficult situation occurred at the ZNPP site and in Energodar due to the Russian military aggression, the ZNPP General Director, guided by the requirements of subpara. 3.1, para. 3 of the above Order, approved and implemented the decision to perform the scheduled (March 19-13 2020) comprehensive inspection of the state of emergency preparedness and response, civil protection and technological safety of ZNPP by the method of self-check.

16.2 Information of the public and neighboring states

Each Contracting Party shall use the appropriate steps to ensure that its own population and competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for the emergency planning and response.

Cabinet Resolution No. 733 of 27 September 2017 approved Provisions on the Notification of a Threat or Occurrence of Emergencies and Communications in Civil Protection Field.

According to para. 12 of these Provisions, special notification systems shall be installed and operated at nuclear power plants.

Cabinet Resolution No. 1570 of 2 October 2003 determined the national competent bodies and contact points in accordance with the Convention on Early Notification of a Nuclear Accident and Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency:

- SESU is the competent national body authorized to send and receive requests for assistance in the event of a nuclear accident or radiological emergency and to accept offers of assistance;
- SNRIU is the competent national body authorized to send emergency notification and information in the case of a nuclear accident or radiological emergency in Ukraine and receive emergency notification and information in case of a nuclear accident or radiological emergency in another state and is the only competent national authority responsible for the round-the-clock duty to ensure that emergency notifications and information, as well as requests for assistance, are received at all times.

As the competent national body and contact point within the Conventions, the SNRIU ensures:

- 24/7 duty to receive and transfer emergency notification of an event or assistance from the IAEA or other countries under international agreements;
- information exchange and communication with the IAEA Incident and Emergency Center and competent authorities of other countries within international agreements (Ukraine concluded 13 such agreements: with the Kingdom of Sweden, Republic of Turkey, Republic of Belarus, Slovak Republic, Hungary, Republic of Finland, Kingdom of Norway, Republic of Poland, Federal Republic of Germany, Republic of Austria, Republic of Bulgaria, Republic of Latvia, Romania and Russian Federation (not in force)).

The SNRIU Emergency Information Center uses the following automated assessment and forecasting systems:

- InterRass for conservative assessment at close distances;
- JRODOS for realistic assessment at close and far distances;
- Hot Spot for rapid assessment of incidents such as releases, explosions (including nuclear) and fires.

On-line monitoring data come from the system for transfer of process and radiation parameters of Ukrainian NPPs, including those from the posts of the automated radiation monitoring systems in the 30-km control areas, to the SNRIU Emergency Information Center.

The SNRIU Emergency Information Center and Energoatom main and backup emergency centers maintain communication with all Ukrainian NPPs and analyze and register information on NPP events and on nuclear and radiation safety. They are combined in one information system by redundant surface and satellite communication channels.

Signals and notifications at NPP sites and in industrial areas, as well as in the settlements around the plants are transmitted from the workplace of the plant shift supervisor. Direct telephone communication is established between the plant shift supervisor and on-duty services of territorial bodies in the field of civil protection.

Within 30 minutes from the moment of accident classification, NPP sends recommendations to management staff of the USCPS territorial subsystem on iodine treatment and evacuation from the control area and regarding on protective measures for the public living in the observation area of the affected NPP. Management bodies of the territorial subsystem make a decision on radiation protection measures (iodine treatment, shelter, evacuation) and notify the public on the protective measures.

To inform local and central governments on the expected doses to the public and provide forecasts and recommendations on public protection, Energoatom uses facility-level decision support systems (DSS) in case of emergencies for the 30-km areas using data of weather stations and stations of the automated radiation monitoring system.

The atmospheric transport models of the KADO software designed by the Institute of Radiation Protection, Academy of Technical Sciences of Ukraine, allow doses for the public to be calculated in the 30-km observation area.

For state-level emergencies or events related to transboundary transfer of radionuclides, an interagency RODOS-Ukraine DSS was created based on the European RODOS system within the program of cooperation with the European Commission under the Instrument for Nuclear Safety Cooperation (INSC).

RODOS DSS was put into commercial operation at Energoatom by Order No. 87 of 26 January 2017.

RODOS DSS uses models of atmospheric transport at significant distances and uses input meteorological data of the weather research and forecasting model (WRF).

The Centre for Prediction of Radiological Accident Consequences (CPRAC) operates within the SESU Ukrainian Hydrometeorological Center to support decisions on radiation

protection of personnel and the public in the NPP responsibility area and beyond its boundaries on the territory of Ukraine. The CPRAC performs continuous monitoring of the RODOS DSS operability and solve test problems with all system components.

The client part of the system is installed at the Energoatom Headquarters Emergency Center in Kyiv and Emergency Centers of ZNPP, RNPP, KhNPP and PNPP (system remote workplaces) and SNRIU EIC (system user workplace).

The Ukrainian Hydrometeorological Center ensures, as agreed administratively, the interaction and transmission of data from the observation network to the European Radiological Data Exchange Platform (EURDEP) that is administrated by the European Commission Directorate-General for Energy and to the IAEA International Radiation Monitoring Information System (IRMIS).

The operator takes systematic actions to inform the public living in the NPP observation areas about radiological risks associated with NPP operation. These actions include:

- dissemination of relevant information material and publications for executive bodies of different levels, mass media and public institutions, as well as use of official websites and printed media of Ukrainian NPPs;
- response to inquiries of the public, mass media, executive bodies of various levels, etc.;
- lectures for the public, including schoolchildren, with visits to nuclear installations;
- broadcasting of topical television and radio programs, appearances of NPP managers and experts, and development and dissemination of special printed and information material (placards, booklets, leaflets, etc.) among the public in the observation areas.

Therefore, Ukraine complies with the provisions of Convention Article 16.

ARTICLE 17 Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented

17.1 Evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime.

The siting requirements are established by Ukrainian legal and regulatory documents. The decision-making procedure and requirements for documents justifying the construction of a nuclear installation are determined by Article 37 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and Law of Ukraine "On Decision-Making Procedure for Siting, Design and Construction of Nuclear Installations and Radioactive Waste Management Facilities of National Importance". In particular, the submittals shall describe:

- characteristics of the environment in the area of a potential site for an installation;
- EIA report for planned activities on nuclear installation construction and decommissioning;
- design-basis measures to prevent and mitigate adverse environmental impacts.

Decisions on the siting, design, and construction of NPPs are made by the Verkhovna Rada of Ukraine by adopting an associated law. The Verkhovna Rada of Ukraine makes a decision only if local executive bodies and local self-governments approve the placement of a nuclear installation on their territory. The draft law is submitted to the Verkhovna Rada of Ukraine by the Cabinet of Ministers of Ukraine.

Criteria for evaluating factors that can affect safety of nuclear installations are determined by NRS regulations and state civil engineering standards. These documents identify performance indicators that characterize natural, economic and demographic conditions in the site area, data of pre-operational monitoring of the environment and meteorological, climatic, geological, seismic, hydrological, hydrogeological, engineering-geological and geochemical characteristics.

In 2008, the SNRIU approved the regulatory document "Safety Requirements for Siting of Nuclear Power Plants" (NP 306.2.144-2008) that establishes safety requirements for NPP siting and takes into account IAEA recommendations.

Cabinet Resolution No. 605-r dated 18 August 2017 approved the Energy Strategy of Ukraine for the Period until 2035 "Safety, Energy Efficiency, Competitiveness" (the Strategy). Ukraine considers nuclear energy one of the most cost-effective low-carbon energy sources.

A draft Site Cadaster specifying the priority sites that comply with the requirements of the regulations on NPP operation and environmental impact was developed and is currently updated to identify candidate sites for new NPP units.

A comprehensive zoning of the entire Ukrainian territory was performed in the Site Cadaster according to various limiting factors. The possibility of NPP construction on new sites and conditions for construction and operation of new units at existing NPPs were determined.

In 2021, the Ministry of Energy of Ukraine sent the Cadaster together with Draft Resolution "On Approval of the Site Cadaster for the Construction of Power Units of New Nuclear Power Plants" for approval to the Cabinet of Ministers of Ukraine, SNRIU, Ministry of Economic Development, Trade and Agriculture of Ukraine, Ministry of Finance of Ukraine, Ministry of Environmental Protection and Natural Resources of Ukraine, Ministry of Development of Communities and Territories of Ukraine, State

Service of Ukraine for Geodesy, Cartography and Cadaster. To date, the coordination of the Cadaster with ministries and departments is under continuation.

The compliance of NPP sites with NRS regulations and standards is verified in periodic safety reviews of operating NPPs. Requirements of the new regulation "Requirements for Safety Assessment of Nuclear Power Plants in External Natural Hazards", approved by SNRIU Order No. 263 dated 30 April 2021, are also considered.

On 31 August 2021, Energoatom and Westinghouse Electric Company (USA) signed a Memorandum on Joint Construction of Power Units in Ukraine.

The construction of new units in cooperation with Westinghouse is of strategic importance for Ukraine, because it will ensure the independence of the Ukrainian energy system, its integration into the world market and diversify nuclear fuel supply to its reactors. The use of the American AP1000 technology in the long term will enable Energoatom to ensure safe and reliable operation of nuclear generation.

On 2 November 2021, Energoatom and Westinghouse signed an agreement on the construction of two new nuclear power units for the Khmelnytsky NPP.

Completion of the Khmelnytsky NPP (KhNPP Units No. 5 and No. 6) is determined by the pilot project.

17.2. Evaluating the likely safety impact of the proposed nuclear installation on individuals, society and the environment.

The legal and regulatory documents of Ukraine govern the evaluation of potential impact of nuclear installations on individual categories of the public, society and the environment in view of safety.

According to Ukrainian legislation, the potential impact of a nuclear installation on the environment is evaluated through EIA. Article 2 of the Law of Ukraine "On Environmental Impact Assessment" provides, in particular, for the development of the EIA report by the respective entity, arrangement and conduct of public discussion of the EIA report by the authorized central body of the Ministry of Ecology and Natural Resources of Ukraine, submission of a well-grounded conclusion on EIA by the authorized body and consideration of this conclusion in decision making by the state body on implementation of the planned activity.

Pursuant to Article 36 of the Law of Ukraine "On Environmental Impact Assessment", EIA for planned or ongoing activity shall justify its feasibility and ways of implementation, possible alternatives, characteristics of the environment, types and levels of environmental impact in normal and extreme conditions, possible changes in its qualitative state, ecological and economic consequences, measures to reduce ecological risks and meet ecological safety requirements, etc.

In December 2017, in furtherance of the Law of Ukraine "On Environmental Impact Assessment", the Cabinet of Ministers of Ukraine adopted resolutions to establish the procedure for public hearings in the EIA process (No. 989 dated 13 December 2017), the criteria for determining planned activities that are not subject to EIA (No. 1010 dated 13 December 2017) and the procedure for submission of EIA conclusions, EIA funding, and procedure for keeping the Unified Environmental Impact Assessment Register (No. 1026 dated 13 December 2017).

The RNPP EIA procedure was started in accordance with the Law of Ukraine "On Environmental Impact Assessment" in 2017. The Environmental Impact Assessment Report and Announcement on Public Discussion of the Environmental Impact Assessment Report are registered in the Unified Environmental Impact Assessment Register (<http://eia.menr.gov.ua/places/view/76>). On 19 March 2019, RNPP concluded an

agreement with the Ministry of Ecology and Natural Resources of Ukraine on the arrangement and conduct of public discussions in the EIA process.

The EIA Report and Announcement on Public Discussion of EIA Report for the Construction of KhNPP Units 3 and 4 were entered into the Unified Environmental Impact Assessment Register (<http://eia.menr.gov.ua/places/view/2231>, case No. 201811232231 dated 26 November 2018) after the Law "On Environmental Impact Assessment" was put in force at the end of 2018. An agreement was concluded with the Ministry of Ecology and Natural Resources of Ukraine on the arrangement and conduct of public discussions at the end of 2018 (8 October 2018). Public hearings were held in Ukraine in eight regions and in Kyiv from 11 to 21 February 2019.

Upon the public discussion and transboundary consultations, the Ministry of Ecology and Natural Resources of Ukraine issued Conclusions on Environmental Impact Assessment of Planned Construction of Khmelnytsky NPP Units 3 and 4 No. 21/01-201811232231/1 on 1 October 2021, which were entered into the Unified EIA Register on 4 October 2021.

17.3. Re-evaluating as necessary all the above relevant factors to ensure the continued safety acceptability of a nuclear installation.

Article 33 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" requires the operator to periodically re-evaluate safety of a nuclear installation or a radioactive waste disposal facility according to NRS regulations, rules and standards and report its results to the SNRIU.

Safety re-evaluation is also performed upon request of the state nuclear regulatory body in case of substantial changes in the design of a nuclear installation or storage facility and if operating experience revealed deficiencies of the previous evaluation.

In order to maintain the safety level and implement corrective actions (if necessary) in a timely manner, re-evaluation of specific factors and nuclear installation site characteristics can be requested. Such re-evaluation may be necessary, in particular, in the following cases:

- a decision is made to place a new nuclear installation at the site (in Ukraine such re-evaluations were part of the state environmental review at ZNPP in connection with DSFSF construction and at KhNPP and RNPP in connection with the construction of KhNPP-2 and RNPP-);
- safety improvement programs are planned (environmental review was performed within the C(I)SIP as part of feasibility studies. The review resulted in positive findings. The main conclusion was that safety would be improved after implementation of the C(I)SIP at Ukrainian NPPs in full scope, which in due course would reduce the risk of incidents and accidents that can potentially affect the health of personnel and the public);
- new scientific findings that indicate the need to revise the design data on natural factors are obtained: surveys were conducted at RNPP to predict potential development of internal erosion and karst processes; seismic studies were conducted and continuous on-site seismic monitoring was implemented for all NPPs;
- negative trends of monitoring data (hydrogeological, engineering-geological, etc.) are revealed: for example, subsidence or sloping of buildings.

Environmental audits were performed at all NPPs in 2018. The audits involved experts who had certificates of environmental auditors issued by the Ministry of Ecology and Natural Resources of Ukraine. The following conclusions were made:

- no significant negative impact on the environment of the region was revealed in NPP operation;
- NPP activities fully comply with requirements of current legislation of Ukraine on environmental protection;
- measures taken at the facilities for environmental protection can be found efficient, comprehensive and justified, and nature protection activity of NPPs is efficient and sufficient;
- environment management system at the facilities under environmental audit is quite efficient and complies with the requirements of ISO 14001:2015.

17.4 Consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

According to the State Construction Standards of Ukraine, if planned activity may affect neighboring states, transboundary EIA shall be developed in compliance with the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) ratified by Ukraine on 19 March 1999.

Under Law of Ukraine No. 2861-IV dated 08 September 2005 “On Decision-Making Procedure for Siting, Design and Construction of Nuclear Installations and Radioactive Waste Management Facilities of National Importance”, reports on measures aimed at notification of neighboring states of a potential transboundary impact shall be developed for new nuclear installations and radwaste management facilities of national importance.

In 2008, the mass media published the Declaration of Intentions to build Khmelnytsky NPP Units 3 and 4.

In 2009-2011, feasibility studies were conducted for the construction of KhNPP Units 3 and 4, including EIA for consequences of transboundary releases under normal operation and in emergencies.

The comprehensive state review of the feasibility study for the construction of KhNPP Units 3 and 4 was conducted by the State Specialized Expert Review Organization (Central Service for Ukrainian State Civil Engineering Review) and resulted in positive conclusions.

According to the Espoo Convention, Energoatom developed “Notification of Planned Activities...”, which was submitted by the Ministry of Ecology and Natural Resources of Ukraine, national coordinator under the Convention, to the neighboring states that are considered potentially affected by the planned activities.

The notified countries confirmed their interest and intention to participate in the procedures of transboundary EIA.

Informational and Analytical Overview of the Feasibility Study for the Construction of KhNPP Units 3 and 4 was prepared to provide adequate information according to the Espoo Convention to the neighboring states, including environmental and engineering data and assessment of transboundary transfer consequences in normal operation and emergencies.

Transboundary consultations were conducted from 2011 to 2013. All questions, remarks and comments of representatives from neighboring countries (Republic of Poland, Republic of Belarus, Hungary, Republic of Moldova, Romania, Slovak Republic, and Republic Austria) were responded with justifications.

In August-September 2013, three expert consultations were held with representatives of state organizations from the Republic of Poland, Republic of Austria and Hungary on the implementation of Article 5 of the Espoo Convention related to the construction of Khmelnytsky NPP Units 3 and 4. Consultations with the Republic of Moldova, Slovak Republic, Romania and Republic of Belarus were conducted by correspondence.

The Cabinet of Ministers of Ukraine approved the feasibility study for the construction of KhNPP Units 3 and 4 by Resolution No. 498-r dated 4 July 2012. Law of Ukraine "On Siting, Design and Construction of Khmelnytsky Nuclear Power Plant Units 3 and 4" No. 5217-VI dated 6 September 2012 became effective on 4 October 2012.

Since the Russian party did not fulfil obligations under the Intergovernmental Agreement, which makes it impossible to construct power units in accordance with the proposed design and which is not acceptable for further review and implementation of the design, and taking into account military aggression of the Russian Federation against Ukraine, the Verkhovna Rada of Ukraine adopted Law of Ukraine No. 697-VIII in 2015 "On Invalidation of the Law of Ukraine On Siting, Design and Construction of Khmelnytsky Nuclear Power Plant Units 3 and 4" and Law of Ukraine No. 696-VIII "On Cancellation of the Agreement between the Cabinet of Ministers of Ukraine and the Government of the Russian Federation on Cooperation in Construction of Khmelnytsky NPP Units 3 and 4".

The Ukrainian party decided to continue the project "Construction of Khmelnytsky NPP Units 3 and 4" with replacement of the reactor supplier. In 2016, the feasibility study for the construction of Khmelnytsky NPP Units 3 and 4 was revised and further approved by the Cabinet of Ministers of Ukraine by Resolution No. 579 of 26 July 2018.

At the same time, a decision was made at the meeting of the Interdepartmental Coordination Council on the implementation of the Espoo Convention in Ukraine on 15 December 2016 to continue the transboundary consultations to complete KhNPP Units 3 and 4, which were initiated in accordance with the procedure established in the Espoo Convention. The interested parties of the Convention were informed about this decision by letter of the Ministry of Ecology and Natural Resources in April 2017. The Republic of Poland, Republic of Austria, and Republic of Belarus decided to continue transboundary consultations. Energoatom prepared updated information on the environmental impact assessment and submitted it to the Ministry of Ecology and Natural Resources of Ukraine in July 2017. In 2017-2018, these countries repeatedly submitted their requests, which received professional responses.

The EIA report for the planned construction of KhNPP Units 3 and 4, containing a section on transboundary impact (in English), was developed to complete the transboundary consultations, in compliance with the Law of Ukraine "On Environmental Impact Assessment". The Report was sent to the Republic of Poland, Republic of Austria and Republic of Belarus in accordance with the established procedure.

Public consultations took place in the Republic of Belarus and the Republic of Poland and expert consultations and public hearings in the Republic of Austria on the construction of Khmelnytsky NPP Units 3 and 4.

Transboundary consultations with the Republic of Poland were completed through bilateral consultations and signing a protocol on 22 May 2019.

Transboundary consultations with the Republic of Belarus were completed through bilateral consultations and signing a protocol on 16 May 2019.

Transboundary consultations with the Republic of Austria were completed through bilateral consultations and signing a protocol on 13 June 2019.

On 1 April 2021, the Ministry of Ecology and Natural Resources of Ukraine also informed the Slovak, Romanian, Moldovan and Hungarian Parties about the completion of the transboundary consultations. All four parties confirmed completion of the consultations on the proposed activities by letters.

Transboundary consultations with Romania were completed by correspondence. Romania presented its conclusions on the transboundary consultations by Letter No. DEICP/10081/21.04.2021 of 21 April 2021.

Transboundary consultations with the Republic of Moldova were completed by correspondence. The Republic of Moldova presented its conclusions on the transboundary consultations by Letter No. 12-12/2273-1 dated 30 June 2021,

Transboundary consultations with Hungary were completed by correspondence. Hungary presented its conclusions on the transboundary consultations by Letter No. KmF/82-13/2021 dated 13 September 2021.

Transboundary consultations with the Slovak Republic were completed by correspondence. The Slovak Republic presented its conclusions on the transboundary consultations by Letter No. 254/2021-1.7./zg51437/2021 dated 22 September 2021.

The decision to consider the results of the transboundary environmental impact assessment of planned activity "Construction of Khmelnytsky NPP Units 3 and 4" was approved at the meeting of the Interdepartmental Coordination Council for Implementing the Espoo Convention in Ukraine on 10 September 2021. The Ministry of Environmental Protection and Natural Resources of Ukraine approved the decision of the Interdepartmental Council by Order No. 598 dated 16 September 2021.

The Ministry of Ecology and Natural Resources of Ukraine issued Conclusions on EIA No. 21/01-201811232231/1 on 1 October 2021, which were entered into the Unified EIA Register on 4 October 2021.

In addition, to meet the decision of the Sixth Review Meeting of the Parties to the Espoo Convention, Ukraine implements the EIA procedure, including that in a transboundary context, at the RNPP site and plans to complete it by 2020. As of 1 June 2022, this activity has not been completed and is ongoing.

The procedure was started pursuant to Decision VI/2 of the Sixth Review Meeting of the Parties to the Convention and the minutes of meeting of the Interdepartmental Coordination Council on the implementation of the Espoo Convention in Ukraine on 15 December 2016, according to which Energoatom submitted an official notification on the intention to perform a safety review at RNPP Units 1 and 2 by 2020 and information on the timeframes for environmental impact assessment of four RNPP units to the Ministry of Ecology and Natural Resources of Ukraine in January 2018.

The EIA procedure for RNPP was started in accordance with Law of Ukraine "On Environmental Impact Assessment" No. 2059-VIII dated 23 May 2017 and in particular with requirements of the Espoo Convention.

In 2008, a report was prepared concerning measures aimed at notification of neighboring states of a potential transboundary impact from CSFSF, and corresponding consultations were held with the Republic of Belarus as the Party that could be potentially affected by the storage facility operation.

In 2009, the Cabinet of Ministers of Ukraine approved the feasibility study of investments into CSFSF construction, and the Verkhovna Rada of Ukraine adopted the Law of Ukraine on the CSFSF Siting, Design and Construction on 9 February 2012. In June 2017, Energoatom obtained SNRIU license for the construction and commissioning of the centralized spent fuel storage facility for national WWER NPPs. The license defines

the exclusion zone of the Chernobyl nuclear power plant as the construction site in accordance with Cabinet Resolution No. 721-r dated 5 October 2016.

After completion of the construction activities on 13 August 2021, a Certificate of the State Architectural and Construction Inspectorate on acceptance of "Construction of the Centralized Storage Facility for WWER Ukrainian NPPs. First Startup Stage" No. IU123210813290 was issued based on the Act of Storage Facility Readiness for Operation.

On 25 April 2022, the SNRIU issued Individual Permit Series OD No. EO 001060/1/15 to Energoatom for CSFSF commissioning.

Ukraine developed the necessary legislative and regulatory framework to ensure compliance with the justification principle of radiation-related activities. Extraordinary safety evaluations and re-evaluations of natural and man-made factors are carried out on a regular basis in accordance with the established procedure.

In siting and construction of new nuclear installations, legally imposed measures shall be taken to inform neighboring states of any potential impact in the transboundary context.

Therefore, Ukraine complies with the provisions of Convention Article 17.

ARTICLE 18 Design and Construction

Each Contracting Party shall take the appropriate steps to ensure that:

18.1. The design and construction of a nuclear installation provide for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur.

In 2008, regulation "General Safety Provisions for Nuclear Power Plants" NP 306.2.141-2008, taking into account IAEA recommendations set forth in the Basic Safety Principles for Nuclear Power Plants (INSAG-12), came into force. Regulation NP 306.2.141-2008 establishes safety criteria, fundamental and organizational and engineering safety principles and requirements for the defense-in-depth strategy based on five levels relying on:

- successive physical barriers to the spread of radiation and radioactive substances to the environment;
- engineering and organizational measures aimed at protecting the physical barriers and maintaining their effectiveness.

After the adoption of this and other safety regulations, the designs of operating NPPs in Ukraine were revised for compliance with the established requirements. Corrective actions were developed and implemented for the identified deficiencies. NPP upgrading and reconstruction projects are developed in accordance with the new safety regulations.

The technical and organizational measures incorporated in the design are intended to prevent any damage of physical safety barriers, strengthen defense-in-depth levels, prevent limits and conditions of safe operation and design-basis accidents from being violated, mitigate consequences and ensure safety in case of any design-basis initiating event.

The power units considering all implemented safety improvement measures are regarded as the NPP design.

Based on the results of the Joint EC-IAEA-Ukraine Project on comprehensive design safety assessment of NPPs, the team of international experts confirmed that no inconsistencies with IAEA requirements were found at Ukrainian NPPs.

18.2 The technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis.

Pursuant to the regulatory document "General Safety Provisions for Nuclear Power Plants" (NP 306.2.141-2008), technical and organizational decisions made to upgrade and improve the safety level incorporate scientific and technical achievements and are implemented in accordance with the established requirements, namely: they shall be proven by experience or trial operation. The requirements for upgrading are defined by the SNRIU regulation "Requirements for Modifications of Nuclear Installations and Their Safety Assessment Procedure" NP 306.2.106-2005.

According to NRS regulations and standards, the licensing procedure provides for introduction of a technology first at a pilot unit and then, after favorable results of trial operation, for its adaptation to other units.

Following the IAEA full-scope Integrated Regulatory Review Service (IRRS) mission, international experts identified a good practice: "application of the pilot approach concept to obtain permission for similar modifications at several plants is efficient if appropriate attention is given to plant differences".

18.3 The design of a nuclear installation allows for reliable, stable and easy manageable operation, with specific consideration of human factors and the man-machine interface.

According to new safety regulations, the NPP modification and upgrading projects are developed with account of human factor and introduction of systems and hardware for diagnostics of operational modes and conditions, including self-diagnostics of hardware and software.

The design envisages informational support system of the operator, as a part of NPP instrumentation and control system, including also a system displaying integrated information on the current safety status of the reactor and plant unit in general.

The I&C incorporated in the design and implemented at the units ensure the most favorable conditions for the operators to make correct decisions on NPP control, minimize the number of erroneous decisions, as well as to ensure collection, processing, documentation and storage of appropriate data sufficient for prompt and reliable identification of initiating, their evolution, determination of the actual operation mode of safety systems and components important to safety (especially those of safety classes 1 and 2) and deviations from standard algorithms of personnel actions. Measures are under way to preserve this information in beyond design basis accident conditions.

Therefore, Ukraine complies with the provisions of Convention Article 18.

ARTICLE 19 Operation

19.1 Each Contracting Party shall take the appropriate steps to ensure that the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning program demonstrating that the installation, as constructed, is consistent with design and safety requirements.

The legal grounds for the licensing process for operation of a nuclear installation at a specific life stage are determined by the Laws of Ukraine "On Nuclear Energy Use and Radiation Safety" and "On Licensing Activity in Nuclear Energy" and are specified in the regulation "General Safety Provisions for Nuclear Power Plants" (NP 306.2.141-2008).

The list of documents to be submitted with the operator's application for obtaining a license at an individual life stage of a nuclear installation is defined in the regulation "Provisions on the List of Documents Submitted by the Operating Organization to Obtain a License for Activities at an Individual Life Stage of a Nuclear Installation", approved by SNRIU Order No. 12 of 28 January 2015.

The license granted to the operator for a specific life stage determines activities or operations that may be conducted in construction, commissioning and operation only under a written permit issued by the state nuclear regulatory body. The terms and procedure for issuing such permits are determined by the state nuclear regulatory body and specified in the regulation "Conditions and Procedure for Issuing Individual Written Permits for Activities or Operations at Commissioning, Operation and Decommissioning Stages of Nuclear Installations", approved by SNRIU Order No. 38 of 27 February 2004.

19.2 Operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation.

The main document defining safe operation of NPP units is technical specifications for safe operation, which defines the limits and conditions of safe operation as well as requirements, methods and general procedure for operations associated with NPP safety.

The technical specifications for safe operation are based on the plant design, SAR, and technical documentation for equipment.

The limits and conditions of safe operation are continuously monitored and specified through operating experience analysis, evaluation of the current safety level and new scientific and technical information, as well as in case of equipment modifications and introduction of new systems, in accordance with regulatory requirements.

The technical specifications for safe operation and other operational documents are amended when necessary, on a permanent basis. Operational documentation is subject to revision every three years.

19.3 Operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures.

Operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with the approved technical specifications for safe operation, operating and inspection procedures.

To ensure compliance of safety-related systems with the design requirements, regular maintenance and inspection activities are carried out. These activities are arranged according to the procedures, programs and schedules and are carefully documented. Conditions for maintenance, repair and inspection of safety systems are established in the SAR and respective specifications. Administrative and technical measures are determined

to prevent possible unauthorized changes in circuits, instrumentation and algorithms of the control safety systems. After maintenance, the systems and equipment are verified for operability and compliance with the design characteristics, the results being recorded.

Operability of safety systems, safety-related systems, monitoring and control systems and condition of the base metal and welds of safety-related systems and components are inspected prior to NPP startup after refueling outage and periodically according to the technical specifications for safe operation and operating procedures. The frequency and scope of periodic inspections are determined in the design and established by NPP schedules. Unscheduled inspections can be conducted upon request of the regulatory body.

As of 1 April 2019, repeated corporate WANO peer review of Energoatom and repeated peer reviews at KhNPP and PNPP were performed. SNRIU conducted scheduled inspections. In the period from 1 June 2019 to 1 June 2022, WANO peer reviews were conducted at KhNPP, RNPP and ZNPP.

In addition, Energoatom conducts internal inspections according to the approved programs such as standard program for NPP nuclear safety verification, program for safety culture review, etc. Following internal inspections, corrective actions are developed and implemented to eliminate the deficiencies in operational safety.

Energoatom submits the results of internal operational safety inspections and periodic safety review reports to the regulatory body.

19.4 Procedures are established for responding to anticipated operational occurrences and to accidents.

Currently, the following Energoatom documents define emergency response actions for events and accidents that may occur in NPP operation:

- procedures for mitigation of reactor abnormal operation;
- reactor emergency operating procedures (EOPs);
- SAMGs;
- emergency response plan of Energoatom Headquarters;
- standard emergency response plan for Ukrainian NPPs and NPP response plans based on the standard plan.

Peer reviews of all Energoatom NPPs were performed to familiarize with and generalize operating experience, exchange information of solving challenging issues, familiarize, check and assess efficiency of organizational and technical measures performed by NPPs regarding EOPs during their support from 2010. The reports with peer review results were submitted to NPPs to be used in operation. Results of peer reviews confirmed their efficiency, so they are planned for the future as well.

According to SNRIU Board Resolution No. 13 dated 24-25 November 2011 "On Results of Targeted Safety Reassessment of Operating NPPs and ZNPP Dry Spent Fuel Storage Facility in the Light of the Fukushima Daiichi Accident", the operator already took measures within the C(I)SIP to develop EOPs for low power and shutdown states and developed SAMGs for full power and shutdown for all NPP units.

SAMGs for reactor operation at full power and SFP were implemented for pilot units PNPP-1, ZNPP-1 and RNPP-1 in 2014. In 2015-2016, SAMGs for reactor shutdown state and SFP were implemented for pilot units PNPP-1, ZNPP-1, and RNPP-1.

SAMG development and implementation for all other Ukrainian NPPs was completed in 2017.

In 2021, the SNRIU developed and introduced the regulation "Requirements for Emergency Documents for Nuclear Power Plants", approved by SNRIU Order 290 of 27 May 2021, to establish requirements for NPP emergency documents.

Provisions on the Use of a Package of Severe Accident Management Guidelines, VL-D.0.41.630-16, and other documents governing the application and maintenance of emergency documents were additionally developed.

19.5 Necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation.

Engineering support of nuclear installations is provided by the corresponding Energoatom departments, Ukrainian and foreign institutes and expert organizations.

Engineering support activities are performed by Ukrainian design institutes, scientific organizations and establishments of the National Academy of Sciences of Ukraine and other countries (including those involved in NPP design).

Engineering support within Energoatom is provided by the dedicated engineering departments established at each NPP; industry-level tasks are performed by Energoatom departments and the Scientific and Technical Centre.

Responsibilities and activities are distributed according to the administrative documents that identify responsibilities, interactions, and organization of the activities.

Engineering support covers the following areas:

- NPP safety analysis;
- implementation of new technologies;
- ageing management;
- equipment qualification;
- radiological materials science;
- strength and resistance of systems, structures, and components;
- reactor core operation;
- radwaste and spent fuel management.

19.6 Incidents significant to safety are reported in a timely manner by the holder of the relevant license to the regulatory body.

In 2022, the SNRIU developed and introduce new regulation NP 306.2.235-2021 "Provisions on the Investigation and Accounting of Operational Events at Nuclear Power Plants", whose classifier contains 23 categories of operational events, to replace NP 306.2.100-2004 "Provisions on the Procedure for Investigation and Accounting of Operational Events at Nuclear Power Plants".

In accordance with the national requirements and recommendations related to the investigation and recording of NPP operational occurrences (operational events since 2022), the operator:

- developed a system for accumulation, analysis and feedback of operating experience;
- is responsible for the adequacy and quality of investigations, reliability and timely submission of the investigation results for NPP operational events to the SNRIU;
- takes measures to prevent safety-significant events, in particular failures of equipment and human errors and improve the operating procedures, methods and means for diagnostics of equipment, systems and components important to safety.

In turn, the SNRIU verifies compliance with the safety rules and regulations during the investigation and analysis of NPP operational events and planning and inspections based on the experience gained from investigation of operational events, in compliance with national NRS standards, provisions of 2014/87/Euratom Council Directive, respective reference levels of the Western European Nuclear Regulators Association (WENRA) and

IAEA recommendations (in particular, SSG-50 Operating Experience Feedback for Nuclear Installations). The SNRIU pays special attention to the following issues in the investigation of NPP operational events by the operator:

- arrangements for investigation of operational occurrences (operational events since 2022) and adequate recording of investigation results;
- correct and timely classification of operational occurrences (operational events since 2022) depending on their features and consequences;
- correct definition of root causes of operational occurrences (operational events since 2022) and identification of corrective measures to exclude the recurrence of similar operational occurrences (operational events since 2022) in the future;
- monitoring over completeness and timeliness of corrective measures identified upon investigation.

In 2016, 12 operational events occurred at Ukrainian NPPs.

In 2017, 16 operational events occurred at Ukrainian NPPs.

In 2018, 22 operational events occurred at Ukrainian NPPs and violation of safe operation conditions occurred for the first time since 2004, when ZNPP personnel did not check the operability of safety system trains 1 and 3 at Unit 4 after they found that safety system 2 was inoperable during scheduled test.

In 2019, there were 13 NPP operational events, one of which was rated at level 1 on the INES scale.

In 2020, there were 13 NPP operational events, one of which was rated at level 1 on the INES scale.

In 2021, there were 16 NPP operational events, one of which was rated at level 1 on the INES scale.

In the first half of 2022, there were 10 NPP operational events, one of which was rated at level 3 on the INES scale and involved decrease in power of ZNPP Units 2 and 3 with their subsequent shutdown and outage of ZNPP Unit 6 into emergency maintenance in connection with shelling of the ZNPP units and site by the Russian soldiers.

19.7 Programs to collect and analyze operating experience are established, the results obtained and the conclusions drawn are acted upon and existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies.

The operator provides collection, processing, analysis and storage of information on equipment failures and human errors, ensures systematization and prompt transfer of the information obtained. The information on equipment failures and human errors is included into the annual safety status reports.

Safe operation of NPPs is supported by the information event database being a part of the unified information system of the operator: information system on operational events at Ukrainian NPPs.

Energoatom implemented programs for operating experience exchange:

- Ukrainian reliability database (for engineering support of the equipment rejection system and determination of reliability characteristics of safety-related systems and components);
- Information system on operational events (for collection, processing, analysis and storage of data on equipment failures and human errors);
- System for assessment of operational safety and technical condition of WWER NPPs (for development of reports on NPP performance indicators and current safety state of power units).

Operating experience, both internal and external, is thoroughly analyzed. There are special divisions dealing with these aspects within the Energoatom Headquarters and at each NPP.

Notifications on significant events at Ukrainian NPPs are promptly submitted to the IAEA and WANO within the operating experience exchange programs. Similarly, the Ukrainian operator receives information about significant events at NPPs worldwide from the IAEA and WANO.

Appropriate contacts are maintained with the plant design institutions, research organizations, and equipment manufacturers to bring the operating experience to their knowledge and to receive their recommendations, if necessary.

The operator developed and implemented company standard SOU NAEK 035:2013 "System for Accumulation, Analysis and Application of Operating Experience" that sets forth general requirements for effective functioning of the Ukrainian and worldwide NPP operating experience feedback system. The standard contains general requirements for implementation of all activities ensuring effective performance of the system for operating experience accumulation, analysis and application (feedback).

According to this standard, the Methodological Guidance for Self-Assessing the Effectiveness of the System for Accumulation, Analysis and Application (Feedback) of Operating Experience was developed for the operator to perform annual self-assessment of the system for accumulation, analysis and application (feedback) of operating experience.

IAEA experts conducted PROSPER mission related to NPP operating experience on the initiative of the operator in 2018. IAEA experts noted that the Ukrainian operator sought to improve operational safety through operating experience feedback, as evidenced by the development of culture for considering low-level events and consistent promotion of operating experience feedback in NPP daily operations.

In the reporting period, Ukraine actively participated in all meetings and workgroups of the WWER Regulators' Forum and exchanged information on WWER operating experience.

19.8 The generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

Each NPP is provided with process systems and facilities for collection and primary treatment of solid and liquid radioactive waste on the NPP site. NPP management keeps records of the amounts, transfer, and location of all radioactive materials, including nuclear fuel, dismantled equipment, contaminated tools, clothes, radwaste and other radiation sources.

The Energoatom Comprehensive Radioactive Waste Management Program for 2017–2021 was developed in 2016 and is under implementation to improve the technical policy in radwaste management, determine and allocate funds for implementation of the first-priority radwaste management measures and monitor their implementation. The Comprehensive Program defines the main areas of radwaste management activities at Energoatom to ensure the safe performance and improvement of the radwaste management system, priority of measures, stages of their implementation, cost of activities, distribution of financial resources and responsibility for the implementation of measures.

In 2021, Energoatom Comprehensive Radioactive Waste Management Program PM-D.0.18.174-16 was revised and updated Energoatom Comprehensive Radioactive

Waste Management Program PM-D.0.18.174-21 was developed for the next period (2022-2026).

In the framework of the Energoatom Comprehensive Radioactive Waste Management Program, technical measures for the development of complex radioactive waste processing and conditioning lines, implementation of individual radioactive waste management facilities for radwaste retrieval, decontamination of radioactive metal and implementation of advanced technologies for radwaste waste conditioning are planned and implemented.

Special attention is paid to the construction and commissioning of radioactive waste treatment plants (RWTP). The introduction of radwaste treatment plants into commercial operation at ZNPP and RNPP in 2019 allowed radwaste to be treated and conditioned to reduce the volumes of their transfer to storage facilities and ensured organized solid waste storage and prepare conditioned radwaste for further transfer for long-term storage or disposal. Most of low-level solid radwaste (LLW) generated in the reporting period was treated at RWTPs. In addition, solid radwaste was extracted with further treatment at compaction and incineration facilities during this period. As a result of these activities, the indicator showing the arrival of radwaste to the ZNPP storages turned out to be negative (more waste was retrieved than received) and thus the total amount of radwaste in the ZNPP storage facilities decreased. At the RNPP, the transfer of LLW to storages decreased by approximately a factor of 1.5–2 compared to its generation. The implementation of RWTPs at KhNPP and PNPP is ongoing.

One of the priority areas for radioactive waste management defined in the Comprehensive Program is to ensure a minimum level of radioactive waste generation in NPP operation. Industry measures and NPP activities to minimize radioactive waste generation are planned and implemented; the most efficient measures are limitation of generation, advanced decontamination technologies, improved work planning in the strict access area and measures determined upon analysis of generation sources and amounts of radioactive media, liquid and solid radwaste, etc.

As part of international assistance project U4.01/14A "Specification of waste forms to allow safe treatment, storage and disposal of problematic radioactive wastes held at Ukrainian nuclear energy facilities", an analysis of the physical and chemical properties and radiochemical analysis of samples were performed, as well as justification of representativeness for samples and calculation of radionuclide vectors for 3 selected problematic radwaste flows: salt melt (ZNPP, RNPP, KhNPP), solid salt deposits (PNPP), spent filtering materials and sludge (all NPPs). Recommendations were made for further management of the mentioned radwaste flows.

In compliance with the requirements of the Law of Ukraine "On Radioactive Waste Management" and in accordance with the Strategy for the Management of Radioactive Waste in Ukraine, NPP radwaste was transferred in the reporting period, namely, the first batch of 60 containers with RNPP salt bitumen compound was transferred for processing and disposal in the Centralized Radwaste Management Enterprise (CRME).

The strategic task for the management of spent fuel implemented at Energoatom is to fundamentally change the existing spent fuel management approach, which is oriented towards the transport of spent fuel for process storage and reprocessing to Russian plants, through the construction and commissioning of the Ukrainian storage facility, CSFSF, for dry spent fuel from RNPP, KhNPP and PNPP. CSFSF and DSFSF, which has been in operation since 2001 at the ZNPP site, shall become a single spent fuel treatment system for the national WWER NPPs. The decision on further management of spent fuel in the long term (reprocessing and disposal of reprocessing waste or disposal of spent fuel in a

geological repository) will be made considering international experience after expiration of the period for spent fuel storage in the existing dry storage facility and the dry storage facility under construction.

The construction of infrastructure for long-term storage of vitrified high-level waste resulting from the reprocessing of WWER-440 spent fuel to be returned to Ukraine from Russian Federation is envisaged at the Vektor site. In connection with the Russian military aggression against Ukraine, the resolution of this issue has been suspended.

Detailed information on NPP radwaste management is provided in the Seventh National Report of Ukraine under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, presented by Ukraine at the Seventh Review Meeting of the Contracting Parties in July 2022 in Vienna (Austria).

Therefore, Ukraine complies with the provisions of Convention Article 19.

ANNEX 1 List of Ukrainian NPPs

1. Power Units in Operation

NPP	Unit No.	Electrical Power, MW	Reactor Type	End of Design-Basis Life/Long-Term Operation
Zaporizhzhya	1	1000	B-320	23.12.2015/23.12.2025
	2	1000	B-320	19.02.2016/19.02.2026
	3	1000	B-320	05.03.2017/05.03.2027
	4	1000	B-320	04.04.2018/04.04.2028
	5	1000	B-320	27.05.2020/27.05.2030
	6	1000	B-320	21.10.2026
Pivdennoukrain sk	1	1000	B-302	02.12.2013/02.12.2023
	2	1000	B-338	12.05.2015/31.12.2025
	3	1000	B-320	10.02.2020/10.02.2030
Rivne	1	420	B-213	22.12.2010/22.12.2030
	2	415	B-213	22.12.2011/22.12.2031
	3	1000	B-320	11.12.2017/11.12.2037
	4	1000	B-320	07.06.2035
Khmelnysky	1	1000	B-320	13.12.2018/13.12.2028
	2	1000	B-320	07.09.2035

2. Power Units to Be Completed and Commissioned

NPP	Unit No.	Electrical Power, MW	Commissioning Date (as Scheduled)
Khmelnysky	3	1000	Basic design efforts are under way
	4	1000	

ANNEX 2 Analysis on Implementation of IAEA Recommendations within Safety Improvement Programs

2.1 Implementation of IAEA Recommendations Provided in the Reports:

Safety Issues and Their Ranking for WWER-1000 Model 320 Nuclear Power Plants, IAEA-EBP-WWER-05;
 Safety Issues and Their Ranking for Small Series WWER 1000 Nuclear Power Plants, IAEA-EBP-WWER-14;
 Safety Issues and Their Ranking for WWER-440 Model 213 Nuclear Power Plants, IAEA-EBP-WWER-03.

Most of the safety recommendations identified in the Reports have been implemented. The remaining activities are incorporated into the existing safety improvement program.

Information on the status of recommendations for rank III safety issues (issues of high safety concern) at NPPs is provided below.

2.1.1 WWER-1000/V-320 Nuclear Power Plants

Nine of the eleven recommendations have been implemented. The remaining two recommendations are being resolved under the Comprehensive (Integrated) Safety Improvement Program (C(I)SIP):

Issue No.	Title	Rank	Status	Comments
G2	Equipment qualification	III	Ongoing	The effort is ongoing under C(I)SIP measure 10101. Completed for all units except for ZNPP-6 (deadline - 2022).
S9	Qualification of steam generator pilot-operated relief valves and BRU-A (steam dump valve to atmosphere) for water and steam-water discharge	III	Ongoing	Steam generator pilot-operated relief valves have been replaced at all V-320 units. Qualification of steam dump valve drives has been completed under C(I)SIP measure 13302 at all NPP units except for ZNPP-6. To be completed at ZNPP-6 in 2023.

2.1.2 WWER-1000/V-302, V-338 Nuclear Power Plants

Implementation status as of 1 June 2022: all 12 recommendations have been implemented at PNPP-1, 2.

2.1.3 WWER-440/V-213 Nuclear Power Plants

Implementation status as of 1 June 2022: all 8 recommendations have been implemented at RNPP-1, 2.

2.2 Status of IAEA Recommendations Provided in the Final EC/IAEA/Ukraine Report (Design Safety)

The design safety assessment demonstrates that all Ukrainian NPPs fully comply with most of the 192 safety requirements set forth by the IAEA for plant design.

Five generic areas in which IAEA requirements are partially met are identified. These areas include equipment qualification, consideration of severe accidents, confirmation of seismic margin, completeness of probabilistic safety analysis and complementary safety analyses, instrumentation and control, and post-accident monitoring equipment.

Effective work is in progress to eliminate the incompliance at all power units within the Comprehensive (Integrated) Safety Improvement Program for Nuclear Power Plants.

The status of activities aimed at implementing the IAEA recommendations at NPPs is shown below.

Measure code	Title	Status	Deadline
WWER-1000/V-320			
10101	Development of documents and qualification of NPP components	Ongoing	The effort is ongoing under C(I)SIP measure 10101. The measure has been completed for all units except for ZNPP-6. To be completed at ZNPP-6 in 2023.
14101	Accident and post-accident instrumentation (PAMS)	Completed	As of 1 June 2022: The effort has been completed under C(I)SIP measure 14101 for all power units.

Measure code	Title	Status	Deadline
16201	Introduction of containment hydrogen control system for beyond-design basic accidents	Completed	As of 1 June 2022: The effort has been completed for all power units.
18101	Seismic resistance of systems and structures	Ongoing	<p>The effort is ongoing under C(I)SIP measure 18101.</p> <p>The effort is divided into two stages: Stage I – conservatively, without results of seismic monitoring; Stage II – after obtaining seismic monitoring results.</p> <p>As of 1 June 2022: The measure has been fully completed for PNPP-3 and ZNPP-1-5. The measure has been completed in the scope of Stage I for ZNPP-6, RNPP-3, 4 and KhNPP-1,2. The measure is to be completed considering seismic monitoring results for ZNPP-6 in 2023 and for other units in 2025.</p>
19101	Development of full-scope SAR in compliance with regulatory requirements	Completed	
19202	Development, technical justification, validation and introduction of symptom-oriented EOPs to manage design and beyond-design basis accidents	Completed	
19203	Improvement of emergency operating procedures for low power and shutdown states	Completed	

Measure code	Title	Status	Deadline
19204	Severe accident analysis. Development of SAMGs	Completed	As of 1 June 2019: the measure has been completed for all power units.
WWER-1000/V-302-338			
20101	Development of documents and qualification of NPP components	Completed	The effort has been completed under C(I)SIP measure 20101.
22201	Prevention of consequences induced by secondary piping rupture outside containment	Completed	The effort has been completed under C(I)SIP measure 22201.
24101	Accident and post-accident instrumentation (PAMS)	Completed	As of 1 June 2022: the measure has been completed for both power units.
26201	Introduction of containment hydrogen control system for beyond-design basic accidents	Completed	As of 1 June 2022: the measure has been completed for both power units.
28101	Seismic resistance of systems and structures	Completed	The effort has been completed under C(I)SIP measure 28101.
29101	Development of full-scope SAR in compliance with regulatory requirements	Completed	The effort has been completed under C(I)SIP measure 29101.
29204	Severe accident analysis. Development of SAMGs	Completed	The effort has been completed under C(I)SIP measure 29204.
WWER-440/V-213			
30101	Development of documents and qualification of NPP components	Completed	
33503	«Habitability of main control room and emergency control room in design and beyond-design basis accidents (installation of iodine filters)	Completed	
34101	Accident and post-accident instrumentation (PAMS)	Completed	As of 1 June 2022: the measure has been completed for both power units.
34408	Introduction of hydrogen control system in steam generator and reactor coolant pump box (A201) and pressurizer compartment (A527/1)	Completed	As of 1 April 2019: to be completed at RNPP-1. As of 1 June 2022: the measure has been completed for both power units.

Measure code	Title	Status	Deadline
38101	Seismic resistance of systems and structures	Ongoing	The effort is ongoing under C(I)SIP measure 38101. As of 1 June 2022: to be completed at RNPP-1,2 in 2025.
39101	Development of full-scope SAR in compliance with regulatory requirements	Completed	
39204	Severe accident analysis. Development of SAMGs	Completed	

ANNEX 3 List of Legislative and Regulatory Documents on Nuclear Energy Use Implemented in 2019-2022

Laws

1. Law of Ukraine No. 107-IX dated 18 September 2019 “On Amendment of Some Laws of Ukraine in the Area of Nuclear Energy”.
2. Law of Ukraine No. 613-IX dated 19 May 2020 “On Amendment of Some Laws of Ukraine on the Safety of Nuclear Energy”.

Resolutions of the Cabinet of Ministers of Ukraine

1. Cabinet Resolution No. 273 dated 3 April 2019 “On Amendment of the Procedures Approved by Cabinet Resolutions No. 1471 of 25 December 1997 and No. 625 of 26 April 2003”.
2. Cabinet Resolution No. 270 dated 3 April 2019 “On Amendment of Item 4 in the Statute on the State Nuclear Regulatory Inspectorate of Ukraine”.
3. Cabinet Resolution No. 759 dated 21 August 2019 “On Amendment of the Procedure for Issuing Permits for International Shipments of Radioactive Materials”.
4. Cabinet Resolution No. 652 dated 29 July 2020 “On Amendment of the Statute of the State Nuclear Regulatory Inspectorate of Ukraine”.
5. Cabinet Resolution No. 803 dated 9 September 2020 “On Amendment of Cabinet Resolutions No. 440 of 6 May 2001 and No. 591 of 1 June 2011”.
6. Cabinet Resolution No. 1141 dated 18 November 2020 “Some Issues in Establishing a Unified State System for Control and Accounting of Individual Doses”.
7. Resolution 1643-r dated 28 December 2020 “On Signature of the Agreement between the European Bank for Reconstruction and Development (as Administrator of Grant Funds from the Nuclear Safety Account), Cabinet of Ministers of Ukraine and State Nuclear Regulatory Inspectorate of Ukraine (as Recipient) on Amendment No. 3 to the Grant Agreement (Chornobyl Nuclear Safety Project) between the European Bank for Reconstruction and Development (as Administrator of Grant Funds from the Nuclear Safety Account), Cabinet of Ministers of Ukraine and State Nuclear Regulatory Inspectorate of Ukraine (as Recipient)”.
8. Cabinet Resolution No. 773 dated 28 July 2021 “On Amendment of Item 6 of the Technical Regulation of Packaging for Storage and Disposal of Radioactive Waste”.
9. Cabinet Resolution No. 949 dated 1 September 2021 “On Amendment of Cabinet Resolution No. 1718 of 16 November 2000”.
10. Cabinet Resolution No. 1075-r dated 8 September 2021 “On Establishment of Commission for Coordinating the Actions of Participants in the State Plan for Interaction

of Central and Local Executive Bodies in the Event of Sabotage in Relation to Nuclear Installations, Nuclear Materials and Other Radiation Sources in Their Use, Storage or Transport and Radioactive Waste in Its Management”.

SNRIU Orders

1. SNRIU Order No. 269 dated 21.06.2019 “On Approval of Safety Requirements for Nuclear Fuel Management”, registered in the Ministry of Justice on 30.07.2019 by No. 833/33804.

2. SNRIU Order No. 526 dated 05.12.2019 “On Approval of Form for Documents Prepared in State Oversight Measures in the Area of Nuclear Energy”, registered in the Ministry of Justice on 21.12.2019 by No. 1268/34239.

3. SNRIU Order No. 508 dated 25.11.2019 “On Amendment of Requirements for Instrumentation and Control Systems Important to Safety of Nuclear Power Plants”, registered in the Ministry of Justice on 24.12.2019 by No. 1280/34251.

4. SNRIU Order No. 520 dated 02.12.2019 “On Approval of Requirements for the Structure and Contents of the Safety Analysis Report for Surface and Near-Surface Radioactive Waste Disposal Facilities”, registered in the Ministry of Justice on 21.01.2020 by No. 64/34347.

5. SNRIU Order No. 57 dated 14.02.2020 “On Approval of Provisions on the Functional Subsystem of Nuclear and Radiation Safety of the Unified State Civil Protection System”, registered in the Ministry of Justice on 13.04.2020 by No. 340/34623.

6. SNRIU Order No. 249 dated 10.06.2020 “On Approval of Requirements for the Safety Analysis Report for Radioactive Waste Treatment Facilities”, registered in the Ministry of Justice on 14.08.2020 by No. 788/35071.

7. SNRIU Order No. 342 dated 18.06.2020 “On Amendment of the Procedure for Radiation Safety Training and Examination of Personnel and Officials of Entities Dealing with Individual Nuclear Energy Activities”, registered in the Ministry of Justice on 07.09.2020 by No. 854/35137.

8. SNRIU Order No. 317 dated 03.08.2020 “On Approval of Methodology for Evaluating Activities to Ensure the Rights of Persons with Disabilities at the State Nuclear Regulatory Inspectorate of Ukraine and Enterprises under the Sphere of Its Management”, registered in the Ministry of Justice on 07.09.2020 by No. 856/35139.

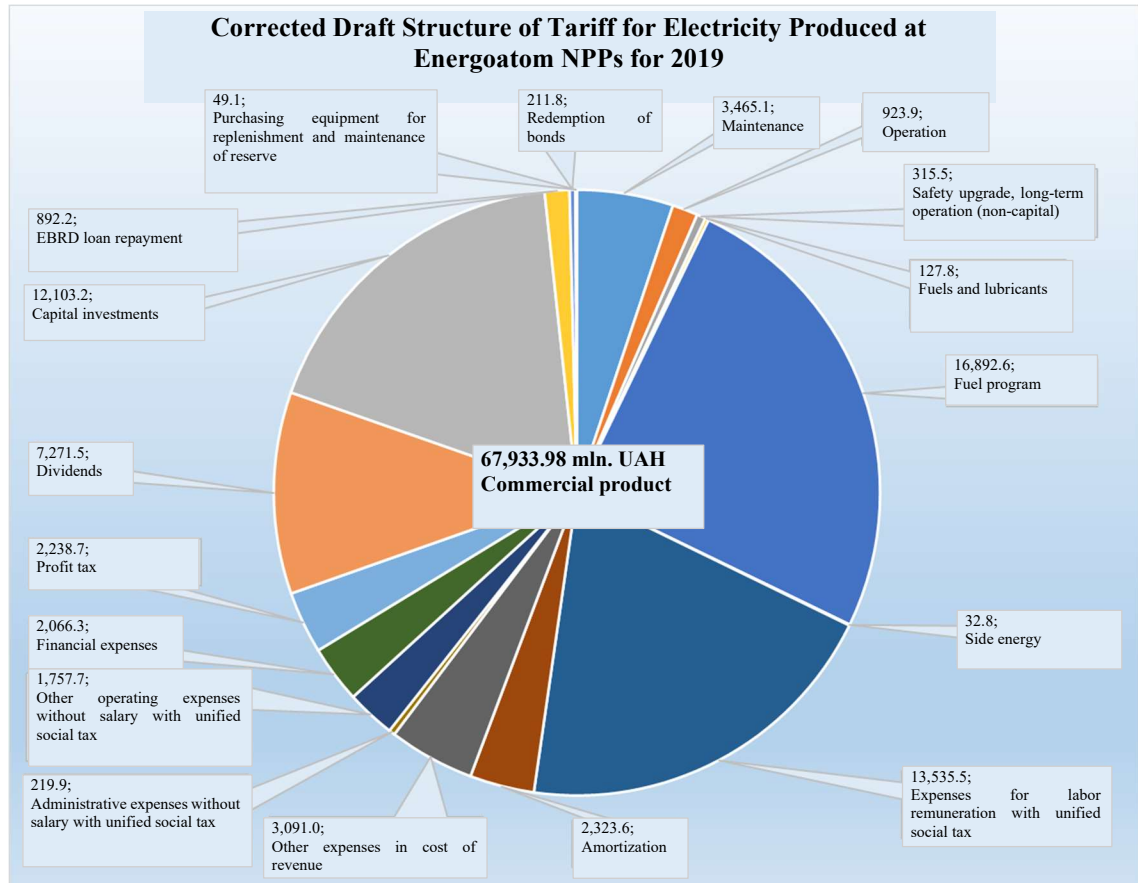
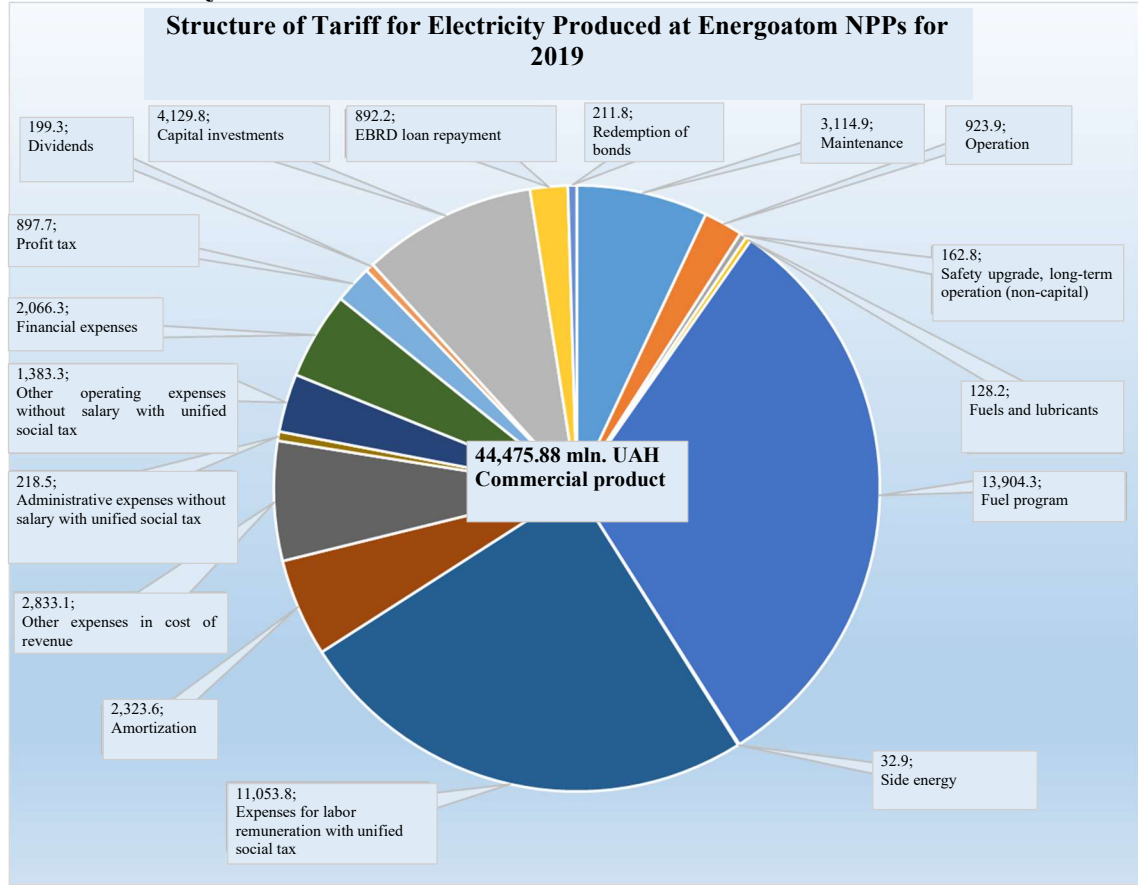
9. SNRIU Order No. 319 dated 04.08.2020 “On Approval of General Safety Requirements for the Design and Operation of Equipment and Piping of Nuclear Power Plants”, registered in the Ministry of Justice on 30.09.2020 by No. 955/35238.

10. SNRIU Order No. 320 dated 04.08.2020 “On Approval of Standard Document Form”, registered in the Ministry of Justice on 02.10.2020 by No. 968/35251.

11. SNRIU Order No. 440 dated 28.10.2020 “On Approval of General Safety Provisions for Decommissioning of Nuclear Installations”, registered in the Ministry of Justice on 30.12.2020 by No. 1311/35594.
12. SNRIU Order No. 436 dated 27.10.2020 “On Approval of Rules for Safe Transfer of Radioactive Materials (PBPRM-2020)”, registered in the Ministry of Justice on 30.12.2020 by No. 1313/35596.
13. SNRIU Order No. 439 dated 28.10.2020 “On Amendment of Some Regulations on Uranium Ore Mining and Processing”, registered in the Ministry of Justice on 04.02.2021 by No. 154/35776.
14. SNRIU Order No. 535 dated 18.12.2020 “On Approval of General Radiation Safety Provisions for Uranium Ore Mining and Processing”, registered in the Ministry of Justice on 12.02.2021 by No. 184/35806.
15. SNRIU Order No. 263 dated 30.04.2021 “On Approval of Requirements for Safety Assessment of Nuclear Power Plants in External Natural Hazards”, registered in the Ministry of Justice on 20.05.2021 by No. 670/36292.
16. SNRIU Order No. 313 dated 27.05.2021 “On Approval of Some Regulations of the State Nuclear Regulatory Inspectorate of Ukraine on Physical Protection”, registered in the Ministry of Justice on 15.06.2021 by No. 798/36420.
17. SNRIU Order No. 290 dated 17.05.2021 “On Approval of Requirements for Emergency Documents for Nuclear Power Plants”, registered in the Ministry of Justice on 30.06.2021 by No. 864/36486.
18. SNRIU Order No. 312 dated 27.05.2021 “On Approval of the Amount of Actual Costs for Copying or Printing Documents Provided upon Request for Information Administered by the State Nuclear Regulatory Inspectorate of Ukraine and the Procedure for Reimbursement of These Costs and Amendments to SNRIU Order No. 121 of 12 August 2011”, registered in the Ministry of Justice on 23.07.2021 by No. 954/36576 and 955/36577.
19. SNRIU Order No. 411 dated 12.07.2021 “On Approval of Provisions on the Procedure for Investigation and Accounting of Operational Events at Nuclear Power Plants”, registered in the Ministry of Justice on 08.09.2021 by No. 1182/36804.
20. SNRIU Order No. 570 dated 30.08.2021 “On Approval of the Procedure for Review of Appeals, Personal Reception of Citizens and Telephone Hotline at the State Nuclear Regulatory Inspectorate of Ukraine”, registered in the Ministry of Justice on 01.10.2021 by No. 1290/36912.
21. SNRIU Order No. 223 dated 22.03.2022 “On Approval of Requirements for Cyber Protection of Instrumentation and Control Systems of Nuclear Power Plants for Nuclear and Radiation Safety”, registered in the Ministry of Justice on 07.04.2022 by No. 395/37731.

ANNEX 4 Structure of Energoatom Electricity Tariff

Prior to 1 July 2019:



Since 1 July 2019, Energoatom sells and buys electrical energy in accordance with the Law of Ukraine "On the Electricity Market", which is close to European standards.

The state has ceased to be the only buyer and seller of electricity and the market has transferred to a competitive mechanism that provides the sale of electricity both through organized electronic tenders and under bilateral agreements between producers and consumers, suppliers.

The price for Energoatom electricity is currently formed in various market segments in accordance with the concluded contracts or conducted tenders, taking into account special obligations in accordance with Resolution of the Cabinet of Ministers No. 483 of 5 June 2019.

ANNEX 5 Dynamics in Licensing of NPP Personnel for 2016-2022

Number of NPP experts licensed in 2016–2022 (as of 1 June 2022)							
Entity	2016	2017	2018	2019	2020	2021	2022 As of 1 June 2022
ZNPP	166	159	153	154	152	164	165
RNPP	60	61	64	60	58	56	60
PNPP	110	109	111	114	114	113	115
KhNPP	87	82	77	83	85	88	87
Total	423	411	405	411	409	421	427

Three workplaces at each of the 15 power units are staffed with 27 licensed experts on average working in shifts.

Officials making decisions and dealing with administrative functions associated with nuclear and radiation safety (three officials of the operator’s top management, including president, four officials at each NPP, including plant general directors, their deputies and plant shift supervisors, director general and deputy director of AtomProjectEngineering).

There are 109 licenses issued by the SNRIU for i:

- top-level managers dealing with licensed activities – 18 licenses;
- top-level managers dealing with licensed activities only when they act as deputies of the above officials – 41 licenses;
- plant shift supervisors – 50 licenses.

ANNEX 6 Radiation Safety and Protection Indicators

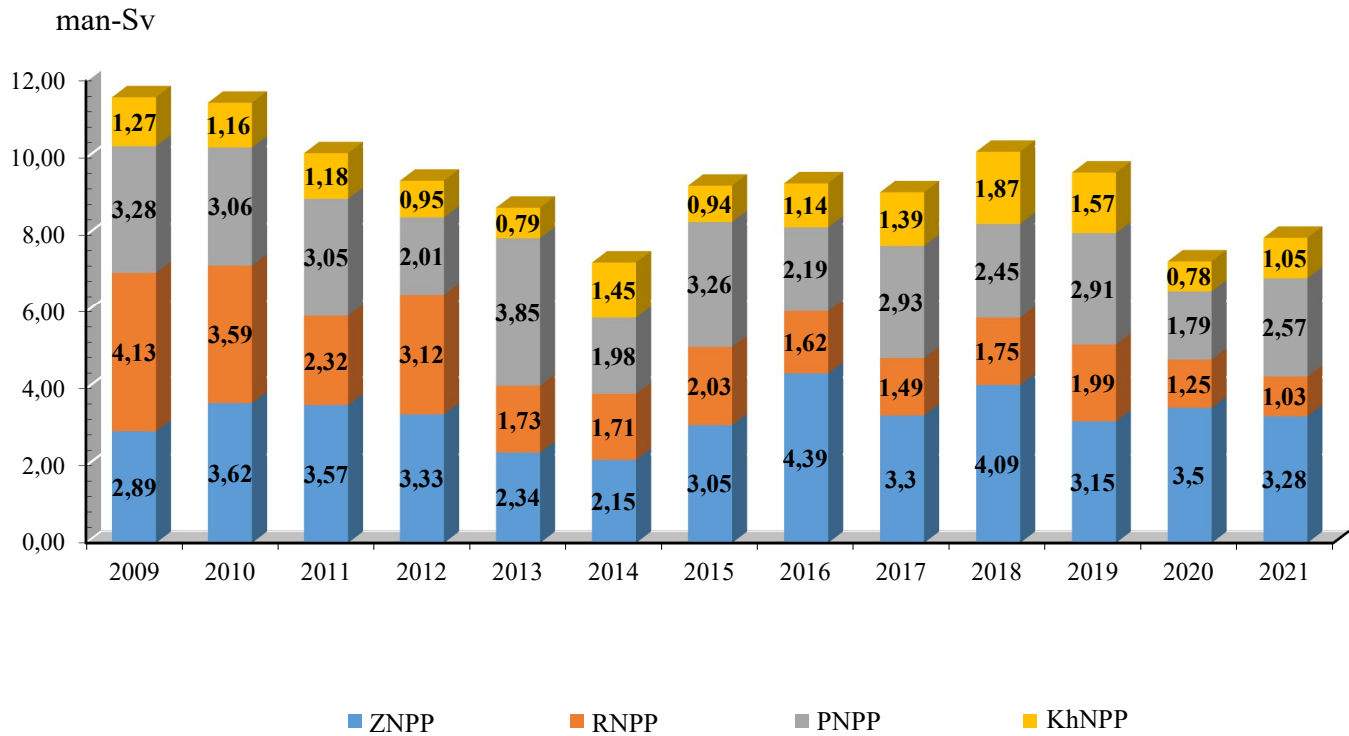


Fig. 1. Collected Doses to WWER NPP Staff (Including Personnel on Assignment) in 2009–2021, man-Sv

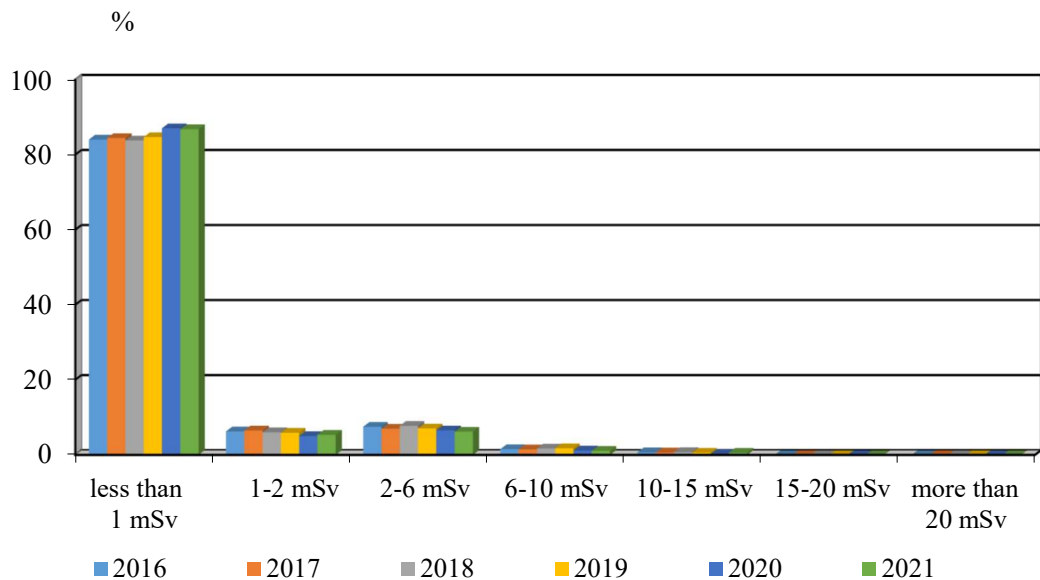


Fig. 2. Percentage of Energoatom NPP Staff Distributed According to Average Individual Doses in 2016-2021

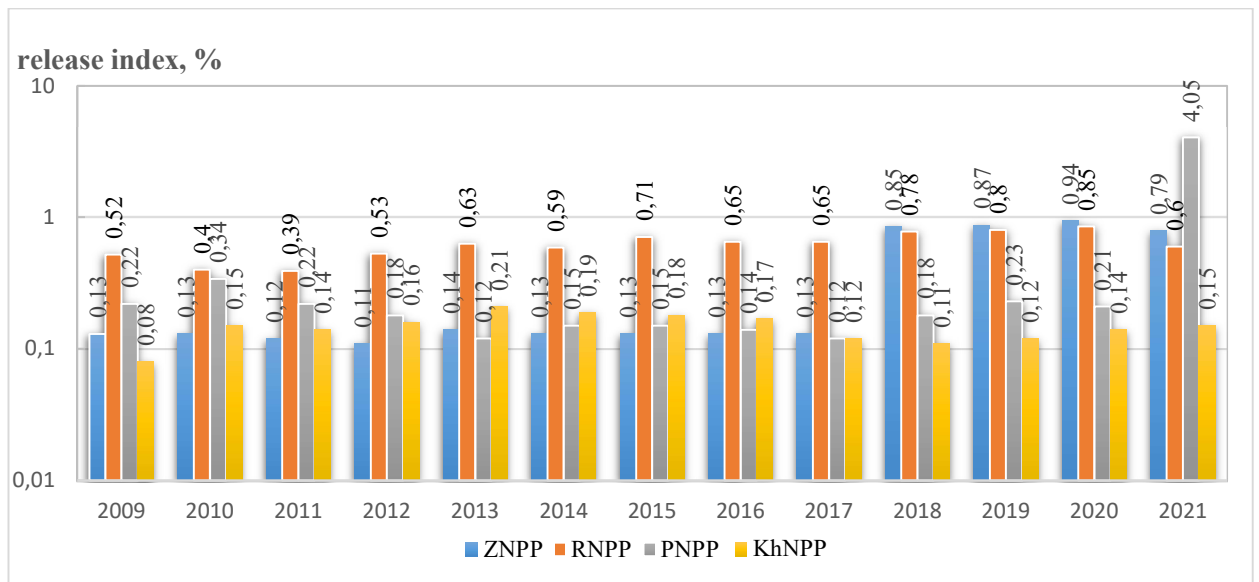


Fig. 3. Dynamics in Total Indicators* for Radioactive Airborne Releases to Environment from Energoatom NPPs for 2009–2021

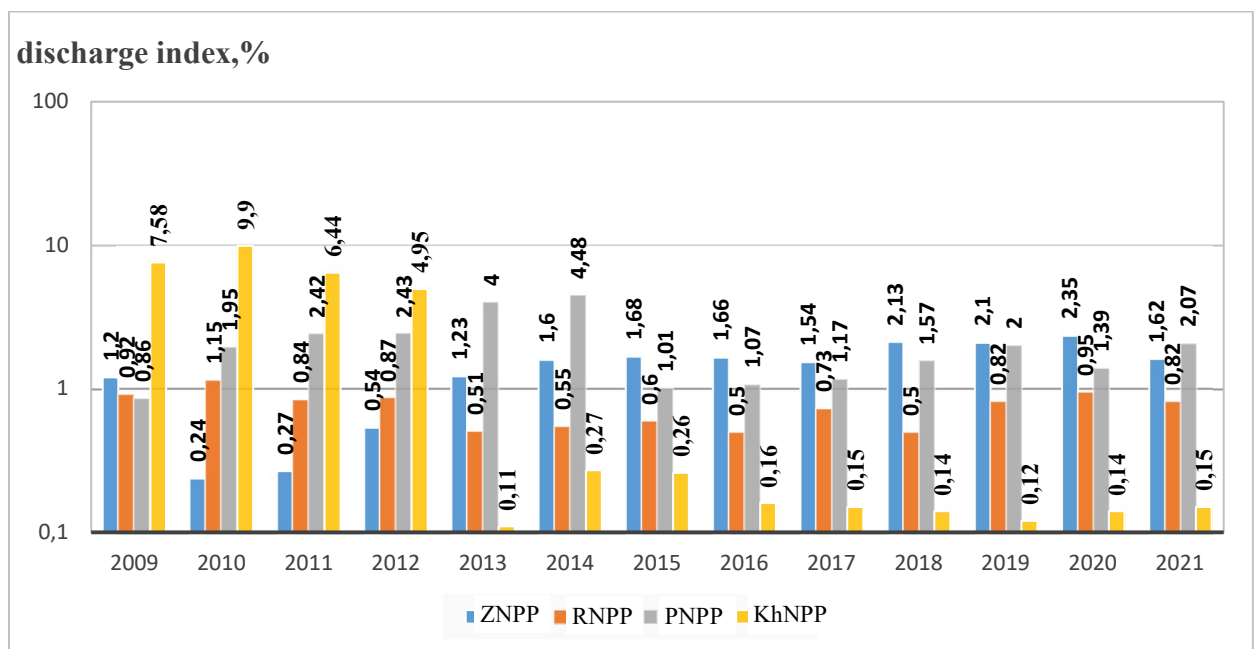


Fig. 4. Dynamics in Total Indicators* for Radioactive Discharges from Energoatom NPPs for 2009–2021

* indicator is the ratio of actual release (discharge) to the permissible value calculated with special methodology allowing for contribution of reference radionuclides

ANNEX 7 Information on Chornobyl NPP

ARTICLE 6. Existing Nuclear Installations

All spent fuel, including damaged fuel from Units 1, 2 and 3, has been transported to ISF-1. The next step of the operator was to agree the decision to declare ChNPP Units 1, 2 and 3 as radioactive waste management facilities in the decommissioning process with the SNRIU. Safety justification of damaged spent fuel placement in ISF-1 is provided in ISF-1 SAR, version 3.02.



Figure 8.1 – Damaged spent fuel in special canisters



Figure 8.2 – Storage of damaged spent fuel in a unified canister/basket for special canisters in the ISF-1 canyon

Interim Spent Fuel Storage Facility (ISF-1)

ISF-1 is a wet spent fuel storage facility and has been in operation since 1986. The operational period of ISF-1 has been agreed until results of the next safety review, which should be completed no later than 31 December 2025, are obtained.

In 2016, damaged spent fuel was transported from Units 1 and 2 to ISF-1 under an individual permit issued by the SNRIU for activities and operations on unloading of damaged spent fuel (DSF) from Units 1 and 2 and its placement into ISF-1 for safe storage.

The transport of spent fuel assemblies from ISF-1 to ISF-2 began in 2021 and there are currently 19,442 SFAs in ISF-1 including:

- 53 damaged SFAs;
- 4 thermometric SFAs;
- 10 measuring SFAs.

The following projects are implemented in compliance with the Plan of ISF-1 Safety Improvement Measures:

- Technical Upgrade of Cable System of Existing Interim Spent Fuel Storage Facility ISF-1;
- Technical Upgrade of ChNPP ISF-1 Lightning Protection System;
- ISF-1 Technical Upgrade to Replace ChNPP Power Equipment, Lighting and Communication Systems and I&C;
- Construction of ChNPP ISF-1 Radiation Monitoring System.

Interim Spent Fuel Storage Facility (ISF-2)

ISF-2 is the key component in the ChNPP decommissioning process. The ChNPP requires long-term storage for spent nuclear fuel, most of which is currently stored in ISF-1. Considering that ISF-1 is a wet storage facility (spent fuel is stored in water) and is not designed for the long-term storage of spent fuel, the transfer of spent fuel from ISF-1 to ISF-2 will resolve the issue of long-term storage of the ChNPP spent fuel.

ISF-2 was constructed through international funds by Holtec International (USA) with the involvement of Ukrainian contractors. ISF-2 meets all modern nuclear safety criteria, including criteria for physical protection of nuclear installations, and is designed for long-term and safe storage of nuclear fuel accumulated over the years of ChNPP operation.

ISF-2 is designed for acceptance, treatment and storage of SFAs (except for damaged thermometric and measuring SFAs) accumulated at ChNPP. ISF-2 will ensure acceptance, treatment and storage of 21,217 RBMK-1000 SFAs for 100 years.

On 26 April 2021, on the 35th anniversary of the Chornobyl tragedy, the SNRIU issued License No. EO 001091 of 23 April 2021 for ISF-2 operation to SSE ChNPP in the presence of President of Ukraine Volodymyr Zelenskyi. The transport of spent fuel at ISF-2 began on 8 June 2021, and currently 1767 SFAs have been placed for storage at ISF-2 and other 75 SFAs are being prepared for long-term storage at ISF-2.

ARTICLE 7. Legislative and Regulatory Framework

2. (ii) System of licensing

Pursuant to Article 7 of the Law of Ukraine "On Licensing Activity in Nuclear Energy", individual activities of ChNPP shall be subject to licensing and are implemented under the following licenses issued by the SNRIU:

- License No. OB 000983 of 4 October 2012 for radioactive material transport, renewed until 17 June 2023;
- License No. OB 010950 (reissued) of 17 July 2015 for use of radiation sources, renewed until 25 April 2024;
- License No. EO 000946 of 12 January 2011 for training of the State Specialized Enterprise Chornobyl NPP personnel at the ChNPP training center for positions: shift supervisor for spent fuel management department and shift supervisor for radiation safety department, renewed until 12 January 2023;
- License No. OB 001092 of 20 May 2021 for treatment and storage of radioactive waste in terms of liquid waste processing, namely operation of the liquid radioactive waste treatment plant, valid until 20 May 2028;
- License No. OB 001093 of 15 July 2021 for activities on training, professional development and skill improvement of experts on physical protection of nuclear installations, nuclear materials, radioactive waste and other radiation sources, valid until 13 July 2024;
- License No. OB 001094 of 12 August 2021 for activities on treatment and storage of radioactive waste that exists and is generated in Shelter transformation into an environmentally safe system within NSC-Shelter operation, valid until 31 December 2033;
- License No. OB 001095 of 30 September 2021 for treatment and storage of radioactive waste in terms of solid radwaste storage, namely operation of ICSRM TSF HLW and LIL-LLW, valid until 31 December 2038;
- License No. OB 001096 of 1 October 2021 for treatment and storage of radioactive waste in terms of solid waste treatment, namely commissioning of the ICSRM solid radwaste retrieval facility and solid radwaste treatment plant, valid until 31 December 2029.

Pursuant to Article 8 of the Law of Ukraine "On Licensing Activity in Nuclear Energy", individual activities of the operator at specific life stages of a nuclear installation

or radioactive waste disposal facility shall be implemented under licenses issued by the SNRIU as follows:

- License No. EO 000040 of 22 March 2002 for decommissioning of Chornobyl NPP Units 1, 2, 3, renewed on 3 November 2020. Individual Permit No. OD 000040/8 of 31 March 2015 for final closure and safe enclosure of Chornobyl NPP Units 1, 2 and 3 was obtained within the license;
- License EO 000859 of 25 June 2008 for operation of Interim Spent Fuel Storage Facility (ISF-1), renewed on 21 June 2020. Individual Permit OD No. EO 000859/1/15 of 21 May 2021 for unloading of conditioned spent nuclear fuel from ISF-1 was obtained within the license;
- License No. EO 001091 of 23 April 2021 for operation of the spent fuel storage facility (ISF-2).

Pursuant to Article 9 of the Law of Ukraine "On Licensing Activity in Nuclear Energy", activities of the operator's officials dealing with administrative functions associated with nuclear and radiation safety are subject to licensing and are carried out under the following SNRIU licenses:

- License No. PO 000053 of 29 January 2013 for position: Technical Director (Chief Engineer), valid until 29 January 2028;
- License No. PO 000054 of 29 January 2013 for position: First Deputy of General Director (Planning and Decommissioning), valid until 29 January 2028;
- License No. PO 000168 of 17 December 2020 for position: Deputy Technical Director (Operation), valid until 17 December 2023;
- License No. PO 000121 of 24 May 2016 for position: Deputy Technical Director (Radwaste Management), valid until 24 May 2025;
- License No. PO 000157 of 11 February 2020 for position: Deputy Technical Director (Infrastructure), valid until 11 February 2023.

In compliance with Article 11 of the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and Article 8 of the Law of Ukraine "On Radioactive Waste Management" and in compliance with Cabinet Resolution No. 1122 of 18 July 1998 "On Approval of Procedure for Public Hearings on Aspects of Nuclear Energy Use and Radiation Safety", public hearings on implementation of the Project on Final Closure and Safe Enclosure of ChNPP Units 1, 2, 3 were held in 2013. The approach to design decisions and established design criteria for Units 1, 2 and 3 prior to the safe storage stage proposed by the operator was approved by public representatives and experts involved in discussion.

ARTICLE 10. Priority to Safety

Priority to safety in the construction and operation of nuclear installations is established in the Law of Ukraine "On Nuclear Energy Use and Radiation Safety" and declared by Chornobyl NPP top management in quality and safety policy statements. The statements are an integral part of the enterprise general policy and have been brought to notice of all personnel, published in the mass media and made available on ChNPP website <https://chnpp.gov.ua/ua/about/application-guide/zaiavy-kerivnytstva>.

ARTICLE 11. Financial and Human Resources

Financial resources

The budget program for keeping the power units and Shelter in safe state and measures for Chornobyl NPP decommissioning are financed annually from the State Budget of Ukraine.

The Law on State Budget of Ukraine for a specific year envisages an individual line for allocation of funds to prepare the ChNPP units for decommissioning, as well as allocation of funds for Shelter transformation into an environmentally safe system.

The main priority in financial planning is given to measures to prevent decrease in the safety level achieved.

Human resources

A special subdivision, training center, was established to exercise the SSE ChNPP policy in the field of training, re-training and professional development.

In compliance with regulatory requirements of Ukraine, the training center performs its functions under the following licenses and permits issued for:

- training of operating personnel taking into account peculiarities of each stage of plant decommissioning and related administrative and technical safety measures (under SNRIU License EO 000946 for personnel training at the training center);
- training on safe methods for hazardous operations and activities in the framework of the Shelter Implementation Plan (under the certificate of the State Committee of Ukraine for Industrial Safety, Occupational Safety and Mining Supervision);
- vocational training on the most important specialties required for ChNPP on-site activities such as health physicists, radwaste processors, riggers and welders (under a license of the Ministry for Education and Science of Ukraine);
- psychological support of professional activities of Chornobyl NPP personnel involved into SIP (under the certificate of the National Academy of Education for psychological and psychophysiological diagnostics of personnel).

The contractors' personnel involved into Shelter-related activities are trained in accordance with a specially developed and approved program covering all safety aspects of activities in conditions of increased radiation and nuclear risks. The contractor's personnel may perform activities only if they have successfully passed examination of their knowledge, as confirmed by respective documents.

ARTICLE 12. Human Factor

In accordance with the Action Plan on Safety Enhancement of Chornobyl NPP Nuclear Installations agreed by the SNRIU in the area of personnel training:

- emergency exercises are conducted over the year for personnel of all shifts, including training of skills in situations associated with numerous failures of regular systems and equipment in extreme natural conditions;
- personnel to be accepted to ChNPP emergency teams undergo psychophysiological examination to select the individuals able to successfully manage and mitigate severe accidents;
- training programs on psychology of activity in extreme conditions were developed for operating personnel, mid-level managers and emergency personnel to improve

their resistance to psychological stresses, self-control, interaction and mutual assistance under mitigation of emergencies and management of accidents.

Operator's self-assessment of administrative and organizational issues

Chornobyl NPP management carries out assessment of administrative and organizational decisions on a permanent basis in compliance with the plant procedures. In particular, when organizational changes are introduced, each change is ranked according to safety impact (category of safety impact is defined) and safety-important organizational changes are analyzed depending on their safety category. When administrative decisions are implemented, all measures for risk reduction are taken in compliance with the approved safety impact assessment, full responsibility for compliance with safety requirements and their observation being assumed.

ARTICLE 13. Quality Assurance

In accordance with Ukrainian regulatory requirements and IAEA standards and recommendations, the SSE ChNPP uses a process-oriented management approach. The process-oriented integrated management system covers all enterprise activities and promotes management's quality policy for the performance of SSE ChNPP tasks.

The operator's management staff consider the quality policy as their direct obligation, contributing to continuous improvement of the management system, which requires appropriate efforts and resources and is based on assessment of internal and worldwide results. To assure the public that SSE ChNPP activities are carried out in a safe manner, management staff declare their adherence to safety assurance principles and consider all activities to be subject to QMS.

Key components of SSE ChNPP management system are as follows:

- working quality council – collegial body for making managerial decisions on quality assurance;
- there are currently 18 high-level processes, 60 processes of level one and 2 processes of level two at the enterprise. Respective monitoring and measuring methods are applied to all processes for their efficient management, including analysis of progress in each process, registration of deviations and adoption of decisions to develop corrective and preventive actions;
- quality programs developed and introduced first of all for the processes and activities that influence safety, including quality programs for safety of spent fuel management and radioactive waste management. Requirements of standards and regulations governing management of the operator's activities, licensing terms, etc. are input data for the development of quality programs. The quality programs include success criteria and types of monitoring over processes or operations and demonstrate how the existing management system is applied to a specific case, project or contract;
- independent assessment of the management system and its components to define the effectiveness of processes, compliance with safety and quality requirements, capabilities to improve the management system, including audits of ongoing processes and individual aspects;
- audits of the suppliers' QMS, first of all for safety-related systems to confirm the suppliers' ability to ensure compliance of their products with respective requirements.

The highest priority of SSE ChNPP is to ensure protection of personnel, the public, future generations and the environment against radiation effects in implementation of its activities.

The General Quality Guideline of the SSE Chornobyl NPP is the basic document within QMS, identifying SSE ChNPP objectives and tasks and describing the existing QMS and interactions between basic SSE ChNPP processes and responsibilities on continuous improvement of the management system. This document is submitted to state regulatory bodies to obtain licenses and permits.

The improvement of the process-based approach in the existing management system is ongoing. Further transfer from functional to process-based system involves changes in the structure, allocation of functions and interaction between subdivisions, with a focus on new aspects of managerial activities.

The ChNPP top management realizes their liability towards the society for negative results of ChNPP decommissioning and Shelter transformation into an environmentally safe system.

To reduce the impact of potential risks that, under certain circumstances, can affect production and financial results, social and natural environment and compliance with the DSTU ISO 9001:2015 requirements, the SSE ChNPP has a risk and opportunity management system aimed at implementation of strategies and plans and achieving the QMS effectiveness. Implementation of this system shall provide confidence that the management system can achieve planned results and improvements and increase the number of desired effects.

ARTICLE 14. Assessment and Verification of Safety

In compliance with the State Program for Chornobyl NPP Decommissioning and Shelter Transformation into Environmentally Safe System (approved by Law of Ukraine No. 886-VI of 15 January 2009), in relation to removal of spent fuel from the power units and compliance with schedule for ChNPP decommissioning, SAR for ISF-1 was completed in 2015. This report justifies the safe placement and storage of special canisters with damaged spent fuel in ISF-1.

The technical design "Equipment and Technology for Stabilization, Transfer and Storage of Special Canisters with Damaged Spent Fuel" provides for placement of special canisters with damaged spent fuel in the ISF-1 canyon. Removal of damaged spent fuel from Units 1, 2 allowed the ChNPP to become less dependent on ISF-2 implementation in decommissioning activities.

ARTICLE 15. Radiation Protection

In the reporting period, in December 2021, two cases of exceeding the reference level of the individual annual external exposure dose of 13 mSv established for category 1 workers were recorded among ChNPP personnel. The external exposure doses received by construction workers since the beginning of the year were 19.30 mSv and 13.83 mSv. This exceeding the reference level of the individual annual external exposure dose was investigated. Based on the investigation results, a report was drawn up, which, according to the established procedure, was sent to the Ministry of Health of Ukraine, State Food and Consumer Service in the Kyiv region and to the Nuclear and Radiation Safety Inspectorate in the Exclusion Zone (as an independent division).

The dose limits, reference levels of skin exposure (H_{skin}) and lens exposure (H_{lense}) dose established for ChNPP personnel were not exceeded within three years.

The collective and individual doses to SSE ChNPP personnel were as follows in 2019-2021:

Year	Collective, mSv	Average, mSv
2019	2782.35	1.02
2020	2346.24	0.92
2021	2192.18	0.89

The reference level of individual equivalent dose to personnel was 13 mSv in 2019-2020, in 2021, as agreed by the Ministry of Health of Ukraine, the reference levels of individual equivalent exposure doses to ChNPP personnel were set according to personnel belonging to the cohorts and were: 13 mSv - for cohort 1 and 5 mSv - for category 2.

In general, there is a tendency to stabilization of the monitored level of air contamination. In the reporting period, the radioactive airborne activity in the Chornobyl NPP rooms and adjacent territories was within appropriate ranges and did not exceed the reference levels.

Airborne releases of long-lived nuclides from all ChNPP sources (Ventilation Stack-1, new ventilation stack, ventilation stack of the new safe confinement, liquid waste storage building, ISF-1, ISF-2, liquid radwaste treatment plant, industrial complex for solid radwaste management).

Radionuclide	MAX release, kBq/month		
	2019	2020	2021
⁹⁰ Sr	3.86E+3	1.04E+4	4.00E+3
¹³⁷ Cs	1.29E+4	3.86E+4	1.68E+4
⁶⁰ Co	2.56E+1	2.31E+2	3.55E+2
α-emitting radionuclides	2.34E+1	2.88E+2	1.08E+3

Reference levels are established for each source of airborne releases. Reference levels of airborne radioactive releases to the environment were not exceeded in the reporting period.

The ChNPP radioactive substances are not discharged into natural water reservoirs. Currently, the activity of the industrial sewage system drains discharged into the service water pond results mainly from washing of residual accident-related contamination with storm and melt waters.

Radioactive discharges into SSE ChNPP service water pools were as follows:

		Discharge, GBq/year				
		2019	2020	2021	Reference level GBq/year to 30 September 2020	Reference level GBq/year from 1 October 2020
¹³⁷ Cs		1.9	2.58	15.52	45.5	21.0

⁹⁰ Sr		4.0	1.72	6.1	14.0	14.0
α-emitting radionuclides		0.015	0.015	0.016	0.46	0.1

ARTICLE 16. Emergency Preparedness

The ChNPP emergency preparedness and response system is an integral part of the emergency preparedness and response system of the SESU.

The SSE ChNPP Response Plan to Accidents and Emergencies is the main guiding document to arrange and implement organizational, engineering and technical, radiation health & safety, evacuation and other measures to reduce the impact of radiation on personnel and the environment in the event of an accident or emergency at the ChNPP.

Exercises and training are periodically conducted at the ChNPP to check operation and preparedness of the system for actions in case of emergencies.

The main ChNPP organizational structures carry out all activities related to emergency planning, emergency preparedness and response in case of an accident or emergency at the ChNPP.

The ChNPP emergency organizational structures include:

- emergency response manager on sites of ChNPP facilities;
- coordination and control body – staff of emergency response manager or ChNPP emergency commission;
- permanent control body – emergency preparedness and response department;
- emergency teams and groups.

The ChNPP site is equipped with two protective buildings to protect personnel. One of the buildings houses the ChNPP on-site emergency center for mitigation of emergencies.

ARTICLE 17. Siting

i) Evaluation of site-related factors.

In 2011, the operator performed the targeted extraordinary safety assessment of ChNPP Units 1, 2, 3 and ISF-1 with regard to external hazards that lead to failure of the main safety functions and, consequently, to severe accidents (beyond design basis accident involving nuclear fuel damage). Based on the main conclusions, extreme natural hazards are ranked as follows:

- 1) Earthquake and tornado are the most hazardous for ChNPP nuclear installations.
- 2) Extreme wind, snow, rain and temperature are less hazardous since:
 - effect of extreme wind, snow and rain is significantly lower than that of tornado;
 - buildings of nuclear installations have high heat retention capability;
 - temperature control in rooms is kept, snow is removed and storm water sewage system is in function.
- 3) External flooding and fire are not hazardous for ChNPP nuclear installations since:
 - elevations of the ChNPP site (113.7–114.0m) are significantly higher than the extreme water level (111.3m);
 - the distance from the area of a potential significant fire to nuclear installations is more than 1 km, and the nuclear installation sites are provided with hard pavement, concrete enclosures, etc.

ii) Safety impact of nuclear installations on individuals and the environment.

In accordance with regulatory requirements, the ChNPP monitors controlled radioactive airborne releases to the atmosphere and radioactive discharges.

Controlled airborne releases to the atmosphere are organized at the ChNPP through:

- ventilation stack of stage 1 and new ventilation stack of stage 2 of the ChNPP main building;
- stacks of liquid radwaste storage building and ISF-1.

Information on radiation monitoring of radioactive releases and discharges into the environment is submitted to the regulatory bodies and mass media on a monthly and quarterly basis, respectively.

iii) Re-evaluation of site-related factors.

After removal of spent fuel from Units 1-3 (including damaged fuel at Units 1-2), the nuclear installations in decommissioning will be regarded as radioactive waste management facilities, allowing the operator to intensify decommissioning of Units 1-3 and focus efforts on nuclear safety of ISF-1.

For this purpose, a series of technical decisions have been implemented over the last three years to ensure safe storage of all spent fuel, including damaged fuel, at ISF-1 for normal operation and design-basis accidents caused by extreme natural hazards.

Achievement of these objectives was confirmed by the extraordinary safety reassessment of ISF-1 in 2015. ISF-1 can withstand external hazards, including safe shutdown earthquake of magnitude 6 and F 1.5 tornado and has a safety margin not lower than magnitude 7.6 for pool lining in an earthquake.

ARTICLE 19. Operation

In the reporting period, the ChNPP assessed ISF-1 safety and proved that all conditioned (undamaged) and damaged spent fuel could be safely stored in ISF-1. The safety assessment justified that spent fuel and damaged fuel would not be transferred to ChNPP Units 1 and 2 in case of leakage in a spent fuel pool compartment or ISF-1 canyon. This allows change in the status of Units 1 and 2 from hazardous facilities to radioactive waste management facilities. The unloading of special canisters with damaged spent fuel from Units 1 and 2 accelerated ChNPP decommissioning.

The operational limits and safe operation conditions are monitored by ChNPP operating and engineering personnel.

All personnel involved into safety-related activities shall undergo occupational selection, training and examination of knowledge by examination commissions. The documentation required for these purposes is ensured by the quality system existing at the enterprise. The workplaces of operating personnel are provided with the required documents (regulations, production and emergency procedures) and engineers and technicians have access to the electronic base of these documents.

In order to limit degradation of safety-related structures, systems and components (induced by ageing, wear, corrosion etc.) and to maintain their operability and reliability in operation, equipment ageing management programs and an action plan to improve safety of the ChNPP nuclear installations were developed, agreed with the SNRIU and implemented at the ChNPP.

Following the Fukushima Daiichi accident and based on WENRA technical specifications and SNRIU recommendations, a targeted safety assessment of spent fuel storages was carried out. The worst scenarios and their combinations were analyzed to identify the most probable major safety risks. To increase robustness of ISF-1 in case of

external hazards, ensure safety in station blackout conditions and extend accident management and mitigation capabilities:

- ISF-1 was equipped with an independent mobile back-up power source;
- organizational and technical measures were identified and implemented to connect a mobile diesel generator station to the ISF-1 power supply system without changing the existing electrical diagram;
- respective changes were introduced to the Guideline for Management of Beyond Design Basis Accidents at Chornobyl NPP Units 1, 2, 3 and ISF-1 (109P-S).

Engineering and technical support

The ChNPP ensures continuous engineering and technical support through permanent communication with:

- Kyiv Research and Design Institute *Energoproekt* (general designer);
- Institute for Safety Problems of Nuclear Power Plants, National Academy of Sciences of Ukraine (research supervisor).

The SSE ChNPP continues operation of the system for information support to Chornobyl NPP decommissioning. The information support system is being supplemented with data on the state of ChNPP facilities and equipment. The structure of various objects (buildings, structures, rooms, etc.) was developed for the system and data on 387 process systems and about 20,000 pieces of ChNPP equipment were introduced.

Under cooperation with the Norwegian Institute for Energy Technology, the ChNPP created a ChNPP decommissioning visualization center. The center's objective is to introduce virtual reality technologies and technologies for three-dimensional modelling and visualization to improve effectiveness and safety of ChNPP decommissioning operations.

Notification of incidents

The procedures to inform the regulatory body were developed in compliance with the Provisions on the Procedure for Investigation and Accounting of Operational Events at Nuclear Power Plants (NP 306.2.100-2004) and agreed with the regulatory body.

Analysis of operating experience feedback

The ChNPP ensures collection, processing, analysis and storage of information on equipment failures and human errors, as well as summarizes and promptly submits the information obtained. Information on equipment failures and human errors is incorporated into the quarterly safety reports. Operating experience is analyzed carefully. The data are used to maintain qualification of operating personnel and plant management and considered in the development of emergency training programs. Information on significant events is regularly submitted to Energoatom and WANO based on bilateral information exchange.

Spent fuel and radwaste management on site

Radwaste management at the SSE ChNPP site is implemented according to the following SNRIU licenses:

- License EO No. 000040 issued on 22 March 2002 for decommissioning of ChNPP Units 1, 2, 3;
- License issued on 12 August 2021 for processing and storage of radioactive waste existing and generated in Shelter transformation into an environmentally safe system within NSC-Shelter operation;

- License No. OV 001092 issued on 20 May 2021 for operation of the liquid radwaste treatment plant (LRTP);
- License No. OV 001095 issued on 30 September 2021 for operation of the temporary storage facility for group III solid waste (high-level waste), low- and intermediate-level long-lived waste (TSF HLW and LIL LLW) of the industrial complex for solid radioactive waste management (ICSRM);
- License No. OV 001096 issued on 1 October 2021 for commissioning of the ICSRМ solid waste retrieval facility (SWRF) and liquid radwaste treatment plant (LRTP).

In the framework of international technical assistance rendered to Ukraine for ChNPP decommissioning, the following projects on construction of ChNPP radioactive waste management facilities were implemented: liquid radwaste treatment plant (LRTP), facilities of industrial complex for solid radwaste management (ICSRM), long-length radwaste cutting facility. These facilities shall ensure removal of accumulated radwaste from the facilities existing at the ChNPP, radwaste treatment to the condition acceptable for temporary storage and disposal, and safe disposal of radwaste packages in the near-surface facility and temporary storage of long-lived and high-level radwaste to be disposed of in a geological repository.

ChNPP obtained SNRIU License OV No. 001092 of 20 May 2021 for processing and storage of radioactive waste in terms of waste processing, namely operation of the liquid radioactive waste treatment plant.

At the moment, the liquid radioactive waste treatment plant is at the operation stage. Currently, liquid radioactive waste (evaporation bottom) is being processed at the facility. At the end of 2021, 788.01 m³ of radwaste were processed, 8677 were formed and 8335 radwaste packages were sent for disposal in the engineered near-surface disposal facility.

ChNPP obtained SNRIU License No. OV 001096 of 1 October 2021 for processing, storage of radioactive waste in terms of processing solid radwaste, namely, commissioning of a solid radwaste retrieval facility and industrial complex for solid radwaste management.

The industrial complex for solid radwaste management is at stage 3 of hot tests.

According to the “Work Program for Hot Tests Stage 3 of ICSRМ”, 78PR-TsORO, the management of two radwaste flows is provided:

- Flow No. 1 (compacted solid radwaste) – solid radwaste retrieved by SWRF from the upper meter layer of the eastern light solid radwaste storage facility;
- Flow No. 2 (low- and intermediate-level short-lived waste, not compacted or incinerated) - from ChNPP facilities external to LRTP, namely: carbon steel from the turbine hall of the equipment and system dismantling site and systems in building No. 2 of the stage 1 main building of block G.

ChNPP obtained SNRIU License No. OV 001095 of 30 September 2021 for processing, storage of radioactive waste in terms of storage of solid radwaste, namely, operation of the temporary storage facility for group III solid waste (high-level), low- and intermediate-level long-lived waste of the industrial complex for solid radwaste management.

In compliance with the extended program for the second stage of ICSRМ hot tests and based on the decision on temporary storage of high-level waste in the interim storage facility for low- and intermediate-level long-lived waste and high-level waste, Building 84, SRTP performs the repackaging of HLW accepted from the interim storage facility for solid high-level waste with subsequent placement for temporary storage in the interim storage facility for low- and intermediate-level long-lived waste and high-level waste in Building 84 of the liquid and solid waste storage facility. As of 1 June 2022, 38 packages

of HLW, 11 packages of LLW and 4 packages of dummy solid waste are in temporary storage in the LILW and HLW facilities.

The Project “Creation of a Facility for Release of Materials from Regulatory Control at ChNPP” (U4.01/11E, this project is continuation of Project U4.01/10E that is also financed by the European Commission) is performed within international technical assistance to implement the procedure for the release of radioactive materials from regulatory control at ChNPP.

The equipment required to create the release facility shall be designed, manufactured and supplied to the ChNPP site. In the framework of the contract, it is envisaged to perform equipment installation. Acceptance tests, certification and licensing and training of NPP personnel involved in operation of the facility are also planned. An up-to-date facility for the release of materials from regulatory control shall be created at ChNPP during Project U4.01/11E. This facility will allow justifying the release of different materials from regulatory control with the help of spectrometric measurements.

ChNPP Order No. 1348 dated 29 September 2020 “On the Trial and Commercial Operation of the Facility for the Release of Materials from Regulatory Control” under the Program for Trial and Commercial Operation of the Facility for the Release of Materials from Regulatory Control”, 18PR-TsRB, inventory No. TV 63 of 29 September 2020.

Report on the Trial and Commercial Operation of the Facility for the Release of Materials from Regulatory Control was sent to SNRIU by letter No. 4824/05010000-2021 dated 22 November 2021.

SNRIU, involving the State Scientific and Technical Center for Nuclear and Radiation Safety (SSTC NRS), performed the state nuclear and radiation safety review of ChNPP document “Report on the Trial and Commercial Operation of the Facility for the Release of Materials from Regulatory Control” and submitted the document by letter No. 24-15/4760-17675 dated 22 April 2022.

At present, ChNPP is working out the SNRIU and SSTC NRS comments stated in the conclusion.

ANNEX 8 Information on the NSC-Shelter

The Shelter, a unique facility in the world practice, occupies a special place among the nuclear facilities of Ukraine. It is ChNPP Unit 4 that was destroyed in 1986 in a beyond-design-basis accident and lost all functional characteristics as a power unit. Immediate measures were taken at Unit 4 to mitigate the accident consequences, and activities are under way to ensure monitoring of its condition.

The Shelter was not constructed in compliance with regulations for siting, design, construction, commissioning, operation and decommissioning of nuclear installations. The Shelter current condition does not and cannot comply with nuclear safety regulations or general industrial safety requirements.

The Shelter in its current state is qualified as a place for surface storage of uncontrolled radwaste (temporary storage for uncontrolled radwaste in stabilization and reconstruction stage). All nuclear and radioactive materials located inside the Shelter are thus regarded as radioactive waste. Activities at the Shelter are regulated in compliance with its qualification specified by NRBU-97/D-2000, based on nuclear and radiation safety regulations in force.

Various modifications of fuel-containing materials amounting to approximately 200 tons (in accordance with conservative estimates) are located in the Shelter. Since there are no technical features to control their criticality, there is a potential risk of a self-sustained chain fission reaction.

Great volumes of the accident-origin radwaste with a total activity of about $5.6E+17$ Bq are located inside the Shelter without reliable protective barriers and thus represent unsealed radiation sources.

The installation and sealing of the arch, commissioning of the new safe confinement reduced potential danger for the public and the environment but the hazard remains significant for personnel involved in Shelter transformation.

In 2021, the SNRIU issued license for processing, storage of radwaste existing and generated during Shelter transformation into an environmentally safe system within NSC and Shelter operation No. OV 001094. In compliance with the license terms, the objective of any activity at the Shelter (including Shelter transformation into an environmentally safe system) is to protect personnel, the public and the environment against adverse effects of radioactive materials located in the NSC-Shelter. Any activity implemented at the Shelter for another purpose is prohibited.

According to the license terms taking into account:

- results of trial and commercial operation of NSC Commissioning Stage 1;
- comments indicated in the conclusion of the state NRS review for SAR of the NSC-Shelter;
- updating information and analyzes on Shelter condition;
- provision of all interconnections between structures and systems that are part of the NSC-Shelter;
- consideration of issues related to further activities (stages) of Shelter transformation into an environmentally safe system and justification for this activity.

SSE ChNPP plans to submit the updated/revised Report on the Safety Analysis of NSC-Shelter Operation to SNRIU by 21 December 2022.

For reference: in compliance with the Memorandum of Understanding between the Government of Ukraine and G7 Governments and European Commission on Chornobyl NPP Closure signed in December 1995, the recommended course of actions was developed

and envisaged the following three action phases to transform the Shelter into an environmentally safe system:

- Phase 1 - stabilization and other short-term measures.
- Phase 2 - preparation for transformation into an environmentally safe system.
- Phase 3 – transformation into an environmentally safe system.

In interaction between the European Commission, USA, Ukraine and international expert team, the Shelter Implementation Plan (SIP) was developed in August 1997 based on the first two phases of the recommended course of actions.

The SIP goal is to construct the New Safe Confinement (NSC), a protective structure including process equipment for removal of fuel-containing materials from destroyed Unit 4 of the ChNPP and radioactive waste management and other systems designed to transform the Shelter into an environmentally safe system and ensure safety of personnel, the public and the environment and to dismantle unstable structures.

The SIP envisaged implementation of 22 tasks in total and overall project management.

At the moment, 19 tasks have been completed, one task is ongoing and two tasks have been postponed to a later period.

First-priority measures to stabilize the Shelter structures were completed in full scope in 2008. The stabilization measures ensured an appropriate level of Shelter stability (as an intermediate level in gradual Shelter safety improvement), which can be considered acceptable for 15 years (approximately until 2023). The issue of Shelter unstable structures shall be further solved by their dismantling or reinforcement inside the NSC.

The following main infrastructure facilities were commissioned in the framework of SIP: training center for Shelter personnel, small and large construction sites to implement the NSC project, facility for decontamination of small equipment and tools, changing facility for 1430 persons, airlock at elevation +5.800, off-site utilities for the SIP infrastructural facilities. The modernized dust suppression system and integrated Shelter database were commissioned.

The Shelter fire protection system and physical protection and access control system were commissioned and the new ventilation stack of ChNPP Stage 2 was completed in a period from 2010 to 2012.

In 2016, an individual permit was issued for operation of the integrated automated system for nuclear, radiation, seismic and Shelter structural monitoring.

At the beginning of 2019, civil structures that act as NSC enclosure were put into operation in the framework of ChNPP Stage II.

Upon completion of the tender process and in compliance with decisions of the Chernobyl Shelter Fund Donors Assembly and EBRD “non-objection” to sign the contract, the Contract between the SSE ChNPP and tender winner, NOVARKA Joint Venture (France), for NSC design and construction was signed on 23 August 2007.

At the beginning of 2013, state review of the project for the NSC SS-1 was completed and SNRIU issued an individual authorization for NSC SS-1 construction and installation on 22 April 2013.

In April 2019, after successful trial operation of almost all equipment and systems within 72 hours, the Contractor (NOVARKA Joint Venture) transferred the constructed NSC SS-1 to the Customer (SSE ChNPP) as the facility ready for operation.

On 10 July 2019, the Contractor and SSE ChNPP signed the “Acceptance Certificate for all NSC SS-1 Facilities”.

Further steps of commissioning the NSC SS-1 were completed in compliance with Resolution of the Cabinet of Ministers of Ukraine No. 305 dated 26 April 2017 “On the

Approval of the Procedure for Commissioning the New Safe Confinement Commissioning Stage 1”:

On 27 September 2019, the “Certificate of Facility Preparedness for Operation” was signed, whose commission included representatives of ChNPP, Contractor and designer (NOVARKA Joint Venture), ChNPP trade union organization, expert group for increasing investment attractiveness in the construction sector, Ministry of Ecology and Natural Resources of Ukraine, Fire Safety Department of the State Emergency Service of Ukraine, Department for Support of the Civil Protection Rescue Service of the State Emergency Service of Ukraine, Main Department of the State Labor Service, Ministry of Health, SNRIU, State Agency on Exclusion Zone Management, Ministry of Energy and Environmental Protection.

A Certificate of the State Architectural and Construction Inspectorate of Ukraine was issued on 20 November 2019.

ChNPP Order No. 1880 dated 18 December 2019 placed the NSC SS-1 on the balance sheet of the SSE ChNPP.

After preparing a package of documents by the SSE ChNPP that were attached to the application for putting the NSC SS-1 into trial and commercial operation, on 24 July 2020, an Individual Permit (OD No. 000033/12) was obtained for the NSC SS-1 trial and commercial operation.

In order to fulfill the requirements of para. 3.8.2 of License Series EO No. 000033 dated 30 December 2001 and upon the Individual Permit for trial and commercial operation of the NSC SS-1, starting from 30 July 2020 to 14 June 2021 in accordance with the “Program for Trial and Commercial Operation of the NSC SS-1”, ChNPP personnel conducted trial and commercial operation.

After NSC SS-1 trial and commercial operation during 2020-2021, in August 2021, the SSE ChNPP obtained the license for processing, storage of radioactive waste that exists and is generated during Shelter transformation into an environmentally safe system (operation of the NSC-Shelter).

In order to implement further steps for Shelter transformation into an environmentally safe system, in accordance with the “Shelter Transformation Strategy” approved by the decision of the interdepartmental commission for comprehensive solution of ChNPP issues No. 2 dated 12 March 2001, in terms of dismantling and strengthening unstable structures based on the necessary justification and design documents, after NSC SS-1 commissioning, the SSE ChNPP performed the following steps

In 2019, the SSE ChNPP signed Contract No. 97 for construction activities for the “New Safe Confinement (NSC). Commissioning Stage (CS-2). Dismantling of ChNPP Shelter Unstable Structures in Terms of Early Dismantling” with LLC “BK UKRBUDMONTAZH” (including design, review, construction, architectural supervision).

Due to the lack of funding and, accordingly, the lack of funding for activities under Contract No. 97, the SSE ChNPP was forced to exercise its rights under the unilateral cancellation of Contract No. 97. Therefore, Contract No. 97 dated 29 July 2019 is considered terminated from 16 August 2020.

In order to prevent the stoppage of activities on implementing the NSC SS-2, in 2021, the SSE ChNPP signed Contract No. 823-114 on the procurement of activities to develop a working project for the “New Safe Confinement (NSC). Commissioning Stage 2 (CS-2). Dismantling of ChNPP Shelter Unstable Structures in Terms of Early Dismantling” with LLC “UTEM-ENGINEERING”.

The first stage of the project provides a survey of unstable structures. Based on the survey results, a report establishing safety improvement measures for the confining building based on service life extension for unstable structures after 2023 will be developed.

Taking into account the importance and need to start the early dismantling of Shelter unstable structures as soon as possible, the SSE ChNPP simultaneously plans to conduct a separate purchase of construction activities for the “Shelter Reconstruction in Terms of Dismantling the Metal Truss for Strengthening the Southern Roof”, whose objective is to dismantle the metal truss uniting the Southern shields and Southern shields. This project has passed all the necessary reviews and approvals. In order to reduce the financial burden, the SSE ChNPP decided to divide the scope of activities into two stages of activities:

1. Design, manufacturing, supply, installation and commissioning of equipment to dismantle Shelter unstable structures that is hung on a mobile instrumentation platform of the NSC main crane system
2. Physical work to dismantle the metal truss.

The safe confinement as a multifunctional facility with a service life of 100 years allows the removal of fuel-containing materials and high-level waste from the Shelter in future. Waste conditioning to ensure further safe storage in compliance with legislation in force shall primarily rely on a national decision to create a geological repository in stable geological formations.

The Shelter transformation into an environmentally safe system requires involvement of significant financial and material resources as well as international assistance to solve these comprehensive issues.